Genuine Progress Index for Atlantic Canada / Indice de progrès véritable - Atlantique

MEASURING SUSTAINABLE DEVELOPMENT

APPLICATION OF THE GENUINE PROGRESS INDEX TO NOVA SCOTIA

THE GPI TRANSPORTATION ACCOUNTS: SUSTAINABLE TRANSPORTATION IN NOVA SCOTIA

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EXECUTIVE SUMMARY

GPI*Atlantic* is constructing an index of sustainable development for Nova Scotia: the *Genuine Progress Index* or *GPI*. This report on sustainable transportation constitutes one of the 20 core social, economic, and environmental components of this index. This document is intended to provide indicators for assessing the long-term sustainability of transportation systems and the resources on which they rely, with particular application to Nova Scotia but with wider applicability beyond this jurisdiction. These indicators, like all those in the Genuine Progress Index, are based on the clear objectives of preventing harm and providing benefit both to current and future generations of humanity and to the natural world. In conjunction with these indicators, this report includes estimates of the true or full economic, social, and environmental impacts of current transportation activities. Together, they can help evaluate the efficiency and equitable functioning of existing transportation systems, and identify possible policy and planning reforms that can help create a more sustainable transportation system and economy.

GPI*Atlantic*'s evaluation methods typically begin with assessments of trends (i.e. quantifiable information on physical impacts over time, such as changes in vehicle-kilometres travelled, accident rates, or the volume of greenhouse gases emitted). Where possible and appropriate, the analysis then monetizes (measures in monetary values) these physical impacts to help quantify the full value of social, economic, and environmental impacts in a format that allows convenient comparison, evaluation, and assessment of economic efficiency.

This report comprises six main sections. Part I provides an introduction to and background on the Genuine Progress Index, as well as a discussion of **GPI***Atlantic*'s working definition of sustainable transportation. Part II sets out the goals, objectives, and indicators used to evaluate Nova Scotia's transport sector. Part III—the main section of the report—presents findings for 17 key indicator categories assessing the sustainability of the province's transportation system. Part IV is a quantitative assessment of the economic costs of road transportation in Nova Scotia (insufficient data were available for a similar evaluation of other transport modes). This section provides estimates for 15 cost categories, many of which go unexamined in standard transportation accounting. Finally, in Part V, a set of recommendations to improve transportation system sustainability is presented, based on this comprehensive analysis of impacts and on the evidence presented in this study.

Although this report focuses on Nova Scotia, it provides a potential template for the country as a whole and for other jurisdictions that are interested in adopting indicators of sustainable transportation and in assessing trends and transportation costs.

This analysis takes into account as many key economic, social, and environmental impacts of transportation as possible, including some that tend to be overlooked because they are indirect transport-induced effects or because they are not measured in the market economy. In doing this, the analysis provides more comprehensive guidance for transportation planners than traditional methods of evaluating transportation options, and can help identify policies and programs that better meet the needs of users and contribute to genuinely sustainable development. This comprehensive analysis can help identify "Win-Win transportation solutions," that is, strategies that provide multiple benefits for a number of public and private sectors. For example, a comprehensive analysis like that undertaken here can help identify those congestion reduction strategies that also help reduce parking costs, reduce accidents, and improve mobility options for non-drivers. Most importantly, such comprehensive analysis can help identify the most sustainable solutions to common transportation problems, and thus contribute significantly to long-term prosperity.

The Genuine Progress Index of Sustainability

As defined by the Brundtland Commission: "S*ustainable development* is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[1] Sustainable development planning requires a comprehensive evaluation system that takes into account economic, social, and environmental impacts, including those that occur in distant times and places. Figure 1 illustrates the range of issues considered in sustainability planning. Sustainability planning balances these planning objectives, resulting in policies that are, overall, optimal for society.

Figure 1. Sustainability Issues

Note: This figure illustrates various sustainability issues. True sustainability occurs in the centre, where economic, social, and environmental objectives are effectively balanced.

The *Genuine Progress Index* (GPI) is such an evaluation system. It is more comprehensive than commonly-used indicators of economic progress, such as Gross Domestic Product, which only

[1] World Commission on Environment and Development (WCED). *Our common future.* Oxford: Oxford University Press, 1987, p. 43.

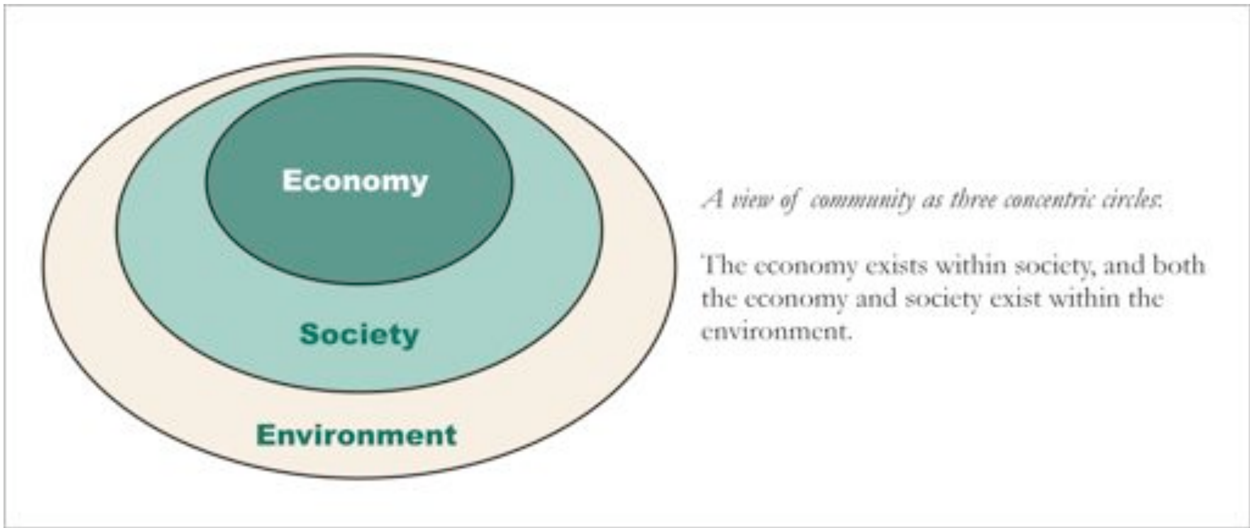
account for market activity (goods and services traded in conventional market exchanges). The GPI recognizes that the *market economy* depends on the *social economy* (families, friends, and communities), which depends on the *natural environment* for essential life support services, as illustrated in Figure 2. For example, few people could be productive without support from family members, friends, and neighbours, who provide services such as shared meals, child care, emotional support, recreation, and security. Even more basically, people rely both for their survival and quality of life on natural resources such as clean air and water, a stable climate, healthy forests and soils, waste assimilation, and natural beauty. However, these valuable services, friendly assistance, neighbourhood security, drinkable water, breathable air, a stable climate, waste absorption capacity, and so on—frequently receive insufficient attention in the policy arena exactly because they are *unpriced.*

Described differently, we are far wealthier than indicated just by conventional market activity alone, because we enjoy uncompensated services provided by family, friends, and the natural environment. For example, people would be much poorer if they needed to pay for each breath of fresh air or each litre of water extracted from rivers and wells (of course, we often do pay for water treatment and distribution, but the natural resource itself is often unpriced.) Figure 2 indicates two ways of illustrating the natural hierarchy between the environmental, social, and economic spheres of life, and the dependence of all human activity on resource and energy flows from the encompassing natural world.

Figure 2. Market, Social, and Natural Economies

Note: The market economy is based on the social economy (such as families, friends, and community members who provide unpaid services to each other), which is based on a natural economy (which provides "free" natural resources and services such as clean air, water, forests, and wild fish). Human society also dumps wastes back into the encompassing natural world, which in turn, affects the functioning of the social and market economies. As the concentric circle model below implies, the encompassing natural world can function without human society, while irreversible changes in natural ecosystems, like climate change and species extinctions, can seriously imperil the functioning of dependent human economies.

A Sustainable View of the Relationship between Economy, Society, & Environment



By assigning zero value to non-market goods and services, conventional economic indicators such as the GDP unintentionally encourage practices that degrade social and environmental resources by recording as gain—"economic growth"—any activity that leads to financial exchange, even when it undermines long-term wellbeing and prosperity. For example, the GDP implicitly treats car crashes, crime, pollution, and disasters as economically beneficial because it measures the additional economic activity that results (e.g. ambulance services, prison building, clean-up costs), but does not properly account for the harms and losses to individuals and society. As a result, GDP undervalues preventive solutions, such as public health , poverty reduction, and energy conservation, which avoid problems, although such solutions often save money in the long term and are generally beneficial to society overall.

By contrast, the Genuine Progress Index does assign explicit worth to non-market values like environmental quality, population health, unpaid work, free time, security, equity, educational attainment, and natural resource health. Unlike conventional economic accounting systems that value only produced or manufactured capital, the GPI also values human capital, social capital, and natural capital, and recognizes that these forms of capital are equally subject to depreciation if managed unsustainably. Where possible, the GPI *monetizes* (measures in monetary units) many non-market benefits and costs so that they can be incorporated into more comprehensive accounting systems and compared with market impacts.

Some people are uncomfortable with this, fearing monetization will lead to the commodification and exploitation of goods such as environmental resources and human health. However, such misuses of monetization can easily be avoided provided that dollar estimates do not replace the use of physical indicators to assess actual trends, and provided that the limitations of money to value non-market and un-priced goods and services are always transparent. At the same time, it must be acknowledged that the failure to monetize non-market benefits and costs frequently results in their being seriously undervalued and even ignored in the policy arena.

For this reason, transportation costs are often monetized in transportation studies. For example, monetized estimates of motorists' travel time and crash risk are frequently used to justify highway expansion. Failing to monetize other impacts, such as pedestrian and congestion delay and environmental damages caused by vehicle traffic, tends to skew decisions to favour automobile-oriented improvements, leading to less sustainable planning decisions. More comprehensive analysis, which includes monetized estimates of currently-overlooked impacts, can lead to more balanced decision-making.

In other words, commonly-used economic indicators are biased in favour of impacts that are easy to measure (such as common market goods and services) at the expense of more difficult to measure impacts (such as those involving social values and environmental services). Sustainability planning requires correcting this bias by providing a functional framework that allows all significant impacts (economic, social, and environmental) to be evaluated, including those not currently traded in a conventional market. The GPI is intended to provide such a comprehensive evaluation and accounting framework.

The GPI Sustainable Transportation Evaluation Framework

This project's goal is to create a practical framework for evaluating transportation system sustainability, taking into account all significant economic, social, and environmental impacts, including those that are indirect, non-market, and long-term. This is by no means the first exercise of this type, but builds on prior research on sustainable transportation indicators[2,3] and on the quantification of transportation impacts.[4,5,6,7] Table 1 lists the types of impacts considered in sustainable transportation analysis.

Table 1. Sustainable Transportation Impacts

Economic	Social	Environmental
Traffic congestion Infrastructure costs Consumer costs Mobility barriers Accident damages Depletion of Non-Renewable Resources	Equity / Fairness Impacts on mobility disadvantaged Human health impacts Community cohesion Community liveability Aesthetics	Air pollution Climate change Noise and water pollution Habitat loss Hydrologic impacts Depletion of Non-Renewable Resources

[2] Centre for Sustainable Transportation, Sustainable Transportation Performance Indicators. cst.uwinnipeg.ca/completed.html.
[3] Litman, Todd. *Well Measured: Developing Indicators for Comprehensive and Sustainable Transport Planning*. (Victoria Transport Policy Institute, 2006f). www.vtpi.org
[4] Delucchi, Mark. *The Social-Cost Calculator (SCC): Documentation of Methods and* Data, and Case Study of Sacramento. (Sacramento Area Council of Governments (SACOG) and the Northeast States for Coordinated Air-Use Management, 2005). www.its.ucdavis.edu/publications/2005/UCD-ITS-RR-05-37.pdf
[5] *European Transport Pricing Initiatives*. www.transport-pricing.ne
[6] Litman, Todd. *Transportation Cost and Benefit Analysis*. Victoria Transport Policy Institute, 2004e) www.vtpi.org
[7] Transport Canada, *Investigation of the Full Costs of Transportation: A Discussion Paper*, Economic Analysis Policy Group, Transport Canada, 2003. This paper outlines a three-year research program called *The Full Cost Investigation of Transportation in Canada* (www.tc.gc.ca/pol/en/aca/fci/menu.htm), which is currently investigating the full financial and social costs (e.g. accidents, noise, congestion delays, and environmental damages) resulting from transport infrastructure, services, and vehicles in Canada.

Of course, this type of project has limitations. Not every impact can be quantified and monetized, and there is significant uncertainty in some economic values, due to insufficient data and variability. For example, there are only a few good monetized estimates of motor vehicle noise costs, and this impact can vary significantly depending on the type of vehicle, and when and where it is driven; so care is needed to estimate the traffic noise costs in a particular situation. However, the evidence to date indicates that, despite such limitations, sufficient information is available for a reasonably comprehensive analysis of transportation impacts, and that attempting to assess such impacts based on the best available evidence is better than ignoring these impacts in formal evaluation. Where uncertainties do exist, this report attempts to make them transparent and to provide a range of estimates, so that readers and users can apply their own discernment and judgement in evaluating the evidence.

Many impacts are also difficult to measure directly, so we evaluate them not just with single measures but rather with sets of indicators that were carefully selected both to be technically feasible, and also to effectively balance sustainability objectives. We group these indicators into four categories – travel patterns, economic, social, and environmental – although some indicators could be assigned to multiple categories. For example, crashes impose both economic costs (losses involving market goods and financial compensation) and social costs (uncompensated non-market losses, such as reduced quality of life and companionship.)

Table 2 summarizes indicators used in this analysis, grouping them according to the sustainability objectives defined and examined in this study.

Table 2. GPI Sustainable Transportation Objectives and Indicators

Objective	Indicator
Transport Activity	
1. Decrease economically excessive motor vehicle transport, and increase use of more sustainable modes	1. Motorized movement of people: - Vehicle-km - Passenger-km - Passenger-km per capita - Comparison of trends: passenger-km and GDP 2. Motorized movement of freight - Tonne-km - Tonne-km per capita - Comparison of trends: tonne-km and GDP 3. Passenger automobiles per capita

Environment	
2. Decrease energy consumption	4. Transport-related energy consumption - Total and per capita energy consumption devoted to transportation - Percentage of primary energy consumption dedicated to transportation - Share of energy consumption by mode and fuel
3. Increased fossil fuel energy efficiency	5. Energy intensity of cars and trucks - Energy consumption per vehicle-km
4 Decrease greenhouse gas (GHG) emissions	6. Transport-related GHG emissions by mode and per capita
5. Decrease emissions of air pollutants	7. Total transport emissions of air pollutants by mode and per capita
6. Decrease pollution emissions per unit of travel	8. Emissions intensity of cars and trucks - Emissions per vehicle-km
7. Decrease water pollution	9. Polluting discharges by mode - Oil spills - Road salt usage - Well contamination
8. Increase recycling and re-use of transportation components	10. Number of tires recycled 11. Number of derelict cars recycled
9. Decrease space taken by transport facilities	12. Land Use - Space taken by transport facilities by mode - Total length of paved roads - Urban density
Social	
10. Increase access to basic services	13. Access to basic services - Average commuting distance - Percentage of children who walk to school - Percentage of commuters who walk, bicycle, or use public transit
11. Increase access to public transportation	14. Access to public transit - Percentage of population who live within 500m of transit station
12. Increase access to the Internet	15. Percentage of population with home internet - Percentage of population who work at home
13. Decrease transport injuries and fatalities	16. Transport injuries and fatalities by mode
14. Increase non-motorized transportation	17. Non-motorized travel: quality and quantity of walking and cycling conditions - Kilometres of bike paths and sidewalks
Economic	
15. Increase percentage of net government spending on public transportation	18. Investments in public transport - Percentage of net government ground transportation expenditures spent on public transportation
16. Increase proportion of household transportation spending devoted to public transit	19. Percentage of household transportation spending devoted to public transit
17. Decrease cost of household transportation expenditure in lowest income quintile	20. Expenditure on personal mobility - Percentage of household expenditures dedicated to transportation for those in lowest income quintile

Trend Analysis

This section of the report discusses the sustainable transportation indicators and their trends. The degree to which these trends support sustainability objectives overall is indicated by these symbols: negative (⇩), positive (⇧). Needless to say, trends can only explain whether something is getting better or worse, but can potentially be deceptive, since everything depends on the base year used. Also, something that is at a very poor level of performance (i.e. highly unsustainable) is more likely to move up, whereas (conversely) something that is already performing well is more likely to stabilize or even to show a downward trend. In other words, the trends do not tell us anything about whether the current state of a particular factor is at or near sustainable levels, only whether things are marginally more or less sustainable than they were.

For example, the small decrease in transport-related greenhouse gas emission intensity in Nova Scotia would seem to signify a positive trend in the system, even though overall emission intensities and levels are completely unsustainable from the perspective of stabilizing greenhouse gas concentrations in the atmosphere. Similarly, there have been significant improvements in energy intensity levels in Nova Scotia, leading to a positive trend marker signal. What these improvements hide is that these emission and energy intensity levels were already very much higher than those in European countries, so the only real direction for Nova Scotia and Canada to go was better. Conversely, European levels of energy intensity had already stabilized at much lower levels and are therefore no longer showing improvements (even though European countries have energy intensity levels and GHG emissions well below those of Canada).

Again, this demonstrates how trend markers showing directionality alone can mask reality. As well, *recent* improvements or downturns may mask overall problems or longer-term trends. For example, a recent *decline* in well contaminations attributable to road salt veils the continued high application of road salt in Nova Scotia, while a recent *increase* in crash deaths and injuries conceals a longer-term reduction. In each of these cases, a decision was made to favour the longer-term trends at the expense of the most recent one. However, only the full report can provide the detailed discussion necessary to describe the status of each of these indicators in comparative context and to analyze the internal nuances of the trends more closely.

Given these caveats, the trend markers used in this Executive Summary are inserted here primarily for illustrative purposes and for their ability to summarize overall trends, but they must be used for caution. The full chapters provide additional information on the current state of each indicator, and the degree to which it is close to sustainable levels. That can be assessed more closely in the international comparisons that are provided for OECD nations. These international comparisons in many of the chapters allow us to set clearer benchmarks of what is possible, and to assess whether or not Canada and Nova Scotia are close to sustainable levels compared to other industrial countries.

The key point here is that in addition to whether or not we are moving in the right direction, it is equally important to know how close or far we are from what might be considered a more sustainable level (at least in relation to best practices). For example, countries like Germany have gone much further than Canada has on many indicators of sustainability. Part 3 of this report provides this kind of detail for each indicator.

Transport Activity

Transport patterns in Canada and Nova Scotia, like those in most developed countries, have become increasingly automobile-dependent, with high levels of per capita vehicle ownership and use, and declining transport options. During the last half-century transit service has declined; homes and businesses have become more dispersed; more neighbourhoods have been built that lack sidewalks; roads and paths have become less connected (with larger blocks and more dead-end streets); and the barrier effect (delay and risk that motor vehicle traffic causes non-motorized modes) has increased, making non-motorized travel more difficult. In addition, alternative modes of transportation have become increasingly stigmatized. The overall effect of these trends is that people drive more kilometres each year and spend more money on transportation, while non-drivers are relatively worse off with fewer alternative options.

These trends are, in part, a result of various market distortions that encourage motor vehicle travel, including under-pricing of road and parking facilities, fixed insurance premiums, and registration fees that are unrelated to kilometres driven, uncompensated crash risks and damages, un-priced environmental and social impacts, planning and investment practices that favour motor vehicle improvements, and various land use policies that favour more dispersed development practices.[8, 9, 10] Although individually some of these distortions may seem modest and justified, their impacts are cumulative and synergistic (total impacts are greater than the sum of individual impacts). As a result, a significant portion of current motor vehicle travel is economically inefficient: – i.e. in a more efficient and equitable market that accounted accurately for the full benefits and costs of different transportation modes, Canadians and Nova Scotians would choose to drive significantly less, rely more on alternative modes of transportation, and be better off overall as a result. The present economically excessive motor vehicle travel (defined here as motor vehicle travel that results from market distortions) contradicts sustainability objectives. As a result, at the margin, compared with current transport patterns, reductions in motor vehicle travel are considered to increase sustainability.

During the last decade, some of these trends towards increased motorized transport activity in the last half century have started to stabilize or even reverse in many developed countries (but not in Canada), due to changes in demographics, economics, and public policies. For example, per capita annual vehicle-kilometres driven has stopped growing in most developed countries due to population aging, rising fuel prices, and changing consumer preferences.[11] New urban planning practices and programs (like that currently under way in Halifax Regional Municipality) have increased walking, cycling, and public transit ridership in several jurisdictions, and even reduced automobile travel (or at least the growth in automobile travel which would otherwise occur) in

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8 Litman, Todd. *Socially Optimal Transport Prices and Markets*. (Victoria Transport Policy Institute, 2006). www.vtpi.org.

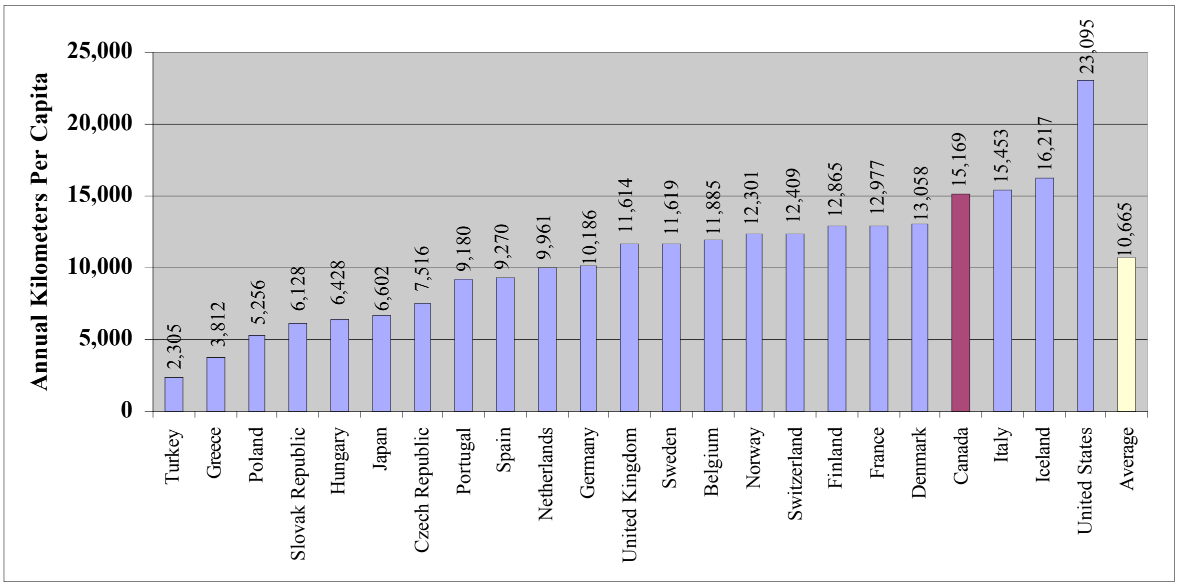
9 Beimborn, Edward and Robert Puentes. *Highways and Transit: Leveling the Playing Field in Federal Transportation Policy*. (Brookings Institute, 2003). www.brookings.edu

10 Murphy, James and Mark Delucchi. "A Review of the Literature on the Social Cost of Motor Vehicle Use in the United States," *Journal of Transportation And Statistics*. (Bureau of Transportation Statistics. January 1998. 1[1]: 15-42. www.bts.gov.

11 Litman, Todd. *The Future Isn't What It Used To Be: Changing Trends And Their Implications For Transport Planning*. (Victoria Transport Policy Institute, 2005b). www.vtpi.org

some communities.[12] Canada has lagged many European countries in instituting such reforms. In 2003, the Organisation for Economic Co-operation and Development (OECD) found that Canada had the fourth highest total for vehicle-km of road transportation per capita amongst selected OECD countries (See Figure 3).

Figure 3. Transport Activity (Vehicle-Km per Capita) for Selected OECD Countries (2003).



Source: Organisation for Economic Co-operation and Development. *OECD In Figures - 2005 Edition*. (www.oecd.org/infigures), 2005.

Canadian passenger vehicle travel grew 15.7% and freight traffic grew 28% between 1990 and 2002, though Canada still registers one-third fewer vehicle-kilometres travelled per person than the United States. Similarly, Nova Scotian per capita automobile vehicle-kilometres and tonne-kilometres of road freight have increased during this period. Broken down by vehicle class the indicators show that car and bus travel changed little in Nova Scotia, but travel by light trucks, SUVs and mini-vans increased, making transport more resource intensive. Provincial-level rail, air, or marine travel data are unavailable, so it is not possible to evaluate trends for these modes in Nova Scotia.

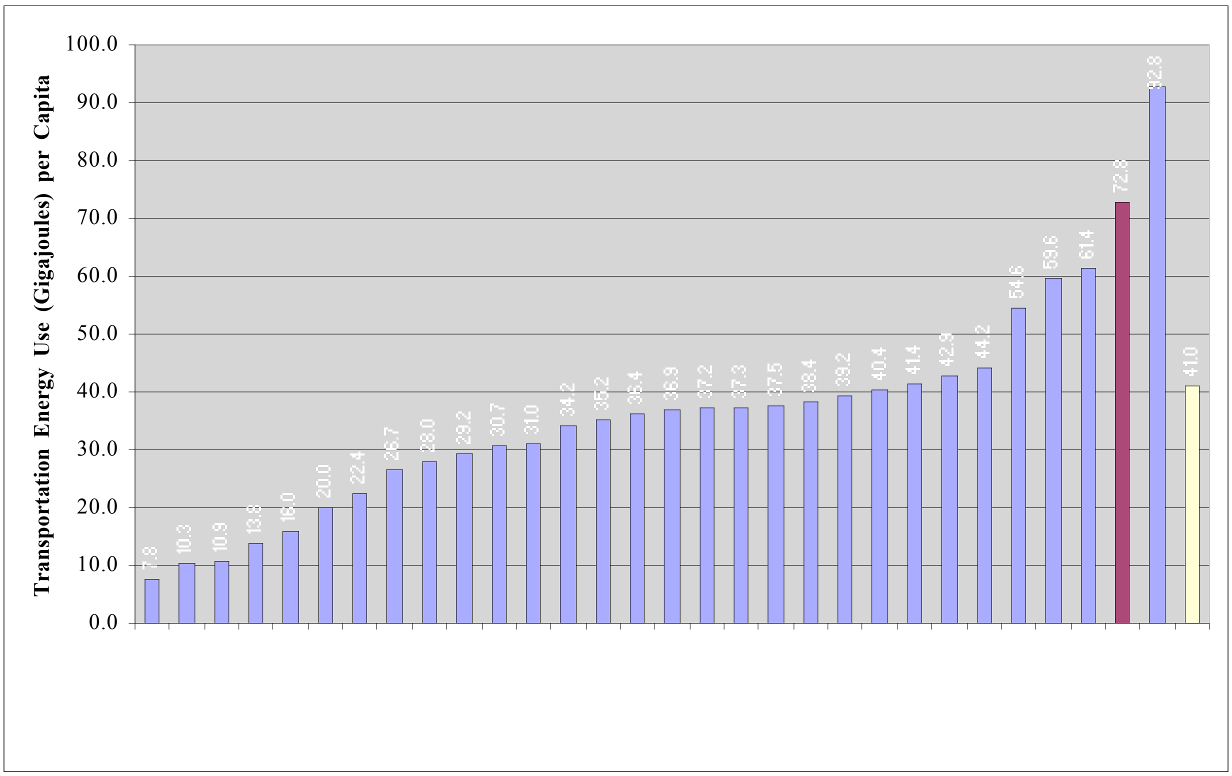
Trend Rating: ⇩

[12] *Moving the Economy Online - Best Practices Database.* www.movingtheeconomy.ca; SMILE - Sustainable Urban Transport Policies and Initiatives. www.smile-europe.org/frame22.html; VTPI, "Success Stories," *Online TDM Encyclopedia*, (Victoria Transport Policy Institute, 2006e). www.vtpi.org

Environmental Indicators

Per capita transportation energy consumption is higher in Canada than in most other countries. Canada had the second highest energy use per capita out of 30 OECD (Organisation for Economic Co-operation and Development) countries — with about 70% higher transport energy use per capita than the OECD average, and second only to the United States (see Figure 4).

Figure 4. Transportation Energy Use (Gigajoules) per Capita for Selected OECD Countries, 2000.



Source: Organization for Economic Co-operation and Development. OECD Environmental Data—Compendium 2002, Tables 8.5 and 12.1A.

Total transportation energy use has increased steadily in Nova Scotia. Indeed, compared to other provinces, an unusually large proportion of total energy use in Nova Scotia is devoted to transportation—38% —a portion that is only surpassed in Prince Edward Island, which probably reflects the relatively low energy consumption by the industrial sector in both provinces. Passenger travel accounts for about two-thirds of the energy used by road vehicles in Nova Scotia. However, freight transport was responsible for 81% of the increase in total road vehicle energy use between 1990 and 2002. Passenger light truck energy use grew by about 28% and heavy freight truck energy use rose 36%. Still more dramatic was the large increase in energy use by off-road vehicles: up 149% from 1990 to 2002, reflecting the increased popularity of ATVs in particular.

Trend Rating: ⇩

This increase in transportation energy consumption resulted from increased vehicle travel. **Transportation energy intensity** (energy consumption per unit of travel) actually declined since 1990 for all vehicle types, including freight vehicles, except small cars and motorcycles, which already had lower energy intensity than other vehicle types.

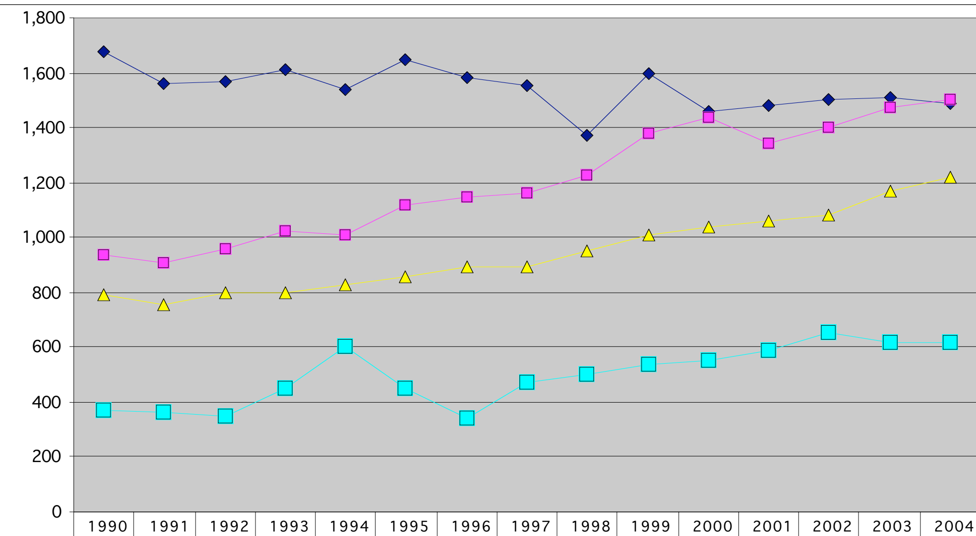
Trend Rating: ⇧

However, in terms of the provincial road passenger fleet as a whole, increased numbers of SUVs, minivans, and light trucks on provincial roads in the last ten years have cancelled out the efficiency gains within the light truck category. As a result, the energy intensity of road passenger transportation in Nova Scotia as a whole is now higher than it was in the mid-1990s, although this is not reflected in the positive trend rating above.

The high rates of transportation energy consumption result in high rates of **transportation-related greenhouse gas (GHG) emissions**. Under the Kyoto Protocol, Canada is obliged to reduce these emissions to 6% below 1990 levels by 2008-2012; but by 2004, Canada's total GHG emissions had *increased* to 27% over 1990 levels. Nova Scotia's GHG emissions grew by 18% between 1990 and 2004, slower than the overall national growth rate in emissions but still well above the target. This is likely due largely to slower population growth in this region.

Within the Nova Scotia transportation sector, road transport contributed the most GHG emissions (69%) in 2004. The air and marine sectors contributed about 8% and 12% of transportation-related GHG emissions, respectively. Rail was responsible for just 2% of total transportation-related emissions. Greenhouse gas emissions from cars actually decreased 11% over the period 1990-2004, reflecting a trend away from cars to SUVs, minivans, and light trucks. However, heavy-duty diesel trucks produced about 54% more emissions than in 1990. The increase in GHG emissions from light-duty gasoline trucks (including SUVs and minivans) was 60%. The largest expansion was in the category of off-road vehicles—emissions from this vehicle class grew by over 68% between 1990 and 2004 (see Figure 5).

Figure 5. Nova Scotia: GHG Emissions from Passenger and Freight Vehicles, 1990-2004 (kt of CO_2 equivalent emissions).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Gasoline Automobile	1,680	1,560	1,570	1,610	1,540	1,650	1,580	1,550	1,370	1,600	1,460	1,480	1,500	1,510	1,490
Light-Duty Gasoline Trucks	939	908	956	1,020	1,010	1,120	1,150	1,160	1,230	1,380	1,440	1,340	1,400	1,470	1,500
Heavy-Duty Diesel Vehicles	790	757	797	800	826	854	896	894	951	1,010	1,040	1,060	1,080	1,170	1,220
Off-Road	370	360	350	450	600	450	340	470	500	540	550	590	650	620	620

Source: Jaques, A. National Inventory Report 1990-2004, Annex 12.

The growth in road transport-related GHG emissions particularly reflects increased vehicle travel by more fuel-intensive vehicles (particularly SUVs, minivans, and light trucks) during the 1990s, as well as a substantial increase in truck freight activity.

Trend Rating: ⇩

Emissions of *Criteria Air Contaminants* (nitrogen oxides [NO_x], sulphur oxides [SO_x] particulate matter [PM], volatile organic compounds [VOCs], and carbon monoxide [CO]) refer to emissions of those air pollutants for which ambient air quality standards and maximum acceptable exposure levels have been set. In general, Nova Scotia compares relatively favourably to other Canadian jurisdictions for **transportation-related emissions of criteria air contaminants**. Nova Scotia has the lowest per capita mobile emission rates for NO_x of all Canada's provinces and territories; the second lowest per capita emissions of total particulate matter and VOCs; and the third lowest per capita CO emissions.

Criteria air contaminant emission trends are therefore basically positive, reflecting the effects of technological improvements and vehicle emission reduction strategies. There was a 28% decline in the composite index of air pollutant emissions from mobile sources for Nova Scotia between 1990 and 2000. However, the rate of decrease slowed in the latter half of the decade, likely due to the increase in overall transport activity as well as the growth in trucking and increased prevalence of SUVs, minivans and light trucks.[13]

Trend Rating: ⇧

The amount of **land used for transportation facilities** is an environmental indicator because such facilities tend to have adverse ecological impacts, including disruption of water flows; damage to unique physical features; road kills and wildlife injuries; and, perhaps most importantly, the disturbance, isolation, and loss of wildlife habitat. Available evidence indicates that Nova Scotia's overall road density exceeds the threshold beyond which natural populations of some large vertebrates (like the endangered mainland moose) have been shown to decline, and may therefore compromise animal habitat in much of the province.[14]

Trend Rating: ⇩

Urban density (people per hectare) is used to assess land use efficiency and accessibility. In general, declining urban density implies movement away from sustainability because residents of dispersed communities tend to use more land and travel more by motor vehicle than residents of more compact settlements. Available evidence indicates that Nova Scotia's urban density diminished by 36% between 1971 and 1996—one of the sharpest provincial declines in the country.

Unfortunately, Statistics Canada has ceased tracking this information, so current trends cannot be stated with certainty. This data gap is particularly regrettable since this is a fundamental indicator of transportation sustainability, directly affecting total transport activity (the first and most basic indicator). These data are also essential to support new policies that attempt to integrate land use and transportation planning. On the positive side, Halifax Regional Municipality is now developing strategies to implement "smart growth" policies and practices which will help integrate transportation and land use planning, and which may help reduce sprawl and create more accessible and multi-modal communities.

Trend Rating: ⇩

The evaluation framework in this study tracks two additional transportation pollution sources: the **salting of roads**, and accidents involving the transport of hazardous materials. In Canada, only Ontario and Quebec apply more total road salt than Nova Scotia. Road salts can taint water supplies, and can cause harm to fish, birds, vegetation, and soil organisms. While new

[13] Unfortunately, the air pollution data are not reported by conventional vehicle types (i.e. they are reported by heavy duty, light duty etc categories… not by SUVs, minivans, or passenger trucks). Therefore we rely on the transport activity data to point to the likely role of SUVs, minivans, and light trucks in slowing the decrease in air pollutant emissions.
[14] Beazley, Karen, Tamaini Snaith, Frances Mackinnon and David Colville. "Road Density and Potential Impacts on Wildlife Species such as American Moose in Mainland Nova Scotia." (*Proceedings of the Nova Scotia Institute of Science*. 2003. 42 [2]: 339-357).

regulations introduced in 1998 were aimed at reducing well contaminations resulting from road salt, 2004 was the first year that saw a marked decline in contaminated well claims. It is not yet clear whether this constitutes the beginning of a new trend, and it is also not clear whether the new policies have also mitigated other impacts like damage to wildlife habitat. For the moment, however, we acknowledge the recent 2004 trend shift here as a potentially positive step, though it must be acknowledged that the quantity of total road salt still used in Nova Scotia leaves this indicator far from sustainable levels.

Trend Rating: ⇩

Re-use and recycling provides environmental benefits by reducing resource and energy consumption, and waste disposal impacts. In Nova Scotia, two transportation materials recovery efforts are officially monitored: tire recycling and derelict vehicle programs supported by the province's Resource Recovery Fund Board. The number of tires recycled has increased steadily from the program's inception in 1997 and, by 2001, there was a 90-95% recovery rate. The number of derelict vehicles salvaged nearly tripled from 712 in 2001 to over 2,100 in 2004. Both trends indicate movement towards sustainability.

Trend Rating: ⇧

GPI*Atlantic* made efforts to track other diversion programs for transportation waste, but without success. Batteries, used motor oil, and anti-freeze have been banned from Nova Scotia's landfill sites since the mid-1990s, but their disposal is not monitored, so it is not presently possible to assess the treatment of such post-consumer toxic substances as battery acid.

Social Indicators

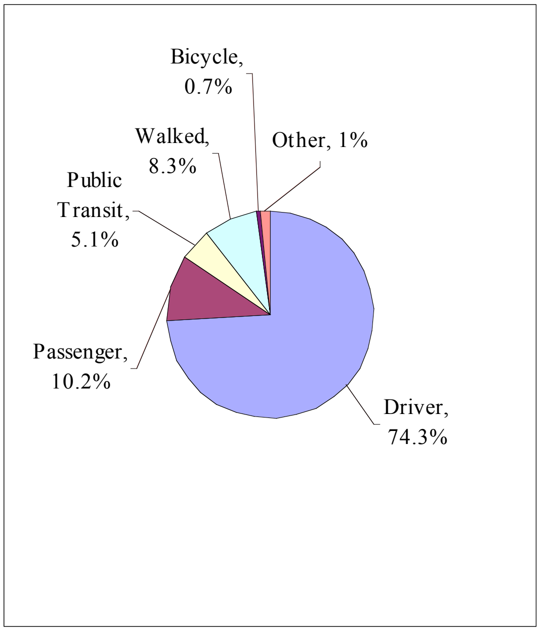
The social indicators evaluate impacts on people and communities, including human health and fitness, social equity, community liveability (including environmental quality from residents' and visitors' perspectives as opposed to objective physical data), community cohesion (the quality of interactions among people in a community), historic and cultural preservation, and aesthetics.

These indicators also reflect the quality of travel options available to people who are economically, physically and socially disadvantaged. Inadequate travel options reduce non-drivers' economic and social opportunities, increase their costs (for example, requiring more taxi rides), and increase the burden on drivers forced to chauffeur non-driving and dependent family members and friends. Automobile dependency increases consumer transportation costs, adding thousands of dollars in annual vehicle expenses to household budgets, which can be a major financial burden to lower-income households. In addition, public health officials are increasingly concerned about the health problems that result from reduced walking and cycling.

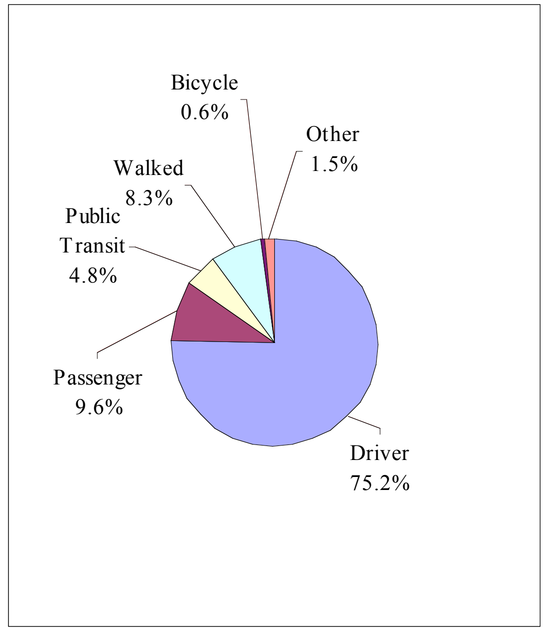
The 1996 and 2001 censuses provide statistics on **commute modal split** (the portion of commuters using various travel modes). Over this time period automobile commuting increased slightly, pedestrian commuting did not change significantly, while transit use, ridesharing, and bicycle commuting all declined. Walking accounted for 8.3% of commute trips in Nova Scotia, and 10% in Halifax. Public transit commuting in Nova Scotia declined from about 5.1% in 1996 to 4.8% in 2001 (see Figure 6).

Figure 6. Nova Scotia: Commute Mode Split (Over 15 years of Age), 1996 and 2001.

1996



2001



Source: Statistics Canada. 1996 and 2001 Census of Population – Labour Force Activity, Occupation and Industry, Place of Work, Mode of Transportation to Work, Unpaid Work, Provinces and Territories in Canada.

Note: "Other" includes commuting to work by motorcycle, taxi, and other modes not listed.

During this period the provincial median commuting distance declined from 8.3 to 7.8 kilometres, although this is still the second longest commute distance of any Canadian province or territory and does not therefore constitute sufficient improvement to denote a definite trend towards sustainability. For the present, the increase in driving and the decline in transit and bicycle commuting constitute trends away from sustainability.

Trend Rating: ⇩

Between 1990 and 2003 the proportion of Nova Scotians with convenient **public transit access** declined, particularly in the Halifax region, due to urban sprawl (more residents locating in areas not served by transit). The King's Transit Authority also recorded a reduction in service availability, although this may be attributable to some extent to inconsistent reporting practices during the period studied. On paper there was an increase in the percentage of the population served by Cape Breton Regional Municipality Transit Services, but this seems to be attributable to emigration from the island rather than to an improvement in transit coverage.

Trend Rating: ⇩

Telework (use of telecommunications to substitute for physical travel) can improve accessibility and reduce automobile travel. The portion of Nova Scotian households with Internet access nearly doubled from 32% in 1997 to 63% in 2003, indicating increased potential for telework. No clear trend could be established for the proportion of Nova Scotians *actually* working from home, which was 6.7% in both 1996 and 2001, so the positive rating given to this trend here is based on increased potential that remains to be realized.

Trend Rating: ⇧

Motor vehicle crashes are a major cause of death, disability, potential years of life lost, and property damages. In Nova Scotia, the number of road accident deaths have been declining since 1990 and the number of injuries have been declining since 2000, but both rose again in 2004. Off-road vehicle accidents have increased drastically since 1996 largely due to the increased popularity of ATVs. There were 991 reported day surgeries and hospital admissions and 35 fatalities involving off-road vehicles between 1995 and 2004. The incidence of off-road vehicles involved in accidents resulting in injuries increased by 150% over the period.[15, 16] The recent 2004 increase in road accident deaths and injuries leads to a negative trend rating here, though it must be acknowledged that present road accident death and injury rates are still well below 1990 levels.

Trend Rating: ⇧

Accidents involving dangerous goods decreased significantly in Nova Scotia between 1990 and 2003. Road and facility accidents have shown the most marked declines. Air, marine, and rail accidents involving dangerous goods remained minimal. Data were unavailable for potential sources of water pollution from transportation like oil spills, bilge discharges, and fluid leaks from cars and trucks.

Trend Rating: ⇧

Some professional organizations (such as the Canadian Institute of Transportation Engineers) and governments (such as Halifax Regional Municipality) are taking steps to implement policies and planning practices for **integrated land use and transportation planning** to create more

[15] Nova Scotia Department of Transportation and Public Works. Motor Vehicle Collision Statistics. www.gov.ns.ca/tran/publications/publication.asp Accessed July 2004.
[16] Sellon, Gary. Policy Analyst, Nova Scotia Department of Transportation and Public Works. (Personal communication: July, 2004).

accessible land use patterns and a more multi-modal transportation system. Based on HRM's current planning process, this trend is rated positively here, even though evidence is lacking for the province as a whole.

Trend Rating: ⇧

Economic Indicators

Economic indicators reflect impacts on economic development, productivity, employment, government and business costs, household budgets, and wealth. Transportation activities impose significant costs on consumers, businesses, and governments. Increasing transportation system efficiency supports economic development by reducing the costs of business and consumption and increasing productivity, employment, and wealth. These impacts can be large. For example, residents of more densely populated, multi-modal communities tend to save hundreds of dollars annually compared with demographically equal households living in more dispersed and automobile-dependent communities.[17,18] Such households often incur significant additional expenses by supporting more than one car per household.

Transportation Expenditures as a Percentage of Total Household Expenditures in Nova Scotia were consistently the second highest household expense during the period 1998-2002, exceeded only by shelter. Of the top three household expenses, transportation was the only one that rose over this term as a proportion of total expenses, an indication that transportation is becoming less affordable. Households in the three highest income quintiles (i.e. the richest 60% of households) spent a greater proportion of their budgets (close to 25%) on transportation than those in the two lowest income quintiles (the poorest 40%). The lowest quintile spent 14% of household expenses on transport, and the second lowest spent 18%, but all quintiles except the second saw their transportation expenses increase significantly as a percentage of their total household spending (see Figure 7).

Trend Rating: ⇩

Public expenditures on alternative transportation modes (walking, cycling, and public transit) are an indicator of transportation equity, as such expenditures ensure basic mobility for people who are transportation disadvantaged, and so that people who rely on these alternative modes receive a fair share of transportation budget expenditures.

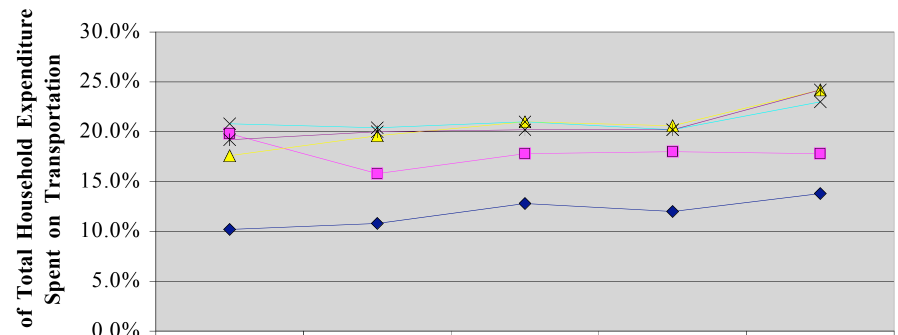
Government expenditures on public transit are a small portion of total government transportation expenditures. For example, between 1991 and 2002, expenditures on public transit in Nova Scotia ranged between 5.3% and 3.4% of total transportation spending. During this

[17] Center for Transit-Oriented Development and the Center for Neighborhood Technology, *The Affordability Index: A New Tool for Measuring the True Affordability of a Housing Choice*. (Center for Transit-Oriented Development and the Center for Neighborhood Technology, Brookings Institute, 2006) www.brookings.edu/metro/umi/20060127_affindex.pdf
[18] Victoria Transport Policy Institute. "Affordability," *Online TDM Encyclopedia*, (Victoria Transport Policy Institute, 2006b). www.vtpi.org

period government spending on transit actually declined 24%, and by an even greater amount during the most recent years. The provincial government has provided no funding for transit since 1999. Since then all funding has been provided by municipal governments, resulting in a cycle of increasing fares and declining ridership.

Trend Rating: ⇩

Figure 7. Nova Scotia: Transportation Expenditures as a Percentage of Total Household Expenditures, by Income Quintile, 1998-2002.



	1998	1999	2000	2001	2002
1	10.2%	10.8%	12.9%	12.0%	13.7%
2	19.8%	15.8%	17.7%	18.0%	17.7%
3	17.6%	19.6%	21.0%	20.7%	24.2%
4	20.7%	20.5%	21.0%	20.2%	23.0%
5	19.2%	20.0%	20.2%	20.2%	24.1%

Source: Statistics Canada. *Survey on Household Spending*. (1998-2002).

Note: 1 represents the lowest income quintile and 5 is the highest.

Summary

Nova Scotia's current rate of per capita motor vehicle travel exceeds what can be considered sustainable due to the various economic, social, and environmental costs that current transportation patterns impose. People sometimes argue that high levels of mobility are sustainable if they use energy efficient or alternative fuel vehicles, and that increased mobility should be supported for the sake of economic development. However, despite the undoubted advantages of energy efficient and alternative fuel vehicles over conventional and inefficient vehicles for a number of environmental reasons, the arguments for increased mobility are not supported by the evidence for the following reasons.

First, although more efficient and alternative fuel vehicles help achieve some sustainability objectives, they have neutral or negative effects with regard to others. For example, even "zero emission" vehicles (that produce no tailpipe emissions) impose significant external costs from vehicle and facility construction, traffic congestion, crash damages, noise and water pollution, and the inequity of a transport system that fails to service non-drivers. Increasing vehicle fuel efficiency without correcting other market distortions has been shown to have the unintended effect of increasing vehicle kilometres (since it reduces vehicle operating costs), and thereby exacerbating problems such as congestion, facility costs, and crashes. As long as motor vehicles impose significant external costs, high levels of vehicle travel can be considered unsustainable.

Economically excessive motor vehicle travel (defined here as motor vehicle travel that results from market distortions) is harmful rather than beneficial to the economy.[19] Mobility can be *decoupled* from economic development by increasing transportation system efficiency, which has been demonstrated to support economic development far more effectively than increased transportation dependency and motorized travel.[20]

For example, economic development requires that employees access work and that shoppers purchase goods and services, but not necessarily by automobile. Many employees can commute by alternative modes (walking, cycling, ridesharing, public transit, and telecommuting), and shopping can take place at local stores, by internet, and using ridesharing, allowing economic development without increased vehicle trips. These alternative modes are usually cheaper than driving overall, taking into account all costs to consumers (vehicle expenses, parking, time, risk, etc.), governments (roads and traffic services), businesses (parking facilities), other motorists (congestion delay and accident risk), and the environment (pollution and GHG damages and community liveability).

As well, money spent on vehicles and fuel tends to provide far fewer regional jobs and less business activity for provinces like Nova Scotia than most other consumer expenditures, since fuel, vehicles, and parts are almost all imported. So transportation policies that reduce driving and vehicle expenditures are usually economically beneficial and stimulate the local economy.

Described differently, the economically optimal level of motorized mobility is what consumers would choose in a truly efficient market that offers multiple transport options (walking, cycling, ridesharing, and public transit services) and prices that accurately reflect the marginal costs of transportation activity (direct charges for using roads and parking, mileage-based insurance and registration, and fees for environmental impacts, fossil fuel energy use, and congestion charges).[21] Current transport markets are distorted in various ways that presently increase motor vehicle travel beyond what is economically efficient and sustainable.[22]

In the past, many transportation professionals considered shifts from alternative modes (walking, cycling, ridesharing, and public transit) to automobile transport to be acceptable and desirable, assuming that the shifts simply reflected consumer preferences. However, a growing body of

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[19] Victoria Transport Policy Institute. "Economic Development," *Online TDM Encyclopedia*. (Victoria Transport Policy Institute, 2006c). www.vtpi.org
[20] European Conference of Ministers of Transport, *Transport and Economic Development*. (Round Table 119, European Conference of Ministers of Transport, February 2001). www.oecd.org/cem/about.htm
[21] Victoria Transport Policy Institute. "Market Principles," *Online TDM Encyclopedia*, (Victoria Transport Policy Institute, 2006d). www.vtpi.org
[22] Litman, Todd. *Socially Optimal Transport Prices and Markets*. (Victoria Transport Policy Institute, 2006b). www.vtpi.org/opprice.pdf

evidence in recent years has caused many experts and individuals to realize that such shifts have in fact often reflected reduced travel options (degradation of walking and cycling conditions, and declining public transit service availability and quality), under-pricing of motor vehicle travel, and more automobile-dependent community design, which in turn stimulates additional driving. Surveys indicate that many people would actually prefer to drive less and to rely more on alternative modes, provided that they offered quality service (convenience, comfort, security, etc.).

Sustainable transportation planning requires, among other key considerations, that we evaluate transport efficiency in terms of *accessibility* (people's ability to reach desired goods, services, and activities) rather than *mobility* (physical travel).[23] Accessibility is the ultimate goal of most transportation activity, except for the very small portion of travel that has no particular destination. For example, people travel to stores to access goods and services, they commute to access work, and they travel to parks to access recreation activities.

High levels of mobility often reflect poor accessibility due to inadequate travel options, dispersed destinations and disconnected road networks. This is indicated by the fact that increased vehicle travel speeds have not reduced the time people devote to travel, nor the frustration many motorists express at the large amount of time and money they devote to motorized travel. In these cases, increased mobility may provide little net benefit to society when it actually reflects reduced accessibility and increased external costs. For example, if motor roadway improvements lead to more automobile-dependent sprawl, people can end up driving more annual kilometres but be no better off overall as a result, when all costs (time, money, congestion, crash risk, environmental quality, the quality of consumer options) are considered. Thus, sprawl frequently reduces or complicates access to goods, services, work, entertainment, and recreational facilities, and makes such access more expensive.

This is not to suggest that sustainability requires giving up motorized travel altogether, but it does indicate that high rates of per capita vehicle travel can be considered unsustainable from an accessibility perspective as well as for environmental reasons, particularly if they result from market distortions and impose significant external costs. Described more positively, policies that reduce economically excessive motor vehicle travel by correcting market distortions help increase transport system sustainability.

Of course, the actual degree to which motorized travel is unsustainable varies, depending on the type of vehicle, travel conditions, and the value of the vehicle trip. For example, some types of drivers and vehicles are particularly dangerous, polluting, and resource intensive, while driving under urban-peak conditions tends to impose higher infrastructure, congestion, and pollution costs than the same number of kilometres driven under rural or off-peak conditions. Some forms of vehicle travel reflect *basic accessibility* (they provide access to what is considered to have high value to society such as employment and basic services), while other vehicle travel can be considered a luxury activity, either because the trip purpose is of low value, or because it could easily shift to a more efficient mode, route, or destination. Distinguishing types of vehicle travel

[23] Victoria Transport Policy Institute, "Accessibility and Mobility," *Online TDM Encyclopedia*, (Victoria Transport Policy Institute, 2006a). www.vtpi.org

in this way, and reducing that portion of vehicle travel that has lower value and carries higher costs, is particularly effective at increasing transport sustainability.

Table 3 summarizes the indicators described above and indicates whether current trends seem overall *positive* (indicated by ⇧), or *negative* (indicated by ⇩). As noted, these basic trend signals are illustrative only and do not tell the whole story, particularly since they do not indicate whether current levels are sustainable or not.

Table 3. Sustainable Transportation Indicators and Trends

Transport Patterns		
Motorized mobility	Per capita annual vehicle kilometres	⇩
Transport mode split	Portion of passenger travel by automobile	⇩
Transport productivity	Passenger-kilometre per unit of GDP	⇧
Truck freight	Truck tonne-km per capita	⇩
Environmental Indicators		
Energy efficiency	Per capita transportation energy consumption	⇩
Air pollution	Per capita transportation air pollution emissions (based on index)	⇧
Land consumption	Total amount of land paved for transportation facilities	⇩
Recycling rates	Portion of motor vehicle tires, batteries and hulks recycled	⇧
Salt pollution	Tonnes of road salt	⇩
Social Indicators		
Commute mode split	Percentage of commuters who walk, bicycle, or use public transit	⇩
School transport accessibility	Portion of children driven to school	⇩
Commuter distance	Average commuting distance	⇧
Transit accessibility	Percentage of population who live within 500 m of transit station	⇩
Telework access	Percentage of households with Internet service	⇧
Transportation accidents	Transport injuries and fatalities by mode	⇧
Hazardous crashes	Number of accidents involving dangerous goods	⇧
Economic Indicators		
Government expenditures	Portion of government expenditures for transit	⇩
Household expenditures	Percentage of household transportation spending devoted to public transit	⇩
Personal mobility expenditures	Percentage household expenditures dedicated to transportation for those in lowest income quintile	⇩

Note: As noted above, the directional trend markers (up and down arrows) can only tell us whether there has been some recent progress in the right direction. They cannot tell us how close our current state is to sustainable levels.

Full Cost Accounting

As part of this study we developed estimates of the full costs of road passenger travel in Nova Scotia. This analysis builds on a wide range of previous research that quantifies and monetizes transportation costs. Table 4 lists the 15 cost categories used in this study. These are divided into three categories: *internal-variable* (costs borne directly by users according to how much they drive), *internal-fixed* (costs borne directly by users, but not significantly affected by how much a motorist drives), and *external* (costs imposed on others). In general, economists tend to consider costs that are fixed or external as *inefficient* (specifically, efficiency requires that prices equal marginal costs), and costs that are external as *inequitable* (specifically, users should bear the full costs resulting from their consumption decisions unless a subsidy is explicitly justified).

Table 4. Cost Categories Considered in this Analysis

Cost	Description	Category
Vehicle Ownership	Fixed costs of owning a vehicle.	Internal-Fixed
Vehicle Operation	Variable vehicle costs (fuel, oil, tires, tolls, and short-term parking fees).	Internal-Variable
Operating Subsidy	Government subsidies for operating transit services	External
Travel Time	Costs of time spent on transport	Internal-Variable
Internal Crash	Crash costs borne directly by travelers.	Internal-Variable
External Crash	Crash costs a traveller imposes on others.	External
Internal Parking	Off-street residential parking and long-term leased parking paid by users.	Internal-Fixed
External Parking	Off-street parking costs not borne directly by users.	External
Congestion	Congestion costs imposed on other road users.	External
Road Facilities	Roadway construction and operating expenses not paid by user fees.	External
Roadway Land Value	The value of land used in public road rights-of-way.	External
Traffic Services	Costs of services such as traffic policing, traffic lights, etc.	External
Barrier Effect	Delays that roads and traffic cause to non-motorized travel.	External
Climate Change	Costs of vehicle greenhouse gas emissions	External
Air Pollution	Costs of vehicle air pollution emissions.	External
Noise	Costs of vehicle noise pollution emissions.	External
Resource Externalities	External costs of resource consumption, particularly petroleum.	External
Water Pollution	Water pollution and hydrologic impacts by transport facilities and vehicles.	External
Waste	External costs associated with disposal of vehicle wastes.	External

Note: This table summarizes the categories of transportation costs considered in this study.

Table 5 presents the estimated value for each cost category, both in total costs and on a per capita basis. In 2002, the full cost of transportation in Nova Scotia is estimated at $6.4 billion ($C2002) on the low end and $13.3 billion on the high end. (The large variation is due almost entirely to huge variations in climate change cost estimates in the literature. Nearly half the high end figure is attributable to predicted climate change damage costs and reflects more catastrophic scenarios including destruction caused by sea level rise, and by extreme storm and hurricane activity.) The total cost estimates translate into a per capita cost of $7,598 ($C2002).[24]

The full report discusses in detail how each cost is quantified and monetized. In most cases, cost estimates per vehicle-kilometre travelled derived from other sources were scaled to reflect Nova Scotian conditions and then multiplied by the amount of vehicle travel that occurs in the province. These cost estimates incorporate a high degree of uncertainty (due to data constraints) and variability (since many costs vary significantly depending on factors such as type of vehicle, driver, and travel conditions).

[24] The per capita cost provided here is much closer to the low-end cost estimate than to the high end one, because it uses a mid-range climate change damage cost estimate that is higher than the lowest ones cited in the literature (which are likely based on unreasonably optimistic projections), but is only one-seventh the high estimates in the literature.

However, despite these limitations, these estimates are useful because they do reflect the value of indirect and non-market goods and services and thus indicate the general magnitude of impacts that are often overlooked in conventional economic analysis. Whatever the uncertainties and variabilities, the results provided here are far more accurate and comprehensive than conventional transportation cost estimates that ignore a wide range of real transportation impacts and thus implicitly (and mistakenly) assign such "externalities" a zero value. The accounting framework used here also allows these indirect and non-market impacts to be compared with more conventionally evaluated impacts using a common metric.

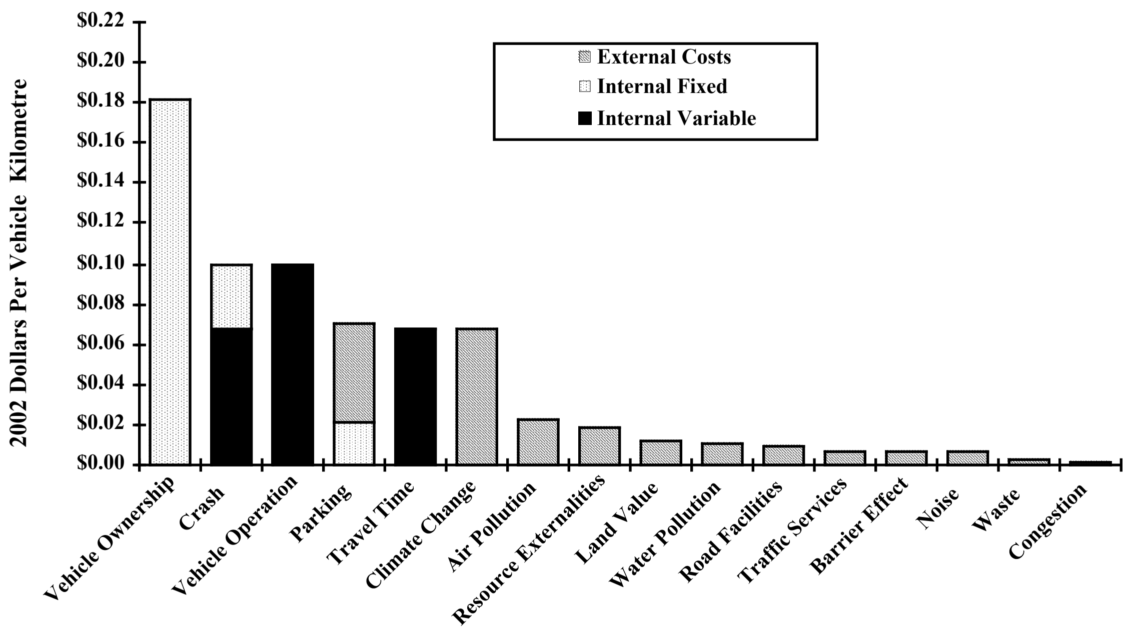
Table 5. Per Capita and Total Cost Estimates for Road Passenger Transportation in Nova Scotia ($C2002)

	Per Capita Costs				Total Costs (million$)	
	Internal-Variable	Internal-Fixed	External		Low***	High***
Vehicle Ownership		$1,913			$1,788	$3,648
Travel Time	$1,236				$1,155	$1,155
Vehicle Operation	$1,052				$983	$1,112
Climate Change**			$700		$99	$4,672
Internal Crash	$695				$650	$650
External Parking			$507		$474	$474
Air Pollution**			$236		$56	$384
External Crash			$347		$325	$325
Internal Parking		$220			$206	$206
Resource Externalities			$213		$199	$199
Land Value			$125		$117	$117
Water Pollution			$103		$96	$96
Road Facilities			$98		$91	$91
Barrier Effect*			$72		$67	$67
Traffic Services			$71		$67	$67
Noise			$67		$62	$62
Waste			$16		$15	$15
Operating Subsidy*			$13		$12	$12
Congestion*			$13		$12	$12
Per Capita Costs:	*$2,982*	*$2,133*	*$2,483*			
Total Per Capita Costs:	*$7,598*			*Totals:*	*$6,382*	*$13,273*

Notes: *Congestion, Operating Subsidy and the Barrier Effect costs are presented here for illustrative and comparative purposes only. They have been netted out to indicate that they are not included in the totals presented in order to avoid double-counting, since congestion and the barrier effect are actually sub-components of the travel time costs and operating subsidy costs are a part of vehicle ownership costs. **The per capita cost estimates for climate change and air pollution are based on mid-range estimates of their costs, rather than on the low or high cost estimates. These costs also include both road freight costs and road passenger costs since data are not available for passenger vehicles only ***Low and High estimates for climate change and air pollution are calculated by using different costing methods than the other cost categories (these methods are explained in Part V).

Figure 8 illustrates the estimated comparative magnitude of these costs. The largest costs are vehicle ownership and operation, crash costs, and parking. Vehicle ownership and operation, and a portion of parking, crash, and roadway costs, are *internal*, and are paid directly by owners and operators and by user fees (e.g. residential parking costs, insurance, road taxes, and fuel). *External* costs, such as congestion, air pollution, and roadway land value, tend to be smaller individually, and so are easily overlooked, but they constitute a considerable cumulative cost.

Figure 8. Costs Ranked by Magnitude



Note: This figure shows average car costs per vehicle-kilometre, ranked by magnitude.

When added together, the fixed and external costs of driving are large in total, representing more than two-thirds of all transportation costs, as illustrated in Figure 9. This indicates that transportation markets are distorted, since fixed costs and externalities conceal full transportation impacts that are a function both of actual vehicle usage and of effects on non-market goods and services.

This point is even more evident when the costs that are paid directly by Nova Scotians are compared against the “invisible” costs that are paid indirectly (for example, through taxes, higher prices for consumer goods, or through reduced health). Statistics Canada’s household spending data reveal that each Nova Scotian spent an average of $3,036 on road transportation costs in

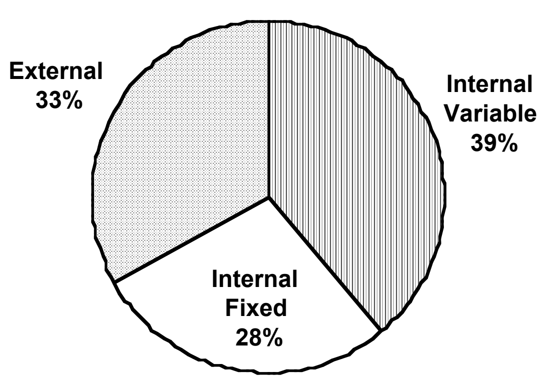
2002.[25] These costs include vehicle ownership and operating costs, transit fares, and out-of-pocket parking expenses.

What most Nova Scotians do not realize is that there are an additional $4,562 in indirect costs that are not counted in their conventional transportation expenditures. These costs are either non-market costs, like travel time and climate change costs, or are costs paid through taxes, rent, and mortgage and other payments, like road facility expenditures, some taxpayer funded medical costs associated with automobile crashes, and residential off-street parking. In other words, Nova Scotians are only directly paying for about 40% of the full costs of passenger road transportation.

When added together, the fixed and external costs of driving are large in total, representing more than two-thirds of all transportation costs, as illustrated in Figure 9. This indicates that transportation markets are distorted, since fixed costs and externalities conceal full transportation impacts that are a function both of actual vehicle usage and of effects on non-market goods and services.

In particular, automobile travel is significantly under-priced and, to the degree that these costs are overlooked in economic analysis, policy and planning decisions are skewed to favour automobile transportation improvements. That in turn results in economically excessive automobile travel, excessive automobile-dependency, and reduced transportation options. The more that costs are transferred from the fixed and external categories to the internal variable category, the more distortions will be rectified and removed, and the more users will pay the full costs of the transport modes they choose. That in turn will naturally encourage development of a wider range of more sustainable transportation options.

Figure 9. Average Car Cost Distribution



Note: This figure illustrates the aggregate distribution of costs for an average car. More than two-thirds of total vehicle costs are either External or Internal-Fixed.

[25] Statistics Canada. Spending Patterns in Canada 2003, Catalogue no. 62-202-XIE. 2005. www.statcan.ca/english/freepub/62-202-XIE/0000362-202-XIE.pdf. Based on Table 1.

To give just one example: Failure to charge users for road space and environmental externalities favours truck over rail freight, which increases both environmental impacts and road wear, congestion delay and accident risk that heavy truck traffic imposes on motorists. An earlier GPI Atlantic report on the full-cost accounting of freight traffic on the Halifax-Amherst corridor found that a 10% shift of freight from road to rail would save more than $10 million annually (see Appendix A of the Nova Scotia GPI Greenhouse Gas Accounts at www.gpiatlantic.org).

The accounting framework used in this report provides a tool for incorporating these generally hidden impacts into policy and planning decisions, and thereby provides guidance in identifying more sustainable transportation options, and reducing total transportation-induced costs to society.

Policy Reforms

At first glance, the transportation analysis in this study may seem discouraging, because it identifies such a variety of problems and unsustainable trends. However, there is actually a very positive message that emerges from the evidence and particularly from the identification and compilation of full transportation costs. This analysis does indicate that the current transportation system is distorted in various ways that result in economically excessive motor vehicle travel (that is, more motor vehicle travel than would occur in an efficient market), which in turn is harmful in a number of ways. But what this means is that that market reforms which correct existing distortions can provide a wide range of economic, social, and environmental benefits that will enhance wellbeing, produce cost-savings, improve environmental quality, and boost long-term prosperity.

For example, improved walking and cycling conditions, improved public transit services, and more efficient pricing can help reduce traffic congestion, road and parking facility costs, consumer costs, accident risk, energy consumption, and pollution emissions, while improving public fitness and health, increasing beneficial economic activity, supporting strategic land use objectives (such as reducing sprawl), and even supporting specific objectives such as urban redevelopment, tourism activities, and heritage preservation.

A wide range of tested and proven policy and planning reforms can help provide such benefits. We call them “Win-Win Transportation Solutions” because each intervention achieves multiple benefits across economic, social, and environmental dimensions. They are cost-effective and technically feasible market reforms that help solve transportation problems by increasing consumer options and removing market distortions that encourage inefficient travel behaviour. Although their individual impacts may appear modest, their combined benefits can be substantial.

If fully implemented to the degree that is economically justified, Win-Win Solutions can provide very significant total benefits. They are “no regrets” measures that are justified regardless of uncertainties about global warming or other environmental and social impacts. They therefore represent true sustainability strategies, as opposed to strategies that help address one or two planning objectives, but exacerbate other problems by increasing total motor vehicle travel and sprawl. Table 6 lists examples of these strategies in summary form. Each of these options has been described in detail in the literature, with examples of best practices.[26]

Table 6. Win-Win Solutions

Name	Description	Transport Impacts
Least-Cost Planning Reforms	More comprehensive and neutral planning and investment practices.	Increases investment and support for alternative modes and mobility management, improving transport options.
Regulatory Reforms	Reduced barriers to transportation and land use innovations.	Tends to improve transport options.
Transportation Demand Management Programs	Local and regional programs that support and encourage use of alternative modes.	Increased use of alternative modes.
Commute Trip Reduction (CTR)	Programs by employers to encourage alternative commute options.	Reduces automobile commute travel.
Commuter Financial Incentives	Offers commuters financial incentives for using alternative modes.	Encourages use of alternative commute modes.
Fuel Taxes - Tax Shifting	Increases fuel taxes and other vehicle taxes with concomitant reductions in income tax.	Encourages fuel-efficiency, and reduces vehicle fuel consumption and mileage.
Pay-As-You-Drive Pricing	Converts fixed vehicle charges into mileage-based fees.	Reduces vehicle mileage.
Road Pricing	Charges users directly for road use, with rates that reflect costs imposed.	Reduces vehicle mileage, particularly under congested conditions.
Parking Management	Various strategies that result in more efficient use of parking facilities.	Reduces parking demand and facility costs, and encourages use of alternative modes.
Parking Pricing	Charges users directly for parking facility use, often with variable rates; provides cash payments to employees not using parking.	Reduces parking demand and facility costs, and encourages use of alternative modes.
Transit and Rideshare Improvements	Improves transit and rideshare services.	Increases transit use, vanpooling and carpooling.
HOV (High Occupancy Vehicle) Lane Priority	Improves transit and rideshare speed and convenience.	Increases transit and rideshare use, particularly in congested conditions.
Walking and Cycling Improvements	Improves walking and cycling conditions.	Encourages use of non-motorized modes, and supports transit and smart growth.
Smart Growth Policies	More accessible, multi-modal land use development patterns.	Reduces automobile use and trip distances, and increases use of alternative modes.
Location Efficient Housing and Mortgages	Encourage businesses and households to choose more accessible locations.	Reduces automobile use and trip distances, and increases use of alternative modes.

[26] Litman, Todd. *Win-Win Transportation Solutions: Cooperation for Economic, Social and Environmental Benefits*. (Victoria Transport Policy Institute, 2005f). www.vtpi.org

Mobility Management Marketing	Improved information and encouragement for transport options.	Encourages shifts to alternative modes.
Freight Transport Management	Encourage businesses to use more efficient transportation options.	Reduced truck transport.
School and Campus Trip Management	Encourage parents and students to use alternative modes for school commutes.	Reduced driving and increased use of alternative modes by parents and children.
Car-sharing	Vehicle rental services that substitute for private automobile ownership.	Reduced automobile ownership and use.
Traffic Calming and Traffic Management	Roadway designs that reduce vehicle traffic volumes and speeds.	Reduced driving, improved walking and cycling conditions.

Source: Litman, Todd. *Win-Win Transportation Solutions: Cooperation for Economic, Social and Environmental Benefits*. (Victoria Transport Policy Institute, 2005f). www.vtpi.org

Note: There are various Win-Win Solutions, in addition to those listed here, which encourage more efficient transportation.

Because they provide multiple benefits, Win-Win Solutions offer opportunities for cooperation and coordination among various organizations and political interests. For example, developers can support these strategies because they reduce parking costs, social service agencies can support them because they improve affordable mobility for non-drivers, health professionals can support them for their health benefits, and environmentalists can support them because they reduce energy consumption, greenhouse gas and pollution emissions and sprawl.

Conclusions and Recommendations

This study indicates that many current Nova Scotia transport trends are leading away from sustainability. Per capita vehicle travel, consumer expenditures, energy consumption, greenhouse gas and pollution emissions, land use sprawl, and traffic congestion are all high and either steady or increasing, while transportation options for non-drivers seem to be declining due to transportation and land use trends.

The full-cost accounting performed as part of this study shows that Nova Scotians bear far higher transportation costs than is conventionally acknowledged, and that current levels of motor vehicle travel appear to be economically excessive, that is, more than what consumers would choose if they had better travel options and efficient prices.

There are also positive trends and opportunities. Changing consumer preferences and planning practices support more sustainable transport and land use patterns. These include urban redevelopment, growing preference by some households for more accessible residential locations, improved walking and cycling conditions, reinvestment in public transit, and various programs like HRM's new Metrolink service that encourage use of alternative modes. Some communities in various parts of the world have demonstrated that it is possible to improve transportation options, redevelop urban neighbourhoods, increase use of alternative modes, and reduce driving. HRM's new Municipal Planning Strategy and proposed Transportation Master Plan are intended to move the municipality in this more sustainable direction.

On the basis of the indicators, trends, evidence, costing analysis, and concrete examples presented in this report, we have developed practical recommendations for creating more efficient transportation and land use patterns. The evidence clearly indicates that if market distortions are corrected, many consumers would choose to drive less, rely more on alternative modes, and be better off overall as a result. This reduction in driving would provide a wide variety of economic, social, and environmental benefits.
We have identified approximately two dozen specific Win-Win Transportation Solutions, summarized above, which are cost-effective, technically feasible, market reforms that can help solve current transportation problems by increasing consumer options and removing market distortions. We believe that such solutions can provide a strong basis for true sustainable transportation and a practical means of attaining the sustainability objectives outlined in this study.

Table 7. Full Cost Estimates for Commuter Travel in HRM by Automobile and Public Transit, 2001 ($C2002).

Improving Evaluation Practices:

Through this research we have identified various gaps in data availability and indicator analysis. Improvements in evaluation require better data on:

- Rail, marine, and air transportation, including:
  - Tonne-kilometre
  - Energy Intensity
  - Land used for rail, air and marine facilities

  (These data are compiled by various agencies, but are not released publicly for confidentiality restrictions).
- Water pollution attributable to vehicles, spills, and run-off from roads and parking lots
- Transportation waste, such as, batteries, oil, and anti-freeze – in particular, the degree of compliance and proper disposal
- Land-use patterns and land used for transportation, in particular, up-to-date data on population density, road density, road lengths, and area used for transportation facilities.
- Vehicle travel by mode.
- Mode split
- Transportation expenditures by consumers, businesses, and governments
- The quality of transportation services available, particularly for people who are physically, economically and socially disadvantaged, and the degree to which these people experience social exclusion due to inadequate transport options.
- Information on the travel patterns of young people.

BULLETIN

Just as this report went to press, the Government of Canada announced a significant investment in Nova Scotia's public transit systems. This investment is directly consonant with one of this report's key recommendations. Following is the press bulletin released on 24 November, 2006:

Government of Canada Invests $37.5 million in Transit in Nova Scotia Service Nova Scotia and Municipal Relations November 24, 2006 11:05

Eleven public transit systems in Nova Scotia will be improved thanks to the Government of Canada's investment of $37.5 million.

The announcement was made today, Nov. 24, by Peter MacKay, Minister of Foreign Affairs and ACOA, on behalf of Lawrence Cannon, Minister of Transport, Infrastructure and Communities, and Jamie Muir, Minister of Service Nova Scotia and Municipal Relations.

These investments towards public transit infrastructure will help reduce traffic congestion and improve air quality, as well as help reduce carbon dioxide and other greenhouse gas emissions.

Transit services that will benefit from the federal funding include Metro Transit in Halifax Regional Municipality, Cape Breton Transit, Kings Transit (Kings County and surrounding area), and eight other community transit organizations. Eligible capital investments may include the purchase of buses and accessible transit vehicles, the construction of new terminals and maintenance facilities, and the acquisition of improved computerized systems for transit services.

"Reliable and efficient public transit is key to ensuring environmentally sound, vibrant, and healthy communities," said Mr. MacKay. "The Government of Canada recognizes that improving public transit use can help reduce congestion, lower automobile emissions, and make our communities more liveable by supporting their economic, social, and cultural development."

"Today's investments will help improve our public transit systems in both urban and rural Nova Scotian communities," said Mr. Muir. "They support healthy, vibrant, sustainable communities, as well as help protect our environment. They also reduce isolation through better access to employment, education, medical services, and community and social events."

The funds include more than $11.7 million from the Canada-Nova Scotia Agreement on the Transfer of Federal Public Transit Funds, and $25.8 million to Nova Scotia through the federal Public Transit Capital Trust.

Service Nova Scotia and Municipal Relations will administer the distribution of these funds, primarily based on ridership. Public transit providers will likely receive funding before March 31, 2007.

"We are delighted that the Canadian government is investing in public transit systems throughout Nova Scotia," said Russell Walker, president of the Union of Nova Scotia Municipalities. "Larger transit services, which include HRM, Kings, and CBRM, will be able to provide improved services, and rural communities will be able to enhance accessible services to seniors, persons with disabilities, and the disadvantaged."

Through Budget 2006, the Government of Canada has provided $1.3 billion in dedicated funding for public transit across Canada. Nationally, $900 million was provided through the Public Transit Capital Trust and $400 million was committed through the Public Transit Fund.

ACKNOWLEDGEMENTS

GPI*Atlantic* gratefully acknowledges funding for this project provided by Transport Canada's Moving on Sustainable Transportation (MOST) program, by Halifax Regional Municipality, by the Nova Scotia Department of Energy, and by the Atkinson Charitable Foundation.

GPI*Atlantic* is also deeply grateful for the generous and ongoing support of Bill and Susan Van Iterson over many years. Their kind contribution to this report enabled the review and revision process to be completed.

We are particularly thankful to David McCusker, Manager, Regional Transportation Planning for Halifax Regional Municipality for finding the funds to finish this report and add an HRM-specific analysis, and for his careful review and supervisory work.

We are also grateful for the sage advice of the members of our Advisory Committee, who made invaluable suggestions, read and reviewed sections of the report in draft form, and provided very important feedback to the researchers. Advisory Committee members were: **Hal Dobbelsteyn**, Program Administration Officer, Nova Scotia Department of Energy; **Andrew Harvey, Ph.D,** Professor of Economics, St. Mary's University; **Nadine MacKay**, Coordinator, Climate Change Centre, Clean Nova Scotia; **David McCusker**, Manager, Regional Transportation Planning, Halifax Regional Municipality; **Ken Reashor**, Manager, Traffic and Right-of-Way Services/Traffic Authority, Halifax Regional Municipality; **Brian Smith**, Chief Administative Officer, Municipality of the County of Kings; **Stephanie Sodero,** Coordinator, TRAX Program, Ecology Action Centre; and **Brian Taylor**, Director, Metro Transit, Halifax Regional Municipality.

We wish to thank the many government employees who took their time to provide GPI*Atlantic* with unpublished data required for this report and we greatly appreciate their keen insight into some of the indicator trends. In particular, we would like to thank: **Michael Arthur**, Director of Community Development, Nova Scotia Office of Health Promotion—Sport and Recreation Division for providing GPI*Atlantic* with unpublished results from a survey on commuting patterns of Nova Scotian children; **Paul Beauchamp**, Manager of Fleet, Metro Transit for explaining some of the issues involved in using biofuels in Metro Transit's fleet and for providing and explaining trend data in bus efficiency; **Cheryl Bidgood**, Communications Officer, Halifax-Dartmouth Bridge Commission for providing unpublished data on pedestrian and cyclists using the Macdonald bridge in Halifax; **Samuel Blais**, Senior Economist, Natural Resources Canada—Office of Energy Efficiency, for his insight into the energy and greenhouse gas trends; **Leonard Bugbee**, Traffic Analyst, Halifax Regional Municipality—Public Works and Transportation Services, for providing unpublished data on traffic volumes in Halifax; **Susanna Fuller**, Founder, Bike Again Program, for providing data on bicycles reconditioned through the Bike Again Program; **Brian Hackett**, General Manager (current), Kings Transit Authority, for providing explanation of the trends in access to transit for Kings Transit; **Robert Leore**, Economist, Transport Canada—Statistics Division, for explaining the problems with Canada's current road length data; **Dale Lyon**, Executive Assistant, Resource Recovery Fund Board, for providing unpublished data on recycled tires and derelict vehicles salvaged in Nova

Scotia; **David McCusker**, Manager of Traffic and Transportation Services, Halifax Regional Municipality for providing explanations about Halifax's traffic volumes and traffic calming programs; **Michael McKeegan**, Cape Breton Regional Municipality Transit Services, for providing data and information about access to Cape Breton's transit system; **Chris Melvin**, Statistics Clerk, Halifax Port Authority, for providing unpublished data on total cargo volumes for the Port of Halifax; **Bob Newcomb**, Economist (former), Nova Scotia Department of Energy, for explaining the impact of the Sable Island Energy Project's impact on transportation energy trends; **Steve Newson**, Policy Advisor, Nova Scotia Department of Transportation and Public Works, for providing unpublished data on road salt used and well contaminations in Nova Scotia; **Andrew Patterson**, General Manager (former), Kings Transit Authority, for providing information about the service area of Kings Transit; **David Poole**, Planning Technician, Planning Department, Municipality of the County of Kings, for providing data and information about access to Kings Transit; **Amy Power**, Transit Planning Technician, Metro Transit, for not only providing data on access to Metro Transit but for taking the time to explain how data are reported to CUTA and the problems with the data; **Ken Reashor**, Traffic and Right-of-Way Services/Traffic Authority, Halifax Regional Municipality, for providing data on Halifax's pedestrian walkways; **Paul Richard**, Operations Analyst, Highways Operations, Nova Scotia Department of Transportation and Public Works, for his help with data on road salt used in the province; **Gary Sellon**, Policy Analyst, Nova Scotia Department of Transportation and Public Works, for providing provincial accident data and some explanatory notes about the data; **Tammy Siu**, Statistics Assistant, Canadian Urban Transit Association, for providing explanations on some of the data reported by CUTA and service area populations; **David Smith**, Supervisor, Database Maintenance Support, Nova Scotia Geomatic Centre, for explaining the problem with Nova Scotia's road length data and current approaches for collecting the data; **Robert Smith**, Director, Environmental Statistics Division, Statistics Canada, for his explanations on how environmental disasters affect the GDP; **Alan Taylor**, Transportation Planner, Halifax Regional Municipality—Public Works and Transportation Services, for providing explanation on Halifax's traffic volumes; **Brett Taylor**, Emissions Inventory Information Analyst, Environment Canada, for providing us with the unofficial air pollution results in advance of Environment Canada's official Criteria Air Contaminant emissions publication in 2005; **Francesca Teggart**, Senior Analyst, Rail Industry, Statistics Canada—Transportation Division, for providing unpublished data on lengths of rail track operated in each province as well as some explanation of the data; and **Greg Wilson**, Planning Technician, Road Network Information Section, Road Safety, Nova Scotia Department of Transportation and Public Works, for explaining how the government intends to improve its records on road lengths in the province

Inspiration for the Nova Scotia Genuine Progress Index came from the ground-breaking work of Redefining Progress, which produced the first GPI in the United States in 1995. Though **GPI***Atlantic*'s methods differ in many ways, particularly in not aggregating index components for a single bottom line, we share with the original GPI the aspiration to build a more comprehensive and accurate measure of wellbeing than can be provided by market statistics alone. **GPI***Atlantic* also gratefully acknowledges the pioneers in the field of natural resource accounting and integrated environmental-economic accounting on whose work this study and the GPI natural resource and environmental accounts build.

*Needless to say, any errors or misinterpretations, and all viewpoints expressed, are the sole responsibility of the authors and **GPI**Atlantic.*

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LIST OF ABBREVIATIONS

μm	micrometres
Ar	Argon
ATVs	All-Terrain Vehicles
BAU	Business as Usual
CAA	Canadian Automobile Association
CACs	Criteria Air Contaminants
CBRM	Cape Breton Regional Municipality
CDN	Canadian
CEPA	Canadian Environmental Protection Act
CFLRI	Canadian Fitness and Lifestyle Research Institute
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2 E	Carbon Dioxide Equivalent
COPD	Chronic Obstructive Pulmonary Disease
CSD	Commission on Sustainable Development
CSERA	Canadian System of Environmental and Resource Accounts
CST	Centre for Sustainable Transportation
CUTA	Canadian Urban Transit Association
DPSIR	Driving forces, Pressures, State, Impacts, and Responses
DTPW	(Nova Scotia) Department of Transportation and Public Works
EEA	European Environment Agency
EPA	(United States) Environmental Protection Agency
EU	European Union
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographic Information Systems
GPI	Genuine Progress Index
GPS	Global Positioning System
H_2SO_3	Sulphurous Acid
H_2SO_4	Sulphuric Acid
HDDV	Heavy-duty diesel vehicles
HDGT	Heavy-duty gasoline trucks
HNO_3	Nitric Acid
HRM	Halifax Regional Municipality
IPCC	Intergovernmental Panel on Climate Change
kt	kilotonnes
L	Litres
LDDT	Light-duty diesel trucks
LDDV	Light-duty diesel vehicles
LDGT	Light-duty gasoline trucks
LDGV	Light-duty gasoline vehicles

MC	Motorcycles
MJ/Pkm	Megajoules per Passenger-kilometre
MJ/Tkm	Megajoules per Tonne-kilometre
MPS	Municipal Planning Strategy
N_2	Nitrogen
N_2O	Nitrous Oxide
NAAQO	National Ambient Air Quality Objectives
NO	Nitrogen Monoxide
NO_2	Nitrogen Dioxide
NO_3	Nitrate
NO_x	Nitrogen Oxides
NRCan	Natural Resources Canada
NS	Nova Scotia
O_2	Oxygen
O_3	Ozone
OECD	Organisation for Economic Co-operation and Development
OEE	Office of Energy Efficiency
PCB	Polychlorinated Biphenyls
PEI	Prince Edward Island
PJ	Petajoules
PM	Particulate Matter
PM_{10}	Particulate Matter with diameters less than or equal to 10µm
$PM_{2.5}$	Particulate Matter with diameters between 2.5 and 10µm
POPs	Persistent Organic Pollutants
ppm	parts per million
ppmv	parts per million by volume
PWTS	Public Works and Transportation Services
ROG	Reactive Organic Gases
RRFB	Resource Recovery Fund Board
SO_2	Sulphur Dioxide
SO_3	Sulphur Trioxide
SO_x	Sulphur Oxides
SPM	Suspended Particulate Matter
StatsCan	Statistics Canada
STPI	Sustainable Transportation Performance Indicators
SUVs	Sport Utility Vehicles
TAC	Transportation Association of Canada
TERM	Transport and Environment Reporting Mechanism
THC	Total Hydrocarbons
TPM	Total Particulate Matter
TSP	Total Suspended Particulate
UN	United Nations
UN ECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UV	Ultraviolet

VMT	Vehicle Miles of Travel
VOC	Volatile Organic Compound
VTPI	Victoria Transport Policy Institute
WCED	World Commission on Environment and Development
WHO	World Health Organization
WMO	World Meteorological Organization

PART I:
INTRODUCTION
AND
BACKGROUND

1. The Genuine Progress Index

We currently measure our progress as a society primarily according to economic growth. If the gross domestic product (GDP—the sum total value of all goods and services exchanged for money)[27] is increasing we describe the economy as "robust," "dynamic," and "healthy." This, we assume, translates into human health, wellbeing, and happiness. That assumption guides countless policy decisions.

What we sometimes overlook is that many economic activities cause damages and risks that offset these apparent gains. For example, vehicle and fuel purchases show up as positive economic activity, although as we drive more kilometres, we increase damages from traffic accidents, ecological damage from greenhouse gas emissions, and urban environmental degradation due to increased vehicle traffic, and we reduce mobility options for non-drivers as transportation systems become more automobile dependent. Because we assign no monetary value to social and environmental assets, their depletion or deterioration is sometimes counted as economic gain that contributes to prosperity, so long as it temporarily increases output, employment, and business activity. As a result, our current accounting is biased in ways that frequently encourage wasteful consumption and harmful activities.

Described differently, conventional economic indicators measure economic *growth*, that is, the *quantity* of material output and consumption. Sustainable economics, by contrast, measures economic *development*, which takes into account the *quality* of goods and services produced and consumed, and it recognizes that excessive consumption can be as harmful as inadequate consumption. For example, sustainable development indicators include assessments of whether people are consuming too much food, energy and other resources, and whether they are spending too much time driving and not enough time walking for their health and enjoyment. This shift, from emphasizing *growth* to emphasizing *development* is particularly important in a materially wealthy society like our own, in which many of the greatest challenges we face are problems of affluence and quality of life rather than problems of poverty and survival. We may therefore choose to place relatively less value on a marginal increase in material wealth, such as a second car or a larger house, and relatively more value on non-market goods, such as health, clean air, free time, the ability of children to walk or bicycle to school rather than be driven, or the legacy of a healthy environment to future generations.

In Nova Scotia, **GPI***Atlantic* is constructing an index of sustainable development, the *Genuine Progress Index* (GPI), which is designed to provide a more accurate and comprehensive picture of community wellbeing. Unlike the GDP, which recognizes only human-produced capital, the GPI also values natural, social, and human capital. Therefore among its social, economic, and environmental components, the Nova Scotia GPI includes natural resource accounts that assign explicit value to our soils, forests, fisheries, water, air, and non-renewable resources, and so

[27] Statistics Canada. "The Economy—Economic size and growth" in *Canada E-Book* (http://142.206.72.67/03/03a/03a_001a_e.htm), 11 September 2006). According to Statistics Canada: "Gross domestic product (GDP) is a popular indicator used to estimate the value of economic activity. GDP measures two things at once over a given period of time: the total income of everyone in the economy and the total expenditure on the economy's output of goods and services produced within the country."

assess the sustainability of our harvesting practices and consumption habits.[28]

In the GPI, natural resources are valued as capital stocks, subject to depreciation like produced capital. Genuine progress is measured by our ability to live off the income or "services" generated by our resources, without depleting the capital stock that is the basis of wealth both for ourselves and our children.

The GPI acknowledges the economic value not only of directly marketable products but also of the full range of ecological and social services provided by these natural capital assets. The GPI forest accounts, for example, count not only the value of timber production, but also the value of forests in protecting watersheds, habitat and biodiversity; guarding against soil erosion; regulating climate; sequestering carbon; and providing for recreation and spiritual enjoyment. Healthy soils and the maintenance of multi-species, multi-aged forests in turn provide multiple economic benefits: enhancing timber quality and productivity; increasing the economic value of forest products; protecting against fire, disease and insects; and supporting the eco-tourism industry. In other words, in the GPI, the health of a forest is assessed not only according to its short-term timber supply—as in conventional accounting mechanisms—but by its capacity to provide multiple ecological, social and economic services that all have definable value, both now and in the future.

Unlike our current measures of progress, which are based on the illusion that prosperity is dependent on limitless material growth, the GPI accounting framework clearly recognizes that finite resource stocks have limited regenerative capacity, and it thus points toward economic policies modelled on the balance and equilibrium that exist in nature. Scientists have noted that biological organisms that have unlimited growth as their operational principle—such as cancer cells, weeds, and algal blooms—are destructive by nature. This rather disturbing analogy can be applied to conventional economic growth theory.

Until we apply the same basic accounting logic to our social and natural capital as we currently do to our produced capital, we are unlikely to cut through the pervasive illusion that "more" is necessarily "better," and so avoid self-destructive practices that harm people and undermine our natural wealth. Including social and natural resource values in our core economic accounts and measures of progress is essential if we are to shift our economic system in a profound way to chart a sustainable future for our children. In marked contrast to measures of progress based on the GDP, this study demonstrates how *less* consumption can be better when it is based on more efficient resource use. While the GDP grows with increased fossil fuel consumption, movement of people and freight, automobile and SUV sales, and expenditures to expand highways to accommodate increased traffic, the GPI recognizes that *reductions* in these activities can signify genuine progress if we can meet human needs and aspirations with fewer economic, social, and environmental costs.

Sustainable transportation analysis challenges the assumption that high levels of per capita vehicle travel reflect consumer demand and contribute to prosperity. People currently lack viable, sustainable alternative travel options, in large part because markets are distorted in such a way that under-price driving, for example by excluding key road and parking costs from conventional analyses of automobile and driving costs. As a result, current levels of travel

[28] The components of the Nova Scotia Genuine Progress Index are listed in Appendix D.

demand do not reflect what is optimal or efficient from the perspective of individual consumers or society overall.[29] Sustainability planning requires that short-term transportation decisions be subordinate to a community's long-term strategic goals, including environmental protection.

As noted, the GPI represents a new, expanded ***accounting*** framework that includes measures of natural, human, and social capital. It is based on a set of ***indicators*** that analyse and report on ***physical*** data, with genuine progress always being assessed by trends in these data and by their current levels in relation to sustainability objectives. For this reason, all **GPI***Atlantic* reports begin with assessments of trends in key indicators, and then, as a separate exercise, build on a system of economic valuation that expands current accounting mechanisms to include social and environmental benefits and costs that are conventionally ignored in the standard accounts.

For example, ***indicators*** of sustainable transportation include reductions in transportation-related greenhouse gas and pollutant emissions, and in transportation-related accidents and deaths. These indicators are measured in physical terms, such as tonnes of carbon dioxide, particulate matter, nitrogen oxides, and volatile organic compounds; and in numbers of car crashes and fatalities. Reductions in emissions, crashes, and injuries signify genuine progress and movement towards a more sustainable transportation system.

Following this analysis of indicator trends, the GPI then adds on a set of ***economic valuations*** in order to assess the true costs of transportation, and the economic savings that could potentially ensue from genuine progress and from movement towards greater sustainability. It *monetizes* (measures in monetary units) the value of non-market social and natural resources that perform vital functions that are literally price-less, so that we can account for damages to these resources and value investments in them. For instance, the direct medical costs of vehicle crashes are calculated, and the human capital approach is applied to transportation fatalities, in order to assess an economic value for crash costs, loss of human life, and productivity losses due to injuries and premature death. Similarly, potential damage costs of climate change and of pollutant impacts on health and ecosystems are referenced from the ecological economics literature, and the costs per tonne of emissions are then applied to the physical data.

However, it is most important not to confuse these two separate sets of analysis. Assessments of genuine progress can only be based on the physical data used to construct the indicator trends, not on the subsequent economic valuations. Higher or lower costs cannot be taken to signify either progress or decline in wellbeing and sustainability, because defensive expenditures – such as restoring a damaged environment – can be assessed either as a proxy for past damage or as an investment in environmental restoration and future productivity.

While full-cost accounting mechanisms are an essential strategy to ensure that transportation is properly priced to include "external" public costs, like pollutant damages and hospital bills, they cannot therefore be used by themselves to assess progress. New Zealand economist Marilyn Waring notes that, in an ideal world, monetizing non-market values would be unnecessary, because a central triad of indicator sets, based on environmental, time use, and market statistics,

[29] Litman, Todd. *Socially Optimal Transport Prices and Markets*. (Victoria Transport Policy Institute, 2006b). www.vtpi.org/opprice.pdf.

would be used both to assess progress and to evaluate all policy options.[30] Presently, however, market statistics so dominate the policy arena that the economic valuation of non-market variables is often necessary to ensure that social and environmental benefits and costs that are hidden in conventional accounting systems are not ignored in policy and planning processes. But that is a different purpose and function than assessing progress.

Because the GPI ***accounting*** system is based on physical indicators, this report—like other **GPI***Atlantic* studies—begins with the identification, definition, and assessment of trends in ***indicators*** (in the present case, of sustainable transportation); and then, as a distinct but related undertaking, embarks on a full-cost accounting evaluation of the true costs of current transportation patterns. The physical indicators, rather than the economic valuation, provide the direct means to track progress. This conceptual distinction explains the basic two-part structure and division of this and other GPI reports.

The Context: Ecology, Society and Economy

Conventional economic theory sees the human economy as a closed system in which firms produce and households consume. That assumption is the basis for calculating economic growth rates which are often used to assess prosperity and social wellbeing, despite the fact that they are biased in ways that undervalue indirect economic, social, and environmental costs.

In actual fact, however, the market economy exists as a sub-system within, and is completely dependent upon, social and ecological systems that provide vital but unpaid services and goods, such as childrearing, household work, and nurturing; climate regulation; pollination; nutrient and hydrological cycling; waste filtration and assimilation; and the enormous range of products provided by natural resources. The energy and matter that enter the human economy from the ecosystem also *return* to the ecosystem, partly as waste. The capacity of the ecosystem to absorb that waste in turn affects the functioning of the human economy.

Described differently, we are far wealthier than indicated by market goods and income alone because we enjoy uncompensated services provided by family, friends, and the natural environment. For example, most people would be much poorer if we were required to pay: our parents for each hour they devoted to childrearing, family members for cooking and cleaning, our friends for entertaining us, the natural world for each breath of fresh air, the warmth of the sun, the rain that makes crops grow, or each litre of water extracted from rivers and wells (of course, we often do pay for water treatment and distribution, but the natural resource itself is often unpriced), or for the many other resources provided free by our communities and the natural environment.

The fundamental flaws in our national accounting system, which result in resource depletion being counted as economic gain, are increasingly acknowledged by experts. World Resources Institute economists Repetto and Austin remark:

> A country could exhaust its mineral resources, cut down its forests, erode its soils,

[30] Waring, Marilyn. "Women, Work, and Wellbeing: A Global Perspective." (Address delivered at the University of Kings College, Halifax, Nova Scotia. April 30, 1998).

> pollute its aquifers and hunt its wildlife and fisheries to extinction, but measured income would not be affected as these assets disappeared.[31]

According to James Gustave Speth, president of the World Resources Institute, relying solely on the GDP as a measure of society's progress creates:

> …a flawed framework for appraising the sustainability of economic growth. While it measures how such man-made assets as factories and equipment depreciate as they are used in current production, it leaves out the effects of resource depletion and degradation. For example, national income accounts record timber output, fish harvest and crop production as income but ignore the costs of deforestation, overfishing and soil erosion. A nation's depletion of its natural resources—consumption of natural capital—can therefore masquerade as growth for decades, even though it will clearly reduce income prospects from resource sectors in the future. Just as ignoring the deterioration of man-made assets skews economic assessments, so does overlooking the degradation of natural assets.[32]

The following statement on the deficiencies of relying on the GDP to measure progress was signed by over 400 prominent economists, academics, and other experts, including Nobel laureates:

> Since the GNP/GDP measures only the quantity of market activity without accounting for the social and ecological costs involved, it is both inadequate and misleading as a measure of true prosperity…. New indicators of progress are urgently needed to guide our society: ones that include the presently unpriced value of natural and social capital in addition to the value of conventionally measured economic production. The Genuine Progress Indicator is an important step in this direction.[33]

Unfortunately, we still take our cues on economic health from an accounting system that was devised at a time when natural resources were thought to be limitless, and ecosystem services "free" and infinite. In fact, the misuse of economic indicators is more entrenched than ever. We continue to adhere to incomplete indictors of wealth and wellbeing because new, more comprehensive accounting systems are still being developed. Statistics Canada—in accordance with recommendations by the United Nations, the Organisation for Economic Co-operation and Development (OECD), the World Bank, and the internationally recognized System of National Accounts—has taken its first steps toward integrated environmental and economic accounting through its new *Canadian System of Environmental and Resource Accounts* (CSERA).[34, 35, 36]

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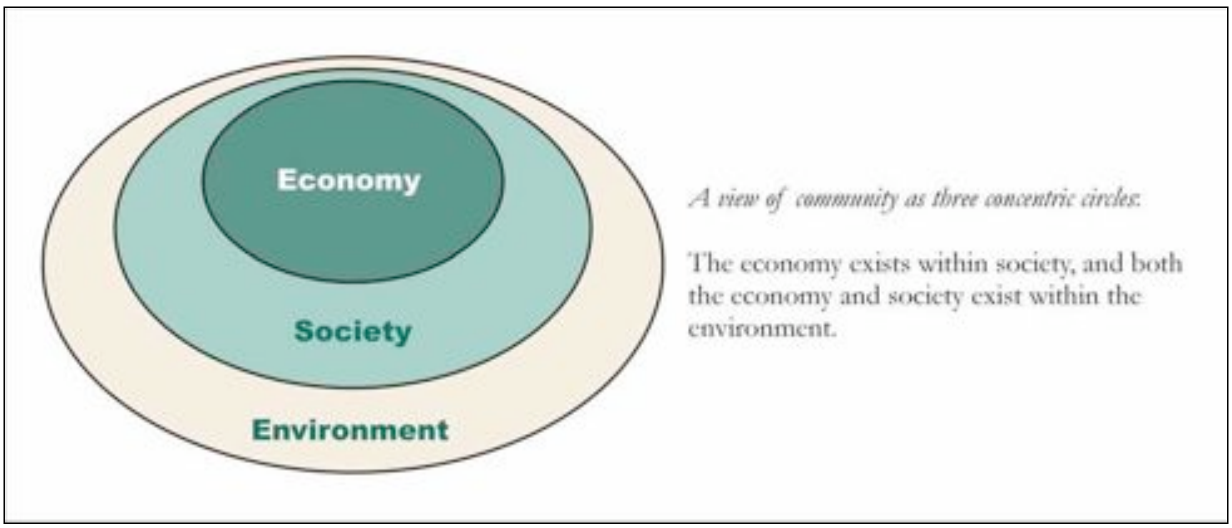
[31] Repetto, Robert and Duncan Austin. *The Costs of Climate Protection: A Guide for the Perplexed*, p.61. (Washington: World Resources Institute, 1997).
[32] Ibid.
[33] Redefining Progress. What's Wrong with the GDP? (www.conversations.com.au/c21c/gpistudy.htm), accessed July, 2004. For more information see also the Redefining Progress web site at www.rprogress.org.
[34] Statistics Canada. *Concepts, Sources and Methods of the Canadian System of Environmental and Resource Accounts*. (Ottawa: Minister of Industry, 1997. Catalogue no. 16-505-GPE).
[35] Statistics Canada. *Econnections: Linking the Environment and the Economy - Indicators and Detailed Statistics*.

The CSERA brings natural resources into the national balance sheets through a set of Natural Resource Accounts, provides expanded input/output tables that account for resource and waste flows through a set of Material and Energy Flow Accounts, and creates a set of Environmental Protection Expenditure Accounts that allow pollution abatement expenditures and clean-up costs to be subtracted from the standard GDP to provide data for calculating a "green GDP".

The integration of natural resource accounts into our core economic accounts implies a profound change in our assumptions. At first glance the notion of "integrated accounts" could imply that economic, social and environmental factors have equal footing in our new approach to measuring prosperity, wealth, and progress. In truth, the change in thinking must be even more profound, recognizing that the human economy is completely dependent upon resource and energy flows from the natural world. Irreversible changes that occur in natural ecosystems, such as climate change and species extinction, can seriously imperil the functioning of human economies.

Therefore, in the GPI accounts, economic and social factors are considered as subsystems of an encompassing ecosystem, rather than simply as co-equal supports— along with environmental indicators—of the same three-legged stool (Figure 10). This approach goes beyond "triple bottom line accounting" to acknowledge a hierarchy of dependence in which environmental conservation is seen as the basis and source of social wellbeing and economic prosperity, and it recognizes the *relationship* and *directionality* of resource and waste flows. By contrast, most triple bottom line exercises, though they go far beyond conventional economic reporting, treat social, economic, and environmental variables as separate, discrete, and co-equal factors.

Figure 10. A Sustainable View of the Relationships between Economy, Society and Environment



Source: Prescott-Allen, Robert. *The Well-Being of Nations: A Country-by-Country Index of Quality of Life and the Environment*. (Washington: Island Press, 2001).

(Ottawa: Minister of Industry, 2001. Catalogue no. 16-200-XKE).
[36] National Round Table on the Environment and the Economy. *The State of the Debate on the Environment and the Economy: Environment and Sustainable Development Indicators for Canada*, pp. 53-54. (Ottawa: 2003). www.nrtee-trnee.ca/Publications/PDF/Report_Indicators_E.pdf

A genuine integration of environmental and economic indicators requires a significantly more far-sighted view of the relationship between economic health and human stewardship of the planet than we have taken to date. Changes that occur today can profoundly affect the ecosystem and its inhabitants in 100 years, 500 years, 1,000 years and beyond, a reality that conventional, narrow income accounts cannot assess. Only measures of progress that evaluate long-term prosperity, rather than just short-term gain, can provide a genuine and accurate guide to policy makers concerned with the wellbeing of future generations as well as of our own.

In order to develop measures of genuine progress, we must begin by carefully delineating our goals for society with regard to transportation. In other words, what social functions do we expect transportation to perform now and in the future? To do this, we must begin with a working definition of *sustainable transportation*. This formulation helps to provide a framework from which we can develop more specific objectives and indicators of genuine progress. Because sustainable transportation is taken here as the goal against which genuine progress in the area of transportation is to be measured, we must be very clear what we mean by this concept.

2. Defining Sustainable Transportation

Sustainable Transportation in the Context of Overall Sustainability

Any index of progress is ultimately *normative* (value-based), since it measures progress towards a particular set of goals. Indicators can therefore be considered as measurable proxies for underlying social values such as security, health, equity, and environmental quality.[37] The normative value used in this report to measure genuine progress is movement towards *sustainable* transportation. This section discusses the definition of sustainable transportation and indicators that can be used to evaluate progress towards sustainability.

Sustainable transportation is an important part of a sustainable society.[38,39] To put sustainable transportation into context, the following section therefore first provides background information on sustainability and its definition.

In 1983, the General Assembly of the United Nations created the World Commission on Environment and Development (WCED), to help address critical environmental and human development problems. Gro Harlem Brundtland, then Norwegian prime minister, was appointed to head the commission, the goal of which was to develop a "global agenda for change." In 1987, the WCED published *Our Common Future* (also known as the "Brundtland Report") which defined the concept of sustainable development as it is most commonly used and recognized today: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[40, 41] *Our Common Future* stressed that economic development must not deplete vital natural resources or harm the environment, and that it *could* take place effectively without doing so. The report also cautioned that economic development must be pursued in an equitable manner.

Concern about sustainability is also partly a reaction to the tendency in decision-making to focus on short-term goals and impacts that are easy to measure while ignoring more complex, longer-term goals and impacts that are more difficult to measure. Sustainable decision-making therefore involves planning that considers a broader range of goals and impacts regardless of how difficult they are to measure. Sustainability reflects concerns about the long-term risks of current resource consumption and therefore about "intergenerational equity" (i.e., being fair to future generations). But the Brundtland Commission and other analysts have noted that concern for *future* equity and environmental quality naturally extend to concern for equity and environmental

[37] For the Nova Scotia Genuine Progress Index, these norms are defined at www.gpiatlantic.org.
[38] Gudmundsson, Henrik. *Indicators to Support Sustainable Transport Policy Decisions: Examples from the US and Canada*, p. 3. (Benchmarking European Sustainable Transport, 2001a). www.bestransport.org/conference03%5CGudmundsson3b.PDF
[39] Litman, Todd. *Well Measured: Developing Indicators for Comprehensive and Sustainable Transport Planning*. (Victoria Transport Policy Institute, 2006f).
[40] Friends of the Earth. Earth Summit 101. (No date.) www.foe.org/WSSD/101.html Accessed May 31, 2004.
[41] World Commission on Environment and Development. *Our Common Future*. (Oxford: Oxford University Press, 1987).

impacts in this generation, and in distant places. Thus, sustainability ultimately reflects the goals of ecological integrity, human welfare, and equity, regardless of time or location.

Sustainability analyses frequently focus on long-term issues like resource depletion and climate change, on the grounds that these problems represent the greatest risk and are prone to being neglected by conventional planning. But sustainability is increasingly defined more broadly to include economic, social, and environmental objectives.[42] Statistics Canada notes that, according to the Brundtland Commission's formulation: "Sustainable development implies that all people have the right to a healthy, productive environment and the economic and social benefits that come with it." Sustainability, in this view, incorporates the objective of "equity, both among members of the present generation and between the present and future generations."[43]

This view and approach ultimately resulted in the identification of three fundamental components of sustainable development that were to guide policy makers: environmental protection, economic development, and social equity. Table 8 indicates various impacts across these three dimensions that are considered when evaluating sustainable transportation.

Table 8. Sustainable Transportation Impacts

Economic	Social	Environmental
Traffic congestion	Equity / Fairness	Air pollution
Infrastructure costs	Impacts on mobility disadvantaged	Climate change
Consumer costs	Human health impacts	Noise and water pollution
Mobility barriers	Community cohesion	Habitat loss
Accident damages	Community liveability	Hydrologic impacts
DNRR	Aesthetics	DNRR

DNRR=Depletion of Non-Renewable Resources

Sustainability tends to change the burden of proof when evaluating risks by applying the *precautionary principle*, which holds that scientific uncertainty must not be a cause for inaction when evaluating serious ecological risks. The precautionary principle has been explicitly written into both federal and provincial environmental legislation. Part One, Section 2 (b) (ii) of Nova Scotia's *Environment Act* states: "The precautionary principle will be used in decision-making so that where there are threats of serious or irreversible damage, the lack of full scientific certainty shall not be used as a reason for postponing measures to prevent environmental degradation."[44] Given the impacts of transportation on climate change and habitat preservation, the precautionary principle has a number of implications for transportation planning. It requires more comprehensive analysis of impacts than is currently the case; consideration of a broader range of long-term solutions; and public involvement in determining alternatives to be evaluated.

[42] Litman, Todd and David Burwell, "Issues in Sustainable Transportation,." (*International Journal of Global Environmental Issues*, Vol. 6, No. 4, 2006, pp. 331-347). www.vtpi.org/sus_iss.pdf.
[43] Statistics Canada. (1997, p.147).
[44] Government of Nova Scotia. *The Nova Scotia Environment Act*. (1994-1995).

2.1 Towards a Working Definition

It is essential to develop a working definition of sustainable transportation, as this in turn determines the objectives, indicators and measures that will be used to assess progress towards sustainability in transportation. Although there is not yet a universally accepted definition of sustainable transportation, several organizations have developed working formulations.

Two of the most notable definitions are those of the *Canadian Centre for Sustainable Transportation* (CST) and of the *European Union* (EU). The following discussion examines these definitions in detail, and highlights their similarities and differences. From this review, a definition of sustainable transportation is developed for use in the current report and as the basis for indicator selection. We shall first examine the CST and EU definitions; then explain the rationale for the **GPI***Atlantic* formula in relation to those two descriptions, noting which parts of the CST and EU formulations have been adopted and which have been modified; and, finally, present the working definition of sustainable transportation that will be used in this report as the basis for the indicators selected and examined.

2.1.1 Centre for Sustainable Transportation

The Centre for Sustainable Transportation (http://cst.uwinnipeg.ca) is a non-profit corporation established in 1996, now located at the University of Winnipeg. It works to help overcome barriers to the attainment of sustainable transportation—in Canada and elsewhere—through the provision of well-reasoned and impartial information and analysis. The centre's mission statement requires it to:

> …work proactively in achieving the sustainable transportation of persons and goods in Canada through co-operative partnerships; relevant and timely research projects; the communication and dissemination of balanced information; and through the monitoring and supporting of sustainable transportation activities.[45]

CST's definition of sustainable transportation was developed in 1997 and updated in 2002.[46, 47] CST was contracted by Transport Canada to help define sustainable transportation, to review indicators of sustainable transportation worldwide, and to come up with a preliminary list of proposed indicators of sustainable transportation for Canada.

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[45] Centre for Sustainable Transportation. *Definition and Vision of Sustainable Transportation*. (Mississauga: 2002). www.cstctd.org/CSTadobefiles/Definition%20Vision%20English%20Oct%202002.pdf Accessed June, 2004.
[46] Gilbert, Richard and Helene Tanguay. *Sustainable Transportation Performance Indicators Project: brief review of some worldwide activity and development of an initial long list of indicators*. (Mississauga: Centre for Sustainable Transportation, 2000). www.cstctd.org/english/docs/STPI%20Phase%201%20project%20final%20report.PDF Accessed June, 2004.
[47] Centre for Sustainable Transportation. (2002).

The CST formula is therefore important to examine for a number of reasons. First, it attempts to address a full range of environmental, economic and social aspects of sustainable transportation that are particularly applicable to Canada. Second, it is comprehensive, supported by a set of elements that further define its parts and serve as goals for a sustainable transportation system. Furthermore the definition is supported by a vision of sustainable transportation for the year 2035, thus creating a suitable long-term perspective. The Centre for Sustainable Transportation also takes a unique approach that attempts to link the different elements of its formula to a set of indicators that can measure movement towards or away from sustainability.[48]

The CST defines sustainable transportation as a system that:

- Allows the basic access needs of individuals to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations.
- Is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy.
- Limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise.[49]

2.1.2 European Union

The European Union is "a group of 25 democratic European countries, committed to working together for peace and prosperity."[50] The EU's Member States have established common institutions to which they delegate some of their sovereignty so that decisions on designated matters of joint interest can be coordinated. There are five key EU institutions, each playing a specific role. One of these is the Council of the European Union, which represents the governments of the Member States.[51] The Council is the main decision-making body of the European Union, and includes designated Ministers for both Transport and Communications.[52] In 2001, the Ministers of Transport and Communications of the member countries of the EU adopted a working definition of sustainable transport that is similar in many respects to the CST formulation. The EU defines a sustainable transport system as one that:

- Allows the basic access and development needs of individuals, companies and societies to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations.
- Is affordable, operates fairly and efficiently, offers choice of transport mode, and supports a competitive economy, as well as balanced regional development.

[48] The CST indicator set will be addressed later in this report.
[49] Centre for Sustainable Transportation. (2002).
[50] European Union. The European Union at a Glance. (No date [a]). www.eu.int/abc/index_en.htm
[51] Ibid.
[52] European Union. European Union Institutions and other Bodies: The Council of the European Union. (No date [b]). www.eu.int/institutions/council/index_en.htm Accessed June, 2004.

- Limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and, uses non-renewable resources at or below the rates of development of renewable substitutes while minimising the impact on the use of land and the generation of noise.[53]

The **GPI***Atlantic* definition of sustainable transportation used in this report incorporates elements of both the CST and EU formulations. The working formula used in this report can best be developed by examining and comparing the environmental, societal, and economic aspects of the CST and EU characterizations.

2.2 Components of the Definition

2.2.1 Environmental component

CST: *Limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise.*

EU: *Limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and uses non-renewable resources at or below the rates of development of renewable substitutes while minimising the impact on the use of land and the generation of noise.*

In an attempt to refine and improve the definition of the environmental domain, some aspects of both the CST and EU formulations were incorporated into the definition used in this report; one element was removed; and a clause to address the impact of transportation on ecosystems was added. In 2000, the CST had considered changing its definition to address the "need to use renewable resources sustainably."[54] The CST referred to the following description from the OECD's Environmentally Sustainable Transport Guidelines project (subsequently adopted by the EU) as a possible substitute:

An environmentally sustainable transport system is one that does not endanger public health or ecosystems and meets needs for access consistent with (a) use of renewable resources at or below their rates of regeneration, and (b) use of non-renewable resources at below the rates of development of renewable substitutes.

For renewable and non-renewable resources, the wording of the EU formulation (originally provided by the OECD) was adopted for the definition used in this report because the phrase "using renewable resources at or below their rates of regeneration" is more specific than "the sustainable yield level" used in the CST definition, and because the latter allows room for

[53] European Union of Ministers of Transport and Communications Council. *Strategy for integrating environment and sustainable development into the transport policy*. (Council Resolution, 2340th Meeting: April 5, 2001). http://ue.eu.int/ueDocs/cms_Data/docs/pressData/en/trans/07587.en1.html#_Toc511149083 Accessed June, 2004.
[54] Gilbert and Tanguay. (2000, p.44).

interpretation about what constitutes sustainable yield. As well, the addition of the phrase "using non-renewable resources at or below the rates of development of renewable substitutes," sets more stringent, definable, and specific limits on the use of non-renewable resources, and explicitly addresses the issue of renewable substitutes. This improves on the vaguer and more general phrase "minimizes consumption of non-renewable resources" from the CST definition.

The GPI definition also changes the placement of the issue of noise generation to the environment and human health domain, which requires that a sustainable transportation system function "in a manner consistent with human and ecosystem health." This is because an excessive level of noise is seen as a hazard to human and ecosystem health rather than as a resource issue, which is the focus of the third paragraph where noise generation currently appears in the CST and EU definitions.

In both the CST and EU formulae, concern is expressed for the amount of land used for transportation (called "land take" in a report prepared for the European Commission)[55] and for the impact on land caused by existing transportation systems. This emphasis on how land is affected needs to be expanded to include the impact on all environments. Attention to ecosystems (defined as "a dynamic system of plants, animals, and other organisms, together with the non-living components of the environment, functioning as an interdependent unit") [56] in the environmental component of the definition would address this need more effectively than the current more limited focus on land alone. An ecosystem does not have precise boundaries—it can be as small as a pond or a dead tree, or as large as the Earth itself. An ecosystem can also be defined in terms of its vegetation, animal species, or type of relief.

Focusing on ecosystem integrity rather than simply minimizing land use for transportation facilities, is important for another reason. Simply minimizing transportation infrastructure (as implied in the environmental component of the CST and EU definitions) does not ensure the protection of a given environment. For example, depending on its placement, a rare ecosystem or the habitat of an endangered species could be damaged by a "small" expansion of a transportation system. The quantitative focus of the CST and EU references to land is therefore too limiting. Instead, the use of the term "ecosystem" in the environmental component of the formula adds a qualitative element, which recognizes that ecological conservation includes protection against both depletion *and* degradation.

It should be noted that both the EU and the CST acknowledge the relevance and importance of "ecosystem health" in the social component of their definitions, where it is paired with human health. Thus we have simply extended this usage explicitly to the environmental segment of the definition. The CST's vision statement also points out that, "with respect to the environment," transportation systems should, **"**make use of land in a way that has little or no impact on the integrity of ecosystems."[57] We therefore believe that the subtle but important change in the

[55] DHV and LT Consultants. *Transport and the Environment: A Multi-country Approach*. (European Commission—Phare Multi Country Transport Programme, 1999). www.unece.org/doc/poja/em/poja.em.2000.eu.1.1.e.pdf Accessed September, 2004.
[56] Natural Resources Canada. *The State of Canada's Forests 2003-2004*, p. 90. (2004a). www.nrcan.gc.ca/cfs-scf/national/what-quoi/sof/sof04/pdf/State_of_Canada_s_Forests.pdf Accessed June, 2004.
[57] Centre for Sustainable Transportation. (2002).

wording of the GPI definition is fully consistent with the intent of both the CST and EU formulations.

The reference to ecosystems in the GPI definition is further supported by the work of the Ontario Round Table on Environment and Economy, another agency that has attempted to define sustainable transportation. The Round Table states that a sustainable transportation system must "minimize disruption of ecological processes" and specifically that "land (and water area) use will be minimized…particularly uses in sensitive habitats."[58] Maintaining the integrity or health of ecosystems is an important component of any description of sustainability, including sustainable transportation, as it points to the need to protect ecosystems from fragmentation and degradation, which can lead to the loss of biodiversity.

Based on the considerations above, the following is a modified version of the environmental component of the definition that is used as part of **GPI***Atlantic*'s definition of sustainable transportation in this study:

Limits emissions and waste to levels below the planet's ability to absorb them, uses renewable resources at or below their rates of generation, uses non-renewable resources at or below the rates of development of renewable substitutes, re-uses and recycles its components, and maintains the integrity of ecosystems.

2.2.2 Economic component

CST: *Is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy.*

EU: *Is affordable, operates fairly and efficiently, offers choice of transport mode, and supports a competitive economy, as well as balanced regional development.*

The economic component of the CST definition was modified for the purposes of this report. First, in accordance with the EU formula, the phrase "operates fairly" was adopted for use in this report, as equity is a core value in the Genuine Progress Index as a whole. Here the addition of "fairly" indicates the need for a just and efficient pricing system in which all external costs are internalized, and in which no social group or segment is unduly disadvantaged. The equity component is written into the description because user-pay systems, however important for economic sustainability, cannot be rigid or blind to equity considerations, nor can they exclude disadvantaged portions of the population from reasonable access to transportation.

To emphasize the need to account for the full costs of transportation without placing undue burdens on disadvantaged groups, **GPI***Atlantic* has added the phrase: "***and identifies and accounts for the full costs of transportation systems in an equitable manner.***" In North America, the evidence indicates that less sustainable modes of transportation (cars, trucks) are currently subsidized to a greater degree than more sustainable modes (rail, mass transit) when the

[58] Heeney, David. *Development and Demonstration of Sustainability Indicators for the Ontario Transportation Sector*, p. 2. (Toronto: IndEco Strategic Consulting, 1995). http://indeco.com/www.nsf/papers/pub_goi

total burden or full costs of the different transportation modes are taken into account. Assessing the full costs of all modes of transportation is thus the first step in addressing these imbalances, which must be corrected over time in order to move towards greater sustainability.

In terms of the quality and type of economy needed to support a sustainable transportation system, neither the CST nor the EU definitions are satisfactory from the GPI perspective. Although the CST acknowledges that "transport is a paradox,"[59] the relationship between transportation and economic goals is not adequately specified in either formula. The terms "vibrant economy" (CST) and "competitive economy" (EU) are both subject to a wide range of interpretations, with the notion of competitiveness sometimes implying reduction of labour costs and real wages, and the sacrifice of local sustainability to global pressures. Further, economies may superficially appear to be "vibrant" and "competitive" when current production and consumption levels are considered in isolation, but may be much less so in the long run if current production and consumption patterns are depleting or degrading natural, human, and social capital.

From the GPI perspective, if transportation is to be sustainable, the economy it supports must also be sustainable. As noted above, sustainable transportation systems have to be "part of a wider concept of a sustainable society."[60] For this reason, **GPI***Atlantic*'s definition extends the notion of sustainability here to the economy as a whole, and substitutes that concept for the phrasing in the CST and EU formulations.

The following is a modified version of the economic component of the definition, as used in this report:

Is affordable, operates fairly and efficiently, offers choice of transport mode, supports sustainable local, regional, and national economies, and identifies and accounts for the full costs of transportation systems in an equitable manner.

2.2.3 Social component

CST: *Allows the basic access needs of individuals to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations*.

EU: *Allows the basic access and development needs of individuals, companies and societies to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations.*

In attempting to refine and improve the description of the social domain, the CST and EU definitions were modified slightly. Therefore, in the first part of **GPI***Atlantic*'s formulation, elements of the CST and EU definitions were combined. The more encompassing term "society" was substituted for "individuals" and "companies," as both individuals and companies are considered to be part of society.

[59] Gilbert and Tanguay. (2000, p. 40).
[60] Gudmundsson. (2001, p. 3).

The CST researchers recognized that the term "basic access needs" is problematic and needs to be defined more carefully, but they have not yet changed the term. For the moment, therefore, the definition in this report incorporates that wording as the best way to define access.[61] The EU's addition of the word "promotes" in relation to equity is proactive and therefore was adopted for the purposes of this report.

The following is the social component of **GPI***Atlantic*'s definition of sustainable transportation:

Meets the basic access needs of society safely and in a manner consistent with human and ecosystem health, including minimizing noise, and promotes equity within and between generations.

2.2.4 Consideration of a governance/institutional component in the definition

Although governance is part of the social domain, **GPI***Atlantic* considered adding a separate government or institutional component to the definition of sustainable transportation, specifying that a sustainable transportation system "is supported and promoted by local, regional, and national government." Attention was given to this possibility because of the legal power that government has to support and encourage progress towards sustainable transportation in all areas.

Governments and institutions receive attention in the discussion sections of this report because progress in all areas is largely dependent on political will, legislation, regulatory mechanisms, and the appropriate allocation of funds. Because of its legal authority, government has the capacity to support the social, economic, and environmental domains through policies and programs that promote sustainability. Government can also influence the behaviour of citizens through education and awareness, and by example.

For these reasons, this study recognizes that a sustainable transportation system can only be achieved with support from all levels of government, with the backing of other sectors of society—including industry, non-governmental organizations, and citizens in general. The case for including a separate governance component in the definition of sustainable transportation was reinforced by the fact that, of all social sectors, only government claims to act in the interests of society as a whole, while other social sectors may have more limited and partial interests in supporting or opposing particular measures.

Despite these arguments, **GPI***Atlantic* in the end did not include a governance component in the final version of the definition. Three factors were especially significant in this decision:

- First, the inclusion of governmental and institutional factors in the definition of sustainable transportation might imply that it is only through governmental actions that

[61] Gilbert and Tanguay. (2000, pp. 35 ff).

sustainability can be achieved, thus downplaying the ability of individuals, community organizations, and corporate bodies to effect change.

- Second, and more practically, in contrast to the indicators for the environmental, social and economic components of transportation, it is not possible at this time to track measurable, quantifiable indicators of governmental actions with regard to sustainable transportation (although qualitative assessments can be made). All the potential indicators examined in this area were seriously flawed either conceptually or due to paucity of data. Potentially, for example, it is possible to investigate and report on the number of instances of particular types of government intervention in support of sustainable transportation; but the results might not be meaningful if one substantive and substantial effort received the same weight as a superficial and ineffectual intervention. **GPI***Atlantic* could not find any adequate or methodologically rigorous means for evaluating and quantifying these qualitative distinctions among types of government action.

- Third, even if it were possible to create adequate measurable indicators for government action, these would differ conceptually from most of the other measures of sustainability in being input indicators, rather than outcomes reflecting the actual sustainability of the transportation system. For example, transport-related pollutant emissions, energy consumption, and road accidents are actual outcome indicators that signify whether a transportation system is becoming more sustainable. Government intervention, on the other hand, is an input that may be *designed* or *intended* to enhance sustainability, but may or may not produce the desired outcome. Although a small number of input indicators have been included in this analysis, particularly in the economic sector where workable outcome indicators were more difficult to identify, these have been kept to a minimum, and the basic approach, framework, and emphasis of this study remains focussed on outcome indicators. Because the entire governance component may be viewed as a set of input indicators, it was felt to be conceptually incompatible with the overall approach taken in this report.

For these reasons it was decided to include a discussion of the role of government in moving towards sustainable transportation in the Recommendations section of this report, rather than to include it as part of the definition of sustainable transportation. It should be emphasized that this decision does not minimize the extraordinary importance of government action, from a policy perspective, in moving towards sustainable transportation.

We also acknowledge that this decision is somewhat inconsistent with **GPI***Atlantic*'s earlier inclusion of "institutional sustainability" components in *The Nova Scotia GPI Fisheries and Marine Environment Accounts* and in *The Nova Scotia GPI Energy Accounts*. However, social and environmental indicator work is still in the experimental stage, so the different approaches to governance in these reports can be viewed as offering a sterling opportunity to examine their comparative strengths and weaknesses from conceptual, methodological, and data availability perspectives. Future updates of this report will certainly reconsider the feasibility of including appropriate governmental/institutional indicators if some of the conceptual, methodological, and data challenges can be more effectively addressed at that time than was possible at present.

The Centre for Sustainable Transportation explicitly recognized the role of government in a sustainable transportation system and also gave consideration to the inclusion of specific indicators to measure the effectiveness of government action. For its Sustainable Transportation Performance Indicators project, CST considered an indicator which would "index the number and intensity of the actions undertaken to change the trajectory of Canada's transport system from 'business as usual' to one consistent with attainment of sustainability."[62] However, CST did not add this item to its initial working set of indicators, deeming it too "difficult to construct and analyze" because "it refers to the behaviour of government officials and others rather than to features of the transportation system."[63] Nevertheless, the CST did include a category for "implementation and monitoring" for which it intends to develop indicators in the future.

Finally, in accord with the GPI view of sustainability presented in the previous chapter, which understands the human economy and society to be sub-systems of a larger and encompassing ecosystem, we have also re-ordered the components of the definition to place the environmental dimension first. As noted above, this reflects a view of sustainability that does not view the economic, social, and environmental aspects of sustainability as co-equal parts of the "three-legged stool," but rather sees human society as dependent upon the encompassing natural world both for resources and to absorb the wastes it produces. Society is placed second both because it is the main driver of the economy and therefore of its impacts on the environment, and because the economy itself serves wider social goals.

Working Definition of Sustainable Transportation

In this report, therefore, sustainable transportation is defined as a system that:

- (**Environment**) limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, uses non-renewable resources at or below the rates of development of renewable substitutes, re-uses and recycles its components, and maintains the integrity of ecosystems;
- (**Society**) meets the basic access needs of society safely and in a manner consistent with human and ecosystem health, including minimizing noise, and promotes equity within and between generations;
- (**Economy**) is affordable, operates fairly and efficiently, offers choice of transport mode, supports sustainable local, regional, and national economies, and identifies and accounts for the full costs of transportation systems in an equitable manner.

[62] Gilbert and Tanguay. (2000, p. 44).
[63] Ibid.

PART II: SUSTAINABLE TRANSPORTATION - *GOALS, OBJECTIVES, AND INDICATORS*

To measure progress towards a sustainable transportation system (and a sustainable society), it is important that the indicators of progress reflect goals that correspond with the definition of sustainability. It is useful to make a distinction between goals and objectives: "*Goals* are desired outcomes to be achieved, such as health, equity and happiness. *Objectives* are ways to achieve goals." Thus, the ultimate goal of economic planning is to maximize social welfare, and the ultimate goal of transportation is access to goods, services and activities. The ultimate goal of sustainability is to maximize the overall wellbeing of current and future generations. This requires that our use of resources and production of wastes remain within the capacity of the planet to regenerate, absorb, and sustain indefinitely.

The European Environment Agency affirms that "introducing common targets would help to direct efforts towards a common objective, thereby strengthening integration across the sectors involved [in trying to achieve a sustainable transportation system]. It would also provide greater transparency and political accountability, and allow for benchmarking progress against clear goals."[64] The following sections of this report will therefore present the goals, objectives, and indicators that will be used to measure the progress of Nova Scotia's transportation system, beginning with goals that can serve as targets against which progress can be measured.

1. Goals

The working definition of sustainable transportation used in this study was presented in Part I above. As noted in Chapter 1, any measure of progress must first answer the question: "Progress towards what?" Identifying clear goals is therefore the essential basis of any set of indicators. The set of goals below therefore simply turns the components of the definition presented in Part I into targets that can act as the basis for indicators and measures of progress. This is a reasonably comprehensive set of goals for sustainable transportation that can form the basis of a long-term vision and policy agenda for sustainable transportation.

Goals of a Sustainable Transportation System:

Environment:

1) Uses non-renewable resources below the rates of development of renewable substitutes.
2) Limits emissions within the planet's ability to absorb them.
3) Limits wastes within the planet's ability to absorb them.
4) Uses renewable resources below their rates of regeneration.
5) Re-uses and recycles its components.
6) Maintains the integrity and health of ecosystems.

[64] European Environment Agency. *TERM 2001—Indicators tracking transport and environment integration in the European Union*. (Luxembourg: Office for Official Publications of the European Communities, 2001, p. 47). http://reports.eea.eu.int/term2001/en/term2001.pdf

Society:

7) Meets the basic access needs of society.
8) Meets access needs safely.
9) Promotes human health.
10) Promotes equity within the present generation.
11) Promotes equity between generations.

Economy:

12) Is economically efficient.
13) Is affordable.
14) Is equitable, including both *horizontal equity* (treats people fairly) and *vertical equity* (provides special support and opportunity for people who are physically, economically, or socially disadvantaged).
15) Promotes balanced modal splits.
16) Identifies and accounts for the full costs of transportation systems in an equitable manner.
17) Supports sustainable local, regional, and national economies.

Many of these goals are connected. For example, part of the value of reducing waste emissions (such as air and water pollution) is to promote human health, and most environmental and economic goals affect equity, which is considered a social goal.

2. Objectives

From the goals listed above, specific and measurable objectives can be established, and a set of indicators can then be developed to measure each objective. **GPI***Atlantic* has drawn on the work of three organizations in identifying objectives and indicators for measuring progress towards sustainable transportation: the European Environment Agency (EEA), the Centre for Sustainable Transportation (CST) and the Victoria Transport Policy Institute (VTPI). Below is a summary and discussion of these three organizations' sustainable transportation objectives and indicators.

The EEA revised the indicators of its Transport and Environment Reporting Mechanism (TERM) in 2002, building on reports in 2000 and 2001. The further development and refinement of these indicators was stimulated by the enlargement of the European Union (adding 10 members in 2004), which presented a major challenge to transportation policy. The integration of environmental concerns into sectoral policies, including transportation, is a major policy component of the EU Sustainable Development Strategy.[65]

For indicator analysis, the EEA uses a conceptual framework known as DPSIR (Driving forces, Pressures, State, Impacts and Responses). This schema is an elaboration of the pressure-state response framework developed by the Canadian government in the 1970s. DPSIR is a system for describing relationships among indicators. It includes five categories: driving or causal forces; pressures created by those driving forces; the current state (of an environmental component, for

[65] European Environment Agency. (2001, p. 4).

example) that has resulted from these pressures; the impacts of that state on human society; and societal responses to the impacts. The various elements of the DPSIR analytic framework—which the EEA uses to show the connections between the causes of environmental problems, their effects, and society's responses to them—are presented in an integrated fashion. The TERM indicators, which cover the most important aspects of transportation and its environmental impacts, also include eco-efficiency indicators.[66] The DPSIR system is now widely accepted as the basis for understanding and communicating environmental information throughout the EU.[67]

Transport Canada encouraged the Centre for Sustainable Transportation to develop Sustainable Transportation Performance Indicators (STPI) for application across Canada.[68] Based on the framework developed for TERM, and on a literature review of indicators developed by five Canadian institutions and six international organizations, the CST created a set of 14 initial indicators, consistent with its definition of sustainable transportation. The indicators were evaluated by potential users in workshops, and the feedback was used to improve the indicators. The CST then undertook a study of these indicators in Canada and confirmed availability of data sources.

Based on this process, the CST developed a somewhat different set of objectives and indicators.[69] Table 9 compares the topics and policy questions in the TERM framework and those of the CST. The CST used the seven topic categories in the TERM framework, but modified the topics and policy questions, and did not adopt the DPSIR framework. The CST argued that the DPSIR system has insufficient relevance to policy, and gives too little attention to trends and their causes.[70] Dr. Peter Hardi, of the International Institute for Sustainable Development, has pointed out that the DPSIR framework is limiting because it oversimplifies linkages between indicators. It also is difficult to use because a given indicator may be considered a "driving force" from one point of view but a "state" from another. In addition, the scientific evidence for causal linkages is often missing.[71] For these reasons, too, this study relies more heavily on the CST indicators, which are not based on the DPSIR schema.

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[66] Ibid., p. 10.

[67] European Environment Agency. *Towards a Transport and Environment Reporting Mechanism (TERM) for the EU—(Part I)*, p. 13. (Copenhagen: European Environment Agency, 1999). http://reports.eea.eu.int/TEC18-1/en/technical_18_part_1.pdf

[68] Gilbert, Richard, Neal Irwin, Brian Hollingworth, Pamela Blais, Hon Lu and Nadia Brescacin. *Sustainable Transportation Performance Indicators (STPI) Project: Report on Phase 3* pp. 16-17. (Mississauga: Centre for Sustainable Transportation, 2002). www.cstctd.org/english/docs/STPI%20Phase%203%20report,%20final.pdf

[69] Centre for Sustainable Transportation. *Options Paper for the November 9, 2000, Workshop*, p. 11. (Mississauga: 2001). www.cstctd.org/english/docs/Final%20STPI%20Phase%202%20report.pdf Accessed July, 2004.

[70] Gilbert et al. (2002, p.24).

[71] Hardi, Peter. Senior Fellow, International Institute for Sustainable Development, Winnipeg, Manitoba. (Personal communication: 2004).

Table 9. Comparison of the Key Categories and Policy Questions of TERM and CST.[72]

TERM topics and questions	CST topics and Questions
1. **Environmental consequences of transport**: *Is the environmental performance of the transport sector improving?*	1. **Environmental and health consequences of transport** *Is the performance of the transport sector improving in respect to its adverse impacts on environment and health?*
2. **Transport demand and intensity** *Are we getting better at managing transport demand and at improving the modal split?*	2. **Transport Activity** *Is transport activity changing in directions consistent with positive answers to other questions?*
3. **Spatial planning and accessibility** *Are spatial planning and transport planning becoming better coordinated so as to match transport demand to the need for access?*	3. **Land use, urban form and accessibility** *Are land use, urban form, and transportation systems changing so as to reduce transportation effort?*
4. **Supply of transport infrastructure and services** *Are we optimizing the use of existing transport infrastructure capacity and moving towards a better balanced inter-modal transport system?*	4. **Supply of transport infrastructure and services** *Are we increasing the efficiency of use of current infrastructure and changing the infrastructure supply in sustainable ways?*
5**. Transport costs and prices** *Are we moving to a fairer and more efficient pricing system, which ensures that external costs are internalized?*	5. **Transportation expenditures and pricing** *Are the patterns of expenditure by governments, businesses, and households, and the associated pricing systems, consistent with moving towards sustainability?*
6. **Technology and utilization efficiency** *How rapidly are improved technologies being implemented and how efficiently are vehicles being used?*	6. **Technology adoption** *Is technology being used more in ways that make vehicle transport systems and their utilization more sustainable?*
7. **Management integration**: *How effectively are environmental management and monitoring tools being used to support policy and decision-making?*	7. **Implementation and monitoring** *How effectively are environmental management and monitoring tools being used to support policy and decision-making towards sustainability?*

The Victoria Transport Policy Institute has produced a set of indicators that put greater emphasis on social goals than either the EEA (TERM) or CST; but for many of these indicators, data are not yet available.[73] Absent from the VTPI goals is the category of technology utilization and efficiency, while the VTPI's social impacts category has been expanded to include more community-based values. The VTPI goals and indicators therefore lean more heavily than other indicator frameworks towards social impacts, and emphasize the greater opportunities for sustainable transportation choices offered by integrated planning and policy.

VTPI defines "economically efficient" transport as the amount of transport activity that consumers would choose in an economically optimal market, in which consumers have viable mobility and accessibility options (such as good walking and cycling conditions, high quality

[72] Gilbert et al. (2002, p. 23).
[73] Litman, Todd. (2006f).

public transit and taxi services, and a variety of location options), the prices for transportation services and facilities reflect full costs unless a subsidy is specifically justified, and public policies and planning practices are unbiased. Because sustainability requires efficient use of resources, sustainable transportation requires that travel demand be reduced to this socially optimal level of transport activity.

The VTPI points out that there is a tension between convenience and comprehensiveness when selecting indicators. A smaller set of indicators for which statistics can be readily obtained may overlook important impacts, while a fuller suite may present unreasonable data collection demands and be difficult to interpret. According to the VTPI, it is important to keep the larger body of goals and indicators on the table, even though the information currently available may be insufficient to assess them. Inclusion of the entire set of indicators and goals helps in determining future data collection needs.

Table 10 presents the objectives of the sustainable transportation frameworks of the EU's Transport and Environment Reporting Mechanism (TERM), the Centre for Sustainable Transportation (CST), and the Victoria Transport Policy Institute (VTPI). Where they were not explicit, these objectives were inferred from the categories and indicators used by those three organizations. For this reason, the phrasing of the objectives listed below is that of the authors of this report and does not necessarily represent the way in which the organizations themselves would express their objectives. These objectives are organized according to the seven questions in the TERM framework above, with the addition of an eighth category (social impacts) from VTPI.

Table 10. Summary of Objectives Inferred from TERM, CST and VTPI Indicators.

CATEGORY	TERM	CST	VTPI
Environmental Consequences of Transport	Decrease environmental and health impacts of the transport sector	Decrease adverse impacts of transportation on environment and health	Reduce environmental and health consequences of transportation
Transport Demand and Intensity	Increase share of movement via more sustainable modes through improved management of transport demand; reduce dependence of economic growth on transport	Reduce overall transport activity; increase proportion of activity through public transport and more sustainable modes	Decrease economically inefficient travel activity (travel that would not occur under optimal market conditions), and increase efficiency of traffic planning
Spatial Planning and Accessibility	Improve access to environmentally-friendly modes of transport and public transportation through coordination of spatial planning and transport planning	Decrease amount of travel required and increase accessibility to sustainable transportation through changes in land use, urban form and transportation systems	Decrease amount of travel required through urban planning, availability of work near homes, and increased internet services in homes

Supply of Transport Infrastructure and Services	Promote sustainable transportation modes by optimizing existing transport structure (including rail and inland waterways) and investing in environmentally-friendly modes of transportation	Decrease dependence on roads and increase use of non-motorized and sustainable travel modes through greater efficiency in use of current infrastructure	Promote sustainable transportation choices through increased quantity and quality of transport options and telework options for individuals and commercial users
Transport Costs and Prices	Promote environmentally-friendly modes and fuels; promote public transport through price instruments and taxes; recover the full cost of transport, including external costs	Promote sustainable transportation and public transit through changes in pricing systems and patterns of expenditure by governments, businesses, and households	Decrease public and private spending on transport and increase relative spending on sustainable modes of transport through changes in pricing system and implementation of full cost accounting and least-cost planning and investment practices
Technology Adoption	Increase efficiency of vehicle energy use by increasing rate of uptake of improved technologies	Decrease fuel intensity, emissions, and dependence on fossil fuels through technology adoption	
Management Planning and Integration	Develop, implement and monitor integrated transport strategies; implement strategic environmental assessment in transport sector; improve environmental performance of transport businesses; improve public awareness and transport choices	Increase integration of transport and land use; increase monitoring of sustainable transportation; increase public support for sustainable transportation	Increase walkability and accessibility of communities; increase range of options considered in transport planning; increase public involvement in transportation planning
Social Consequences of Transportation	**VTPI** Only		
	Increase fairness of transportation systems through transport policies that reflect full costs of transportation, and improve equity for low-income people, non-drivers, and disabled people; Decrease health consequences of transport through improved safety and through increase in active transportation; Increase degree to which transport planning considers cultural and historical values and impacts on non-motorized traffic; Increase overall satisfaction rating of transport systems and degree to which transport activities improve local environmental quality of communities		

The TERM objectives are closely tied to policy issues while the CST objectives are more closely related to its definition of sustainable development. As noted above, the VTPI objectives are somewhat more comprehensive and give more weight to social concerns and equity issues.

Based on the **GPI***Atlantic* transportation goals described earlier in this chapter, and on a review of the objectives of the three organizations outlined above, a more specific set of objectives has been developed for use in this study. These objectives can be related directly to the objectives and indicators of the CST, thereby allowing comparison with the results of the CST's study on sustainable transportation indicators for Canada. In the GPI objectives, a general category—transportation activity—is included among the list of environmental and human health consequences of transportation. This is because the evidence indicates that the sum total of transportation activities currently exceeds environmentally sustainable levels; so an overall decrease in transport activity is seen as progress in meeting the environmental goals.

The objectives for **GPI***Atlantic*'s *Sustainable Transportation Accounts* can therefore be described as follows. It should be noted that, although some of the objectives listed below are general societal imperatives (e.g. reduction in emissions of greenhouse gases and air pollutants), all of the following objectives are specifically related to the transportation sector for the purposes of this study.

Objectives related to Environmental and Human Health Consequences of Transportation

1. Decrease overall motorized transport activity
2. Increase share of movement of people and freight by more sustainable modes
3. Decrease overall energy consumption
4. Decrease emissions of greenhouse gases
5. Decrease emissions of air pollutants
6. Decrease water pollution from transportation
7. Decrease fossil fuel energy consumption through technology adoption
8. Decrease fossil fuel emissions through technology adoption
9. Increase recycling and re-use of transportation components
10. Decrease space taken by transport facilities

Social Objectives: Land Use and Access

11. Increase access to basic services
12. Increase access to public transportation
13. Increase access to Internet
14. Decrease transport injuries and fatalities
15. Increase non-motorized transportation
16. Improve neighbourhood quality of life

Economic Objectives

17. Increase percentage of net government spending devoted to public transportation
18. Increase percentage of full transportation costs (including "externalities") funded by user-paid revenues, with due regard to equity considerations
19. Decrease cost of household transportation in lowest economic quintile

A decision was made not to include governmental and institutional factors in the definition of sustainable transportation used in this report for reasons specified above. Nevertheless, for discussion purposes, it is worth noting governmental, institutional and planning objectives that could support movement towards more sustainable transportation. These include:

- Increase implementation of policy and practices that lead to more accessible, clustered development;

- Increase implementation of policy and practices that reduce the impacts of motorized transport on non-motorized transport;
- Increase implementation of policy and practices that internalize full costs of transportation;
- Increase cooperation between environment, transportation, and planning departments;
- Increase public awareness and involvement in planning processes.

All these institutional inputs have the potential to produce transportation outcomes that are more sustainable.

Table 11 shows the relationship between the comprehensive set of goals listed earlier in the chapter and the related objectives. All of the comprehensive goals are included in this system, although the arrangement in categories has been revised to be more directly comparable to the CST system, and to indicate the prominence of environmental issues in accord with the strong sustainability model (Figure 10 above), which recognizes the dependence of human society on ecosystem services. It should be mentioned that there is overlap between the goals and objectives. For example, a decrease in overall transportation also results in a decrease in energy use and pollutant emissions. As well, the specific objectives are not assumed to achieve every aspect of the broader and more general goals.

Note that four of the listed goals—health, sustainable economic development, and intra- and inter-generational equity—are not simply the outcome of particular objectives but rather constitute broad, overarching societal outcomes associated with wellbeing and sustainability. As such, they are seen to be related to *all* the objectives achieved in an integrated manner.

Table 11. Interrelation of GPI Sustainable Transportation Goals and Objectives.

OVERALL GOAL	Category	Objective
Environmental:		
Uses non-renewable resources below the rates of development of renewable substitutes; Limits emissions to levels that are within the planet's ability to absorb them; Limits wastes to levels that are within the planet's ability to absorb them; Uses renewable resources below their rate of regeneration	Environment and Human Health	1. Decrease overall motorized transport activity and increase share of movement of people and freight by more sustainable modes
Uses non-renewable resources below the rates of development of renewable substitutes	Environment and Human Health	2. Decrease energy consumption
Uses renewable resources below their rate of regeneration	Environment and Human Health	2. Decrease energy consumption
Limits emissions to levels that are within the planet's ability to absorb them	Environment and Human Health	4. Decrease GHG emissions from transport 5. Decrease air pollutant emissions from transport 6. Decrease fossil fuel consumption through technology adoption
Limits wastes to levels that are within	Environment and Human Health	7. Decrease water

the planet's ability to absorb them		pollution from transport
Re-uses and recycles its components	Environment and Human Health	8. Increase recycling and re-use of transportation components
Maintains the health and integrity of ecosystems	Social	9. Decrease space taken by transport facilities
Social:		
Meets the basic access needs of society	Social	10. Increase access to basic services 11. Increase access to public transportation 12. Increase access to internet
Meets access needs safely	Social	13. Decrease transport injuries and fatalities
Is consistent with human health		14. Increase non-motorized transportation All objectives achieved in integrated way
Promotes equity within the present generation		All objectives achieved in integrated way
Promotes equity between generations		All objectives achieved in integrated way
Economic:		
Promotes balanced modal splits	Economic Environment and Human Health	15. Increase percentage of net government spending devoted to public transportation 16. Increase proportion of full transportation costs (including externalities) funded by user-paid revenues, with due regard to equity considerations Also: *1 .Decrease overall motorized transport activity* *2. Increase share of movement by more sustainable modes* *3 Increase non-motorized transportation*
Is affordable, and operates fairly and efficiently	Economic	17. Decrease per cent of household spending on transportation by population in lowest quintile income bracket
Supports sustainable economies	All	All objectives achieved in integrated way

3. Indicators

A key step in applying the concept of sustainability to policy and planning decisions is to develop practical indicators to quantify and evaluate the impacts of human activity.[74] Among its recommendations for achieving sustainable development, the seminal UN document, *Agenda 21* encourages the use of appropriate indicators of sustainability as measuring tools. Transport Canada committed to the development of sustainable transportation indicators by 2005, for use in charting progress towards sustainable transportation, and therefore commissioned the Centre for Sustainable Transportation to help develop these indicators.[75]

Indicators are statistical sets designed to allow significant trends to be monitored. Henrik Gudmundsson defines them as "selected, targeted, and compressed variables that reflect public concerns and are of use to decision-makers."[76] In other words, an indicator describes the current state of an economy, environment, or society, and can help both to monitor progress towards (or away from) a defined goal such as sustainability and to identify where improvements need to be made.

The CST uses Gudmundsson's definition, and outlines several purposes served by indicators, as follows. Indicators can help with:

- comparisons of similar trends across jurisdictions;
- comparison of different transportation phenomena;
- the understanding of trends;
- educating policy-makers, stakeholders, and the public;
- setting priorities; and
- evaluating progress towards or away from sustainable transportation.[77]

Indicators can also be used for assessing particular policies and planning options, and to set performance targets.[78] One of the most important reasons for developing indicators is the need to anticipate future developments and to find out if society is approaching critical thresholds that otherwise may not be noticed.[79] In other words, good indicators can provide early warning signals to decision-makers, and allow graduated policy responses before crises develop.

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[74] Litman, 2006f.
[75] Transport Canada. *Sustainable Development Strategy 2001-2003*. (Minister of Public Works and Government Services, 2001a, p. 33). www.tc.gc.ca/programs/environment/SD/strategy0103/final%20SD%20Strategy%20-%20eng.pdf Accessed September, 2004.
[76] Gudmundsson, Henrik. *Indicators of "Environmentally Sustainable Transport" (EST)—what, how and why to indicate?* (Paper presented at the European Science Foundation and the National Research Foundation Conference on Social Change and Sustainable Transport, March 10-13, 1999). See also: Gudmundsson, Henrik. *Indicators and Performance Measures for Transportation, Environment and Sustainability in North America*. (National Environmental Research Institute, Denmark: 2001b).
www2.dmu.dk/1_viden/2_Publikationer/3_arbrapporter/rapporter/AR148.pdf
[77] Gilbert et al. (2002, p. 25).
[78] Litman. (2006f, p. 1).
[79] European Environmental Advisory Councils. *Environmental Indicators and Sustainable Development Trends*, p. 17. (Brussels: Milieu en Natuurraad van Vlaanderen, 2001). www.minaraad.be/English/EEAC-verslagboek.pdf Accessed September, 2004.

The choice of indicators can significantly influence the results of an analysis. In particular, the tension between comprehensiveness and practicality in indicator selection is not easily resolved. Every effort has been made to be as inclusive as possible in selecting indicators for this report, but we are also limited to indicators for which suitable statistics can be found. In order to be useful, an indicator must be based on a reliable source of data and must provide information over time so that trend lines can be established. In selecting indicators for this study, the prior efforts of the CST, the VTPI, and the European Environment Agency were given particular attention. Their systems—which are already quite comprehensive—are based on extensive literature reviews, and represent some of the most advanced thinking in the area of sustainable transportation indicators. A larger, independent survey of the literature was beyond the scope of the present project.

For the sake of comparability, the indicators selected for use in this report have been consciously modelled on the framework used by the Centre for Sustainable Transportation. We hope that this report, including suggested modifications of the CST framework, may also serve to inform further efforts by the CST in this area.

The EEA has selected and grouped its TERM indicators to address the seven key policy questions noted in Table 9 above. EU decision-makers regard these as key to understanding whether current policy measures and instruments are influencing transport/environment interactions in a sustainable direction. The first set of TERM indicators was developed in 2000; these were updated in 2002, and the process is still evolving.[80, 81] As noted earlier, TERM used the DPSIR framework for its indicators.

The Victoria Transport Policy Institute has developed a set of 42 sustainable transportation indicators.[82] Twenty-one of these are in the economic category; 13 are social; and eight are environmental. VTPI rates the quality of data availability for each indicator. For 24 of them, the data are limited and may require special collection. For another 11 indicators, the data are often available but not standardized. For only six of the indicators are data usually available in standardized form. This analysis points to the problem of obtaining reliable data for indicators of sustainable transportation. However, VTPI notes that even when required information is unavailable, it is important to keep the full set of indicators in the list as this can pinpoint data collection needs and perhaps encourage agencies that collect statistics to redirect some of their efforts to obtaining this information.

As noted earlier, the VTPI indicators are more comprehensive, but in some ways less practical, than the other two indicator sets because it includes so many indicators for which standardized data are not available. The VTPI indicators do not include a category for technology utilization and efficiency, but emphasize the impact of transportation at the social and community

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[80] European Environment Agency. *Are we moving in the right direction? Indicators on transport and environment integration in the EU*. (Copenhagen: 2000). http://reports.eea.eu.int/ENVISSUENo12/en/term2000.pdf
[81] European Environment Agency. *Paving the way for EU enlargement: Indicators of transport and environment integration*. (Luxembourg: Office for Official Publications of the European Communities, 2002). http://reports.eea.eu.int/environmental_issue_report_2002_24/en/TERM-2002_final.pdf
[82] Litman. (2006f, pp. 11-12).

level—including liveability of communities, equity in accessibility, and transportation planning that takes a broader view of potential social impacts.

As part of the Sustainable Transportation Performance Indicator project, the CST has done considerable work on developing indicators, extensively reviewing the efforts of other organizations, and narrowing a list of 160 potential indicators down to 14 initial indicators. The CST reviewed environmental and transportation indicators developed by Environment Canada, the National Round Table on the Environment and the Economy, the Ontario Round Table on Environment and Economy, the Transportation Association of Canada, and the Victoria Transport Policy Institute.[83] The CST also examined indicators from the World Bank, the Organisation for Economic Co-operation and Development, the Baltic countries, New Zealand, the United Kingdom, and the city of San Francisco (USA). The CST's initial indicator set is based on its goals and definition of sustainable transportation. According to the CST, the steps for developing a set of indicators are:

1) Define what is meant by sustainable transportation.
2) Quantify the elements of the definition in terms of criteria for attainment of sustainable transportation.
3) Construct indicators that allow assessment of progress towards meeting the criteria.

In selecting variables that could serve as indicators, the CST used four criteria:

1) The variable should concern sustainable transportation, as elaborated in the CST's definition, or provide a clear answer to one of the seven key policy questions listed in Table 9 above, or both.
2) It should be a time series so that information can be provided on changes in performance.
3) To the extent possible, it should represent all of Canada.
4) Data should come from what the project team considers to be a reputable and reliable source, usually the federal government for Canada-wide data.[84]

The CST's initial set of indicators is shown in Table 12, along with lists of indicators that the CST considered might be added in the short term and longer term. In the CST's 2002 *Report on Phase 3*, each indicator, plus potential data sources, is discussed in detail.[85]

[83] Gilbert and Tanguay. (2000, pp. 4-14).
[84] Gilbert et al. (2002, p. 12).
[85] Ibid., p. 14.

Table 12. CST's Sustainable Transportation Performance Indicators, with Proposed Short-Term and Long-Term Additions.

CATEGORY	INITIAL SET	ADDITIONS FOR SHORT-TERM	ADDITIONS FOR LONG-TERM
1. Environment and Human Health Consequences of Transportation	1. Use of fossil fuel energy for all transport 2. Greenhouse gas emissions from all transport 3. Index of emissions of air pollutants from road transport 4. Index of incidence of road injuries and fatalities	- Air Quality - Waste from road transport - Discharges into water - Land use for transport - Proximity of infrastructure to sensitive areas, and ecosystem fragmentation	- Noise - Effects on human health - Effects on ecosystem health
2. Transport Activity	5. Total motorized movement of people 6. Total motorized movement of freight 7. Share of passenger transport NOT by land-based public transport 8. Movement of light-duty passenger vehicles	- Use of passenger vehicles - Urban automobile vehicle-kilometres - Travel by non-motorized modes in urban areas - Journey-to-work mode shares	- Urban and inter-city person-kilometres - Freight modal participation - Use of freight vehicles
3. Land Use, Urban Form, and Accessibility	9. Urban land use per capita	- Urban land use by size class and zone - Employment density by Census Metropolitan Area, and urban size class and zone - Mixed use	- Share of urban population and jobs served by mass transit - Share of population and employment growth on already-urbanized lands - Travel and modal split by urban zone
4. Supply of Transport Infrastructure and Services	10. Length of paved roads	- Length of sustainable infrastructure - Transit seat-kilometres per capita	- Congestion index
5. Transportation Expenditures and Pricing	11. Index of relative household transport costs 12. Index of the relative cost of urban transit	- Per cent of net government transport expenditures spent on ground-based public transportation	- Transport-related user charges - Expenditures by businesses on transportation
6. Technology Adoption	13. Index of energy intensity of cars and trucks 14. Index of emissions intensity of the road-vehicle fleet	- Per cent of alternative fuel vehicles in the fleet	- Per cent of passenger-km and tonne-km fuelled from renewable energy - Per cent of labour force regularly telecommuting
7. Implementation and Monitoring		- Number of sustainable transport indicators regularly updated and widely reported - Public support for initiatives to achieve sustainable transportation	- Number of CMAs where planning and delivery of transport and related land use matters have a single entity

GPI Indicators

Below we describe three categories of indicators of sustainable transportation that are used in this study, and which follow closely the categories described above: environment and human health; social; and economic. However, it is important to remember that in **GPI***Atlantic*'s framework of sustainability (Figure 10 above), these three categories are not co-equal. Rather, social and economic factors are seen as contingent on environmental resources and on the continuing capacity of the environment to absorb human-generated wastes. A sustainable transportation system therefore depends first and foremost on the conservation of those environmental resources on which human society is dependent, and on not loading the planet with wastes—such as excess greenhouse gas emissions—beyond its absorptive capacity. Thus in the list below the indicators are arranged and phrased so as to highlight the pre-eminence of environmental indicators**.**

For the reasons outlined earlier, governmental/institutional indicators have not been included here, despite an original intention to do so. It is noteworthy that the CST also wished to include governmental/institutional factors in its indicator suite in the seventh category in Table 12 above—implementation and monitoring. However, due to data limitations and the difficulties in conceptualising these indicators and applying consistent and rigorous methodologies to their measurement, the CST has postponed the development of these institutional indicators. This study similarly acknowledges the importance of this dimension of sustainable transportation and intends to revisit the challenge of developing appropriate governmental/institutional indicators in future updates of this report.

Vehicle Travel as a Key Indicator

Several of the sustainable transportation indicators in this study reflect the key assumption that excessive levels of per capita motor vehicle travel contradict sustainability objectives, and so reductions in overall motorized travel are interpreted as a trend towards sustainability. Thus, shifts from automobile travel to alternative modes, such as walking, cycling, public transit, and telecommuting for personal travel, and from truck to rail or barge for freight travel, are considered to increase transportation system efficiency and therefore sustainability.

This assumption requires explanation, as some may argue that automobile travel can be sustainable if it uses efficient or alternative fuel vehicles. This argument might be true if the only sustainability objective were reducing fossil fuel consumption. But even a solar-powered vehicle imposes significant economic, social, and environmental impacts (such as congestion, road and parking infrastructure costs, consumer costs, accidents, use of resources, and inadequate mobility for non-drivers), and current transportation markets are distorted in ways that underprice all forms of motorized travel (even more fuel-efficient ones), resulting in inefficient travel patterns (Table 13). For example, externalizing major road and parking costs distorts the market in favour of all kinds of motor vehicle travel, regardless of fuel efficiency. Only if all of the distortions listed in Table 13 below were corrected could resultant levels of motorized travel be considered efficient and sustainable. In a more efficient market, in which motorists paid directly for using roads and parking facilities, in which insurance and registration fees were distance-based, and in which transportation planning and investment decisions reflected least cost principles, the evidence indicates that motor vehicle travel would probably decline by 20-40%.[86]

Table 13. Transportation Market Distortions

	Description	Examples	Potential Reforms
Consumer options and information	Markets often offer limited alternatives to automobile transportation and automobile-oriented location.	Poor walking and cycling conditions. Inadequate public transit services. Shops that do not offer delivery services. Lack of vehicle rental services in residential areas.	Recognize the value of alternative modes and more accessible development in planning decisions.
Under-pricing	Many motor vehicle costs are fixed or external.	Fixed insurance and registration fees. "Bundled" parking (automatically included with building space). Free parking without *cash out* (being able to choose the cash value rather than a parking space). Un-priced roads. Tax policies that favour automobile travel.	As much as feasible, convert fixed costs to variable charges and charge motorists directly for the costs they impose.
Transport Planning Practices	Transportation planning and investment practices favour automobile-oriented improvements, even when other solutions are more cost effective.	Dedicated highway funds. Transport indicators that focus on vehicle traffic conditions. "Reductionist" planning[87], which ignores multiple objectives and options.	Apply least-cost planning so alternative modes and management strategies are funded if they are the most cost-effective way to improve transport.
Land Use Polices	Current land use planning policies encourage lower-density, automobile-oriented development.	Dedicated highway funding. Development fees, utility rates and taxes that fail to reflect location-based costs.[88]	Smart growth policy reforms that support more multi-modal, accessible land use development.

Source: Litman, Todd. *Transportation Market Distortions: A Survey*. (Victoria Transport Policy Institute, 2006e).

Note: This table summarizes major categories of transportation market distortions and potential reforms.

[86] Litman, Todd. *Socially Optimal Transport Prices and Markets*. (Victoria Transport Policy Institute, 2006b). www.vtpi.org/opprice.pdf.
[87] An example of "reductionist" planning is a decision to widen a highway in response to increased motor vehicle traffic, rather than to approach the problem in a systemic way based on the multi-dimensional approach illustrated in this study that includes consideration of multiple objectives and options, including alternative transport modes.
[88] For example, low-density development often increases unit utility costs for electricity, water, roads, sewage and other services, that are passed on to all consumers (externalized) rather than to those imposing the costs by living in low-density developments.

So long as such pervasive market distortions persist in favour of motor vehicle travel and automobile-dependent development, progress towards sustainability can therefore be indicated by *decreases* in total motorized movement of people and freight, vehicle ownership per household, movement of light-duty vehicles, and percentage of freight moved by truck. In this way trends in transport activity and modal distribution are the foundation for other indicators in this study.

Environment and Human Health

There is mounting evidence to indicate that the contribution of motorized travel to climate change, air pollution, and other environmental problems is unsustainable at current levels. From this perspective, *decreases* in transport-related fossil fuel energy consumption; greenhouse gas emissions; air pollutant emissions; water pollution; and intensity of energy use and emissions from cars and trucks—all these are seen as trends toward sustainability. A *decrease* in land used by transportation infrastructure is viewed as progress towards sustainability, since transportation infrastructure can harm ecosystems, habitats, and biodiversity. Conversely, an *increase* in the share of passenger travel by public transit indicates a trend towards sustainability, as the evidence indicates that public transit reduces environmental impacts per passenger kilometre travelled. An *increase* in the recycling and re-use of transportation components is also understood as movement towards sustainability.

Social

The following social trends are viewed as progress towards sustainability.

1) Decrease in:
   - transport injuries and fatalities; and
   - average commuting time
2) Increase in:
   - length of sidewalks and bike paths;
   - percentage of people who commute by walking, bicycling, or public transit;
   - percentage of households located near public transit access;
   - percentage of people who work at home; and
   - percentage of people who have Internet access (thereby facilitating work from home and a reduction in commuting)

Economic

The following economic trends are viewed as progress towards sustainability.

1) Decrease in:
   - the proportion of household expenditures on transportation in the lowest income quintile
2) Increase in:

- the proportion of government spending on public transit as a percentage of total government expenditures on ground transportation;
- the share of full transportation costs (including externalities) funded by user-paid revenues, with due regard to equity considerations; and
- the percentage of household transportation spending devoted to public transit

Described differently, various types of travel changes provide various types of benefits to individual consumers and society, as summarized in Table 14. For example, reductions in automobile ownership and use, and increased use of walking, cycling, ridesharing, and public transit travel, will typically result in reduced congestion, road and parking facility cost savings, consumer cost savings, improved transportation options (and therefore improved mobility options for non-drivers), reduced traffic accidents, reduced pollution, energy conservation, more compact land use development, and improved public fitness and health. There may be a few exceptions, for example, shifting from driving to ridesharing may not increase physical fitness, although most public transit trips include walking links, so public transit ridership tends to provide this benefit indirectly.

Note that Table 14 below does not provide a full list of transportation planning objectives or benefits, including benefits deriving from automobile ownership and use. Rather, Table 14 simply illustrates the way certain benefits that might accrue from a reduction in motor vehicle use and a move towards greater transportation sustainability may vary according to different types of travel changes.

Table 14. Benefits of Various Types of Travel Changes

Planning Objective	Reduced Vehicle Ownership	Reduced Vehicle Trips	Shift To Transit/ Ridesharing	Shift To Walking/Cycling	Shift Trip Time
Congestion reduction	✓	✓	✓	✓	✓
Roadway cost savings	✓	✓	✓	✓	✓
Parking cost savings	✓	✓	✓	✓	
Consumer cost savings	✓	✓	✓	✓	
Transport Options	✓	✓	✓	✓	✓
Improved traffic safety	✓	✓	✓		
Reduced pollution	✓	✓	✓	✓	✓
Energy conservation	✓	✓	✓	✓	✓
Efficient land use	✓	✓	✓	✓	
Improved fitness & health	✓	✓		✓	

Source: Litman, Todd. *Mobility Management Economic Evaluation*. (Victoria Transport Policy Institute, 2006a).

Note: (✓ = helps achieve that objective)

Table 15 presents the objectives and corresponding primary indicators used in the present study. The indicators with an asterisk are those that were also included in the CST's initial set of 14 indicators. Half of the key indicators used by the CST are included in the GPI suite of primary indicators noted below. Others are referenced in different parts of this report. Several indicators have been added, most of them taken from the short-term or long-term expansions suggested by the CST. Each of the indicators, and its relation to the CST indicators, will be discussed in depth in the next section, which presents trends in the indicators for Nova Scotia. For reasons discussed in the recommendations section of this report, it was not possible at this time to develop the indicators or assess trends corresponding to objective 16 ("Increase proportion of full transportation costs funded by user-paid revenues"). Nevertheless, indicators have at least been suggested here for this objective, because it is hoped that it will be possible to complete this work at a later date.

It should also be pointed out that neither the objectives nor the following indicators attempt to describe a "complete" picture of transportation. Rather, they are intended to ***indicate*** or point towards a description of the state of transportation. For example, affordability is here assessed according to transportation expenditures by the lowest quintile (or one-fifth) of earners. Clearly affordability is also an issue in higher income brackets, and certainly for the second and middle quintiles. As a complete set of descriptive indicators is never possible, the larger picture must therefore always be inferred from the limited number of specific indicators listed below.

Table 15. GPI Sustainable Transportation Objectives and Indicators

Objective	Indicator**
Environment and Human Health	
1. Decrease economically excessive motor vehicle transport, and increase use of more sustainable modes	1. Motorized movement of people: - passenger-km* - passenger-km per capita - comparison of trends: passenger-km and GDP 2. Motorized movement of freight - tonne-km* - tonne-km per capita - comparison of trends: tonne-km and GDP 3. Passenger automobiles per capita
2. Decrease energy consumption	4. Transport-related energy consumption - Total* and per capita energy consumption devoted to transportation - Per cent of primary energy consumption dedicated to transportation - Share of energy consumption by mode and fuel
3. Increase fossil fuel energy efficiency	5. Energy intensity of cars and trucks - energy consumption per vehicle-km
4 Decrease greenhouse gas (GHG) emissions	6. Transport-related GHG emissions by mode* and per capita
5. Decrease emissions of air pollutants	7. Total transport emissions of air pollutants by mode* and per capita
6. Decrease fossil fuel emissions through technology adoption	8. Emissions intensity of cars and trucks - emissions per vehicle-km*
7. Decrease water pollution	9. Polluting discharges by mode - oil spills - road salt usage - well contamination
8. Increase recycling and re-use of transportation components	10. Number of tires recycled 11. Number of derelict cars recycled
9. Decrease space taken by transport facilities	12. Land Use - space taken by transport facilities by mode - total length of paved roads* - urban density*

Social	
10. Increase access to basic services	13. Access to basic services - average commuting distance - per cent of children who walk to school - per cent of commuters who walk, bicycle, or use public transit
11. Increase access to public transportation	14. Access to public transit - per cent of population who live within 500 m of transit station
12. Increase access to the Internet	15. Per cent of population with home Internet - per cent of population who work at home
13. Decrease transport injuries and fatalities	16. Transport injuries and fatalities by mode
14. Increase non-motorized transportation	17. Non-motorized travel: quality and quantity of walking and cycling conditions - km of bike paths and sidewalks
Economic	
15. Increase percentage of net government spending on public transportation	18. Investments in public transport - per cent of net government ground transportation expenditures spent on public transportation
16. Increase proportion of household transportation spending devoted to public transit	19. Percentage of household transportation spending devoted to public transit
17. Decrease cost of household expenditure in lowest income quintile	20. Expenditure on personal mobility - per cent of household expenditures dedicated to transportation for those in lowest income quintile

Note: Indicators marked with an asterisk (*) are those that were also included in the CST's initial set of 14 indicators. **This list of indicators includes only the primary indicators, there are additional, secondary indicators, in the report.

PART III: SUSTAINABLE TRANSPORTATION INDICATORS FOR NOVA SCOTIA

Reporting on Trends in Sustainable Transportation

Environment Canada describes the role of indicators in analysing trends in sustainable development as follows:

> Environmental indicators provide an effective means by which complex environmental data can be transformed into easy-to-use communication and decision-making tools—tools that can help us keep track of the state of the environment and measure progress toward sustainable development. Ideally, environmental indicators can be used in much the same way that economic indicators have been for many years.[89]

Environment Canada's *Environmental Signals* series tracks 13 environmental indicators, organized into four categories—ecological life-support systems; human health and wellbeing; natural resources sustainability; and human activities—over periods of one or two decades. A number of these indicators—climate change, stratospheric ozone, urban air quality, energy consumption, and passenger transportation—are directly or indirectly related to transportation. The trends assessed by Environment Canada are broad in scope, covering all of Canada.[90]

In 2003 the European Environment Agency published the third assessment of Europe's environment, building on previous reports in 1995 and 1998.[91] Continental in scope, the document includes 13 indicators of sustainable transportation, summarized in short sections with easy-to-read graphs, and with trends highlighted. The Centre for Sustainable Transportation has produced the first report on its Canada-wide indicators, as well as a booklet with one-page descriptions of each indicator, with trends clearly demonstrated for 10 to 20 year terms.[92, 93]

To the extent possible, this section presents international, national, and Nova Scotian data that have been collected for the indicators listed in the previous chapter, along with the trends they show towards or away from sustainable transportation. The CST worded its indicators in such a way that a decrease in a trend would demonstrate progress towards sustainable development. In the CST system, a reader can quickly see from a graph whether the indicator shows progress or not, since progress is always indicated by a downward trend. Despite this advantage, **GPI***Atlantic* has chosen not to use this technique because of the awkward language involved for some of the indicators (e.g. "share of urban travel ***not*** by land-based public transport"). For the indicators in this report, therefore, progress is sometimes shown by an **increase** in the indicator, and sometimes by a **decrease.** It is hoped that the following indicators and trends will be updated

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[89] Environment Canada. *Environmental Signals: Canada's National Environmental Indicator Series 2003*, p. iv. (Ottawa: 2003. Catalogue no. En40-775/2002E).
[90] Ibid.
[91] European Environment Agency. *Europe's Environment: The Third Assessment*. (Luxembourg: Office for Official Publications of the European Communities, 2003). http://reports.eea.eu.int/environmental_assessment_report_2003_10/en/tab_content_RLR
[92] Gilbert et al. (2002).
[93] Gilbert, Richard and Katharine Myrans. *STPI synopsis*. (Mississauga: Centre for Sustainable Transportation, 2003). www.cstctd.org/english/docs/STPI%20synopsis%20final,%20English.pdf

at regular intervals and will provide useful information both for public education purposes and for decision-makers.

Before presenting the evidence, it is important to mention some of the specific ways in which the current document differs from **GPI***Atlantic*'s original intentions for this report – largely due to data limitations discovered in the course of the research.

Data for tonne-km transported and passenger-km travelled for rail, air, and marine transport were unavailable for either Nova Scotia or the Atlantic region. **GPI***Atlantic* researchers attempted to obtain this information from Statistics Canada, from Natural Resources Canada's Office of Energy Efficiency, from the Railway Association of Canada, and from CN Rail. However, these statistics were withheld for reasons of confidentiality and are not publicly available. Without such basic data for these three transportation modes that are comparable to the available records for road transport, it is impossible fully to determine trends in sustainability for Atlantic Canada when modal shares are being compared at the provincial or regional level. Statistics were obtained from the Office of Energy Efficiency on energy consumption and emissions of greenhouse gases and air pollutants in the rail, air, and marine transport sectors—but figures for the overall volume of freight materials transported and the numbers of people being moved by non-road transportation in the province and region were unavailable and therefore cannot be compared with similar statistics for road transport. For this reason, this report emphasizes road transportation, although the original intention was to provide a detailed inter-modal comparison.

GPI*Atlantic* had also planned to present an economic indicator that reflected the share of public expenditures on transportation facilities and services borne directly by users through user fees such as fuel taxes or transit fares. Such an indicator could help indicate the magnitude of the market distortions that lead to economically excessive transport activity, and that in turn cause economic and ecological problems, and are unfair (horizontally inequitable). However, these costs were not compiled both because it proved too difficult to quantify many of them, particularly at the municipal level, and because user fees must be assessed in relation to true (or full) transportation costs, which include "externalities" like greenhouse gas and pollutant emissions, parking subsidies, and uncompensated accident costs, rather than just to public expenditures on transportation facilities and services. Sufficient resources were unavailable to consult the numerous local authorities that might have access to municipal cost data, and the present study was only able to undertake full-cost accounting exercises for road passenger transport in Nova Scotia and in HRM, rather than for all transportation modes. However, it is hoped that this very important question will be addressed at a later date as resources and data become available.

Chapter 1. Transport Activity

Transport activity (also called *mobility*) refers to the movement of people and goods. Changes in transport activity, including changes in modes, are indicators of sustainability, according to the definition, goals, and objectives described above. To the degree that motor vehicle travel is under-priced due to a large portion of actual travel costs being fixed and external (such as fixed rather than mileage-based vehicle insurance and registration fees, road and parking costs not paid directly by user charges, and uncompensated crash and environmental damages), current motor vehicle travel activity can be considered *economically excessive* (i.e. attributable to market distortions and inefficiencies). Reduced motor vehicle travel reduces unsustainable impacts, such as excessive fuel consumption, greenhouse gas emissions, and accidents, and indicates progress toward sustainability.

The Indicators

As noted earlier, trends in transport activity and modal distribution are the foundation for other indicators. For this reason trends in transport activity are considered before the environmental indicators.

Transport activity may be estimated in two basic ways:

1) passenger-kilometres (distance travelled by number of passengers) or tonne-kilometres (distance travelled by tonnes of freight); and
2) vehicle-kilometres (number of vehicles and distance travelled).

This analysis focuses primarily on passenger-km and tonne-km in preference to vehicle-km, a category that the CST considers of uncertain utility. The data on passenger-km and tonne-km for this report were taken from the 2002 Comprehensive Energy Use Database maintained by Natural Resource Canada's Office of Energy Efficiency.[94, 95] Data on rail freight in the Comprehensive Energy Use Database are available only at the national level because of privacy requirements. This data gap is a serious impediment to analysing trends in both passenger and freight transportation at the provincial level.

[94] Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Canada. www.oee.nrcan.gc.ca/corporate/statistics/neud/dpa/trends_tran_ca.cfm (August 5, 2004a).
[95] Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia. www.oee.nrcan.gc.ca/corporate/statistics/neud/dpa/trends_tran_ns.cfm (August 5, 2004b).

Data Revision
Note that in June 2005, the OEE released the 2003 Comprehensive Energy Use Database. One of the major changes to the database was an amendment to the way occupancy rates are measured. These rates are used to calculate passenger-kilometres. As a result of these amendments, new historical series were built for cars and light trucks for the 2003 database, revising the historical numbers presented in the 2002 database. In addition, heavy truck average distance travelled was revised for the period prior to 1994.[96]

The net result of these amendments is that the 2003 passenger-km numbers are lower than reported in the 2002 database. The passenger-km numbers that had been reported for earlier years were reduced by various amounts depending on the year and mode of transportation. In some instances, like for example, the 1990 value for small cars, the reported passenger-km were reduced by as much as 14% compared to what had previously been reported for that year. For other years and modes, the passenger-km were reduced by less than 1%. The average difference in 2003 from the passenger-km reported in the 2002 database, across all modes of passenger road transportation, was about a 5 to 6% reduction. Despite these changes in the absolute numbers, the overall ***trend*** in passenger transportation activity remained the same as indicated by the 2002 data.

Passenger-kilometre data are also used to calculate the different modal amounts of energy use, energy intensity, and greenhouse gas (GHG) emissions, as well as the GHG intensity. The net effect on these energy and emissions data as a result of the difference in passenger-km was minor (less than 1%). As the data for these indicators and for passenger-kilometres were assembled for this report prior to the 2005 release of the new 2003 database, It would have been ideal to have updated the trends to 2002 presented in this report using the new database. However, time and resources did not allow this systematic update. Nevertheless, a comparison of the results indicates that the 2002 data are still a fair representation of trends in passenger transport activity, and that the absolute effect of the methodological changes on other data in this report is marginal.

Vehicle ownership is a key factor influencing vehicle use and passenger-kilometres travelled, and therefore a significant indicator of transport activity. Simply put: once people purchase vehicles, they tend to use them. As noted by the CST, the size of the vehicle fleet is also an indicator for environmental concerns such as:

- energy use during manufacture;
- land use from vehicle storage, maintenance, and parking; and
- waste from vehicle disposal.[97]

Information on vehicle registrations is now compiled by Statistics Canada through its Canadian Vehicle Surveys, but these surveys only began in 1999. Because these surveys changed the classifications of registered vehicles from previous data sets, only a short trend line is possible for this indicator.[98] Data for the number of vehicles registered are provided according to vehicle

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[96] Behidj, Naima, Johanne Bernier, Samuel Blais, Sebastien Genest, William King, Carolyn Ramsum, and Katherine Sassi. 2005. *Energy use data handbook, 1990 and 1997 to 2003*. Gatineau: Energy Publications, OEE, Natural Resources Canada. http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/data_e/handbook05/datahandbook2005.pdf (Accessed April 12, 2006).
[97] Gilbert et al. (2002, p. 60).
[98] The *Canadian Vehicle Survey* (Catalogue no. 53-223-XIE) is published annually by Statistics Canada. The publication can be downloaded at www.statcan.ca/english/freepub/53-223-XIE/free.htm.

weight, so it has been assumed that the category of vehicles with a mass of 4.5 tonnes or less accounts for most passenger vehicles.

The indicators used to track changes in transport activity are as follows:

1. Motorized movement of people:
   - Total passenger-km
   - Passenger-km by mode of transport
   - Passenger-km per capita
   - Passenger-km compared to GDP
   - Number of vehicles per capita
   - Share of passenger transportation by public transportation

2. Motorized movement of freight:
   - Tonne-km
   - Tonne km by mode of transport
   - Tonne-km per capita
   - Tonne km compared to GDP

Another indicator considered was the number of registered vehicles per household. Data on the number of households are available only for census years, the most recent being 1996 and 2001. As the classification of registered vehicles changed between 1996 and 2001, statistics even for these two years cannot be compared, so it was not possible to develop a trend for this indicator at this time, though it is recommended for the future, especially after the 2006 Census data become available.

1.1 Motorized Movement of People

In countries such as Canada—where most movement of people is by motorized modes using non-renewable resources (fossil fuels)—reduction in passenger travel and vehicle ownership are generally indicative of trends towards sustainability. In Canada, in 2002, passenger transportation accounted for 57% of the energy consumed by transportation.[99]

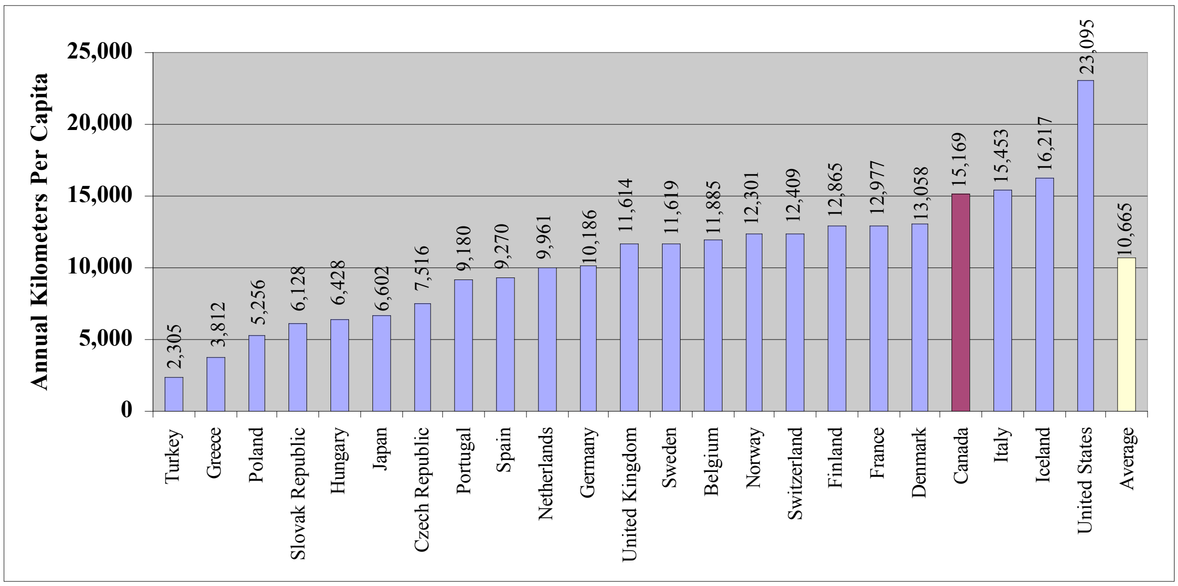
The Centre for Sustainable Transportation has used total passenger-km and passenger-km per mode to assess transport activity trends, using data from the Office of Energy Efficiency. This study relies on the same figures and data source. At the provincial level, records of passenger-km travelled are available for road, but not for rail, air and marine transport.

[99] Ramsum, Carolyn, Naima Behidj, Johanne Bernier, Samuel Blais, Sebastien Genest, Jessica Norup, Cory Peddigrew and Anna Zyzniewski. *Energy Efficiency Trends in Canada, 1990 to 2002*, p. 29. (Ottawa: Natural Resources Canada, 2004a). http://oee.nrcan.gc.ca/neud/dpa/data_e/Trends04/Trends2004.pdf

Trends: International

In 2003, the Organisation for Economic Co-operation and Development (OECD) found that Canada had the fourth highest total for vehicle-km of road transportation per capita amongst selected OECD countries, exceeded only by Italy, Iceland, and the United States.[100] This number was 42% higher than the OECD average (Figure 11).[101] Canada has the second largest land mass of the world's nations, so this helps explain why its transportation activity is greater than that of many other countries. Canada's per capita road transport activity was only slightly lower than that of Italy and Iceland, and was 34% less than that of the United States. It should be noted that these OECD data are provided only in vehicle-km per capita and cannot be compared to data on passenger-km. Thus the OECD statistics are useful for international comparisons only.

Figure 11. Transport Activity (Vehicle-Km per Capita) for Selected OECD Countries (2003).



Source: Organisation for Economic Co-operation and Development. *OECD In Figures - 2005 Edition*. (www.oecd.org/infigures), 2005.

In 2004, the OECD found that, of 30 member countries, Canada ranked 11th for number of motor vehicles registered per capita (including passenger automobiles, motorcycles and commercial vehicles).[102] This number was 14% higher than the OECD average (Figure 12). Luxembourg, Portugal, and the United States had the highest number of motor vehicles registered per capita. Turkey, Russia and Korea had the lowest.

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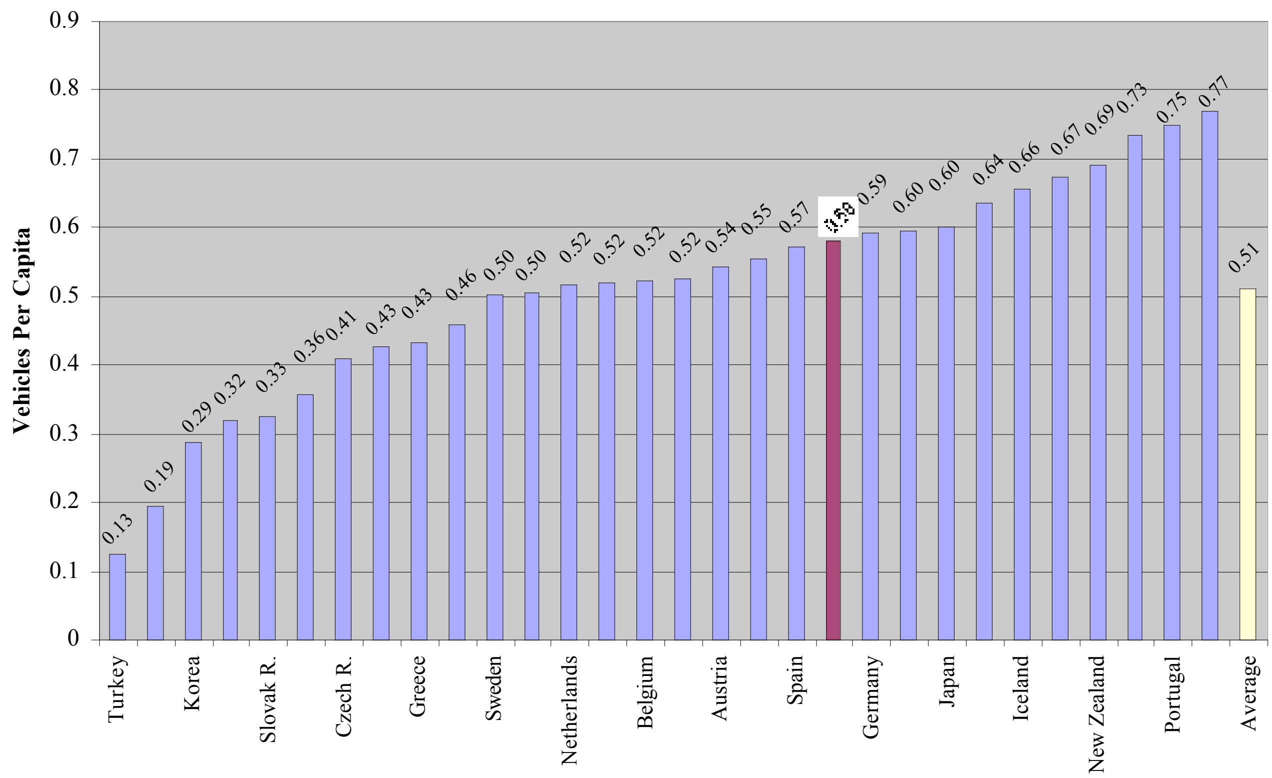
[100] The number of OECD countries reported fluctuates throughout this report, depending on data availability.
[101] Organisation for Economic Co-operation and Development. *OECD Environmental Data—Compendium 2002*, Chapter 8, p. 14. (2003). www.oecd.org/dataoecd/52/59/2958321.pdf Accessed December, 2004.
[102] Organisation for Economic Co-operation and Development and European Conference of Ministers. International Road Traffic and Accident Database: Selected Reference Values for the Year 2003. (September, 2004). www.bast.de/htdocs/fachthemen/irtad//english/weng1.html This number includes passenger automobiles, motorcycles and commercial vehicles.

Canada's proportion of vehicles per capita shifts dramatically when only the number of licensed drivers is used instead of total population. In 2004, Canada had 0.88 vehicles per licensed driver, compared to 0.58 vehicles per capita when all Canadians of all ages are counted.[103] In other words, Canada's number of vehicles is approaching the number of licensed drivers.

Figure 12. Number of Motor Vehicles Registered per Capita for Selected OECD Countries, 2004

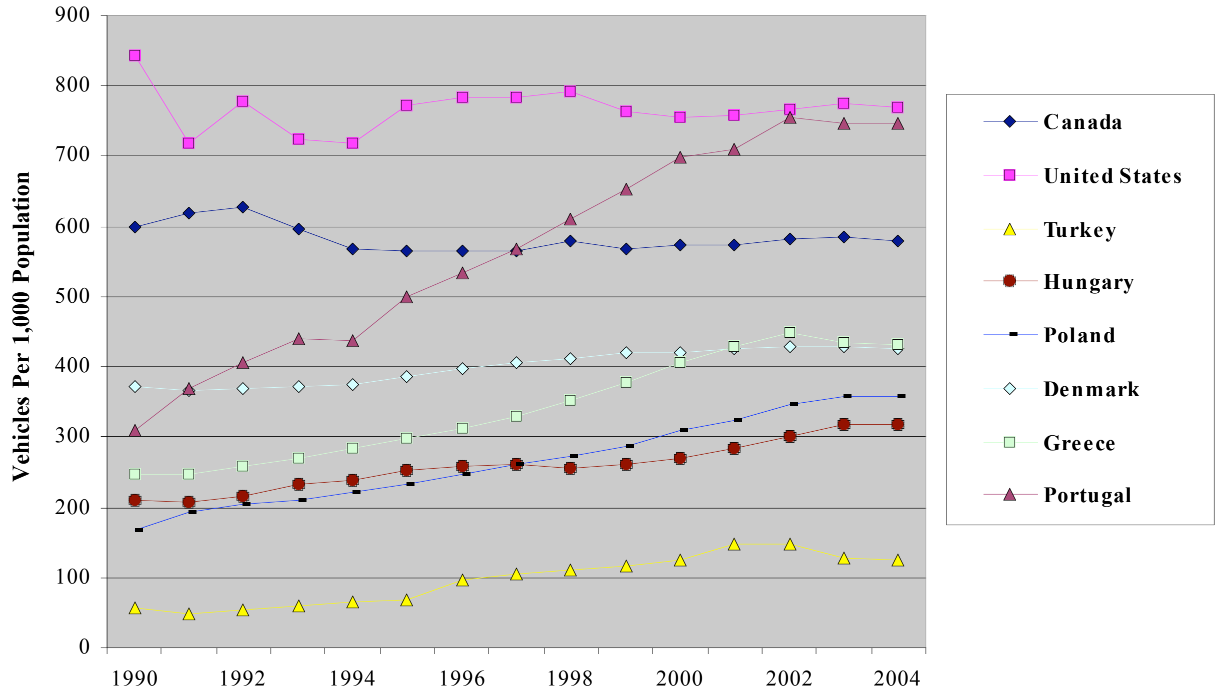


Source: Organization for Economic Co-operation and Development, "Quality of life - passenger transport - road motor vehicles and road fatalities" *OECD Factbook 2006: Economic, Environmental and Social Statistics*. (2006).

Figure 13 illustrates vehicle ownership trends in illustrative OECD countries between 1990 and 2004. Most higher income countries in the OECD have seen little growth in vehicle ownership, indicating that they are approaching saturation, while most lower-income countries show steady growth.

103 Transport Canada. Licensed Drivers and Motor Vehicle Registrations by Type of Vehicle 1985-2004. (September 18, 2006). http://www.tc.gc.ca/roadsafety/tp/tp3322/2004/page12.htm

Figure 13. Number of Motor Vehicles Registered per Capita for Illustrative Higher and Lower OECD Countries, 1990-2004.



Source: Organization for Economic Co-operation and Development, "Quality of life - passenger transport - road motor vehicles and road fatalities" *OECD Factbook 2006: Economic, Environmental and Social Statistics*. (2006)

Trends: Canada

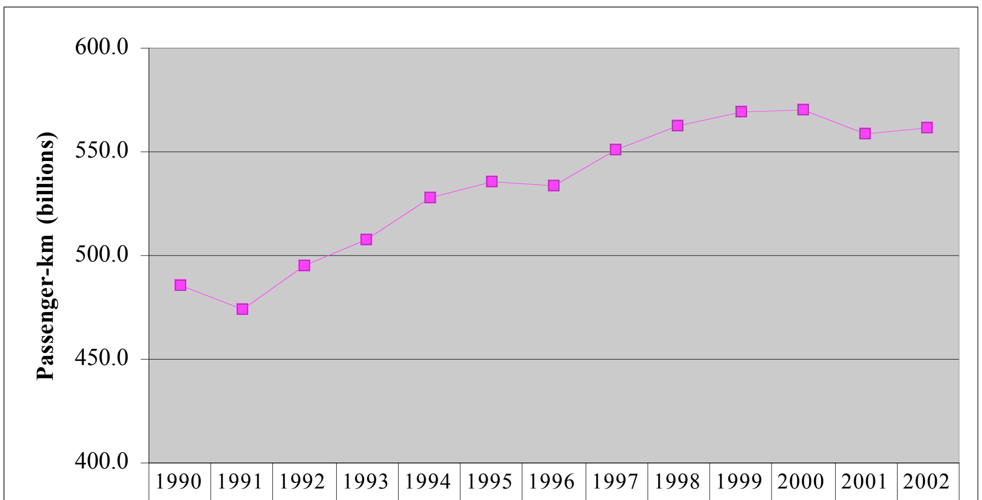
Using data on passenger-kilometres, Figure 14 shows that total passenger transport activity in Canada increased by 16% from 1990 to 2002. Although there was a slight decrease in transport activity between 2000 and 2001, this period is not of sufficient length to indicate a reliable new trend towards sustainability, especially in light of the fact that transport activity marginally increased again between 2001 and 2002.

Figure 15 shows the movement of people by transportation mode. The most significant shift in passenger travel in this period is in air travel, where the increase of 49% represents a strong trend away from sustainability. Travel by road increased by 11% between 1990 and 2002. Most of this increase occurred in the early 1990s, with relative stability in the last decade. Travel by rail decreased by 11%, with most of the decline occurring between 1990 and 1991. There has been a small increase in rail transportation since that time, though it has not yet recovered to 1990 levels. (Note that the units of rail transport in the graph in Figure 15 are too small to demonstrate these shifts visually, since rail transportation accounts for less than three percent of total passenger-kilometres travelled in Canada).

The high rates of motor vehicle travel in Canada and its growth since 1990 indicate a lack of sustainability in Canadian transport activity trends. The overall shift since 1990 towards air and road transportation, and the continued marginalization of rail transportation appears to indicate a move away from sustainability. Although recent trends since the late 1990s are more ambiguous, there is no evidence of significant overall movement towards more sustainable transportation modes and a more sustainable transportation system.

Since the population of Canada increased by only 13% during the 1990-2002 reference period, compared to the 16% increase in overall passenger kilometres travelled, it appears that the average Canadian travelled more during that period.

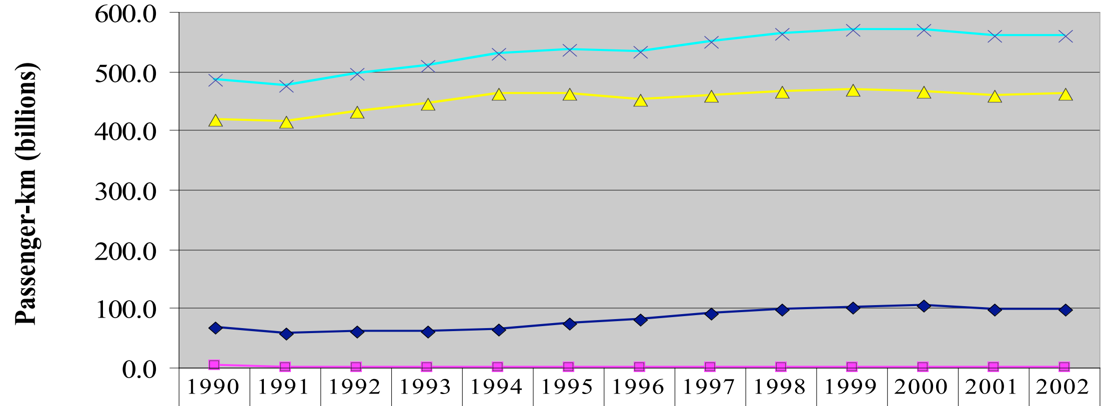
Figure 14. Total Passenger Movement in Canada, 1990-2002 (billions of passenger-km).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
p-km	485.1	473.8	494.7	507.9	527.7	535.8	534.1	550.6	563.0	569.1	569.8	558.6	561.2

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Canada, Table 2.

Figure 15. Passenger Movement by Mode in Canada, 1990-2002 (billions of passenger-km).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Air	66.8	58.0	62.2	61.1	65.6	73.5	82.1	91.9	96.6	99.6	103.8	97.0	99.4
Rail	1.8	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.6	1.6
Road	416.6	414.4	431.1	445.4	460.6	460.9	450.5	457.2	464.9	468.0	464.5	460.0	460.2
Total Passenger	485.1	473.8	494.7	507.9	527.7	535.8	534.1	550.6	563.0	569.1	569.8	558.6	561.2

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 2, 13, 20 and 26.

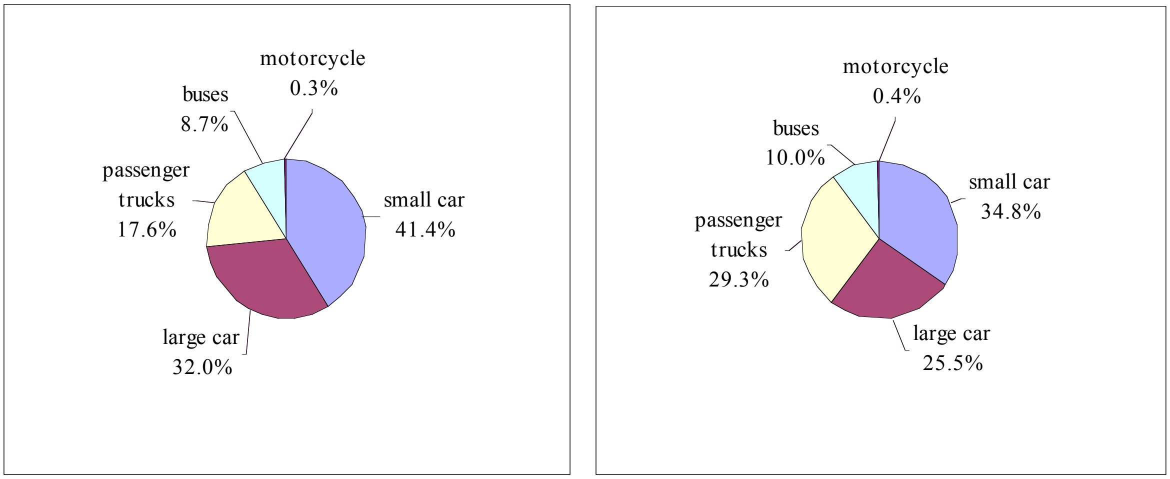
Figure 16 depicts the modal share of road passenger movement in both 1992 and 2002. The most marked difference between these years is the shift from cars to passenger trucks, a category that includes pick-up trucks, vans, and Sport Utility Vehicles (SUVs).[104] This is a move away from sustainability since passenger light trucks, particularly SUVs, have much lower fuel efficiencies and emit more pollutants and greenhouse gases per kilometre travelled than most cars, and are therefore more environmentally damaging. On average, one SUV has about three times the environmental impact of a small car.[105]

By 2002, passenger trucks accounted for 29% of the modal share, which is almost 12 percentage points (or 66%) more than its share in 1992. This shift to passenger trucks came equally from both large and small cars, which each lost about seven percentage points in the modal share of road passenger movement. In total, cars went down from 73.4% of road passenger movement in 1992 to 60.3% in 2002, while the passenger light truck share went from 17.6% to 29.3%. Buses and motorcycles also showed small increases in their share of road passenger movement across the country, though it appears that the increase in bus share is due almost entirely to increased school bus use (Figure 18).

[104] Some of the larger SUVs, like the Hummer, would fall into the medium truck category.
[105] Wilson, Jeffrey, Ronald Colman and Anne Monette. *The Nova Scotia Ecological Footprint*, p. iii. (**GPI***Atlantic*, 2001). www.gpiatlantic.org/pdf/ecofoot/ns-ecofoot.pdf Accessed July, 2004.

Figure 16. Modal Share (Percentage) of National Road Passenger Movement, 1992 and 2002.

1992 **2002**



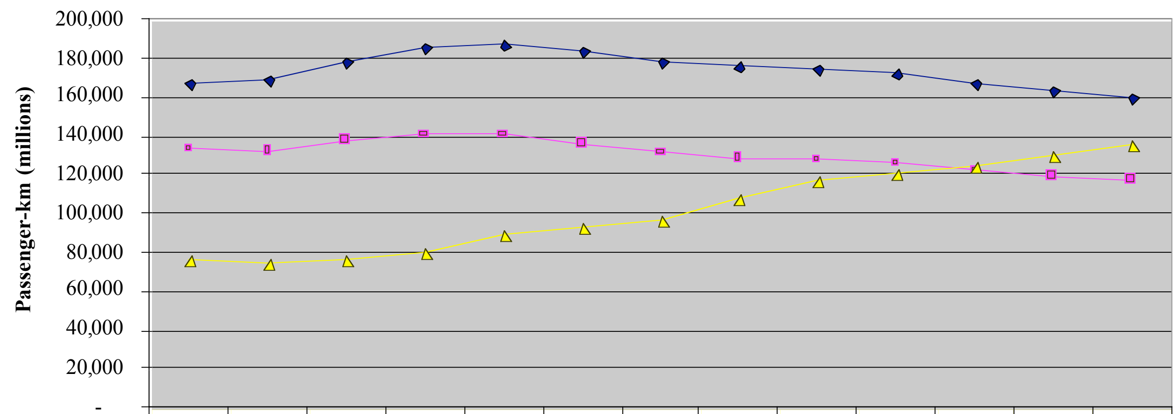
Source: Natural Resources Canada - Office of Energy Efficiency. 2002 Comprehensive Energy Database: Transportation Sector, Canada Tables 33, 37, 43, 45 & 55.

This shift to passenger trucks is also shown in Figure 17, which presents passenger-km by mode of road travel (excluding buses and motorcycles). This figure demonstrates that while small cars continue to dominate transport activity, there has been a dramatic 75% increase in travel by passenger light trucks, while small car travel declined steadily after 1994.

Figure 18 shows that between 1990 and 2002, the percentage of travel by bus fluctuated from as low as 8.4% to as high as 10.6%. When these percentages are disaggregated and the different types of bus travel are examined separately, important trends are observed. Most notably, the percentage of total passenger transportation by school bus rose over this period by 54%. This is considered a trend away from sustainability, as an increase in school bus travel signifies longer distances that students are required to travel to school, probably due to school consolidations, especially in rural areas.

There was also a 20% decline in the portion of total passenger transportation by public transit (urban transit and inter-city bus) during this period, another indication of trends towards less sustainable modes of transportation, although the greatest decline in transit ridership occurred during the early 1990s and it has remained fairly steady since then.

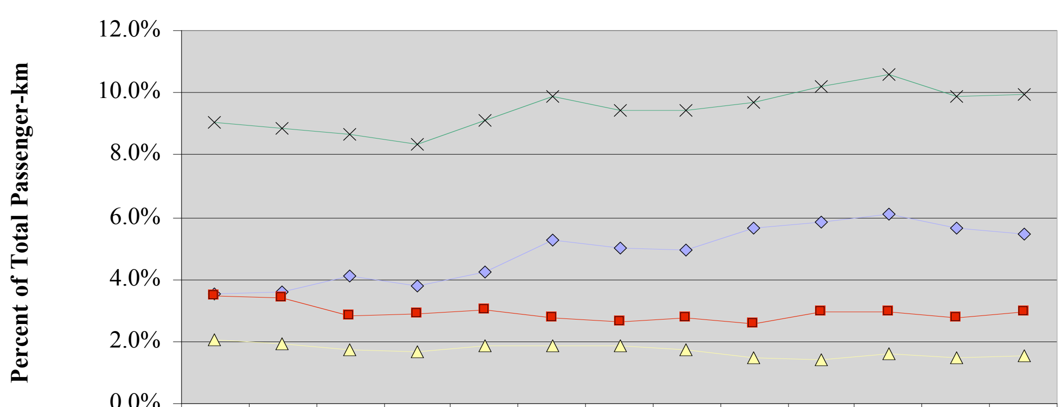
Figure 17. Road Passenger-Km in Canada, 1990-2002 (millions of passenger-km).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Small car	167,425	169,663	178,278	185,694	187,059	184,169	178,295	176,219	174,728	172,283	167,485	163,762	160,370
Large car	133,052	132,577	137,851	141,077	140,292	136,422	131,305	128,977	127,348	125,775	122,503	119,608	117,432
Light Truck	76,859	73,934	76,058	79,938	89,745	93,503	96,996	107,640	116,357	120,680	123,733	129,422	134,740

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 43, 45 and 47.

Figure 18. Travel by Urban Transit, Inter-City Bus and School Bus as a percentage of Total Road Passenger-km, Canada, 1990-2002.



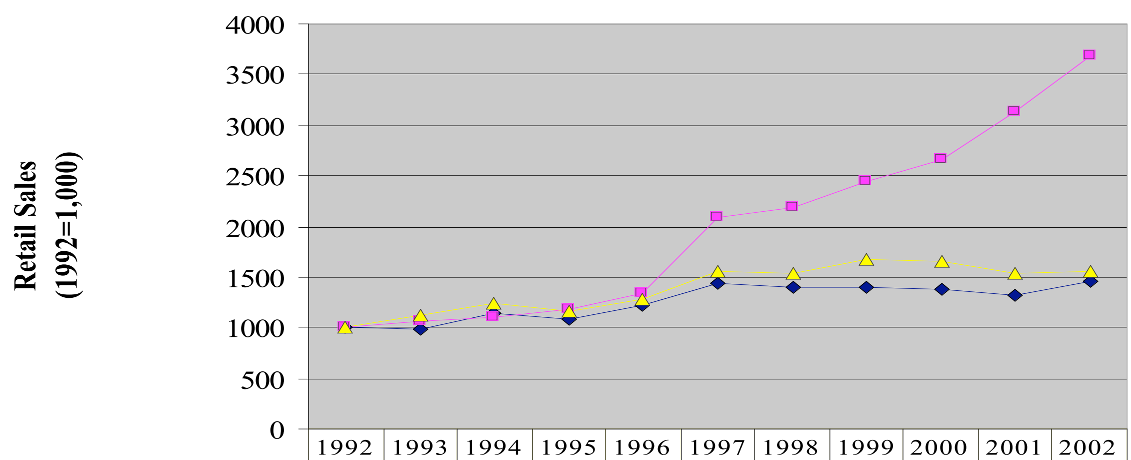
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
school bus	3.5%	3.6%	4.1%	3.8%	4.3%	5.3%	5.0%	5.0%	5.6%	5.9%	6.1%	5.7%	5.4%
urban transit	3.5%	3.4%	2.8%	2.9%	3.0%	2.7%	2.6%	2.8%	2.6%	3.0%	2.9%	2.8%	3.0%
inter-city bus	2.1%	1.9%	1.8%	1.7%	1.9%	1.8%	1.8%	1.7%	1.5%	1.4%	1.6%	1.5%	1.5%
total bus	9.1%	8.9%	8.7%	8.4%	9.1%	9.9%	9.5%	9.4%	9.7%	10.2%	10.6%	9.9%	10.0%

Source: Natural Resources Canada-Office of Energy Efficiency. 2002 Comprehensive Energy Database: Transportation Sector, Canada Tables 13, 33-35.

Figure 19 shows the increase in retail sales of the different components of the passenger light truck category in Canada between 1992 and 2002. In order to show comparative rates of increase, these figures have been normalized so that the 1992 values are all equal to 1,000 units.[106] In 2002, according to Industry Canada retail sales statistics, SUVs constituted almost 16% of Canadian retail sales of passenger vehicles. There was a 268% increase in retail sales of SUVs between 1992 and 2002.[107] Total light truck sales, which include pick-up trucks, SUVs and vans, accounted for 45% of all retail sales of passenger vehicles in 2002. There was over a 90% increase in retail sales for total light truck sales between 1992 and 2002.

These increases mark an alarming trend away from sustainability. Unfortunately, actual fleet data for SUVs are not available, since the Canadian Vehicle Survey only collects fleet size data based on vehicle weights, rather than vehicle types. This makes is difficult to estimate fleet sizes for the various vehicle modes.

Figure 19. Retail Sales of Passenger Light Trucks in Canada, 1992-2002.



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Pick-up Trucks	1000	978	1142	1078	1213	1444	1400	1401	1384	1314	1460
Sports Utility Vehicles	1000	1054	1097	1189	1347	2086	2184	2453	2661	3136	3681
Vans	1000	1115	1236	1164	1278	1547	1529	1684	1652	1534	1555

Source: Industry Canada—Aerospace and Automotive Branch. Statistical Review of the Canadian Automotive Industry: 2002 Edition.

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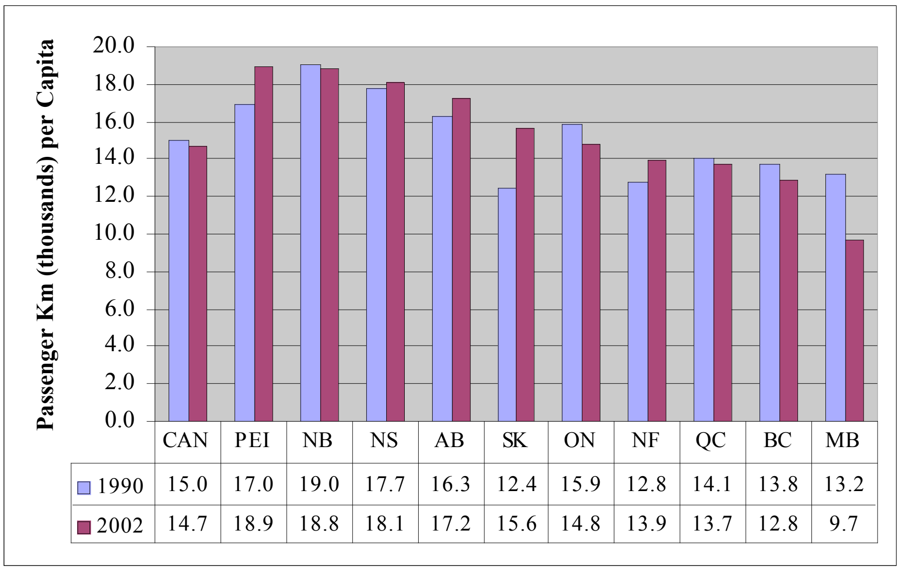
106 In statistics, *normalization* denotes the adjustment of a series of values, using a mathematical transformation function, so that the data set can be readily compared to a designated reference point. StatSoft, Inc. *Electronic Statistics Textbook*. (Tulsa: StatSoft, 2004). www.statsoft.com/textbook/glosn.html In the current instance, establishing a benchmark year (1992) and then assigning it the arbitrary total of 1,000 simplifies the computations required to determine the magnitude of differences across variables (i.e. years and vehicle types).

107 Industry Canada. *Statistical Review of the Canadian Automotive Industry: 2002 Edition*, Tables 1.3 and 1.5. (Ottawa: 2003). http://strategis.ic.gc.ca/epic/internet/inauto-auto.nsf/vwapj/total.pdf/$FILE/total.pdf Accessed October, 2004.

Figure 20 shows passenger-km per capita, by province, for 1990 and 2002. Nova Scotia has the third highest total of passenger-km per person of all the provinces, following the other two Maritime Provinces, and is 24% higher than the national average. This is likely due to the fact that a larger proportion of the Maritime population live in rural areas than in the country as a whole.

Nova Scotia is also one of the five Canadian provinces to have seen an increase in passenger-kilometres per capita travelled since 1990. In Nova Scotia this may partly reflect the faster growth rates of Halifax Regional Municipality's suburban and rural commutershed areas compared to the urban core (see Table 27 below.)

Figure 20. Road Passenger-Km per Capita, by Province, 1990-2002.



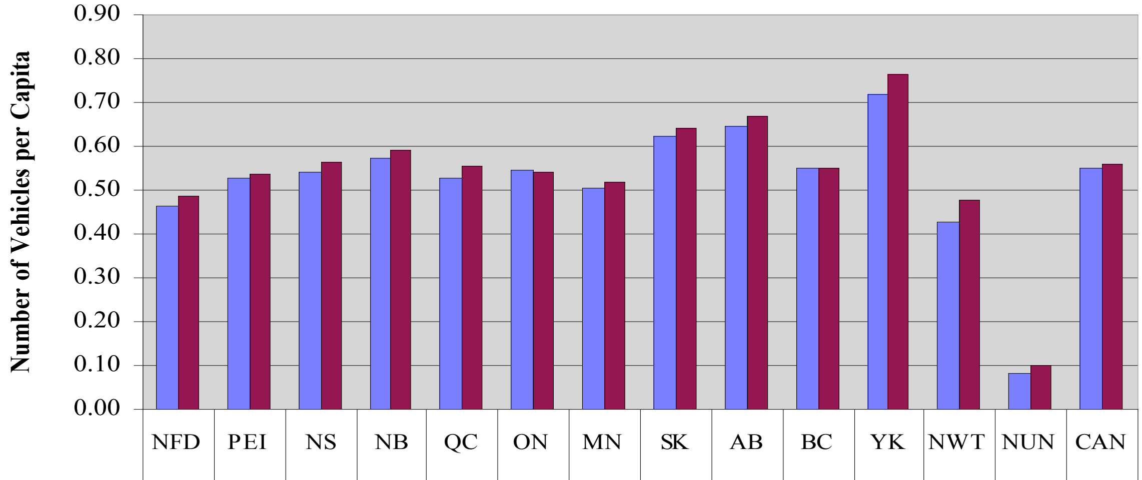
	CAN	PEI	NB	NS	AB	SK	ON	NF	QC	BC	MB
1990	15.0	17.0	19.0	17.7	16.3	12.4	15.9	12.8	14.1	13.8	13.2
2002	14.7	18.9	18.8	18.1	17.2	15.6	14.8	13.9	13.7	12.8	9.7

Sources: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Canada, Table 13; and Statistics Canada. CANSIM Table 051-0001.[108]

Figure 21 shows the number of registered vehicles (up to 4.5 tonnes weight) per capita, by province and territory, for 1999 and 2003. Nova Scotia had the fifth highest number of registered vehicles per capita of all the provinces. This puts it on par with the national average. All provinces and territories saw an increase in vehicles registered per capita since 1999, except for Ontario and British Columbia which saw virtually no change.

[108] Statistics Canada. CANSIM Table 051-0001—Estimates of population, by age group and sex, Canada, provinces and territories, annual. (November 23, 2004). CANSIM is a searchable on-line compendium of socio-economic data compiled by Statistics Canada. The home page is: http://cansim2.statcan.ca/.

Figure 21. Number of Vehicles (4.5 tonnes or less) per Capita Registered in Canada, by Province and Territory, 1999 and 2003.



	NFD	PEI	NS	NB	QC	ON	MN	SK	AB	BC	YK	NWT	NUN	CAN
1999	0.46	0.53	0.54	0.57	0.53	0.54	0.51	0.62	0.64	0.55	0.72	0.43	0.08	0.55
2003	0.49	0.54	0.56	0.59	0.55	0.54	0.52	0.64	0.67	0.55	0.77	0.48	0.10	0.56

Sources: Statistics Canada. *Canadian Vehicle Survey* (1999-2003); and Statistics Canada. CANSIM Table 051-0001.

Although vehicle ownership and annual vehicle travel increased steadily during most of the last century, there is evidence that these trends have reached saturation in Canada, the U.S., and many Western European countries, and that average per capita vehicle mileage may decline somewhat in the future due to demographic trends, higher fuel prices, and consumer preferences.[109] Although vehicle travel may continue to increase with population growth, growth rates will probably be slower, and may become negative in slower-growing communities. This may offer new opportunities to gain support for sustainability policies, for example, by improving alternative modes of transportation as a response to the needs of an aging population and higher fuel prices.

Trends: Nova Scotia

Road

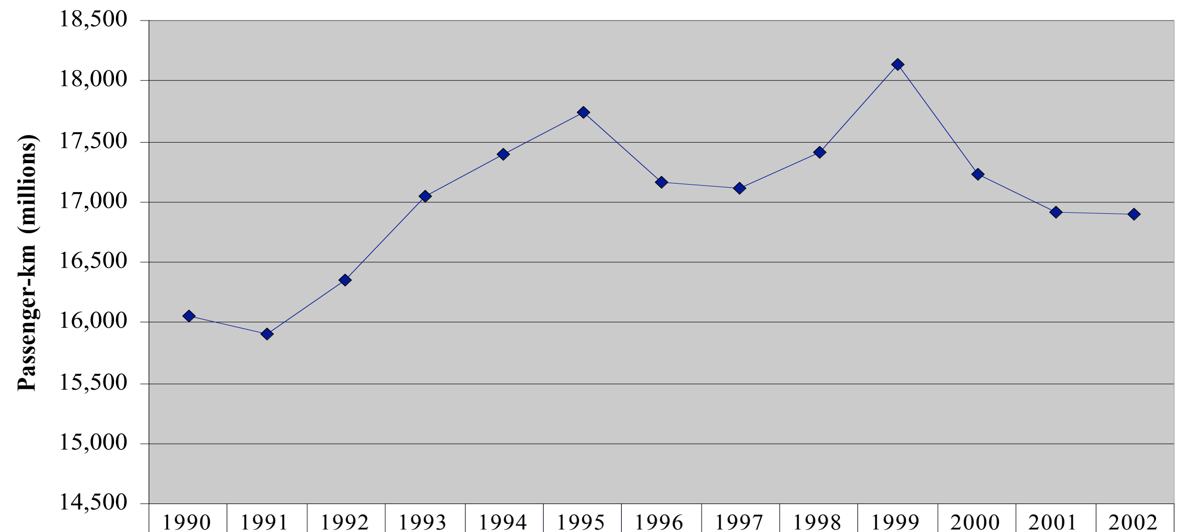
Total Passenger Movement

Figure 22 shows the road passenger movement totals for Nova Scotia from 1990 to 2002, in millions of passenger-kilometres travelled. Overall there has been a 5.2% increase in passenger movement in the province since 1990 (with a peak in 1999). During this same period there was only a 2.7% increase in population, so Nova Scotians are clearly travelling more than they did in

[109] Litman, Todd, *The Future Isn't What It Used To Be: Changing Trends and Their Implications for Transport Planning*. (Victoria Transport Policy Institute, 2005b). www.vtpi.org/future.pdf

the early 1990s. From the 1999 peak to 2002, there was a 6.8% decrease in passenger movement, but the downward trend seems to have levelled off, and total passenger movement remains well above the levels of the early 1990s.

Figure 22. Total Road Passenger Movement in Nova Scotia, 1990-2002 (millions of passenger-km).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
p-km	16,060	15,905	16,351	17,051	17,392	17,744	17,165	17,119	17,413	18,132	17,232	16,915	16,895

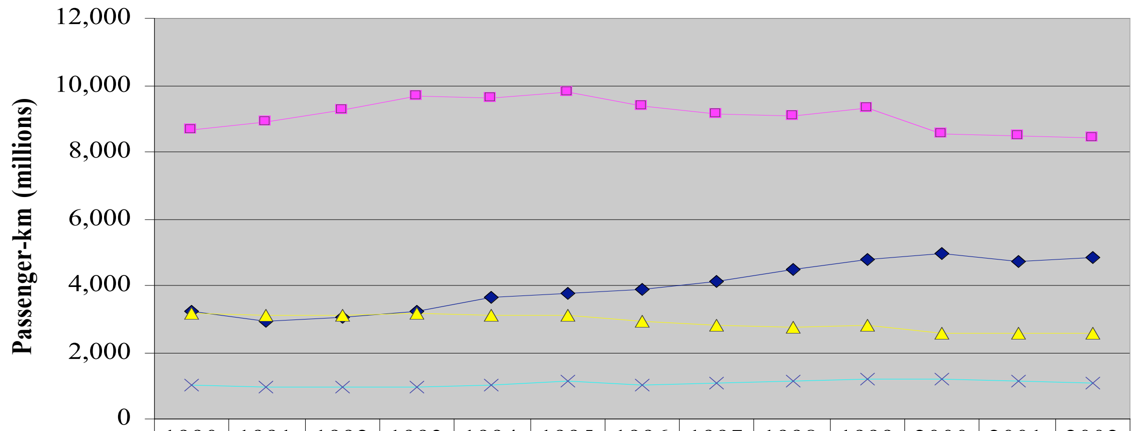
Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Table 9.

Road Passenger Movement by Mode of Travel

Figure 23 shows the trends in road passenger movement for different types of vehicles in Nova Scotia between 1990 and 2002**.** In 2002, light trucks (including SUVs and minivans) accounted for 29% of all passenger movement; small cars for 50%; large cars for 15%; and buses for six percent. While there was a 20% decrease in passenger travel in large cars, passenger-kilometres travelled in light trucks increased by 49%. Small cars have shown a three percent decrease; and buses a 7.8% increase.

(The bus category is discussed below in the section on share of passenger travel by public transit – Figure 28 – like the Canadian figures, indicates that the increase in bus travel in Nova Scotia is largely due to an increase in school bus travel, with urban transit travel remaining relatively unchanged.)

Figure 23. Road Passenger Travel in Nova Scotia, by Vehicle Type, 1990-2002 (millions of passenger-km).



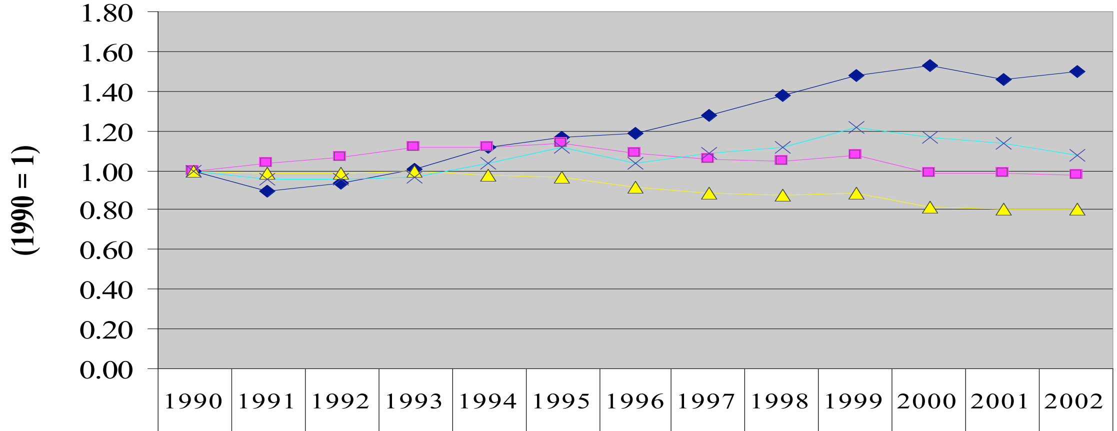
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Truck	3,241	2,908	3,031	3,245	3,620	3,777	3,853	4,125	4,451	4,804	4,946	4,728	4,844
Small Car	8,637	8,916	9,234	9,665	9,638	9,773	9,366	9,108	9,064	9,288	8,528	8,485	8,425
Large Car	3,179	3,126	3,129	3,177	3,091	3,079	2,906	2,799	2,776	2,822	2,586	2,562	2,545
Buses	1,003	955	958	964	1,043	1,115	1,039	1,086	1,122	1,218	1,172	1,139	1,081

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Tables 22, 28, 29 and 37.

When the data in Figure 23 are normalized—i.e., the 1990 values are taken as one and other values are adjusted accordingly—the change in travel by mode in Nova Scotia is shown more dramatically, as Figure 24 illustrates. Disturbingly, from a sustainability perspective, the sharpest decline in passenger travel in recent years has been in bus travel, with an 11% decline since 1999. Passenger movement by bus in 2002 was at its lowest level since 1996, although more recent local figures indicate that ridership has increased since 2002 at least in the Halifax Regional Municipality.[110]

[110] Gillis, John. “HRM—a transit growth zone.” *Chronicle Herald*. December 14, 2004

Figure 24. Road Passenger Travel in Nova Scotia, by Vehicle Type, 1990-2002. (Normalized to 1990 = 1).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Truck	1.00	0.90	0.94	1.00	1.12	1.17	1.19	1.27	1.37	1.48	1.53	1.46	1.49
Small Car	1.00	1.03	1.07	1.12	1.12	1.13	1.08	1.05	1.05	1.08	0.99	0.98	0.98
Large Car	1.00	0.98	0.98	1.00	0.97	0.97	0.91	0.88	0.87	0.89	0.81	0.81	0.80
Buses	1.00	0.95	0.95	0.96	1.04	1.11	1.04	1.08	1.12	1.21	1.17	1.14	1.08

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Tables 22, 28, 29 and 37.

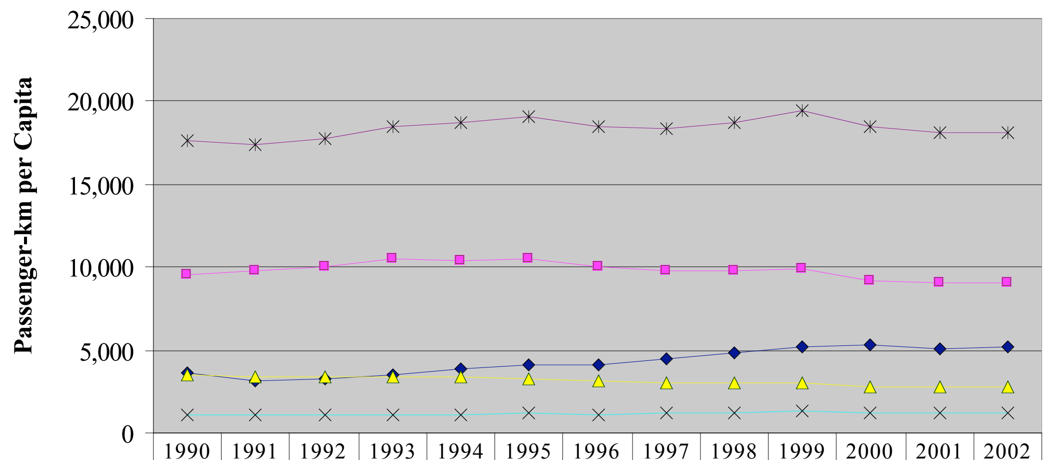
Road Passenger Movement per Capita

Figure 25 represents the trajectory of change in passenger-km per capita in Nova Scotia from 1990 through 2002. Road passenger travel per capita peaked in 1999 and has declined by seven percent since then. Encouragingly, overall passenger travel per capita in 2002 was at its lowest level in ten years, though it remained 2.4% higher than in 1990.

Although the average Nova Scotian is still travelling marginally more by road than in 1990, it is the ***mode*** of travel that indicates the greatest movement away from sustainability. There has been a 45% increase in passenger-km per capita for light trucks (including pick-ups, mini-vans, and SUVs), where the expansion in travel is sharply outpacing population growth. This increase has been largely at the expense of a five percent decline in passenger-km per capita for small cars and a 22% decline for large cars. As noted earlier, travel by light trucks, SUVs, and minivans now accounts for 29% of all passenger movement.

Per capita bus travel in Nova Scotia remains five percent higher than it was in 1990 (due largely to the increase in school bus travel,) but bus ridership declined sharply from 1999 to 2002. As Figure 23 shows, the average Nova Scotian was 11% less likely to travel by bus in 2002 than in 1999. However, more recent evidence indicates a partial recovery, at least in the Halifax Regional Municipality. Halifax Metro Transit reported near the end of 2004 that transit ridership was up 5.2% from 2002, and it has continued to grow since.[111] As a proportion of total passenger travel, however, bus travel remains relatively unchanged over time, accounting for about six percent of all travel.

Figure 25. Road Passenger-km per Capita in Nova Scotia, by Vehicle Type, 1990-2002.



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Truck	3,563	3,178	3,296	3,512	3,905	4,069	4,137	4,424	4,776	5,144	5,296	5,071	5,184
Small Car	9,496	9,743	10,042	10,460	10,397	10,529	10,056	9,768	9,726	9,946	9,132	9,100	9,017
Large Car	3,495	3,416	3,402	3,438	3,335	3,317	3,121	3,002	2,979	3,022	2,769	2,748	2,724
Buses	1,102	1,044	1,041	1,044	1,125	1,202	1,115	1,165	1,204	1,304	1,255	1,222	1,157
Total	17,656	17,381	17,781	18,453	18,762	19,117	18,429	18,358	18,685	19,417	18,452	18,141	18,081

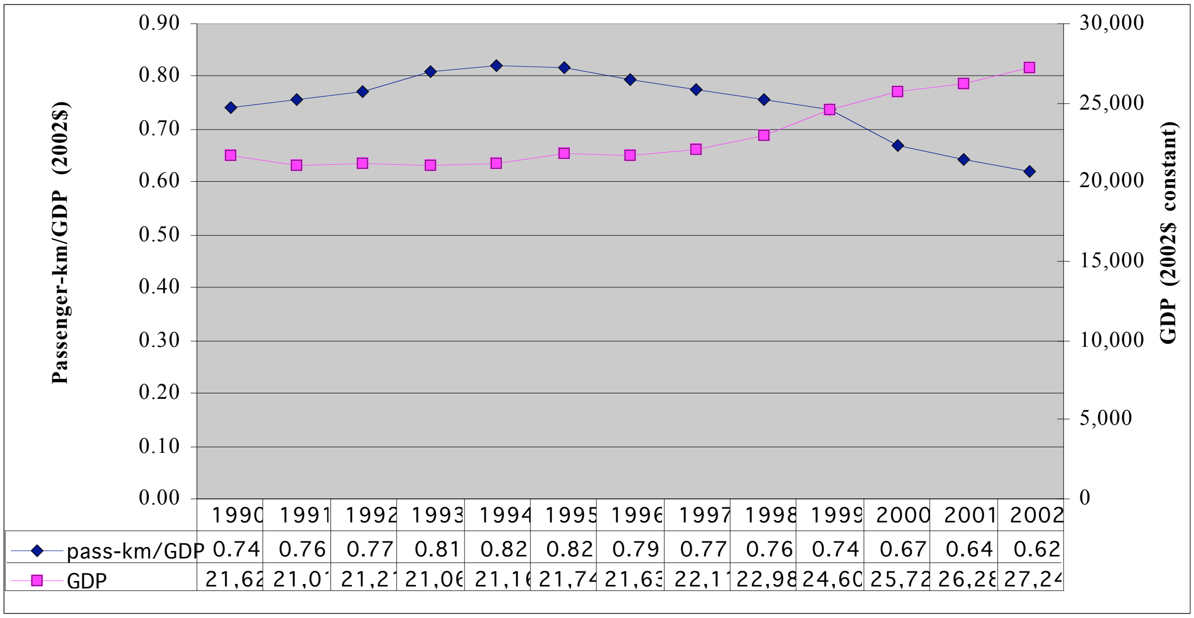
Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database Transportation Sector—Nova Scotia, Tables 22, 28, 29 and 37; and Statistics Canada. CANSIM Table 051-0001.

Road Passenger Movement and GDP

Figure 26 shows the 26% growth in GDP in Nova Scotia from 1990 to 2002. Overall passenger-kilometres of travel are not positively correlated with the GDP: passenger-km per dollar of GDP have been decreasing since 1995, a sign of increasing efficiency (more material output per unit of travel) and movement towards sustainability. However, the 49% increase in light truck passenger-km over this period (Figure 23) outpaced the rate of GDP growth, indicating that the rise in this mode of travel is likely linked to a general increase in consumption, and that economic growth is spurring more unsustainable travel forms.

[111] Gillis, John. "HRM—a transit growth zone." *Chronicle Herald*. December 14, 2004.

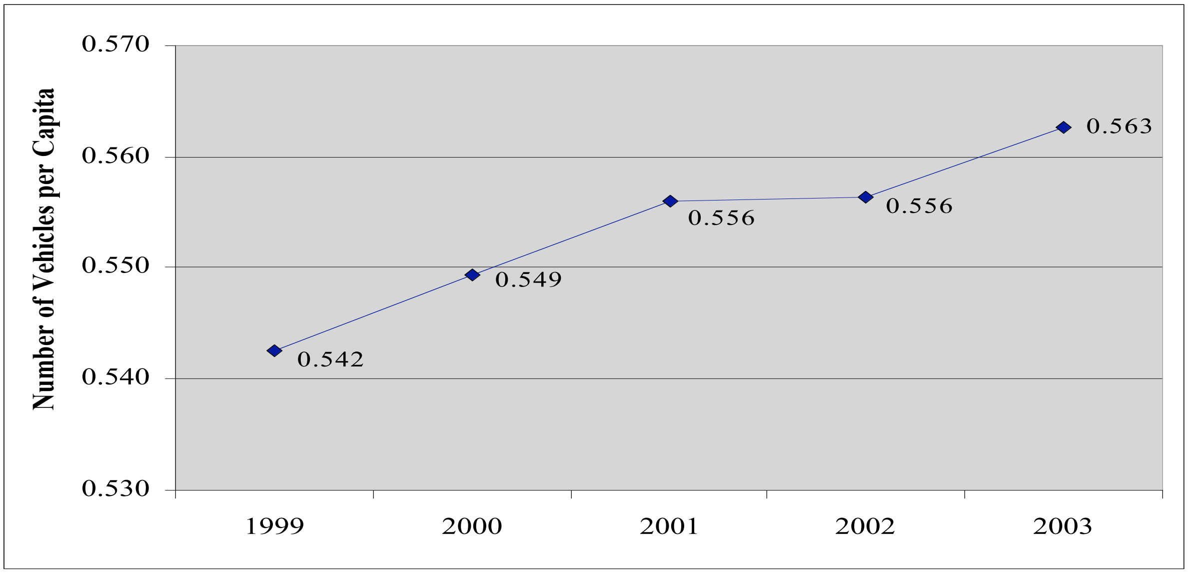
Figure 26. Passenger-kilometres per Gross Domestic Product (GDP) and GDP, Nova Scotia, 1990-2002, (constant 2002$ millions).



Source: Statistics Canada. CANSIM Table 384-0002. Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Tables 22, 28, 29 and 37.

Figure 27 presents the number of registered vehicles (up to 4.5 tonnes) per capita in Nova Scotia from 1999 to 2003. There has been a 3.9% increase in vehicles registered per capita since 1999, while population growth was only 0.23% during this period. The increase in per capita vehicle ownership indicates a move away from sustainability.

Figure 27. Number of Vehicles per Capita for Nova Scotia, 1999-2003.



Sources: Statistics Canada. *Canadian Vehicle Survey* (1999-2003); and Statistics Canada. CANSIM Table 051-0001.

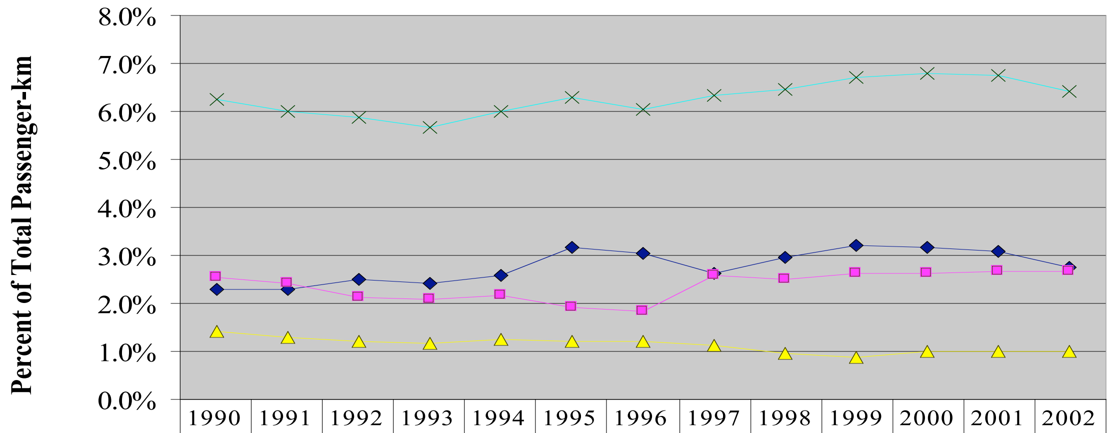
Share of Road Passenger Movement by Public (Mass) Transport

Bus and rail transport people more efficiently than do cars, trucks, or planes, in terms of numbers of people moved per unit of resource (including fuel) consumed and emissions generated. Therefore, an increase in the proportion of total passenger movement by public transit constitutes a trend towards sustainability. As noted earlier, data for rail passenger-km travelled are unavailable for Nova Scotia, so only bus travel trends are examined here.

As Figure 28 shows, over the 13 years examined there was no significant increase in the proportion of total passenger transportation by bus in Nova Scotia, with the proportion remaining around six percent for the entire period.[112] However, important differences are observed when the type of bus transport is considered. The sum of travel by urban transit and inter-city bus together was 3.9% in 1990, and in 2002 was 3.6%; so there was actually a slight decrease in public transit's share of total passenger travel in the province. The proportion of travel by school bus in Nova Scotia grew by 21% while inter-city bus travel decreased by 36%. This can actually be considered a trend away from sustainability, as an increase in school bus travel signifies longer distances that students are required to travel to school, and less walking and cycling. This trend is likely a result of school consolidations, especially in rural areas.

[112] However, near the end of 2004, Halifax Metro Transit reported that transit ridership was up 5.2% from 2002. (Gillis, John. "HRM—a transit growth zone." *Chronicle Herald*. December 14, 2004).

Figure 28. Travel by Urban Transit, Inter-City Bus, and School Bus as a percentage of Total Road Passenger-Km, Nova Scotia, 1990-2002.



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
School Bus	2.3%	2.3%	2.5%	2.4%	2.6%	3.1%	3.0%	2.6%	3.0%	3.2%	3.2%	3.1%	2.8%
Urban Transit	2.5%	2.4%	2.1%	2.1%	2.2%	1.9%	1.8%	2.6%	2.5%	2.6%	2.6%	2.6%	2.6%
Inter City Bus	1.4%	1.3%	1.2%	1.1%	1.3%	1.2%	1.2%	1.1%	1.0%	0.9%	1.0%	1.0%	1.0%
Total Bus	6.2%	6.0%	5.9%	5.7%	6.0%	6.3%	6.1%	6.3%	6.4%	6.7%	6.8%	6.7%	6.4%

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Tables 22 and 31-33.

Air Travel

Figure 29 illustrates the trend for the number of air passengers who enplaned and deplaned in Nova Scotia from 1995 to 2003.[113, 114] There was a 12% increase in air passenger traffic during that time. Air traffic actually peaked in 1999, when more than three million passengers enplaned and deplaned in Nova Scotia, and it has fluctuated since that time, with the number of passengers in 2003 still about six percent less than in 1999. Although the overall trend since 1995 indicates an increase in air traffic activity, it should be noted that these figures are not directly comparable to the road traffic data because passenger-km numbers for air travel are unavailable.

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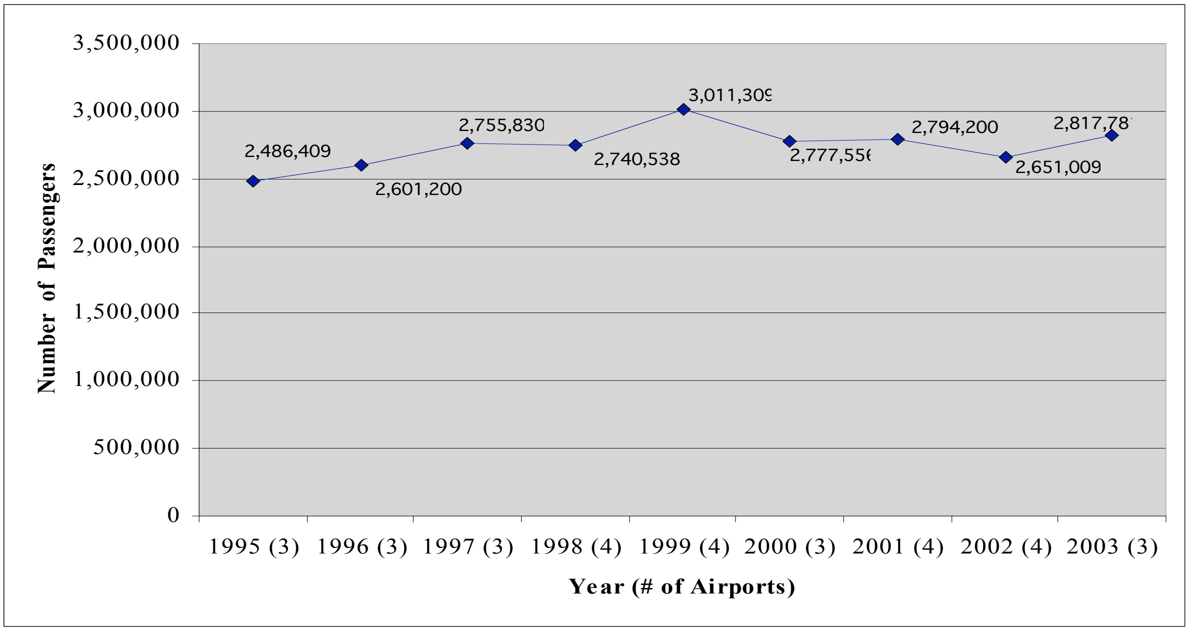
[113] Note that these figures represent only revenue passengers and that the number of airports included in the data series vary. The latter is less of an issue since the vast majority of air passengers in Nova Scotia arrive at and depart from Halifax International Airport.

[114] Statistics Canada does not indicate which airports are included in these figures. The data do however include major scheduled services; regional and local scheduled services; and major charter services.

Figure 29. Air Passenger Traffic, Enplaned and Deplaned in Nova Scotia, 1995–2003.



Source: Statistics Canada. *Air Carrier Traffic at Canadian Airports* (1996-2003).

Note: These data include: major scheduled services; regional and local scheduled services; and major charter services.

Conclusion

Nova Scotia has the third highest rate of road passenger travel per capita of any province in Canada. Overall road passenger travel, measured in passenger-kilometres travelled, grew 5.2% between 1990 and 2002, compared with a 15.7% increase for Canada during the same time period, but that difference is largely due to a rate of population growth that was much slower in Nova Scotia than the national average. Most of this road transport growth occurred early in this period, and there is some indication that per capita vehicle travel has levelled off. Between 1999 and 2002, there was a 6.8% decrease in road passenger travel in the province. However, during this period travel shifted to less sustainable modes, particularly light trucks which include SUVs.

As well, the increase in air travel since 1990 represents a trend away from sustainability. The share of passenger travel by public transit has remained relatively unchanged since 1990, at about 3.6% of total passenger transportation (not counting school buses, where increased usage appears to represent longer distances travelled by students to consolidated schools). These long-term trends represents a failure to move towards sustainability, although recent years have seen modest progress, including small reductions in per capita vehicle travel and increases in transit ridership.

1.2 Motorized Movement of Freight

Freight transport is essential for a vibrant economy. However, freight movement also imposes significant economic, social, and environmental costs, as discussed elsewhere in this report. Therefore, an overall decrease in freight travel and a reduction in the amount of freight transport per unit of economic activity indicates increased economic efficiency and is viewed as genuine progress. Less dependence on long-distance freight could also reflect increased dependence on local goods and stimulate the local economy – another indicator of genuine progress.

Because truck freight contributes much more heavily to environmental degradation than shipment by rail, a shift in tonnage from truck to rail is also seen as a trend towards genuine progress. A previous **GPI***Atlantic* report that compared the full costs of rail and truck freight determined that transferring 10% of freight from truck to rail along the Halifax-Amherst corridor in Nova Scotia could save $10 million each year, when social and environmental externalities like accident costs, infrastructure maintenance, and greenhouse gas and pollutant emissions are included.[115]

Following the methodology of the Centre for Sustainable Transportation, freight activity in this study is represented by tonne-kilometres, which is the weight of goods transported multiplied by the distance over which they are moved. An overall decrease in tonne-km is viewed as a trend towards genuine progress.

The CST cautions against modal comparisons, because trains typically handle heavier goods transported over longer distances, resulting in higher tonne-km, whereas trucks and aircraft are preferred for higher value, time-sensitive materials. Another difficulty in comparing truck and rail freight trends is that many goods are moved through inter-modal means, using both truck and rail. In Nova Scotia it is impossible to make a modal comparison since provincial statistics for rail freight are not released due to confidentiality reasons. As with passenger travel, the key data source for freight traffic is the Office of Energy Efficiency 2002 Comprehensive Energy Use Database.

For Canada, the main indicator is total decrease or increase in freight tonne-km. With the caution mentioned above, a modal comparison can also be made nationally; but for Nova Scotia (and the rest of Atlantic Canada) total tonne-km are unavailable for rail, air, or marine freight. Therefore, the main indicator of freight transport activity for Nova Scotia must be tonne-kilometres of truck freight.

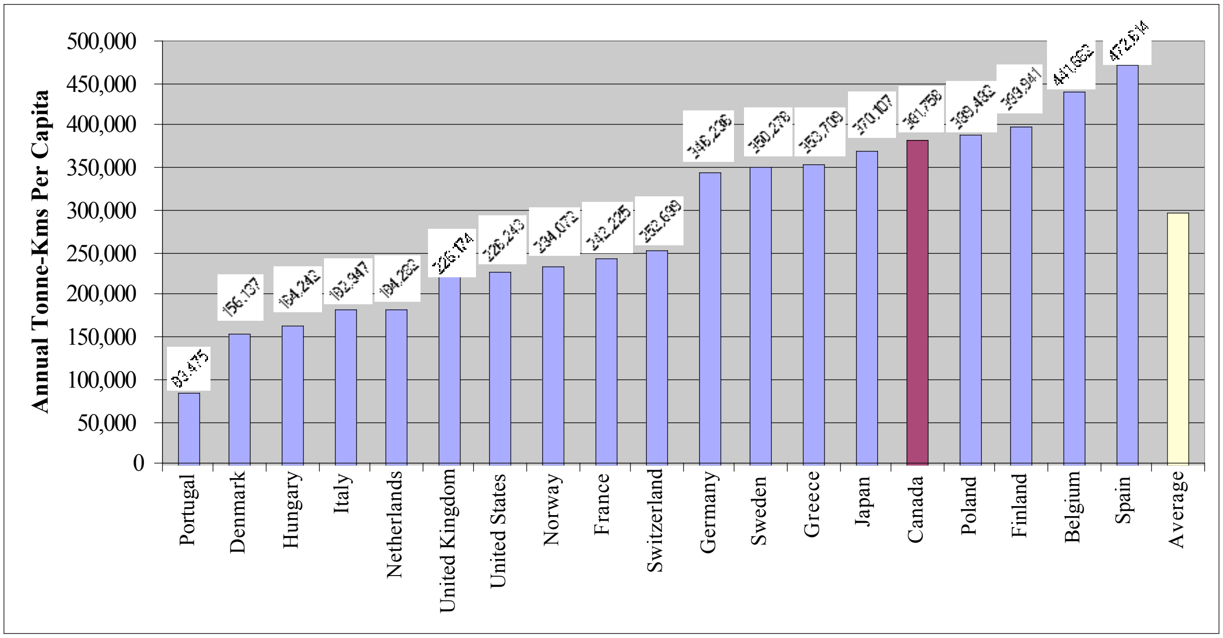
Trends: International

Figure 30 compares annual rates of movement (tonne-km) of road freight per capita among 19 selected OECD countries (not including the USA) for which comparable data were available. Canada ranks fifth in per capita tonne-km of freight transported annually by road, after Spain,

[115] Walker, Sally, Ron Hilburn and Ronald Colman. *Application of the Genuine Progress Index Approach to Analyzing Reduction of Greenhouse Gas Emissions in the Nova Scotia Freight Transport Sector*, p. 55. (Walker Environmental and **GPI***Atlantic*, 2001). www.gpiatlantic.org/pdf/greenhouse/ghg.pdf Accessed July, 2004.

Belgium, Finland, and Poland and moves 28% more freight per capita (in tonne-km) than the OECD average (of the 19 selected countries in Figure 30).

Figure 30. International Comparisons of Selected OECD Countries, Annual Tonne-Km of Road Freight per Capita, 2003.



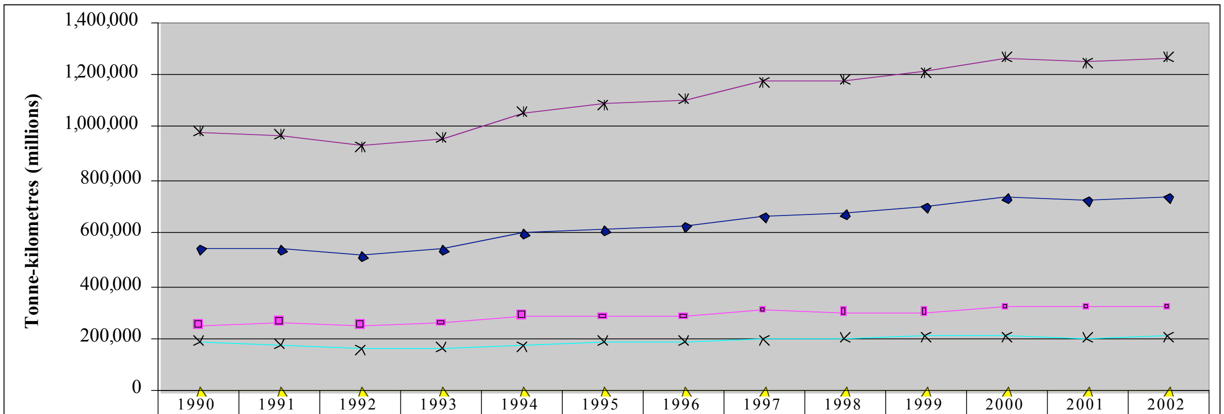
Source: Organisation for Economic Co-operation and Development. *OECD In Figures - 2005 Edition*. (2005).

Trends: Canada

Figure 31 shows that in Canada there has been an overall increase in freight transport, and therefore a trend away from genuine progress and sustainability in this area. From 1990 to 2002, there was a 28% increase in total freight transport, while Canada's population increased only 13%. In other words, for every Canadian, more goods are now being transported greater distances. From 2000 to 2002, there was a slight decrease of 0.1% in total tonne-km.

Trucking has become ever more important. In 1990, trucking comprised 55% of total freight, whereas in 2002 it comprised 59%. There was little change in the share of total freight transported by rail and air (rail, 25%; air, 0.18%). Marine freight transport decreased by three percent over this period. The modal trends, showing an increase in the proportion of freight moved by truck and no increase in the share moved by rail, also indicate a move away from sustainability.

Figure 31. Freight Tonne-Km in Canada, 1990-2002: Total and by Mode (millions of tonne-km).



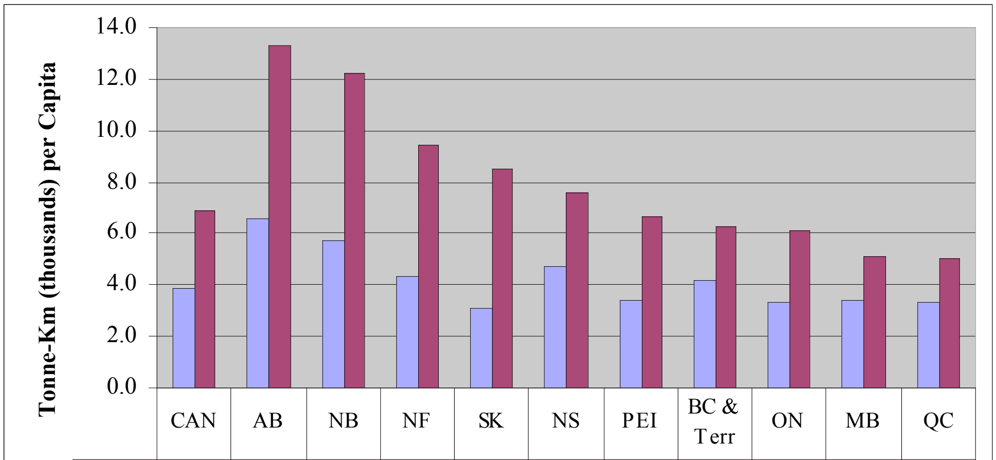
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Road	546,349	536,419	515,905	536,718	596,176	613,810	630,506	668,403	675,314	702,922	734,768	729,435	740,571
Rail	248,371	260,537	250,607	256,338	288,432	280,426	282,482	306,198	298,797	297,504	319,769	317,904	317,286
Air	1,754	1,573	1,498	1,646	1,799	2,045	2,178	2,371	2,292	2,365	2,329	2,327	2,324
Marine	190,115	175,650	161,478	163,835	172,529	189,050	192,427	196,129	201,560	208,039	210,347	200,209	205,446
TOTAL	986,589	974,180	929,488	958,537	1,058,936	1,085,331	1,107,594	1,173,100	1,177,963	1,210,831	1,267,213	1,249,874	1,265,627

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 14, 21, 27 and 28.

Since the indicator for Nova Scotia is tonne-km of truck freight, Figure 32 offers a provincial comparison of tonne-km (thousands) of truck freight per capita by province. This graph shows the dramatic increase in truck freight for all provinces, with an average 82% per capita increase for the country as a whole. In Alberta, New Brunswick, Saskatchewan, and Newfoundland and Labrador, per capita truck freight movement more than doubled.

In 2002, Nova Scotia was fifth in tonne-km of truck freight per capita, 10% higher than the national average. Alberta continues to rank highest in truck freight per capita, while Manitoba and Quebec tie for the lowest amount.

Figure 32. Tonne-Km (thousand) of Truck Freight per Capita, by Province, 1990 and 2002.



	CAN	AB	NB	NF	SK	NS	PEI	BC & Terr	ON	MB	QC
1990	3.8	6.6	5.7	4.3	3.1	4.7	3.4	4.2	3.3	3.4	3.3
2002	6.9	13.3	12.2	9.4	8.5	7.6	6.7	6.3	6.1	5.1	5.1

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Canada, Table 18.

Trends: Nova Scotia

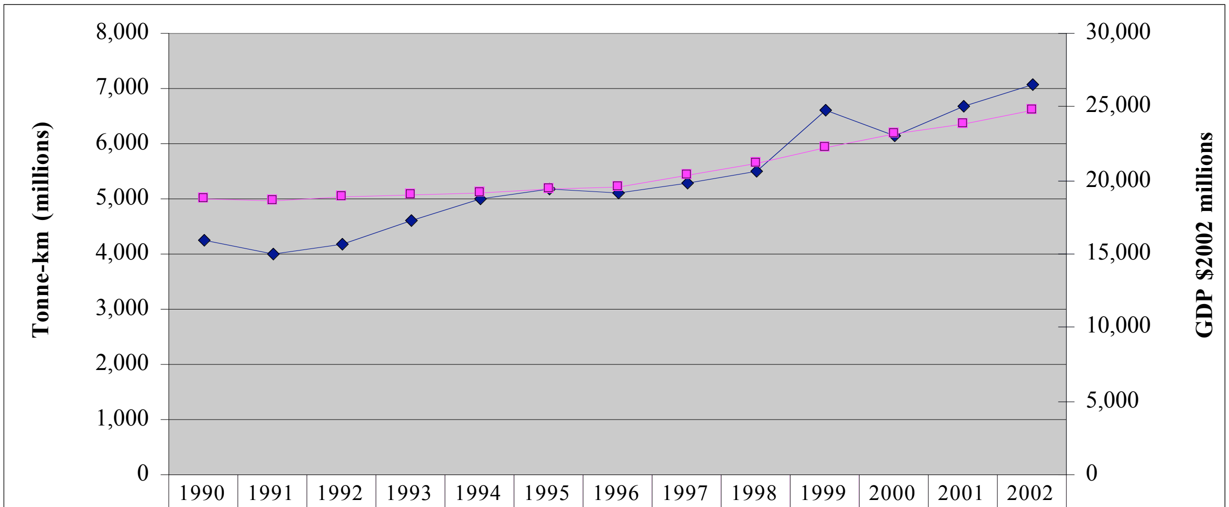
Truck Freight Transportation

As mentioned above, due to data limitations, the only available indicator for freight activity in Nova Scotia is trucking tonne-km. Figure 33 shows the dramatic increase in total truck freight (66%) over the period 1990-2002. Between 2000 and 2002 alone, there was a 15% increase in truck freight traffic. This represents a trend away from sustainable transportation and genuine progress, and will be explored further in this report in the environmental indicators section.

Figure 33 also indicates that the overall increase in truck freight, at 66%, was nearly double the increase in GDP in Nova Scotia (33%) during this period. This relationship between truck freight activity and GDP demonstrates the strong link between trucking services and domestic economic growth.[116] But it also points to factors exogenous to Nova Scotia that may have produced changes in the ***type*** of economic activity, like greater reliance on trade and on distant rather than local markets. These potential causal and explanatory factors that may help account for the sharp increase in truck freight definitely require further investigation, as the relative stability of marine cargo volumes at the Port of Halifax during this period (Figure 35 below) does not necessarily support the globalization/free trade hypothesis.

[116] Casaubon, Rejean, Hertsel Labib, Nick Macaluso, David McNabb, Nancy Roberts, Joycelyn Exeter, Michel Berube, Hy-Hien Tran, Jai Persaud, Wally Geekie, Catherine, Roberts, JoAn Halliday, Co Tran and Lifang Cui. *Canada's Emission Outlook: An Update*, p. 21. (Ottawa: Natural Resources Canada, 1999). www.nrcan.gc.ca/es/ceo/outlook.pdf

Figure 33. Tonne-Km of Freight Transported by Truck (millions of tonne-km) and Nova Scotia GDP growth in millions of 2002$, 1990-2002.

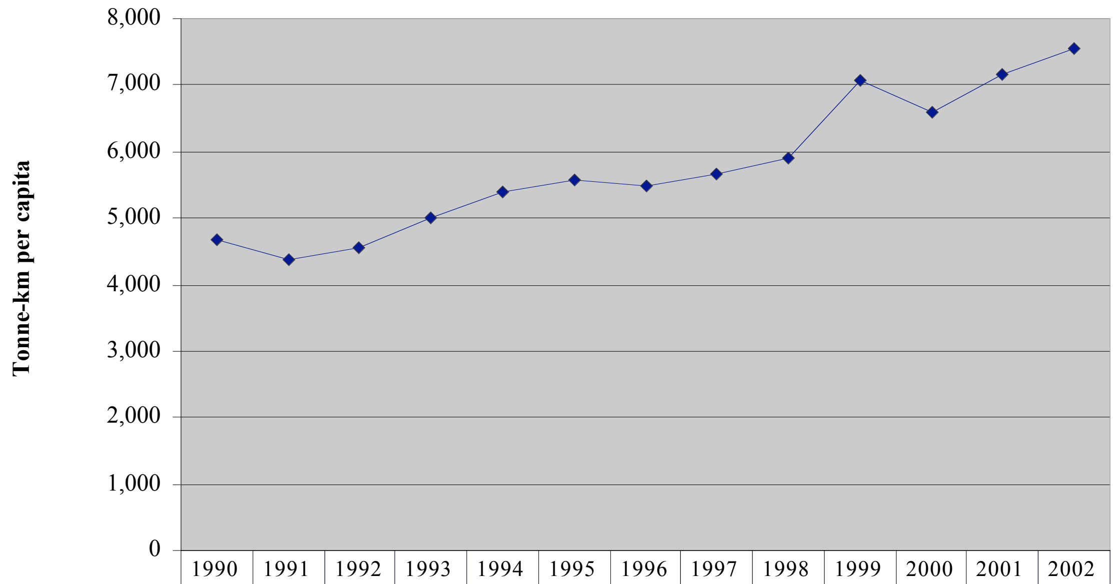


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
tonne-km	4,265	3,994	4,189	4,620	4,995	5,182	5,117	5,291	5,512	6,603	6,157	6,678	7,060
GDP	18,730	18,570	18,831	19,011	19,090	19,410	19,529	20,368	21,127	22,285	23,174	23,783	24,825

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Table 11.

Figure 34 shows the tonne-km of freight transported per capita in Nova Scotia from 1990 through 2002. There was a 61% increase in freight transportation on a per capita basis over this period, compared with a 66% expansion in total tonne-km. This indicates that population is only a very minor factor in the growth of truck freight, and that the dramatic increase is probably due to macro-economic forces like the expansion of globalization and free trade.

Figure 34. Tonne-Km of Truck Freight per Capita, 1990-2002.



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
tonne-km per capita	4,689	4,365	4,555	5,000	5,388	5,583	5,494	5,674	5,914	7,070	6,593	7,163	7,556

Sources: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Table 11; and Statistics Canada. CANSIM Tables 051-0001 and 384-0002.

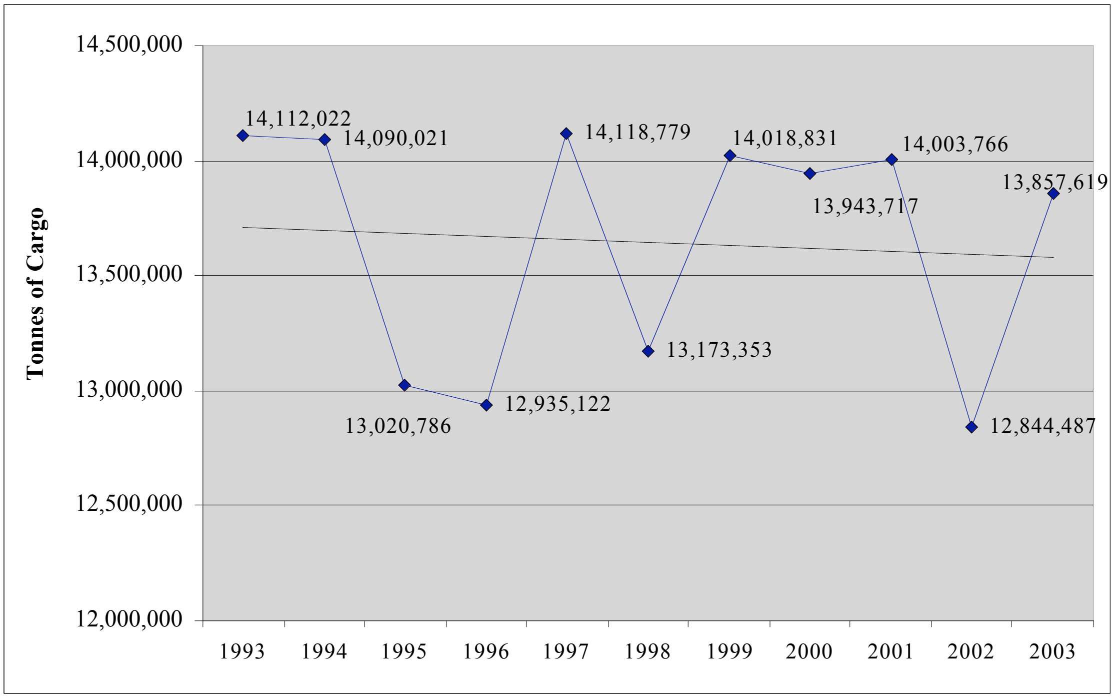
Marine and Air Freight Transportation

As already mentioned, extant data on Nova Scotia's marine and air freight transportation are very limited. Unlike road transportation, tonne-km statistics were not provided by Natural Resources Canada's Office of Energy Efficiency for either marine or air transportation because data were suppressed for confidentiality reasons. This gap in the data made it impossible to compare changes in the different modes of transportation.

What were available on a provincial scale, as a result of personal communications with the Halifax Port Authority, were the total cargo volumes for the Port of Halifax for 1993-2003 (Figure 35, which also shows the trend line).[117] The trends for tonnes of marine cargo shipped fluctuated during this period, though the fluctuations generally remained roughly in the 13 to14 million tonne per year range, and averaged about 13.6 million tonnes. The causes of the frequent variances can in part be attributed to changes in receipts of particular kinds of international cargo. For example, between 2001 and 2002 there was a 7.6% decrease in total tonnage handled at the port due to decreased shipments of crude petroleum from Europe and South America in that year.[118]

[117] Personal communication with Chris Melvin, Statistics Clerk, Halifax Port Authority. December, 2004.
[118] Statistics Canada. *Shipping in Canada—2002*, p. 16. (Ottawa: Minister of Industry, 2004a). http://dsp-psd.communication.gc.ca/Collection-R/Statcan/54-205-XIB/0000254-205-XIE.pdf Accessed December, 2004.

Figure 35. Tonnes of Cargo Shipped at the Port of Halifax, 1993-2003.



Source: Personal communication with Chris Melvin, Statistics Clerk, Halifax Port Authority. December, 2004.

Conclusion

Road freight transportation in Nova Scotia shows definite trends away from sustainability, both in overall tonne-km of freight transported, and in the increasing proportion of freight moved by trucks. The overall increase in truck freight was seen to outpace increases in population and increases in GDP. There is no ready explanation for the spike in truck freight in 1999, but truck freight continued to grow steadily after 2000, and in 2002 was at its highest level on record.

Because of the economy's strong dependence on the trucking industry, it may at first glance seem difficult to reverse current trucking trends without major economic setbacks. However, one approach would be to shift a portion of freight traffic from truck to rail, a more environmentally benign form of transportation. The feasibility of such a shift, including an analysis of freight types and their suitability to rail transport, was examined in an earlier GPI report, which found that at least a 10% shift would be possible without significant economic disruption.[119]

A greater reliance on local supply of goods and services, rather than on distant markets, would also help to reverse the present unsustainable freight transport trends in more fundamental ways while stimulating the local economy. This would certainly require an economic restructuring that involves greater support for local business efforts and a greater detachment from the globalized

[119] Walker, Sally, Ron Hilburn and Ronald Colman. *Application of the Genuine Progress Index Approach to Analyzing Reduction of Greenhouse Gas Emissions in the Nova Scotia Freight Transport Sector*, p. 55. (Walker Environmental and **GPI***Atlantic*, 2001). www.gpiatlantic.org/pdf/greenhouse/ghg.pdf Accessed July, 2004.

economy, with a more basic commitment to provincial and regional self-reliance and sustainability.

Another more transportation-specific alternative to present trends would be to increase use of inter-modal transportation. Although not examined in detail in this report because of a lack of data, inter-modal transportation involves the use of standard containers that are trans-shipped between modes (e.g., marine/rail; rail/truck; truck/air). As explained by the Centre for Sustainable Transportation, altering the form of conveyance in response to changing conditions en route maximizes efficiency, which in turn implies movement toward greater sustainability.[120]

Subsequent indicators and the full cost accounting section of this report will explore the reasons for the dramatic increase in truck freight in greater detail. The absence of tonne-km statistics at the provincial level for the rail, marine, and air modes of freight transportation makes the analysis of freight movement incomplete and renders this indicator less useful than it would be with those data. One of the key data recommendations in this report is that a more satisfactory balance needs to be found between confidentiality provisions designed to protect the commercial interests of particular companies and the public interest in having key data available that are needed for transportation policy and planning purposes.

[120] Gilbert et al. (2002, p. 59).

Chapter 2. Energy Consumption

To be sustainable, a transportation system must consume resources at a rate no greater than that at which they can be replaced. In the transportation systems that exist today in industrialized societies, most energy used in the movement of vehicles comes from non-renewable resources.[121] By definition, then, such systems are unsustainable.

Transportation is the world's fastest-growing form of energy use, accounting for nearly 30% of global energy demand and 95% of the planet's oil consumption.[122] Projections for the next quarter century show that transportation's demand for energy will expand more rapidly than any other end-use sector, overtaking requirements for industry and for all other sectors of the global economy.[123]

Transportation's dependence on oil is unsustainable because the world is depleting easily extracted petroleum supplies, and because the consumption of fossil fuels produces significant environmental damages, including climate change. There is some controversy over when global oil production will peak, but Francis Harper, a senior British Petroleum consultant, recently stated that this is likely to occur between 2010 and 2020.[124] Chris Skrebowski, editor of *Petroleum Review*, analysed all known projects with estimated reserves of more than 500 million barrels. He found that these will already be insufficient to meet world energy demand by 2007.[125]

Unless energy consumption decreases sharply or alternative energy sources are found, diminishing world oil supplies will dramatically increase the reliance of all countries on the major oil-producing states of the Middle East. The potential peak in oil production, combined with an ever deepening dependency on imports from unstable regions is expected to increase future oil and gasoline prices, and also increase the use of alternative fossil fuels, such as tar sands and liquefied coal, which in turn will increase environmental damages per unit of energy consumed.

Transportation in Canada is responsible for 70% of total oil use in the country, while the transportation sector itself relies on oil almost exclusively (99%).[126] With an expansive landmass, and with transportation an integral component of Canadian society, the economic implications of volatile energy prices would be significant for this country. For a more detailed discussion of "peak oil" and its economic and security implications, see the GPI Energy

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[121] Ibid, p. 29.
[122] WorldWatch Institute. 2004. *State of the World 2004*—Trends and Facts: Making Better Energy Choices. www.worldwatch.org/features/consumption/sow/trendsfacts/2004/07/07/ Accessed December, 2004.
[123] International Energy Agency 2004. *World Energy Outlook 2004*, p. 32. www.iea.org/textbase/npsum/WEO2004SUM.pdf Accessed December, 2004.
[124] Orange, Richard. "Oil supply to peak sooner than we think, says BP scientist." *The Business*. November 07, 2004. www.thebusinessonline.com/modules/news/view.php?id=29138 Accessed December, 2004.
[125] Skrebowski, Chris. 2004. "Oil Field Mega Projects 2004." *Petroleum Review*, January 2004, pp. 18-20.
[126] National Energy Board. 2003. Canada's Energy Future: Scenarios for Supply and Demand to 2025, Appendix 3: Table A3.1, Section 2. Ottawa. www.neb-one.gc.ca/energy/supplydemand/2003/index_e.htm Quoted in: Centre for Sustainable Transportation. Sustainable Transportation Monitor, No.10, June, 2004, p. 18. www.cstctd.org/CSTadobefiles/STM10E-final.pdf.

Accounts for Nova Scotia.[127] In view of these economic, security, and environmental considerations, any reduction in non-renewable fuel consumption constitutes movement towards sustainability. Shifts towards more energy-efficient transportation modes can also indicate increased sustainability.

The Indicators

In its work on the performance indicators for transportation sustainability, the Centre for Sustainable Transportation used total transport consumption of fossil fuels by mode as the primary indicator for energy consumption.[128] The CST also compared changes in energy consumption by mode to changes in gross domestic product and population. Data at the national level were obtained by the CST from Natural Resources Canada's *Energy Use Data Handbook*.[129]

GPI*Atlantic*'s principal data for this particular indicator were obtained from Natural Resources Canada's 2002 Comprehensive Energy Use Database, a compendium maintained by the Office of Energy Efficiency.[130] Since the OEE database provides more detailed transportation statistics at the provincial level than Natural Resources Canada's *Energy Use Data Handbook,* the present report relies on the OEE data for information on energy use by mode of travel.

However, this report also examines additional energy use indicators that required different data sources. Although the OEE numbers are based partly on Statistics Canada's *Energy Supply and Demand Reports*, there are differences in the way energy consumption is reported by the two agencies. One consequence of this is the absence from the OEE database of a figure for ***overall*** energy use in Nova Scotia. For that reason, **GPI***Atlantic* used the Statistics Canada reports directly to assess transportation energy use as a proportion of total energy consumption.[131]

The indicators selected by **GPI***Atlantic* to analyse transportation energy consumption include:

- transportation energy use as a percentage of total use;
- total energy use and per capita energy use for transportation; and
- percentage of total energy use by transport mode.

However, for the reasons explained below, only the second two of these indicators are used to assess actual movement towards or away from sustainability.

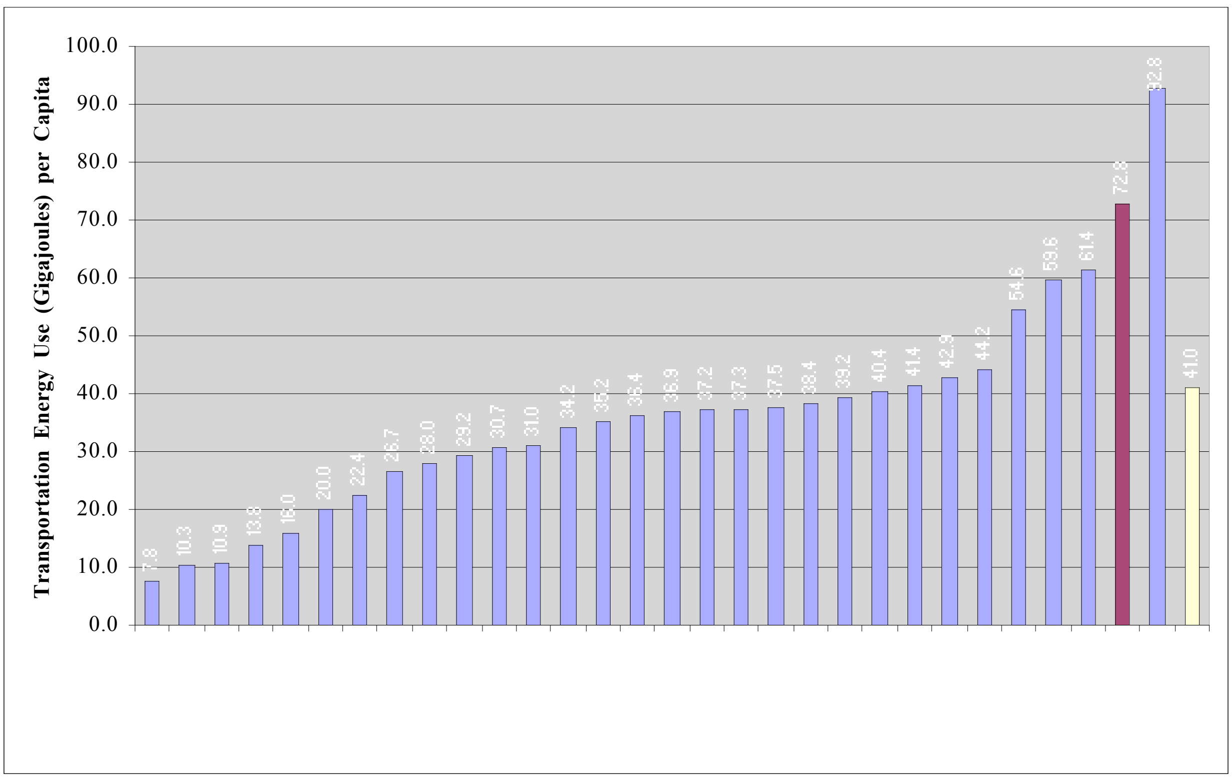
[127] Available at www.gpiatlantic.org.
[128] Gilbert et al. (2002, p. 85).
[129] Ramsum, Carolyn, Naima Behidj, Johanne Bernier, Samuel Blais, Sebastien Genest, Jessica Norup, Cory Peddigrew and Anna Zyzniewski. *Energy Use Data Handbook, 1990 and 1996 to 2002*. (Ottawa: Natural Resources Canada—Office of Energy Efficiency. 2004b).
http://oee.nrcan.gc.ca/neud/dpa/data_e/Handbook04/TofC.cfm?text=N&printview=N
[130] Natural Resources Canada—Office of Energy Efficiency. (August 5, 2004a and August 5, 2004b).
[131] Statistics Canada. 2003. *Report on Energy Supply/Demand in Canada*. Catalogue no. 57-003-X1B. Years 1992-2002.

The next section of the report briefly outlines international and Canadian data for the first two of these indicators on energy use in the transportation sector. This is followed by a more extensive review of the Nova Scotia evidence, including the third indicator on energy use by mode.

Trends: International

Canada's use of energy for transportation is significantly greater than that of most other industrialized nations. When energy use by the transportation sector is directly compared on a per capita basis with other member countries of the Organisation for Economic Co-operation and Development (plus Russia), Canada has the third highest per capita energy use out of 31 countries (see Figure 36). The only countries that use more transportation energy per person than Canada are Luxembourg (not shown in Figure 36 – see note below) and the United States. In fact, Canada uses about twice as much energy for transportation per capita as countries like Germany, the United Kingdom, and Italy.

Figure 36. Transportation Energy Use (Gigajoules) per Capita for Selected OECD Countries, 2000.[132]



Source: Organization for Economic Co-operation and Development. OECD Environmental Data—Compendium 2002, Tables 8.5 and 12.1A.

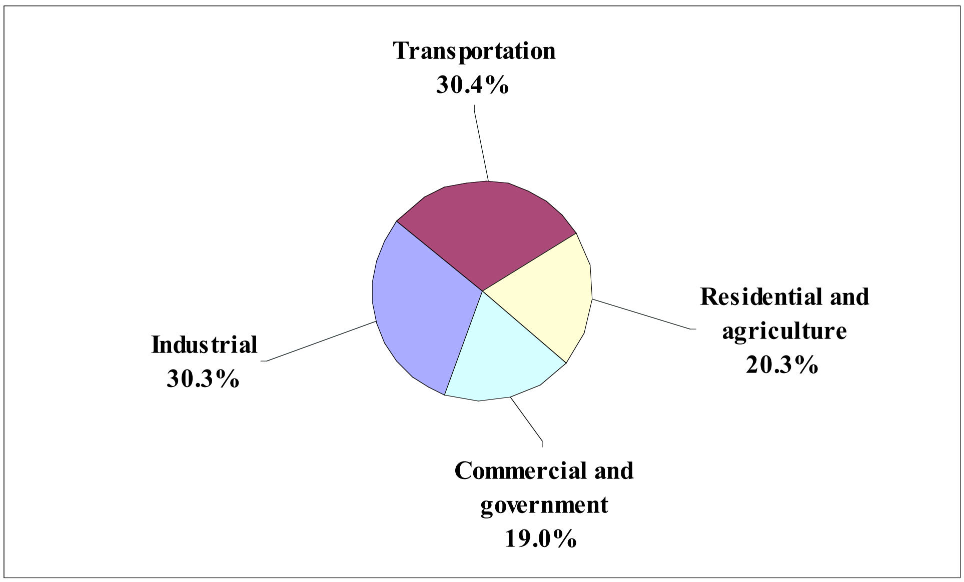
[132] A petajoule is a measure of energy use equivalent to 948 billion British Thermal Units (BTUs), or "roughly the amount of energy required to operate the Montreal subway system for one year." (Statistics Canada. "Energy consumption estimates for manufacturing industries," *The Daily*, August 1, 2003).

Note: There are 30 countries registered with the OECD. This chart only includes 29 of these OECD countries plus Russia, in order to optimize comparability. Luxembourg was excluded from this chart because its energy use per capita is the result of unique policies and if included would skew the chart. It is a tiny country with low fuel taxes, so many motorists from other countries fill their tanks there.

Trends: Canada

From 1990 through 2002, Canadian energy consumption in the transportation sector rose by 23%, while total energy consumption rose by 18%, and population by only 13%. In 2002, transportation accounted for 30% of overall energy use in Canada—more than any other sector (Figure 37).[133]

Figure 37. Energy Demand by Sector as a Percentage of Total Energy Demand in Canada, 2002.



Source: Statistics Canada. "Energy Supply and Demand" in *The Daily* (October 2, 2003).

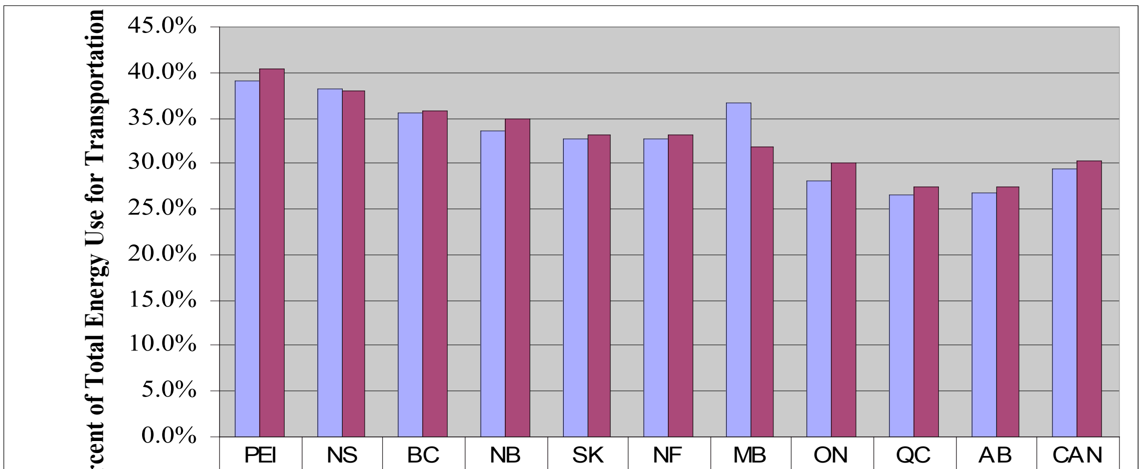
Figure 38 presents a comparison of transportation energy use as a percentage of total energy use for Canada and all the provinces, plus amalgamated numbers for the northern territories. This shows that Nova Scotia—at 38% in 2002—ranks second in the country in the proportion of total energy dedicated to transportation. Nova Scotia stands a full 7.5 percentage points higher than the national average of 30% in the proportion of total energy use attributable to the transportation sector. These provincial ratio differences are attributable in large part to differences in energy intensity and the degree of industrialisation and urbanisation in different provinces rather than to higher rates of transportation energy use. More highly industrialised provinces like Ontario,

[133] Statistics Canada. "Energy Supply and Demand." (*The Daily*. October 2, 2003). www.statcan.ca/Daily/English/031002/d031002a.htm Accessed September, 2004.

Quebec, and Alberta, for example, will have higher ratios of industrial energy use to total energy use, and therefore correspondingly lower ratios of transportation energy use to total energy use.

As well, very high rates of transportation-related energy use can be concealed in these ratios by even higher rates of total energy use. Thus, Alberta has the lowest ratio of transportation energy use to total energy use of any province, but actually has the highest per capita transportation-related energy use of any province. For these reasons, the transport energy to total energy use ratios are reported here, but only the actual trends in transportation energy use are used as an indicator of movement towards sustainability.

Figure 38. Transportation Energy Use as a Percentage of Total Energy Use, by Province/Territory, 1992 and 2002.



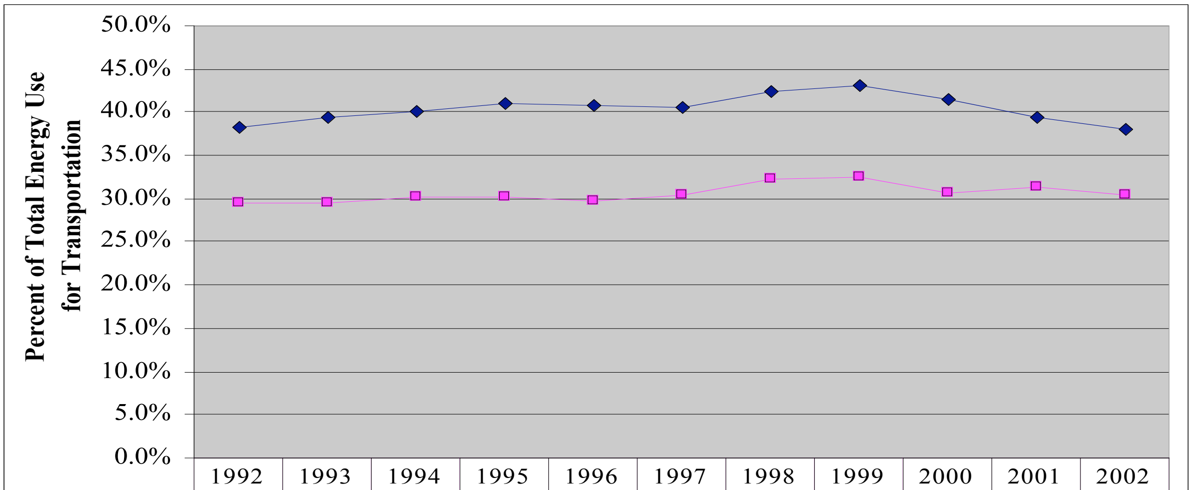
	PEI	NS	BC	NB	SK	NF	MB	ON	QC	AB	CAN
1992	39.1%	38.3%	35.7%	33.6%	32.8%	32.7%	36.6%	28.1%	26.5%	26.7%	29.5%
2002	40.3%	37.9%	35.7%	34.8%	33.2%	33.1%	31.8%	30.2%	27.5%	27.4%	30.4%

Source: Statistics Canada. *Report on Energy Supply/Demand in Canada*. Years 1992-2002.

Figure 39 extends this comparison by showing the changing ratios of transportation energy use to total energy use over time for Canada and Nova Scotia. Nova Scotia followed the Canadian trend, with the ratios of transportation energy to total energy increasing fairly steadily to 1999 and then dropping. Nova Scotia's ratio of transportation energy use to total energy use has actually dropped considerably from its 1999 peak of 43% to its 2002 ratio of 38%. This is the lowest proportion since comparable records were kept in 1992, though it remains higher than any other province except Prince Edward Island.

Again, these changes in the ratio of transportation energy use to total energy use are not entirely due to lower transportation energy use alone, but also to increased total energy use. Thus, Nova Scotia's transportation energy use has fallen since its 1999 peak, but it is still higher than in any year prior to 1998 (Figure 42 below). In other words changes in both the nominator and the denominator will affect a ratio change, which is why this indicator is not used to assess movement towards or away from sustainability.

Figure 39. Nova Scotia and Canada: Transportation Energy Use as a Percentage of Total Energy Use, 1992-2002.



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
NS	38.3%	39.4%	40.1%	41.0%	40.7%	40.5%	42.5%	43.1%	41.4%	39.5%	37.9%
Canada	29.5%	29.4%	30.3%	30.2%	29.7%	30.4%	32.2%	32.5%	30.7%	31.3%	30.4%

Source: Statistics Canada. *Report on Energy Supply/Demand in Canada*. Years 1992-2002.

Figure 40 shows energy use per 100,000 persons for freight and passenger transportation, by province. Nova Scotia ranks fourth in energy use per capita for passenger transportation (4.52 PJ), and sixth in energy use per capita for freight transport (3.38 PJ). Alberta has the highest rate of transport-related energy consumption based on population, with 5.18 PJ per 100,000 persons for passenger transport, and 5.45 PJ for freight transport. Manitoba has the lowest figure for freight transport energy use, with only 2.03 PJ per 100,000 persons in 2002.

The per capita rate of transportation energy use by province can vary due to a number of factors. These include the transportation dependency of particular kinds of economic activity, the modes of transportation used, and differing rates of economic growth, income, and consumption.

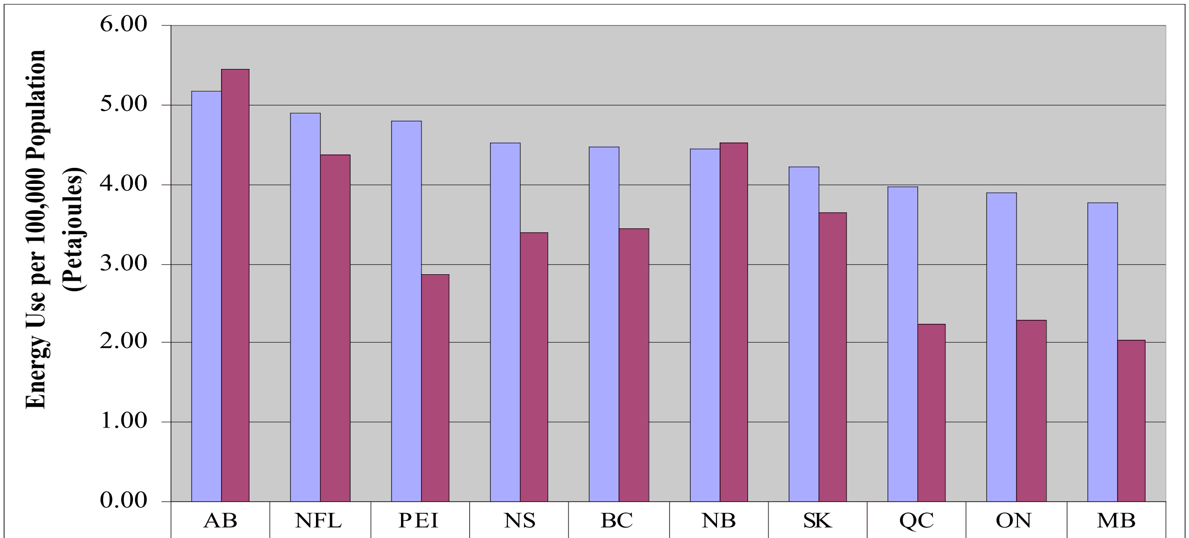
In 2000, Ontario—which has 38% of Canada's population—consumed 35% (865 PJ) of total Canadian transportation energy. By comparison, Alberta, with only 9.8% of Canada's population, consumed 15% (363 PJ) of Canadian transportation energy, and has the highest rate of transportation energy use per person in the country. This is likely linked to the strong economic growth, tar sands oil boom, and overall increase in energy use that are occurring in that province.[134]

Manitoba—the province with the lowest per capita transportation energy use for both passenger and freight transport—consumed 3.6% (89 PJ) of total Canadian transportation energy in 2000. Manitoba has 3.7% of Canada's population. In the year 2000, Atlantic Canada consumed eight

[134] Canadian Press. "Alberta Led In Energy Growth Between 1990 & 2002." (*The Electricity Forum News*. October, 2003). www.electricityforum.com/news/oct03/alberta.html Accessed December, 2004.

percent (205 PJ) of Canadian transportation energy.[135] Atlantic Canada comprises 7.6% of Canada's population.

Figure 40. Freight and Passenger Transportation Energy Use (PJ per 100,000 persons), by Province, 2002.



	AB	NFL	PEI	NS	BC	NB	SK	QC	ON	MB
Passenger	5.18	4.90	4.80	4.52	4.47	4.44	4.23	3.97	3.88	3.77
Freight	5.45	4.36	2.85	3.38	3.44	4.51	3.64	2.22	2.27	2.03

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 10 and 11; and Statistics Canada. CANSIM Table 051-0001.

Changes in energy use for freight in Canada are shown in Figure 41, with the data normalized to 1990 = 100 for comparative purposes. Countrywide, energy use for trucking grew by 52% between 1990 and 2002. Over the same period, energy use for rail freight fell by 16%.

The increase in trucking was also noted in the previous section on transport activity, which showed that trucking occupies a growing share of total freight transported in Canada (55% in 1990, and 59% in 2002). The increase in the amount of energy used by trucking, and the concurrent decline in the energy used by rail, indicates a trend away from sustainability, as rail transport is much less energy-intensive per tonne of freight moved than truck transport. This shift towards trucking has significant implications for the environmental impact of the transportation sector as a whole. As noted in the section on greenhouse gas emissions below, as a result of being more energy intensive, the movement of freight by truck generates 12 times the volume of GHG emissions per tonne-kilometre transported than equivalent rail activity produces.[136]

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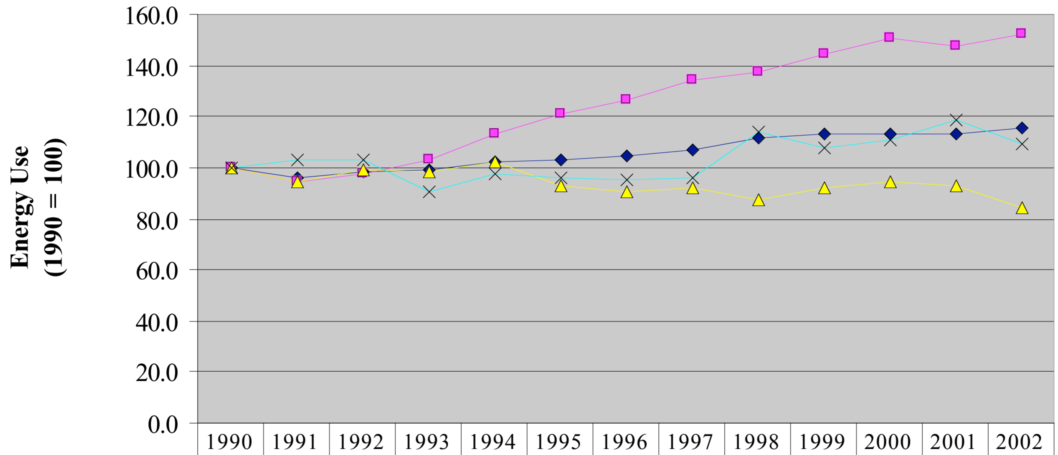
[135] Transport Canada. (2001b, p. 33).
[136] Railway Association of Canada. *Trends in Freight Energy Use and Greenhouse Gas Emissions, 1990-1999*, p. 6. (2001). www.railcan.ca/documents/publications/131/TrendsInFreightEnergyUse_en.pdf Accessed December, 2004.

Figure 41. Canada: Changes in Freight Energy Use, by Transport Mode, 1990-2002. (Normalized to 1990 values = 100).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total Freight	100.0	96.4	98.4	99.4	102.4	103.3	104.4	107.3	111.3	113.5	113.2	113.2	115.5
Total Truck Freight	100.0	94.7	97.8	103.0	113.2	120.9	126.7	134.6	137.2	144.6	150.4	147.7	151.9
Freight Rail	100.0	94.2	98.8	98.4	102.3	92.8	90.6	92.0	87.5	92.5	94.7	93.0	84.3
Total Other Freight	100.0	102.8	103.1	90.8	97.4	95.7	95.6	96.1	114.0	107.9	110.9	118.7	109.1

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Canada, Table 7. Adapted from Box 3, p. 5, *Sustainable Transportation Monitor* (No. 10, June, 2004).

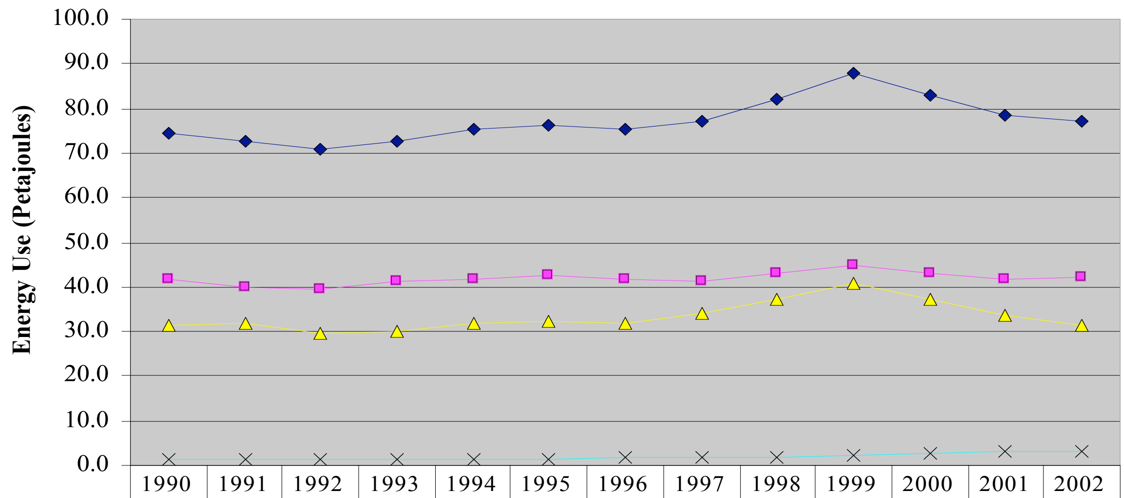
Trends: Nova Scotia

Figure 42 shows energy use by the transport sector in Nova Scotia for the period 1990-2002. Figure 43 presents the same data normalized to a value of 10 in 1990 to demonstrate the relative change over time. These charts show that total transportation energy use in Nova Scotia increased by 3.4% between 1990 and 2002, which indicates a trend away from sustainability. Aside from off-road transport, the graphs depict a general decline in transportation energy use following a spike in 1999. Both the peak in transportation energy use in 1999 and the subsequent decline will be discussed in more detail later in the analysis and in the conclusion.

Between 1990 and 2002, passenger energy use grew by 1%; and freight energy use by 0.3%. By far the largest relative increase in transport-related energy use was in off-road transport, which jumped by 146%, from 1.3 petajoules in 1990 to 3.2 petajoules in 2002 (see Figures 42 and 43). Nearly three-fourths of that increase occurred between 1998 and 2002 alone, at a time when other transport-related energy use was declining. Although off-road vehicle energy use still represents only a small portion of total transport-related energy use, the off-road proportion jumped sharply from 1.7% in 1990 to 4.2% in 2002.

The rise in off-road transport, which includes All-Terrain Vehicles (ATV's, or "dune buggies"), snowmobiles and amphibious vehicles, has particular implications for sustainability, as ATVs in particular have been shown to be detrimental to wildlife habitat.[137] In Nova Scotia, a heated controversy has arisen about the uncontrolled use of ATVs in the countryside.[138] The most common complaints have been about safety, particularly with respect to use by minors, and about noise pollution. In Nova Scotia, ATV accidents have been increasing dramatically, rising 63% since 1996 alone.[139] This trend will be discussed in further detail when examining the indicators for injuries and fatalities from transportation below.

Figure 42. Nova Scotia: Transportation Energy Use (Petajoules), by Transport Function, 1990-2002.

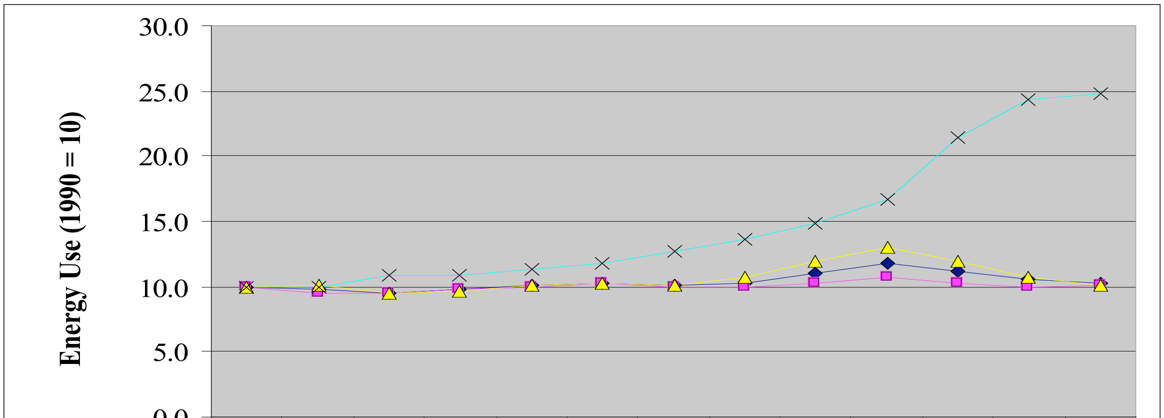


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total	74.6	72.6	70.7	72.7	75.2	76.3	75.2	77.0	82.2	87.9	83.1	78.4	77.1
Passenger	41.8	39.7	39.6	41.1	41.7	42.7	41.5	41.3	42.8	44.7	42.9	41.6	42.2
Freight	31.5	31.6	29.7	30.2	32.1	32.1	32.0	34.0	37.4	41.0	37.4	33.6	31.6
Off-Road	1.3	1.3	1.4	1.4	1.5	1.5	1.7	1.8	1.9	2.2	2.8	3.2	3.2

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Table 1.

[137] University of Rhode Island. "Study of Cape Cod Seashore finds off-road vehicles harmful to beach fauna." (May 24, 2004). www.uri.edu/news/releases/index.php?id=2646 Accessed November, 2004.
[138] Dorey, Barry. "Off-road vehicle report contains some surprises." (Halifax: *Chronicle Herald*. October 30, 2004).
[139] CBC News. *Alcohol Causing Spikes in ATV Accidents: Report*. (Toronto: February 05, 2003). www.cbc.ca/stories/2003/02/05/Consumers/ATVs_030205 Accessed July, 2004.

Figure 43. Nova Scotia: Change in Transportation Energy Use, by Transport Function, 1990-2002. (Normalized to 1990 Value = 10).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total	10.0	9.7	9.5	9.7	10.1	10.2	10.1	10.3	11.0	11.8	11.1	10.5	10.3
Passenger	10.0	9.5	9.5	9.8	10.0	10.2	9.9	9.9	10.3	10.7	10.3	9.9	10.1
Freight	10.0	10.0	9.4	9.6	10.2	10.2	10.2	10.8	11.9	13.0	11.9	10.7	10.0
Off-Road	10.0	9.9	10.9	10.8	11.3	11.8	12.7	13.7	14.8	16.6	21.5	24.3	24.8

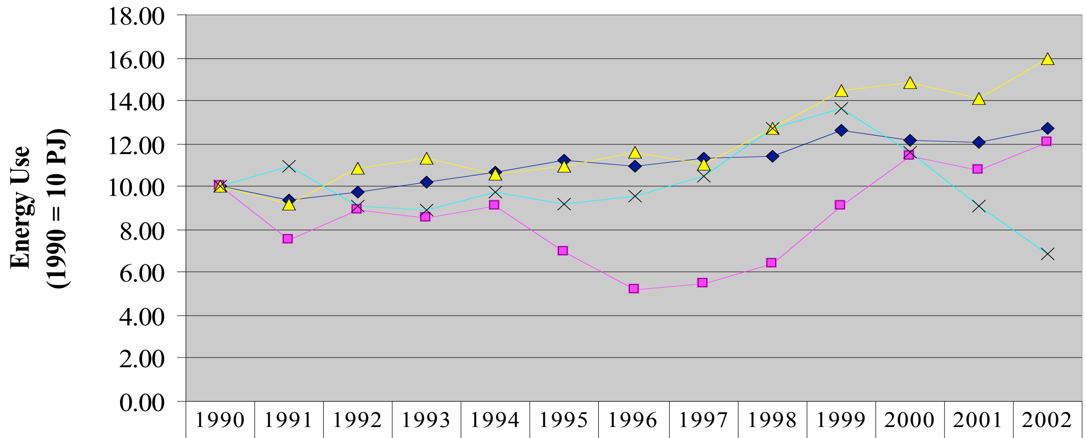
Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation—Nova Scotia, Table 1.

Figure 44 provides an overview of relative changes in energy use for the varying modes of freight transport in Nova Scotia when values are normalised to 1990 = 10. From 1990 to 2002, energy use for truck, rail, and air freight all increased: a trend away from sustainability. Truck freight energy use grew by 27%; rail by 20%; and air freight by 59%.

Marine freight was the only category to show a decrease between 1990 and 2002, with a decline of 32% (4.5 PJ), where only the two end points (1990 and 2002) are considered. However, this is deceptive. As noted in the previous chapter on transport activity, the year 2002 was an anomaly in marine freight trends, due to a 7.6% decrease in total tonnage handled at the Port of Halifax that year due to decreased shipments of crude petroleum from Europe and South America in that year (see Figure 35).[140] When the internal shape of the trend is considered for the absolute energy use of marine freight during this period (see trendline for Figure 45 below), marine freight energy use remained almost unchanged.

[140] Statistics Canada. *Shipping in Canada—2002*, p. 16. (Ottawa: Minister of Industry, 2004a). http://dsp-psd.communication.gc.ca/Collection-R/Statcan/54-205-XIB/0000254-205-XIE.pdf Accessed December, 2004.

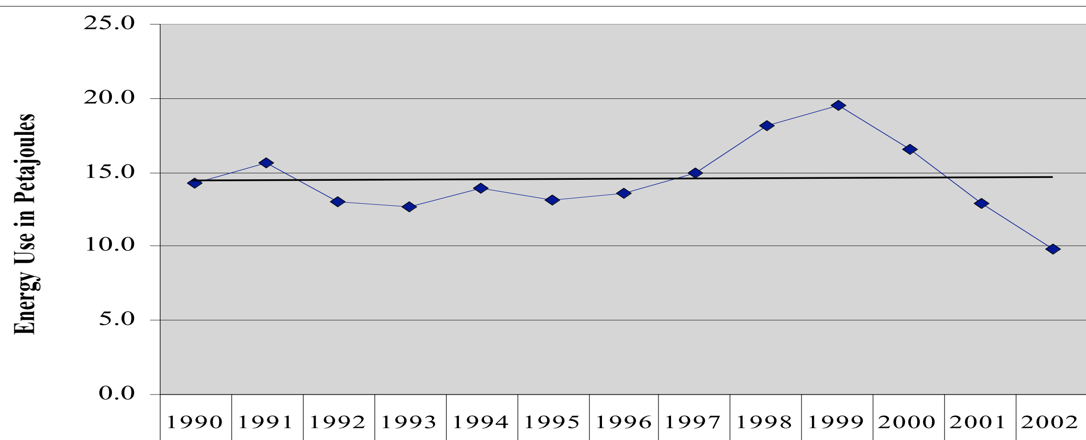
Figure 44. Nova Scotia: Changes in Energy Use for Freight Transport, by Mode, 1990-2002. (Normalized to 1990 Values = 10).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total Truck Freight	10.00	9.38	9.75	10.19	10.68	11.23	10.99	11.36	11.42	12.65	12.16	12.10	12.72
Freight Rail	10.00	7.52	8.86	8.55	9.11	6.94	5.17	5.48	6.39	9.06	11.43	10.73	12.04
Air Freight	10.00	9.16	10.82	11.32	10.54	10.92	11.60	11.05	12.74	14.47	14.86	14.12	15.91
Marine Freight	10.00	10.97	9.10	8.90	9.72	9.22	9.54	10.46	12.73	13.67	11.58	9.06	6.84

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Table 7. Adapted from Box 3, p. 5, *Sustainable Transportation Monitor* (No. 10, June, 2004).

Figure 45. Nova Scotia: Change in Energy Use for Marine Freight, 1990-2002, (Petajoules).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Marine Energy Use	14.3	15.7	13.0	12.7	13.9	13.2	13.6	14.9	18.2	19.5	16.5	12.9	9.8

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Table 7.

Note: The black line above represents the trendline calculated by regression analysis.

But the relative changes illustrated in Figure 44 above, taken alone, can be misleading, as it is the absolute size of the increases, stated in petajoules, that highlights their implications for sustainability. Trucking freight energy demand grew by 4.4 PJ, while rail freight energy use increased by only 0.2 PJ, and air freight energy use by 0.1 PJ. Therefore, in terms of actual energy use, the increase in trucking freight is by far the most substantial, because truck freight is much more energy intensive than rail freight; because it dominates freight transportation; and because air freight still constitutes only a very small portion of total freight transport. The increase in truck freight energy use therefore has the most direct and significant impact on the overall sustainability of the Nova Scotia transportation system.

Further evidence of the growing reliance on trucking for freight transport in Nova Scotia was noted in the transport activity section of this report, where it was seen that truck freight in tonne-kilometres increased by 66% over the period 1990-2002. Given the much larger increase in energy use for trucking freight relative to rail freight, the trend for energy consumption in the Nova Scotia freight sector is clearly away from sustainability.

The shift towards greater reliance on trucking, as opposed to rail, is not sustainable either environmentally ***or economically*** from a full-cost accounting perspective. A previous **GPI***Atlantic* report, which estimated the full costs of road and rail freight in Nova Scotia for the Halifax-Amherst corridor, showed that a transfer of 10% of existing freight from truck to rail could produce savings in excess of $11 million per year.[141] When full costs are not included in accounting mechanisms, misleading price signals are sent to market actors, and economic inefficiencies and policy distortions result. For example, the increased fossil fuel energy use of the truck freight sector results in increased air pollutant and greenhouse gas emissions, which in turn produce costly damages that are not initially included in the market prices for truck freight, but are eventually paid for by taxpayers.

From 1990 to 2002, ***overall*** transportation energy use in Nova Scotia rose 3.4%, topping out in 1999 (Figure 42 above). This indicates that total primary energy demand must have grown at a similar rate, since transportation energy use as a percentage of total primary energy demand remained relatively unchanged over this period. (Direct estimates for total primary energy demand are not available for Nova Scotia, so the increase in primary energy demand is inferred from the ratio).

From 1990 to 2002, energy use for passenger transport in Nova Scotia consistently remained somewhat higher than that for freight transport. Looking just at the two end points in the data series (1990 and 2002), energy use for both functions increased marginally over this period (see Figure 42 above). Passenger transport energy use grew by 1% between 1990 and 2002, and freight energy use by 0.3%. But this conceals an important internal variation during this time period. Energy use in both sectors crested in 1999 and has declined somewhat since then. In 1999, passenger energy use was 7% higher than 1990 levels, and freight energy use was 30% higher, with both then falling back towards the levels of the early 1990s. As noted earlier, only off-road vehicle energy consumption continued to rise dramatically after 1999, showing a

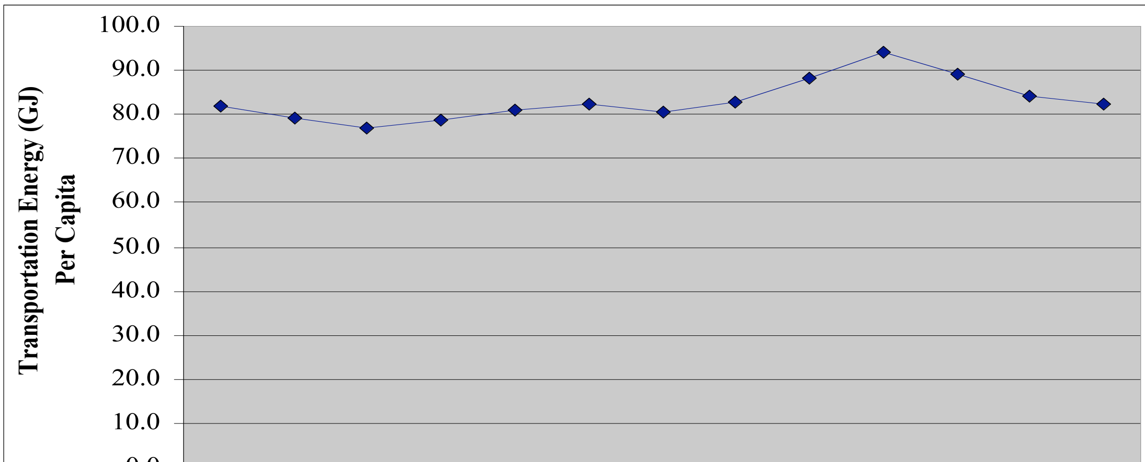
[141] Walker, Sally, Anne Monette and Ronald Colman. *The Nova Scotia Greenhouse Gas Accounts for the Genuine Progress Index.* (**GPI***Atlantic* and Walker Environmental, 2001). www.gpiatlantic.org/pdf/greenhouse/ghg.pdf Accessed September, 2004. Figure is in 2002 Canadian dollars.

148.5% jump between 1990 and 2002, and accounting for most of the overall 3.4% increase in transportation energy use between 1990 and 2002.

The peak in transportation energy use in Nova Scotia in 1999 partly reflects activities related to the Sable Island Offshore Energy Project (SOEP) – which developed an offshore natural gas pipeline. The sheer size of that project (which cost over $4 billion) increased transportation energy demand significantly, particularly for freight shipments of building materials, by road, rail and marine transport. The project spanned the period from 1997 through 2000 and construction peaked in 1999, with this peak mirroring the energy use trends particularly for truck and marine freight (Figures 42-45).[142] As Figure 39 above shows, overall transportation energy use also peaked in Canada in 1999, so the Sable gas development is certainly not the whole explanation for the Nova Scotia peak.

Figure 46 shows changes in overall transportation energy consumption per capita in Nova Scotia, from 1990 to 2002. In order to present whole numbers, this parameter is shown in gigajoules (one millionth of a petajoule). With the exception of the spike in 1999 (15% higher than 1990), transport energy consumption per capita rose by only 0.6% overall between 1990 and 2002.

Figure 46. Nova Scotia: Changes in per Capita Energy Consumption for Transportation, 1990-2002 (Gigajoules).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
per capita	82.0	79.3	76.9	78.7	81.1	82.2	80.7	82.6	88.2	94.1	89.0	84.0	82.5

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Table 1; and Statistics Canada. CANSIM Table 051-0001.

[142] Newcomb, Bob (Former Economist), Nova Scotia Department of Energy. (Personal Communication: March 2006).

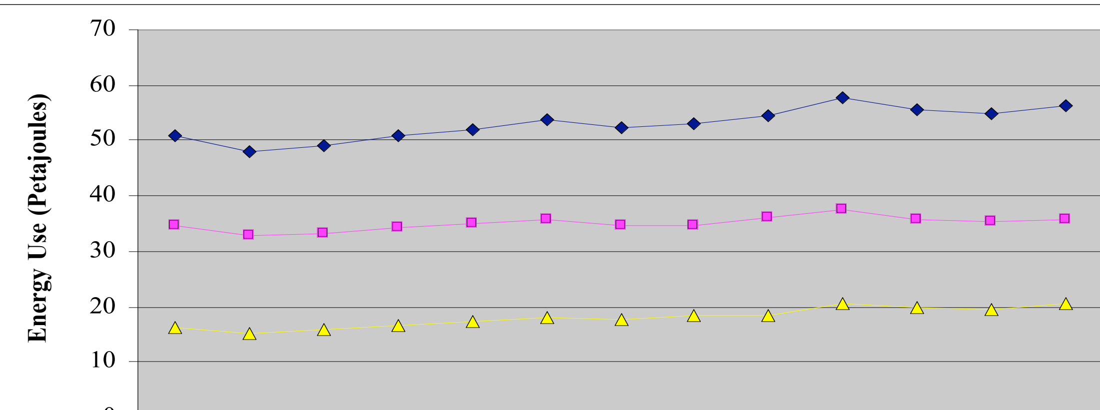
Road and Off-Road Energy Consumption

The charts and commentary above refer to the energy consumed by all modes of passenger and freight transportation in Nova Scotia (road, rail, marine, air, and off-road vehicles) When road transportation alone is examined, as we do in this section, we see a very sharp increase in truck freight energy use that was concealed by the composite charts above.

Passenger travel accounts for the majority of energy used by road vehicles in Nova Scotia. However, the share of freight transport energy use has steadily grown, from 32% of total road vehicle energy use in 1990 to 37% in 2002. From 34.8 PJ in 1990, passenger transport energy use for road vehicles rose slightly (by 2.8%) to 35.8 PJ in 2002. Total road vehicle energy use went up steadily, expanding from 51 PJ in 1990 to 56.4 PJ in 2002 (an increase of 11%).

However, this increase in total road vehicle energy use is due almost entirely to the sharp increase in freight transport energy use, which jumped by 27%, from 16.2 PJ in 1990 to 20.6 PJ in 2002 (Figure 47). Stated another way, freight transport was responsible for 81% of the *increase* in total road vehicle energy use between 1990 and 2002. This highlights the unsustainable trend of increasing truck freight, and the corresponding increase in energy use.

Figure 47. Nova Scotia: Road Vehicle Energy Use (Petajoules), by Transport Function, 1990-2002.



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total	51	47.9	49	50.8	52.1	53.8	52.4	53.2	54.5	57.8	55.5	54.8	56.4
Passenger	34.8	32.7	33.2	34.2	34.9	35.6	34.6	34.8	36	37.4	35.8	35.3	35.8
Freight	16.2	15.2	15.8	16.5	17.3	18.2	17.8	18.4	18.5	20.5	19.7	19.6	20.6

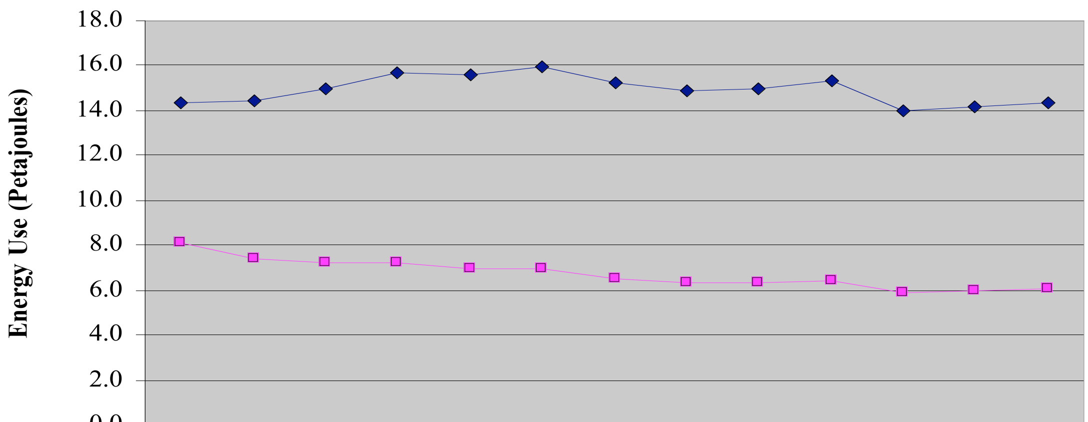
Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Table 9.

Note: The above data include small cars, large cars, light trucks, buses, and motorcycles for passenger vehicles and freight light, medium and heavy trucks.

Small car energy use in Nova Scotia increased from 14.3 PJ in 1990 to a high of 15.9 PJ in 1995 and then fell back to levels near those of 1990: 14.4 PJ in 2002 (Figure 48). Overall, energy use for small cars grew by a mere 0.4% between 1990 and 2002. Large car energy use fell almost continuously over the same period, dropping 26% from 8.1 PJ in 1990 to 6.0 PJ in 2002.

One possible cause for the decline in the proportion of energy use by large cars is the growing number of SUVs on the road taking the place of large cars, and the corresponding increase in light truck energy use (which includes SUVs) shown in Figure 49 below. As reported by Canada's national broadcaster: "The mid-sized SUV is the fastest growing segment of the Canadian auto market."[143] That statement is confirmed by the Industry Canada sales figures presented above.

Figure 48. Energy Use by Cars in Nova Scotia, 1990-2002 (Petajoules).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Small Cars	14.3	14.4	15.0	15.6	15.6	15.9	15.3	14.9	15.0	15.3	14.0	14.2	14.4
Large Cars	8.1	7.4	7.2	7.2	6.9	6.9	6.5	6.3	6.3	6.4	5.9	6.0	6.0

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Table 21.

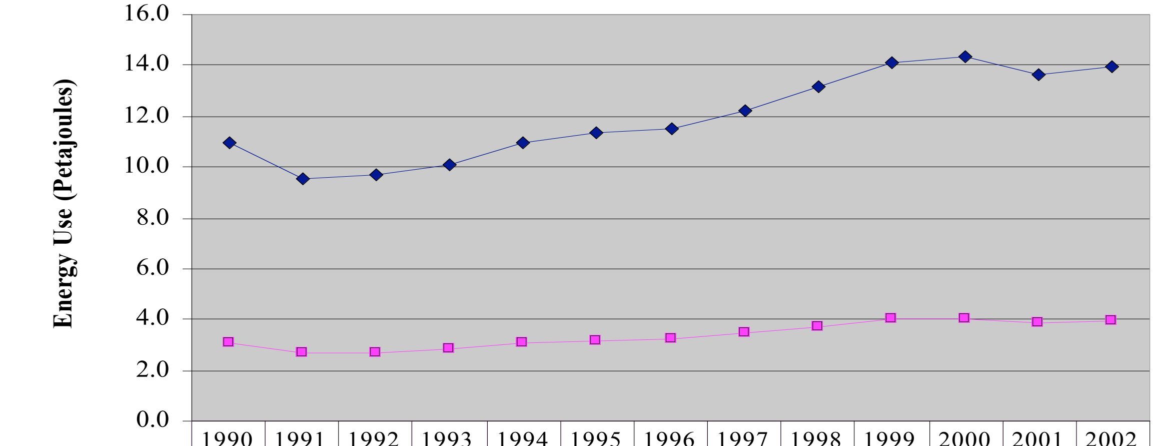
In Nova Scotia, passenger light truck energy use rose from a low of 9.5 PJ in 1991 to a peak of 14.4 PJ in 2000, an increase of more than 50%. The total increase for the whole 1990 to 2002 time period was 28% (3.1 PJ). Freight light truck energy use expanded as well by almost the same proportion, from a low of 2.7 PJ in 1991 to a peak of 4.0 PJ in 2000, an increase of 48%. Total growth in freight light truck energy use over the whole 1990-2002 time period was 26%, or 0.8 PJ (Figure 49).

The increasing use of light trucks, including SUVs, minivans and pick-up trucks, in the 1990s has had a significant adverse impact on the environmental and economic sustainability of the transportation system, even when compared with the decline in the large car category. According to Natural Resources Canada:

[143] CBC News. 'I Want My SUV': Canadians. (February 27, 2003). www.cbc.ca/story/news/national/2003/02/20/Consumers/SUV_030220.html Accessed December, 2004.

By driving a large car instead of a light truck for a year (16,500 kilometres), a household would reduce its fuel use by 528 litres (L) of motor gasoline (18.5 gigajoules—or 0.0000185 PJ). At a price of 70 cents/L, $370 in fuel costs would be saved. In addition, about 1.3 tonnes of GHGs would be avoided.[144]

Figure 49. Energy Use by Light Trucks in Nova Scotia, 1990-2002 (Petajoules).



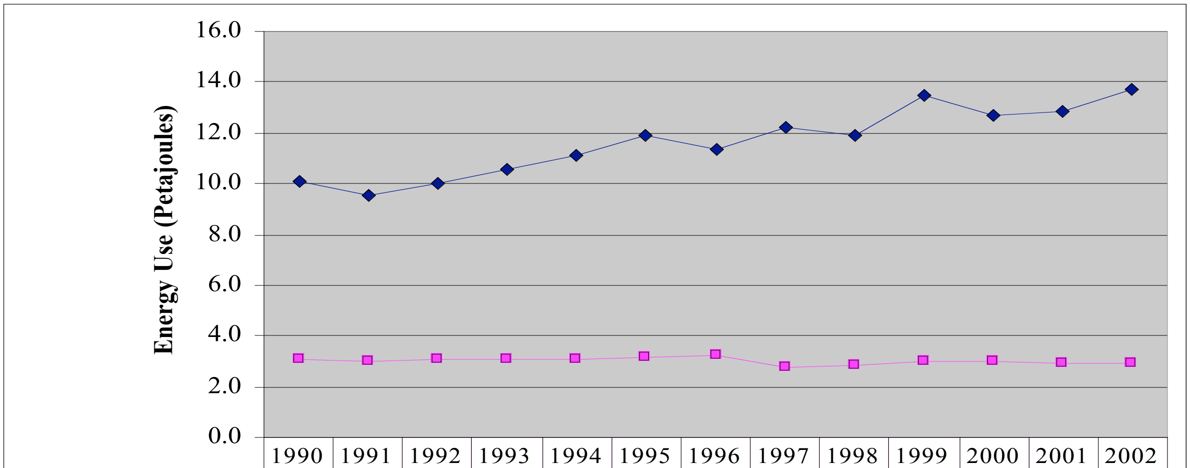
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Passenger	10.9	9.5	9.7	10.1	11.0	11.4	11.5	12.2	13.2	14.1	14.4	13.6	14.0
Freight	3.1	2.7	2.7	2.8	3.1	3.2	3.2	3.5	3.7	4.0	4.0	3.8	3.9

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Table 36.

Figure 50 shows that energy use by medium sized trucks decreased from 3.1 PJ in 1990 to 2.9 PJ in 2002 (a decline of 4.9%). However, heavy truck energy use increased by 36% over the same period (from 10.1 PJ in 1990 to 13.7 PJ in 2002). The growth in heavy truck energy is linked to the increased amount of freight moved by trucks in Nova Scotia.

[144] Ramsum et al. (2004a, p. 30). Needless to say, the dollar figures in this estimate must be increased in accord with today's higher gas prices.

Figure 50. Energy Use by Medium and Heavy Trucks in Nova Scotia, 1990-2002 (Petajoules).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Heavy Trucks	10.1	9.5	10.0	10.6	11.1	11.9	11.4	12.2	11.9	13.4	12.7	12.8	13.7
Medium Trucks	3.1	3.0	3.0	3.1	3.0	3.1	3.2	2.8	2.8	3.0	3.0	2.9	2.9

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Table 39.

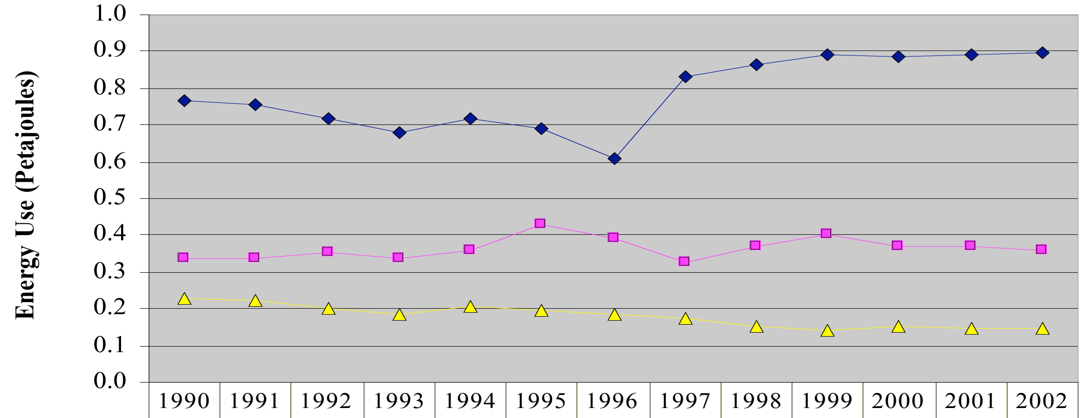
Motorcycle energy use decreased by 23% between 1990 and 2002. The implications of this shift for transportation sustainability are marginal, since this category demands only a very small amount of energy: consistently between 0.08 and 0.06 PJ.

Overall, energy use by buses accounted for only 2.5% of total road transportation energy use—1.4 PJ in 2002, up only slightly from 1.3 PJ in 1990. However, there were some differences in the trends for the different categories of buses, with increases in energy use for urban transit and school buses, and a decline for inter-city buses (Figure 51).

Energy use by urban transit buses decreased from 0.8 PJ in 1990 to 0.6 PJ in 1996. However, the figure then jumped back to 0.8 PJ the following year and increased gradually to 0.9 PJ by 1999, remaining steady at that level to 2002. Overall, energy use for urban transit buses increased by 17% between 1990 and 2002, and was responsible for 64% of total energy consumption by buses in 2002. School bus energy use remained fairly constant with a small increase from 0.3 PJ in 1990 to 0.4 PJ in 2002 (a 4.9% change[145]); this category was responsible for 26% of total bus energy demand in 2002. On the other hand, energy use by inter-city buses decreased by 37%. However, as inter-city buses were responsible for only 10% of total bus energy use in 2002 (Figure 51) this represented only a small decline in absolute terms (from 0.2 PJ in 1990 to 0.1 PJ in 2002).

[145] Because the PJ numbers have been rounded to a single decimal point, the actual increase is smaller than the absolute PJ numbers here appear to indicate.

Figure 51. Energy Use by Buses in Nova Scotia, 1990-2002 (Petajoules).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Urban Transit	0.8	0.8	0.7	0.7	0.7	0.7	0.6	0.8	0.9	0.9	0.9	0.9	0.9
School Buses	0.3	0.3	0.4	0.3	0.4	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.4
Inter-City Buses	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.1	0.1

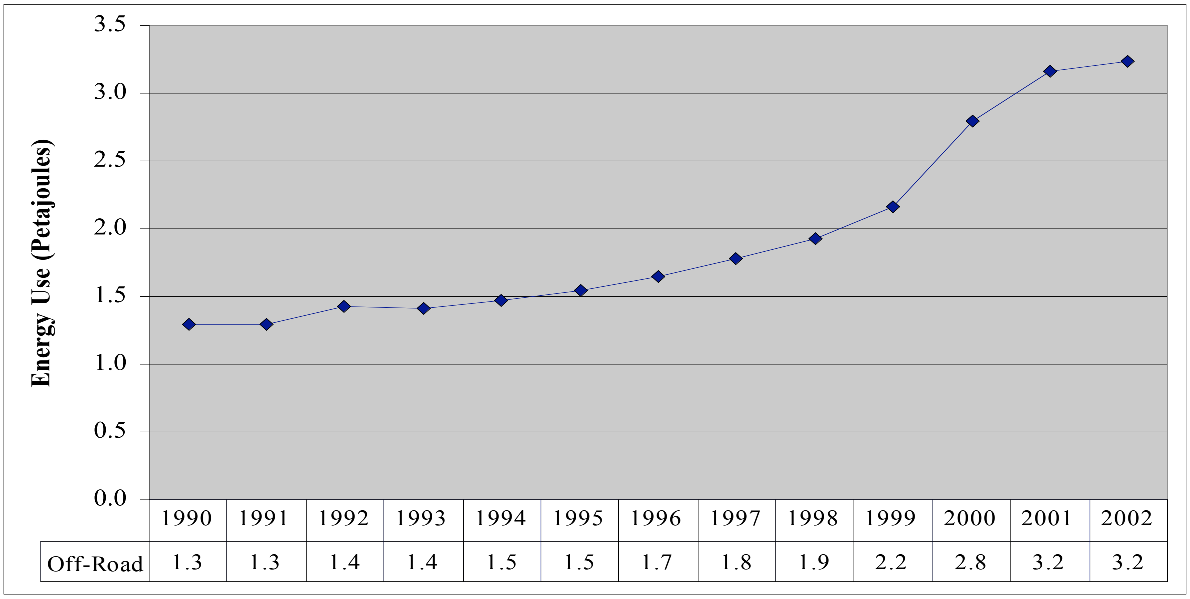
Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Table 23.

From 1990 to 2002, the growth in off-road vehicle energy use in Nova Scotia was dramatic: 149%. Over this period, energy use by off-road vehicles more than doubled, rising from 1.30 to 3.23 PJ (Figure 52). This large expansion is at least partially attributable to a substantial increase in the number of off-road vehicles, including ATVs, snowmobiles, and dirt bikes, in use in Nova Scotia during this time.[146] Interestingly, the increase has been sharpest since 1999, with more than half the total 1990-2002 increase occurring in 1999-2001 alone—the same period that overall energy consumption by road passenger transportation declined. This dramatic increase in off-road energy use in a very short period of time corresponds to vehicle registrations in this category nearly doubling from 1999 to 2002 alone.

In 2002, off-road vehicle energy use amounted to 5.7% of the energy used by all road vehicles, up from 2.5% in 1990, and to nine percent of the energy used by road passenger vehicles, up from 3.7% in 1990. Off-road vehicles in Nova Scotia now use more than twice as much energy as all categories of buses in the province, including urban transit, inter-city buses, and school buses combined.

[146] Statistics Canada. 1997. Road Motor Vehicle Registration, Nova Scotia, 1992-1996. (Catalogue no. 53-219). Nova Scotia Department of Finance. *Nova Scotia Statistical Review 2003*, p. 167. (Halifax: 2003).
The number of vehicle registrations in the category "Off-Road, Construction and Farm Vehicles" nearly doubled between 1999 and 2002.

Figure 52. Energy Use by Off-Road Vehicles in Nova Scotia, 1990-2002 (Petajoules).



Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Table 1.

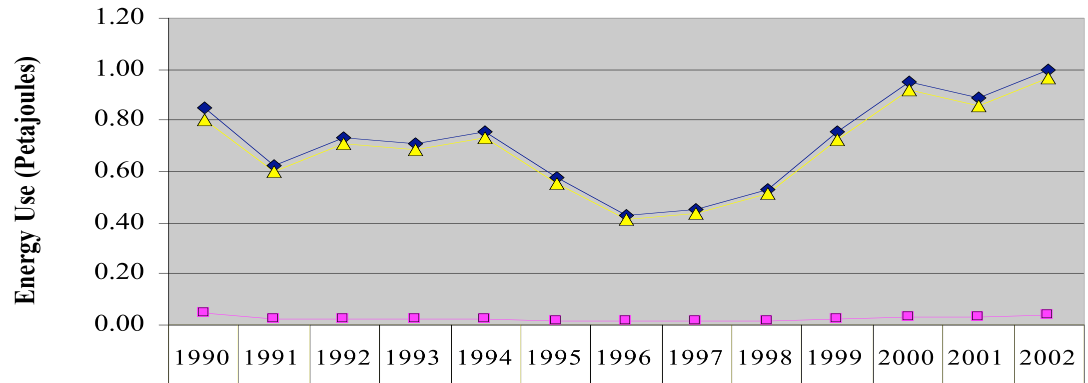
Rail Energy Consumption

Energy use by trains is almost entirely connected with freight movement. As such, the trends for freight and total energy consumption for rail are almost identical for the period 1990-2002. Both categories show a decrease in energy use from about 0.8 PJ in 1990 to roughly 0.4 PJ in 1996 (Figure 53). However, freight rail and total rail energy consumption has been increasing steadily since 1996, and in 2002 both exceeded 1.0 PJ (which is above 1990 energy use levels). Aggregate rail energy use increased by 18% from 1990 to 2002; and freight energy use by 20%.

The increase in rail freight energy use is the result of the sharp overall increase in total tonne-km of freight transported during this period. But the net 0.2 PJ increase in rail freight energy use between 1990 and 2002 is dwarfed by the 4.4 PJ increase in trucking freight energy use during this period. Rail freight accounted for only four percent of the total increase in freight energy use from 1990-2002, truck freight for 94%, and air freight for the remaining two percent.

Rail passenger transport energy use remained well below 0.1 PJ from 1990 to 2002, experiencing an overall 20% decline during this period, though it has recovered somewhat from its lowest levels in 1996-97. As a proportion of total passenger transport energy use in Nova Scotia, however, rail passenger transportation remains insignificant, accounting for less than one-tenth of one percent of passenger transport energy use in the province.

Figure 53. Rail Energy Use in Nova Scotia, by Function, 1990-2002 (Petajoules).



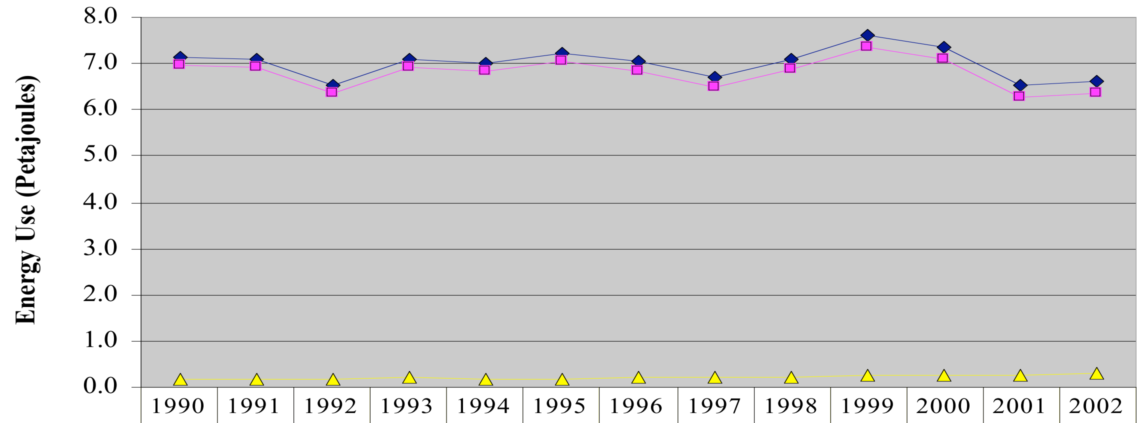
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total	0.85	0.63	0.74	0.71	0.75	0.57	0.43	0.45	0.53	0.75	0.95	0.89	1.00
Passenger	0.04	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.03	0.03	0.04
Freight	0.80	0.60	0.71	0.69	0.73	0.56	0.42	0.44	0.51	0.73	0.92	0.86	0.97

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Table 16.

Air Energy Consumption

Energy consumption by air transport in Nova Scotia is almost exclusively the result of passenger travel (a pattern opposite to that of rail). Accordingly, total air transport energy use and air passenger transport energy use followed the same general pattern from 1990 to 2002. Passenger transport stayed between 6.3 and 7.4 PJ, while the figure for total air transport remained between 6.5 and 7.6 PJ (Figure 54). However, there was an overall decrease in energy use for passenger transport of 8.7% (from 7.0 to 6.4 PJ) during this period, and a similar drop of seven percent for total air transport from 7.1 to 6.6 PJ. In 2002, air passenger transport accounted for 15% of total passenger transport energy use in Nova Scotia. Air freight energy use increased slightly—from 0.2 to 0.3 PJ—between 1990 and 2002, but still accounts for only one percent of total freight transport energy use in the province.

Figure 54. Air Energy Use in Nova Scotia, by Function, 1990-2002 (Petajoules).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total	7.1	7.1	6.5	7.1	7.0	7.2	7.1	6.7	7.1	7.6	7.3	6.5	6.6
Passenger	7.0	6.9	6.4	6.9	6.8	7.0	6.8	6.5	6.9	7.4	7.1	6.3	6.4
Freight	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Tables 13-15.

Marine Freight Energy Consumption

Because marine freight is by far the largest component of total marine transportation, the previous explanation for Figure 45 on marine freight energy use applies equally to Figure 55 below on total marine energy use, and is therefore repeated here. As noted earlier, the energy used for Nova Scotia marine transportation has fluctuated between 1990 and 2002, remaining fairly steady through the mid-1990s, then increasing sharply in the late 1990s, and declining steadily since then (Figure 55). Marine energy use reached its highest level in 1999, at 19.5 PJ. From then on it declined, dropping to 9.8 PJ—its lowest point—in 2002.

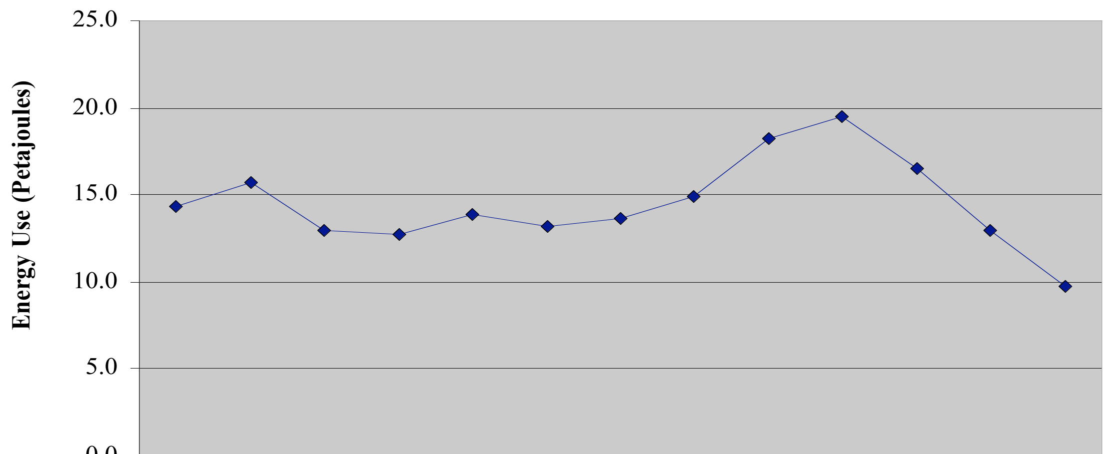
Overall, marine freight energy use appears to have dropped quite sharply by 32% between 1990 and 2002, when only the two end points (1990 and 2002) are considered. But as noted earlier, this is deceptive. The previous chapter on transport activity indicated that the year 2002 was an anomaly in marine freight trends, due to a 7.6% decrease in total tonnage handled at the Port of Halifax that year due to decreased shipments of crude petroleum from Europe and South America (see Figure 35 above).[147] When the internal shape of the trend was examined to take into account and adjust for fluctuations in energy use of marine freight during this period (see trendline for Figure 45 above), it became apparent that marine freight energy use actually remained almost unchanged overall.

Once again, the peak in marine energy use in 1999 is related to the Sable Island gas pipeline development. In the late 1990s drilling equipment was transported from Halifax and installed in

[147] Statistics Canada. *Shipping in Canada—2002*, p. 16. (Ottawa: Minister of Industry, 2004a). http://dsp-psd.communication.gc.ca/Collection-R/Statcan/54-205-XIB/0000254-205-XIE.pdf Accessed December, 2004.

the seas over the Thebaud and Venture gas fields near Sable Island. The vessels carrying the equipment were very large. For example, the *Saipem 7000*, which is more than two football fields long, was the largest vessel ever to enter Halifax Harbour, and made three calls at the port.[148] Visits from vessels such as *Saipem 7000*—as well as from smaller ships—bringing in materials related to the pipeline development, help explain the significant rise in marine energy use in the late 1990s.

Figure 55. Nova Scotia: Marine Freight Energy Use, 1990-2002 (Petajoules).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Petajoules	14.3	15.7	13.0	12.7	13.9	13.2	13.6	14.9	18.2	19.5	16.5	12.9	9.8

Source: Natural Resources Canada.—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Table 19.

Energy Consumption by Fuel Type

In Nova Scotia, as elsewhere, fossil fuels account for almost all transport energy use. The vast majority of fuel used in the province's transportation sector is motor gasoline. Diesel is the second most common fuel used for transport in Nova Scotia, but its use is only a little over half that of motor gasoline. Small percentages of transportation energy are provided by heavy fuel oil and aviation turbo fuel: less than 10 petajoules each. Aviation gasoline and propane are consumed in very small amounts (less than 0.3 PJ per year). In 2002, electricity, natural gas, and coal were not used at all in Nova Scotia's transport sector.

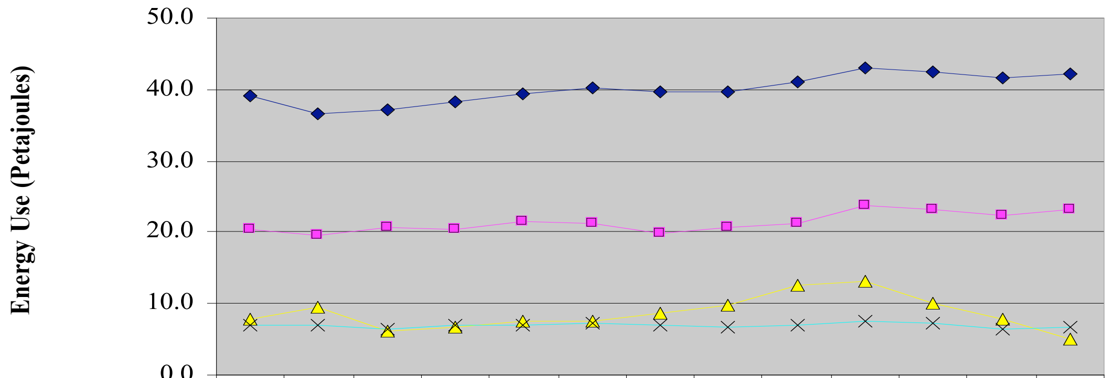
The consumption of motor gasoline increased fairly steadily in Nova Scotia from 1993 to 1999, and then fell somewhat, with an overall increase of 8.1% between 1990 and 2002—from 39.1 PJ to 42.3 PJ (Figure 56). Diesel fuel use remained fairly steady to the mid-1990s and then grew,

[148] McManus, Greg. "Blazing the Trail—Sable Island gas changing economics of energy in Maritimes, New England." (*Bangor Daily News*. May 25, 1999).

registering an overall increase of 14% between 1990 and 2002 (from 20.3 PJ in 1990 to 23.1 PJ in 2002), corresponding to the steady increase in truck freight during this period.

Energy from heavy fuel oil use increased consistently from 1992 (6.3 PJ) to 1999 (13.1 PJ). However, thereafter its use declined sharply and by 2002 had fallen to 4.9 PJ, significantly below 1990 levels. Overall, during the period 1990-2002, heavy fuel oil use declined by 37%. Energy from aviation turbo fuel has remained fairly steady over time, but decreased overall by 7%, from 7.1 PJ in 1990 to 6.6 PJ in 2002 (Figure 56). As noted earlier, the 1999 peaks for all categories of fuel are at least in part related to the Sable Island pipeline development.[149]

Figure 56. Energy Use in Nova Scotia, by Fuel Type, 1990-2002 (Petajoules).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Motor Gasoline	39.1	36.5	37.2	38.4	39.4	40.2	39.7	39.6	41.2	43.1	42.4	41.6	42.3
Diesel Fuel Oil	20.3	19.5	20.5	20.4	21.4	21.3	19.7	20.8	21.3	23.8	23.2	22.3	23.1
Heavy Fuel Oil	7.8	9.4	6.3	6.7	7.4	7.5	8.6	9.9	12.5	13.1	10.2	7.8	4.9
Aviation Turbo Fuel	7.1	7.0	6.5	7.1	7.0	7.2	7.0	6.6	7.0	7.6	7.3	6.5	6.6

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Table 1.

Conclusion

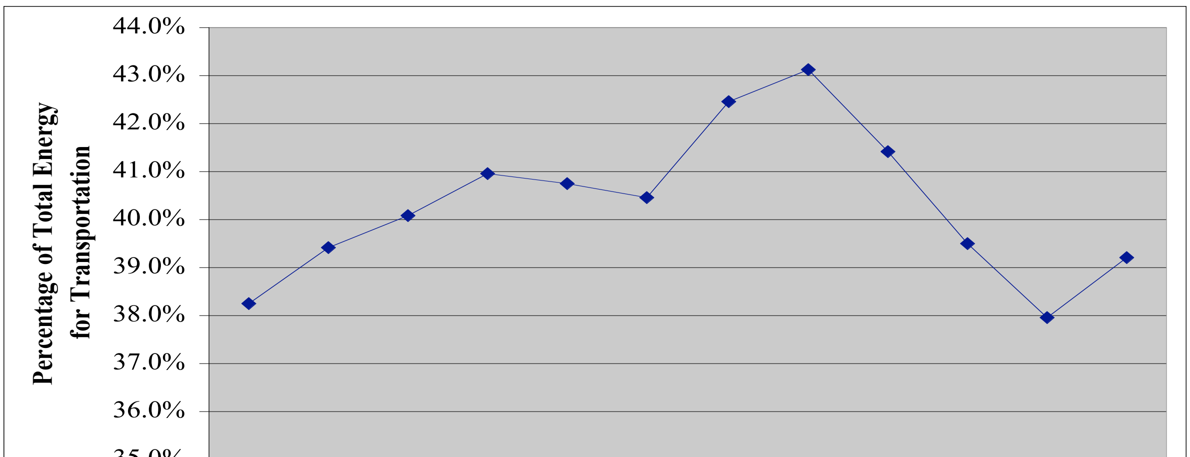
As depicted in Figure 36 above, Canada has the third highest per capita energy use for transportation among the 31 industrialized countries examined. This statistic alone indicates a relatively unsustainable transportation system compared with peer countries. Nova Scotia's transportation sector accounts for a larger share of total energy use (38%) than any other province in Canada aside from Prince Edward Island, well above the national average of 30%. This reflects the relatively low degree of industrial activity in the province. In per capita transportation energy use, a better comparative indicator of sustainability, Nova Scotia ranks in the mid-range among Canadian provinces—fourth in per capita passenger energy use and sixth

[149] Newcomb. (March 2006).

in per capita freight energy use, with Alberta using more transportation energy per capita than any other province.

Figure 57 presents the percentage of total energy use attributable to transportation in Nova Scotia from 1992 to 2003. Transportation's share of total energy use rose from 1992 to 1995, and again from 1997 to 1999—there reaching a 10-year high of 43%. It then decreased from 1999 to 2002, dropping to its lowest point (38%) in 2002. As already explained, the 1999 peak and then drop in transportation energy use was partly related to the massive Sable Island pipeline development project. In 2003, the proportion of energy used for transportation was once again on the rise, increasing by 1.3 percentage points from 2002. This indicates, that although the Sable Island pipeline project may have affected energy use in the province for a period of time, transportation energy use as a whole remains the most significant component of total energy use in the province.

Figure 57. Nova Scotia: Energy Use for Transportation as a percentage of Total Energy Use, 1992-2003.



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
% of total energy	38.3%	39.4%	40.1%	41.0%	40.7%	40.5%	42.5%	43.1%	41.4%	39.5%	37.9%	39.2%

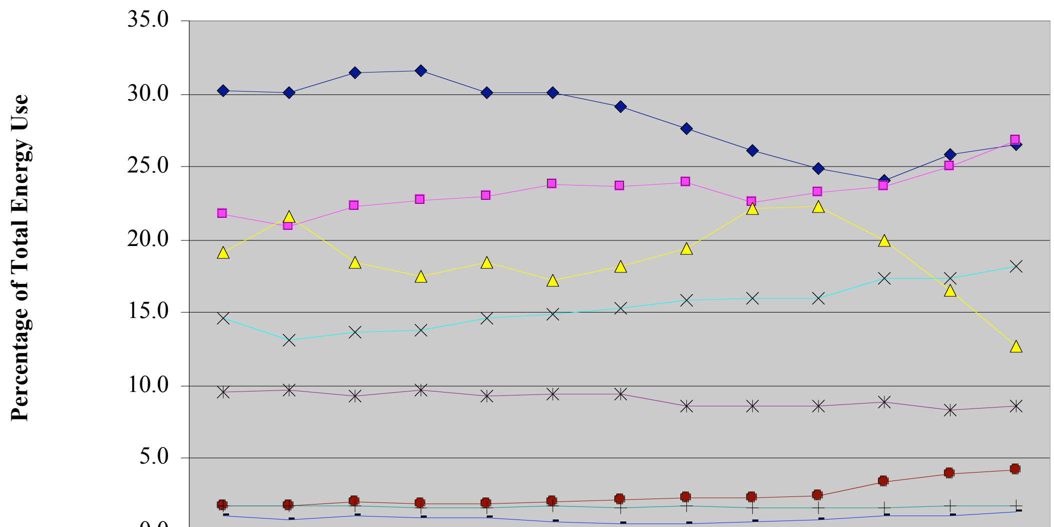
Source: Statistics Canada. *Report on Energy Supply/Demand in Canada*. Years 1992-2002.

When energy use by the various sectors of Nova Scotian transportation is analysed, varying patterns emerge. Marine energy use has fluctuated over time, but ended the 1990-2002 period considerably below 1990 levels (Figure 55 above). Meanwhile, energy demand from air transport remained relatively stable over the term studied (Figure 54 above). Passenger road transportation energy use remained relatively unchanged while road freight transport energy use grew by 27% during this period (Figure 47 above). Particularly sharp increases in energy demand have been shown for the light truck category (Figure 49 above), as well as the heavy truck category—the latter change indicative of the growing importance of this mode for freight carriage in Nova Scotia (Figure 50 above).

In addition, the off-road vehicle category demonstrates a dramatic surge in energy consumption from 1990 through 2002, with most of the increase occurring between 1999 and 2001 (Figure 52 above). Off-road energy demand is still fairly small in absolute terms (less than 4 PJ), but is growing so rapidly that it is now equivalent to 9% of the energy used by all road passenger transportation in the province and to more than two times the energy used by all buses.

Given these changes across transport modes in Nova Scotia, it is important to consider the significance of the changing distribution of energy demand among them. Figure 58 summarizes some of the key data for this important indicator of sustainable transportation: the share of transportation energy use by mode of transport.

Figure 58. Energy Use by Transport Mode, as a percentage of Total Transportation Energy Use, Nova Scotia, 1990-2002.



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Cars	30.2	30.1	31.5	31.5	30.1	30.0	29.1	27.6	26.1	24.9	24.1	25.8	26.5
Trucks	21.8	20.9	22.3	22.8	22.9	23.9	23.7	23.9	22.5	23.3	23.7	25.0	26.7
Marine	19.2	21.6	18.4	17.5	18.5	17.3	18.1	19.4	22.1	22.2	19.9	16.5	12.7
Passenger Light Trucks	14.7	13.1	13.7	13.9	14.6	14.9	15.3	15.9	16.0	16.0	17.3	17.4	18.1
Air	9.6	9.8	9.3	9.8	9.3	9.5	9.4	8.7	8.6	8.7	8.8	8.3	8.6
Off-Road	1.7	1.8	2.0	1.9	2.0	2.0	2.2	2.3	2.3	2.5	3.4	4.0	4.2
Bus	1.8	1.8	1.8	1.6	1.7	1.7	1.6	1.7	1.7	1.6	1.7	1.8	1.8
Rail	1.1	0.9	1.0	1.0	1.0	0.8	0.6	0.6	0.6	0.9	1.1	1.1	1.3

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Table 7.

Note: The "truck" category above constitutes all forms of truck freight – i.e. heavy, medium and light truck freight, but no passenger truck transportation, which is captured separately by the passenger light truck category. The Rail and Air categories include both passenger and freight transport.

It is important to note in Figure 58 above, that the more efficient and sustainable modes of transportation (e.g. bus and rail) claim the smallest shares of transport energy use in the province. By contrast, unsustainable modes, like truck freight, passenger light trucks (including SUVs and minivans), and off-road vehicles, are commanding an increasing proportion of the energy used for transportation. This indicator reveals a currently unsustainable system and a trend away from sustainability, yet it also points to opportunities to alter the mix of both passenger and freight transport modes to achieve greater sustainability and reduce energy demand. This could be done by shifting to more energy-efficient forms of transportation such as train or bus, and by using the vehicle registration and insurance systems to create a system of financial incentives and penalties that encourage consumer use of smaller and more fuel-efficient vehicles.

Figure 58 also depicts trends in Nova Scotia that parallel national patterns for energy use by mode of transportation. Natural Resources Canada has identified three main causes for the overall increase in energy use in the Canadian transportation sector:

- an overall increase in vehicle activity;
- the growing share of the personal vehicle market claimed by minivans and SUVs; and
- an increasing use of trucking—a very energy-intensive form of transport—for moving freight.[150]

All three of these causal trends (or "driving forces" to use the language of the DPSIR framework used in the European Environment Agency's Transport and Environment Reporting Mechanism described in Part II) are key movements away from sustainability. Again drawing from the language of the DPSIR approach, it is necessary to change these central driving forces in order to reduce a wide range of adverse pressures on the environment that in turn have negative societal impacts, and in order to improve a wide range of sustainability outcomes. Societal responses that address only the impacts, or symptoms, of these underlying problems will fail to generate real change and long-term movement towards sustainability, and will produce, at most, superficial and temporary relief from some of the most acute manifestations of these adverse trends.

From this perspective, it would be very helpful for future updates of this initial report to prioritise the key indicators of sustainable transportation according to the logic of the DPSIR framework. Thus, while this report identifies quite a large number of indicators of sustainable transportation, the DPSIR approach points to the value of identifying as key, or headline, indicators, those trends that signify causal or "driving force" factors, which in turn affect all or most other trends.

The three causal trends identified by Natural Resources Canada—increased overall motor transport activity, growth in SUVs and minivans, and increased use of trucking for freight transport—would all qualify as such key driving force indicators. A fourth driving force indicator (which could also be combined with the SUV/minivan passenger transport indicator) would be passenger transport modal split, particularly the relative shares of passenger transportation occupied by public transit (bus and train), different classes of private motorized vehicles, and active transportation modes (bicycling, walking). In relation to these key driving

[150] Natural Resources Canada. *The State of Energy Efficiency in Canada: Office of Energy Efficiency Report 2003*, p. 25. (2004). http://oee.nrcan.gc.ca/neud/dpa/data_e/SEE03/Transportation.cfm?PrintView=N&Text=N Accessed November, 2004.

force indicators, outcome and impact indicators like energy use, pollutant and greenhouse gas emissions, and accidents, could be listed as subsidiary or secondary indicators that are likely to be influenced by the key driving force indicators.

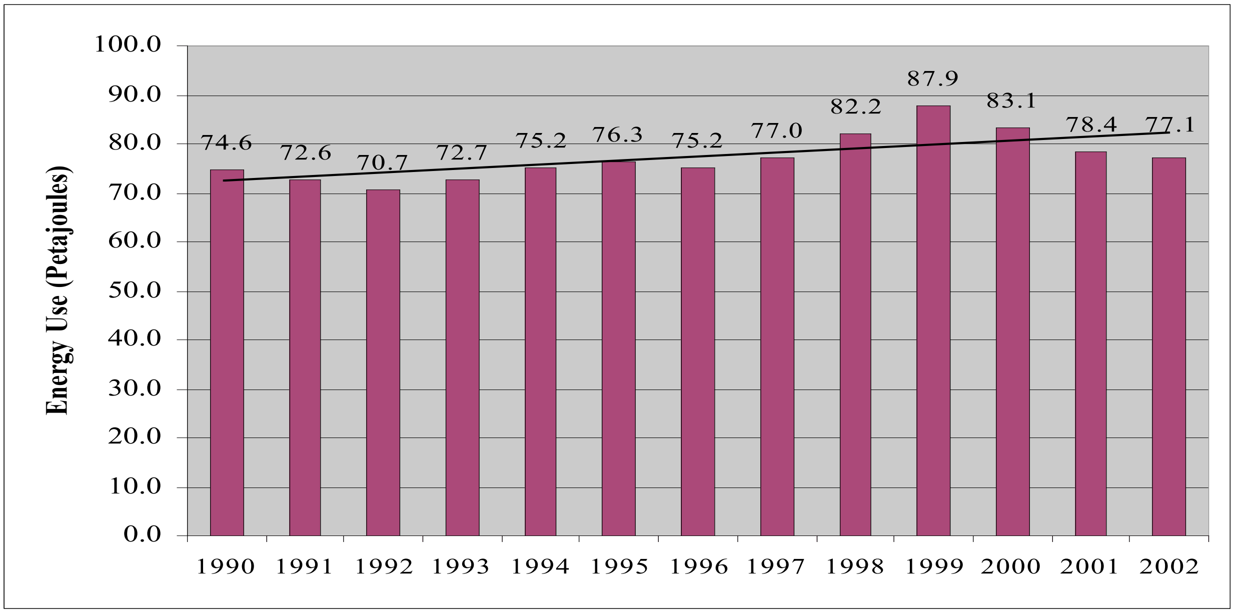
This prioritisation and classification of indicators has not been undertaken for this report because the DPSIR model is not universally accepted as a suitable indicator framework. Some have argued that it is more appropriate for policy purposes (to identify whether policy responses adequately address driving forces or only impacts) than as an indicator framework (to identify trends). However, Natural Resources Canada's identification of three key causal factors and trends that have driven increased energy use in the transportation sector does suggest the possibility and potential utility of such prioritisation and classification. Based on reviewer feedback and public and policy responses to this report, this classification exercise could be undertaken in the future.

In addition to the modal split indicator for energy use, a second key indicator for energy consumption in the transportation sector is total transport-related energy use, which is shown in Figure 59. As illustrated by the overall trend line in the graph, total energy use for transportation in Nova Scotia increased from 1990 to 2002 after accounting for fluctuations. Figure 60 graphically illustrates ***changes*** in this trend line during this period by showing the same information normalised to 1990 levels. These figures demonstrate the sharp rise in energy demand in the Nova Scotia transportation sector in the late 1990s, and the subsequent decline in demand.

Overall, the results in Figures 59 and 60, and in this section indicate the unsustainability of Nova Scotia's current transportation system (due to continued very high energy demand from non-renewable fossil fuels) and a further movement away from sustainability (due to a net increase in energy demand during 1990-2002). Within that trend, the recent 12% decline in transport-related energy use from the 1999 peak of 87.9 Petajoules to the 2002 level of 77.1 Petajoules) has begun to demonstrate a movement towards greater sustainability, although the 2002 level remains 3.4% above the 1990 level. In absolute terms, too, the 77.1 Petajoule aggregate transport-related energy demand in 2002 for a provincial population of less than one million still ranks far above most industrialized countries on a per capita basis, and far exceeds the criterion for sustainable energy use outlined in both the European Union and GPI definitions of sustainable transportation, namely that it "***uses non-renewable resources at or below the rates of development of renewable substitutes.***"

An important consideration here, again from the DPSIR perspective, is that improvements in energy efficiency have not resulted in an adequate or substantial decline in overall transportation energy use. Arguing from the DPSIR perspective, this is because the response (R) (improved technology to enhance vehicle efficiency) deals only with an impact (I) (increased energy use and GHG emissions) and not with the three causes or driving forces (D) identified by Natural Resources Canada and described above. This issue of energy efficiency/intensity will be discussed further in the next chapter of this report.

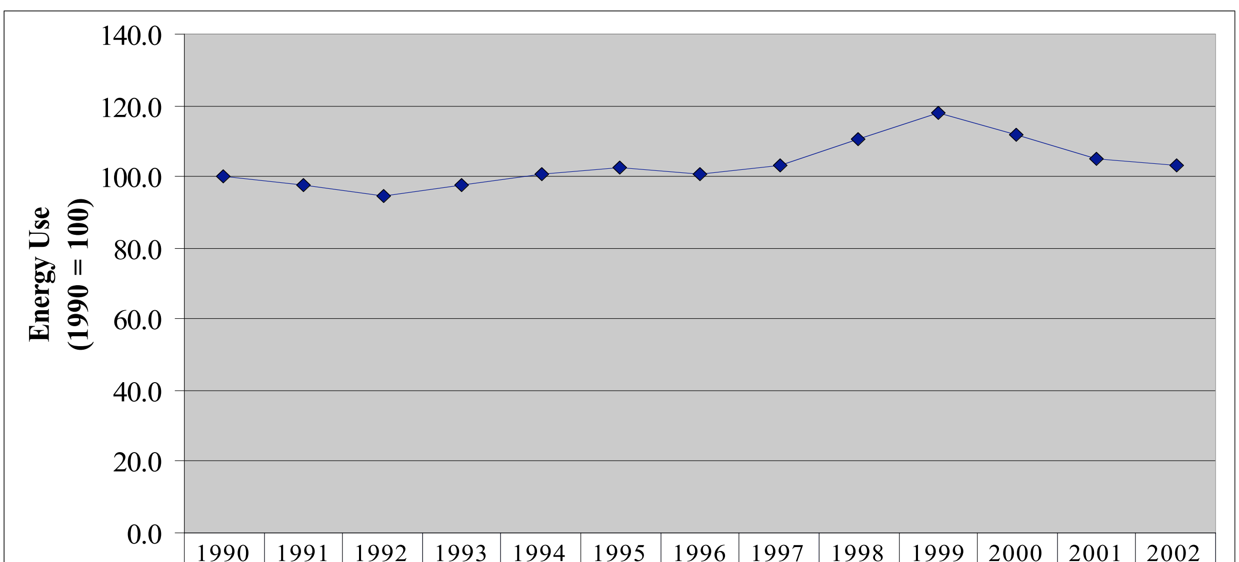
Figure 59. Energy Used for Transportation in Nova Scotia, 1990-2002 (Petajoules).



Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Table 1.

Note: The black line above represents the trendline calculated by regression analysis.

Figure 60. Energy Used for Transportation in Nova Scotia, 1990-2002. (Normalized to 1990 = 100).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
energy use	100.0	97.4	94.8	97.5	100.9	102.4	100.8	103.3	110.3	117.9	111.5	105.1	103.4

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Table 1.

Many of the graphs in this chapter, showing the 1999 spikes in freight and marine energy use (e.g. Figures 45 and 55) and in diesel oil (Figure 56) for example, may reflect the large increase in economic and transportation activities related to the Sable Island gas pipeline development in Nova Scotia. The results indicate that it is important to consider the possible social, economic, and environmental effects of such massive undertakings, and their resulting impacts on transportation energy use and greenhouse emissions in the province of Nova Scotia. This analysis may therefore help to demonstrate the underlying energy demands involved in such mega-projects.

The spike in transportation energy use in 1999 also helps explain why transportation energy use has been falling since that time (e.g. Figures 59 and 60). While this rapid yet small decline is a step in the right direction, it does not yet constitute a fully sustainable trend, according to the criteria noted above. To qualify for that designation, the decrease would have to continue over a longer span of time, fall below 1990 levels, and achieve and maintain much more substantial reductions to levels that are more in line with the OECD average. For the present, it must be concluded that the overall net trend for energy consumption in Nova Scotia for the 1990-2002 period has been moving away from sustainability.

Chapter 3. Energy Intensity

As noted in the previous section on energy consumption, Canada faces a number of major challenges related to energy and its use. The energy-related problems confronting Canadians range from global environmental issues like climate change to security issues like the impending advent of peak oil production to basic economic and affordability issues like prices at the gas pump. While the entire planet must eventually grapple with these problems, Canada has been identified as "one of the most energy-intensive countries in the industrialized world."[151]

A review of energy intensity in the transportation sector necessarily will have features in common with analyses of energy consumption, as contained in the previous chapter, but it also differs in a number of ways. As noted by the UN's Department of Economic and Social Affairs, an analysis of *energy intensity* (the amount of energy consumed per unit of transportation activity) "is a key measure of how efficiently transportation systems convert energy into human mobility and goods distribution."[152] In contrast to an undifferentiated focus on the reduction of gross energy consumption, a knowledge and understanding of energy intensity can be used to reduce the ecological harm caused by the transportation sector while maintaining its social and economic benefits.

The energy intensity of a country's transportation system can be affected by a number of elements, including geographical size, climate, standard of living, and industrial structure.[153] Other factors, such as small changes in vehicle technology, can also have a significant impact on the amount of energy that vehicles consume to accomplish a given quantity of work.

Through an examination of energy intensity, a comparison of the most energy-efficient modes of passenger and freight movement can be made. This analysis encourages the choice of sustainable options, which in turn can help enable the creation of a transportation system that consumes resources below the rates at which they can be replaced.

The Indicators

The Centre for Sustainable Transportation has represented energy intensity through the use of an index that reflects the overall fuel efficiency of the road vehicle fleet. This measurement is based on data taken from Natural Resources Canada's handbook on energy data.[154] The index uses a weighted average for each category of vehicle (passenger car; light, medium, and heavy trucks) based on the proportion of energy used by each vehicle type relative to the combined total of the

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[151] United States Department of Energy. Canada: Environmental Issues. (February, 2004). www.eia.doe.gov/cabs/canenv.html Accessed January, 2005.
[152] United Nations Department of Economic and Social Affairs. *Indicators of Sustainable Development: Guidelines and Methodologies*, p.249. (2001). www.un.org/esa/sustdev/natlinfo/indicators/indisd/indisd-mg2001.pdf Accessed January, 2005.
[153] Anderson, Dean. *Progress Towards Energy Sustainability in OECD Countries*. (Helio International, 1998). www.helio-international.org/Helio/anglais/reports/oecd2.html#trends Accessed January, 2005.
[154] Gilbert et al. (2002, p. 114, note 29).

entire vehicle fleet. The index reveals that energy intensity increased during the first half of the 1990s but levelled off thereafter. The CST's conclusion was that energy intensity (and, by extension, vehicle technology) has not been moving towards sustainability, although the plateau of the later '90s suggests positive potential.

This report analyses the energy intensity of road transportation using a different method that follows United Nations guidelines (see below). Trends were identified on the basis of the energy intensity data provided in the 2002 Comprehensive Energy Use Database of the Office of Energy Efficiency at Natural Resources Canada (NRCan).[155] The information provided by this particular NRCan database was used because it is more current than the data analysed by the CST.

The NRCan records detail energy used per passenger-kilometre (and per tonne-kilometre for freight). The use of passenger- and tonne-kilometre statistics allows for a more meaningful examination of energy intensity than measures using vehicle-km, since the former permit direct comparisons across vehicle modes based on task accomplished (i.e. the movement of a given number of passengers or a certain tonnage of freight).

The two indicators **GPI***Atlantic* uses in this report for Nova Scotia's overall energy intensity are:

- energy intensity of total road passenger movement (megajoules per passenger-kilometre), by mode, and
- energy intensity of total road freight movement (megajoules per tonne-kilometre), by mode.

For both of the indicators, a **decrease** in energy intensity indicates greater efficiency (because less energy is required to move a given quantity of people or goods) and is therefore considered movement towards sustainability.

Trends: International

The intensity of energy use in transportation is globally acknowledged as an important indicator that can be used to monitor sustainable development. This recognition comes largely from the Work Programme on Indicators of Sustainable Development adopted by the Commission on Sustainable Development (CSD) at the United Nations.[156]

The CSD has established a set of 58 core indicators that policy-makers can employ to measure progress towards sustainable development. In 2001 the CSD published a report on the guidelines and methodologies related to its established list of sustainable development indicators. Included in this document is a worksheet that describes the indicator of energy intensity for the transportation sector.[157] It outlines the policy related to its development and use, as well as the

[155] Natural Resources Canada—Office of Energy Efficiency (NRCan—OEE). (August 5, 2004a and August 5, 2004b).
[156] United Nations Department of Economic and Social Affairs. Indicators of Sustainable Development. (March 22, 2005). www.un.org/esa/sustdev/natlinfo/indicators/isd.htm Accessed April, 2005.
[157] United Nations Department of Economic and Social Affairs. (2001, pp. 247-252).

recommended methodology for establishing the indicator. In this present report **GPI***Atlantic* uses the method suggested by the United Nations, in which energy intensity is measured based on the passenger- and tonne-kilometres moved per unit of energy. Although country-specific data for this indicator are not currently available, its inclusion as a core indicator in the United Nations list of sustainable development indicators implies that country-specific results will likely be published at a future date.

Although directly comparable statistics using the UN-recommended methods are unavailable at the international level at this time, other data sources and methods can provide at least a basic overview of how Canada's transportation energy intensity compares to that of other countries. Previous work conducted by the World Energy Council has found that regional transportation energy intensities vary significantly around the world. The transportation energy intensity of regions such as Europe and Japan are similar, while North American energy intensity is nearly 2.2 times higher. The Oceania region (which includes Australia, New Zealand and the Pacific Islands) maintains a transportation system that is about 1.9 times more energy intensive than the more efficient regions of Japan and Europe.[158]

While transportation in North America is more energy intensive than in many other parts of the world, the World Energy Council notes that it is the only region where member states of the Organisation for Economic Co-operation and Development are becoming more energy efficient. The study notes that the North American transportation sector is starting at a much higher energy intensity level than that of Europe, so improvements are more feasible. For example, while average car energy consumption per vehicle-kilometre declined by about 40% in the U.S. between 1973 and 1993, the starting point was double that of European automobiles.[159]

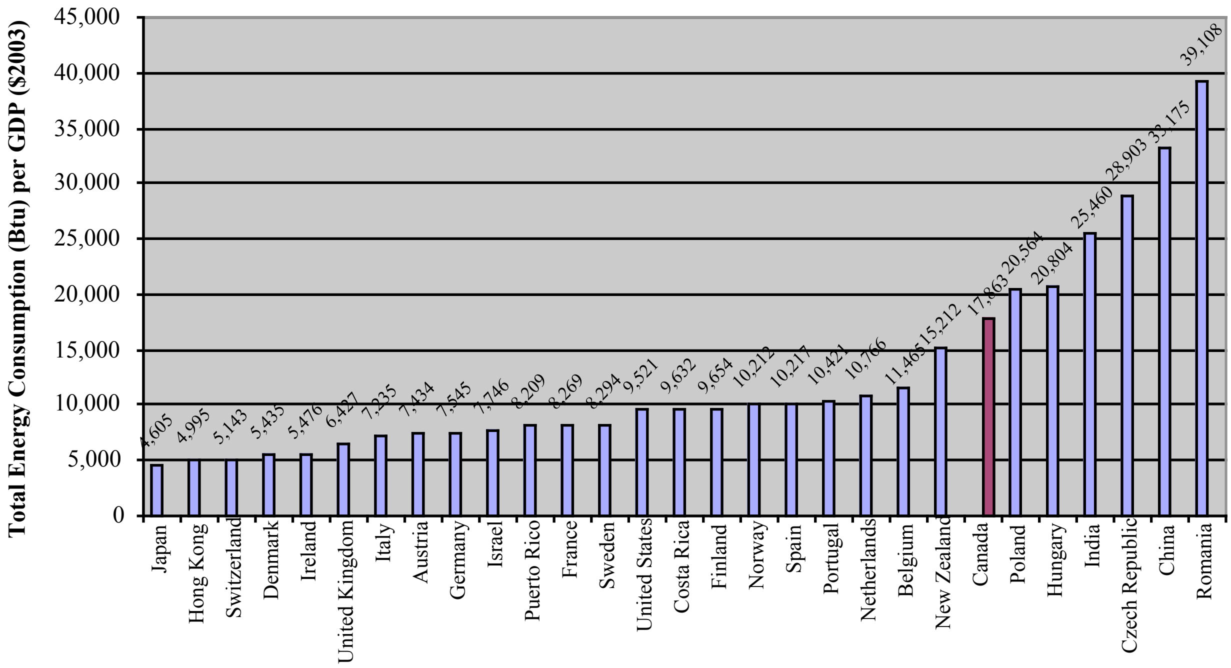
Another study by the WorldWatch Institute used available data to compare the overall energy efficiency (the inverse of energy intensity) of the OECD countries, based on the tonnes of oil equivalent used to generate $1,000 US worth of GDP.[160] While this measure reflects activities other than transportation, the previous chapter on energy consumption noted the strong link between oil and transportation, with transportation responsible for approximately two-thirds of world oil consumption.

Using this overall measure of energy efficiency, Canada ranks 28th out of 29 countries, at a level almost twice the OECD average.[161] Only Iceland trails Canada in this measure of energy efficiency, while Poland comes close to Canada, ranking 27th. Canada is 33% less energy-efficient than the United States. Italy, Japan, and Switzerland are the most energy-efficient countries in the OECD. As stated above, although these results are not directly comparable to the data used in the following analysis and are based on different methodologies, they do indicate that, by global standards, North America in general is relatively energy intense in the transportation sector and that Canada in particular is relatively energy inefficient overall.

158 Eichhammer, Wolfgang, Philippe Menanteau, Jean-Pierre Orfeuil, Bertrand Chateau and Marc LaFrance. *Energy Efficiency Policies and Indicators* (Part 1), p. 28. (London: World Energy Council, 2001). www.worldenergy.org/wec-geis/global/downloads/eepi1.pdf Accessed December, 2004.
159 Ibid., p. 29.
160 WorldWatch Institute. Op cit.
161 Boyd. (2001, p. 17).

When comparing total primary energy consumption as a function of GDP for selected countries (Figure 61), Canada ranks 23rd out of 29 selected countries in terms of overall energy efficiency. Among these 29 countries, Canada performs better only than Romania, China, the Czech Republic, India, Hungary, and Poland – all of which have far lower GDP per capita – and it performs worse than any other country with a comparable GDP per capita. That is to say that relative to the Canadian economy as a whole, Canada is very energy intensive by this particular measure of efficiency. This is in striking contrast to the United States, whose economy is far more energy efficient by this measure, and ranks 14th in energy efficiency among the 29 selected countries in Figure 61.

Figure 61. Energy Intensity of Selected Country Economies, Total Primary Energy Consumption (Btu) Per Dollar of 2003 GDP.



Source: Energy Information Administration. *International Energy Annual 2003. Energy Information Administration. International Energy Annual 2003 - Selected Countries and Years, 1980-2004 (Btu per (2000) U.S. Dollars Using Market Exchange Rates)*. (2006).

Trends: Canada

Note: The data for this section were collected before the OEE 2003 Comprehensive Energy Use Database was released in 2005. Because of the changes made to passenger-kilometre calculations and methodology (as already noted in the previous chapter), the 2003 database also produced changes in the energy intensity data reported in 2002, since energy intensity for passenger transportation is calculated using passenger-kilometres. Unfortunately, it was not possible to update the figures in this report to reflect the amended energy intensity values, due to resource, financial, and time constraints. However a comparison of the 2002 and 2003 databases indicates that when 2003 energy intensity values are compared to 2002 values for both Canada and Nova Scotia, the newer 2003 data reveal that energy intensity is somewhat higher for small cars, large cars, freight light trucks, and buses than indicated in the 2002 database, somewhat lower for passenger light trucks and medium freight trucks, and about the same for heavy trucks. Nevertheless, the database changes are not sufficient to invalidate any of the basic conclusions reached below about the relative energy intensity of the different transport modes.

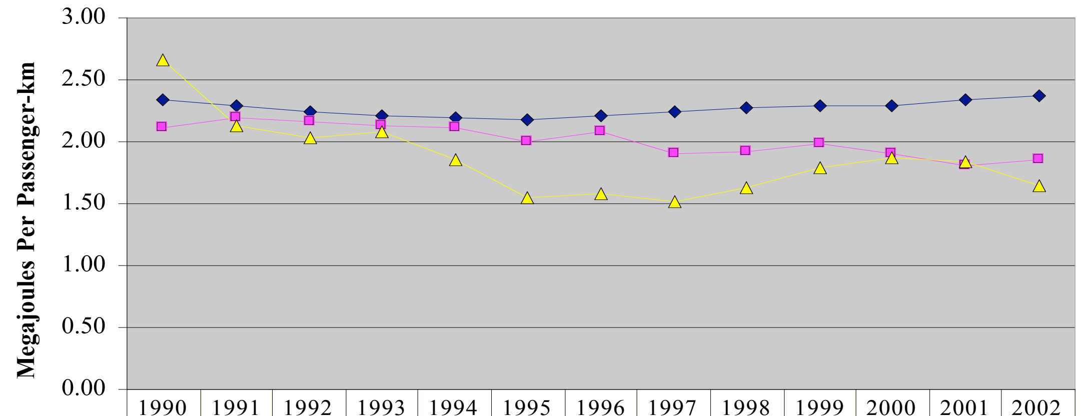
Passenger Movement

Figure 62 shows the energy intensity of passenger movement in Canada by mode of transportation. The only type of passenger travel to show an increase in energy intensity (a movement away from sustainability) is road transportation. The energy intensity of passenger transportation by road grew by nearly 1.5% between 1990 and 2002, while the energy intensity of both air and rail travel decreased during the same time period. As noted in the previous section, the increase in the overall energy intensity of road passenger travel could potentially be explained at least in part by the growing consumer preference for more energy-intensive vehicles, such as SUVs, minivans, and light trucks. It may also be driven by trends in other vehicle categories, as discussed in the following section.

Air passenger transportation energy intensity fell by about 12%, while rail passenger energy intensity decreased by roughly 38%. The energy intensity of passenger rail transportation fell from 2.66 megajoules per passenger-kilometre (MJ/PKm) in 1990 to 1.64 MJ/PKm in 2002. This is a significant improvement in energy intensity, and a move towards sustainability for rail passenger transportation.

The different modes of passenger transportation also show different trend patterns within the 1990-2002 reference period. Road transport energy intensity decreased (improved) steadily from 1990 to 1995, but has increased steadily since then to erode all the gains of the early 1990s and end up at its highest level during this period. Air and rail transport energy intensity also improved in the early 1990s and then, by contrast to road transport, largely maintained the lower levels achieved in the mid-1990s.

Figure 62. Energy Intensity of Passenger Movement in Canada, by Mode, 1990-2002 (Megajoules per passenger-km).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Road	2.34	2.28	2.24	2.21	2.19	2.18	2.22	2.24	2.28	2.29	2.28	2.33	2.37
Air	2.11	2.20	2.17	2.13	2.12	2.00	2.08	1.91	1.91	1.98	1.91	1.81	1.85
Rail	2.66	2.12	2.04	2.08	1.85	1.55	1.58	1.52	1.63	1.78	1.87	1.84	1.64

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 12, 19 and 25.

To understand the road transport energy intensity patterns, the movement of passengers by road can be further broken down into the various vehicle categories, as shown in Figure 63. This graph demonstrates that, on a national level, the energy intensity related to the movement of passengers by road vehicles has changed by relatively small amounts ***within*** each vehicle classification. The two types of road vehicles that experienced an increase in energy intensity between 1990 and 2002 were motorcycles and small cars. Motorcycle energy intensity grew by nearly 3.5%, while small car energy intensity increased by 11% over the same period. Motorcycle energy intensity increased from 1.30 to 1.35 megajoules per passenger-kilometre, while small car energy intensity grew from 1.81 to 2.01 MJ/PKm.

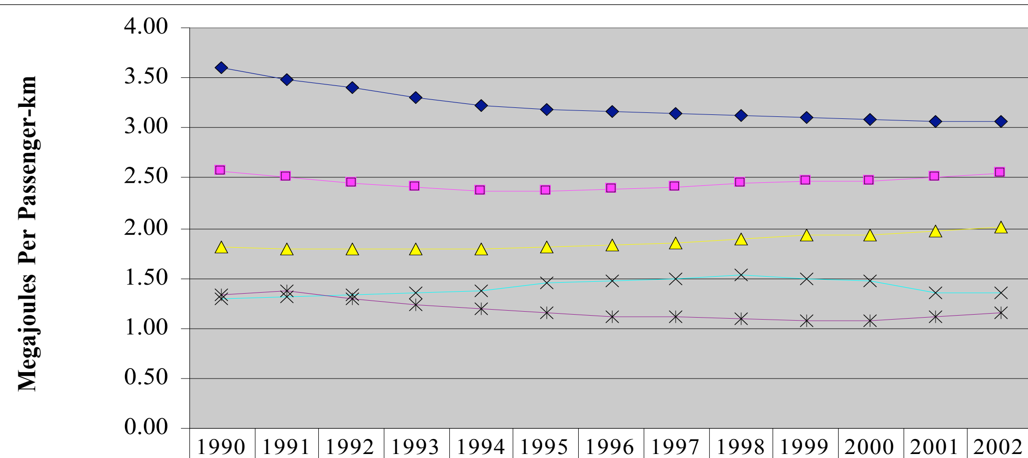
A possible explanation for the increased energy intensity of small cars could be that vehicle performance (acceleration speed, etc.) became an increasingly important criterion for the automotive-buying public in the 1990s.[162] Given that smaller cars are generally more energy-efficient than larger vehicles, the demand for increased horsepower and larger engines could explain the overall increase in energy intensity within this category.

By contrast to small cars and motorcycles, the other modes of road passenger movement shown in Figure 63 experienced declines in energy intensity. The large car category saw a drop in energy intensity of almost 7.5% between 1990 and 1995. From that point on, however, large car energy intensity began to increase again, following the pattern described above, resulting in a net decrease of only one percent for that vehicle category over the 1990-2002 period.

[162] Blais, Samuel. Economist (Market Analysis), Natural Resources Canada—Office of Energy Efficiency. (Personal communication: January 10, 2005).

A larger and more sustained decrease in energy intensity occurred for buses, with a steady improvement to 2000 and a slight increase since then, resulting in a net decline (improvement) in energy intensity of more than 12% over the reference period. Meanwhile, passenger light truck intensity dropped steadily and consistently during the entire period by a total of 15% between 1990 and 2002. The improved energy intensity of passenger light trucks from 3.61 MJ/PKm in 1990 to 3.06 MJ/PKm in 2002 could potentially be explained by the improved technology that became available, and by the fact that the large and generally more inefficient engines used in this vehicle category more readily allow improvement.[163]

Figure 63. Energy Intensity of Road Passenger Movement in Canada, by Vehicle Type, 1990-2002 (Megajoules per passenger-km).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Passenger Light Truck	3.61	3.49	3.40	3.30	3.22	3.18	3.16	3.13	3.13	3.11	3.08	3.07	3.06
Large Car	2.56	2.50	2.44	2.40	2.37	2.37	2.39	2.41	2.44	2.46	2.46	2.51	2.55
Small Car	1.81	1.80	1.79	1.79	1.79	1.81	1.83	1.86	1.90	1.92	1.93	1.97	2.01
Motorcycle	1.30	1.31	1.32	1.35	1.38	1.45	1.47	1.49	1.54	1.50	1.48	1.35	1.35
Bus	1.32	1.37	1.30	1.23	1.20	1.16	1.12	1.11	1.10	1.08	1.08	1.11	1.16

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 37, 43, 45, 48 and 55.

As bus and light truck (including SUV and minivan) energy intensity decreased (improved) during this period, while small car energy intensity increased, the key reason for the overall increase in road passenger movement energy intensity is clearly the much larger *numbers* of light trucks, including SUVs and minivans, on the road. Even at their improved levels of energy intensity in 2002, light trucks are still 52% more energy intensive than small cars, even at their higher 2002 levels of energy intensity. Light trucks, including SUVs, are also 20% more energy intensive than large cars and 164% more energy intensive than buses on a passenger-kilometre basis. In sum, any increase in the number of SUVs and minivans on the road will act to increase

[163] Ibid.

the energy intensity of the vehicle fleet as a whole, regardless of the efficiency improvements that have taken place in the light truck category since 1990.

As Figure 63 above shows, buses are by far the most energy efficient form of road passenger transportation, with about half the energy intensity of cars and only 38% of the intensity of light trucks. Conversely, therefore, any shift to bus travel and any increase in the proportion of road passenger movement that occurs by bus will reduce the energy intensity of the vehicle fleet as a whole and constitute movement towards sustainability.

Freight Movement

An analysis of the energy intensity of freight movement in Canada, shown in Figure 64, sharply contrasts the higher energy intensities of air and road carriage with the far more energy-efficient modes of marine and rail transport. Of these four types of transportation, air freight was the only one to increase in energy intensity. The energy intensity of air freight grew sharply—by just over 42%, from 4.14 megajoules per tonne kilometre in 1990 to 5.88 in 2002. This contrasts with the decline in energy intensity of air passenger movement noted above. Air freight experienced an 88% increase in total energy use between 1990 and 2002, while tonne-kilometres of freight moved by air increased only 32%, from 1,754 million to 2,324 million tonne-km (Figure 31 above).[164] This significant expansion in total air freight energy use, combined with relatively smaller increases in total tonne-kilometres of freight moved, produced the upsurge in energy intensity seen below, since energy intensity is expressed as a ratio of these two factors.

Marine freight energy intensity fell marginally (by 4%) between 1990 and 2002, while road freight energy intensity decreased by over 25% during the same period. As with passenger energy intensity, rail freight experienced the largest improvement in energy efficiency between 1990 and 2002. Rail freight energy intensity fell by 34%, from 0.34 MJ/TKm to 0.23 MJ/TKm. This is a significant improvement given that rail is already the most efficient mode of transportation for moving freight in Canada.

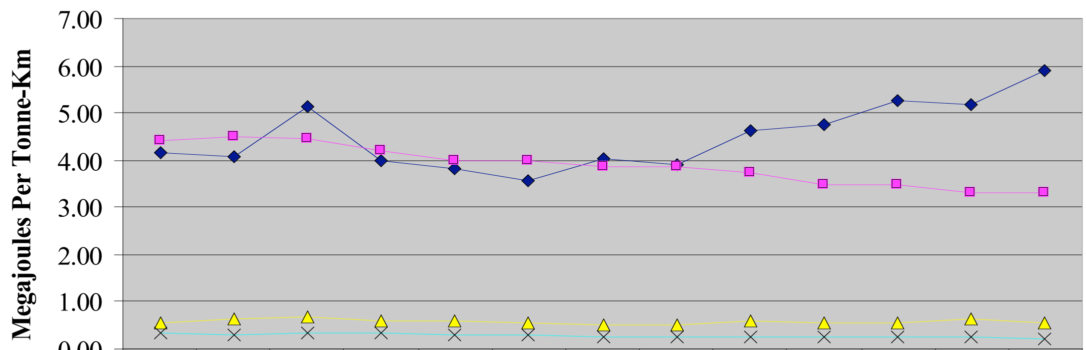
Again, there are significant trend patterns within this period. Air freight has experienced considerable fluctuations in energy intensity, with a general improvement in the early 1990s, followed by sharp increases in intensity since 1995. From its 1995 low point of 3.55 MJ/TK, air freight energy intensity actually increased by 66% to its 2002 high point of 5.88 MJ/TK. Marine freight has also experienced some fluctuations, but the overall trend line has remained fairly steady over the reference period at around 0.54-0.56 MJ/TK. Only road and raid freight have seen steady and continuous declines in energy intensity during the entire reference period.

More significant are the relative modal energy intensities revealed in Figure 64. Despite the steady improvements in road freight energy intensity, road freight is still more than 14 times more energy intensive than rail freight per tonne-kilometre moved. Air freight is 78% more energy intensive than road freight; 11 times more energy intensive than marine freight; and 26 times more energy intensive than rail freight. As rail is by far the most energy efficient freight

[164] NRCan—OEE. (August 5, 2004a, Table 19). Accessed January, 2005.

transportation mode, any shift in freight from road or air to rail constitutes significant movement towards transportation sustainability.

Figure 64. Energy Intensity of Freight Movement in Canada, by Mode, 1990-2002 (Megajoules per tonne-km).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Air	4.14	4.09	5.14	3.98	3.81	3.55	4.04	3.90	4.60	4.77	5.24	5.16	5.88
Road	4.41	4.50	4.48	4.20	3.97	3.98	3.87	3.85	3.72	3.47	3.48	3.31	3.30
Marine	0.56	0.63	0.68	0.59	0.60	0.54	0.52	0.51	0.59	0.54	0.54	0.62	0.54
Rail	0.34	0.31	0.33	0.33	0.30	0.28	0.27	0.25	0.25	0.26	0.25	0.25	0.23

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 14, 21, 27 and 28.

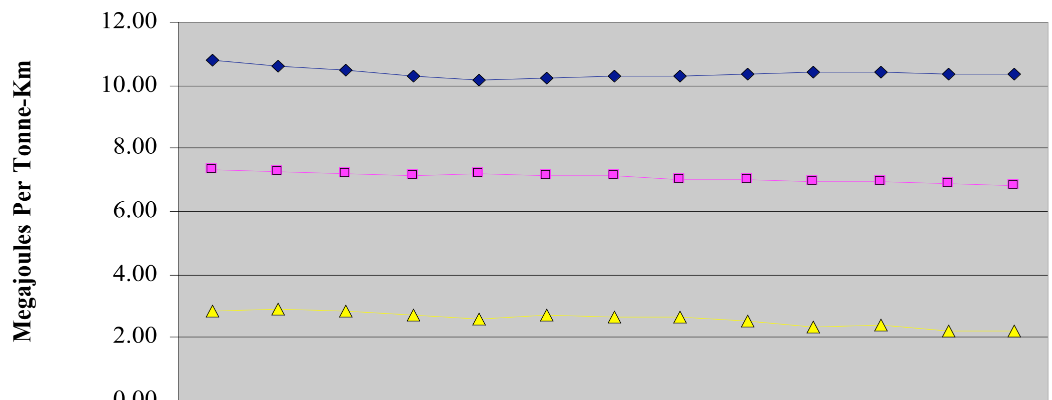
Figure 65 presents a breakdown of the road freight energy intensities of the different vehicle classifications. All three classes experienced a decrease in energy intensity from 1990 to 2002. Light truck energy intensity declined by just over four percent; medium truck energy intensity dropped by more than six percent; and heavy trucks—the most energy-efficient category—saw a decline in energy intensity of almost 23%. Clearly the reason for the greater energy efficiency of heavy trucks is related to the larger quantities of goods transported for longer distances, since energy intensity is the ratio of energy consumed to tonne-kilometres moved.

In order to assess whether the improved energy efficiency of the road freight fleet contributed to a decline in the energy intensity of Canadian freight transportation as a whole (and therefore movement towards sustainability), we need to observe the changes in the energy intensity of total freight movement in Canada over time (Figure 66 below). The reason this equation cannot be assumed is that any movement of freight transport away from the far more energy efficient rail and marine freight modes to the far more energy intensive road and air modes can erode the efficiency gains within the road freight fleet. We observed the same phenomenon in the passenger fleet, where improvements in energy efficiency in the light truck fleet (including SUVs) were eroded by the increased numbers of SUVs, minivans, and pick-up trucks on the road at the expense of less energy intensive cars.

In the freight sector, trucking, with an overall energy intensity of 3.3 MJ/TKm, comprised 59% of total freight moved in 2002 compared to 55% in 1990, while the marine freight share, with a much lower energy intensity of 0.54 MJ/TKm, declined by three percentage points over the same period from 19.3% of tonne-kilometres moved in 1990 to 16.2% in 2002 (Figure 31 above). The marine freight portion of total freight declined to about 17% in the late 1990s and then to 16.6% in 2000, 16% in 2001, and 16.2% in 2002, while the portion of truck freight rose steadily during the reference period. So the change in modal share is less subject to fluctuations than the marine freight trends considered in isolation, and the gap between trucking and other modes has increased steadily over time.

As Figure 66 below indicates, this shift in favour of trucking and away from marine freight had a negative impact on the energy intensity of the freight sector as a whole, which increased by 0.23% during the reference period, indicating that the gains observed in Figure 65 below were cancelled out or nullified by the overall increase in trucking at the expense of more energy efficient modes.

Figure 65. Energy Intensity of Road Freight Movement in Canada, by Vehicle Type, 1990-2002 (Megajoules per tonne-km).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Freight Light Truck	10.78	10.59	10.48	10.30	10.20	10.20	10.29	10.29	10.38	10.41	10.40	10.37	10.34
Medium Truck	7.31	7.26	7.22	7.17	7.19	7.12	7.12	7.04	6.99	6.97	6.95	6.88	6.85
Heavy Truck	2.85	2.88	2.86	2.72	2.62	2.70	2.62	2.68	2.53	2.33	2.38	2.19	2.21

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 61, 63 and 64.

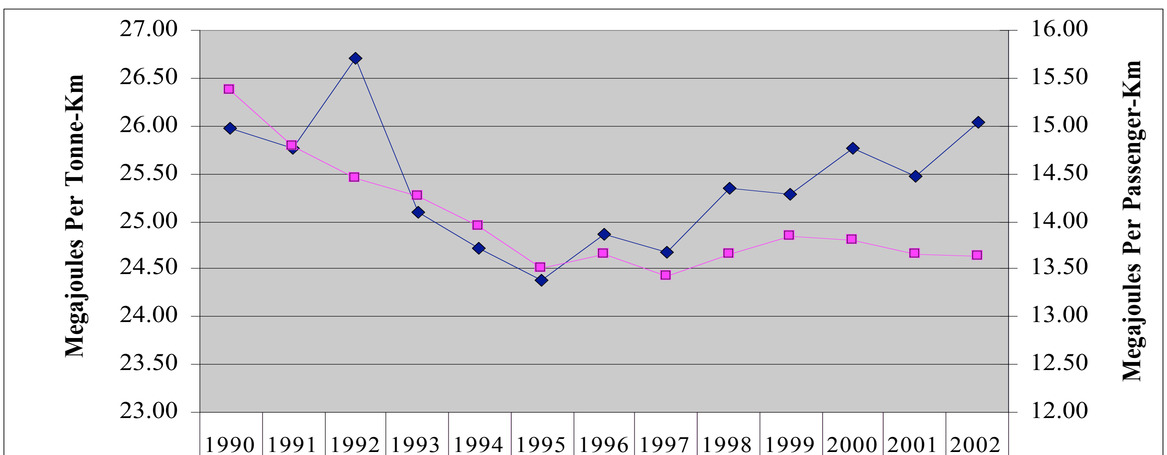
Combined Freight and Passenger Transport

As noted above, it is important to assess the modal data above in the context of total passenger and freight energy intensity. Figure 66 presents the aggregate totals of passenger transport energy intensity and of freight transport energy intensity for Canada. The energy intensity of freight in megajoules per tonne-kilometre is measured against the left axis, and the energy intensity of passenger movement in Canada is measured against the right axis in megajoules per passenger-kilometre.

Between 1990 and 2002, the overall trend for energy intensity of Canadian freight was a small increase of 0.23%. The shifts in freight energy intensity over this period were due to a combination of fluctuations in the energy intensity of air freight, fluctuations in marine freight tonnage, and an increase in trucking. The increase in energy intensive trucking and the decline of energy efficient marine freight, along with increased air freight and increased energy intensity in that sector are together responsible for the small overall increase in freight transport energy intensity, largely cancelling out the improvements in energy efficiency that occurred ***within*** the road, marine, and rail sectors during this time. Put another way: had the relative modal ***shares*** of freight transport remained unchanged over time, the observed ***sectoral*** improvements in energy efficiency would have translated into a net decline in the energy intensity of freight transport as a whole.

The energy intensity of passenger movement in Canada decreased from 1990 to 1995, and then levelled off through 2002. Overall, this resulted in a reduction of 11.3%, indicating a movement toward sustainability. Although there were small increases in the energy intensity of some vehicle categories, such as small cars and motorcycles, these were offset by larger decreases for passenger light trucks, buses, air travel, and rail. Without the massive increase in the number of SUVs on the road, energy efficiency would likely have continued to improve through the late 1990s, resulting in a larger overall gain in passenger transport energy efficiency.

Figure 66. Energy Intensity of Freight and Passenger Movement in Canada, 1990-2002.



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Freight	25.98	25.76	26.71	25.08	24.72	24.38	24.86	24.67	25.34	25.28	25.76	25.46	26.04
Passenger	15.37	14.79	14.46	14.27	13.94	13.51	13.65	13.43	13.65	13.84	13.81	13.66	13.63

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 20, 21, 26-28, 33, 43, 45, 55, 57, 58, 62 and 64.

Trends: Nova Scotia

Unfortunately Natural Resources Canada does not provide energy intensity data for rail, air, or marine transport at the provincial level. This restricts the analysis of passenger and freight movement energy intensity to road transportation and limits the scope of the conclusions that can be drawn regarding the energy intensity of transportation in Nova Scotia. It also limits the capacity for comparative analyses that investigate the potential efficiency gains of modal shifts, thereby depriving policy makers and the general public of essential data required for informed decision-making. In the meantime, the extensive review of energy intensity at the Canadian level provided above will be used here to supplement the existing data for Nova Scotia.

As shown in Figure 67, from 1990 to 2002, energy intensity trends for Nova Scotia have varied by vehicle category. Energy intensity increased marginally for passenger movement by car and motorcycle during this period, while passenger light trucks, large cars, and buses all declined in energy intensity. This is very similar to the pattern for Canadian trends shown in Figure 63 above.

Between 1990 and 2002, small car energy intensity in Nova Scotia remained fairly steady, increasing slightly in 2001-02, for a net increase in intensity of almost three percent (0.04 MJ/PKm) for the full reference period. Motorcycle energy intensity grew by slightly more than three percent (0.05 MJ/PKm) during the same period. Bus energy intensity decreased by just over three percent (0.04 MJ/PKm); and large car energy intensity by almost seven percent (0.18 MJ/PKm).

The largest efficiency gain was in the passenger light truck category, which saw a 14% drop in energy intensity—a reduction of 0.49 MJ/PKm. This is similar to the results for the energy intensity of passenger light trucks nationally. As mentioned earlier, improved technology applied to relatively large and inefficient engines appears to be driving the downward trajectory in the energy intensity of passenger light trucks.[165] Nevertheless, light trucks, which include SUVs and minivans, are still 22% less energy efficient than large cars and nearly 70% less energy efficient than small cars even at improved 2002 levels. In terms of the provincial road passenger fleet as a whole, therefore, the increased numbers of SUVs, minivans, and light trucks on provincial roads in the last ten years have cancelled out the efficiency gains within the light truck category. As a result, the energy intensity of road passenger transportation in Nova Scotia is now higher than it was in the mid-1990s (see Figure 69 below).

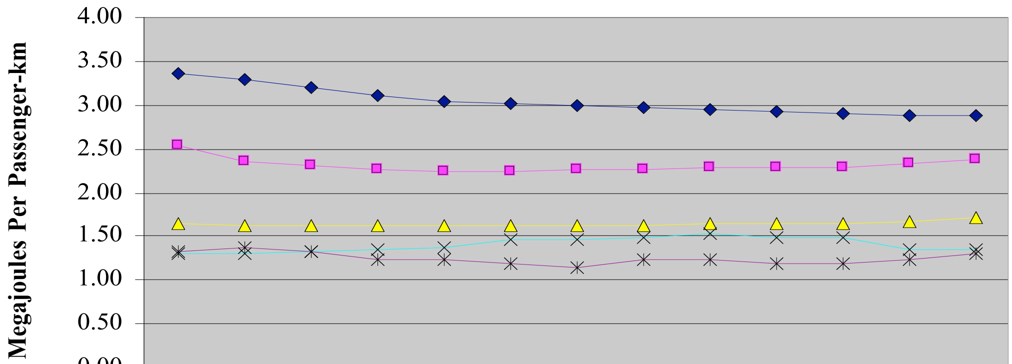
It is noteworthy that light truck energy intensity is 6% lower in Nova Scotia than at the national level; large car energy intensity is 7% lower; and small car energy intensity is 15% lower. This is likely due to a combination of factors, including less traffic congestion than in many other parts of the country, the province's more rural composition[166] and therefore longer distances travelled,[167] higher average vehicle occupancy, and possibly the purchase of smaller (and therefore more energy efficient) vehicles within each vehicle classification due to lower average

[165] Blais. (January 10, 2005).
[166] Statistics Canada. Population urban and rural, by province and territory. http://www40.statcan.ca/l01/cst01/demo62a.htm?sdi=rural (Accessed March 7, 2006.)
[167] Statistics Canada. 2001 Census - Commuting Distance (km), Age Groups and Sex for Employed Labour Force 15 Years and Over Having a Usual Place of Work, for Canada, Provinces, Territories, Census Metropolitan Areas 1 and Census Agglomerations, 2001 Census - 20% Sample Data. www12.statcan.ca/english/census01/products/standard/themes/RetrieveProductTable.cfm?Temporal=2001&PID=55530&APATH=3&GID=431515&METH=1&PTYPE=55440&THEME=49&FOCUS=0&AID=0&PLACENAME=0&PROVINCE=0&SEARCH=0&GC=99&GK=NA&VID=0&FL=0&RL=0&FREE=0 (Accessed March 7, 2006)

incomes in the province. All these factors can positively affect the energy intensity of the vehicle fleet.

Contrary to the apparent differences between bus energy intensity figures depicted in Figure 63 above and Figure 67 below, the OEE's 2003 Comprehensive Energy Use Database reports that Nova Scotia's bus transportation is actually equally energy efficient as the national average, at about 1.2 MJ/p-km.[168] Buses are more energy efficient than private automobile travel – 32% more than small cars, 84% more than large cars, and 2.2 times more than light trucks, including SUVs and minivans. Because buses experience efficiencies of scale (increased ridership tends to increase average load factors, reducing unit energy consumption), a shift to bus travel in Nova Scotia would tend to conserve resources and would therefore constitute movement towards sustainability.

Figure 67. Energy Intensity of Passenger Movement in Nova Scotia, by Vehicle Type, 1990-2002 (Megajoules per passenger-km).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Passenger Light Truck	3.37	3.28	3.19	3.11	3.03	3.01	2.99	2.96	2.96	2.93	2.91	2.88	2.88
Large Car	2.55	2.37	2.31	2.27	2.24	2.25	2.25	2.25	2.28	2.28	2.28	2.32	2.37
Small Car	1.66	1.62	1.62	1.62	1.62	1.63	1.63	1.63	1.66	1.65	1.65	1.67	1.70
Motorcycle	1.30	1.31	1.32	1.35	1.38	1.45	1.47	1.49	1.54	1.50	1.48	1.35	1.35
Bus	1.33	1.38	1.33	1.24	1.23	1.18	1.14	1.23	1.23	1.18	1.20	1.24	1.29

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Tables 22, 28, 29, 35 and 37.

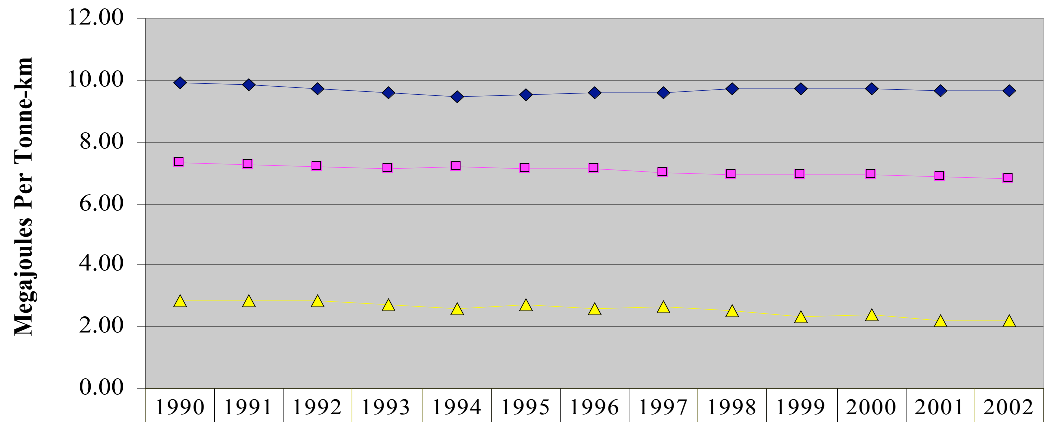
An analysis of road freight energy intensity in Nova Scotia, shown in Figure 68 below, produces results almost identical to those for Canada (Figure 65 above). In both cases, energy intensity for all three vehicle classifications improved (that is to say, declined) over the term studied.

In Nova Scotia, between 1990 and 2002, the energy intensity of passenger light trucks fell by 2.6%. For medium trucks there was a decrease of just over seven percent; and for heavy trucks of

[168] Natural Resources Canada – Office of Energy Efficiency. 2003 Comprehensive Energy Use Database – Transportation Sector- Canada, Table 33 and Nova Scotia, Tables 22. (April 2006).

22.5% or 0.64 MJ/TKm. The greater energy efficiency of heavy trucks is due in large part to the larger quantities and tonnage of goods transported over longer distances.

Figure 68. Energy Intensity of Freight Movement in Nova Scotia, by Truck Type, 1990-2002 (Megajoules per tonne-km).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Freight Light Truck	9.94	9.84	9.72	9.60	9.49	9.54	9.62	9.63	9.71	9.74	9.76	9.68	9.69
Medium Trucks	7.34	7.27	7.22	7.16	7.17	7.12	7.11	7.03	6.97	6.95	6.94	6.86	6.82
Heavy Trucks	2.85	2.88	2.86	2.72	2.62	2.70	2.62	2.68	2.53	2.33	2.38	2.19	2.21

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Tables 38 and 39.

Conclusion

Transportation activity is more energy intensive in Canada than in most other industrialized countries. Canadians drive relatively larger vehicles and so consume more energy per passenger-kilometre than in most other developed countries. On a national level, air and rail passenger travel grew less energy-intensive—which is to say, more energy-efficient—between 1990 and 2002. The intensity of road travel, however, increased marginally during the same period (Figure 62), due to the larger numbers of SUVs, minivans, and light trucks on the roads, which cancelled out the gains achieved through technology improvements. As noted in Figure 63, all categories of road transport, except for small cars and motorcycles, showed improved energy efficiency (reduced intensity), including light trucks, though these remain the most energy intensive of all passenger road vehicles.

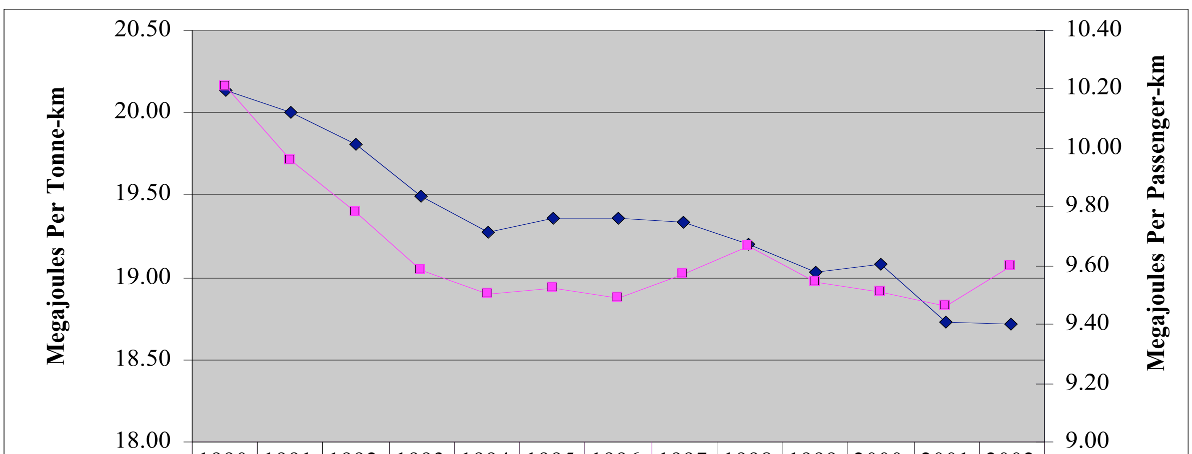
For Canadian passenger transport as a whole, when all modes are considered together, significant gains in energy efficiency were made in the early 1990s, but the overall energy intensity of passenger transportation has remained flat since 1995, with no further overall improvement (Figure 66), again largely due to the increased numbers of SUVs and other light trucks.

The movement of freight in Canada is showing improved energy intensities in all modes other than air, which experienced a fairly significant growth in energy intensity (Figure 64). Energy intensity decreased in all three truck freight classifications—heavy, medium, and light (Figure 65). For the freight transportation fleet as a whole, however, greater reliance on trucking (which remains far more energy intensive than rail or marine freight) has cancelled out the energy efficiency gains within the road freight sector, producing a slight overall net gain in freight transport energy intensity (or movement away from sustainability) during the reference period.

An analysis of data on road transportation energy intensity for Nova Scotia showed similar trends to those found for Canada. Improvements were made in passenger movement in all categories except small cars and motorcycles; and freight carriage by road showed improvement for all vehicle categories. Figure 69 below shows total energy intensity for road freight and passenger movement by road in Nova Scotia. As in Figure 66, road freight energy intensity is shown on the left axis, while passenger energy intensity is on the right.

Road freight energy intensity in Nova Scotia fell by just over seven percent between 1990 and 2002. Provincial energy intensity data are not available for other freight modes, though the Canadian data indicate that efficiency gains in road freight were nullified in the freight sector as a whole by an overall shift to trucking, which is far more energy intensive than rail or marine freight. Figure 69 shows that passenger energy intensity decreased by six percent between 1990 and 2002. But the entire improvement occurred between 1990 and 1994, with no overall efficiency gains for the road passenger fleet as a whole since that time, again probably due to the increased numbers of SUVs and minivans on the road. Indeed, the energy intensity of the road passenger fleet in Nova Scotia was higher in 2002 than during the mid-1990s (1993-97).

Figure 69. Energy Intensity of Road Freight and Road Passenger Movement in Nova Scotia, 1990-2002 (Megajoules per tonne-km [left axis] and per passenger-km [right axis]).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Freight	20.13	20.00	19.81	19.49	19.28	19.36	19.36	19.33	19.21	19.03	19.08	18.73	18.71
Passenger	10.21	9.96	9.78	9.58	9.50	9.52	9.49	9.57	9.66	9.54	9.51	9.46	9.60

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Tables 22, 28, 29, 35 and 37-39.

The unavailability of statistics on rail, marine, and air energy intensity in Nova Scotia severely limits analysis in this area, so some conclusions in the above analysis are based largely on the Canadian trends. These indicate that the shift to freight trucking and the increased numbers of SUVs and minivans have likely nullified the apparent efficiency gains indicated in Figure 69.

Chapter 4. Greenhouse Gas Emissions

The European Union and Centre for Sustainable Transportation definitions and corresponding goals for sustainable transportation both contain the proviso that transport emissions be limited to levels that are within the planet's ability to absorb them. This provision, also adopted in the definition and goals for this study, applies to both air pollutants and emissions of greenhouse gases from transportation sources. The evidence that emissions of greenhouse gases (carbon dioxide, nitrogen oxides, methane, and others) are linked to climate change was reviewed in a previous **GPI***Atlantic* report.[169] In light of this evidence, the increasing levels of carbon dioxide and other GHGs in the atmosphere are cause for very serious concern.

According to Michel Jarraud, the Secretary-General of the World Meteorological Organization (WMO), in May, 2004:

> Scientific assessments have shown that over the past several decades, human activities, especially burning of fossil fuels for energy production and transportation, are changing the natural composition of the atmosphere. Proxy records indicate that for over 160,000 years, up to about 1800 AD, the atmospheric concentration of carbon dioxide (CO_2) varied only by 1-3%. Since then, it has increased by more than 33%, and reached 372 parts per million by volume (ppmv) at the end of 2002. WMO's Global Atmosphere Watch Observing Network, monitoring atmospheric chemistry, show that today's atmospheric CO_2 concentration has not been exceeded during the past 420,000 years. More than half of that increase in CO_2 concentration has occurred since 1950.[170]

As this statement along with the reports of the United Nations Intergovernmental Panel on Climate Change and abundant other evidence suggest, there is almost universal scientific agreement about the increasing levels of atmospheric CO_2. More contentious are the probable effects of these atmospheric alterations. A growing body of scientific research attempts to investigate what changes are already occurring as a result of the increase in atmospheric CO_2 concentrations, and what the future impacts might be.

The International Arctic Climate Impact Assessment has revealed some of the likely consequences attendant on the ever-increasing amounts of greenhouse gases in the atmosphere. This study found that the high northern latitudes are already warming at an alarming rate and it predicts larger changes to come. The report also identified global consequences from the changes that are occurring in the Arctic. According to the report:

> Continuing to add carbon dioxide and other greenhouse gases to the atmosphere is projected to lead to significant and persistent changes in climate, including an increase in average global temperature of 1.4 to 5.8^{o}C (according to the

[169] Walker et al. (2001).
[170] World Meteorological Organization. *Statement On the Occasion Of the Opening Of the Symposium on Global Change Research*. (May 6, 2004). www.wmo.ch/web/Press/Press.html#sa Accessed May, 2004.

> Intergovernmental Panel on Climate Change) over the course of this century. Climate changes are projected to include shifts in atmospheric and oceanic circulation patterns, an accelerating rate of sea-level rise, and wider variations in precipitation. Together, these changes are projected to lead to wide-ranging consequences including significant impacts on coastal communities, animal and plant species, water resources, and human health and well-being.[171]

The challenge of reducing emissions of greenhouse gases internationally was addressed in the Kyoto Protocol, which is based on negotiations that took place among 160 countries in 1997 in Kyoto, Japan.[172] The agreement sets out targets for emission reductions for each party, as well as the options and mechanisms to achieve these goals. Canada has accepted a national target for GHG emissions that is six percent below 1990 levels.[173]

Ratification of the Kyoto Protocol by a minimum of 55 states—including those countries collectively responsible for at least 55% of the industrialized nations' GHGs in 1990—was required for the accord to become law. Although the United States, the world's largest emitter of greenhouse gases, did not ratify the agreement, Russia's accession in October, 2004 brought the protocol over the 55% hurdle.[174, 175] As a result, the treaty officially came into force on February 16, 2005. This reduces the uncertainty of global and regional climate change negotiations and has increased international pressure on Canada to reduce its GHG emissions.

Climate change is widely considered the foremost environmental issue of the 21st century.[176] The precautionary principle, described in the introduction, requires that climate change be viewed from the perspective of future generations and that pre-emptive measures be taken without delay to prevent future damage that may be very serious and perhaps irreversible. Because the transportation sector is a major contributor to GHG emissions, action in this area is imperative to help forestall or mitigate potentially catastrophic climate change.

To this point Canada's record on climate change has been rather poor. As expressed by Alex Boston, the David Suzuki Foundation's Senior Climate Change Specialist:

> The litmus test for assessing performance on climate protection and sustainable energy are emission and energy trends. Canada has one of the industrial world's least energy efficient and most carbon intensive economies. Canada's economy is 33% less energy efficient than the United States. Canada's uptake of renewable

[171] Hassol, Susan Joy. *Impacts of a Warming Arctic: Arctic Climate Impact Assessment*, p. 2. (Cambridge: Cambridge University Press, 2004). http://amap.no/workdocs/index.cfm?dirsub=%2FACIA%2Foverview Accessed November, 2004.
[172] Government of Canada. Canada and the Kyoto Protocol. (July 11, 2001). www.climatechange.gc.ca/cop/cop6_hague/english/overview_e.html Accessed December, 2004.
[173] Further details regarding the Kyoto Protocol are provided in Appendix A.
[174] CBC News. Russia's parliament ratifies Kyoto. (October 27, 2004). www.cbc.ca/story/world/national/2004/10/27/russia_kyoto041027.html Accessed November, 2004.
[175] Associated Press. "Russia Formally Accedes to Kyoto Protocol." (Nairobi: November 18, 2004).
[176] Walker et al. (2001, p. 7).

> energy is one of the slowest in the G-8. According to the most recent figures, Canada's emissions are growing faster than any other G8 country.[177]

As Boston points out in the same paper, even the US—which opposes the accord— is in a better position to achieve its Kyoto target.[178]

Why do Canada's GHG emission trends matter? As noted above, greenhouse gas emissions and climate change pose serious threats to the environment, the economy, and human health. The Canadian government, in its *Climate Change Plan for Canada*, has acknowledged some of the problems caused by climate change that have already been felt in Canada:

- increasing number and intensity of heat waves and attendant health problems;
- declining water levels in the Great Lakes;
- changes in fish migration and melting of the polar ice cap;
- insect infestations in British Columbia's forests;
- hotter summers and higher levels of smog in major urban centres; and
- more extreme weather events such as droughts on the Prairies, ice storms in eastern Canada, flooding in Manitoba and Quebec.[179]

The ten hottest years on record (since reliable records began in 1861) have all occurred since 1995. Furthermore, 2003—the fourth warmest year on record (after 1998, 2005, and 2002)—was filled with natural disasters in Canada, Nova Scotia, and internationally.[180] According to the World Meteorological Organization:

> [2003] saw the development of 16 named storms, well above the 1944-96 average of 9.8, but consistent with a marked increase in the annual number of tropical systems since the mid 1990s…. Hurricane Isabel hit North Carolina as one of the strongest on record. Hurricane Juan was the worst hurricane to hit Halifax, Nova Scotia, in modern times, and Hurricane Fabian was the most destructive hurricane to hit Bermuda in more than 75 years.[181]

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[177] Boston, Alex. *Planning for the Next Generation: Ten Principles for Climate Protection and Innovation*, pp. 1-2. (Vancouver: David Suzuki Foundation, 2004). www.davidsuzuki.org/files/Climate/KyotoPlanTenPrinciples.pdf Accessed June, 2004.

[178] Boston—drawing on the work of David Boyd, Eco-Chair of Environmental Law and Policy at the University of Victoria—notes further that Canada ranks 27 th out of 29 OECD nations for energy use per capita. Canadians annually consume more than 6.19 tonnes of oil equivalent per capita. This is almost double the OECD average of 3.18 tonnes of oil equivalent per capita, and more than five times the world average. Only Iceland and Luxembourg use more energy per capita than Canadians. See Boyd (2001).

[179] Government of Canada. *Climate Change Plan for Canada*, pp. 5-6. (2002). www.climatechange.gc.ca/plan_for_canada/plan/pdf/full_version.pdf Accessed June, 2004.

[180] World Meteorological Organization. *WMO Statement on the Status of the Global Climate in 2003*. (December 16, 2003). www.wmo.ch/web/Press/archive_pr.html Accessed June, 2004. 1998 remains the hottest year on record (+0.55°C above the 1961-90 annual average); followed by 2005 and 2002 (+0.48°C); and then 2003 (0.45°C). The average temperature during 2005 in the northern hemisphere was 0.65 Celsius above the average for 1961-1990, making it the hottest year on record in this hemisphere.

[181] Ibid.

Michel Jarraud, Secretary General of the World Meteorlogical Organization also points out that the shift in weather patterns cannot "be attributed to any particular cause, but was part of a global warming trend that was likely to continue."[182] The year 2005 was the hottest year ever recorded in the northern hemisphere, and the second hottest globally, and 2004 was the fifth hottest on record, with both years producing a number of turbulent weather patterns including powerful hurricanes in the Caribbean and typhoons in Asia. The extraordinary 2005 hurricane season included one of the powerful hurricanes ever recorded (Rita) and the catastrophic damage to New Orleans wreaked by Hurricane Katrina. Meteorologists have noted that higher than normal water temperatures fuelled the intensity of many of these hurricanes, including Rita, Katrina, and Juan.

Meteorologists have been hesitant thus far to definitively link the increase in extreme weather events to human-induced climate change, pointing out that the warming trend and more intense hurricane activity could be a part of natural climatic cycles. While there remains some uncertainty about the causes of climate change and of extreme weather events, we do know that the rate of increase in atmospheric GHG over the past 50 years is unprecedented, that the global climate is warming, and that an increase in extreme weather events is consistent with the predictions of climate change models. Though complete scientific certainty on the causes of climate change may never be attained, ample evidence does exist to invoke the precautionary principle, and to reduce GHG emissions without delay in order to protect the planet from potentially disastrous future changes.

While more frequent and intense storms can produce tremendous damage, destruction to infrastructure, and loss of life, climate change can also have a more direct impact on human health and wellbeing. Health Canada has compiled a list of potential health problems related to global warming.[183] These include:

- respiratory and cardiovascular illnesses from increased temperatures;
- asthma and other respiratory diseases from increased air pollution;
- changed patterns of diseases caused by bacteria, viruses, and other pathogens carried by mosquitoes, ticks, and other vectors;
- skin damage and skin cancer caused by more intense and prolonged exposure to ultraviolet rays; and
- increasing costs to health care that affect community health in general.

Climate change will also have varying effects on different regions in Canada's diverse landscape. According to Environment Canada, "The specific impacts of climate change in New Atlantic Canada will be dramatic."[184] The predicted changes for this region include:

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[182] Grey, Kevin. "4th Hottest Year on Record—2004." (Buenos Aires: CBS Broadcasting. December 15, 2004). www.cbsnews.com/stories/2004/12/18/tech/main661856.shtml Accessed December, 2004. Note this citation is from before 2005, which is now the second hottest year on record, thus relegating 2004 to 5th place.
[183] Health Canada. Canada's Health Concerns from Climate Change and Variability. (July 28, 2003). www.hc-sc.gc.ca/hecs-sesc/ccho/health_story_table.htm Accessed July, 2004.
[184] Environment Canada. Atlantic Canada Fact Sheet. (April 3, 2002). www.ec.gc.ca/press/2002/020403-2_f_e.htm Accessed July, 2004. No explanation is provided for what is meant by "New" Atlantic Canada, but it may be assumed that it means Atlantic Canada after major climate change has been experienced.

- rising sea levels;
- flooding of coastal marshes and beach migration, along with a disruption of wildlife in those areas; shifts in distribution of fish species and lower sustainable fish harvests;
- increased risk of forest fires and insect invasions;
- unpredictable breakup of ice, affecting power companies and damaging property; and
- increased smog and air pollution, affecting especially the health of the very old and very young, and people in poor health.

Environment Canada concludes:

> The real cost issue related to climate change is the cost of not reducing our GHGs—the cost of subsiding infrastructure and eroding coasts; the cost of increasingly violent weather with more storms, more drought, more pestilence and plant disease; the cost of changing habitats on our wildlife and our leisure past-times; the cost of increased air pollution and damage to human health.[185]

Given the broad range of potential impacts of climate change, a key challenge is to define what constitutes a "sustainable" level of GHG emissions. This issue is complicated by the fact that greenhouse gases can stay in the atmosphere for as long as two centuries. As a result, even the most drastic reductions in emissions would only stabilize the levels of GHGs in the atmosphere and would not produce a decrease in environmental concentrations for years to come. The reality of the long atmospheric life spans of GHGs puts the Kyoto Protocol targets into perspective, and shows that they are only meaningful as a very modest first step on the way toward far greater reductions of greenhouse gases to more sustainable levels.

While Canada's Kyoto target of reducing GHG emissions to six percent below 1990 levels constitutes a substantial 26% reduction from 2004 levels, it must be kept in mind that pre-industrial atmospheric concentrations of CO_2 were only 280 ppmv (parts per million by volume), while today they are over 370 ppmv.[186] Merely to stabilize CO_2 emissions at 550 ppmv—almost twice the pre-industrial levels—the Intergovernmental Panel on Climate Change recommends a 50% reduction in global GHG emissions.[187] This is a very significant decrease, far greater than those agreed to in the Kyoto Protocol, to achieve a target that will still involve very substantial global warming with its attendant potential dangers. Even that very ambitious reduction cannot therefore be considered truly "sustainable" from a climate change perspective or from that of the EU and CST criteria adopted for this report, namely that "emissions be limited to levels that are within the planet's ability to absorb them."

In order for Canada to reach the Kyoto target by 2010, GHG emissions must decrease from 2004 levels of 758,000 kilotonnes (kt) to 563,060 kt per year of CO_2 equivalents.[188] This means that

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[185] Ibid.

[186] Bjorke, Sven Ake and Megumi Seki (eds.). *Vital Climate Graphics*, graph 7: Global Atmospheric Concentration of CO_2. (United Nations Environmental Programme/GRID-Arendal, 2001). www.grida.no/climate/vital/07.htm Accessed August, 2004.

[187] United Nations Environmental Programme/Grid-Arendal. Carbon Dioxide Emissions Globally and from Annex 1 Countries. (March 17, 2003). www.grida.no/db/maps/collection/climate6/annex1.htm Accessed August, 2004.

[188] There are several gases that contribute to the greenhouse effect. Carbon dioxide (CO_2) is one of the most important because CO_2 emissions account for the vast majority of GHG emissions, but gases such as methane (CH_4)

over the five years from 2006 to 2010, there would have to be an average annual decrease in greenhouse gas emissions of 38,988 kt. Achieving genuine progress, therefore, would require an initial yearly reduction of nearly 39,000 kt in GHG emissions, while striving for the even greater cuts that will be essential to begin approaching more sustainable levels.

The Indicators

The Centre for Sustainable Transportation indicator tracks GHG emissions totals for the transportation sector, and considers a reduction in emissions to constitute evidence of progress towards sustainable transportation.[189] The CST data set was derived from two sources, *Environment Canada* and *Natural Resources Canada* (NRCan). According to the CST, the Environment Canada numbers are more comprehensive and in line with international standards, but the NRCan data are more recent and can be broken down into passenger and freight transport, which make the NRCan records easier to use in comparing results for this indicator to the work done on other transportation indicators.[190]

Since Environment Canada's figures are now more current than the information on which the CST relied at the time, they are used here. The Environment Canada statistics follow IPCC guidelines, making them compatible with other international sources of data on greenhouse gas emissions. Environment Canada obtains its data from Statistics Canada reports, as well as from a variety of other publications listed in the reference section of its annual report, *Canada's Greenhouse Gas Inventory*.[191]

The GHG emissions indicators used in this report are:

- Total GHG emissions from the Nova Scotia transportation sector;
- Per capita transport-related emissions of GHGs; and

and nitrous oxide (N_2O) are also significant. Since these gases last in the atmosphere for different lengths of time and have different impacts, "CO_2 equivalents" are used to create a single number that is easier to apply. The CO_2 equivalent of any given gas is determined by multiplying a million metric tonnes of the gas by the Global Warming Potential (GWP) of the gas—the degree to which the gas heats the earth over 100 years—compared to the GWP of carbon dioxide (which is set at 1 for comparative purposes). For example, the GWP for methane is approximately 21. This means that the emission of 1 million metric tonnes of methane is equivalent to the emission of 21 million metric tonnes of carbon dioxide in terms of its impact on global warming.

[189] Gilbert et al. (2002, p. 32).

[190] Ibid., pp. 31-32.

[191] In the present report, the 2003 and 2004 editions were used. These are:
Olsen, Ken, Maria Wellisch, Pierre Boileau, Dominique Blain, Chia Ha, Lori Henderson, Chang Liang, James McCarthy and Scott McKibbon. *Canada's Greenhouse Gas Inventory 1990-2001*. (Ottawa: Environment Canada, 2003). www.ec.gc.ca/pdb/ghg/1990_01_report/1990_01_report_e.pdf; and
Matin, Afshin, Pascale Collas, Dominique Blain, Chia Ha, Chang Liang, Loretta MacDonald, Scott McKibbon, Craig Palmer and Kerry Rhoades. *Canada's Greenhouse Gas Inventory 1990-2002*. (Ottawa: Environment Canada, 2004). www.ec.gc.ca/pdb/ghg/1990_02_report/1990_02_report_e.pdf
At the time this report went to press, the 2005 edition of *Canada's Greenhouse Gas Inventory*.(containing the 2003 emissions data) was available, but time and resources did not permit a revision of the information in this chapter to update the statistics in accord with the latest available data.

- Share of GHG emissions by transportation mode.

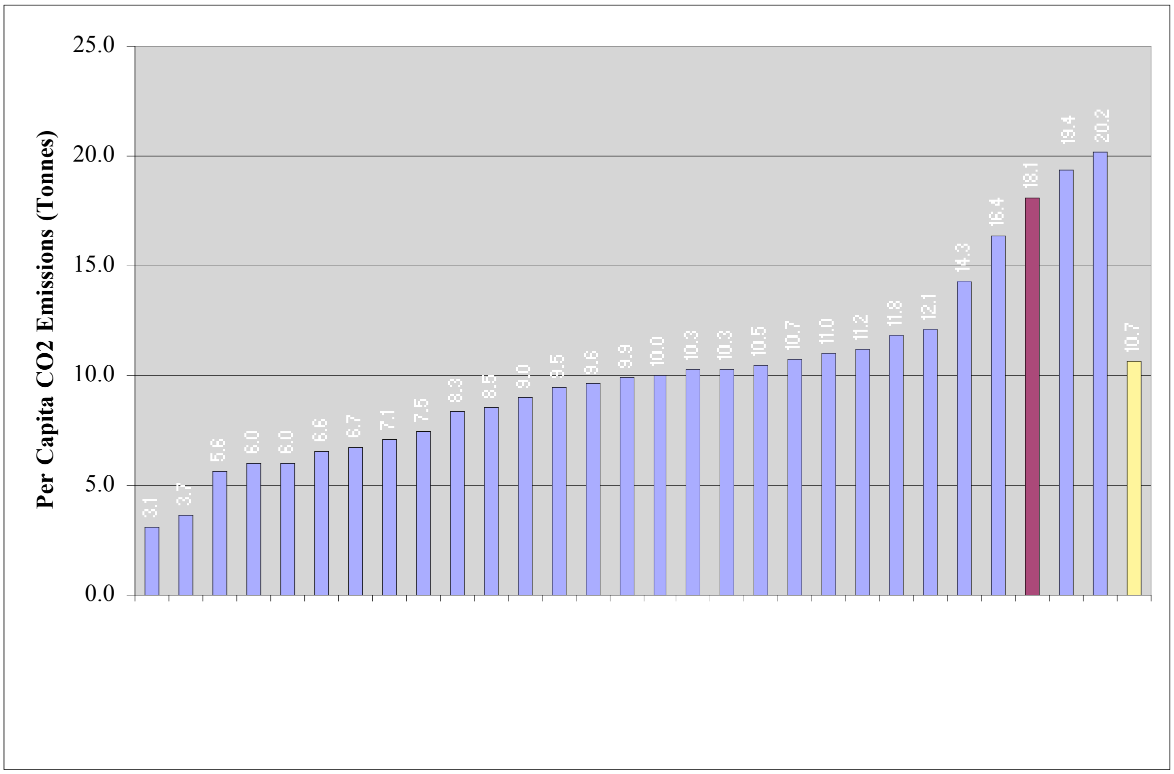
The following sections provide a brief overview of international and national trends for GHG emissions from transportation, followed by a more detailed review of GHG emissions from the Nova Scotia transportation sector.

Trends: International

When GHG emissions from all sources are compared across the OECD countries on a per capita basis, Canada has the third highest emissions out of the 30 OECD members, reflecting the country's high per capita rate of energy consumption (Figure 70). This is similar to its ranking in energy use for transportation (Figure 36 above), though the international comparison in Figure 70 below refers to CO_2 emissions from all sources. In 2004, Canada released about 70% more total CO_2 equivalent emissions per person than the OECD average of 10.66 tonnes of CO_2 equivalent emissions per person. The only two countries that had higher per capita emissions for 2004 were the United States and Australia.[192] Canada's per capita CO_2 emissions were more than double those of Sweden, France, and Italy.

[192] The OECD average of per capita emissions of CO_2 reported here includes Luxembourg despite it being excluded from Figure 70. There are 30 countries registered with the OECD. Figure 70 only includes 29 of these countries in order to optimize comparability. Luxembourg was excluded from this chart because its emissions are the result of unique policies and if included would skew the chart. It is a tiny country with low fuel taxes, and many motorists from other countries fill their tanks there.

Figure 70. OECD: Total Per Capita Emissions of CO_2 from all sources, 2004 (Tonnes of CO_2 equivalent emissions).



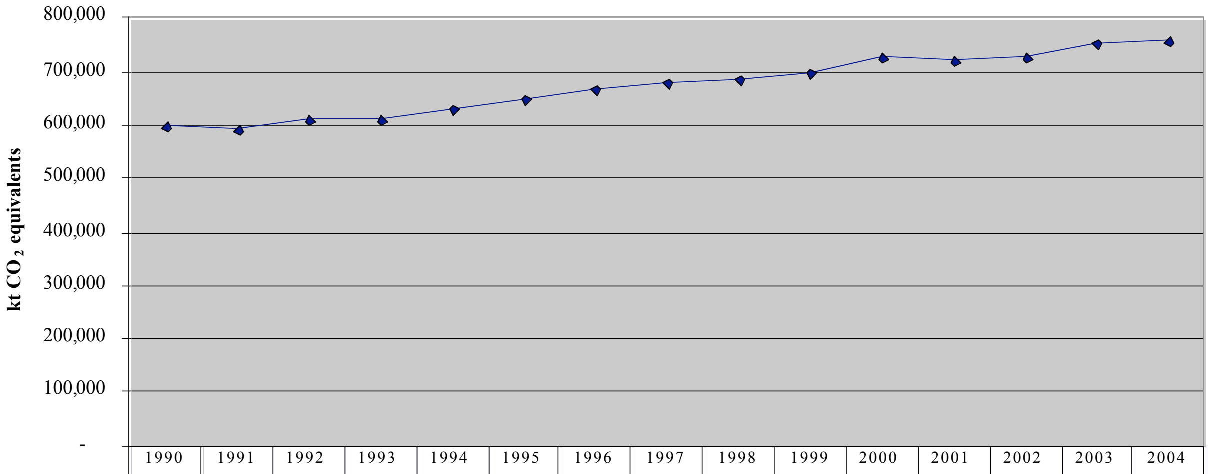
Source: Energy Information Administration. *International Energy Annual 2004 – Energy Related Carbon Emissions - Per Capita Emissions*. Table H.1cco2.

Trends: Canada

Between 1990 and 2004, Canada's GHG emissions (in total CO_2 equivalents) rose 26.5% (Figure 71). Since 1997, the year of the Kyoto Protocol, when Canada first agreed to reduce emissions to six percent below 1990 levels, GHG emissions have risen 11.5%. There was a marginal 0.8% drop in emissions from 2000 to 2001 (from 725,000 kt to 719,000), with emissions continuing to rise again in 2002 and after. According to Environment Canada, the decrease in emissions in 2001 was caused mainly by a reduction in travel due to the events of September 11, 2001—rather than as a result of government policies or public attitudes.[193]

[193] Olsen et al. (2003, p. 5).

Figure 71. Canada: Total GHG Emissions, 1990-2004 (kt of CO_2 equivalent emissions).



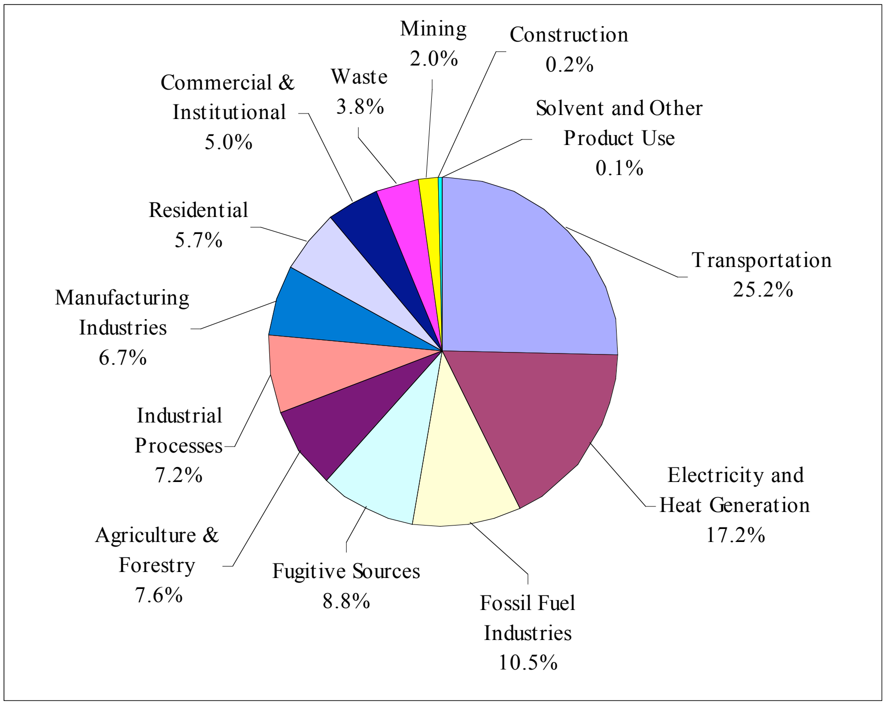
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Emissions	599,000	592,000	609,000	611,000	631,000	649,000	667,000	680,000	686,000	698,000	725,000	719,000	726,000	754,000	758,000

Source: Jaques, A. National Inventory Report 1990-2004, Annex 8.

The main source of Canada's GHG emissions is the energy sector, which in 2004 accounted for 82% of the national emissions total. The energy sector includes transportation combustion; stationary combustion from electricity and heat generation, fossil fuel industries, construction, manufacturing industries, the residential sector, the commercial and institutional sector, mining, agriculture and forestry; and fugitive sources from natural gas and coal mining. This sector is responsible for 91% of the 159,000 kt *increase* in total annual Canadian GHG emissions between 1990 and 2004, and three of the energy sources accounted for 65% of the increase. Electricity and heat generation accounted for 22% of the increase (34,700 kt); transportation for 25% (40,000 kt); and fossil fuel industries for 18% (26,000 kt). The main non-energy sources of greenhouse gas emissions in Canada—industrial processes, agriculture, waste management, land use change and forestry, and solvent and other product use—remained much more stable during the reference period.

The transportation sector itself is a major contributor to Canada's GHG emissions, and in North America generally is a significant source of CO_2 releases. The relative contribution of transportation to Canadian emissions totals depends on how the sectors are categorized. When the "Energy" category used by Environment Canada is separated into sub-categories (including Fugitive Sources; Electricity and Heat Production; Fossil Fuels and Mining; Manufacturing; Construction; and Residential), transportation is seen to be the single largest contributor to greenhouse gas emissions in Canada, accounting for one-quarter of all emissions (Figure 72).

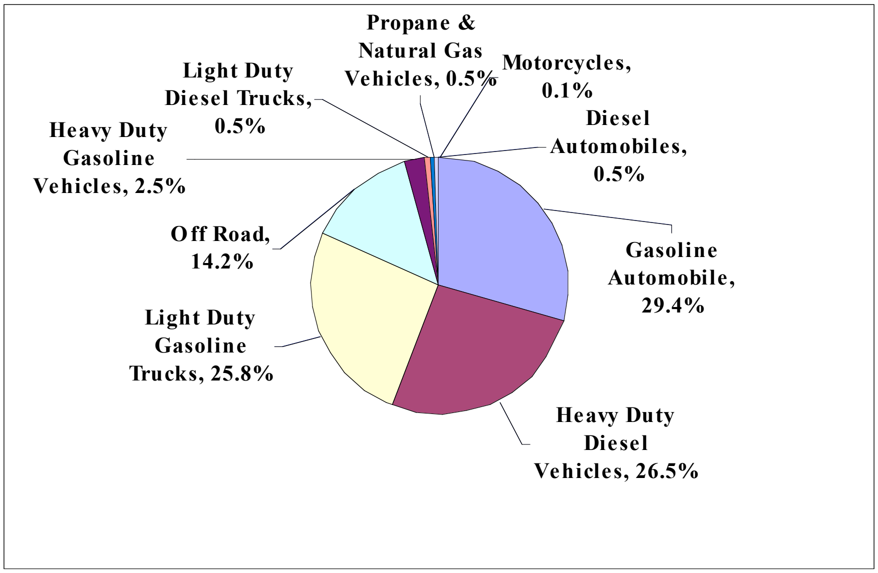
Figure 72. Canada: GHG Emissions, by Sector, 2004.



Source: Jaques, A. National Inventory Report 1990-2004, Annex 8.

Within Canada's transportation sector, use of road and off-road vehicles accounts for 89% of the 2004 national transportation GHG emissions. Of the emissions from vehicular use, 70% are from automobiles (29.9%); light-duty trucks (including vans and sport utility vehicles) (26.3%); and off-road vehicles (14.2%), which includes all vehicles not licensed to operate on roads (including snowmobiles, ATVs, and farm equipment) (Figure 73). Heavy-duty diesel vehicles contribute 26.5% of national road transportation GHG emissions, while the remaining 3.1% comes from categories such as propane and natural gas vehicles; motorcycles; heavy-duty gasoline vehicles; light-duty diesel trucks; and diesel automobiles.

Figure 73. GHG Emissions from Canada's Motor Vehicles, 2004, by Vehicle Category.

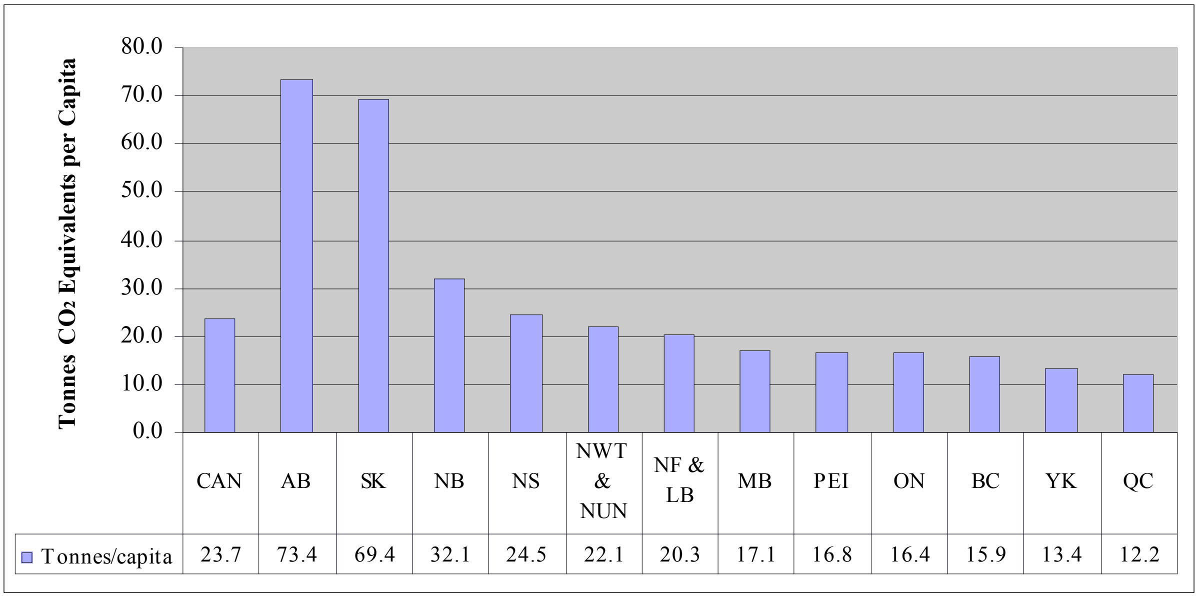


Source: Jaques, A. National Inventory Report 1990-2004, Annex 8.

Emission totals vary dramatically between provinces due to the distribution of natural resources, demographic variations, and the composition of industry within each province. For example, in absolute terms the three largest producers of GHG emissions nationally are Alberta, with 31% of total emissions (235,000 kt); Ontario, with 27% (203,000 kt); and Quebec, with 12% (91,800 kt). In comparison Nova Scotia was responsible for only 3% (23,000 kt) of national emissions in 2004.

However, on a per capita emissions basis, the provinces rank differently, as shown in Figure 74. Alberta is still highest—but Saskatchewan is second. Ontario ranks ninth and Quebec has the lowest per capita GHG emissions in the country. Nova Scotia ranks fourth in per capita emissions, with 24.5 tonnes per capita, which is 3.4% above the Canadian average of 23.7 tonnes per capita.

Figure 74. Canada: GHG Emissions (Tonnes CO_2 equivalents per capita), by Province, 2004.



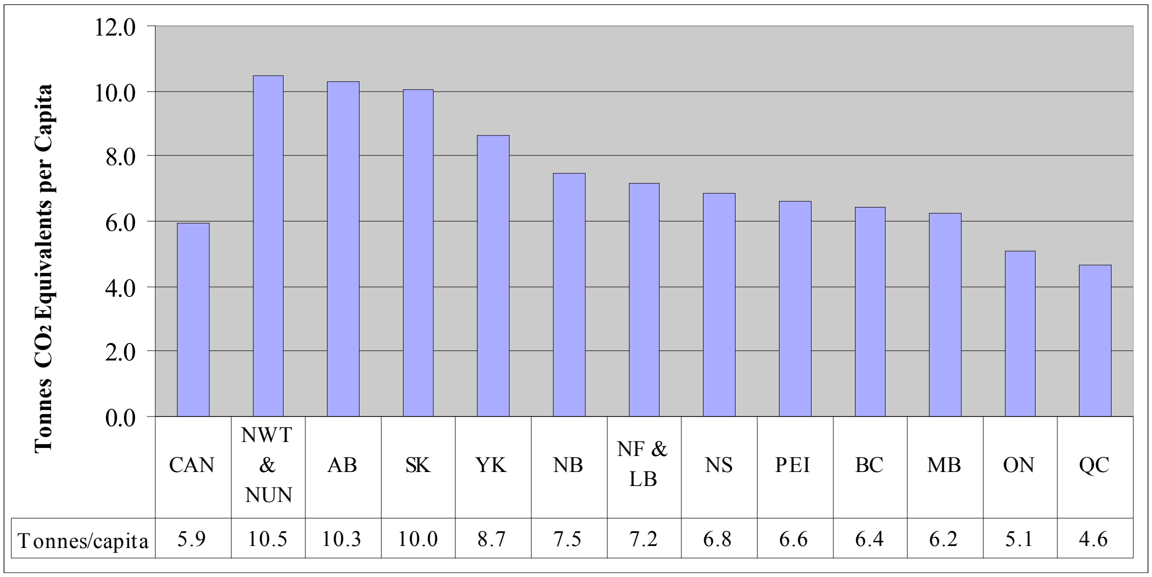
Sources: Jaques, A. *National Inventory Report 1990-2004*, Annexes 8 and 12; and Statistics Canada. CANSIM Table 051-0001.

Alberta's very high per capita emissions (three times the national average) are linked to its abundance of fossil fuels (which are the source of high fugitive emissions from the processing of oil and natural gas) as well as the heavy reliance of its electricity system on coal.[194] Saskatchewan's industrial composition and electricity system are similar to those of Alberta. By contrast to these provinces, Quebec has the lowest provincial per capita emissions of GHGs in the country (about half the national average and about one-sixth those of Alberta), due in large part to its use of hydro, rather than petroleum, as the primary means of generating electricity.[195]

Provincial rankings of transportation–related GHG emissions per capita are somewhat similar to per capita emissions totals, as shown in Figure 75. The Northwest Territories have the highest transportation-related GHG emissions per capita; Alberta and Saskatchewan are second and third. Ontario and Quebec have the two lowest transportation-related emissions per capita. Nova Scotia has the seventh highest GHG emissions per capita, with 6.8 tonnes per capita, which is 15% above the national average of 5.9 tonnes per capita. According to Environment Canada, GHG emissions from transportation are driven primarily by energy used for personal transportation.[196] The provinces with higher emissions per capita, most likely have a higher proportion of light-duty gasoline trucks per capita, which emit on average 40% more GHGs per kilometre than gasoline automobiles.[197]

[194] Olsen et al. (2003, p. 172 ff.).
[195] Ibid., p. 165.
[196] Matin et al. (2004, p. 24)
[197] Ibid. pp 24-25.

Figure 75. Canada: Transportation Related GHG Emissions (Tonnes CO_2 equivalents per capita), by Province, 2004.



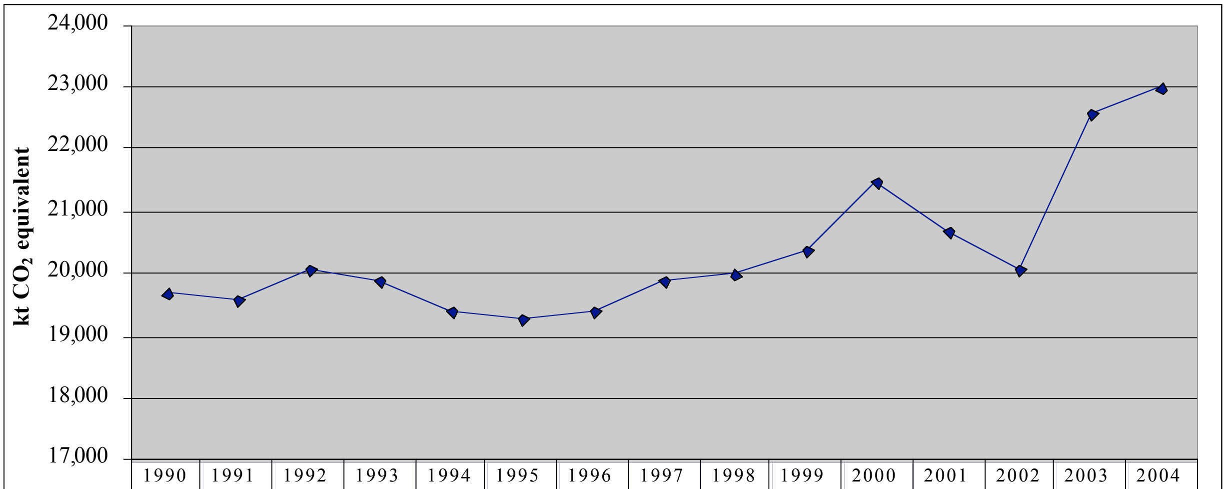
Sources: Jaques, A. *National Inventory Report 1990-2004*, Annexes 8 and 12; and Statistics Canada. CANSIM Table 051-0001.

Trends: Nova Scotia

Nova Scotia's annual GHG emissions climbed 16.8% between 1990 and 2004 (Figure 76). The single largest increase in emissions over this period was the 12% (2,500 kt) rise between 2002 and 2003. This increase, between 2002 and 2003, was due to a large increase in emissions from stationary sources (1,900 kt) and transportation (600 kt).

This rise in emissions is clearly a movement away from sustainability. The province has considerable work to do to match Canada's Kyoto target for emissions (a reduction, by 2008-2012, to six percent below the 1990 level). To attain this target, Nova Scotia must lower its emissions by a total of 4,482 kt, or an average decrease of 896 kt per year every year between 2006 and 2010. If the 800 kt decrease achieved between 2000 and 2001 is any measure of what is possible to achieve annually, then with continuous and cumulative 900 kt/year decreases until 2010, Nova Scotia could reach and surpass this Kyoto goal.

Figure 76. Nova Scotia: GHG Emissions, 1990-2004 (kt of CO_2 equivalent emissions).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Emissions	19,700	19,600	20,100	19,900	19,400	19,300	19,400	19,900	20,000	20,400	21,500	20,700	20,100	22,600	23,000

Source: Jaques, A. National Inventory Report 1990-2004, Annex 12.

Table 16 shows, by economic sector, the kilotonnes of CO_2 equivalent emissions produced in Nova Scotia in 2001. Energy production and consumption in 2001 accounted for 81% of GHG emissions nationally, and 92% of emissions in Nova Scotia. This is because the province is heavily dependent on fossil fuels for its energy sources, while hydro power is much more dominant in other parts of Canada.

Nova Scotia Power Incorporated—the company responsible for 97% of the power generation in the province—relies on coal for 55% of its generating capacity, and on oil and natural gas for 27% of its capacity; only 18% of capacity comes from hydro or wind power. When the actual sources of electricity generation in the province are examined, rather than generating capacity, the reliance on fossil fuels is even greater, with 75% of actual production attributable to coal, 12% to oil, and only nine percent to renewables. The remaining 4% is from independent power producers and/or electricity imports (3%) and from natural gas (1%).[198]

The transportation sector is the second largest emitter of GHGs in Nova Scotia, after electricity and heat generation. Transportation accounted for 27% of total GHG emissions in Nova Scotia in 2001, and electricity and heat generation for 42%. For the reasons noted above, this breakdown is very different from the 2004 national portrait, where 25% of emissions are attributable to transportation (the largest source) and 17% to electricity and heat generation.

[198] Emera, Inc. *2003 Annual Report*, p. 21. (2004). www.emera.com/investors/AR/EmeraAnnualReport2003.pdf Accessed December, 2004.

Table 16. Nova Scotia: GHG Emissions, by Sector, 2001.[199]

GREENHOUSE GAS CATEGORIES		2001 KT CO_2 E	Percent of Total
TOTAL		20,900	100%
Stationary Combustion Sources			
	Electricity and Heat Generation	8,710	41.67
	Fossil Fuel Industries	819	3.92
	Mining	46	0.22
	Manufacturing Industries	516	2.47
	Construction	37	0.18
	Commercial & Institutional	1,070	5.12
	Residential	1,870	8.95
	Agriculture & Forestry	135	0.65
Transportation Combustion Sources			
	Domestic Aviation	438	2.10
	Road Transportation	4,030	19.28
	Railways	72	0.34
	Domestic Marine	536	2.56
	Other Transportation (off-road; pipelines)[200]	583	2.79
Fugitive Sources			
	Coal Mining and Natural Gas	473	2.26
TOTAL ENERGY SOURCES		19,300	92.34
INDUSTRIAL PROCESSES		263	1.26
AGRICULTURE		591	2.83
WASTE MANAGEMENT		718	3.44
Solvent & Other Product Use; Land Use Change & Forestry		16	0.08
TOTAL		**20,900**	**100%**

Source: Olsen et al. Canada's Greenhouse Gas Inventory 1990-2001, Annex 10.[201]

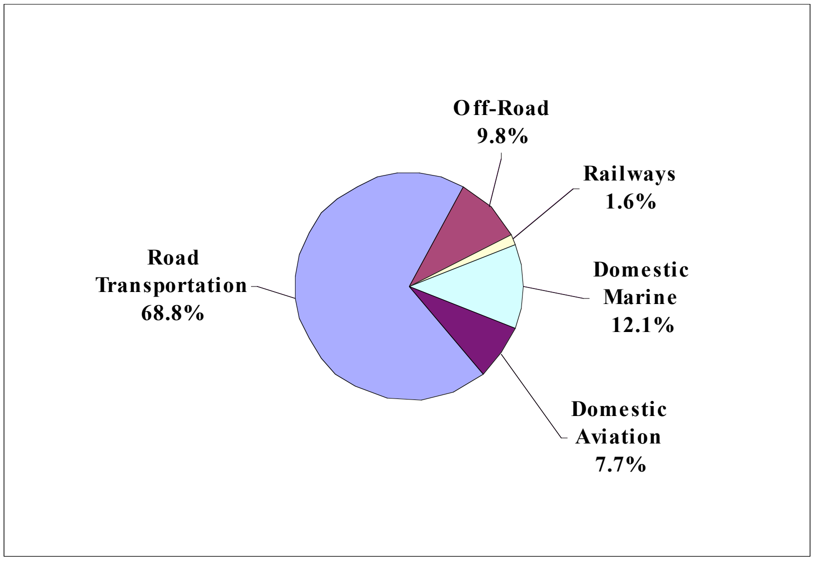
[199] More recent figures were not used for this portion of the analysis because, starting in 2002, specific emissions statistics were no longer provided by federal government agencies for the Electricity and Heat Generation; Mining; and Agriculture and Forestry sectors, due to new privacy and confidentiality regulations. Thus the 2001 data were more comprehensive and useful for analysis than the newer statistics. These data issues are discussed in detail in the GPI Energy Accounts, available at www.gpiatlantic.org, where missing 2002 and 2003 data are derived using supplementary sources.

[200] According to Environment Canada, oil and gas pipelines can be considered a form of "non-vehicular transport." (Matin et al., op. cit., p. 24).

[201] Totals may not correspond exactly to sums of numbers in the table, due to rounding. In order to avoid double-counting, residential energy use excludes both residential transportation use (counted under Transportation) as well as the emissions resulting from electricity generation. Clearly a change in household behaviour and a reduction in residential energy use and GHG emissions could also reduce emissions in these other sectors.

A breakdown of the 2004 Nova Scotia transport-related GHG emissions total reveals that the use of road vehicles (69%) and off-road vehicles (10%) accounted for 79% of Nova Scotia's transportation emissions (Figure 77).

Figure 77. Nova Scotia: GHG Emissions from Transportation, 2004.



Source: Jaques, A. National Inventory Report 1990-2004, Annex 12.

In 1990, road and off-road GHG emissions accounted for 78% of overall transportation emissions in Nova Scotia (Table 17). In other words, the proportion of transportation emissions from road and off-road vehicles increased by 1 percentage point between 1990 and 2004, with emissions from marine, rail and air transportation also on the rise. While Chapter 2 pointed to an anomalous 2002 decline in marine shipments and energy use, Halifax Port activity and marine energy use climbed sharply after 2002, which explains the rise in marine GHG emissions noted here. Had 2002 been taken as the end year in Table 17 below, as it was in Chapter 2 above, GHG emissions would have shown an 18% decline from 1990. This indicates that energy use suddenly went up again after the 2002 slump noted earlier.

Table 17 provides a comparison of the GHG emissions from different modes of transportation in Nova Scotia in 1990 and 2004. The largest absolute change was the 750 kt increase in road transportation emissions (up 21%), and the largest relative changes were the 68% increase in off-road emissions and the 43% increase in railway emissions. Both domestic marine and air transport also saw large increases (26% and 23%, respectively). Total transport-related GHG emissions grew by 25% from 1990 to 2004.

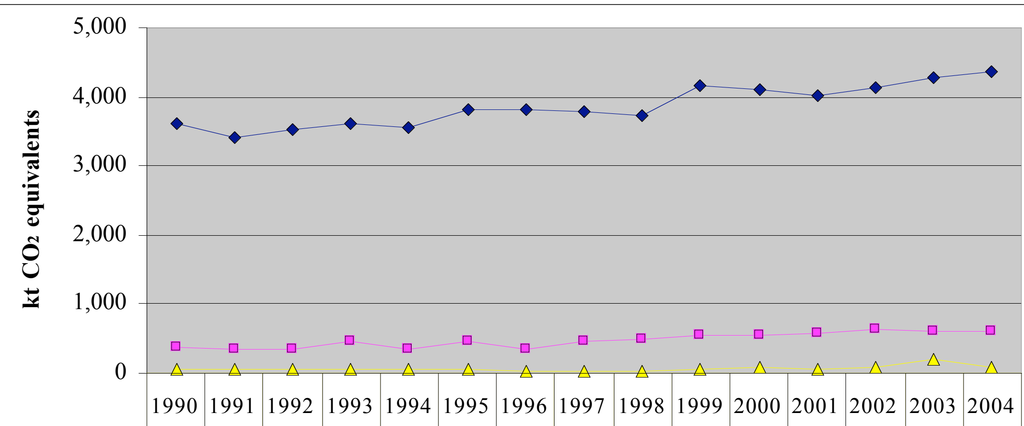
Table 17. Nova Scotia: Transportation GHG Emissions, by Mode, 1990 and 2004 (kt of CO_2 equivalent emissions).

NOVA SCOTIA TRANSPORT-RELATED GHG EMISSIONS			
MODE OF TRANSPORTATION	**1990 (kt)**	**2004 (kt)**	**Percent Change**
Road	3,610	4,360	21%
Domestic Marine	610	770	26%
Domestic Aviation	400	490	23%
Off-Road	370	620	68%
Railway	70	100	43%
TOTAL	**5,100**	**6,400**	**25%**

Source: Jaques, A. National Inventory Report 1990-2004, Annex 12.

Figure 78 shows the GHG emission trends in road, off-road, and rail transportation from 1990 to 2004. This illustrates the overwhelming and growing dominance of GHG emissions from road transport, the dramatic increase in off-road emissions from 7.2% of total transportation emissions in 1990 to 9.7% in 2004, and the still negligible contribution of rail emissions (1.6% of total emissions).

Figure 78. Nova Scotia: Road, Off-road and Rail GHG Emissions, 1990-2004 (kt of CO_2 equivalent emissions).



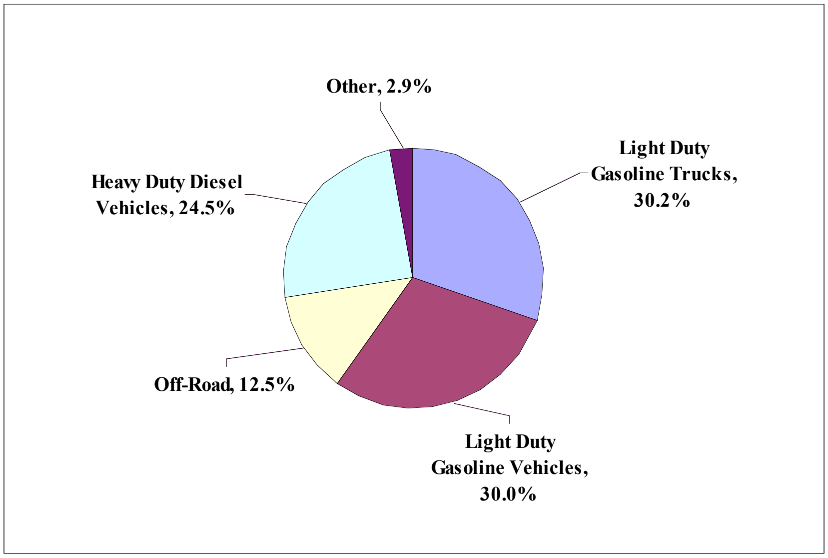
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Road	3,610	3,410	3,520	3,620	3,550	3,820	3,820	3,780	3,740	4,160	4,100	4,010	4,120	4,290	4,360
Off-Road	370	360	350	450	340	450	340	470	500	540	550	590	650	620	620
Railway	70	50	60	60	60	50	30	40	40	60	80	70	80	200	100

Source: Jaques, A. National Inventory Report 1990-2004, Annex 12.

When the data on 2004 emissions from road transportation alone are broken down, 73% of emissions are seen to be from gasoline automobiles (30%), light-duty trucks (30%) and off-road vehicles (12.5%), while 25% are from heavy-duty diesel vehicles used to carry freight (Figure

79). The category of "Other" in Figure 79 denotes: heavy-duty gasoline vehicles; diesel automobiles; light-duty diesel trucks; motorcycles; and propane and natural gas vehicles. This break-down is similar to that at the national level noted above.

Figure 79. Nova Scotia: Road and Off-Road GHG Emissions, by Vehicle Type, 2004.

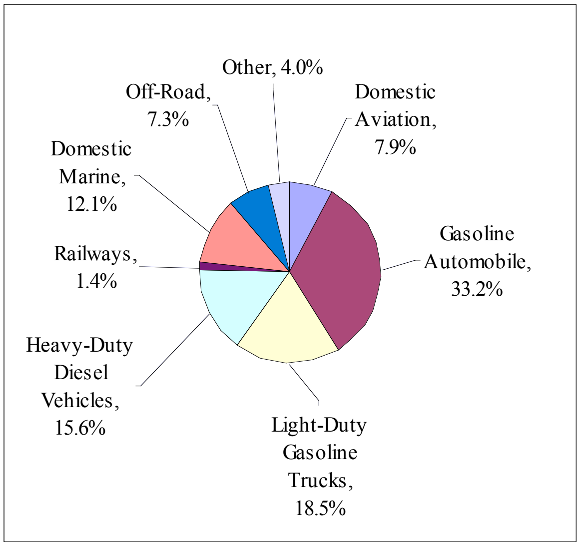


Source: Jaques, A. National Inventory Report 1990-2004, Annex 12.

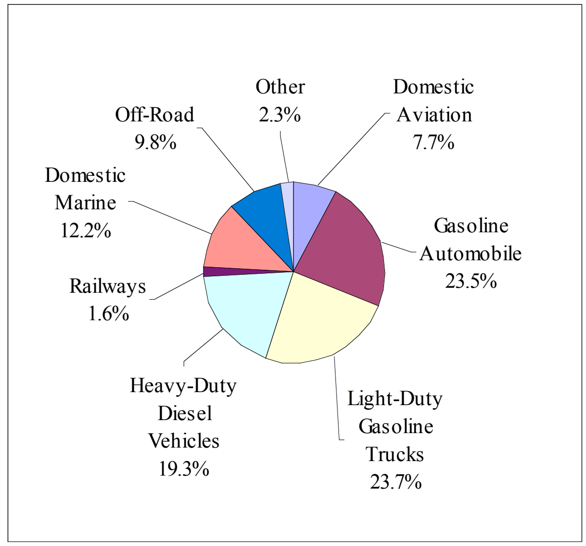
The two charts in Figure 80 present a more detailed analysis of the change in transportation emissions from 1990 to 2004. Here, "Other" refers to: heavy-duty gasoline vehicles; motorcycles; diesel automobiles; propane and natural gas vehicles; and light-duty diesel trucks.

Figure 80. Nova Scotia: GHG Emissions from Transportation (1990 and 2004), by Mode and by Vehicle Type.

1990



2004



Source: Jaques, A. National Inventory Report 1990-2004, Annex 12.

In 1990 light-duty trucks including SUVs represented 18.5% of all GHG emissions from transportation. By 2004, they accounted for 23.7% of all transport-related emissions. In 1990 cars accounted for a third of all transport-related GHG emissions. In 2004 that was down to less than a quarter (23.5%) (Figure 80 above). These trends again show the growth in more energy-intensive and less sustainable forms of passenger road transportation that have greater environmental impacts.

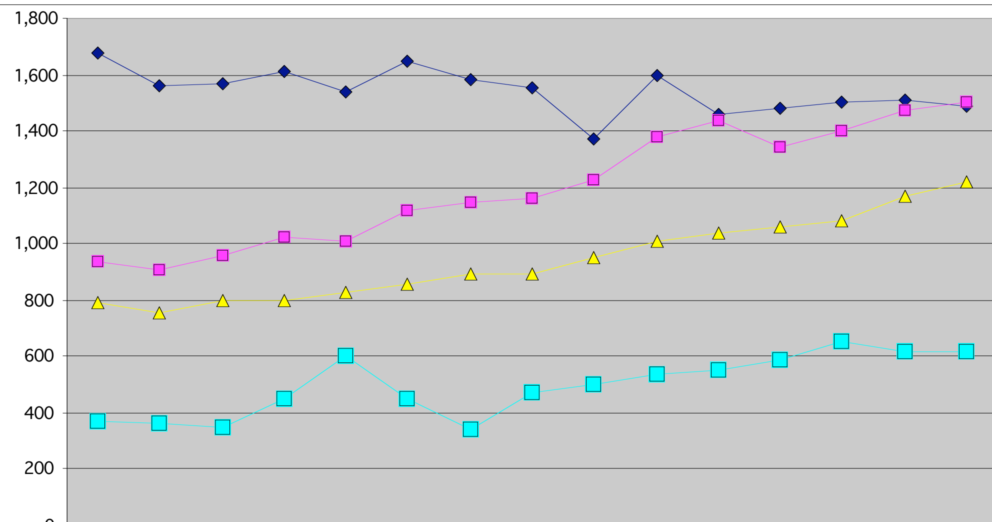
Changes in emission levels over time for the dominant vehicle types are illustrated by Figure 81. Between 1990 and 2004 there was an 11% decrease in GHG emissions from gasoline automobiles, a 60% increase in emissions from light-duty gasoline trucks (a category which includes vans and SUVs), and a 68% increase in emissions from off-road vehicles (Figure 81 below). These changes in passenger transportation emissions reflect the sharp increase in SUVs, minivans, light trucks, snowmobiles, and all-terrain vehicles in Nova Scotia.

The sharp increase in light duty truck emissions demonstrates that the North American trends regarding a consumer preference for SUVs and vans (discussed in the indicator on transport activity above) are having a direct impact on Nova Scotia's GHG emissions. Although light duty trucks (including SUVs, minivans and pick-up trucks) account for 29% of the passenger-kilometres travelled in Nova Scotia compared to 65% for cars (Figure 25 above), they emit about the same quantity of greenhouse gas emissions. In fact, in 2004, for the first time, GHG emissions from light trucks actually surpassed GHG emissions from cars. This illustrates that every SUV in Nova Scotia accounts for about twice the greenhouse gas emissions of the average car and about three times the emissions of a small car. In 1990, with fewer SUVs and vans on the road, car emissions exceeded light duty truck emissions by 78%. The gap steadily narrowed through the 1990s with the growing numbers of SUVs on the road, and by 2000, emission levels for cars and light duty trucks were almost identical.

Between 1990 and 2004 there was also a 54% increase in GHG emissions from heavy-duty diesel vehicles, reflecting greater use of trucking for freight in Nova Scotia (Figure 81 below). In 1990, heavy diesel trucks accounted for 15.6% of all transport-related GHG emissions. By 2004, they accounted for 19.3% of all transport-related emissions (Figure 80 above). This shift to trucking has also been noted on a national level in Canada.

The CST mentions this development and states that the rise in trucking activity in recent years "has been extraordinary."[202] The CST concludes that altering the way in which trucks are used and operated in Canada to shift towards more multi-modal freight patterns that effectively combine truck and rail transport could significantly reduce not only the energy consumed by this industry but also the amount of greenhouse gases it emits. The Railway Association of Canada notes that "on average, in 1999 truck generated 12 times as much GHG emissions as rail per tonne-kilometre."[203]

Figure 81. Nova Scotia: GHG Emissions from Passenger and Freight Vehicles, 1990-2004 (kt of CO_2 equivalent emissions).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Gasoline Automobile	1,680	1,560	1,570	1,610	1,540	1,650	1,580	1,550	1,370	1,600	1,460	1,480	1,500	1,510	1,490
Light-Duty Gasoline Trucks	939	908	956	1,020	1,010	1,120	1,150	1,160	1,230	1,380	1,440	1,340	1,400	1,470	1,500
Heavy-Duty Diesel Vehicles	790	757	797	800	826	854	896	894	951	1,010	1,040	1,060	1,080	1,170	1,220
Off-Road	370	360	350	450	600	450	340	470	500	540	550	590	650	620	620

Source: Jaques, A. National Inventory Report 1990-2004, Annex 12.

[202] Centre for Sustainable Transportation. (June, 2004).
[203] Railway Association of Canada. *Trends in Freight Energy Use and Greenhouse Gas Emissions, 1990-1999,* p.6. (2001). www.railcan.ca/documents/publications/131/TrendsInFreightEnergyUse_en.pdf Accessed December, 2004.

During the period 1990-2004, as noted above, there was also a 26% increase in GHG emissions in the much more energy efficient marine transport sector, and a 23% increase in the highly energy-intensive air transport sector in Nova Scotia. The 26% increase in marine transport emissions is largely due to the sudden rise in marine energy use since 2002, an anomalous year in marine freight trends, due to a 7.6% decrease in total tonnage handled at the Port of Halifax that year as a result of decreased shipments of crude petroleum from Europe and South America. This increase resulted in a 54% increase in marine-related GHG emissions in 2004, relative to the low energy use and low emissions year of 2002. The relative shares of total transport-related emissions did not change for marine and air transport between 1990 and 2004 despite the increased emissions from both sectors, because ***total*** transport-related emissions also increased by 25% during this period (Figures 82 and 83 below). Thus marine transport constituted 12% of all transport-related GHG emissions both in 1990 and 2004 and air transport accounted for 8% of all transport-related emissions both in 1990 and 2004 (Figure 80 above).

There was also a 50% decrease in GHG emissions from heavy-duty gasoline vehicles, a 45% decrease in propane and natural gas vehicle emissions, and a 27% increase in light-duty diesel truck emissions. While some of these modes (which are all classified as part of the "other" category in Figure 80 above) showed reductions in emissions, the combined total from all these three vehicle types constituted only 1.5% (98 kt) of the overall emissions from the transportation sector in 2004. Compared to the more than 4,200 kt of CO_2 equivalent emissions from gasoline automobiles, light duty gasoline trucks (including SUVs), and heavy duty diesel trucks in Nova Scotia in 2004, the significance of the decline in emissions from these other vehicle classes is slight.

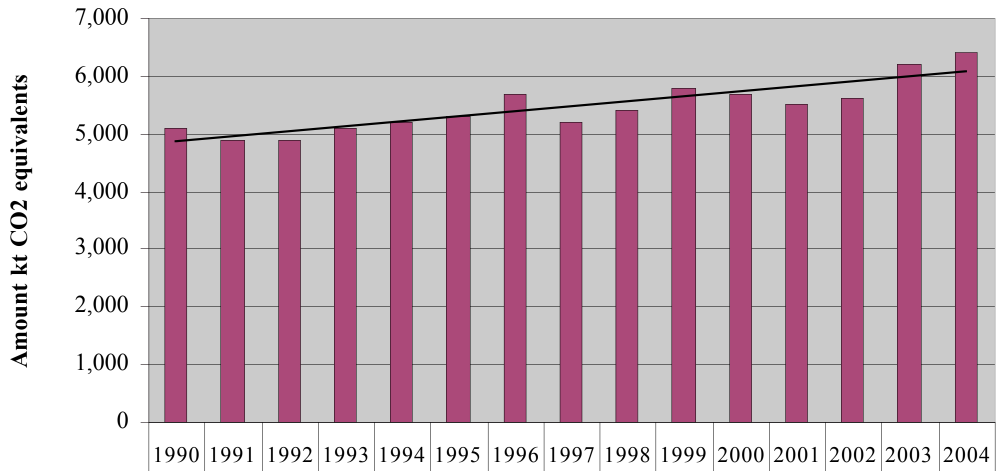
Conclusion

This analysis indicates that greenhouse gas emissions from a number of transport-related sources are increasing both in the province of Nova Scotia and in Canada generally. The international comparison in Figure 70 shows that Canada produces considerably higher per capita GHG emissions from all sources than all other OECD countries except the US and Australia. As well, overall GHG emissions in Canada are increasing (Figure 71), with the transportation sector responsible for 25% of GHG emissions in 2004 (Figure 72).

Overall, Nova Scotia's total greenhouse gas emissions have also been increasing since 1990, though the growth pattern has been more uneven than at the national level. There were declines in emissions between 1992 and 1995 and again between 2000 and 2002, and periods of sharp growth between 1995 and 2000, as well as 2002-2003 (Figure 76). Nova Scotia's transportation sector contributed 28% (6,400 kt) of the total GHG emissions for 2004, with road transportation responsible for the majority of these releases (68% or 4,360 kt). Figure 82 presents the indicator for Nova Scotia's GHG emissions from transportation, and shows that the overall trend, accounting for fluctuations, has been increasing over the past 15 years of recorded data.

Figure 83 further illustrates the year-to-year changes in GHG emissions during this period with 1990 values normalised to 100. With both of these figures illustrating a general 25% increase in transport-related GHG emissions over time, it is clear that the Nova Scotia transportation sector is not moving towards sustainability in this regard.

Figure 82. Nova Scotia: GHG Emissions from Transportation, 1990-2004 (kt of CO_2 equivalent emissions).

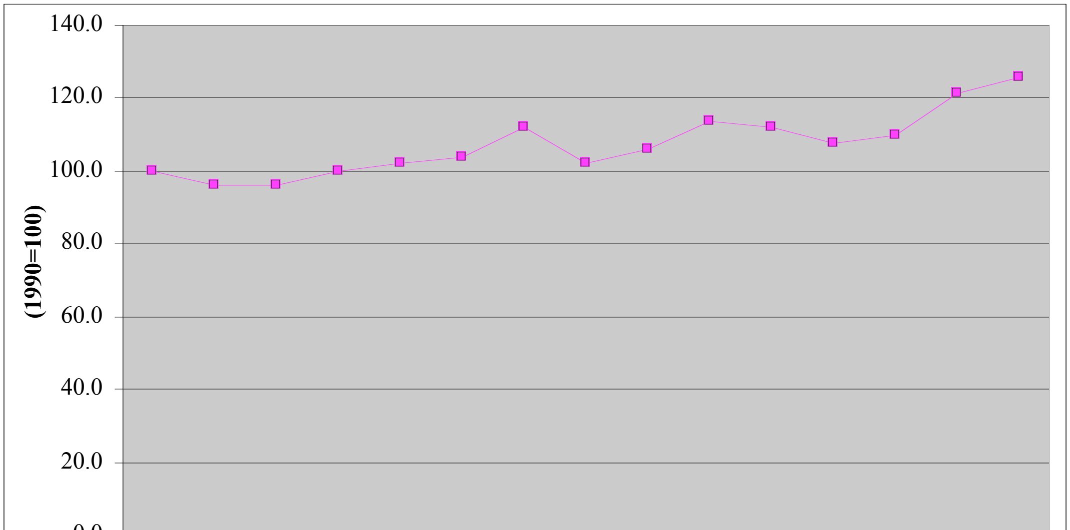


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Emissions	5,100	4,900	4,900	5,100	5,200	5,300	5,700	5,200	5,400	5,800	5,700	5,500	5,600	6,200	6,400

Source: Jaques, A. National Inventory Report 1990-2004, Annex 12.

Note: The black line above represents the trendline calculated by regression analysis.

Figure 83. Nova Scotia: GHG Emissions from Transportation, 1990-2004. (Normalized to 1990 = 100).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Emissions	100.0	96.1	96.1	100.0	102.0	103.9	111.8	102.0	105.9	113.7	111.8	107.8	109.8	121.6	125.5

Source: Jaques, A. National Inventory Report 1990-2004, Annex 12.

The rise in greenhouse gas emissions from the Nova Scotia transportation sector can be attributed to a number of factors. In 2002, 45% of Nova Scotian households owned a single car, truck or van, while 35% of households owned two or more such vehicles.[204] This is comparable to the Canadian average of 44% of households with one vehicle, and 36% with more than one. The number of new motor vehicles sold in Nova Scotia has remained consistent over the past five years (1999-2003), with 46,360 units sold in 2003.[205] Total vehicle registrations in Nova Scotia have been increasing annually, from 593,727 in 1999 to 643,509 in 2003.[206] There has also been a nearly 29% expansion in the number of licensed drivers in Nova Scotia over the past 10 years, with 611,358 registered in 1993, and 788,277 registered in 2003.[207] These trends, along with the overall increase in passenger-kilometres travelled in the province (chapter one above) reflect the overall growth in transport activity in the province, which has contributed to the increase in transport-related GHG emissions.

The above statistics indicate how many drivers and vehicles there are in Nova Scotia. To understand GHG emission trends, it is also important to consider how these vehicles are used. One important measure of vehicle use is commuting statistics. Of Nova Scotians travelling to

[204] Nova Scotia Department of Finance. *Nova Scotia Statistical Review 2004*, page 44. (Halifax: 2004). www.gov.ns.ca/finance/publish/statsrev/2004/sr2004.pdf
[205] Nova Scotia Department of Finance. (2004, p. 166).
[206],Ibid., p. 172.
[207] As determined by the total number of licenses issued and renewed during the fiscal year 2002-2003. Sources: Ibid., page 174; and *Nova Scotia Statistical Review 1999*, p. 90. (Halifax: 1999). www.gov.ns.ca/finance/publish/statsrev/strev99.pdf

work in 2001, 75% (280,365) drove a car, truck, or van, while an additional 9.6% (35,870) were passengers in cars, trucks, or vans.[208] These vehicles covered a median commuting distance of 7.8 km, with 37% of commuters travelling less than five km to their workplace. The significantly high proportion of Nova Scotians commuting in cars, trucks, or vans is in stark contrast to the number of commuters who walk to work (8.3%); use public transit (4.8%); or bicycle (0.6%). These transportation patterns and behaviours, showing a very heavy dependence on private motorized vehicles (85% of all commuters) for commuting to work and school, have a significant impact on overall greenhouse gas emissions in the province.

Although the number of vehicles in Nova Scotia is gradually increasing, the effect of the increase is compounded because so many of the extra vehicles being driven are of the type that has a greater impact on GHG emissions. As noted earlier, the impact on the environment of one SUV is about three times that of a small car.[209] Figures 80 and 81 show the increased reliance on light-duty gasoline trucks (including SUVs and vans) for personal transportation, which in turn is responsible for a growing proportion of the GHG emissions from the transportation sector in Nova Scotia. Also as noted, the shift to greater reliance on trucking and heavy-duty diesel vehicles to move freight, and the growing number of off-road vehicles such as ATVs, are also contributing significantly to the increase in provincial transport-related GHG emissions (Figure 81).

These patterns in Nova Scotia mirror the trends that are occurring on a greater scale across North America. Surveying transportation issues in the US and Canada over the past three decades, the United Nations Environment Programme observed that:

> Much of the decline in fuel economy since the late 1980s has resulted from the increasing market share of light trucks and Sport Utility Vehicles (SUVs). Most SUVs are used for everyday driving and even though North American family sizes have been decreasing, there has been a marked trend toward this type of larger passenger vehicle.[210]

In North America, 45% of the rise in greenhouse gas emissions from the automotive sector between 1990 and 1999 was due to rapid growth in sales of minivans, SUVs, and pickup trucks.[211] A recent Scotiabank analysis noted that while recent gas prices have increased, sales of the largest class of SUVs have continued to grow globally.[212] The rising gas prices had an even smaller impact on American light truck purchases. Continuing gas price increases may soon change this pattern.

In both Nova Scotia and Canada, the growing reliance on moving freight by truck, rather than by more sustainable forms of transportation such as rail, is a concern in terms of greenhouse gas

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208 Nova Scotia Department of Finance. (2004, p. 62), citing 2001 Census statistics.
209 Wilson et al. (2001, p. 51).
210 Peterson, Jane (editor). *North America's Environment: A Thirty-Year State of the Environment and Policy Retrospective*, p. 21. (Nairobi: United Nations Environment Programme, 2002). http://grid2.cr.usgs.gov/publications/NA/NorthAmerica.pdf
211 Lalonde, Michelle. "Vehicles, Environment Linked." (Montreal: *The Gazette*. June 16, 2001).
212 Scotiabank Group. Global auto sales to edge higher in 2005, says Scotiabank economist. (Toronto: Scotiabank Economic Report News Releases. December 30, 2004). http://micro.newswire.ca/release.cgi?rkey=1212309039&view=40582-0&Start=0. Accessed January, 2005.

emissions. The evidence indicates that the trucking industry faces specific challenges related to GHG emissions. Assessing trends in energy efficiency, Natural Resources Canada found that: "Despite actions taken by the trucking industry to improve energy efficiency and air quality (air contaminant emissions control) through improved engines and better quality fuel, trucks are still the fastest growing GHG emitter of all vehicle types."[213]

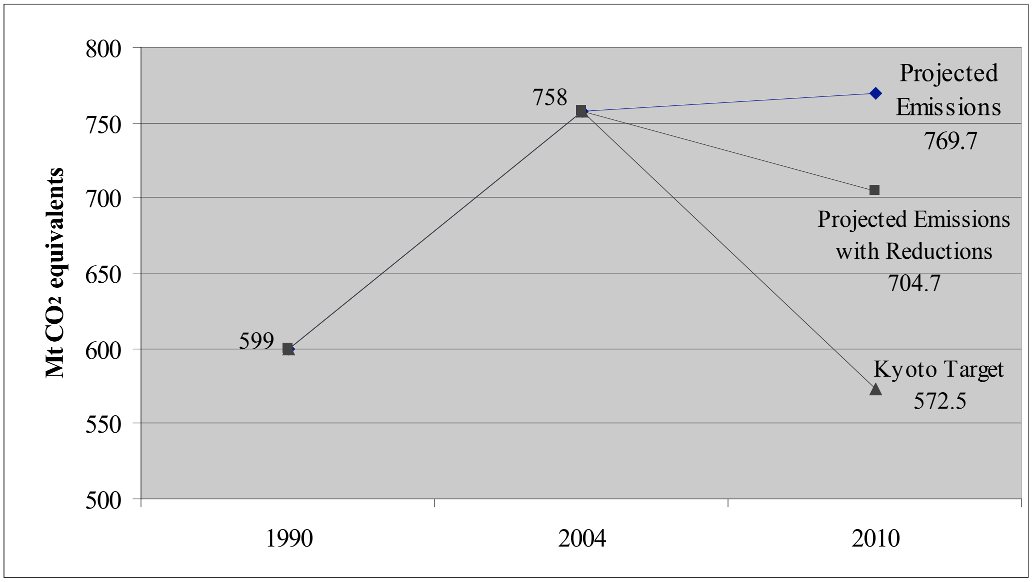
The trends observed here will make the agreed targets of the Kyoto Protocol more difficult to achieve. If Canada is to attain the reductions outlined in the agreement, it will have to improve drastically on the small cuts made in the past (e.g. between 2000 and 2001), and then maintain them yearly through 2010.

Figure 84 highlights this challenge by comparing overall Canadian GHG emissions in 2004 with the projected emissions in 2010 (based on current trends), along with the Kyoto targets, and a scenario for emission levels based on future anticipated reductions. The "projected emissions with reductions" scenario is based on modelling that was done by the Canadian government and submitted to the United Nations Framework Convention on Climate Change.[214] This projection includes the efforts that would be initiated and implemented by the Canadian government to reduce GHG emissions in the period up to 2010. This chart clearly outlines the challenges that Canada must overcome to meet the established Kyoto targets, and the inadequacy of efforts and results to date.

Nova Scotia faces a similar challenge in contributing to Canada's reduction of GHG emissions. While the province has experienced a number of year-to-year declines in GHG emissions (e.g. 1992-1995 and 2000-2002—see Figure 76), overall emissions continued to rise during the 1990-2004 reference period, and there is still much work to be done to reduce emissions below 1990 levels and to set the province, and its transportation sector in particular, on a sustainable path.

[213] Ramsum et al. (2004a, p. 35).
[214] United Nations Framework Convention on Climate Change. *National Communications from Parties Included in Annex I to the Convention—Compilation and Synthesis of Third National Communications—Projections*, p. 21. (2003). http://unfccc.int/resource/docs/2003/sbi/07a03.pdf Accessed December, 2004.

Figure 84. Canada: Current Annual Emissions Trends, Forecast Emissions with Projected Reductions, and Kyoto Protocol Commitment Levels (Mt of CO_2 equivalent emissions).



Sources: UNEP/GRID-Arendal. Greenhouse Gas Emissions from Annex I Countries;[215] and Jaques, A. *National Inventory Report 1990-2004*, Annex 12.

The Kyoto Protocol has been criticized for being ineffective, since its targets would only result in a modest reduction in anthropormorphic (human induced) influences on climate change. However, it can be considered a small first step in achieving needed greenhouse gas reductions, even though such an achievement does not meet the CST and EU definitions of sustainable transportation, which include "*limiting emissions and waste within the planet's ability to absorb them.*" (see Part 1 above). Due to the fact that GHGs can persist in the atmosphere for 100-200 years and the strong scientific evidence accumulated by the UN Intergovernmental Panel on Climate Change (IPCC) that global warming has already begun, the only truly "sustainable" level of emissions for the next century is nil. Potentially this would allow the effects of past releases to reach their zenith and then decline safely.

Although the ideal of zero emissions is impossible to meet, it helps to demonstrate that even significant emission reductions of 50% below current release rates would not achieve a genuinely sustainable level of emissions, as defined by both the EU and the CST. As the IPCC noted, such drastic cuts would still result in further global warming, an almost 50% increase in atmospheric GHG concentrations over current levels, and a stabilization of atmospheric GHG concentrations at nearly twice the pre-industrial levels. Nevertheless, cutting emissions by half would certainly constitute a significant step in the direction of sustainability that goes far beyond the Kyoto targets. Given that transportation is the single largest emitter of greenhouse gases Canada-wide, and the second largest emitter in Nova Scotia, it is clear that significant changes must occur in this sector if the country and the province are to begin the necessary shift.

[215] United Nations Environmental Programme/GRID-Arendal. Greenhouse Gas Emissions—Canada. (April 7, 2005). www.grida.no/db/maps/collection/climate9/graph.cfm?countryiso=CA

As mentioned above, in order for the province of Nova Scotia to meet the national Kyoto target of a six percent reduction in emissions below 1990 levels, a continuous and ongoing reduction in total GHG emissions of 900 kt per year in each of the five years between 2006 and 2010 would be required. This is equivalent to a 19% overall decrease from GHG emission levels in 2004, to 18,518 kt per year—which is six percent below the 1990 emissions of 19,700 kt (Figure 76). If the same overall Kyoto target of a six percent reduction below 1990 levels were applied to transport-related emissions in Nova Scotia, the transportation sector would have to reduce emissions by 25% from the 2004 levels of 6400 kt to 4,794 kt per year—which averages out to an annual decrease in GHG emissions of 321 kt each year between 2006 and 2010.

This is a modest and attainable target. Between 1990 and 1991, total transportation GHG emissions in Nova Scotia fell by 200 kt; between 1996 and 1997, they fell by 500 kt; and between 1999 and 2001, they dropped by 300 kt. If cuts of this magnitude can occur in the absence of any coordinated policy or emissions reduction plan, then the Kyoto emissions reduction objectives seem more than achievable as a short-term target for 2010 without social or economic disruption.

If the more stringent, long-term, and sustainable goal of a 50% reduction in GHG emissions is adopted, as suggested by the Intergovernmental Panel on Climate Change, the emissions cuts would be much more significant and require more dedicated action. Applied to overall greenhouse gas releases in Nova Scotia, this would mean reducing emissions to 11,500 kt. per year (from 23,000 kt in 2004). Nova Scotia's transportation sector would need to reduce emissions to 3,200 kt annually (from 6,400 kt in 2004).

Regardless of the target, Figures 82 and 83 show that emissions of GHGs from the Nova Scotian transportation sector are currently on an unsustainable path, with emissions generally increasing rather than declining. Careful transportation planning will be required if the province is to meet even the minimum standards outlined in the Kyoto Protocol.

Chapter 5. Transportation Emissions of Air Pollutants

According to the European Union and CST definitions, to be sustainable, a transportation system must *limit emissions and wastes within the planet's ability to absorb them*. This definition has been adopted for this report. Emissions of air pollutants from transportation threaten human and ecosystem health and also reflect the unsustainable use and depletion of non-renewable resources. Pollutants are also currently being emitted from transportation sources at levels far above the planet's capacity to process them, with chemical reactions instead producing ground-level ozone, smog, and other compounds that seriously compromise air quality. For these reasons, emissions of air pollutants are a key indicator of sustainable transportation, with a **decrease** in transportation-related emissions signalling movement towards sustainability.

The World Health Organization (WHO) defines health as "a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity."[216] Using this definition, it is clear that air pollution, even when it is not life-threatening, can still damage human health and impair quality of life. If the climate is altered—through smog, reduced plant growth, or other common air pollutant effects—or if the presence of air pollution produces anxiety or discomfort, or compromises aesthetic quality, then human health is affected, even if no overt physical ailments have yet manifested.

The WHO definition also has implications for assessing what constitutes a sustainable level of pollution. From a simple physical perspective, it could be argued that a sustainable level of pollutant emissions would require hospital admissions attributable to air pollution to be zero. But from the WHO perspective, this criterion would be a necessary rather than sufficient condition of sustainability. In addition, the WHO definition implies that Canadians should be free from psychological distress related to knowledge that the atmosphere is being contaminated, and that the rest of the biosphere must also be protected against harm caused by air pollutants.

An accumulating body of research offers proof of the threat that air pollution poses to human health, with various studies revealing links between poor air quality and higher hospital admissions and asthma rates. For example, an April, 2004, report by Harvard Medical School's Center for Health and the Global Environment reports that global warming and air pollution are causing an increase in asthma rates, especially amongst inner-city children. Between 1980 and 1994 there was a 160% rise in asthma among preschool children in the United States.[217]

A WHO monograph on the effects of air pollution on children's health and development ranks the quality of available evidence on the effects of air pollution on children. The authors graded evidence on a scale of 1 to 4, as follows:

1) evidence sufficient to infer causality;
2) evidence suggestive of causality;

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[216] World Health Organization. *Constitution of the World Health Organization*, preamble. (1985). www.who.int/about/en/ Accessed August, 2004.
[217] Ault, Alicia. "Report Blames Global Warming for Rising Asthma." (London: *The Lancet*. May 8, 2004. 363: 9420). www.thelancet.com/journal/vol363/iss9420/contents Accessed September, 2004.

3) evidence insufficient to infer causality; and
4) evidence showing no association.

A selection of statements taken from the paper illustrates the strength of the evidence:

> The evidence is sufficient to infer a causal relationship between particulate air pollution and respiratory deaths in the post-neonatal period…
>
> Evidence is sufficient to infer a causal relationship between exposure to ambient air pollutants and adverse effects on lung function development. Both reversible deficits of lung function as well as chronically decreased lung growth rates and lower lung function levels are associated with the exposure to air pollution, with clearer relationships for particulates and traffic related air pollution (indicated by nitrogen dioxide)…
>
> The available evidence is also sufficient to assume a causal relationship between air pollution exposure and aggravation of asthma (mainly due to exposure to particulate matter and ozone) as well as a causal link between increased prevalence and incidence of cough and bronchitis due to particulate exposure. The evidence is suggestive for a causal association between the prevalence/incidence of asthma symptoms and living in close proximity to traffic…
>
> Evidence suggests a causal relationship between exposure to ambient air pollution and increased incidence of upper and lower respiratory symptoms (much of which are likely to be symptoms of infections)…
>
> There is evidence of adverse effects of environmental contaminants such as certain heavy metals or persistent organic pollutants (POPs) on the development of the nervous system and behaviour in children. There is sufficient evidence for a causal relationship between exposure to lead indicated by blood-lead levels of 100 µg/l [micrograms per litre] and below, and neurobehavioral deficits in children. There is evidence suggestive of a causal link between adverse health effects and exposure to mercury and to polychlorinated biphenyls (PCBs)/dioxins at current background levels in industrialised European countries….
>
> While recognizing the need for further research, current knowledge about the health effects of air pollution is sufficient for a strong recommendation to reduce children's current exposure to air pollutants, in particular to the pollutants related to traffic. The experts who conducted this review consider that such reductions in levels of air pollution will lead to considerable children's health benefits.[218]

In addition to negative impacts on the health of children, air pollution also affects the elderly, people with cardiac and respiratory problems, and—ironically—people who exercise

[218] Binkova, Blanka et al. *The Effects of Air Pollution on Children's Health and Development: A Review of the Evidence*. (Copenhagen: WHO Regional Office for Europe, 2004).

outdoors.[219, 220] Some research indicates that people living in low-income areas tend to be more heavily affected by air pollution, which raises equity issues that are also relevant to sustainability.[221] Evidence also indicates that air pollution has negative effects not only on human health but also on natural ecosystems—inhibiting plant growth, increasing the acidity of lakes, and corroding stone, plastic, metal, and other substances.[222]

For all these reasons, a decrease in the emission of air pollutants from transportation indicates movement towards sustainability. While any reduction in the volume of pollutants released is important, the WHO definition of health, and both the CST and EU pairing of "human and ecosystem health" in their definitions of sustainable transportation, require that transport-related pollutant emissions decrease to a level that does not impair human and ecosystem health and wellbeing in the broadest sense.

Background on Air Pollutants[223]

The atmosphere is primarily composed of nitrogen (N_2) and oxygen (O_2): 78 and 21% respectively. The remaining one percent is made up of carbon dioxide (CO_2), argon (Ar), and other gases; and varying amounts of water vapour. Four distinct layers make up the atmosphere, based on thermal, chemical, and physical characteristics. They are listed here in order of distance from the ground:

- *Troposphere*: Beginning at the Earth's surface and extending 8-14.5 km high, this is the densest part of the atmosphere. Within this layer, as altitude increases, the temperature drops from about 17°C to -52°C. Almost all weather occurs in this layer.
- *Stratosphere*: Beginning just above the troposphere and extending 50 km high, this part of the atmosphere is drier and less dense than the troposphere. The temperature in this region increases gradually to -3°C due to the absorption of ultraviolet (UV) radiation. The ozone layer, which absorbs and scatters the solar UV radiation, is located in the stratosphere. Ninety-nine percent of "air" is located in the troposphere and stratosphere.
- *Mesosphere*: This layer extends 85 km above the stratosphere. Temperatures in the mesosphere fall as low as -93°C as altitude increases.

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219 Environment Canada. Clean Air: Introduction. (November 18, 2004). www.ec.gc.ca/air/introduction_e.html Accessed August, 2004.
220 Ontario Medical Association. Smog-Wise Information Program—Backgrounder. (No date.) www.oma.org/phealth/Smogwise.htm Accessed August, 2004.
221 Finkelstein, Murray, Dave Verma, Malcolm Sears and Kenneth Chapman. *A Cohort Study of Air Quality And Utilization of Hospital Services* (executive summary). (Health Canada. June 20, 2003). www.hc-sc.gc.ca/hecs-sesc/tsri/research/tsri_142.htm Accessed August, 2004.
222 Environment Canada. Clean Air: What is Acid Rain? (November 25, 2002). www.ec.gc.ca/air/acid-rain_e.html Accessed August, 2004.
223 The following description of air pollutants was adapted from *The Ambient Air Quality Accounts for the Nova Scotia Genuine Progress Index* by Anne Monette and Ronald Colman (**GPI***Atlantic*, 2004), which is available at www.gpiatlantic.org/pdf/airquality/airquality.pdf.

- *Thermosphere*: This layer extends 600 km above the mesosphere. Temperature increases with altitude due to energy from the sun, reaching 1,727°C.

The air we breathe is never completely "pure" or unpolluted. Even "clean" air contains water vapour; particles of dust, pollen, and ash; and gases such as sulphur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), and carbon monoxide (CO)—all of natural origin. In polluted air, SO_2, NO_2, O_3, CO, particulate matter (PM), and organic gases and vapours are found at higher than natural levels. These increased concentrations result from anthropogenic activities (i.e., the pollutants are released into ambient air from stationary and mobile sources as a result of human activities).

Air pollution occurs when there is a degradation of air quality resulting from the excess presence of chemicals or other materials. This pollution can result in significant, and sometimes irreversible, impacts on air, water, soils, biota, habitats, and human health. Such impacts occur on local, regional and global scales, and are often quite complex, indirect, and difficult to predict or measure. Air pollution can also have less tangible effects, such as economic costs related to lost productivity, diminishing availability of natural resources, and social disruption.

Generally, air pollutants fall into two main groups: primary pollutants—those pollutants emitted directly from identifiable sources; and secondary pollutants—those pollutants produced in the air by interactions between two or more primary pollutants, or by reaction with normal atmospheric constituents. Primary pollutants that lead to the formation of secondary pollutants are called precursors. A precursor is a directly emitted pollutant that, when released into the atmosphere, contributes to the formation of a secondary pollutant. For example, non-methane hydrocarbons and nitrogen oxides are precursors to the formation of ground-level ozone. The formation of ground-level ozone is a photochemical reaction called photo-oxidation (i.e., a reaction that requires the light energy of the sun).

The term *Criteria Air Contaminant*, as defined by Environment Canada and the United States Environmental Protection Agency, refers to an air pollutant for which efforts have been made to assess "acceptable" levels of exposure and for which an ambient air quality objective (or standard) has been set. There are seven air pollutants that are considered Criteria Air Contaminants (CACs), as defined by Environment Canada:[224]

- Carbon Monoxide (CO)
- Total Particulate Matter (TPM or PM) or Total Suspended Particulates (TSP)
- Particulate Matter 10 (PM_{10})
- Particulate Matter 2.5 ($PM_{2.5}$)
- Sulphur Dioxide (SO_2)
- Nitrogen Oxides (NO_x)
- Volatile Organic Compounds (VOCs)

A 2004 **GPI***Atlantic* report on ambient air quality found that the majority of emissions in Nova Scotia that exceeded National Ambient Air Quality Objectives (NAAQO) occurred prior to

[224] Environment Canada. Air Pollutant Emissions: Glossary. (February 07, 2005). www.ec.gc.ca/pdb/ape/cape_gloss_e.cfm Accessed February, 2005.

1986. For example, ambient air concentrations of SO_2 in Nova Scotia only exceeded the annual NAAQO for this pollutant in the 1970s and early 1980s. Similar results were found for nitrogen dioxide (NO_2), where the NAAQO for this pollutant has not been exceeded since 1985. By contrast, many of the air quality monitoring sites in Nova Scotia have exceeded the NAAQO for ground-level ozone frequently in the last two decades, and as recently as 2001.[225]

In assessing genuine progress in this area, it should be noted that there are actually two sets of criteria and data that are relevant. ***Ambient air quality*** refers to the air that Nova Scotians actually breathe, which is the product both of emissions within the province and of trans-boundary pollution. Ambient air quality in Nova Scotia is significantly affected by pollutant emissions in the northeast and mid-western United States and in central Canada.

The second set of measures refers to pollutant ***emissions*** within Nova Scotia, which in turn affect air quality both within and beyond the province. Thus, although the NAAQO for SO_2 has not been exceeded in more than two decades, as noted above, Nova Scotia has one of the highest per capita rates of SO_2 emissions in the world—seven times the Canadian level—due to its heavy reliance on coal for electricity generation and the lack of adequate pollution controls at some of its coal-fired generating plants. Thus, the **GPI***Atlantic* air quality report examined both ambient air quality and emissions levels for each of the criteria air contaminants (CACs).

A brief description of each CAC is provided in the following sections, with a discussion of the main sources of emissions and the known human health and other impacts of each pollutant.

5.1 Carbon Monoxide

Description

Carbon monoxide (CO) is a colourless, odourless, and tasteless gas. CO is a product of the incomplete combustion of fossil fuels—i.e., any combustion process where carbon-containing organic material is burned without sufficient oxygen.

Sources of Carbon Monoxide Emissions

The major sources of CO are primarily natural: volcanic, marsh, and natural gases; oceans; fires; and electrical storms.[226] The major anthropogenic sources of CO in Canada are industrial, including fossil fuel-based electricity generation; residential heating (e.g. fires, wood or gas stoves, etc.); and waste disposal.

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[225] Monette and Colman. (2004, p. 118).
[226] Andrews, Lynn, Beth Kwavnick, Douglas Haines and Silke Neve. *The Health and Environment Handbook for Health Professionals*. (Ottawa: Health Canada, 1998). The information cited appears in the Carbon Monoxide entry in the *Handbook*'s Contaminant Profiles annex, which is archived at http://dsp-psd.pwgsc.gc.ca/Collection/H46-2-98-211E-18.pdf. The full text of the *Handbook* can be downloaded (in sections) from: http://dsp-psd.pwgsc.gc.ca/Epubs/epub_author02-e.html#H.

Human Health Effects of Carbon Monoxide

Tissues with high oxygen demand are the most sensitive to the effects of CO: particularly the heart, brain, and exercising skeletal muscle. High levels of CO (usually occurring indoors) can result in headache, drowsiness, and cardiac arrhythmias (any irregularity in the natural rhythm of the heart). At sufficiently high levels, CO can lead to coma and death. Studies have shown that healthy adults exposed to elevated levels of CO may exhibit decreased aerobic capacity; impaired work capacity; and reduced visual perception, manual dexterity, and performance of complex sensory-motor tasks.[227]

Health effects associated with relatively low-level, short-term exposure to CO include decreased athletic performance and aggravated cardiac symptoms. Small increases in CO exposure could adversely affect myocardial function and produce ischemia (a local loss of blood flow): and these effects may lack a safe threshold.[228]

In other words, there is no safe level of exposure to carbon monoxide. At the levels typically found in large cities, CO may increase hospital admissions for cardiac diseases, and there is also evidence of an association with premature deaths.[229] Exposure to CO is considered most harmful to people with severe anemia, chronic lung disease (such as chronic obstructive pulmonary disease), coronary artery disease, arteriosclerosis, chronic angina, and ischemic heart disease.[230, 231, 232] Other risk groups include pregnant women, fetuses, newborn infants, and people with cardiovascular or respiratory diseases–especially the elderly and young children.

5.2 Particulate Matter

Description

Airborne particulate matter (PM) is any aerosol that is released to the atmosphere in either solid or liquid form that can be inhaled into the respiratory system. This includes particles such as dust, soot, ash, fibre, and pollen. Airborne particulate matter has an upper size limit generally considered to be approximately 75 micrometres (µm) in diameter.[233, 234] The terms suspended

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227 Ibid.

228 Hopper, F., S. MacDonald, M. Shepherd, K. Wilby and P. Wong. *National Ambient Air Quality Objectives for Carbon Monoxide: Desirable, Acceptable, and Tolerable Levels*, p. 2. (Ottawa: Environment Canada and Health Canada, 1994). www.hc-sc.gc.ca/hecs-sesc/air_quality/pdf/carbon_monoxide.pdf

229 Health Canada. *Health and Air Quality—Let's Talk about Air*. (December 11, 2003a). www.hc-sc.gc.ca/hecs-sesc/air_quality/talk.htm Accessed September, 2004.

230 Health Canada. *Health and Air Quality—Health Effects.* (December 11, 2003b). www.hc-sc.gc.ca/hecs-sesc/air_quality/health_effects.htm Accessed September, 2004. Chronic obstructive pulmonary disease (COPD), also known as chronic obstructive lung disease, encompasses two major disorders: emphysema and chronic bronchitis. Emphysema is a chronic disorder in which the walls and elasticity of the alveoli are damaged. Chronic bronchitis is characterized by inflammation of the cells lining the inside of the bronchi, which increases the risk of infection and obstructs airflow in and out of the lungs.

231 Angina: pain or discomfort in the chest that happens when some part of the heart does not receive enough blood.

232 Andrews et al. (1998).

233 One micrometre (µm), is one millionth of a metre; or one thousandth of a millimetre. Micrometres are also referred to as "microns."

particulate, total suspended particulate (TSP), suspended particulate matter (SPM), particulate matter (PM), total particulate matter (TPM), aerosols, and airborne particles, are generally used interchangeably.

Airborne particles or particulate matter with diameters larger than about 10µm are large enough to settle soon after being emitted from a source.[235] Smaller particles can remain suspended in air for long periods of time. PM with diameters less than or equal to 10µm are referred to as PM_{10}. PM_{10} are also called "thoracic particles," since they can be inhaled into the thoracic (tracheobronchial and alveolar) regions of the respiratory system. PM_{10} are also sometimes referred to as "respirable" or "inhalable" particles, although these terms are generally applied to particles less than or equal to 15µm in diameter. PM_{10} can be sub-divided into two fractions: a fine fraction of particles with diameters less than or equal to 2.5µm (called $PM_{2.5}$), and a coarser fraction of particles with diameters greater than 2.5µm but less than or equal to10µm ($PM_{10-2.5}$).

Sources of Particulate Matter Emissions

Particles vary in size, shape, and chemical composition, and originate from both natural and anthropogenic sources. The main natural sources of PM include volcanoes, wind erosion of soil and rock, forest fires, and plants. The principal sources of PM emitted as a result of human activity are industrial processes, fuel combustion, transportation, and solid wastes.

Human Health Effects of Particulate Matter

PM_{10} and $PM_{2.5}$ are considered to be "toxic" under the 1999 *Canadian Environmental Protection Act* (CEPA).[236, 237] Short-term exposure to airborne PM is associated with a variety of adverse effects including: eye, nose, and throat irritation; breathing difficulties; reduced lung function; and asthma exacerbation (worsening of asthma symptoms). Long-term exposure to PM is associated with decreased lung function and increased mortality rates. Longer term, sub-chronic, or chronic exposures have been associated with increases in mortality, respiratory disease symptoms, and decrements in lung function.[238] Groups that are particularly susceptible to the

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[234] Environment Canada. (February 07, 2005).
[235] Andrews et al. (1998: Contaminant Profiles: Particulate Matter).
[236] Under the *Canadian Environmental Protection Act*, a substance is deemed "toxic" if it is entering or may enter the environment in a quantity or concentration or under conditions:
(a) having or that may have an immediate or long-term harmful effect on the environment;
(b) constituting or that may constitute a danger to the environment on which human life depends; or
(c) constituting or that may constitute a danger in Canada to human life or health.
Government of Canada. *The Canadian Environmental Protection Act* (Chapter 33, Section 64). (1999). www.ec.gc.ca/CEPARegistry/the_act/Download/CEPA_Full_e.htm Accessed November, 2004.
[237] Environment Canada and Health Canada. *Priority Substances List Assessment Report: Respirable Particulate Matter Less than or Equal to 10 Microns*. (Ottawa: Minister of Public Works and Government Services, 2000). www.ec.gc.ca/substances/ese/eng/psap/final/PM-10.cfm
[238] Bailey, Renata, Marc Bourgeau, Elizabeth Bush, Tom Dann, Stephen MacDonald, Sara Pryor, Marjorie Shepherd, Natalie Suzuki, Kerri Timoffee, Grace Wood, and Ling Liu. *National Ambient Air Quality Objectives for Particulate Matter. Part 1: Science Assessment Document*, p. 12. (Ottawa: Minister of Public Works and

effects of PM include the elderly; those with chronic pulmonary or cardiovascular diseases; the very young; asthmatics; smokers; and people with respiratory infections or bronchitis.

PM may cause a wide spectrum of immunological disorders and can aggravate lung infections, possibly by reducing the body's ability to fight infection.[239] The finer particles pose a greater threat to human health because they can travel deeper into the lungs. Exposure to PM has been shown to cause increases in chronic cough and bronchitis, and in respiratory-related activity restrictions, which in turn lead to increased numbers of lost work days and school absences.[240] Exposure to particulates is also associated with increases in the number of consultations with family doctors; emergency room visits; hospital admissions of people with cardiac and respiratory disease; and early deaths.[241]

Other Effects of Particulate Matter

PM can affect vegetation by physical smothering of the leaf surface, by physical blocking of stomata, and by inducing a chemical effect due to particle composition. Indirect effects include disturbances of soil pH and ionic composition; nutrient imbalances through particle deposition to soils; and reduced light intensity due to particle loads in air.[242]

The most obvious effect of particulate deposition on vegetation, including trees and agricultural crops, is the physical smothering of the leaf surface.[243] Particle accumulation on the leaf surface causes reduced light transmission, affecting photosynthesis, and may increase the plant's susceptibility to disease. The effects of PM on materials have been investigated for metals, wood, stone, painted surfaces, electronics, and fabrics. The deposition of PM on these materials may cause soiling and discoloration, thus reducing their aesthetic appeal, and necessitating cleaning and repainting. The presence of PM has been linked to enhanced speed of corrosion on metal surfaces; altered paint durability; accelerated stone corrosion; and corrosion and failure of electronics.[244]

Increasing concentrations of particles and gases in air can also result in reduced visual range. The presence of particles in the air reduces the distance at which we can determine the colour, clarity, and contrast of distant objects, because the particles in the atmosphere scatter and absorb light. In more polluted areas, PM can drastically reduce the range of visibility;[245] this is one of the

Government Services, 1999). All page references are to the report's executive summary, available at: www.hc-sc.gc.ca/hecs-sesc/air_quality/pdf/98ehd220.pdf.
[239] MacPhail, Judith. *Ontario Medical Association Ground Level Ozone Position Paper*, section 5.3. (Toronto: Ontario Medical Association, no date). www.oma.org/phealth/ground.htm Accessed September, 2004.
[240] Bailey et al. (1999, p. 12).
[241] Health Canada. (December 11, 2003).
[242] United States Environmental Protection Agency (USEPA). Health and Environmental Impacts of PM. www.epa.gov/air/urbanair/pm/hlth1.html (December 20, 2004a). Accessed February, 2005.
[243] Bailey et al. (1999, p. 10).
[244] Ibid.
[245] Commissioner of the Environment and Sustainable Development. *2000 Report of the Commissioner of the Environment and Sustainable Development to the House of Commons*. (Ottawa: Office of the Auditor General of Canada, 2000). www.oag-bvg.gc.ca/domino/reports.nsf/html/c0menu_e.html Accessed September, 2004.

indicators of poor air quality most readily perceived by the public.[246] Degradation of viewing conditions has economic implications and may lead to loss of tourism, lower property values, and reduced quality of life.

5.3 Sulphur Oxides

Description

Sulphur dioxide (SO_2) is a colourless gas with a pungent odour that combines easily with water vapour in air to form sulphurous acid (H_2SO_3). It will unite with oxygen in air to form the more corrosive sulphuric acid (H_2SO_4). Sulphur forms a number of oxides but only SO_2 and sulphur trioxide (SO_3) are important as gaseous air pollutants. Usually only a small amount of SO_3 accompanies SO_2, and together the two are designated sulphur oxides (SO_x).

Two common air pollutants acidify precipitation: SO_2 and nitrogen oxides (NO_x). Acid rain is a generic term used for precipitation that contains a high concentration of sulphuric and nitric acids. These acids form in the atmosphere when SO_x and NO_x emissions combine with water in air.[247] When the environment cannot neutralize the acid being deposited, damage can occur. Clean rain has a pH value of about 5.6; by comparison, vinegar has a pH of 3.[248] Rain measuring between 0 and 5 on the pH scale is called “acid rain.” It can be as much as 100 times more acidic than normal precipitation.[249]

Sources of Sulphur Oxides Emissions

SO_2 is generally a by-product of industrial processes and the burning of fossil fuels. Ore smelting, coal-fired electricity generation, petroleum refining, pulp and paper milling, incineration, and natural gas processing are the main sources of SO_2 emissions.[250]

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[246] Bailey et al. (1999, p. 8 ff.).
[247] Environment Canada. Glossary of Terms: Acid Rain. (March 25, 2004). www.ec.gc.ca/glossary_e.html#A Accessed September, 2004.
[248] The pH scale is used to measure the amount of acid in a liquid. Acids release hydrogen ions and the acid content of a solution is based on the concentration of hydrogen ions, expressed as a number between 0 and 14. The smaller the number on the pH scale, the more acidic the substance is: 0 = maximum acidity; 7 = neutral; and 14 = maximum alkalinity. The pH scale is logarithmic, i.e., each decrease in pH by one unit (e.g. from 7 to 6) means a tenfold increase in acidity; and each increase in pH by one unit means a tenfold decrease in acidity. See under “What is pH?” at the Environment Canada website: Acid Rain and…The Facts www.ec.gc.ca/acidrain/acidfact.html.
[249] Environment Canada. *Acid Rain*. (Ottawa: 1999). www.ec.gc.ca/soer-ree/English/Indicators/Pdf_file/99-3_e.pdf Accessed September, 2004.
[250] Environment Canada. Acid Rain and…The Facts: Where do sulphur dioxide emissions come from? (April 8, 2003). www.ec.gc.ca/acidrain/acidfact.html Accessed September, 2004.

Human Health Effects of Sulphur Oxides and Acid Deposition

The human health concerns related to acid rain are derived primarily from the precursors SO_2 and NO_x. Because SO_2 is very soluble in water, when inhaled it will rapidly dissolve in the secretions covering the cells of the upper respiratory tract (nose, mouth, throat, trachea, and bronchi). This will cause tissue irritation and congestion at relatively high levels of exposure.[251] At lower levels of exposure, hypersensitive individuals—particularly asthmatics and persons with lung disease—may experience breathing difficulties. Eye irritation, shortness of breath, and reduction of lung function can also result from SO_2 exposure. Groups that are particularly sensitive to SO_2 exposure include people with asthma who are active outdoors; children; the elderly; and people with heart or lung disease.[252]

SO_2 can react with water vapour and other chemicals in the air to form very fine particles of sulphate. These airborne particles form a key element of urban smog and are a serious health hazard.[253] Significant associations have been found between increased sulphate levels and an increase in the number of acute care respiratory hospital admissions.[254] Exposure to sulphate particles is also associated with a higher incidence of premature death.[255]

Other Effects of Sulphur Oxides and Acid Deposition

Acid rain has major impacts on soil, aquatic ecosystems, plants, and materials. In Canada, about four million square kilometres—46% of the total surface area—are highly sensitive to acid rain.[256] Much of this area is in eastern Canada, where acid rain is a particular problem because many of the water and soil systems lack natural alkalinity and therefore cannot neutralize or "buffer" against acid rain naturally. Provinces that are part of the Canadian Precambrian Shield—Ontario, Quebec, New Brunswick and Nova Scotia—are affected the most because their water and soil systems cannot effectively fight the damaging consequences of acid rain.[257] In Nova Scotia, the south shore is especially sensitive due to natural acidification by organic acids.[258] Acid rain is a less serious problem in western Canada because of lower overall exposure to acidic pollutants and a generally less acid-sensitive environment.[259]

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[251] Federal-Provincial Advisory Committee on Air Quality. *Review of National Ambient Air Quality Objectives (Maximum Tolerable Levels) for Sulphur Dioxide, Carbon Monoxide, Ozone, and Nitrogen Dioxide*. (Ottawa: Minister of Supply and Services Canada, 1987).
[252] USEPA. Health and Environmental Impacts of SO2. (December 20, 2004b). www.epa.gov/air/urbanair/so2/hlth1.html Accessed February, 2005.
[253] Environment Canada. Acid Rain and…Your Health: What is the link between acid rain and human health? (February 7, 2003). www.ec.gc.ca/acidrain/acidhealth.html Accessed September, 2004.
[254] Andrews et al. (1998: Contaminant Profiles: Sulphur Dioxide).
[255] USEPA. (December 20, 2004b).
[256] Environment Canada—Indicators and Assessment Offices. (1999).
[257] Environment Canada. (December 19, 2002).
[258] Environment Canada. *1997 Canadian Acid Rain Assessment Volume 1: Summary of Results*. (Ottawa: Minister of Supply and Services, 1998a. Catalogue no. En56-123/1-1997E).
[259] Environment Canada. (Fall, 1999).

Almost 80% of Nova Scotia's lakes greater than one hectare in surface area are susceptible to acidification.[260] It is estimated that as many as 14,000 lakes in eastern Canada are acidic.[261] The more acidic a lake becomes, the fewer species it can support. Plankton, and invertebrates such as crayfish and clams, are among the first to die as a result of acidification. When the pH of a lake drops below 5, more than 75% of its fish species gradually disappear.[262] As fish stocks dwindle, so do populations of loons and other water birds that feed on them.

Acid deposition has had a significant impact on Atlantic salmon habitat. Since 1950, one-third of Atlantic salmon habitat in Nova Scotia has been lost to acidification—a loss of 9,000-14,000 fish per year to the salmon fishery.[263]

The ability of forest soils to buffer acidity depends on the thickness and composition of the soil, and the type of bedrock beneath the forest floor. Forests in eastern Canada receive roughly twice the level of acid deposition they can tolerate without long-term damage.[264] The loss of nutrients in forest soils may threaten the long-term sustainability of forests in areas with sensitive soils. Acid rain has caused severe depletion of nutrients in forest soils in parts of Ontario, Quebec, and the Atlantic provinces, as well as in the north-eastern US.[265] Forests in affected areas are using up the pool of minerals accumulated in soils during pre-industrial times and are thus gradually compromising the sensitive nutrient balance of forest soils. Continued exposure over time can affect the biodiversity of plants and animals in an ecosystem.[266]

SO_2 and acid rain can also accelerate the corrosion of many types of materials: paint and other coatings; wood; glass; limestone; sandstone; marble; masonry; brick; mortar; concrete; and metals (notably bronze). This damages buildings, outdoor sculptures, monuments, etc.[267] Automotive coatings may be damaged by any form of acid rain, including dry deposition (especially when dry acidic deposition is mixed with dew or rain).[268]

Sulphate particles—formed when SO_2 reacts with water vapour and other chemicals in air—are very effective at scattering light and play a large role in reducing visibility. Impairment of viewing conditions could lead to a loss of revenue from tourism in wilderness areas, and in National and Provincial Parks.

[260] Nova Scotia Department of the Environment (NSDOE). *The State of the Nova Scotia Environment 1998*, p. 10. (Halifax, 1998).
[261] USEPA. Where Does Acid Rain Affect Lakes and Streams? (November 12th, 2003a). www.epa.gov/airmarkets/acidrain/effects/surfacewater.html#where Accessed September, 2004.
[262] Environment Canada. (November 25, 2002).
[263] NSDOE. (1998, p. 10).
[264] Environment Canada. (November 25, 2002).
[265] Environment Canada. Acid Rain and…Forests: Are these effects reversible? (December 19, 2002). www.ec.gc.ca/acidrain/acidforest.html
[266] USEPA. How Does Acid Rain Affect Ecosystems? (November 12th, 2003b). www.epa.gov/airmarkets/acidrain/effects/surfacewater.html#ecosystems
[267] USEPA. Effects of Acid Rain: Materials. (November 12th, 2003c). www.epa.gov/acidrain/effects/materials.html
[268] USEPA. The Effects of Acid Rain on Automotive Coatings. (November 12th, 2003d). www.epa.gov/airmarkets/acidrain/effects/carcoatings.html

5.4 Nitrogen Oxides

Description

Nitrogen oxide (NO_x) is a generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts. Many of the nitrogen oxides are colourless and odourless. With respect to air pollution the most important of these compounds are nitric oxide (NO) and nitrogen dioxide (NO_2).[269] NO_2 is a reddish-brown gas with a characteristic pungent odour. In the presence of sunlight, nitrogen oxides can transform into acidic air pollutants such as nitrate (NO_3) and nitric acid (HNO_3) particles. Nitrogen oxides also play a key role in the formation of smog.

Sources of Nitrogen Oxide Emissions

Most of the nitrogen oxides in the environment come from natural sources such as lightning, and biological and non-biological processes in soil.[270] The main anthropogenic source of NO_x emissions is the combustion of fuels (in motor vehicles; residential and commercial furnaces; industrial and electrical-utility boilers and engines; and other equipment).[271] Various industrial processes, and solid waste disposal, also contribute to NO_x emissions.[272]

Human Health Effects of Nitrogen Oxides

The major concern about NO_x emissions is the role they play in the formation of ground-level ozone. Nitrogen oxides are also problematic because they can contribute to the acidification of precipitation.

NO and NO_2 are the most important of the nitrogen oxides with respect to direct effects on human health. NO_2 has a greater impact on human health than does NO.[273] Those at increased risk of suffering adverse health effects from NO_x include people with asthma and chronic obstructive pulmonary disease (COPD), children, and the elderly. Prolonged exposure to high concentrations of NO_x can affect the body's ability to defend itself against bacterial and viral infection, and is associated with an increased incidence of respiratory illness.[274]

Nitric acid and related particles can affect the human respiratory system, making breathing difficult, damaging lung tissue, aggravating existing heart disease, and causing premature

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[269] Andrews et al. (1998: Contaminant Profiles: Nitrogen Oxides).
[270] Ibid.
[271] Environment Canada. Acid Rain and…The Facts: Where do NO_X emissions come from? (April 8, 2003). http://www.ec.gc.ca/acidrain/acidfact.html
[272] Andrews et al. (1998: Contaminant Profiles: Nitrogen Oxides).
[273] Ibid.
[274] Ibid.

death.[275] These small particles can penetrate deeply into sensitive parts of the lungs, causing or worsening respiratory diseases such as asthma, emphysema, and bronchitis.[276]

Other Effects of Nitrogen Oxides

Increased nitrogen loading in water bodies accelerates "eutrophication,"[277] which leads to oxygen depletion and reduces fish and shellfish populations. NO and NO_2 contribute to the formation of acidic precipitation, which can affect the growth and health of forests. Excessive nitrogen deposition can also harm forests in other ways: vigorous growth stimulated by nitrogen fertilization may result in nutrient deficiency; nitrogen compounds can alter physiological and anatomical development; and excessive nitrogen may increase the susceptibility of trees to freezing or desiccation in winter.[278]

NO_2 can affect visibility since it is an intensely-coloured gas, and absorbs light over the entire visible spectrum. Nitrate particles can also block the transmission of light, reducing visibility.[279] NOx exposure can cause the corrosion of metals; fading of fabric dyes; and degradation of textile fibres, rubber products, and polyurethanes.

Nitrous oxide (N_2O) is a greenhouse gas (GHG)[280] and can accumulate in the atmosphere with other GHGs, such as carbon dioxide (CO_2), affecting the global climate system. N_2O has 310 times the ability of CO_2 to trap heat.[281] That is, each tonne of N_2O emitted has much greater potential to enhance the greenhouse effect than does a tonne of CO_2. Climate change can lead to increased risks to human health, a rise in sea level, droughts, more extreme weather events, and other adverse changes to plant and animal habitat.

[275] USEPA. Health and Environmental Impacts of NOx. (January 6, 2005). www.epa.gov/air/urbanair/nox/hlth.html Accessed February, 2005.
[276] Ibid.
[277] Eutrophication, also known as nutrient enrichment, is the process of over-fertilization of a body of water by nutrients that produce more organic matter than the self-purification reactions can overcome. Eutrophication can be a natural process. It can also be caused or accelerated by an increase of nutrient loading to a water body by human activity.
[278] MacKenzie, James and Mohammed T. El-Ashry. "Tree and crop injury: a summary of the evidence," in MacKenzie, J.J. and El-Ashry, M. T. (eds.), *Air Pollution's Toll on Forests and Crops*. (New Haven: Yale University Press, 1989).
[279] USEPA. (January 6, 2005).
[280] Greenhouse gases are those gases in the atmosphere—either naturally occurring, produced by humans, or both—that can absorb the longer wavelengths of radiation and trap heat within the atmosphere, thereby enhancing the "natural" greenhouse effect (see the previous chapter on greenhouse gas emissions in this report).
[281] Each GHG is rated (by internationally accepted standards) according to its ability to trap solar heat, using a scale called the "global warming potential." In this scale, the warming potential of each gas is compared to the global warming potential of one kg of CO_2. For more information see the section on greenhouses gases in the previous chapter of this report.

5.5 Volatile Organic Compounds

Description

The term "volatile organic compound" (VOC) refers to photo-chemically reactive hydrocarbon gases and vapours that tend to evaporate quickly at ordinary temperatures. VOCs contain at least one carbon atom (but do not include CO_2 and CO).

There are many thousands of organic compounds in the troposphere that meet the definition of a VOC. VOCs are also called "reactive organic gases" or "non-methane volatile organic compounds." Total hydrocarbons (THC) is a broader term for organic gases and vapours, and includes methane. VOCs are a sub-set of THCs. VOCs can react with nitrogen oxides in the presence of sunlight to form ground-level ozone. The categories of VOC most relevant to ground-level ozone formation include:

- Alcohols—e.g., methanol, ethanol
- Alkanes—e.g., ethane, propane
- Alkenes—e.g., ethylene, propylene
- Biogenic alkenes—e.g., isoprene
- Alkynes—e.g., acetylene
- Aromatics—e.g., benzene, toluene
- Aldehydes—e.g., formaldehyde, acetaldehyde
- Ketones—e.g., acetone
- Ethers—e.g., methyl tertiary-butyl ether[282]

Sources of Volatile Organic Compound Emissions

The main sources of emissions of VOCs are incineration; industrial activities such as petroleum refining, petrochemical processing, and the manufacturing of plastics; and transportation.[283] Benzene is a VOC that occurs naturally in crude oil and in many petroleum products. It is also a by-product of the incomplete combustion of organic substances. Trichloroethylene and tetrachloroethylene are synthetic compounds used primarily as solvents (in metal-degreasing, the dry cleaning industry, and in various manufacturing processes). Methylene chloride is a colourless commercial chemical used in paint removers, as a foam-blowing agent, and as a component of aerosols.

[282] Bush, Elizabeth, Tom Dann, Daniel Galarneau, Barry Jessiman, Ling Liu, Kevin Percy, Marjorie Shepherd, Kerri Timoffee, and Grace Wood. *National Ambient Air Quality Objectives for Ground Level Ozone: Science Assessment Document*, pp. 2-10 and 2-11. (Ottawa: Minister of Public Works and Government Services, 1999). www.hc-sc.gc.ca/hecs-sesc/air_quality/publications/ground-leve_ozone.htm
[283] Environment Canada. *Canadian Emissions Inventory of Criteria Air Contaminants (1990).* (Ottawa, 1996. Report No. EPS 5/AP/7E).

Human Health Effects of Volatile Organic Compounds

VOCs can be classified according to whether they are a direct human health concern; if they can promote ground-level ozone formation; or both. Some of the potentially toxic VOCs (benzene, for example) are known to be carcinogenic to humans. Health Canada has classified methylene chloride as a probable human carcinogen. Trichloroethylene and tetrachloroethylene have been shown to cause cancer in laboratory animals, but the health risk to humans is not known.[284]

Numerous studies have demonstrated an association between occupational exposure to benzene and human health impacts. Occupational benzene exposure has been shown to cause toxic effects on the blood, immune, and nervous systems; and incidences of leukemia in petrochemical industry workers, chemical workers, oil refinery workers, graphic industry workers, and rubber industry workers.[285] However, the health effects of exposure to environmental levels of benzene are unknown. The highest reported concentration of benzene in urban air in Canada is over 100,000 times less than the level at which adverse effects have been observed in laboratory mammals;[286] and almost 240,000 times lower than the minimum concentration reported to be lethal to plants, terrestrial invertebrates, and mammals subjected to acute laboratory exposure to benzene in air.[287]

Long-term exposure to high levels of trichloroethylene in the workplace is associated with adverse liver and cardiovascular effects, kidney damage, and other debilities.[288] Short-term exposure to high levels of tetrachloroethylene is associated with symptoms ranging from eye, throat, and nasal irritation, to dizziness and nausea. At very high concentrations, and after long-term exposure, tetrachloroethylene can cause cancer in some laboratory animals, although it is unclear whether these results are applicable to humans.[289] Short-term exposure to elevated concentrations of methylene chloride vapours can cause sluggishness, irritability, light-headedness, nausea, and headaches.[290]

5.6 Ground-Level Ozone and Smog

Description

Ozone is a molecule consisting of three atoms of oxygen that are bound together. Tropospheric ozone (or ground-level ozone) is not emitted as a pollutant but is formed through a complex series of reactions involving oxides of nitrogen and VOCs in the presence of sunlight.[291]

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[284] Andrews et al. (1998: Contaminant Profiles: Perchloroethylene (Perc)/PCE/Tetrachloroethylene).
[285] Government of Canada, Environment Canada, Health Canada. *Canadian Environmental Protection Act Priority Substances List Assessment Report: Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans*. (Ottawa: Minister of Supply and Services Canada, 1993).
[286] Andrews et al. (1998: Contaminant Profiles: BTEX—Benzene, Toluene, Ethyl benzene and Xylene/Gasoline.
[287] Government of Canada et al. (1993).
[288] Andrews et al. (1998: Contaminant Profiles: Perchloroethylene (Perc)/PCE/Tetrachloroethylene).
[289] Ibid.
[290] Ibid.
[291] It is important to note the difference between tropospheric and stratospheric ozone. Though the molecule is exactly the same in each case (three atoms of oxygen bound together), its presence in different parts of the

Pollutants from point sources (fixed identifiable sources) or area sources (numerous point or mobile sources) are referred to as primary pollutants. Interactions among two or more primary pollutants and normal atmospheric constituents can create secondary pollutants. Many of these chemical reactions require photo-activation, with solar ultraviolet radiation providing the energy required for the reaction.

In the absence of pollution, ozone is produced and consumed in a cyclical reaction involving natural NO_x, resulting in fairly constant ozone concentrations throughout the troposphere. In polluted air, which contains increased concentrations of NO_x and VOCs, the natural equilibrium between NO_x and ozone is upset, and more ground-level ozone is produced.

Smog is the term given to a noxious mixture of air pollutants, including gases and fine particles, which can often be seen as a brownish-yellow or greyish-white haze.[292] The mixture is produced by photochemical reactions between NO_x and VOCs. Because both these compounds are produced by motor vehicles, transportation is a major contributor to smog. The main components of smog in eastern North America are elevated concentrations of ground-level ozone, a photochemical oxidant, and particulates. Ninety percent of all smog found in urban areas is made up of ground-level ozone.[293]

Human Health Effects of Ground-Level Ozone and Smog

Ground-level ozone—even at low levels for short periods—has been linked to a broad spectrum of human health effects. Because of its reactivity, ozone can injure biological tissues and cells. When inhaled, ozone can inflame and damage the lining of the lung, causing symptoms such as wheezing, coughing, shortness of breath, throat irritation, and pain on deep inspiration.[294] Repeated exposure to ozone pollution for several months may cause permanent lung damage.[295] Other health effects of ozone exposure include:

- nausea
- eye irritation
- headache
- increased respiratory illness such as bronchitis, asthma, pneumonia, and emphysema
- decreased lung function, including decreased exercise capacity; premature aging of the lungs; possible long-term development of chronic lung disease
- reduction of the body's defences against infection (e.g., ozone can increase the susceptibility of asthmatics to common allergens)
- exacerbation of cardiovascular disease

atmosphere has entirely different consequences. Stratospheric ozone (the "ozone layer") blocks harmful solar radiation. By contrast, ground-level ozone (ozone occurring in the troposphere) is a pollutant which can have negative effects on human health, agricultural crops, forests, etc.

[292] Environment Canada. Fact Sheets—Smog. (December 18, 2002). www.msc-smc.ec.gc.ca/cd/factsheets/smog/index_e.cfm Accessed September, 2004.

[293] Environment Canada. Glossary of Terms: Smog. (March 25, 2004). www.ec.gc.ca/glossary_e.html#S

[294] USEPA. Health and Environmental Impacts of Ground-level Ozone. (December 20, 2004c). www.epa.gov/air/urbanair/ozone/hlth.html Accessed September, 2004.

[295] Ibid.

• exacerbation of respiratory disease such as asthma
• increased incidence of hospital admissions
• increased incidence of emergency room visits
• increased incidence of cardiovascular- and respiratory-related premature mortality

There are several groups of people who are particularly sensitive to ground-level ozone exposure. These include children; the elderly; people who are active outdoors; and people suffering from heart ailments.[296]

Active children often spend a large part of their summer vacation outdoors, engaged in vigorous activities. Children breathe more air per kilogram of body weight than adults. Also, children's respiratory systems are still developing, so they are more susceptible than adults to environmental threats.

As with children, adults who exercise or work vigorously outdoors have a higher level of exposure to ground-level ozone than those who are less active outdoors. It is ironic that, while physical inactivity is a key risk factor for many illnesses (cardiovascular diseases, diabetes, colon cancer, osteoporosis, and more), vigorous activity in polluted conditions can also be dangerous to health.

People with respiratory diseases, such as asthma, emphysema, and chronic bronchitis, are more vulnerable to the effects of ground-level ozone, and can experience the adverse effects of ozone earlier and at lower levels than less sensitive individuals. The elderly and people with cardiac diseases are also especially sensitive to ground-level ozone.

Other Effects of Ground-Level Ozone and Smog

Plant response to ozone exposure is a sequence of biochemical and physiological events, possibly resulting in visible foliar injury; altered carbohydrate allocation which compromises growth, reproduction, and overall plant health; and impacts on the competitive relationships within plant communities and ecosystems.[297] The foliage is the primary site of plant response to ozone exposure.

Ground-level ozone has been shown to reduce agricultural yields for many economically important crops, including soybeans, kidney beans, wheat, cotton, corn, peanuts, potatoes, sorghum, and turnips.[298] Foliar injuries to sensitive crops in response to ground-level ozone exposure have been demonstrated in New Brunswick (potato), Quebec (dry bean, soybean, tobacco), Ontario (dry bean, soybean, potato, tomato, onion, tobacco, cucumber, grape, peanut, radish) and British Columbia (pea, potato).[299] However, assessment of the impacts of ozone on agricultural yield is difficult because of the ubiquity of ground-level ozone exposure, the effect of meteorological variables on ozone distribution within crop canopies, and the effect of other

[296] Ibid.
[297] Bush et al. (1999, p. 8-1). http://dsp-psd.pwgsc.gc.ca/Collection/En42-17-7-1-1999E-4.pdf
[298] Ibid., p. 8-44.
[299] Ibid., p. 8-14.

factors that can alter plant response. In addition, plants are exposed to mixtures of air pollutants, rather than to a single pollutant at a time.

Tree foliage damage has been demonstrated in experimental and natural situations. These effects have the potential to alter the productivity, successional patterns, species composition, energy resource flow patterns, and biogeochemical patterns of forests.

It has been clearly demonstrated that ground-level ozone concentrations common in several areas of Canada are sufficient to reduce tree growth significantly.[300] Ozone damage may be reducing forest growth and timber yield of sensitive species such as maple, ash, white spruce, white pine, poplar, white birch, and red oak, and contributing to forest decline in some parts of Canada.[301] Numerous forest declines have occurred in Europe and North America in the last two centuries, and air pollutants, particularly ground-level ozone, are considered important in several of these episodes, including:[302]

• decline of pines in California's San Bernadino Mountains
• white pine mortality in the eastern United States
• multi-species forest decline in Germany's Black Forest and in central Europe
• reduced growth of yellow pines in the south-eastern US
• red spruce and Fraser fir declines in the eastern US
• decline of sugar maples in the north-eastern US and south-eastern Canada

Most forest declines reflect numerous stresses acting together and cannot be solely attributed to a single cause such as air pollution, much less to a single type of pollutant. However, findings in Europe and the US suggest that air pollutants are among the primary causes of forest decline (although the evidence is stronger for some species and some episodes than for others).

Based on a review of the literature, Environment Canada and Health Canada summarized the potential ground-level ozone damages to many different types of materials.[303] Ozone damages materials both functionally and aesthetically—alone, or synergistically in the presence of SO_2 and NO_x. Factors such as sunlight, heat, and moisture can influence the extent of damage to materials caused by pollutants. Observed effects of ground-level ozone on materials include:

• damage at the molecular level to materials such as natural rubber, general diene rubber, and polybutadiene, causing hardening and cracking;
• tensile strength reduction in cotton and silk;
• fading and discoloration of dyes;
• erosion of surface coatings such as oil-based house paints;
• corrosion of metals such as zinc, silver, aluminum, nickel, copper, and iron (primarily due to synergistic effects with SO_2); and
• damage to marble, sandstone, limestone, brick, concrete, and gravel (in combination with SO_2).

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[300] Ibid., p. 8-10.
[301] Commissioner of the Environment and Sustainable Development. (2000).
[302] MacKenzie and El-Ashry. (1989).
[303] Bush et al. (1999, p. 7-1 ff.). http://dsp-psd.pwgsc.gc.ca/Collection/En42-17-7-1-1999E-3.pdf

The Indicators

The Centre for Sustainable Transportation indicator on transport-related air pollution is an index that combines emissions of carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen oxides (NO_x), and volatile organic compounds (VOCs).[304] The CST index was constructed by normalizing the values for each year, with 1990 values for each pollutant being 100. The sum of the four results for each year was then multiplied by 0.25 to create the index for that year, since each pollutant would represent 25% of the total.

The comparable **GPI***Atlantic* indicator in this report adopts a model based on that of the CST, but includes TPM in the index, as well as SO_x, NO_x, VOCs, and CO. Because of this, the results in this chapter differ slightly from those of the CST, and the sum of the emissions results for all five pollutants for each year were multiplied by 0.20, rather than 0.25. In addition to this index of emissions, this report also looks at emissions trends for each Criteria Air Contaminant (CAC) individually, as the aggregate index alone may obscure important differences in the trends for each pollutant.

When aggregating the various pollutant emissions by tonnes of emissions, CO emissions tend to overwhelm and thus diminish the relative importance of the other pollutant emissions. Future updates of this work should consider weighting the emissions in proportion to their known health and environmental impacts.

The CST data source was a file supplied by Environment Canada as part of a series submitted in January, 2002, to meet international reporting requirements in connection with Canada's participation in the work of the United Nations Economic Commission for Europe (UN ECE).[305]

For this report, **GPI***Atlantic* used a different data source that provides information on total transportation-related pollutant emissions from 1990 through 2000. At the time these data sets were assembled for this report, the official Criteria Air Contaminant emission report had not been updated since 1995. Environment Canada therefore kindly provided **GPI***Atlantic* with unofficial results in advance of its publication of updated results in 2005.[306] This source offered the most current Canadian data available at the time this report was compiled—more recent than the data used in the CST indicator set, and preferable to any international estimates.

The indicators used to analyze air pollution from the Nova Scotia transportation sector in this report include:

- total transportation air pollutant emissions by mode
- total transportation air pollutant emissions per capita
- total on-road transportation air pollutants per vehicle-km
- combined index of air pollutant emissions from transportation

[304] Gilbert et al. (2002, p. 35).

[305] Centre for Sustainable Transportation. *Sustainable Transportation Performance Indicators: Underlying Data and Calculations*, pg. 4. (Mississauga: 2003). www.cstctd.org/english/docs/STPI%20data%20and%20calculations,%20English.pdf Accessed August, 2004.

[306] Taylor, Brett. Emissions Inventory Information Analyst, Environment Canada. (Personal communication: July 20, 2004).

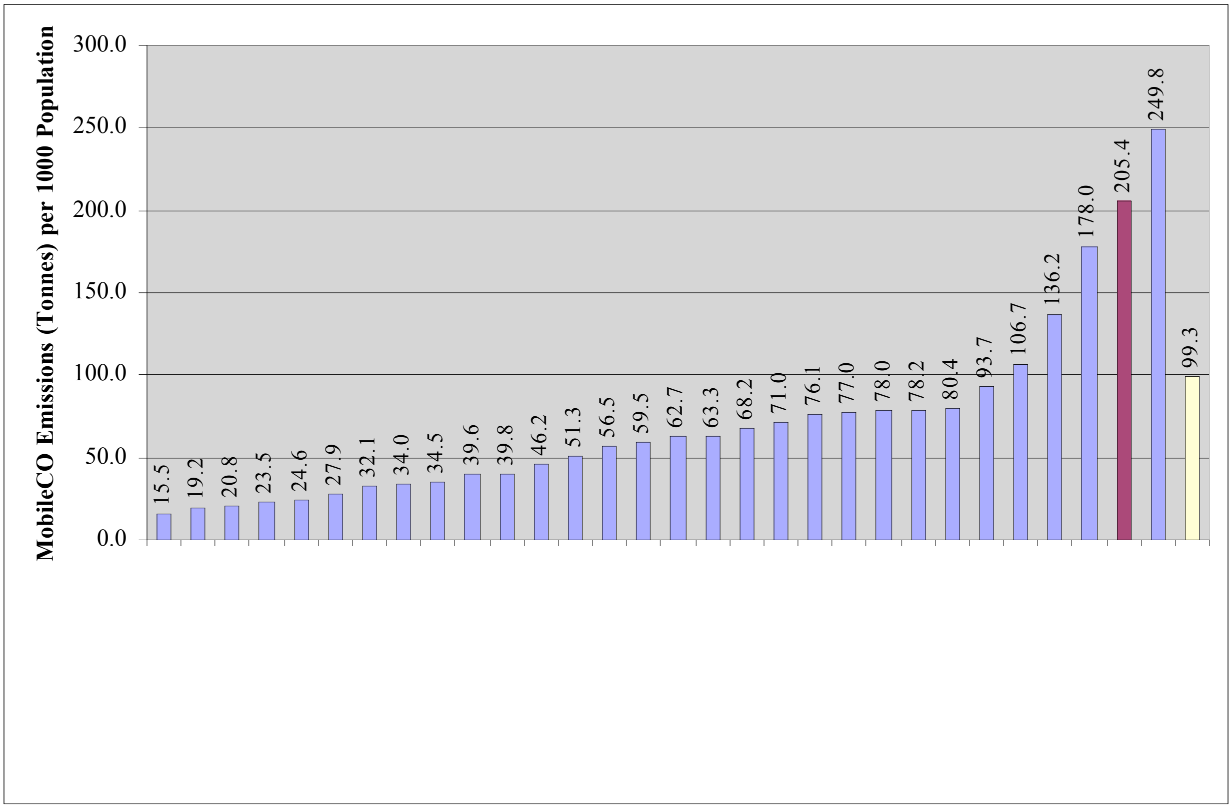
- total combined air pollutant emissions from transportation.

Trends: International

When emissions of air pollutants from Canada's transportation sector are compared on a per capita basis with other countries in the Organization for Economic Co-operation and Development (OECD), Canada's road transport dependence and significant contribution to transport-related air pollution are clearly illustrated.

Figure 85 presents mobile (transport-related) emissions of CO per 1,000 people for the OECD countries. By this measure, Canada had the second highest emissions out of the 30 countries, with Canadian emissions more than double the average per capita emissions for the OECD countries. The only country with higher per capita CO emissions from transportation is the United States. Canada's per capita emissions are more than three times those of the United Kingdom and six times those of Germany. Japan and Korea have the lowest per capita emissions of CO from transportation in the OECD.

Figure 85. OECD Countries: Mobile CO Emissions per 1,000 Persons, Late 1990s (tonnes).[307]

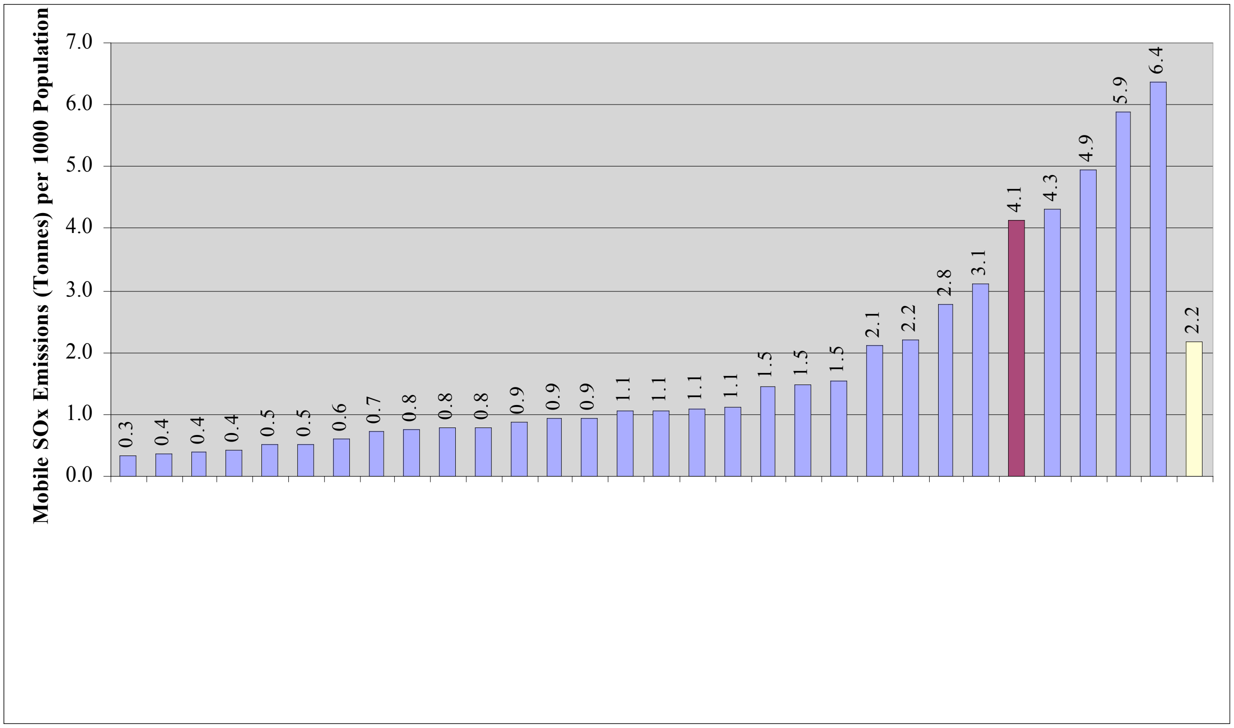


Source: Organisation for Economic Co-operation and Development. *OECD Environmental Data—Compendium 2002*, Tables 2.2D and 12.1A.

The results are similar for mobile emissions of SO_x per capita, where Canada had the fifth highest emissions out of the 30 OECD countries (Figure 86). Canada's emissions are almost twice the OECD average. The only countries with higher per capita SO_x emissions from transportation than Canada are Greece, Iceland, South Korea, and the United States. The three countries with the lowest per capita transport-related SO_x emissions are Switzerland, Hungary, and Germany. Canada's per capita transport-related SO_x emissions are more than five times greater than those of the UK and almost eleven times greater than those of Germany.

[307] The most recent years for which statistics on mobile emissions were available for the OECD countries varied between countries from 1997 to 2000. The average year of the data used was found to be 1999, and therefore this year was selected for the population statistics used by GPI Atlantic to derive the comparative per capita estimates. The same method was applied to Figures 86-88.

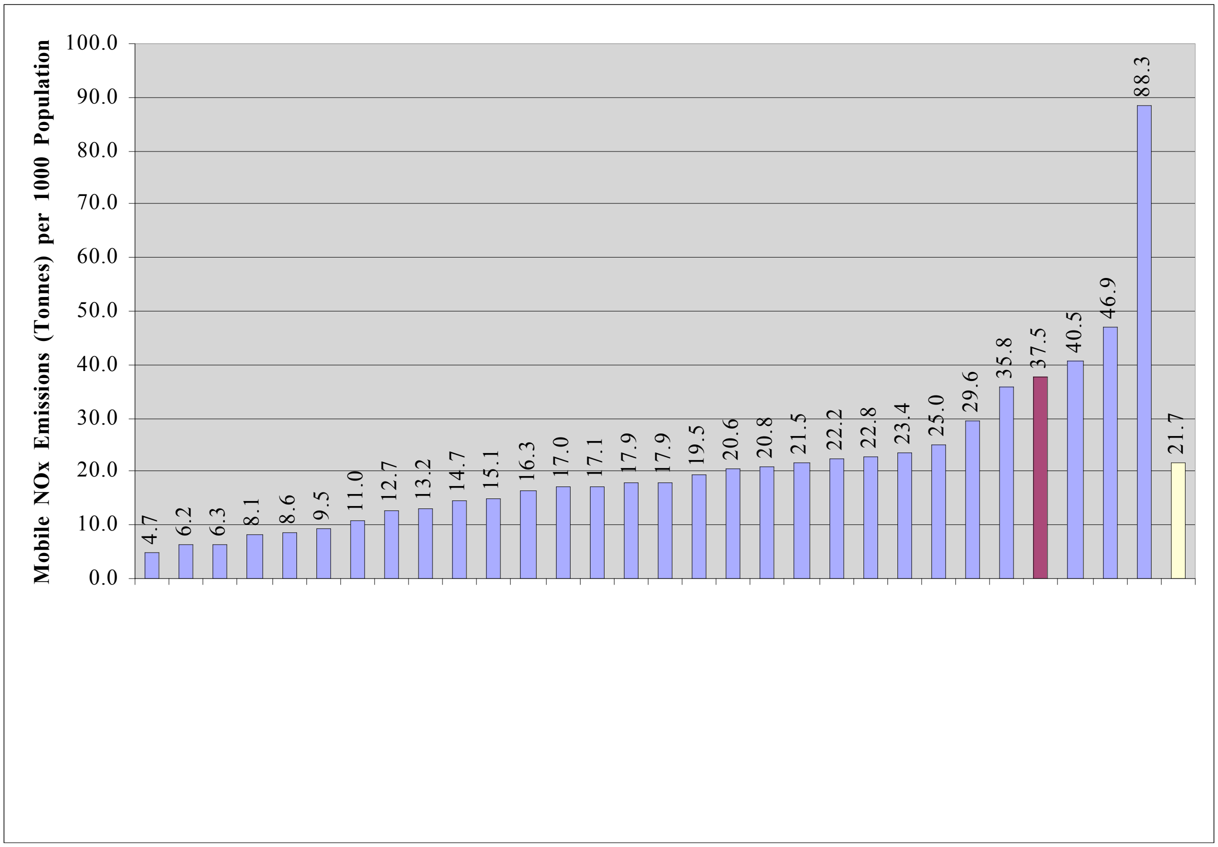
Figure 86. OECD Countries: Mobile SO_x Emissions per 1,000 Persons, Late 1990s (tonnes).



Source: Organisation for Economic Co-operation and Development. *OECD Environmental Data—Compendium 2002*, Tables 2.2A and 12.1A.

The comparison of transport-related NO_x emissions with other OECD countries places Canada with the fourth highest emissions out of 30, with only Iceland, the USA and New Zealand having higher per capita emissions (Figure 87). Canada's per capita mobile NO_x emissions are three times greater than those of Germany.

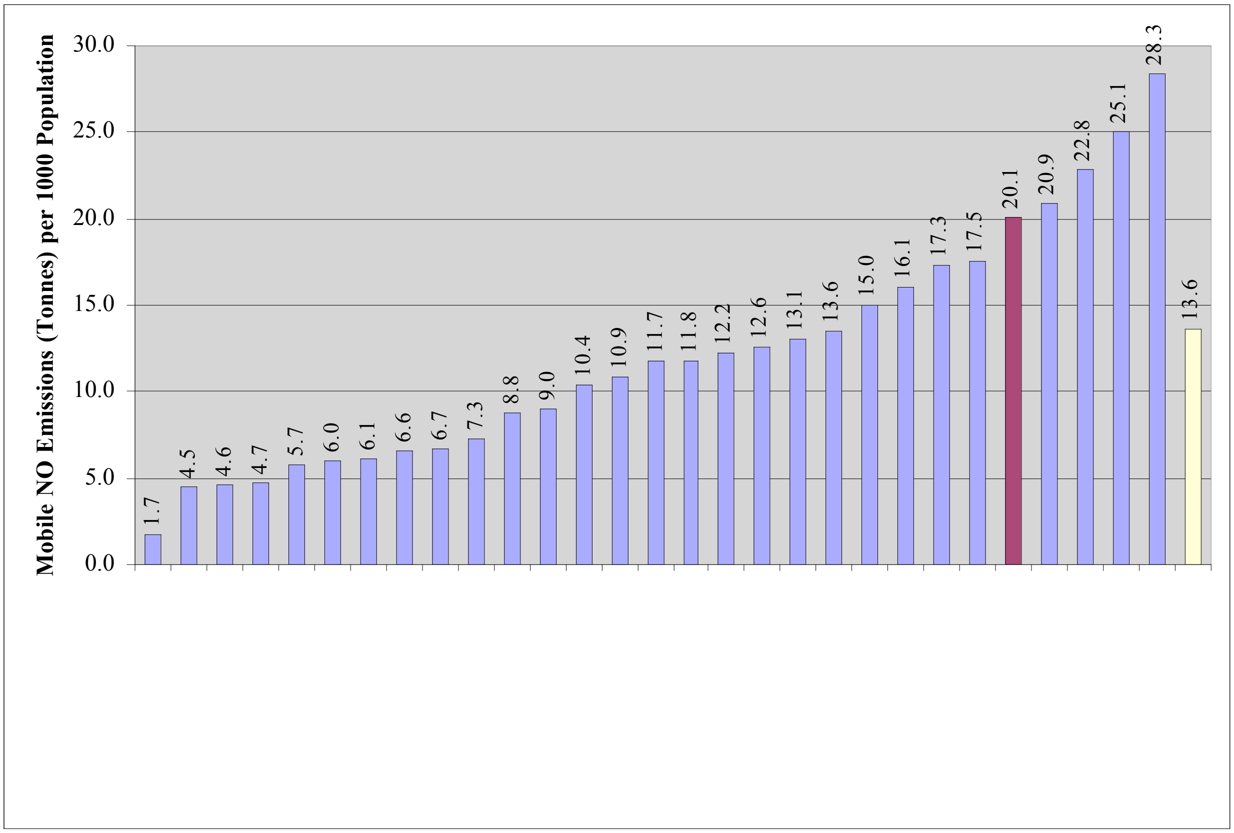
Figure 87. OECD Countries: Mobile NO_x Emissions per 1,000 Persons, Late 1990s (tonnes).



Source: Organisation for Economic Co-operation and Development. *OECD Environmental Data—Compendium 2002*, Tables 2.2B and 12.1A.

For per capita mobile emissions of VOCs, Canada has the fifth highest emissions out of 29 countries (no data were provided for South Korea). The four countries with per capita emissions higher than Canada are Greece, Australia, New Zealand, and the United States. Canada's per capita transport-related VOC emissions are four times greater than those of Germany (Figure 88).

Figure 88. OECD Countries: Mobile VOC Emissions per 1,000 Persons, Late 1990s (tonnes).

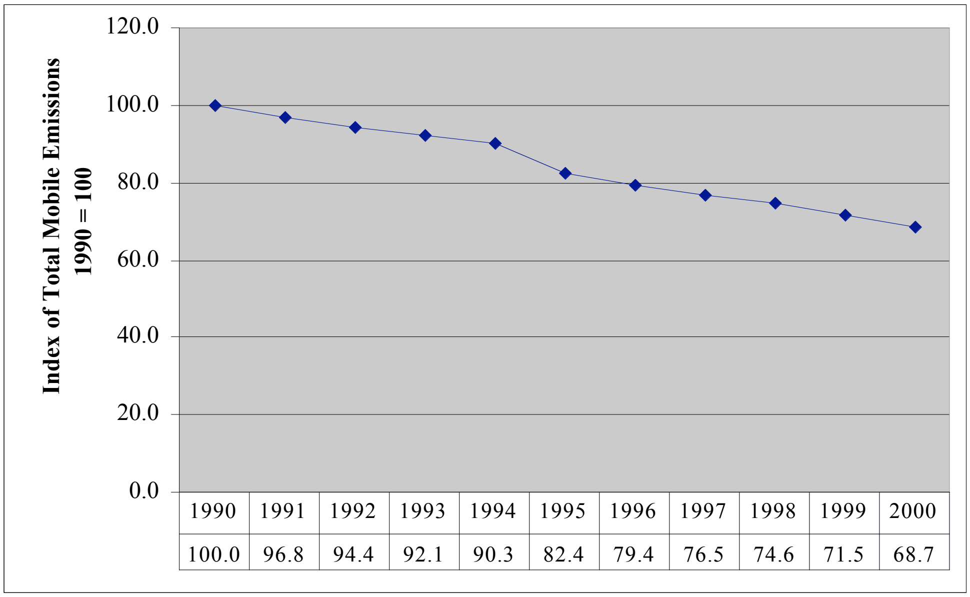


Source: Organisation for Economic Co-operation and Development. *OECD Environmental Data—Compendium 2002*, Tables 2.2E and 2.1A.

Trends: Canada

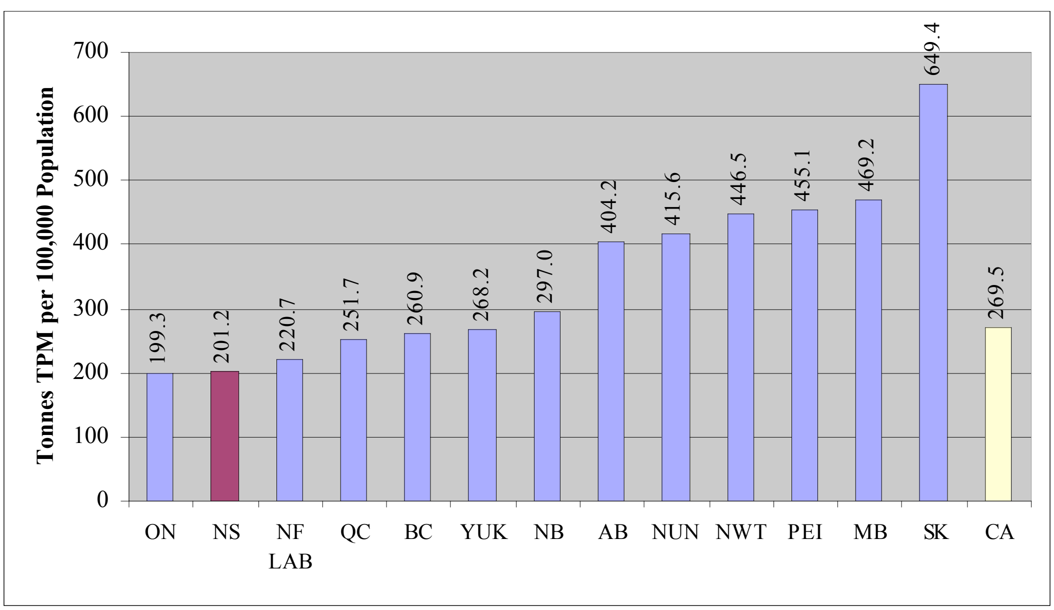
As described above, **GPI***Atlantic* has constructed a transport-related air pollution index as a weighted index of the aggregate transport-related emissions of five criteria air pollutants, based on the CST model that examined four pollutants. As shown in Figure 89, for Canada this index declined significantly from 1990 to 2000—representing an improvement of 31% (since lower values signify a decline in emissions).

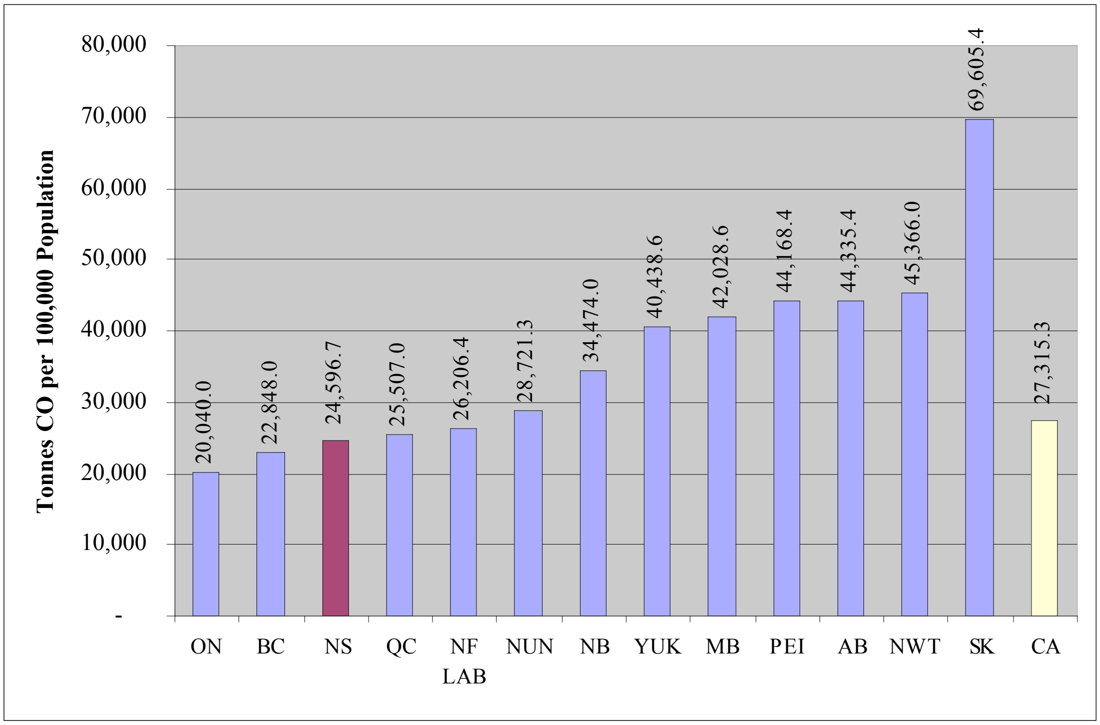
Figure 89. Canada: Index of Total Air Pollutant Emissions from Mobile Sources, 1990-2000. (Normalized to 1990 = 100).

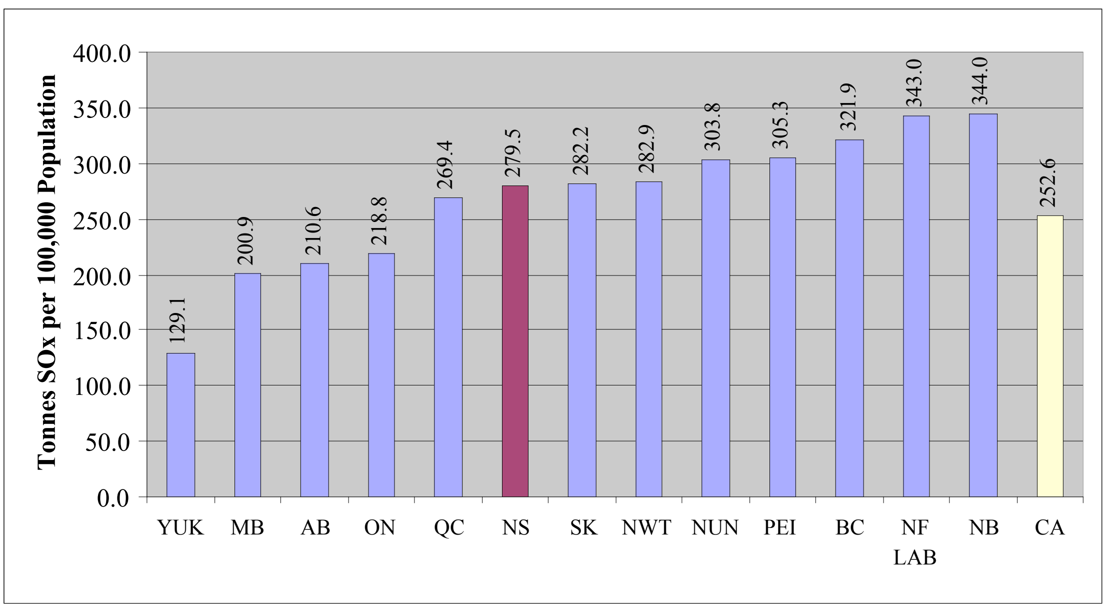


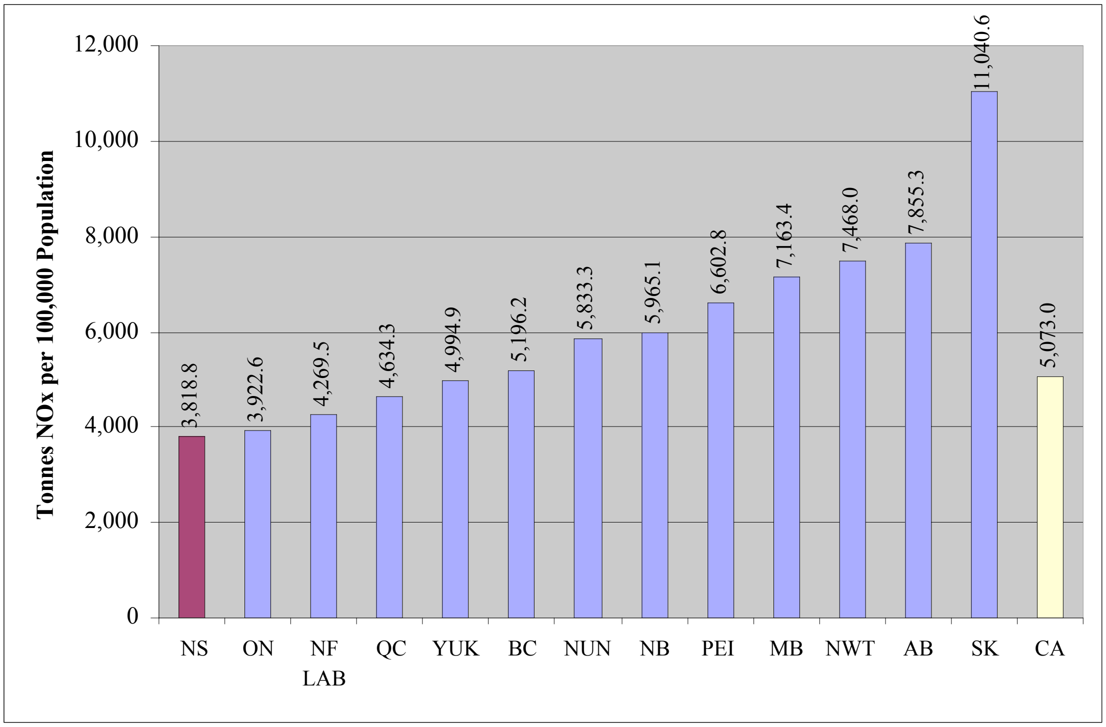
Sources: Richard Gilbert et al. *Sustainable Transportation Performance Indicators (STPI) Project: Report on Phase 3,* and personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. December, 2004.

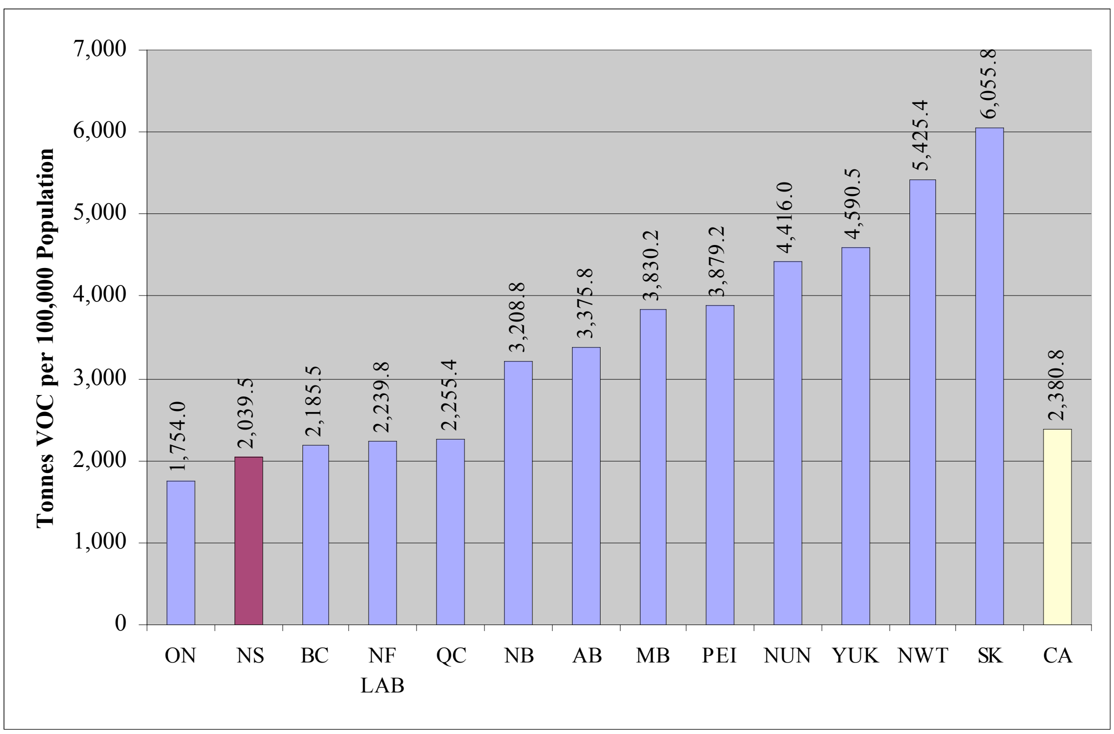
Figure 90. Criteria Air Contaminant Emissions from Mobile Sources, per 100,000 Persons, 2000 (Tonnes) – TPM, CO, SOx, NOx, VOCs.




Tonnes CO per 100,000 Population
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
20,040.0
22,848.0
24,596.7
25,507.0
26,206.4
28,721.3
34,474.0
40,438.6
42,028.6
44,168.4
44,335.4
45,366.0
69,605.4
27,315.3
ON
BC
NS
QC
NF LAB
NUN
NB
YUK
MB
PEI
AB
NWT
SK
CA


Tonnes SOx per 100,000 Population
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
129.1
200.9
210.6
218.8
269.4
279.5
282.2
282.9
303.8
305.3
321.9
343.0
344.0
252.6
YUK
MB
AB
ON
QC
NS
SK
NWT
NUN
PEI
BC
NF LAB
NB
CA



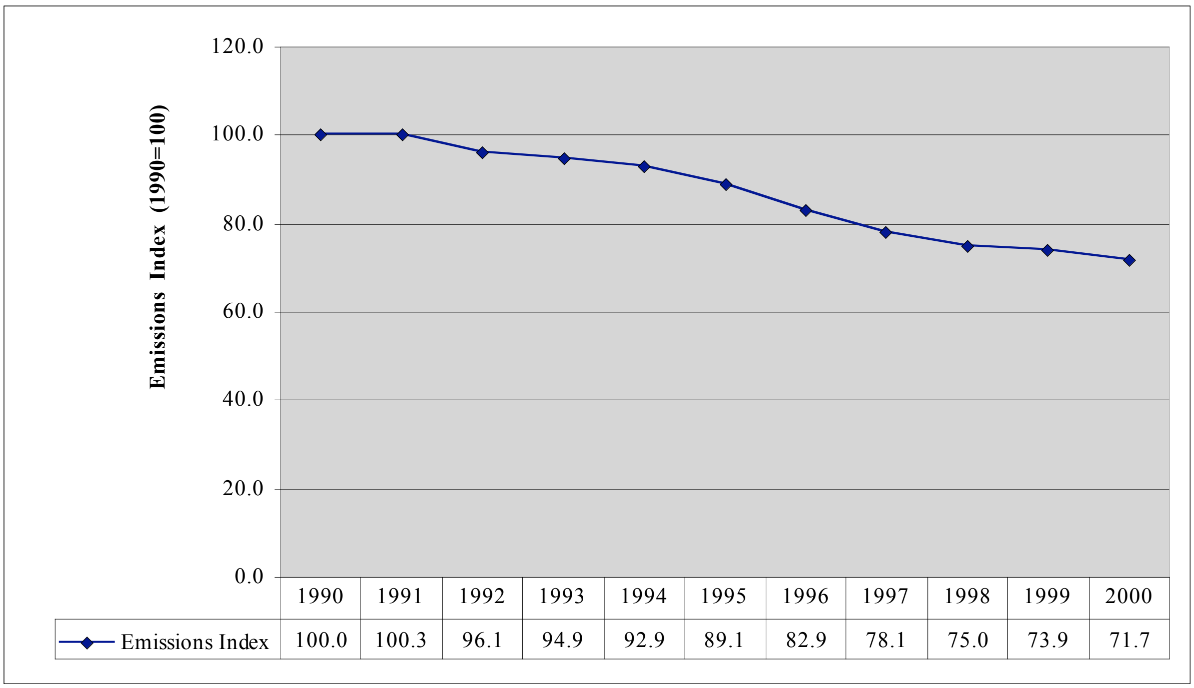


Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. December, 2004.

Trends: Nova Scotia

Figure 91 presents the index of total air pollutant emissions for all mobile (transport-related) sources in Nova Scotia from 1990 to 2000. The trend is similar to that for Canada, although the decline in emissions for Nova Scotia is 28%, compared with 31% for Canada. In both cases, the clear trend towards lower transport-related pollutant emissions indicates steady movement towards greater sustainability in this area.

Figure 91. Nova Scotia: Index of Total Air Pollution Emissions from all Mobile Sources, 1990–2000. (Normalized to 1990 = 100)



Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004.

Carbon Monoxide Emissions

Total estimated Nova Scotia carbon monoxide emissions in 2000 were more than 290 kilotonnes (kt). They are presented by category in Table 18.

Table 18. Nova Scotia: CO Emissions, by Category, 2000 (tonnes).

CATEGORY	TONNES CO
TOTAL INDUSTRIAL SOURCES	5,818
TOTAL NON-INDUSTRIAL FUEL COMBUSTION (mostly residential fuel wood combustion)	52,778
TRANSPORTATION	
Air Transportation	990
Heavy-duty diesel vehicles (HDDV)	3,575
Heavy-duty gasoline trucks (HDGT)	2,003
Light-duty diesel trucks (LDDT)	126
Light-duty diesel vehicles (LDDV)	122
Light-duty gasoline trucks (LDGT)	75,658
Light-duty gasoline vehicles (LDGV)	79,103
Marine Transportation	318
Motorcycles (MC)	279
Off-road use of diesel	3,854
Off-road use of gasoline	63,517
Rail Transportation	159
Tire wear & Brake lining	0
TOTAL TRANSPORTATION	***229,704***
TOTAL INCINERATION	1,942
TOTAL MISCELLANEOUS	389
TOTAL OPEN SOURCES*	2,476
TOTALS	
TOTAL WITH OPEN SOURCES	293,106
TOTAL WITHOUT OPEN SOURCES	290,630

Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004.

* Open sources include emissions from sources such as construction, dust from paved and unpaved roads, landfill sites, wind erosion from agricultural activities, and forest fires.

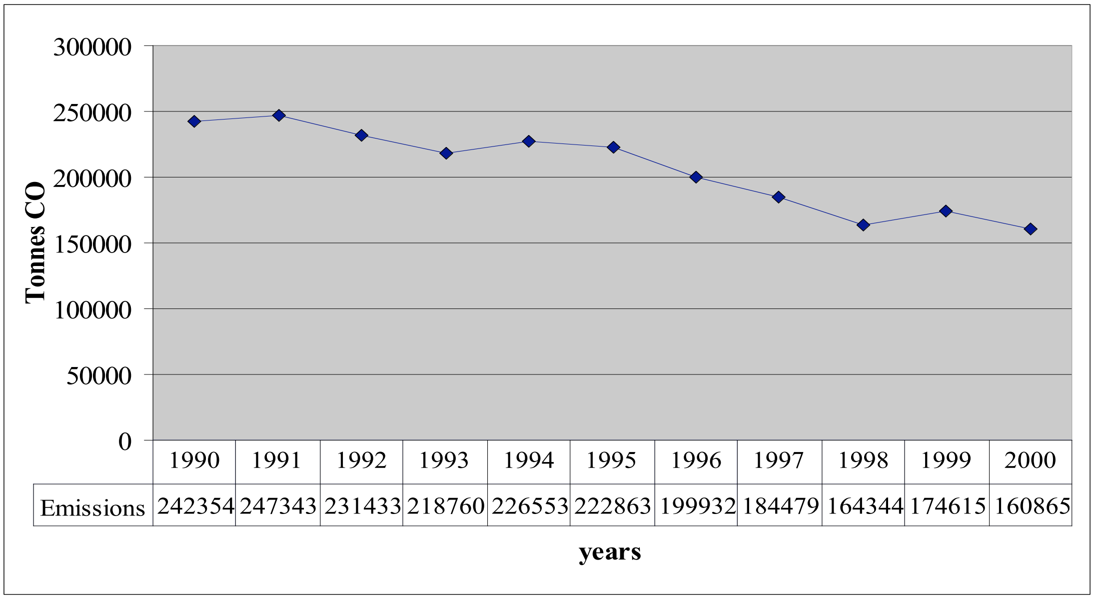
Transport-related sources accounted for 78% of total CO emissions in the province. Of the total of 229.7 kilotonnes of CO emitted by the transportation sector, 154.7 kt or 67% came from light-duty gasoline trucks (76 kt) and light duty gasoline vehicles, including cars, vans, and SUVs (79 kt).[308] Off-road vehicles, including ATVs, snowmobiles, and farm equipment, accounted for 67

[308] The term "vehicle" in this sentence refers to all motorized traffic exclusive of light-duty gasoline trucks. There are no universally accepted names or weight limits for the various transportation category sources. This has resulted in differences in definition and methods of calculating greenhouse gas emissions inventories and criteria air contaminant emissions inventories in Canada. In *Canada's Greenhouse Gas Emissions Inventories*, transportation emissions are calculated and categorised in accordance with the Intergovernmental Panel on Climate Change (IPCC) reporting procedures. Canada's emissions estimates for criteria air contaminants are calculated using the designations of the United States Environmental Protection Agency (USEPA). Under the IPCC definitions, sport utility vehicles (SUVs), vans, and mini-vans fall under the light-duty gasoline trucks source sector. Under the USEPA designations, SUVs and mini-vans fall under the light-duty vehicles source sector.

kt or 29% of transport-related CO emissions. The major non-transportation source of CO emissions in Nova Scotia in 2000 was residential fuel wood combustion, at 47 kt, which is the largest source of CO emissions from stationary non-industrial fuel combustion.

Figure 92 shows Nova Scotia's emissions trends for On-Road carbon monoxide emissions from 1990-2000. Just as Nova Scotia's total transport-related Criteria Air Contaminant emissions decreased during this decade, so too did transportation emissions from carbon monoxide, falling by 33.6%.

Figure 92. Nova Scotia: On-Road CO Emissions, 1990-2000 (tonnes).



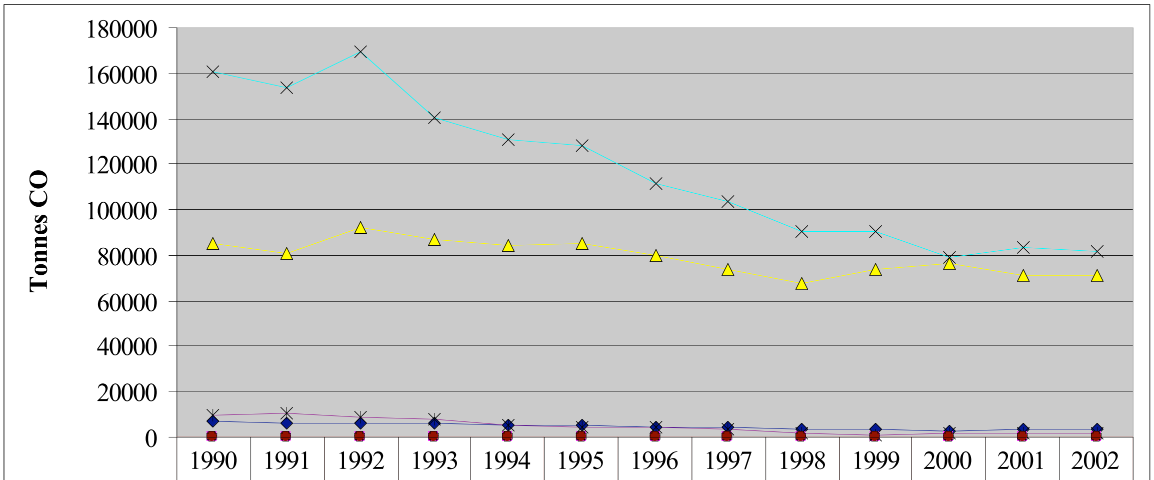
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Emissions	242354	247343	231433	218760	226553	222863	199932	184479	164344	174615	160865

Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004.

Figure 93 provides a breakdown of the emissions of CO by vehicle type. The main forms of transportation responsible for the emissions of CO are light duty gasoline trucks and light duty gasoline vehicles. The CO emissions from light duty gasoline vehicles decreased markedly by 49% from 1990 to 2002, while emissions from light duty gasoline trucks declined by 16%. CO emissions from heavy duty diesel vehicles declined by 56%. Although not clearly depicted in Figure 93 due to their tiny proportion of total emissions, light duty diesel vehicles were the only category to experience an increase in CO emissions. These emissions increased by 27%, from 217 tonnes in 1990, to 275 tonnes in 2002.

For more information on the definitions of source categories and sectors, see Environment Canada's Greenhouse Gas Emissions and Air Pollutant Emissions web sites at: www.ec.gc.ca/pdb/ghg/1990_99_report/sec2_1_e.cfm and www.ec.gc.ca/pdb/ape/cape_gloss_e.cfm .

Figure 93. Nova Scotia: Emissions of CO, by Vehicle Type, 1990-2002.



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
HDDV	7081	6472	6069	5709	5097	5061	4558	4176	3666	3075	2964	3369	3083
LDDV	216	190	242	265	266	274	255	254	234	257	252	257	275
LDGT	85174	80419	92013	86523	84452	85379	79782	74016	68001	73778	76407	70932	71311
LDGV	160859	153617	169335	140450	130780	127758	111794	103276	90298	90094	79403	83728	81770
HDGT	9891	10206	9063	8021	5657	4494	4182	3089	2127	1262	1629	1789	1427
MC	397	392	367	358	335	306	382	294	305	300	275	292	311

Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004.

Note: HDDV = heavy-duty diesel vehicles. LDDV = light-duty diesel vehicles. LDGT = light-duty gasoline trucks. LDGV = light-duty gasoline vehicles. HDGT = heavy duty gasoline trucks. MC = motorcycles.

Particulate Matter Emissions

As discussed previously, for statistical purposes there are two classifications of particulate matter, $PM_{2.5}$ and PM_{10}, which are of particular importance from a human health and toxicity perspective. These finer particles, with very small diameters, pose a greater threat to human health because they can travel deeper into the lungs than larger, coarser particles, and they are therefore considered to be "toxic" under the 1999 *Canadian Environmental Protection Act* (CEPA).

Table 19 shows PM emissions by category in Nova Scotia for the year 2000. The province's total $PM_{2.5}$ emissions were 27 kilotonnes (kt); total PM_{10} emissions were 107 kt. Transportation contributed six percent of total $PM_{2.5}$ emissions, and just 1.7% of PM_{10} emissions.

Table 19. Nova Scotia: $PM_{2.5}$ and PM_{10} Emissions, 2000 (tonnes).

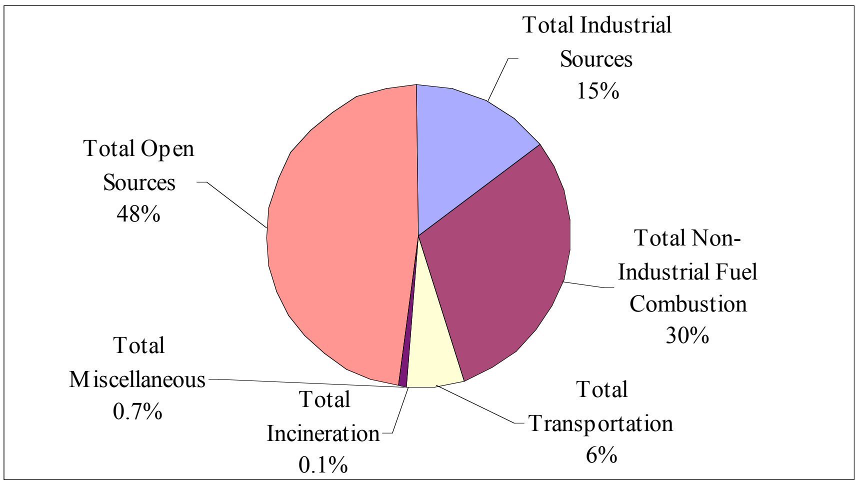
CATEGORY	TONNES $PM_{2.5}$	TONNES PM_{10}
TOTAL INDUSTRIAL SOURCES	4,050	8,078
TOTAL NON-INDUSTRIAL FUEL COMBUSTION	8,135	10,899
TRANSPORTATION		
Air Transportation	*22*	*31*
Heavy-duty diesel vehicles (HDDV)	*439*	*475*
Heavy-duty gasoline trucks (HDGT)	*3*	*4*
Light-duty diesel trucks (LDDT)	*16*	*18*
Light-duty diesel vehicles (LDDV)	*16*	*18*
Light-duty gasoline trucks (LDGT)	*26*	*31*
Light-duty gasoline vehicles (LDGV)	*22*	*23*
Marine Transportation	*199*	*217*
Motorcycles (MC)	*0*	*0*
Off-road use of diesel	*653*	*709*
Off-road use of gasoline	*160*	*174*
Rail Transportation	*18*	*20*
Tire wear & Brake lining	*46*	*131*
TOTAL TRANSPORTATION	***1,620***	***1,851***
TOTAL INCINERATION	35	49
TOTAL MISCELLANEOUS	196	245
OPEN SOURCES		
Agriculture (Animals)	162	1,019
Agriculture (Tilling and Wind Erosion)	58	1,792
Construction Operations	347	17,126
Dust from Paved Roads	**6,360**	**26,594**
Dust from Unpaved Roads	**5,903**	**39,191**
Forest Fires	211	256
Landfill Sites	3	12
Mine Tailings	1	5
TOTAL OPEN SOURCES	13,045	85,996
TOTALS		
TOTAL WITH OPEN SOURCES	27,082	107,117
TOTAL WITHOUT OPEN SOURCES	14,037	21,121

Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004. Road dust sub-categories are bolded above because of their magnitude and relation to transportation.

By far the largest source of both $PM_{2.5}$ and PM_{10} emissions in Nova Scotia in 2000 was dust from paved and unpaved roads. These two road-based sources released a total of 32,954 tonnes and

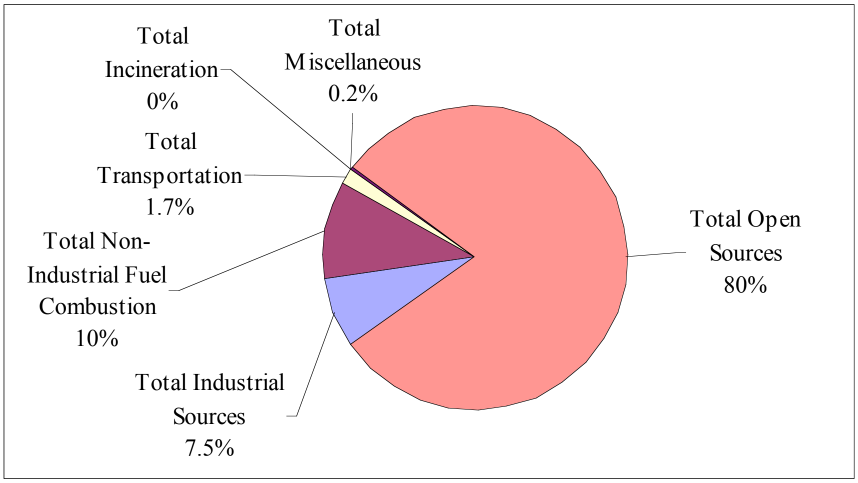
45,094 tonnes of fine particulate matter respectively, accounting for 58% of total $PM_{2.5}$ and PM_{10} releases in the province. While automobile tailpipe emissions do not contribute significantly to the quantity of particulate matter released, traffic over both paved and unpaved roads is responsible for a large proportion of the particulate matter released from roads in the form of dust. As well, roads exist primarily ***for*** motorized transportation. Though not officially listed as transport-related emissions, the largest proportion of "open source" emissions of $PM_{2.5}$ and PM_{10} is therefore directly attributable to motorized transportation. When the 3,471 tonnes of fine particulate emissions from transportation sources are added to the 78,048 tonnes of emissions arising from road dust, transportation is actually seen to be responsible for 61% of fine particulate emissions in the province. The percentage breakdown of particulate matter sources is included in Figures 94 and 95.

Figure 94. Nova Scotia: $PM_{2.5}$ Emissions by Source in percentages, 2000.



Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004. Note that road dust is responsible for 94 per cent of open source emissions above.

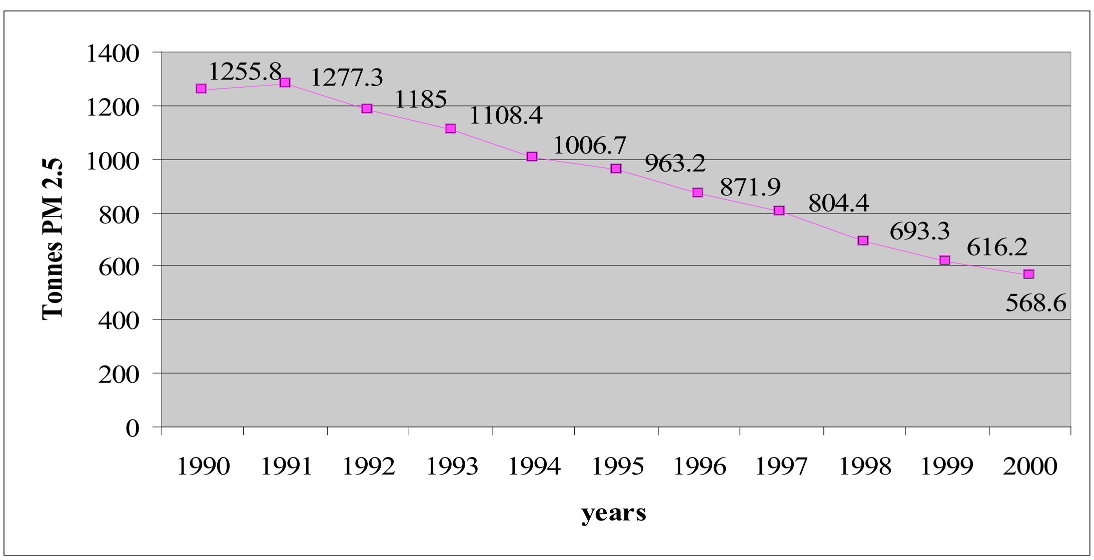
Figure 95. Nova Scotia: PM_{10} Emissions by Source in percentages, 2000.



Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004. Note that road dust is responsible for 76.5% of open source emissions above.

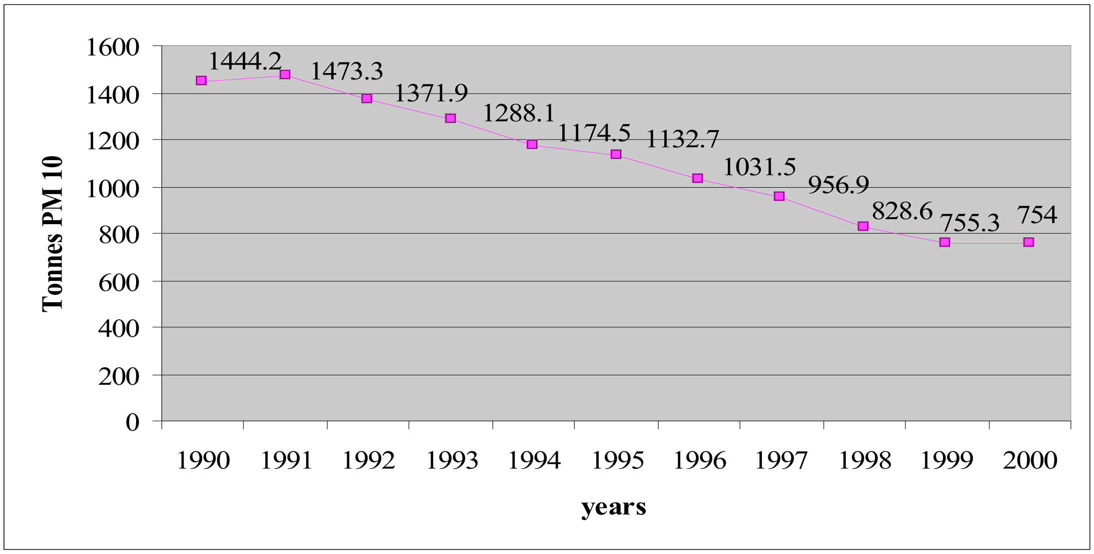
Figures 96 and 97 show Nova Scotia's trends for specific on-road transport-related $PM_{2.5}$ and PM_{10} emissions from 1990 to 2000. Just as Nova Scotia's total Criteria Air Contaminant emissions decreased in the past decade, so too did on-road transportation emissions from fine particulate matter. On-road transport-related $PM_{2.5}$ emissions fell by 55% while on-road PM_{10} emissions fell by 48% during the same period.

Figure 96. Nova Scotia: On-Road Emissions of $PM_{2.5}$, 1990-2000 (tonnes).



Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004.

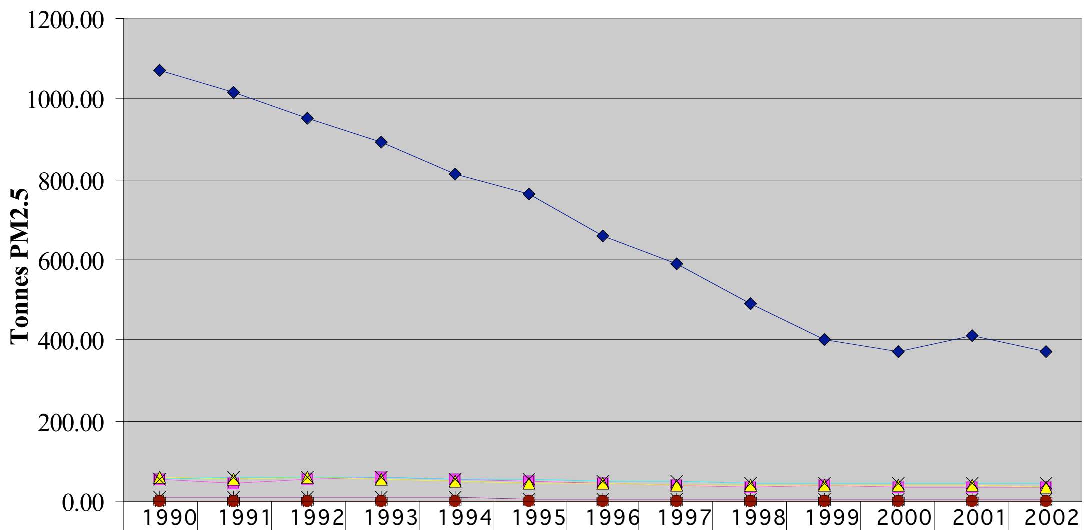
Figure 97. Nova Scotia: On-Road Emissions of PM_{10}, 1990-2000 (tonnes).



Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004.

Figures 98 and 99 provide the breakdown of emissions by transportation mode for both $PM_{2.5}$ and PM_{10}. The heavy-duty diesel vehicle category is by far the main contributor of fine PM emissions in the province while all other categories emit much smaller amounts. The emissions from heavy-duty diesel vehicles have declined significantly for both categories of fine particulate matter, with $PM_{2.5}$ decreasing by 66% and PM_{10} by 64% during the 1990-2002 period. All other modes show diminished emissions over this period, but mostly by relatively smaller amounts when compared to the heavy-duty diesel vehicle category.

Figure 98. Nova Scotia: On-Road $PM_{2.5}$ Emissions, by Mode, 1990-2002 (tonnes).

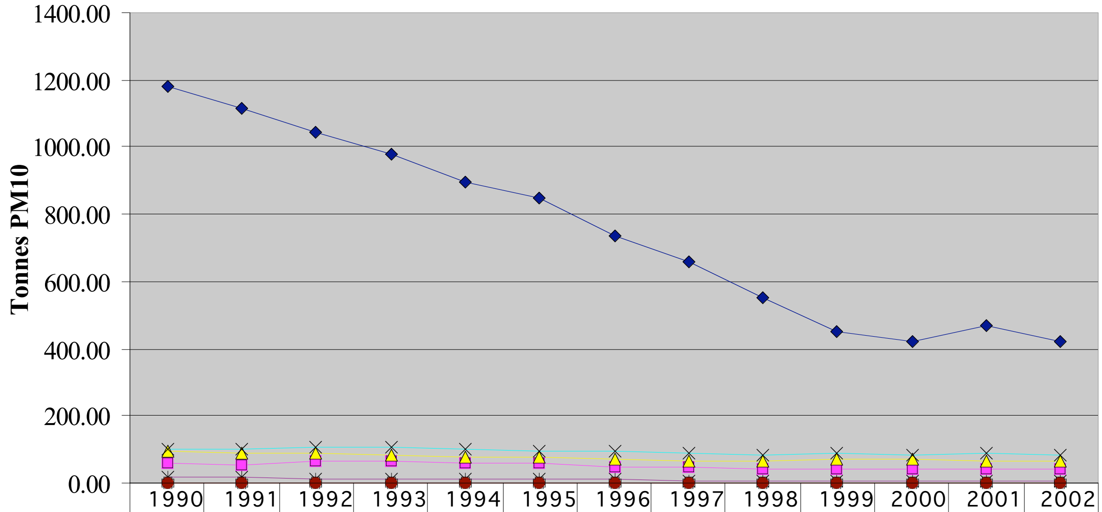


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
HDDV	1072.9	1016.	950.9	892.9	815.7	764.7	660.7	590.8	490.9	400.6	373.7	412.5	369.9
LDDV	53.53	45.51	56.78	57.20	54.22	51.37	44.56	42.00	35.37	37.31	35.32	35.41	36.26
LDGT	57.86	55.38	58.67	53.49	48.48	46.81	43.96	39.85	38.57	39.71	41.04	37.44	35.78
LDGV	52.21	57.32	58.67	58.45	55.44	52.20	50.74	48.34	45.50	44.99	42.58	44.55	42.46
HDGV	10.22	10.77	9.82	8.95	7.55	6.83	6.56	5.28	4.04	3.00	3.37	3.96	3.44
MC	0.54	0.56	0.52	0.51	0.48	0.44	0.55	0.42	0.45	0.43	0.40	0.41	0.44

Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004.

Note: HDDV = heavy-duty diesel vehicles. LDDV = light-duty diesel vehicles. LDGT = light-duty gasoline trucks. LDGV = light-duty gasoline vehicles. HDGT = heavy duty gasoline trucks. MC = motorcycles.

Figure 99. Nova Scotia: On-Road PM_{10} Emissions, by Mode, 1990-2002 (tonnes).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
HDDV	1178.	1115.	1043.	980.4	897.1	845.3	732.7	658.4	550.7	452.6	423.6	470.4	423.4
LDDV	59.85	50.80	63.37	63.87	60.62	57.77	50.29	47.53	40.20	42.52	40.43	40.64	41.69
LDGT	92.42	87.05	91.80	84.61	77.48	76.77	72.65	67.22	63.38	69.32	71.39	66.99	65.93
LDGV	99.07	103.4	105.4	104.4	100.0	97.62	94.39	90.89	82.38	87.10	81.27	87.04	85.23
HDGV	15.47	16.27	14.79	13.44	11.23	10.12	9.68	7.74	5.83	4.29	4.82	5.61	4.85
MC	0.96	0.99	0.92	0.91	0.85	0.77	0.98	0.75	0.79	0.76	0.70	0.74	0.78

Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004.

Note: HDDV = heavy-duty diesel vehicles. LDDV = light-duty diesel vehicles. LDGT = light-duty gasoline trucks. LDGV = light-duty gasoline vehicles. HDGT = heavy duty gasoline trucks. MC = motorcycles.

SOx Emissions

Total estimated Nova Scotia SO_x emissions in 2000 were 166 kt. They are presented by category in Table 20.

Table 20. Nova Scotia: SO_x Emissions, by Category, 2000 (tonnes).

CATEGORY	TONNES SO_X
TOTAL INDUSTRIAL SOURCES	17,129
NON-INDUSTRIAL FUEL COMBUSTION	
Commercial Fuel Combustion	3,404
Electric Power Generation (Utilities)	139,745
Residential Fuel Wood Combustion	103
Residential Fuel Combustion (Other)	3,298
TOTAL NON-INDUSTRIAL FUEL COMBUSTION	146,549
TRANSPORTATION	
Air Transportation	*104*
Heavy-duty diesel vehicles (HDDV)	*280*
Heavy-duty gasoline trucks (HDGT)	*7*
Light-duty diesel trucks (LDDT)	*14*
Light-duty diesel vehicles (LDDV)	*7*
Light-duty gasoline trucks (LDGT)	*162*
Light-duty gasoline vehicles (LDGV)	*175*
Marine Transportation	*1,585*
Motorcycles (MC)	*1*
Off-road use of diesel	*195*
Off-road use of gasoline	*28*
Rail Transportation	*38*
Tire wear & Brake lining	*0*
TOTAL TRANSPORTATION	***2,596***
TOTAL INCINERATION	103
TOTAL	**166,377**

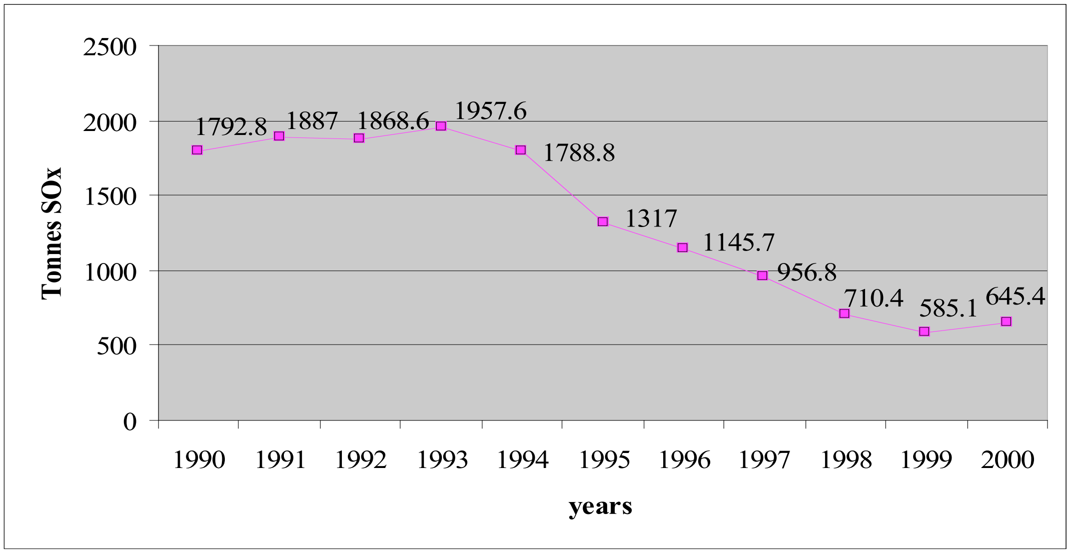
Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004.

In 2000, 88% of Nova Scotia's SO_x emissions came from the non-industrial fuel combustion category. Ninety-five percent of these non-industrial fuel combustion emissions, and 84% of total SO_x emissions in the province, resulted from electrical power generation by utilities (139.7 kt).

Transportation is not a comparatively large source of SO_x emissions, accounting for just 1.6% of total SO_x emissions in Nova Scotia. Transportation-related emissions of SO_x decreased between 1990 and 2000, just as the Nova Scotia total SO_x emissions did. SO_x emissions from on-road transportation fell by 64% during this period (Figure 100).

However, it should be noted that there was an increase in SO_x emissions from 1999 to 2000. While this does not constitute a trend, the recent rise in emissions is a potential cause for concern, as it may indicate that the measures used to reduce emissions sharply and effectively between 1993 and 1999 may no longer be sufficient to combat the increase in heavy truck freight, automobile usage, and overall transport activity, which in turn may lead to emissions increases.

Figure 100. Nova Scotia: On-Road SO_x Emissions, 1990-2000 (tonnes).



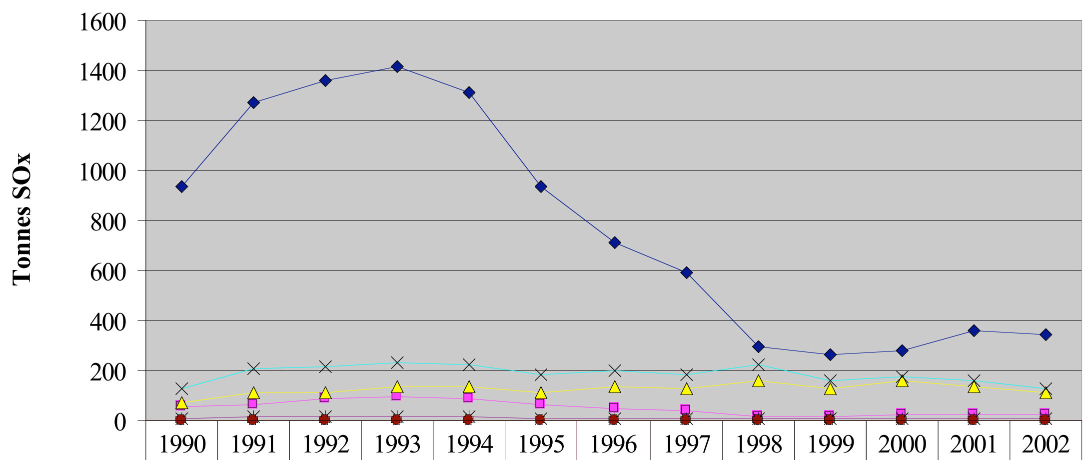
Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004.

Figure 101 presents the emissions of SO_x by mode of transportation. The most significant change over time has been in the SO_x emissions from heavy-duty diesel vehicles, which are the largest emitters of SO_x of any vehicle category. These emissions rose from 1990 to 1993, then declined sharply to 1999, and rose slightly to 2002. Overall, SO_x emissions from heavy-duty diesel vehicles fell by 62.8% between 1990 and 2002. The recent increase in emissions may be due to the growth in heavy truck freight noted earlier, which may begin to erode some of the significant gains in emission reductions achieved in the 1990s.

Light-duty diesel vehicles also experienced a decline in emissions of 57.3% over the same period, though they account for only a very small portion of total vehicle emissions. Heavy-duty gas vehicles fell by 37.2%, but contribute an even smaller portion of overall emissions.

Two vehicle categories which account for considerably larger numbers of vehicles and a considerably higher proportion of emissions increased their SO_x emissions between 1990 and 2002, with light-duty gasoline vehicle emissions rising by two percent (2.5 tonnes) and light-duty gasoline truck emissions rising by 65% (44.3 tonnes). SO_x emissions from light-duty gasoline trucks actually more than doubled between 1990 and 2000, before declining somewhat; and SO_x emissions from light-duty gasoline vehicles increased by 76% between 1990 and 1998 before falling back towards 1990 levels. The increased numbers of SUVs, minivans, and light trucks on the road may help explain the increase in SO_x emissions in these two vehicle categories.

Figure 101. Nova Scotia: On-Road SO_x Emissions, by Mode, 1990-2002 (tonnes).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
HDDV	936.01	1272.5	1361.8	1417.6	1315.1	936.28	713.40	591.11	292.65	260.31	277.34	359.54	347.74
LDDV	54.31	66.69	89.27	98.41	91.87	66.45	49.78	39.30	18.50	18.65	20.64	21.96	23.17
LDGT	68.80	111.24	114.94	136.72	136.63	114.99	132.46	128.08	163.67	130.86	161.95	138.52	113.14
LDGV	126.15	205.84	213.58	232.52	224.16	182.85	196.94	184.99	221.56	161.78	174.88	163.37	128.63
HDGT	7.81	14.24	13.71	14.33	13.14	9.99	10.97	8.95	9.64	5.15	6.72	6.92	4.91
MC	0.44	0.75	0.72	0.78	0.73	0.54	0.76	0.56	0.81	0.51	0.54	0.49	0.41

Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004.

Note: HDDV = heavy-duty diesel vehicles. LDDV = light-duty diesel vehicles. LDGT = light-duty gasoline trucks. LDGV = light-duty gasoline vehicles. HDGT = heavy duty gasoline trucks. MC = motorcycles.

NOx Emissions

Total estimated Nova Scotia NO_x emissions in 2000 were 70.6 kt. They are presented by category in Table 21. Emissions of NO_x in Nova Scotia are generated almost entirely by three categories of sources: 50% from transportation (35.6 kt)—the largest category; 43% from non-industrial fuel combustion (30.5 kt); and 6.2% from industrial sources (4.4 kt).

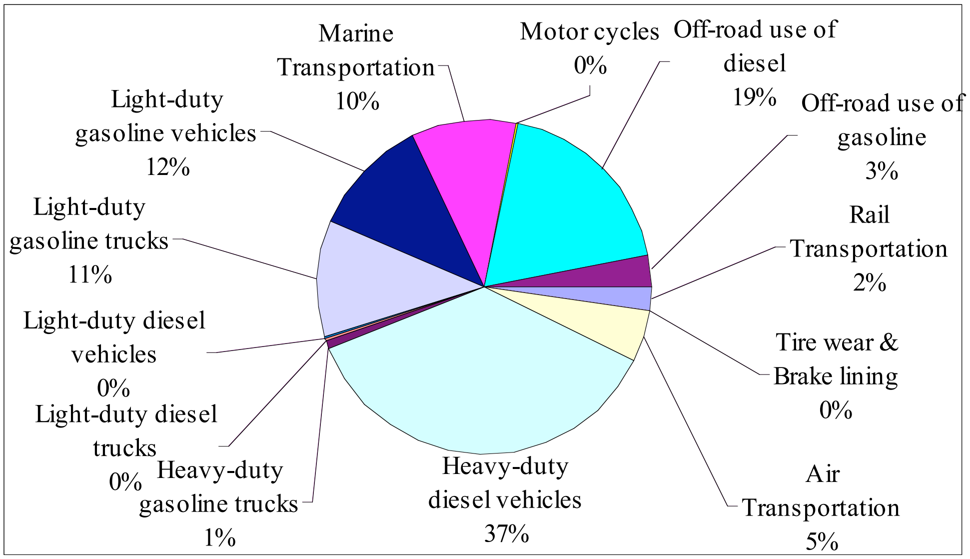
Table 21. Nova Scotia: NO_x Emissions, by Category, 2000 (tonnes).

CATEGORY	TONNES NO_x
TOTAL INDUSTRIAL SOURCES	4,412
NON INDUSTRIAL FUEL COMBUSTION	
Commercial Fuel Combustion	1,119
Electric Power Generation (Utilities)	26,999
Residential Fuel Wood Combustion	719
Residential Fuel Combustion (Other)	1,677
TOTAL NON INDUSTRIAL FUEL COMBUSTION	30,514
TRANSPORTATION	
Air Transportation	*1,728*
Heavy-duty diesel vehicles (HDDV)	*12,989*
Heavy-duty gasoline trucks (HDGT)	*271*
Light-duty diesel trucks (LDDT)	*144*
Light-duty diesel vehicles (LDDV)	*124*
Light-duty gasoline trucks (LDGT)	*3,762*
Light-duty gasoline vehicles (LDGV)	*4,323*
Marine Transportation	*3,669*
Motorcycles (MC)	*28*
Off-road use of diesel	*6,595*
Off-road use of gasoline	*1,199*
Rail Transportation	*832*
Tire wear & Brake lining	*0*
TOTAL TRANSPORTATION	***35,663***
TOTAL INCINERATION	81
TOTAL	**70,671**

Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004.

The largest contributors to transportation-related NO_x emissions are: heavy-duty diesel vehicles (13 kt, 36% of transportation-related NO_x emissions); off-road use of diesel (6.6 kt, 18%); light-duty gasoline vehicles (4.3 kt, 12%); light duty gasoline trucks (3.8 kt, 11%); and marine transportation (3.7 kt, 10%). Figure 102 shows the breakdown of transportation-related NO_x emissions by source.

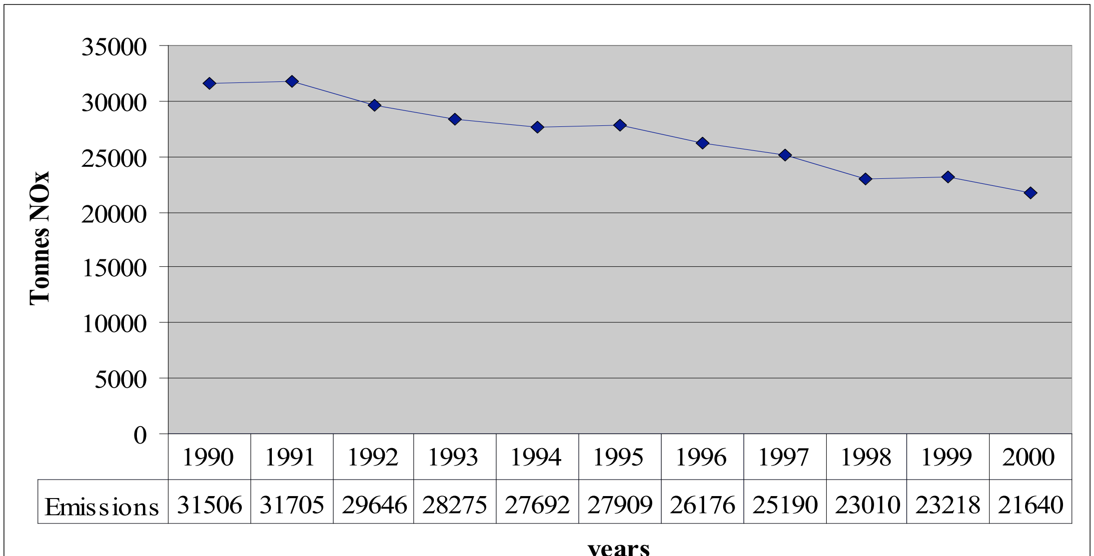
Figure 102. Nova Scotia: Transportation Emissions of NOx, by Source, 2000.



Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004.

Nova Scotia's transportation-related NO_x emissions diminished between 1990 and 2000, as did emissions of all Criteria Air Contaminants. The 31% decrease in on-road NO_x emissions is shown in Figure 103, and indicates movement towards sustainability.

Figure 103. Nova Scotia: On-Road Emissions of NO_x, 1990-2000 (tonnes).



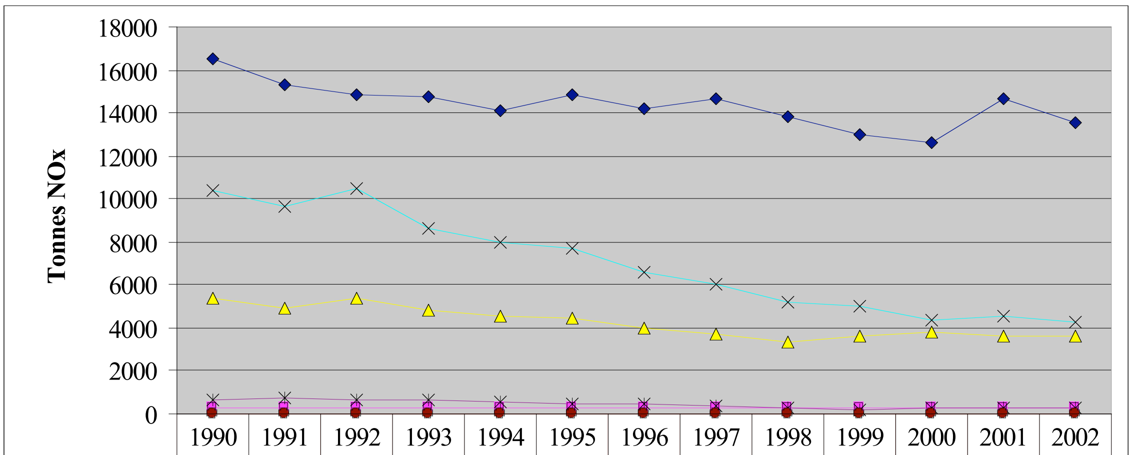
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Emissions	31506	31705	29646	28275	27692	27909	26176	25190	23010	23218	21640

Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004.

Figure 104 provides a breakdown of NO_x emissions by mode of transportation from 1990 to 2002. The main contributors of transport-related NO_x emissions include heavy-duty diesel vehicles, light-duty gas vehicles, and light-duty gas trucks. Overall, NO_x emissions from heavy-duty diesel vehicles fell by 18%, though emissions in 2001 and 2002 were higher than in 2000. This again is probably due to the increase in truck freight, which (as with SO_x emissions) may be eroding some of the earlier gains in emission reductions.

NO_x emissions from light-duty gasoline vehicles fell more steadily and sharply—by 59% between 1990 and 2002. Emissions from light-duty gasoline trucks fell by 33% during this period, but remained stable between 1999 and 2002 at levels slightly higher than in 1998. The only vehicle category to show an overall increase in NO_x emissions during this period—although by only 0.2% (0.58 tonnes)—was light-duty diesel vehicles, which account for only a very small proportion of total transport-related emissions.

Figure 104. Nova Scotia: NO_x Emissions, by Vehicle Type, 1990-2002 (tonnes).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
HDDV	16494	15322	14873	14754	14131	14879	14156	14680	13793	13031	12627	14691	13580
LDDV	287	246	310	317	308	316	288	280	252	273	272	278	288
LDGT	5391	4927	5377	4823	4541	4417	4032	3712	3330	3645	3792	3596	3633
LDGV	10408	9659	10487	8611	7968	7659	6587	6024	5170	5049	4355	4520	4270
HDGT	673	720	664	610	541	496	475	391	295	230	256	296	260
MC	39	40	37	36	34	31	38	30	31	30	28	29	31

Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004.

Note: HDDV = heavy-duty diesel vehicles. LDDV = light-duty diesel vehicles. LDGT = light-duty gasoline trucks. LDGV = light-duty gasoline vehicles. HDGT = heavy duty gasoline trucks. MC = motorcycles.

VOC (Volatile Organic Compound) Emissions

Total estimated Nova Scotia VOC emissions in 2000 were 56 kt. They are presented by category in Table 22. Transportation was responsible for just over a third of the VOC emissions (34%)—the largest source—while non-industrial fuel combustion produced 21% of VOC emissions, and industrial sources generated 16%.

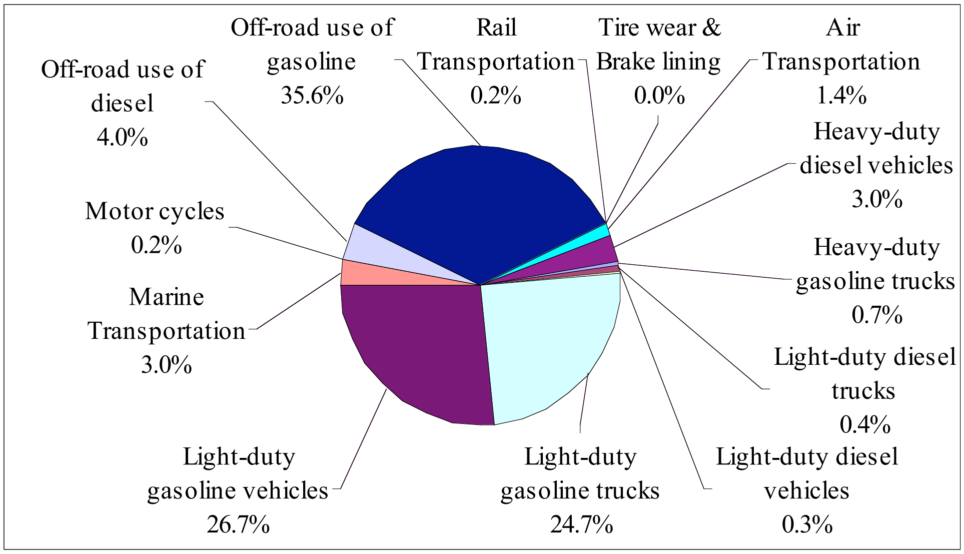
Table 22. Nova Scotia: Emissions of VOCs, by Category, 2000 (tonnes).

CATEGORY	TONNES VOC
TOTAL INDUSTRIAL SOURCES	9,026
TOTAL NON-INDUSTRIAL FUEL COMBUSTION	11,473
TRANSPORTATION	
Air Transportation	*274*
Heavy-duty diesel vehicles (HDDV)	*632*
Heavy-duty gasoline trucks (HDGT)	*132*
Light-duty diesel trucks (LDDT)	*71*
Light-duty diesel vehicles (LDDV)	*52*
Light-duty gasoline trucks (LDGT)	*4,695*
Light-duty gasoline vehicles (LDGV)	*5,011*
Marine Transportation	*633*
Motorcycles (MC)	*37*
Off-road use of diesel	*811*
Off-road use of gasoline	*6,656*
Rail Transportation	*42*
Tire wear & Brake lining	*0*
TOTAL TRANSPORTATION	***19,047***
TOTAL INCINERATION	411
TOTAL MISCELLANEOUS	13,827
TOTAL OPEN SOURCES	2,298
TOTAL	**56,082**

Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004.

Of the 19 kt of VOC emissions contributed by transportation in 2000, off-road gasoline use, and light-duty gasoline trucks and vehicles (including SUVs, vans, and mini-vans), were the main transportation sources. Respectively they contributed 6.6 kt (36% of total transportation-related VOC emissions), 4.6kt (25%) and 5kt (27%). The total Nova Scotia transportation-related VOC emissions by source are presented in Figure 105.

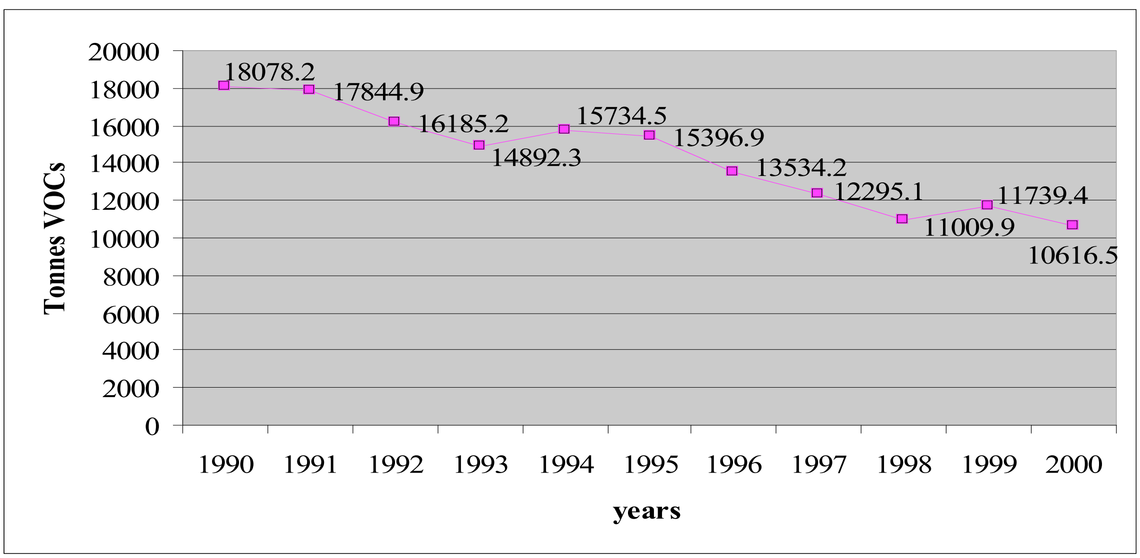
Figure 105. Nova Scotia: Transportation Emissions of VOCs, by Source, 2000.



Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004.

Total on-road VOC emissions in Nova Scotia diminished between 1990 and 2000, as did emissions in the other Criteria Air Contaminant categories. The 41.3% emissions decrease is shown in Figure 106.

Figure 106. Nova Scotia: On-Road Emissions of VOCs, 1990-2000 (tonnes).

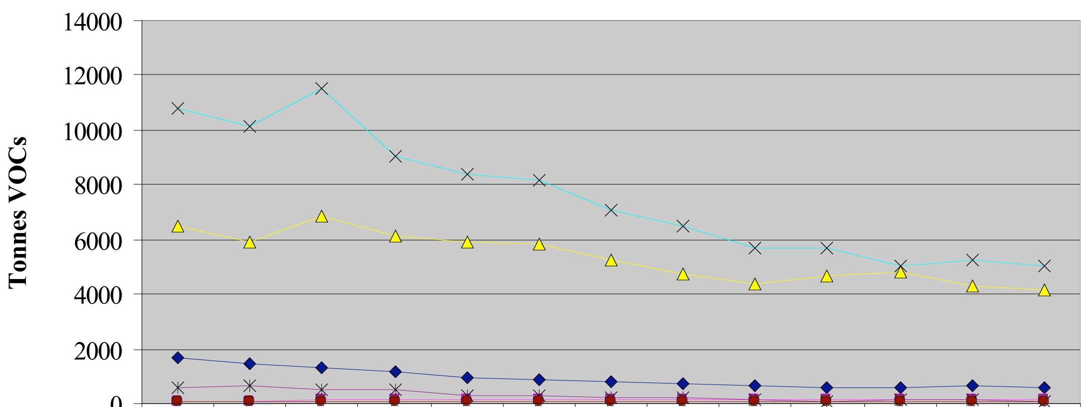


Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004.

Figure 107 provides a breakdown of the on-road VOC emissions for Nova Scotia by mode of transportation from 1990 to 2002. The main contributors of on-road VOC emissions were light-duty gasoline vehicles and light-duty gasoline trucks. Both these vehicle categories saw significant declines in emissions during this period, with VOC emissions from light-duty gasoline vehicles falling by 53% and emissions from light-duty gasoline trucks by 36% between 1990 and 2002. For the latter category, the most significant emission reduction gains were achieved by 1998, with VOC emission levels fairly stable since then. For light-duty gasoline vehicles (which include SUVs and vans), the lowest level of emissions was achieved in 2000, with levels fairly stable since then.

Between 1990 and 2002 VOC emissions from heavy-duty diesel vehicles decreased by 65%, and from heavy-duty gasoline trucks by 83% (though these were already relatively minor sources of emissions). Only one vehicle category showed an increase in VOC emissions over the same period: VOC emissions from light-duty diesel vehicles rose by 24%, from 106 tonnes in 1990 to 131 tonnes in 2002. However, all three of these vehicle categories account for relatively minor sources of VOC emissions by comparison with the light-duty gasoline truck and light-duty gasoline vehicle categories.

Figure 107. Nova Scotia: Emissions of VOCs, by Mode, 1990-2002 (tonnes).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
HDDV	1663	1465	1315	1195	946	905	804	738	650	555	548	639	590
LDDV	106	95	120	133	133	137	126	126	118	129	125	125	131
LDGT	6491	5936	6856	6148	5875	5831	5271	4760	4357	4637	4787	4273	4172
LDGV	10774	10110	11524	9029	8358	8162	7047	6495	5723	5702	5016	5280	5028
HDGT	613	632	543	483	325	263	252	192	136	85	110	123	101
MC	64	60	54	51	47	42	52	40	41	40	37	39	41

Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004.

Note: HDDV = heavy-duty diesel vehicles. LDDV = light-duty diesel vehicles. LDGT = light-duty gasoline trucks. LDGV = light-duty gasoline vehicles. HDGT = heavy duty gasoline trucks. MC = motorcycles.

Conclusion

Motor vehicle transportation produces many different kinds of air pollutant emissions, which have a variety of harmful effects on human health and ecological integrity, as summarized in Table 23.

Table 23. Vehicle Pollutant Emissions

Emission	Description	Sources	Harmful Effects	Scale
Carbon dioxide (CO_2)	A byproduct of combustion.	Fuel production and engines.	Climate change	Global
Carbon monoxide (CO)	A toxic gas that undermines the blood's ability to carry oxygen.	Engine	Human health	Very local
CFCs	Durable chemical harmful to the ozone layer and climate.	Older air conditioners.	Ozone depletion	Global
Fine particulates (PM_{10}; $PM_{2.5}$)	Inhaleable particles consisting of bits of fuel and carbon.	Diesel engines and other sources.	Human health, aesthetics.	Local and Regional
Hydrocarbons (HC)	Unburned fuel. Forms ozone.	Fuel production and engines.	Human health, ozone precursor.	Regional
Lead	Element used in older fuel additives.	Fuel additives and batteries.	Circulatory, reproductive and nervous system.	Local
Methane (CH_4)	A gas with significant greenhouse gas properties.	Fuel production and engines.	Climate change	Global
Nitrogen oxides (NOx)	Various compounds. Some are toxic, all contribute to ground-level ozone and acid rain.	Engine	Human health, ozone precursor, ecological damages, acid rain.	Local and Regional
Ozone (O_2)	Major urban air pollution problem resulting from NOx and VOCs combined in sunlight.	NOx and VOCs	Human health, plants, aesthetics.	Regional
Road dust	Dust particles created by vehicle movement.	Vehicle use.	Human health, aesthetics.	Local
Sulphur oxides (SOx)	Lung irritant, and causes acid rain.	Diesel engines	Human health risks, acid rain	Local and Regional
Volatile organic compounds (VOCs) - hydrocarbons.	A variety of organic compounds that form aerosols.	Fuel production and engines.	Human health, ozone precursor.	Local and Regional
Toxics (e.g. benzene)	VOCs that are toxic and carcinogenic.[309]	Fuel production and engines.	Human health risks	Very local

Source: United States Environmental Protection Agency. *Indicators of the Environmental Impacts of Transportation*. (USEPA, 1999); Oak Ridge National Laboratory. *Transportation Energy Data Book* (ORNL, 2000); Litman, Todd. *Transportation Cost and Benefit Analysis*. (Victoria Transport Policy Institute, 2004e).

Note: This table summarizes various types of motor vehicle pollutant emissions and their impacts.

This analysis indicates that air pollutant emissions from the transportation sector in Nova Scotia have, for the most part, been declining steadily since 1990. The few exceptions to this general trend come from the increased emissions of CO, NO_x, and VOCs from the light-duty diesel vehicle category, and from small increases in SO_x emissions from light-duty gasoline trucks, and light-duty gasoline vehicles. The combined total of all these increases only amounted to a 54.5

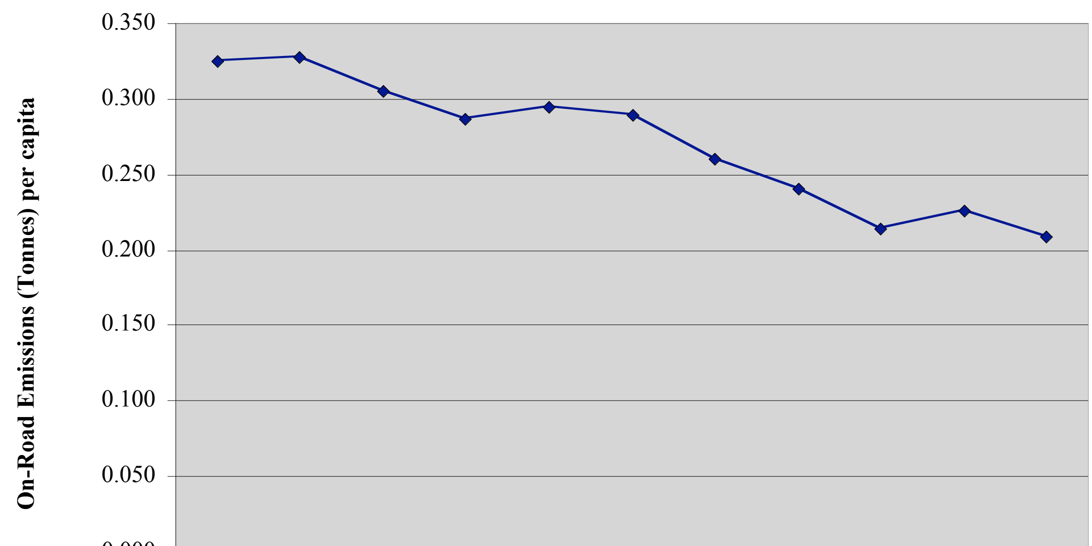
[309] South Coast Air Quality Management District. *Multiple Air Toxics Exposure Study (MATES-II)*. (2002) www.aqmd.gov/matesiidf

tonne addition in emissions, with 44.3 tonnes of that increase resulting from the rise in SO_x emissions in the light-duty gasoline truck category.

These small increases in some categories are dwarfed by the overall decline of nearly 20,000 tonnes in the combined on-road emissions of SO_x, NO_x, VOCs, and fine particulates in Nova Scotia between 1990 and 2002, and by the 81,500 tonne decline in CO emissions during this period. These overall trends in Criteria Air Contaminant emissions from transportation sources indicate a definite movement towards sustainability. The key potential cause for concern noted above is that some of the most significant pollutant emission reductions were achieved by the late 1990s, and that the growth of truck freight, SUVs, and overall transport activity may begin to erode some of these earlier gains.

Figure 108 demonstrates that the combined total of all on-road air pollutant emissions per capita declined significantly between 1990 and 2000, a trend that indicates a definite movement towards sustainability. Per capita mobile emissions of these criteria air contaminants fell from 0.325 tonnes per person in 1990 to 0.208 tonnes per person in 2000, a decline of 36%.

Figure 108. Nova Scotia: Combined On-Road Emissions of CO, TPM, SO_x, NO_x and VOCs, per Capita, 1990-2000 (Tonnes per 1,000 Population).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Emissions/capita	0.325	0.328	0.305	0.287	0.294	0.289	0.260	0.240	0.215	0.226	0.208

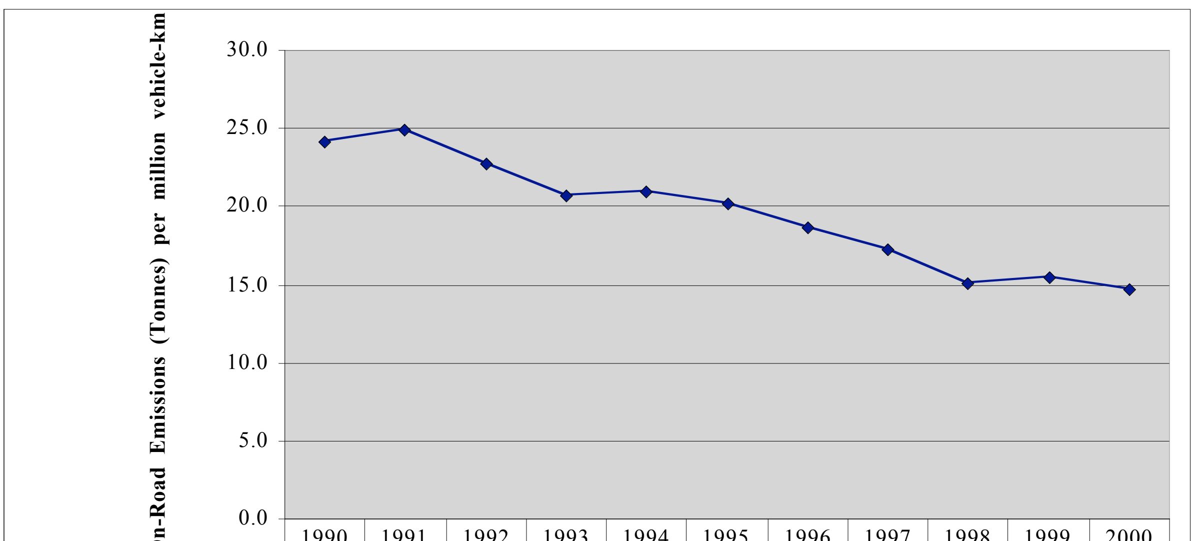
Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004.

As discussed earlier, the Centre for Sustainable Transportation has produced an index of total transport-related emissions of Criteria Air Contaminants in Canada as its key indicator for air pollution attributable to the transportation sector. The CST index, adapted for this report with the addition of particulate matter emissions (Figure 89), showed that while total transport-related pollutant emissions in Canada had decreased considerably from 1990 to 2000, the majority of the decline occurred in the first half of the decade, from 1990 to 1995. The decline continued until 2000, but at a much slower rate.

GPI*Atlantic*'s index reports similar results for Nova Scotia. Figure 91 showed the results of the weighted index of total transport-related Criteria Air Contaminant emissions in Nova Scotia for 1990-2000. Nova Scotia's emissions declined considerably from 1990-1998 (by 25%), but in 1998-2000 the emissions reduction (3.3%) was relatively smaller when compared to the more rapid decreases in the first part of the decade. Thus, while the overall decline in total transport-related emissions indicates definite movement towards sustainability, the slower rate of decrease in the last part of the decade is a potential cause for concern, indicating that the growth of truck freight, SUVs, and total transport activity may potentially erode earlier significant emission reduction gains. It is too early to tell whether the apparent stalling of progress in 1998, also demonstrated by Figure 108 above, is a long-term cause for concern or just a short-term trend (like that in 1993-95) that will again be followed by more rapid emission reductions in the future.

Figure 109 shows Nova Scotia's total combined transportation emissions per vehicle-kilometre over time. Emissions per vehicle-kilometre fell by 39% from 1990 to 2000. This indicator shows a similar trend to those above and further demonstrates the improvements that have occurred in reducing transportation-related pollutant emissions. Figure 109 also demonstrates the slowing of progress in 1998 noted above.

Figure 109. Nova Scotia: Combined Transport-Related Emissions of CO, TPM, SO_x, NO_x, and VOCs, 1990-2000 (Tonnes per million vehicle-kilometres).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Emissions/v-km	24.1	24.9	22.7	20.7	20.9	20.2	18.6	17.2	15.1	15.4	14.7

Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. December, 2004.

The first section of the analysis compared Canada's transportation-related pollutant emissions with those of the OECD countries and showed that, on a per capita basis, Canada ranked among the five highest emitters in each of the four categories analysed (CO, SO_x, NO_x, VOCs). This clearly illustrates the serious environmental consequences of the heavy dependence on fossil-fuel based transportation of the Canadian lifestyle and economy.

This international context also puts into perspective the observed improvements in emission reductions that occurred in Canada and Nova Scotia in the 1990s. It is easier to reduce emissions when starting from very high relative levels; yet even after a decade of steady improvements in transport-related emissions, Canada still ranked among the poorest performers and highest per capita polluters in the world. Thus, while we have classified the emission reductions documented in this chapter as a definite *movement* towards sustainability, neither Canada nor Nova Scotia can claim to have entered the realm of true transportation sustainability. Present absolute emission levels indicate that the existing transportation system is still far from sustainable. We noted, for example, that Canada's per capita pollutant emissions are still several times those of Germany, even after the reductions documented above. From an international perspective, therefore, only far more drastic and continuous emission reductions can begin to place the Canadian and Nova Scotian transportation systems on a sustainable basis with regard to pollutant emissions.

This major caveat is not to deny that the Canadian and Nova Scotian transportation sectors are making progress towards greater sustainability. The two indicators of per capita and per vehicle-kilometre emissions shown above (Figures 108 and 109), the aggregate index of Nova Scotia air pollutant emissions (Figure 91), the separate trends for each Criteria Air Contaminant, and the indicators for air pollutant emissions by mode, which were outlined in the above analysis, have all shown improvements. The reduction in transport-related emissions can largely be attributed to advances in technology that include improvements in devices like catalytic converters, and to regulations that have removed lead and reduced contaminants in gasoline.[310]

Other factors, however, have been working against the technology improvements and the decline in emissions. The increase in overall transport activity, truck freight, and use of SUVs, minivans, and light trucks for passenger transport, can easily minimize the improvements achieved to date and already appear to have reduced the rate of progress. For example, on a national level, pollutant emission factors for large trucks declined—by 16% for CO and 47% for NO_x—between 1990 to 2000. However, the activity of trucks, measured in vehicle-kilometres, increased by 35% over the same time period.[311] SUVs, minivans, and light trucks are also more energy-intensive than cars, and therefore produce more pollutant emissions. According to data developed for the US Environmental Protection Agency (EPA), for example: "A light truck or SUV produces 30% more NOx emissions per kilometre than a typical passenger car."[312] As well, the overall growth in transport activity could also help explain the slowing down of emission reductions between 1995 and 2000. Thus, both the volume and the composition of the transportation fleet can have significant implications for the effectiveness of pollutant emission controls and for transportation sustainability.

[310] Transportation Association of Canada. *Briefing: Urban Transportation and Air Quality*, p. 4. (2004). www.tac-atc.ca/english/pdf/airquality.pdf Accessed December, 2004.
[311] Ibid.
[312] Ibid.

This chapter has emphasized the importance of continued emission reductions both in Canada and Nova Scotia. An important step in this direction should be the Canadian government's January 1, 2004, introduction of stricter auto emission regulations that align Canadian emission standards with the US EPA emission regulations, which are considered some of the most stringent national emission standards in the world. As stated in the *Canada Gazette*, Part II, which outlines the *On-Road Vehicle and Engine Emission Regulations*, the new standards will replace the *Motor Vehicle Safety Act* administered by Transport Canada. According to the *Gazette*, standardization with the US EPA:

> …provides Canadians with significant emission reductions from on-road vehicles and engines at a low additional cost. For most vehicle classes and on a per-vehicle basis, the targeted standards represent an average reduction in the allowable levels of smog-forming emissions of about 90% relative to current regulated limits.[313]

The Regulatory Impact Analysis Statement contained within the *Canada Gazette*, Part II, goes on to estimate that: "The allowable levels of smog-forming emissions such as NO_x, VOCs and PM from new heavy light-duty trucks (i.e. large pick-up trucks, vans and sport utility vehicles) will on average be reduced by 95%, 84% and 92% respectively."[314]

An article on the new regulations in an automotive industry newsletter estimates that, by 2020, Canada will have achieved the following on-road vehicle emission reductions from present levels:

- nitrogen oxides: -73%;
- particulate matter: -64%;
- carbon monoxide: -23%;
- volatile organic compounds: -14%; and
- there will also be decreased emissions of several "toxic" emissions such as benzene and acetaldehyde.[315]

However, the Transportation Association of Canada warns that the reductions that will occur as a result of the improved standards "will be negated by increased vehicle use."[316]

Other efforts are being made to improve the sustainability of the transportation sector that should also contribute to further transport-related pollutant reductions. For example, the former Canadian Government considered imposing fuel economy standards on major automobile manufacturers unless there is a 25% increase in fuel efficiency between 2008 and 2010 achieved through voluntary compliance. Former Environment Minister David Anderson said: "We fully intend to work as closely as we can with [American] jurisdictions, which are led by California but which include New York and New Jersey…who we believe to be also favouring a substantial

[313] Government of Canada. *Canada Gazette*, Part II, Vol. 137, no. 1, January 1, 2003, p. 29. http://canadagazette.gc.ca/partII/2003/20030101/html/sor2-e.html Accessed September, 2004. PDF versions can be found at http://canadagazette.gc.ca/partII/2003/index-e.html.
[314] Ibid., p. 47.
[315] Japan Automobile Manufacturers Association of Canada. "Canada to Harmonize Stringent New Vehicle Emission Regulations with US in 2004." (Toronto: *Auto Quarterly*. Winter, 2003). www.jama.ca/aq/2003/aq2003_Winter.pdf Accessed September, 2004.
[316] Transportation Association of Canada. (2004, p. 4).

improvement in fuel efficiency which would be similar to our 25% target."[317] Anderson went on to state that, while the auto industry presently objects to the imposition of emission reductions, it also recognizes the large portion of the market held by California, New York, New Jersey, and Canada (100 million people in total). The industry understands that this is a significant force in the integrated North American automobile industry which cannot be ignored.[318] The present Government has also stated its intention to move towards mandatory compliance with stricter emissions standards.

In light of these developments, there is cause for optimism concerning the direction Canadian governments are moving in terms of further reductions in transport-related pollutant emissions that can substantially improve air quality. While current air pollution amounts are still far from a sustainable level, as noted in the international comparisons above, stringent action to curb automobile emissions is an important step in the direction of sustainability. It remains to be seen whether these regulations are enough to combat the expanding automobile market and truck freight sector, and consumer preference for SUVs, minivans, and light trucks, and whether the predicted effects of the regulations will become a reality in the future. Nevertheless, the existence of the new *On-Road Vehicle and Engine Emission Regulations* alone, along with the stated commitment to improve fuel efficiency substantially, are encouraging signs of an increased awareness of the necessity for a sustainable transportation system in general and for reducing mobile pollutant emissions in particular.

[317] Ljunggren, David. "Canada minister mulls tough auto emissions levels." (Ottawa: Reuters. March 15, 2004). www.planetark.com/dailynewsstory.cfm/newsid/24271/story.htm Accessed September, 2004.
[318] For an update on this situation see Part V of this report.

Chapter 6. Emissions Intensity

In addition to examining the quantity of air pollutant and greenhouse gas emissions from transportation, it is important to consider trends in the *intensity* of emissions—that is to say, in the amount of such substances released per unit of energy use. This can provide insight into both improvements in technology and the uptake of those improvements by the transportation sector.

The analysis of emissions intensity neither replaces nor duplicates the work in the previous two chapters of this report. Rather, it identifies changes that cannot be discerned in the basic emission trends alone.[319] For example, an examination of emissions intensity could demonstrate that greater quantities of air pollutants (or GHGs) are being released into the environment even while the emissions *per unit of energy use* are decreasing (or vice versa). An analysis and understanding of emissions intensity provides knowledge of a broader range of sustainability options, including the degree to which new technologies can reduce emissions without compromising present lifestyles, and the comparative value of investments in efficiency versus investments in conservation.

The issue of emissions intensity has become a key part of the international debate on the Kyoto Protocol and climate change. Not everyone agrees with the focus on total emissions in the Kyoto targets, which is part of the reason that the United States renounced its involvement with the Kyoto treaty and its accountability for meeting its prescribed targets.

Instead, the Bush administration has announced a domestic objective based on a somewhat different definition of emissions intensity than that used in this report and by the CST. The US target is a reduction in emissions intensity (defined as emissions per dollar of gross domestic product) of 18% between 2002 and 2012.[320] The government of Alberta has also put forward a plan to address climate change based on emissions intensity targets. Both proposals have drawn strong criticism from environmental groups. The Pembina Institute, for example, has criticised the Alberta government's climate change plan on the grounds that it could result in a decline in intensity while the volume of emissions continues to increase—along with the environmental consequences.[321] The distinction between total emissions and emissions intensity also underlies the present federal government's ambivalence about the Kyoto targets.

Despite the potential misuse of emissions intensity indicators, when considered in a vacuum, to avoid reducing emissions, these indicators are nevertheless regarded here as important markers of transportation sustainability when considered as *complementary* to emission reduction indicators. Both conservation *and* efficiency are important and necessary pathways to a sustainable economy and a sustainable transportation system and can mutually support the goal outlined in the EU and CST definitions of sustainable transportation adapted for use in this report, namely to *"limit emissions and waste within the planet's ability to absorb them."*

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[319] Gilbert et al. (2002, p. 85).
[320] Pizer, William. *The Case for Intensity Targets*, p. 1. (New York City: Centre for International Governance Innovation, 2004). www.cigionline.ca/v.2/conf_docs/g20.newyork.pizer.pdf Accessed January, 2005.
[321] Pembina Institute. Alberta Government Climate Change Plan Not Credible. (May 21, 2002). www.pembina.org/newsitem.asp?newsid=42&section Accessed January, 2005.

The Indicators

The Centre for Sustainable Transportation uses an index of the emissions intensity of the total road fleet as its basic indicator in this area. Employing its established index of emissions of air pollutants from road transport, the CST divided each year's total emissions by the energy use or fuel consumption for that year in order to establish an index of emissions intensity. The air emissions covered under this measure include sulphur oxides, nitrogen oxides, volatile organic compounds, and carbon monoxide. The CST found that, after a small increase in emissions intensity from 1990 to 1991, emissions intensity then declined steadily to 2000, thus indicating a movement towards sustainability.

The data used by the CST were provided by Environment Canada, and had been developed to support Canada's participation in the deliberations of the United Nations Economic Commission for Europe. Additional records from Natural Resources Canada were also used.[322]

Due to the selection of a different indicator to represent air pollutant emissions intensity, including particulate matter emissions, and the inclusion of an additional indicator on GHG emissions intensity, different information sources were required for this study than those used by the CST. The data used here came from a variety of resources including the Organisation for Economic Co-operation and Development's 2002 Environmental Data Compendium.[323] Most of the statistics for the analysis of both Canadian and Nova Scotian emissions intensity were taken from the 2002 Comprehensive Energy Use Database of the Office of Energy Efficiency at Natural Resources Canada (NRCan.)[324] Further data related to air pollutant emissions—described in the previous chapter of this report—were taken from unpublished files especially supplied by Environment Canada for use in this report in advance of their 2005 publication of these data.[325] These sources were selected as they constitute the most relevant and up to date information available for the proposed set of indicators.

The indicators selected to represent Nova Scotia emissions intensity in this study include:

- total transportation GHG emissions intensity; and
- total transportation air pollutant emissions intensity.

For both indicators, a **decrease** in emissions intensity indicates a movement towards sustainability.

[322] Centre for Sustainable Transportation. (2003, pp. 4 and 16).
[323] Organisation for Economic Co-operation and Development. (2003).
[324] Natural Resources Canada—Office of Energy Efficiency. (August 5, 2004a and August 5, 2004b).
[325] Taylor, Brett. Emissions Inventory Information Analyst, Environment Canada. (Personal communication: July 20, 2004).

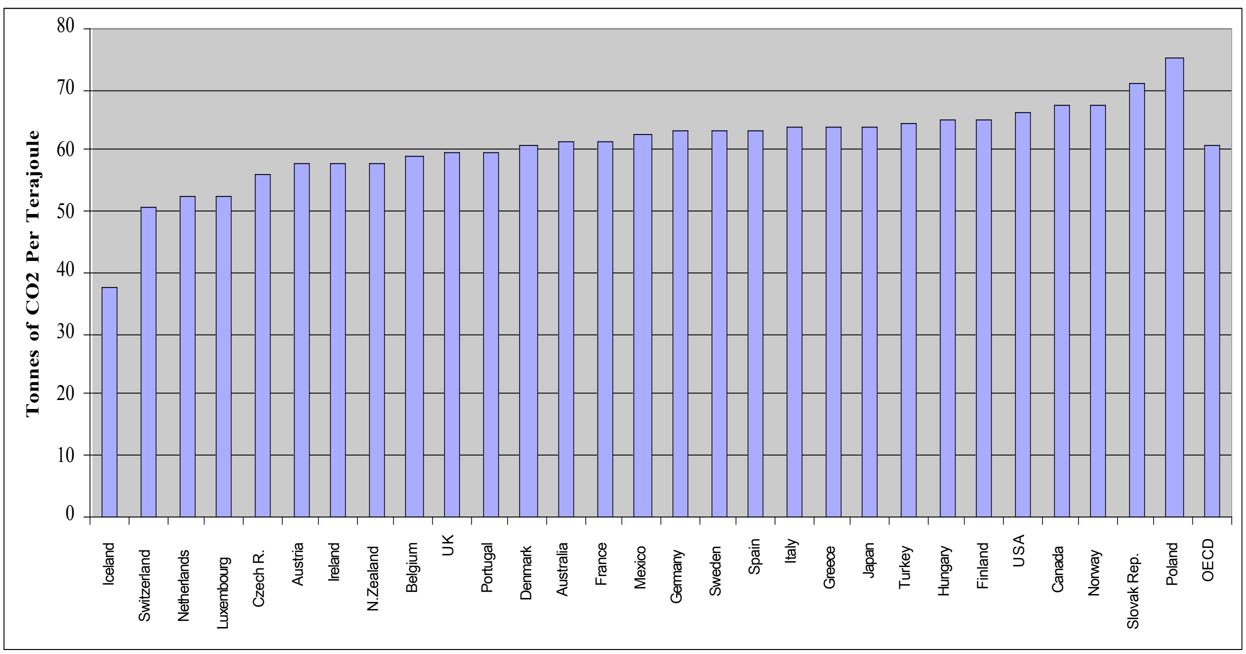
Trends: International

GHG Emissions Intensity

Analysis of international energy intensities of transportation-related greenhouse gas emissions is limited by the availability of data. Information in the OECD Environmental Data Compendium provides some rough estimates. However, the utility of these statistics is limited by a lack of comparability between the figures for transport-related carbon dioxide equivalent emissions and those for total transportation energy use, as the data for these measures were from different years. Despite this inconsistency, general comparisons were made for the CO_2 emission intensities of the transportation sectors of OECD countries, as shown in Figure 110. In this case, emissions intensity is expressed as tonnes of CO_2 equivalent emissions per terajoule of energy used.

The results show that Canada had the fourth highest emissions intensity out of the 29 countries represented, ahead of only Poland, the Slovak Republic, and Norway. The United States had the fifth highest emissions. The countries with the lowest emissions intensities for CO_2 were Iceland, Switzerland, and the Netherlands.

Figure 110. OECD Countries: CO_2 Equivalent Emissions Intensity of Transportation, late 1990s (tonnes of CO_2 equivalent emissions per terajoule of energy use).



Source: Organisation for Economic Co-operation and Development. *OECD Environmental Data—Compendium 2002*, Tables 2.3B and 8.5.

Air Pollutant Emissions Intensity

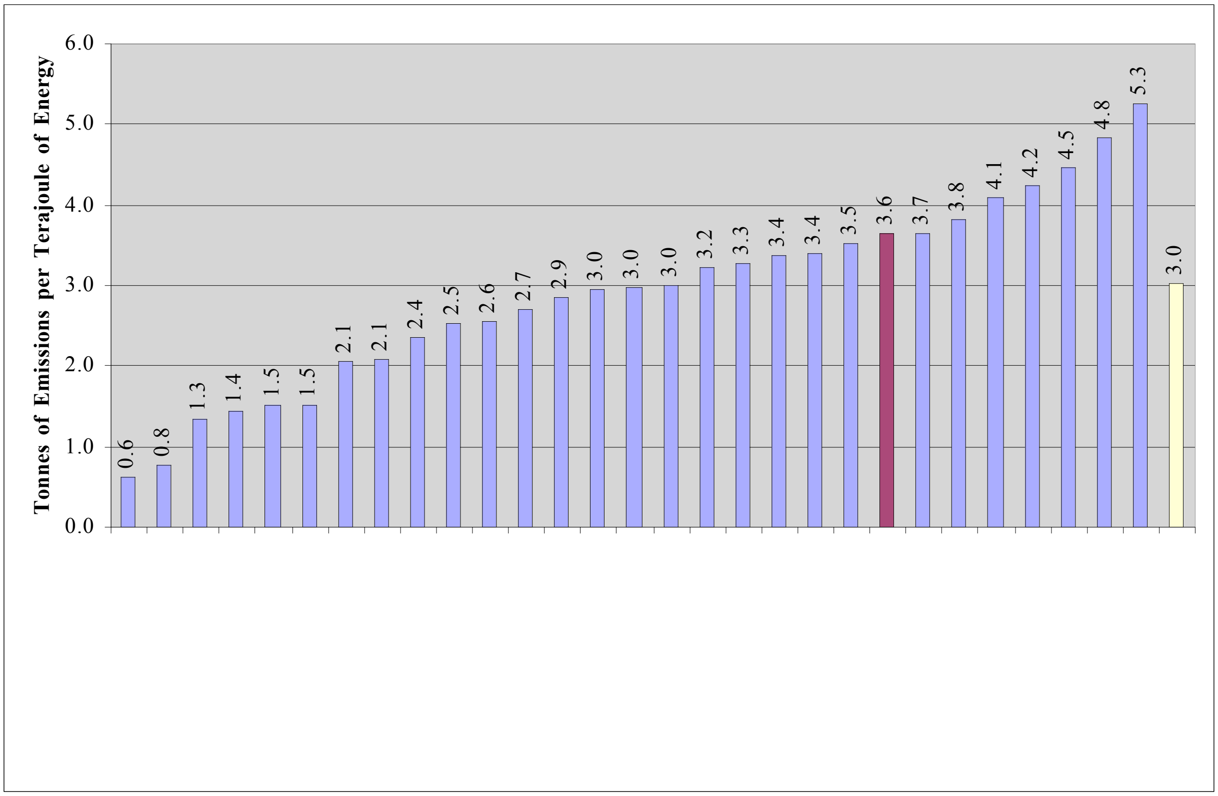
As with the GHG data, statistics on air pollutant emissions intensities were limited. Using the OECD Environmental Compendium "Emissions by Source" tables for sulphur oxides, nitrogen oxides, carbon monoxide, and volatile organic compounds, the latest available year of emission records was isolated for the transportation category.

The problem with these data was that the most recent year for any given pollutant ranged from 1996 to 2000. Despite this limitation, emission figures for each of the four pollutants were combined to create an estimate of the overall total of transport-related air pollutant emissions for each country. These sums, roughly representing the late 1990s, were then divided by the amount of total transportation energy used in 2000 (the closest available year of data comparable to the emissions data of the late 1990s). This resulted in estimates of an aggregate air pollutant emissions intensity number for each of the OECD countries. While the data limitations prevented a fully reliable and comprehensive analysis, the method used did permit rough comparative estimates.

Figure 111 shows the emissions intensities of air pollutants from the transportation sector across OECD countries. Canada had the eighth highest emissions intensities out of 29 countries, with an emissions intensity about 20% above the OECD average. The United States had a lower air pollutant emissions intensity than Canada (eleventh highest), about the same as the OECD average. Greece was the country with the highest overall emissions intensity at more than three and a half times the OECD average. Turkey, Poland, Portugal, and Iceland also had relatively high transportation-related air pollutant emissions intensities—at least two-thirds higher than that of Canada.

The countries with the lowest emissions intensities were Luxembourg, Switzerland, and Germany. The air pollutant emissions intensity of the UK was less than half that of Canada, while that of Germany was less than a quarter of the Canadian intensity, indicating that considerable further improvement is possible for Canada.

Figure 111. OECD Countries: Transportation Air Pollutant Emissions Intensity, Late 1990s (tonnes of pollutant emissions per terajoule of energy used).



Source: Organisation for Economic Co-operation and Development. *OECD Environmental Data—Compendium 2002*, Tables 2.2A, 2.2B, 2.2D, 2.2E, and 8.5.

Trends: Canada

GHG Emissions Intensity

The international comparison above shows that Canada's performance is below average among the OECD countries for both CO_2 equivalent and air pollutant emissions intensity from transportation. Understanding where and how high rates of emissions intensity are produced by different modes of transportation can help Canada target its policies successfully to reduce its emissions intensities, improve the efficiency of energy use for mobility, and pursue a more sustainable transportation strategy. The following section reviews the greenhouse gas emissions intensity of Canadian transportation in some detail, and then provides a briefer discussion of air pollutant emissions intensity in the transportation sector.

GHG emissions from transportation are created by the combustion of fuel.[326] This means that GHG emission levels cannot currently be improved through devices such as catalytic converters,

[326] Blais, Samuel. Economist (Market Analysis), Natural Resources Canada—Office of Energy Efficiency. (Personal communication: January 14, 2005).

which do reduce air pollutant emissions. At present the only options for reducing the GHG emissions intensity of vehicles are to improve energy efficiency or alter fuel sourcing (e.g., by substituting propane or other fuels for gasoline). This means that the trend lines for GHG emissions intensity will show little variation from year to year unless changes occur either in fuel economy or in the types of fuels used to power transportation (discussed below).

While the information presented here is important and useful for the analysis of transportation sustainability, the resulting patterns vary less over time than those associated with some other data. All the same, it is important to be aware of the GHG emissions intensities of the various modes of transportation and vehicle classifications. This knowledge can be used to help assess alternative options to meet environmental goals and targets, such as those outlined in the Kyoto Protocol.

An analysis of the emission factors for different mobile combustion sources is important to determine the comparative emissions of the various fuel types. For example, gasoline has a lower carbon dioxide emission factor than does diesel fuel.[327] Both heavy and light fuel oils have a higher CO_2 emission factor than diesel fuel. The fossil fuels with the lowest emission factors are natural gas and propane. A basic knowledge of these comparative CO_2 emission factors will allow for a better understanding of the GHG emissions intensity trends provided below.

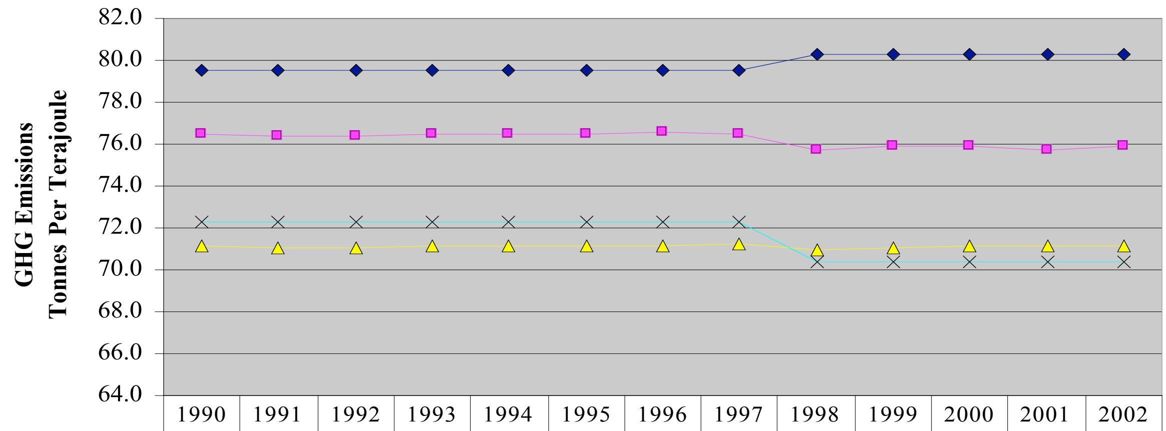
Figure 112 provides a general overview of the GHG emissions intensity of the Canadian transportation system. This figure shows that the GHG emissions intensity for each mode of transportation varied only slightly between 1990 and 2002, with the only significant shifts apparently occurring between 1997 and 1998. Those apparent changes are actually a statistical artefact and are due to a small adjustment in the energy content value conversion factor used by Statistics Canada.[328] This formula is used to express the work potential of a given amount of fuel—e.g. gasoline or diesel—in units of energy (such as petajoules or terajoules). As shown in Figure 112, this procedural alteration caused an increase to be recorded for rail transport, and a decrease for air and marine transport. This apparent change in GHG emissions intensity for these modes from 1997 to 1998 appears in the graphs throughout this section.

Figure 112 shows that rail and marine transportation each produce more GHG emissions per unit of energy used than do road or air transportation. As will be seen, this is due largely to the fuel mix used by the various modes. Marine transportation relies on diesel and heavy fuel oil as primary energy sources.[329] Some fuel use surveys indicate that rail transportation consumes a variety of fuels, but NRCan's Office of Energy Efficiency (which relies on Statistics Canada data) states that rail uses diesel fuel exclusively.[330] Assuming the OEE is correct, this explains the relatively high GHG emissions intensity of rail shown in Figure 112. By contrast, road transportation in 2002 relied on roughly 69% motor gasoline, 30% diesel fuel, and marginal quantities of electricity, natural gas and propane.[331] Needless to say, the actual GHG emissions

[327] Matin et al. (2004, p. 173).
[328] Blais. (January 14, 2005).
[329] Natural Resources Canada—Office of Energy Efficiency. (August 5, 2004a, Table 28). Accessed January, 2005.
[330] Blais, Samuel. Economist (Market Analysis), Natural Resources Canada—Office of Energy Efficiency. (Personal Communication: February 8, 2005).
[331] Natural Resources Canada—Office of Energy Efficiency. (August 5, 2004a, Table 12). Accessed January, 2005.

attributable to each transportation mode are a product of both its emissions intensity *and* the quantity of fuel consumed (which is not illustrated in the following charts).

Figure 112. Canada: GHG Emissions Intensity, by Mode of Transportation, 1990-2002 (tonnes of CO_2 equivalent emissions per terajoule of energy use).



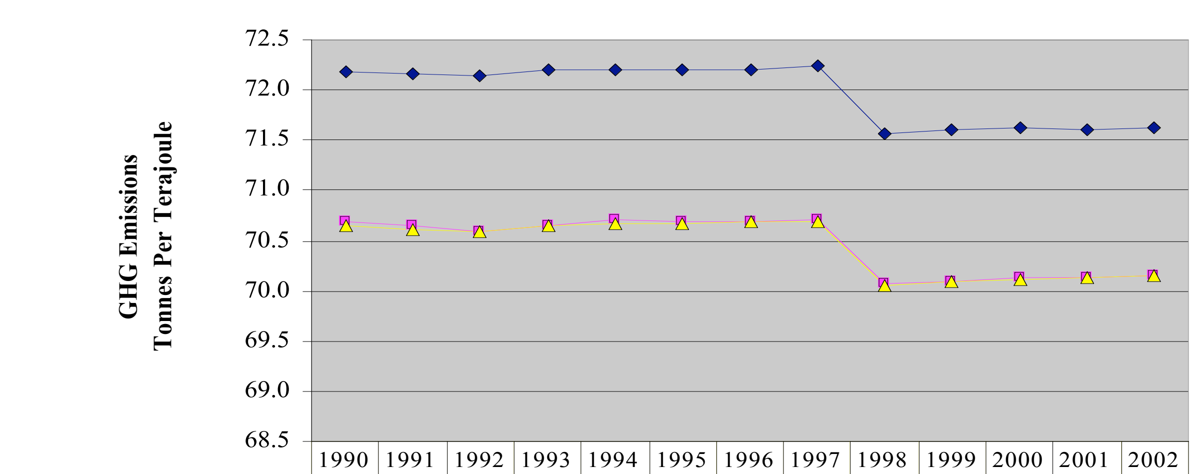
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Rail	79.5	79.5	79.5	79.5	79.5	79.5	79.5	79.5	80.3	80.3	80.3	80.3	80.3
Marine	76.5	76.3	76.3	76.4	76.4	76.5	76.5	76.5	75.7	75.9	75.9	75.7	75.9
Road	71.1	71.1	71.0	71.1	71.2	71.1	71.2	71.2	71.0	71.0	71.1	71.1	71.2
Air	72.3	72.3	72.3	72.3	72.3	72.3	72.3	72.3	70.3	70.3	70.3	70.3	70.3

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 12, 19, 25 and 28.

Figure 113 presents the GHG emissions intensity for passenger road transportation in Canada. This includes passenger light trucks (SUVs, minivans, pick-up trucks, etc.) as well as large and small cars. Figure 113 shows that the GHG emissions intensity of passenger light trucks is higher than that of either large or small cars, which share almost identical intensities. A review shows that, in 2002, 99% of the fuel used by passenger light trucks was motor gasoline, the remainder being either diesel fuel oil or propane.[332] Large and small cars were slightly more likely to consume fuels other than motor gasoline (e.g. diesel fuel oil, natural gas, or propane).[333, 334] These slight differences in fuel mix help account for the marginal differences in GHG emissions intensity between passenger light trucks and cars (both small and large).

[332] NRCan—OEE. (August 5, 2004a, Table 57). Accessed January, 2005.
[333] NRCan—OEE. (August 5, 2004a, Table 45). Accessed January, 2005.
[334] NRCan—OEE. (August 5, 2004a, Table 43). Accessed January, 2005.

Figure 113. Canada: Passenger Road Vehicle (Light Trucks, Large and Small Cars) GHG Emissions Intensity, 1990-2002 (tonnes of CO_2 equivalent emissions per terajoule of energy use).



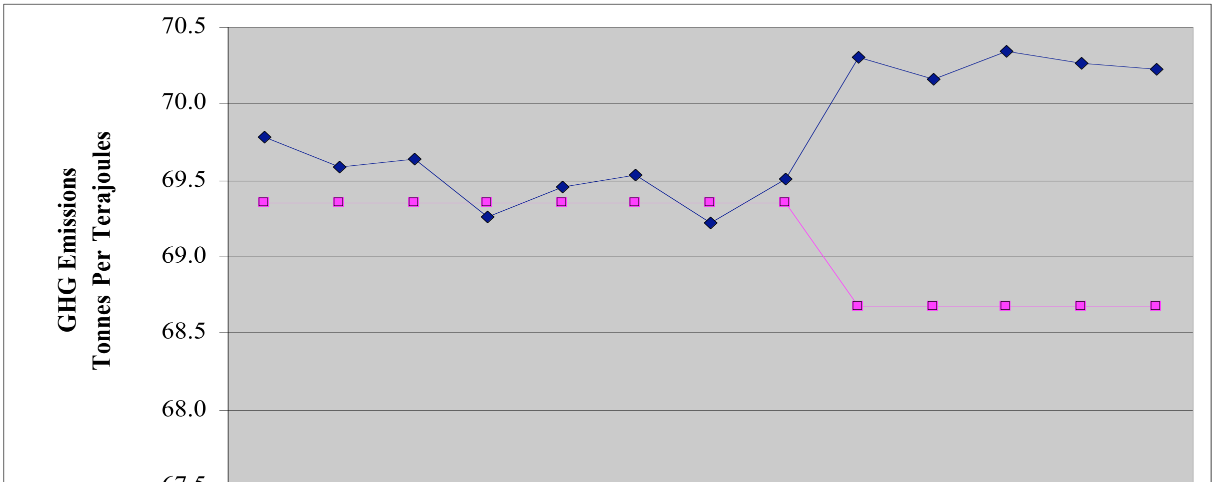
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Passenger Light Truck	72.2	72.2	72.1	72.2	72.2	72.2	72.2	72.2	71.6	71.6	71.6	71.6	71.6
Large Cars	70.7	70.6	70.6	70.7	70.7	70.7	70.7	70.7	70.1	70.1	70.1	70.1	70.2
Small Cars	70.7	70.6	70.6	70.6	70.7	70.7	70.7	70.7	70.1	70.1	70.1	70.1	70.2

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 43, 45 and 57.

Bus and motorcycle GHG emission intensities are represented in Figure 114. Much like other vehicle categories, the GHG emissions intensity of motorcycles was relatively stable over time, aside from the apparent shift that was due to the altered conversion factor from 1997 to 1998. The trend for Canadian bus GHG emissions intensity is somewhat more varied. This is mainly because of changes in the already heterogeneous fuel mix of buses. For example: in 2002, roughly 78% of Canadian bus activity was powered by diesel fuel oil; eight percent by motor gasoline; seven percent by propane; six percent by electricity; and one percent by natural gas.[335] Between 1990 and 2002, there were marginal increases in the use of diesel fuel oil, propane, and natural gas, and a more substantial decrease in the use of motor gasoline. Still, even these changes only altered the GHG emissions intensity for buses by 1.4% from its lowest point in 1996 (69.2 tonnes per terajoule) to its highest point in 2000 (70.3 tonnes per terajoule).

[335] NRCan—OEE. (August 5, 2004a, Table 33). Accessed January, 2005.

Figure 114. Canada: GHG Emissions Intensity, Buses and Motorcycles, 1990-2002 (tonnes of CO_2 equivalent emissions per terajoule of energy use).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Bus	69.8	69.6	69.6	69.3	69.5	69.5	69.2	69.5	70.3	70.2	70.3	70.3	70.2
Motorcycle	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	68.7	68.7	68.7	68.7	68.7

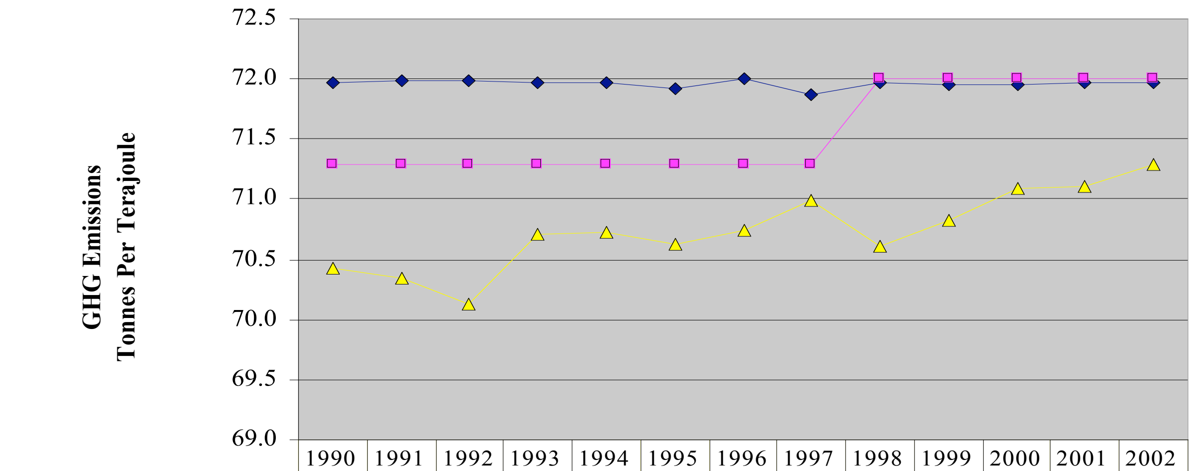
Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 33 and 55.

Figure 115 depicts the GHG emissions intensities of Canadian road freight for the period 1990-2002. The GHG emissions intensity of both medium and heavy trucks was relatively high throughout the reference period, and the intensity of freight light trucks increased somewhat (by 1.3%).

In 2002, approximately 65% of medium truck activity was powered by diesel fuel oil and 35% by motor gasoline.[336] Although data are not available from the Office of Energy Efficiency on fuels used by heavy trucks, other data indicate that they rely preponderantly on diesel fuel. Figure 115 below indicates that heavy truck GHG emissions intensities are comparable to those of medium trucks from 1998 through 2002. By contrast, freight light trucks used motor gasoline for 96% of their fuel requirements in 2002; propane powered three percent, and diesel fuel oil and natural gas made up the remaining one percent. This accounts for some of the difference in GHG emissions intensities recorded for these categories.[337] The increase in GHG emissions intensity for freight light trucks between 1990 and 2002 can be explained by the declining amounts of propane used as fuel. Propane comprised nearly 15% of the fuel used for freight light trucks in 1990, but fell to three percent in 2002, largely replaced by motor gasoline.

[336] NRCan—OEE. (August 5, 2004a, Table 62). Accessed January, 2005.
[337] NRCan—OEE. (August 5, 2004a, Table 58). Accessed January, 2005.

Figure 115. Canada: Road Freight (Medium, Heavy and Light Trucks) GHG Emissions Intensity, 1990-2002 (tonnes of CO_2 equivalent emissions per terajoule of energy use).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Medium Trucks	72.0	72.0	72.0	72.0	72.0	71.9	72.0	71.9	72.0	72.0	72.0	72.0	72.0
Heavy Trucks	71.3	71.3	71.3	71.3	71.3	71.3	71.3	71.3	72.0	72.0	72.0	72.0	72.0
Freight Light Truck	70.4	70.3	70.1	70.7	70.7	70.6	70.7	71.0	70.6	70.8	71.1	71.1	71.3

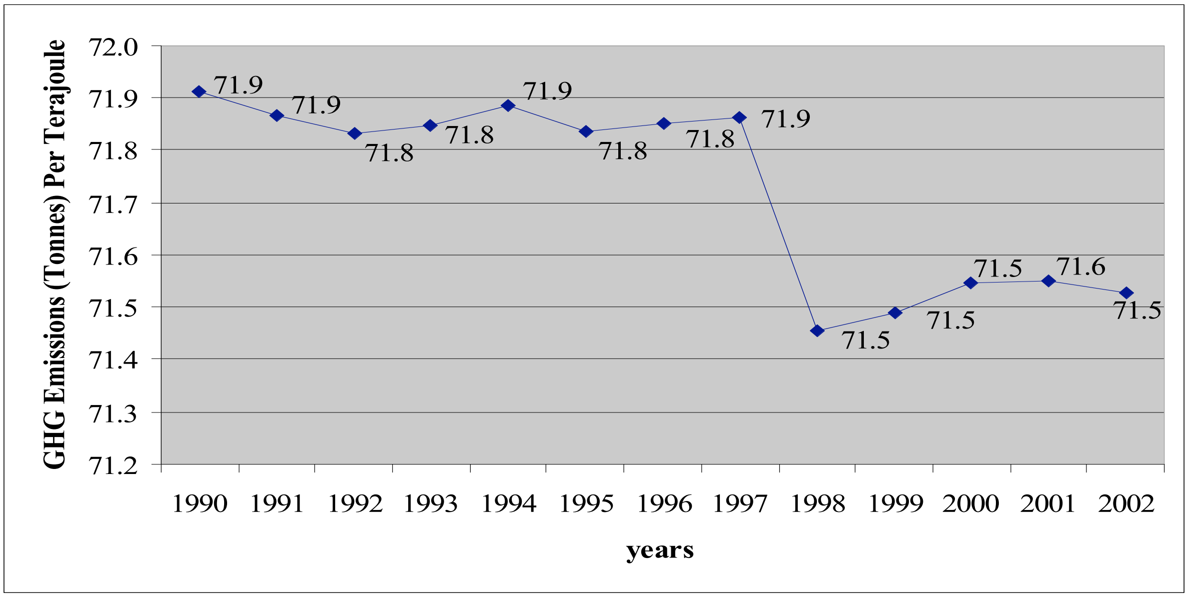
Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 58, 62 and 64.

Figure 116 shows that, in the aggregate, GHG emissions intensity from Canada's transportation sector declined slightly between 1990 and 2002. While the graph presents what appears to be a significant change (because the Y axis is scaled to cover less than one tonne per terajoule), the drop in GHG intensity for the period was only 0.53%, and that is entirely due to a change in accounting methods rather than to any substantive change. Without the change in Statistics Canada's calculation of energy conversion factors between 1997 and 1998, overall GHG emissions intensity would likely have remained virtually static.

A review of the fuel supply for Canadian transportation also reveals only minor changes. The most notable shift was a limited migration from motor gasoline to diesel fuel oil.[338] This relative stasis, combined with the alteration of the conversion factor in 1997-98, make it difficult to evaluate the overall sustainability of Canadian transportation with respect to GHG emissions intensity. The current level is not likely to shift dramatically up or down unless significant changes in overall fuel composition are achieved. For example, significant shifts to natural gas, biodiesel, ethanol, electricity, hybrid cars, and use of hydrogen fuel cells, vegetable oils, and other fuel sources have the potential to change emissions intensities substantially. For the present, however, Canadian transportation GHG emissions intensity is relatively stable—moving neither towards nor away from sustainability.

[338] NRCan—OEE. (August 5, 2004a, Table 1). Accessed January, 2005.

Figure 116. Overall GHG Emissions Intensity of Canadian Transportation, 1990-2002 (tonnes of CO_2 equivalent emissions per terajoule of energy use).



Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Canada—Transportation Sector, Table 1.

Air Pollutant Emissions Intensity

The emissions intensity of air pollutants can also be analysed at the national level. As with the emissions intensity measure for GHGs, air pollutant emissions intensity expresses the volume of a substance emitted per unit of energy used. Unlike the very stable trends for GHG emissions intensity above, however, the transport-related emissions intensity for air pollution has changed substantially over time. As shown in Figure 117, the overall air pollutant emissions intensity for Canadian transportation declined steadily and significantly from 1990 to 2002, falling by more than 42% during this period.

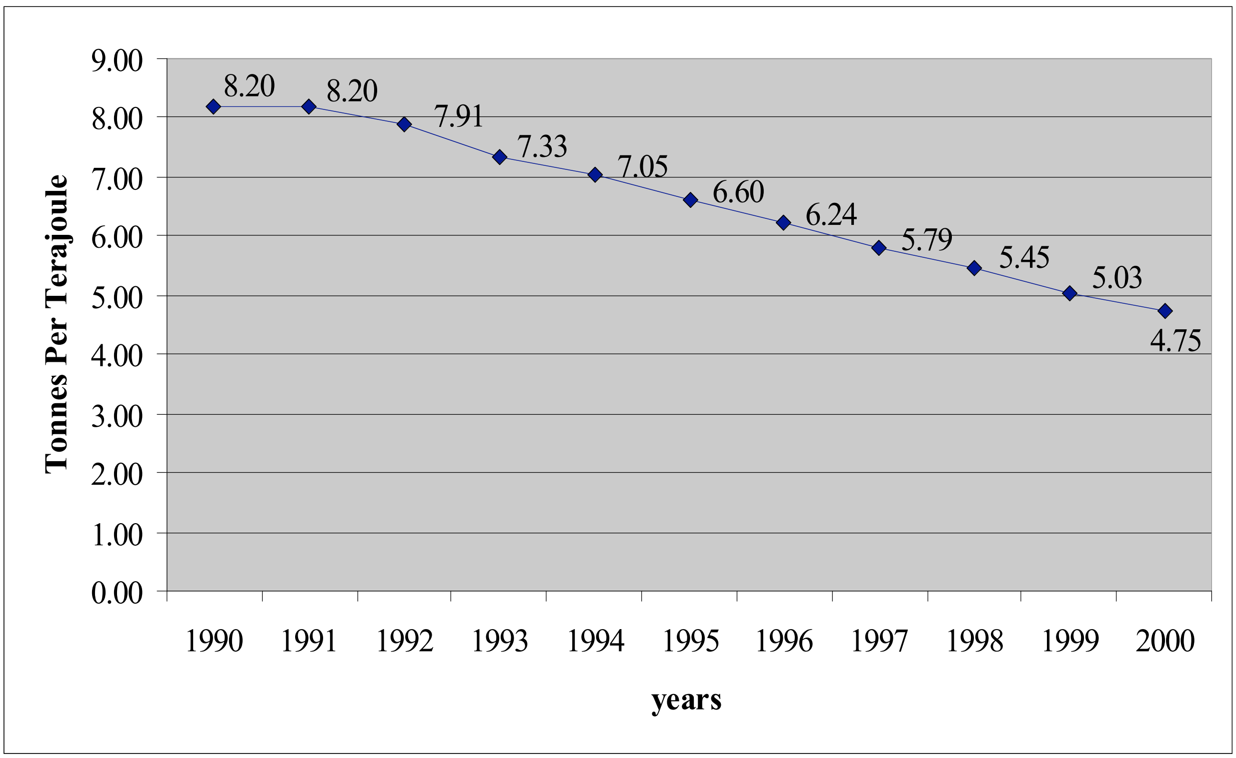
Improvements in air pollutant emissions intensity can be attributed to better vehicle technology driven largely by increasingly stringent government standards. For example, Environment Canada has reduced emissions from heavy trucks since 1998 by lowering the permissible limit for emissions of nitrogen oxides, as well as reducing the allowable sulphur content for on-road diesel fuel.[339] The controls on NO_x emissions were updated in 2004, with further regulations to be implemented in 2007. The reduction in sulphur content of on-road diesel fuel will also be strengthened in 2006. These new Canadian initiatives reflect an effort to align with rigorous standards recently implemented by the United States Environmental Protection Agency. Efforts such as these will hopefully further reduce the air pollutant emissions intensity of Canadian transportation and propel Canadian transportation towards greater sustainability.

[339] Ramsum et al. (2004a, p. 38).

Although these efforts and regulatory initiatives have succeeded in reducing the intensity of air pollutant emissions per unit of energy consumed, the actions taken to date have not yet had an impact on greenhouse gas emissions and overall energy consumption. Indeed, Natural Resources Canada has expressed some concern about the unintended effects of the new air pollution controls and standards in these areas.[340] The problem is that some of the technologies used to reduce air pollutant emissions could adversely affect vehicular fuel consumption, resulting in increased fuel use and GHG emissions per vehicle-kilometre driven.

This trade-off highlights the complexity and challenges of attempting to make transportation more sustainable so long as the transportation fleet relies overwhelmingly on private, motorized, fossil fuel powered vehicles. So long as that basic modal composition remains in place, it is possible that the pursuit of reduced air pollutant emissions and emissions intensity could actually lead to increased releases of GHGs.

Figure 117. Canada: Transportation Air Pollutant (TPM, SO_x, NO_x, VOC, CO) Emissions Intensity, 1990-2000 (Tonnes of emissions per terajoule of energy use).



Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004).

340 Ibid.

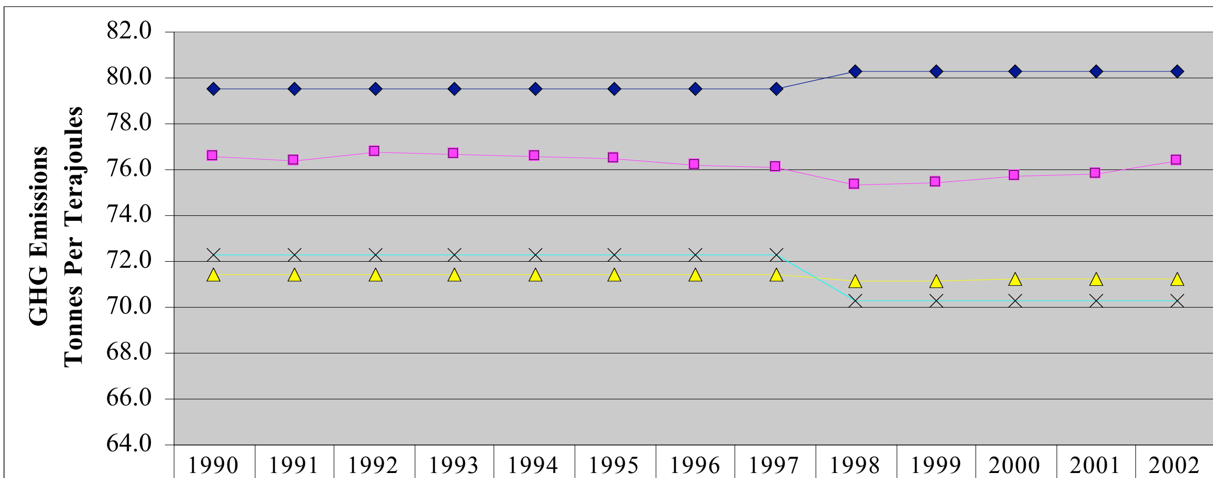
Trends: Nova Scotia

Analyses of greenhouse gas and air pollutant emissions intensities for Nova Scotia generally reveal similar results to those shown above for the Canadian transportation sector. While largely congruent, certain minor differences between the two jurisdictions can nevertheless be identified.

GHG Emissions Intensity

Figure 118 shows Nova Scotia's GHG emissions intensity by mode. Trends in Nova Scotia's transport-related GHG emissions intensities are nearly identical to those at the national level (Figure 112). The single, subtle variation is the marginally higher GHG intensity for marine transport in Nova Scotia. This could be explained by the slightly greater percentage of diesel fuel oil used in this sector in the province.[341]

Figure 118. Nova Scotia: GHG Emissions Intensity, by Mode of Transportation, 1990-2002 (tonnes of CO_2 equivalent emissions per terajoule of energy use).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Rail	79.5	79.5	79.5	79.5	79.5	79.5	79.5	79.5	80.3	80.3	80.3	80.3	80.3
Marine	76.5	76.3	76.8	76.6	76.6	76.5	76.2	76.1	75.3	75.4	75.8	75.8	76.4
Road	71.4	71.4	71.4	71.4	71.4	71.4	71.4	71.4	71.2	71.2	71.2	71.2	71.2
Air	72.3	72.3	72.3	72.3	72.3	72.3	72.3	72.3	70.3	70.3	70.3	70.3	70.3

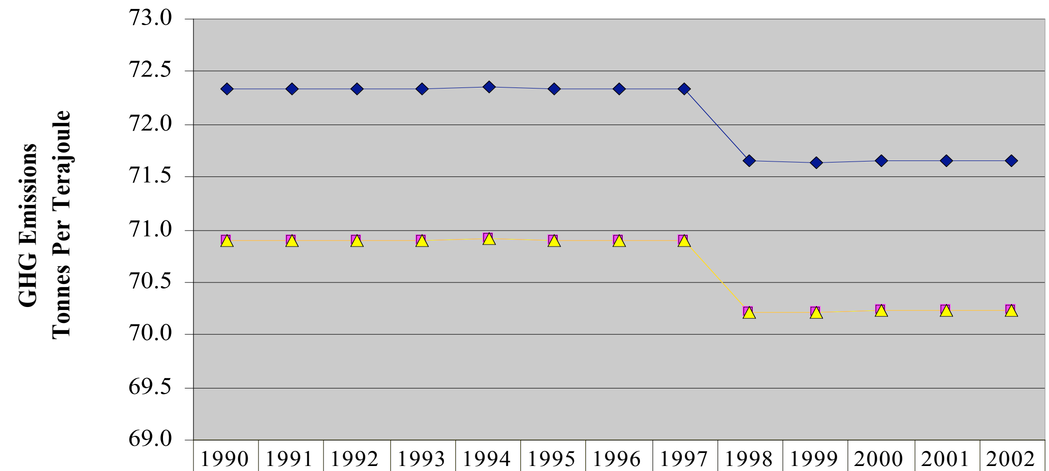
Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Tables 9, 13, 16 and 19.

Figure 119 illustrates the GHG emissions intensity of three passenger vehicle classifications. As in the national analysis shown in Figure 113, passenger light trucks were more emissions

[341] NRCan—OEE. (August 5, 2004b, Table 19). Accessed May, 2005.

intensive, while small and large cars had nearly identical trend lines for GHG emissions intensity.

Figure 119. Nova Scotia: Passenger Road Vehicle (Light Trucks, Small and Large Cars) GHG Emissions Intensity, 1990-2002 (tonnes of CO_2 equivalent emissions per terajoule of energy use).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Passenger Light Truck	72.3	72.3	72.3	72.3	72.3	72.3	72.3	72.3	71.6	71.6	71.7	71.7	71.7
Small Car	70.9	70.9	70.9	70.9	70.9	70.9	70.9	70.9	70.2	70.2	70.2	70.2	70.2
Large Car	70.9	70.9	70.9	70.9	70.9	70.9	70.9	70.9	70.2	70.2	70.2	70.2	70.2

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Tables 28, 29 and 37.

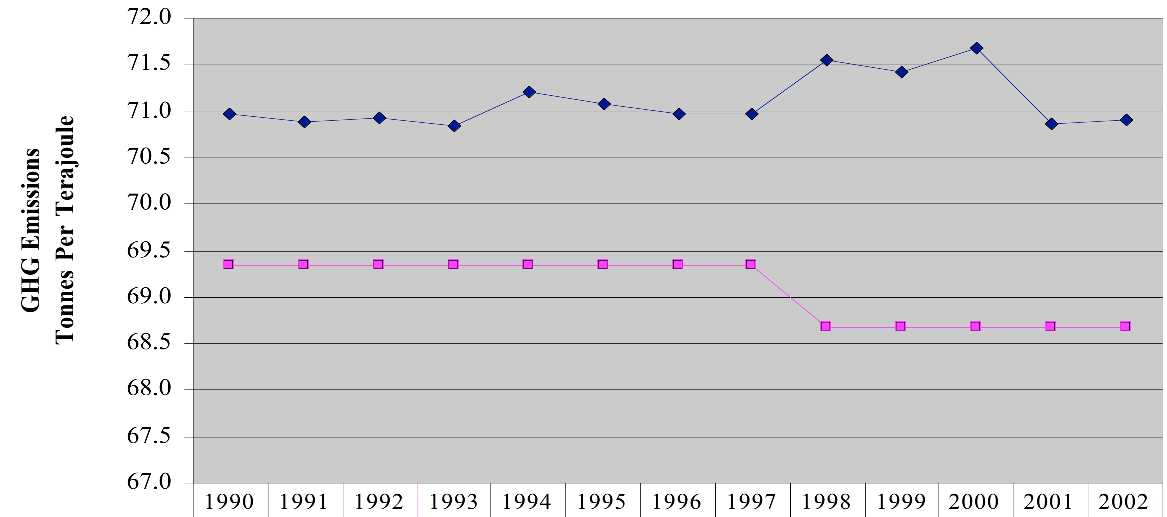
Figure 120 illustrates the GHG emissions intensities for buses and motorcycles in Nova Scotia. Again, these trends are similar to those for Canada generally (Figure 114). The provincial results for motorcycles are almost identical to the national numbers, but there is some difference for bus GHG emissions intensity. Nova Scotia's buses have a somewhat higher GHG emissions intensity than is recorded for Canada overall. This is likely due to heavier reliance on diesel oil as a fuel source for buses in Nova Scotia (school buses, urban transit, and inter-city buses).[342]

In 2004, Halifax Regional Municipality's introduced biodiesel fuel for its Metro Transit bus fleet. Biodiesel can reduce tailpipe emissions by 17%, while being only marginally more expensive. However, Metro Transit had to stop using the fuel temporarily in December 2005 due to technical difficulties. The Transit Authority remains committed to using biofuel and will resume using the fuel once it finds the right mixture that will work well with its fleet.[343] This will reduce the GHG emissions intensity of the fleet and likely bring it below national levels, which should be reflected in future statistics.

[342] NRCan—OEE. (August 5, 2004b, Tables 31-33). Accessed January, 2005.
[343] Smulders, Marilyn. "Metro Transit Parks Biodiesel." (Halifax: *Daily News*, Jan 19, 2006. pg. 4)

Efficiency in engines also has an impact on emissions. The 2000-01 drop in GHG emissions intensity for buses, reflected in Figure 120, is likely due to technology changes in bus engines.[344]

Figure 120. Nova Scotia: GHG Emissions Intensity, Buses and Motorcycles, 1990-2002 (tonnes of CO_2 equivalent emissions per terajoule of energy use).



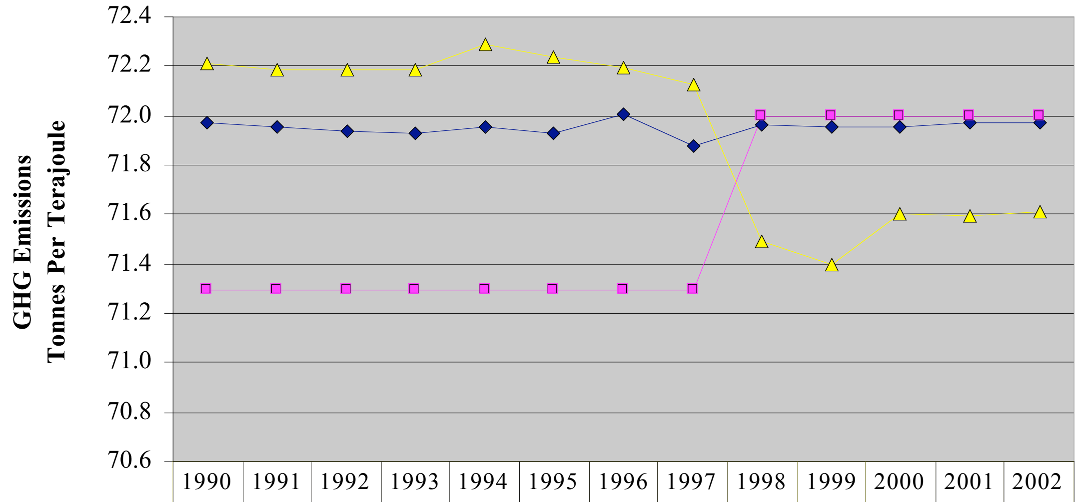
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Bus	71.0	70.9	70.9	70.8	71.2	71.1	71.0	71.0	71.6	71.4	71.7	70.9	70.9
Motorcycle	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	68.7	68.7	68.7	68.7	68.7

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Tables 22 and 35.

The GHG emissions intensity for the movement of freight by road is shown in Figure 121. The results for medium and heavy trucks are consistent with the national trends (Figure 115) but there is a noticeable difference in the freight light truck category. On a national level, GHG emissions intensity increased, largely as a result of a shift from the use of propane to motor gasoline between 1990 and 2002. In Nova Scotia, by contrast, freight light trucks were almost completely reliant on motor gasoline for the entire period between 1990 and 2002, with only small amounts powered by diesel fuel oil or propane.[345] So, aside from the accounting change that occurred between 1997 and 1998, as noted above, the provincial trend for light freight truck GHG emissions intensity has remained stable over time. The shift towards greater reliance on motor gasoline at the national level has caused the GHG emissions intensity level for light freight trucks to approximate the provincial trend more closely over time, so that by 2002 the two levels were very similar.

[344] Beauchamp, Paul. Manager of Fleet, Metro Transit, (Personal communication: March 2006).
[345] NRCan—OEE. (August 5, 2004h, Table 38). Accessed January, 2005.

Figure 121. Nova Scotia: Road Freight (Medium, Heavy and Light Trucks) GHG Emissions Intensity, 1990-2002 (tonnes of CO_2 equivalent emissions per terajoule of energy use).

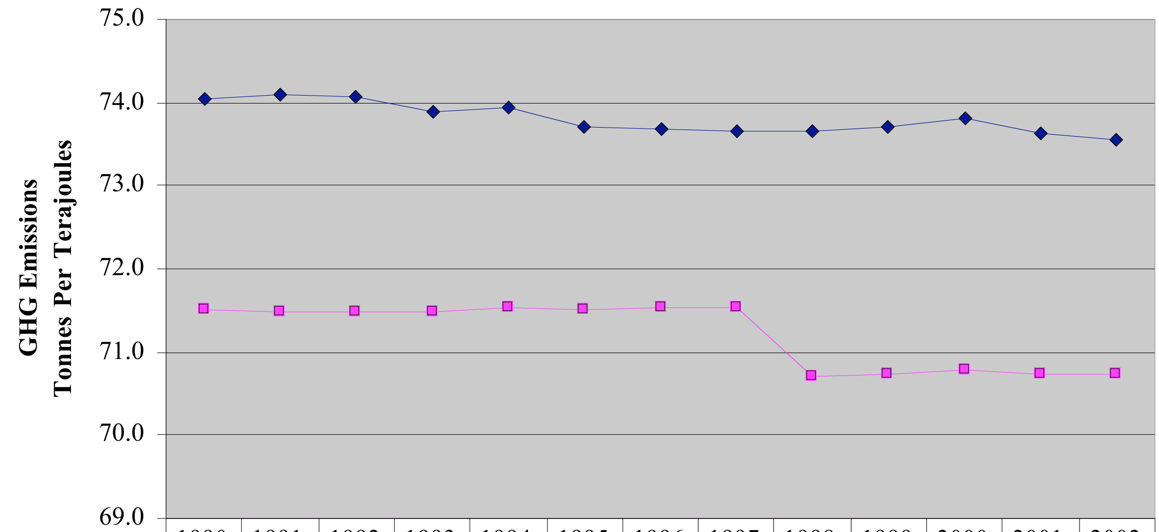


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Medium Trucks	72.0	72.0	71.9	71.9	72.0	71.9	72.0	71.9	72.0	72.0	72.0	72.0	72.0
Heavy Trucks	71.3	71.3	71.3	71.3	71.3	71.3	71.3	71.3	72.0	72.0	72.0	72.0	72.0
Freight Light Truck	72.2	72.2	72.2	72.2	72.3	72.2	72.2	72.1	71.5	71.4	71.6	71.6	71.6

Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Tables 38 and 39.

Another way of looking at this information is by examining GHG emissions intensity for all modes of passenger and freight transportation (Figure 122). Between 1990 and 2002, freight GHG emissions intensity fell by just 0.67% according to this measure, while passenger emissions intensity apparently dropped by just over one percent. However, the entire apparent passenger transport decrease is in fact attributable to the 1997-98 change in Statistics Canada's adjustment in the energy content value conversion factor rather than to any substantive change. These two trends therefore again demonstrate the relatively stable nature of GHG emissions intensity. Even the very slight actual decrease in freight transport emissions intensity over time (not explainable by Statistics Canada's accounting change) is too marginal and insignificant to be identified as real movement towards sustainability.

Figure 122. Nova Scotia: Freight and Passenger GHG Emissions Intensity, 1990-2002 (tonnes of CO_2 equivalent emissions per terajoule of energy use).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Freight	74.0	74.1	74.1	73.9	73.9	73.7	73.7	73.7	73.7	73.7	73.8	73.6	73.6
Passenger	71.5	71.5	71.5	71.5	71.5	71.5	71.5	71.5	70.7	70.7	70.8	70.7	70.7

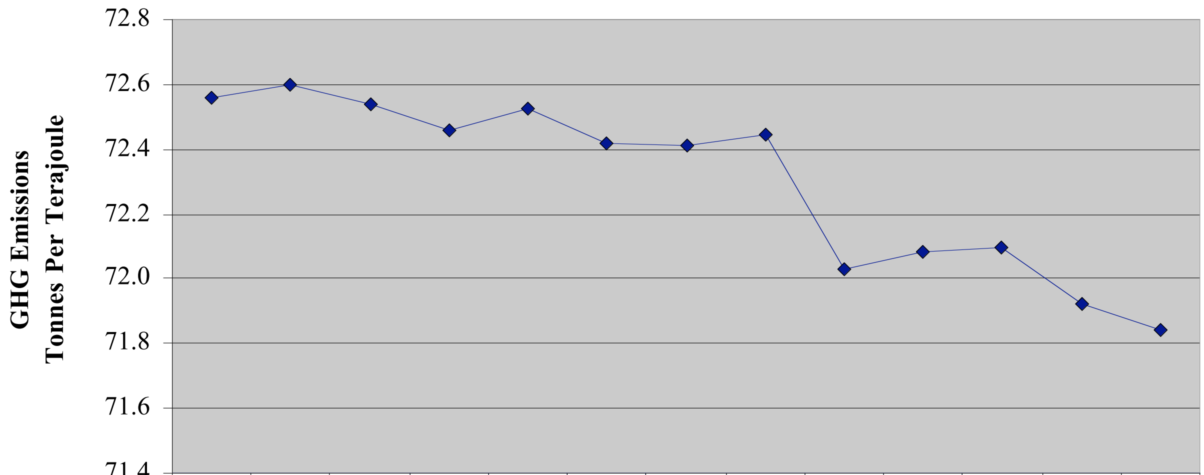
Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Tables 5 and 6.

Figure 123 shows the aggregate GHG emissions intensity for all transportation in Nova Scotia between 1990 and 2002. During this time there was a slight decline in GHG emissions of almost one percent, but fully half of this decline is attributable to the 1997-98 change in Statistics Canada's adjustment to the energy content value conversion factor rather than to substantive changes. The 2002 results for Nova Scotia are comparable to the overall GHG emissions intensity for Canadian transportation (Figure 116).

The provincial decline in emissions intensity was only slightly greater than at the national level, though Nova Scotia began with a higher overall GHG emissions intensity in 1990, and the 2002 provincial level still remains slightly above the national one. As at the national level, the overall GHG emissions intensity for Nova Scotia has remained relatively unchanged over time, with changes too marginal to have significance, and so is assessed here as moving neither towards nor away from sustainability.

The international comparison in Figure 110 above shows that Canada has the fourth highest GHG emissions intensity out of the 29 OECD countries for which comparable data are available. As noted at several points throughout this analysis, the trend lines for Nova Scotia can only demonstrate relative movement over time and tell us nothing about how far existing levels are from those that might be considered sustainable. As Nova Scotia's GHG emissions intensity is marginally higher than Canada's, and since Canada is one of the poorest performers globally, Nova Scotia's current levels cannot be considered sustainable regardless of the trend analysis.

Figure 123. Total GHG Emissions Intensity of Nova Scotian Transportation, 1990-2002 (tonnes of CO_2 equivalent emissions per terajoule of energy use).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
GHG Intensity	72.6	72.6	72.5	72.5	72.5	72.4	72.4	72.4	72.0	72.1	72.1	71.9	71.8

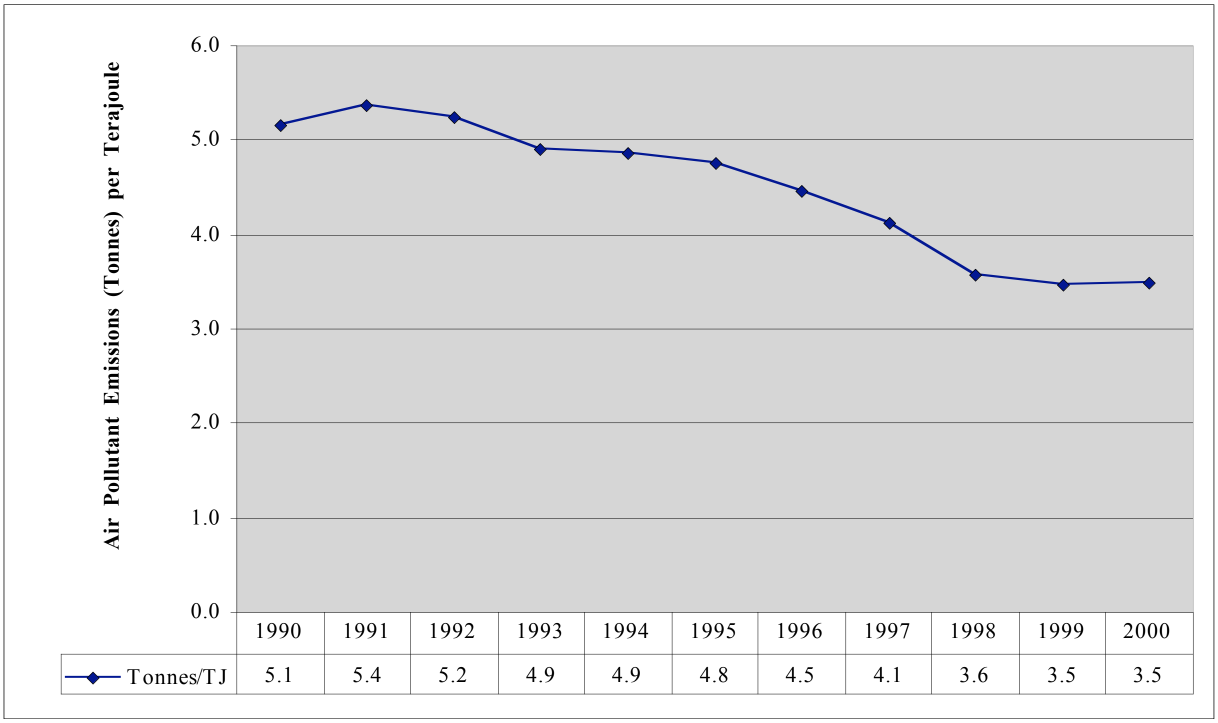
Source: Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Table 1.

Air Pollutant Emissions Intensity

The second indicator of transport-related emissions intensity, transportation air pollutant emissions intensity, is illustrated in Figure 124. Unlike greenhouse gas emissions intensity, provincial transport-related air pollutant emissions intensity declined dramatically between 1990 and 2002, just as it did at the national level (Figure 117), falling by 31% in Nova Scotia during this period. This is a clear indication that air pollutant emissions intensity is moving towards sustainability both in Nova Scotia and across Canada.

In this case, however, unlike the congruence of provincial and national results on GHG emissions intensity, Nova Scotia's air pollutant emissions intensity is less than half the national figure. This undoubtedly reflects the evidence presented in the last chapter, which showed Nova Scotia to have among the lowest per capita transport-related air pollutant emissions in the country. In this case, the evidence indicates that not only are the trends moving towards greater sustainability, but – in absolute terms as well – the province is closer to sustainable emissions intensity levels than the country as a whole.

Figure 124. Nova Scotia: Transportation Sector Air Pollutant (TPM, SO_x, NO_x, VOC, CO) Emissions Intensity, 1990-2000 (Tonnes of emissions per terajoule of energy use).



Sources: Personal Communication with Brett Taylor, Emissions Inventory Information Analyst, July 20, 2004; and Natural Resources Canada—Office of Energy Efficiency. 2002 Comprehensive Energy Use Database: Transportation Sector—Nova Scotia, Table 1.

Conclusion

International comparisons of transport-related greenhouse gas and air pollutant emissions intensities (measured as emissions per unit of output) demonstrated that Canada is fairly intensive in both areas (Figures 110 and 111). A national review of greenhouse gas emissions intensities across varying modes of transportation showed little change over time in any of the categories (Figure 112). Relatively higher emissions intensities were noted for marine and rail transportation.

As shown in Figure 113, the GHG emissions intensity of passenger movement in Canada was higher for light trucks than for large or small cars (which had almost identical emissions intensities). Changes in fuel sourcing for Canadian buses led to a small increase in GHG emissions intensity over time. The motorcycle category remained stable (Figure 114).

Medium and heavy freight trucks in Canada showed similar patterns of emissions intensities (Figure 115). The decline in the use of propane as a fuel source for freight light trucks in Canada led to an overall increase in GHG emissions intensity for this mode over time.

In general, findings at the national level for GHG emissions intensity corresponded to the analysis for Nova Scotia (Figures 118-123). Two small differences were apparent. The first was the higher GHG emissions intensity of buses in Nova Scotia due to their greater reliance on diesel fuel oil. The second was the more stable GHG emissions intensity of freight light trucks compared to the national figures, likely due to the greater reliance of the provincial light freight truck fleet on gasoline rather than propane in the 1990s. An aggregate review of the GHG emissions intensity of passenger and freight movement in Nova Scotia showed generally stable results over time, with the slight decline apparent in the passenger sector attributable to a change in Statistics Canada's accounting procedures in 1997-98 rather than to any substantive change, and the decline in the freight sector too marginal (less than one percent) to carry significance (Figure 122).

The first overall indicator for this section of the report, shown in Figure 123, revealed that total aggregate GHG emissions intensity for transportation in Nova Scotia only declined very slightly between 1990 and 2002 (by less than one percent), with half that drop attributable to the 1997-98 accounting change. The final 2002 result is still slightly higher than the national level. The stability of this measure leads to the assessment that GHG emissions intensity for transportation in Nova Scotia is moving neither towards nor away from sustainability. The province's high GHG emissions intensity compared to the vast majority of OECD nations examined in Figure 110 indicates that – in more absolute terms – present levels cannot be considered sustainable.

The second indicator, shown in Figure 124, showed a significant 31% decline in total air pollutant emissions intensity from transportation in Nova Scotia. This is a clear indication that air pollutant emissions intensity in the province is moving towards greater sustainability. Because provincial air pollutant emissions intensity was about 30% less the national level in 2002, the province can be considered closer to sustainable levels than the country as a whole.

The decline in air pollutant emissions intensity during the 1990s at both the national and provincial levels can be explained by the new federal government regulations described earlier in the chapter. These include national standards mandating reduced emissions of nitrogen oxides from heavy trucks and lowering the sulphur content of diesel fuel.

Initiatives at the local level can also help reduce emissions intensity. For example, in October of 2004, the Halifax Regional Municipality (HRM) announced that is was switching the entire fleet of public transit buses to biodiesel fuel.[346] This is a mix of 80% regular diesel and 20% "bio-fuel." As HRM's Transit Authority explains: "Bio-fuel is a by-product of the production of Omega-3 Oil, which (is) refined from fish oil."[347] Preliminary tests of this fuel have demonstrated reductions in emissions of 18% for particulate matter, 16% for carbon dioxide, and 11% for unburned hydro-carbons. This change will reduce and limit the emissions intensity of buses for both GHGs and air pollutants in Nova Scotia, and will likely bring bus-attributable emissions intensities below national levels.

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[346] Halifax Regional Municipality—Metro Transit. Entire Metro Transit Bus Fleet to Adopt Use of Biodiesel Fuel. (Halifax: October 12, 2004). www.halifax.ca/metrotransit/news/10_2004-Biodiesel.html Accessed January, 2005.
[347] Ibid.

Biological additives can also be used to supplement other fuels and thereby reduce GHG and pollutant emissions intensities. For example, Premier Dalton McGuinty of Ontario announced in November, 2004, that all gasoline sold in the province will contain an average of five percent ethanol by 2007. As explained in the Ontario Government press release: “Ethanol is a high-octane fuel additive made from agricultural crops. It is blended with conventional gasoline and results in cleaner fuel combustion and fewer emissions.”[348] The targeted 2007 ethanol levels are projected to reduce GHG emissions in Ontario by 800,000 tonnes annually, the equivalent of removing 200,000 vehicles from the road.[349] However, there is considerable debate concerning the overall emission reductions provided by biofuels; many studies indicate that with current production methods, ethanol provides no net GHG emission reductions.[350]

These two examples illustrate the utility of examining emissions intensities as key indicators of transportation sustainability, as they point to significant potential efficiency gains and policy options related to fuel switching, which are not apparent from the analysis of overall emissions trends alone. Indeed, initiatives like the HRM and Ontario ones noted above – with the significant caveat on biofuel production noted – have the potential finally to produce a change in the stubborn stability of GHG emissions intensity trends over time.

There appears to be widespread support among Canadians for initiatives to improve transportation energy efficiency. A poll conducted by Leger Marketing in January, 2005, found that nearly 90% of Canadians want the federal government to set strict fuel efficiency standards for new vehicles.[351] Moreover, 81% of Canadians feel that these benchmarks should be mandatory, as opposed to the voluntary standards often used. However, because increasing vehicle fuel efficiency tends to marginally increase annual vehicle mileage (a “rebound effect”), strategies that simply increase vehicle fuel efficiency tend to increase other traffic problems, such as congestion, road and parking facility costs, accidents, and sprawl.[352] It is therefore important to apply emission reduction strategies that are paired with effective mobility management.

As well, the European DPSIR model referenced earlier cautions that policy responses (R), which deal primarily with symptoms and that are designed only to alleviate pressures (P), states (S), and impacts (I) may be relatively ineffective or even counter-productive in the longer term. Thus, improvements in fuel efficiency, laudable as they may be in reducing emissions intensity and emissions per vehicle-kilometre driven, may actually result in increased driving as noted above, and certainly do not address the underlying “driving force” (D) – which is the dependence on private motorized transportation. Similarly highway twinning may temporarily relieve

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[348] Government of Ontario. Cleaner Gasoline for Healthier Ontarians and a Healthy Economy. (Chatham: November 26, 2004). www.premier.gov.on.ca/english/news/CleanerGas112604.asp Accessed January, 2005.
[349] Ibid.
[350] Ho, Mae-Wan. *Biofuels for Oil Addicts: Cure Worse Than The Addiction*. (Press Release, Institute of Science in Society Feb. 28, 2006) www.i-sis.org.uk
[351] David Suzuki Foundation. Poll shows Canadians want tougher fuel economy standards for cars. (Ottawa: News Release. January 19, 2005). www.davidsuzuki.org/Campaigns_and_Programs/Climate_Change/News_Releases/newsclimatechange01190501.asp Accessed January, 2005.
[352] Litman, Todd. “Efficient Vehicles Versus Efficient Transportation: Comparing Transportation Energy Conservation Strategies.” (*Transport Policy* Volume 12, Issue 2, March 2005, Pages 121-129) (2005a) www.vtpi.org/cafe.pdf

congestion but may also fuel ex-urban development that increases automobile reliance. This chapter on emissions intensity, and on options to improve fuel efficiency and switch to lower-intensity fuels, must therefore be taken in the larger context of this study as a whole, which finds the overwhelming reliance on motorized road transport to be the primary driver of an unsustainable transportation system to which policy responses must be ultimately directed.

Chapter 7. Water Pollutants

As noted in the previous chapters, this study has adopted the provision of the EU and CST definitions and goals of a sustainable transportation system that entails *limiting emissions and wastes within the planet's ability to absorb them*. Just as atmospheric pollutants like greenhouse gases and air pollutant emissions threaten human and ecosystem health and are therefore incompatible with sustainable transportation, liquid and other pollutants from transportation also pose threats to human and ecosystem health when they exceed the planet's capacity to process them naturally. For this reason, a decrease in transport-related water pollution is also an important indicator of movement towards transportation sustainability.

Water pollution here refers to harmful, often toxic, liquids and other pollutants released into the environment generally, and into water bodies in particular. The term "water pollution" is therefore used somewhat more broadly here than is usual, to refer both to *types* of pollutants (e.g liquids like oil) wherever they are discharged, and to environmental water bodies that are receptors of a wide range of transport-related pollutants. These two meanings are combined in this chapter for convenience in order to group a number of related indicators. Motor vehicles, roads, and parking facilities—as well as accidents involving hazardous materials, from any of several modes of transportation—are major causes of water pollution.[353] Some of the different sources of water pollution from transportation include:

- Road de-icing (salt) damage;
- Oil spills, waste discharge, and transportation accidents involving hazardous materials;
- Crankcase oil drips and disposal;
- Roadside herbicides; and
- Leaking underground fuel and chemical storage tanks.

The release of these pollutants can lead to the contamination of surface and ground water, and can cause well water contamination, wildlife habitat damage, reduction in fish stocks, destruction of unique natural features, and aesthetic losses.[354]

Road De-Icing Salts

Road de-icing salts cause significant environmental and material damages. Salts are used in the winter to mitigate ice and snow conditions on roads, and to provide safer driving conditions.[355] However, the heavy use of road salts can harm vegetation, as is most obvious when roadside flora are damaged by salt splash. Road salts have also been associated with damage to organisms in soil, to birds, and to other wildlife.

[353] Litman, Todd. *Transportation Cost and Benefit Analysis: Techniques, Estimates and Implications*, p. 5.15-1. (Victoria Transport Policy Institute, 2003c). www.vtpi.org/tca/tca0515.pdf Accessed December, 2004.
[354] Ibid.
[355] Environment Canada. Road Salts—Frequently Asked Questions. (August 6, 2003). www.ec.gc.ca/nopp/roadsalt/en/faq.cfm?q=3 Accessed December, 2004.

Almost all chloride ions from road salts eventually find their way into watercourses, whether by direct runoff into surface water or by moving through the soil and groundwater.[356] In surface water, road salts can harm freshwater plants, fish, and other organisms that cannot adapt to living in saline conditions. Another major cause of concern about de-icing salts is their propensity to contaminate well water when improperly stored and used. This type of contamination occurs when the road grade or drainage system channels the salty runoff directly toward wells.

Oil Spills, Waste Discharge, and Other Transportation Accidents involving Dangerous Goods

Crude oil transportation can also result in environmental impacts, including oil spills. While only major spills generally appear in the headlines, smaller spills occur more frequently. Transporting oil from source to user often requires many transfers, using ocean tankers, pipelines, tanker trucks, and railways—and with each transfer, there is an increase in the risk for spills.[357]

Spilled oil poses serious threats to fresh water and marine environments. Harmful effects from oil spilled or leaked in transit include: physical and chemical alteration of natural habitats resulting from oil incorporation into sediments; physical smothering effects on flora and fauna; and the toxicity of the oil itself, which can poison exposed organisms. The severity of an oil spill's impact depends on a variety of factors, including the physical properties of the oil, whether or not oils are petroleum-based, and the natural actions of the receiving waters on the oil.[358]

The discharge of solid wastes and sewage by maritime vessels can also contribute to water pollution, especially in coastal areas where the volume of traffic is high. Moreover, transport-related facilities such as gas stations, maintenance shops, service stations, and freight terminals also affect water quality through runoff of gas, oil, and dirt; spills during refuelling; waste releases to sewer systems; and cleaning of freight tank interiors. Truck, railcar, and ship cargo interiors that carry fluids must be washed, resulting in the discharge of spent cleaning fluids, water treatment system sludge, and tank residues.

Transportation accidents involving dangerous goods are another source of environmental pollution in general and water pollution in particular. These materials are shipped by all modes of transportation, and accidents that release hazardous materials damage the environment. Under Transport Canada's *Transportation of Dangerous Goods Act*, dangerous goods are divided into nine different classes:

- **Class 1** - Explosives, including explosives within the meaning of the *Explosives Act*.
- **Class 2** - Gases: compressed, deeply refrigerated, liquefied, or dissolved under pressure.

[356] Ibid.
[357] Statistics Canada. *Human Activity and the Environment—Annual Statistics 2004*. (Catalogue no. 16-201-XPE. 2004b).
[358] United States Environmental Protection Agency. Threats from Oil Spills. (December 23, 2004). www.epa.gov/oilspill/effects.htm Accessed December, 2004.

- **Class 3** - Flammable and combustible liquids.
- **Class 4** - Flammable solids; substances liable to spontaneous combustion; substances that, on contact with water, emit flammable gases.
- **Class 5** - Oxidizing substances; organic peroxides.
- **Class 6** - Poisonous (toxic) and infectious substances.
- **Class 7** - Radioactive materials and radioactive prescribed substances within the meaning of the *Atomic Energy Control Act*.
- **Class 8** - Corrosives.
- **Class 9** - Miscellaneous products, substances, or organisms considered by the Governor-in-Council to be dangerous to life, health, property, or the environment when handled, offered for transport, or transported and prescribed to be included in this case.[359]

The reporting of transportation accidents involving dangerous goods depends on the class under which the dangerous goods fall. The regulations accompanying the *Transportation of Dangerous Goods Act* state the amounts for each class of discharged goods that constitute an accident that must be reported. Accidents are reported to the appropriate provincial authority as well as to the Canadian Transport Emergency Centre of the Department of Transport (CANUTEC).

Crankcase Oil Drips and Disposal

As indicated most visibly by oil spots on roads and in parking lots, and by rainbow sheens of oil in puddles and roadside drainage ditches, vehicles leak hazardous fluids, including crankcase oil; antifreeze; and transmission, hydraulic, and brake fluids. Runoff from roads and parking lots has high concentrations of toxic metals, suspended solids, and hydrocarbons, all of which originate largely from automobiles. This makes highway runoff toxic to many aquatic and other species.

Leaking Underground Storage Tanks and Roadside Herbicides

Underground storage tanks are used to store fuel and various chemicals at gas stations and other transport facilities. Leaking tanks can be a source of groundwater contamination. Releases from tanks and piping occur from corrosion of older, unprotected steel tanks and piping, or from cracks in tanks made from other materials. Roadside vegetation control is a major source of herbicide dispersal that can also cause environmental damage.

In short, there is a wide range of transport-related pollutants that can harm the environment in general and water bodies in particular. Although their nature and potential impacts extend beyond conventional definitions of water pollutants, they are grouped together for convenience under that title in this chapter.

[359] Transport Canada. *Transportation of Dangerous Goods Act.* (1992). www.tc.gc.ca/acts-regulations/GENERAL/T/tdg/act/tdg.htm

The Indicators

Although drinking water quality standards are usually met in most Canadian jurisdictions, the impact of transport-related pollution is generally on water *sources* rather than on the water that comes out of household taps after chlorination, filtration, and other purification processes. For example, some transport-related pollutants accumulate gradually in sediments or through the food chain. Unfortunately, it is difficult to determine exactly how much the transportation sector contributes to water pollution problems, and even more difficult to assess its impacts on water used for drinking, swimming, fishing, and other human activities. This is because the impacts of transport-related pollution are diffuse and cumulative, and almost impossible to trace through the multiple processes that link the initial pollutant discharge with final water quality.

As well, and partly because of these difficulties, data availability for water pollution due to transportation is severely limited, and there is little reported on such pollutants, even at the initial discharge level. For example, recent data on transport-related oils spills in Canada were unavailable. The last report on oil spills was from 1995.[360] No data were found on crankcase oil drips and disposal, application of roadside herbicides, or leaking underground storage tanks.

The only indicators that could therefore be used in this chapter, based on available statistics, were road salt tonnage used, well contamination claims, and numbers of reported accidents involving dangerous goods. Information about road salt usage and well contamination claims and costs were obtained from the Nova Scotia Department of Transportation and Public Works. Records of dangerous goods accidents were drawn from Statistics Canada's CANSIM database.

The data gaps for this key subject are therefore quite significant, with no reporting currently possible, at either the national or provincial levels, on most of the important issues identified above. As well, no reports on international trends for water pollution from transportation could be found despite an exhaustive search. Even on the issue of road salt impacts, where provincial data on tonnage and well contamination claims were obtained, there was no information on the actual impact of road salt on a nationwide scale or by comparison to other provinces.

The limited indicators used to investigate water pollution from transportation therefore include:

- Tonnes of road salt used (provincial only);
- Number of wells contaminated by road salt (provincial only);
- Total yearly costs from claims for road salt contamination of wells (provincial only);
- Number of accidents involving dangerous goods by province
- Number of accidents involving dangerous goods by transport mode.
- Number of accidents involving dangerous goods by class (national only)

[360] Environment Canada. *Summary of Spill Events in Canada: 1984-1995.* (1998b). www.ec.gc.ca/ee-ue/stats/sum_spills/1984_1995/sum_spills_1984-1995_poster_e.asp

Trends: Canada

Road De-Icing Salts

On average, five million tonnes of road salts are used each year as de-icers on Canadian roadways.[361] Due to concerns about the large quantities of chlorides being released to the environment, road salts underwent a comprehensive five-year scientific assessment under the *Canadian Environmental Protection Act* (1999), beginning in 1995. Since the start of this evaluation, many road authorities across Canada have taken action to improve their salt management practices.[362] Unfortunately, information about the different provincial and municipal salt management programs across the country was unavailable.

Estimates from studies in Ontario and Maine indicate that 20% of road-side wells exhibit salt contamination where highways are heavily salted.[363] Based on data from some of the provinces, Environment Canada estimated the cost of well contamination claims attributable to road salt to range from $5,500 to $16,000 per well per year.[364] In Nova Scotia, the average cost of well claims is $11,725[365]—slightly above the median cost across Canada. Specific details about the cost of well claims on a province by province basis are unavailable, as are data regarding the cost of salt contamination to surface water.

Accidents Involving Dangerous Goods

Figure 125 shows the number of accidents involving dangerous goods, by province, for 1990 and 2002. Nova Scotia had relatively fewer accidents involving dangerous goods over this period than other provinces. Between 1990 and 2002, the incidence of dangerous goods accidents in Nova Scotia declined by 43%, while the overall number of accidents involving dangerous goods in Canada increased by 11%. To put these absolute numbers into comparative perspective, however, the number of accidents involving dangerous goods should be assessed on a per capita basis. From that perspective, Nova Scotia's accident rate involving dangerous goods was well above the national average in 1990 and comparable to the national average in 2002.

Ontario and Alberta had the most accidents in the country, while PEI and Newfoundland have had the fewest, though a per capita assessment reveals that Ontario's 2002 accident rate was well below the national average. Alberta was the only province that had a significant increase in accidents involving dangerous goods over the period, with the number of accidents more than

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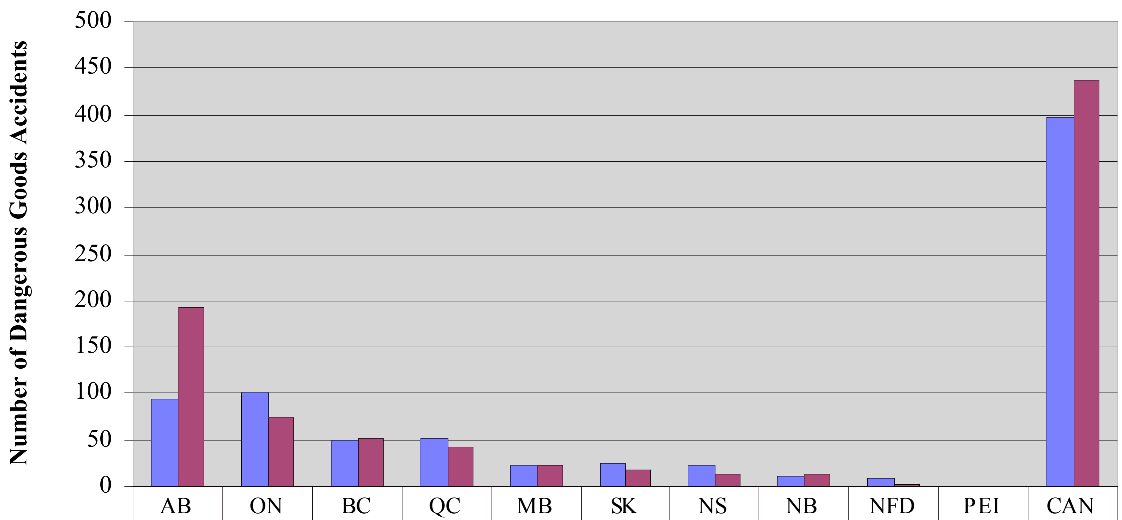
[361] Environment Canada. *Code of Practice for the Environmental Management of Road Salts*, p. 3. (Ottawa: 2004). www.ec.gc.ca/nopp/roadsalt/cop/pdf/1774_EngBook_00.pdf Accessed December, 2004.
[362] Ibid.
[363] Wilson, Sara. *The GPI Water Quality Accounts: Nova Scotia's Water Resource Values and the Damage Costs of Declining Water Resources and Water Quality*, p. 78. (**GPI***Atlantic*, 2000). www.gpiatlantic.org/pdf/water/waterquality.pdf
[364] Environment Canada. Winter Road Maintenance Activities and the Use of Road Salts in Canada: A Compendium of Costs and Benefits Indicators. (March 20, 2003). www.ec.gc.ca/nopp/roadsalt/reports/en/winter.cfm Accessed December, 2004.
[365] Newson, Steve. Policy Advisor, Nova Scotia Department of Transportation and Public Works. (Personal communication: August, 2004).

doubling between 1990 and 2002. In 2002, Alberta alone accounted for 44% of all accidents involving dangerous goods in the country, which may be related to that province's rapid development of its tar sands deposits.

As a caveat, it should be noted that indicators of incidence rates like this one are really inadequate to assess environmental impacts, as some incidents may involve much more serious damage than others. Unfortunately, aggregate data assessing actual impacts are not available, and time and resources did not permit the case by case examination of each accident that would be necessary to compile such an aggregate impact assessment for the purposes of this study.

Figure 125. Number of Accidents Involving Dangerous Goods, by Province, 1990 and 2002.



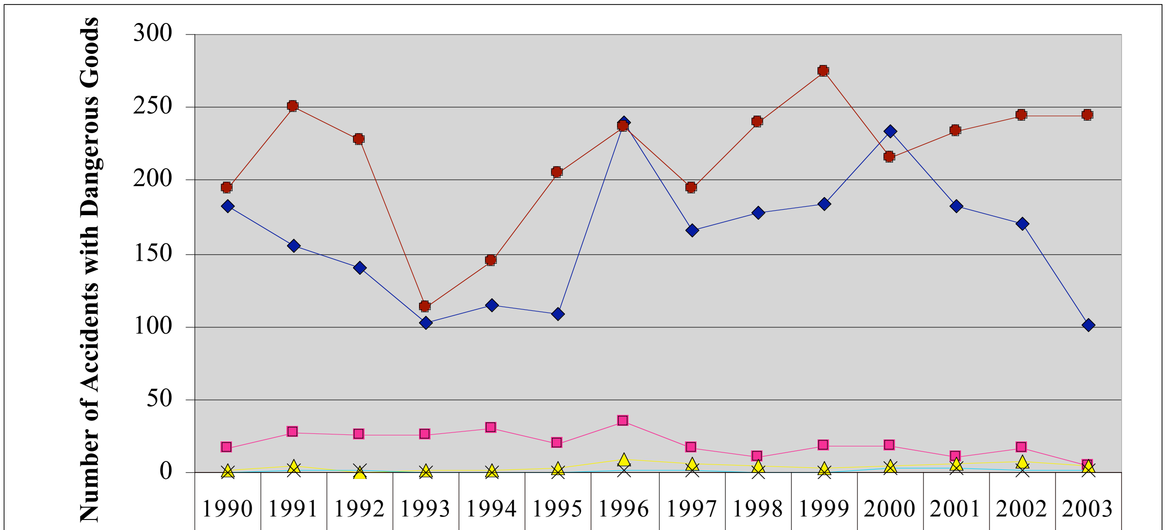
	AB	ON	BC	QC	MB	SK	NS	NB	NFD	PEI	CAN
1990	94	102	50	51	22	25	23	12	9	0	396
2002	193	74	52	43	22	17	13	13	3	0	438

Source: Statistics Canada. CANSIM Table 409-0002.

Figure 126 shows the number of accidents involving dangerous goods in Canada, by transport mode, from 1990 through 2002. Numbers for rail, marine, and air accidents involving dangerous goods have remained fairly stable. By contrast, dangerous goods accidents on roads and at transport facilities, like terminals, ports, and stations, have both varied considerably. The 2003 data show on-road dangerous goods accidents at their lowest level on record, while facilities accidents were at their third highest level on record, but the sharp variations do not allow a trend analysis for these categories. As well, the aggregate data in Figure 126 provide no information on the relative seriousness of the accidents. On average, 94% of accidents involving dangerous goods occur either on roads or at transportation facilities.

In order for the transportation sector to be more sustainable, from the perspective of reducing the environmental dangers associated with the potential release of hazardous materials during accidents, a reduction in the number of dangerous goods accidents on roads and at transportation facilities would be desirable. Again, qualitative data on the seriousness of different types of accidents and the degree of environmental damage would be required to assess impacts adequately.

Figure 126. Canada: Number of Accidents Involving Dangerous Goods, by Transport Mode, 1990-2003.



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
road	183	155	140	103	114	109	239	166	178	184	234	182	170	101
rail	17	27	25	25	30	19	35	16	11	18	18	11	16	5
air	2	4	0	1	1	3	9	6	4	3	4	6	8	5
marine	0	2	1	0	0	0	1	1	0	0	3	3	1	1
facility	194	251	228	113	145	205	237	194	239	274	215	234	244	244

Source: Statistics Canada. CANSIM Table 409-0002.

Figure 127 illustrates the distribution of the classes of materials that were involved in dangerous goods accidents reported for 1990 and for 2002. The great majority of accidents involved either class 2 goods (gases), class 3 goods (flammable and combustible liquids), or class 8 goods (corrosives). Most accidents involved Class 3 goods, which accounted for 47% of the accidents. There was also a 23% increase in the number of accidents involving these kinds of goods between 1990 and 2002.

Figure 127. Canada: Number of Accidents Involving Dangerous Goods, by Class, 1990 and 2002.

	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9
1990	13	96	211	16	8	23	2	100	8
2002	2	115	274	8	30	19	8	87	18

Source: Statistics Canada. CANSIM Table 409-0005.

Trends: Nova Scotia

Road De-Icing Salts

Other than Quebec and Ontario, Nova Scotia uses the most road salt of any Canadian jurisdiction, and on a per capita basis uses more than any other province.[366] There are approximately 11,500 kilometres of two-lane equivalent roads serviced with road salt in Nova Scotia, where a reported average of 280,000 tonnes of salt are applied every year.[367,368] Road salting is more common in Nova Scotia than in most other jurisdictions because of fluctuating temperatures during the winter, bringing a high number of freeze/thaw cycles. This is attributable to the province’s proximity to the Atlantic Ocean. The overall quantity of salt used in the province is dependent mostly on weather conditions. Road salting is a policy measure that does not reflect the amount of driving on roads. Rather, the measure is practiced when officials judge that the conditions warrant it.[369]

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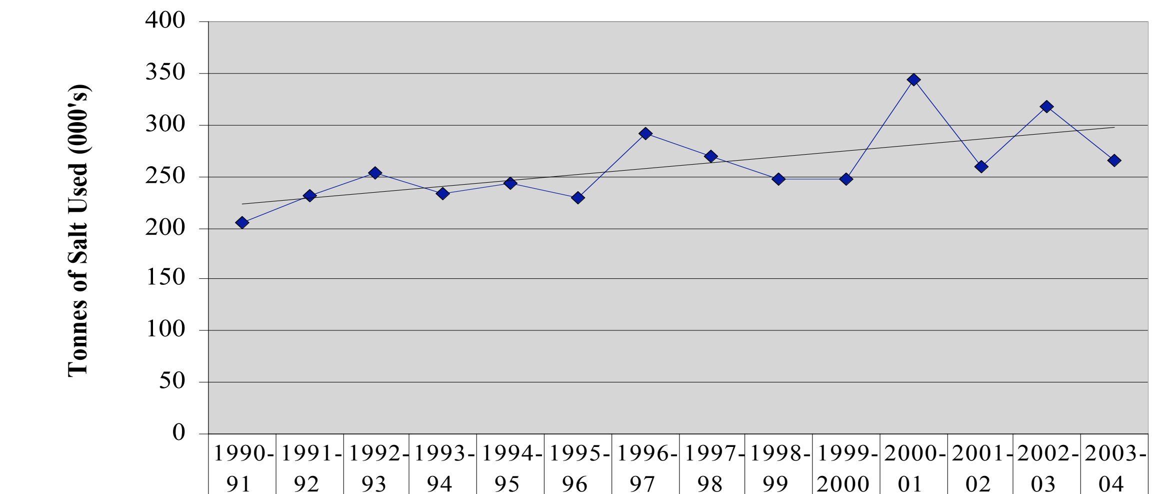
[366] McCormick Rankin Corporation/Ecoplans Limited. *Utilizing Technological Advances in the Management of Road Salt Usage in Nova Scotia*. (Environment Canada, 2004). www.ec.gc.ca/nopp/roadsalt/cStudies/en/ns.cfm Accessed December, 2004.
[367] Ibid.
[368] Although Environment Canada provided some inter-provincial comparisons, it only provided the numerical road salt data for Nova Scotia, most likely because the data came from a report that focused on Nova Scotia.
[369] Kind, Vanessa. *Measuring Progress Towards Sustainable Transportation*. (Halifax: Dalhousie University, 2001. Unpublished thesis).

Figure 128 shows the tonnes of road salt used in Nova Scotia between 1990 and 2004. Although there were fluctuations in use as a result of varying road conditions and weather patterns in different winters, the overall trend during this period indicates that the amount of road salt used has gradually increased. Between the winter of 1990-91 and that of 2003-2004, there was a 29% increase in tonnes of road salt used. This is roughly the same degree of increase that is observed when the fluctuations are evened out and the overall trend for the period assessed. The observed increase indicates that objective weather conditions alone may not be the sole cause of the change in road salting practices. Because of the adverse environmental impacts of road salt use, this increase constitutes a negative trend in sustainable transportation.

Figure 128. Nova Scotia: Tonnes of Road Salt Used, 1990-2004.



	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000	2000-01	2001-02	2002-03	2003-04
tonnes of salt used	205	231	253	234	243	230	291	270	248	248	343	259	317	265

Source: Personal communication with Steve Newson, Policy Advisor, Nova Scotia Department of Transportation and Public Works. August, 2004.

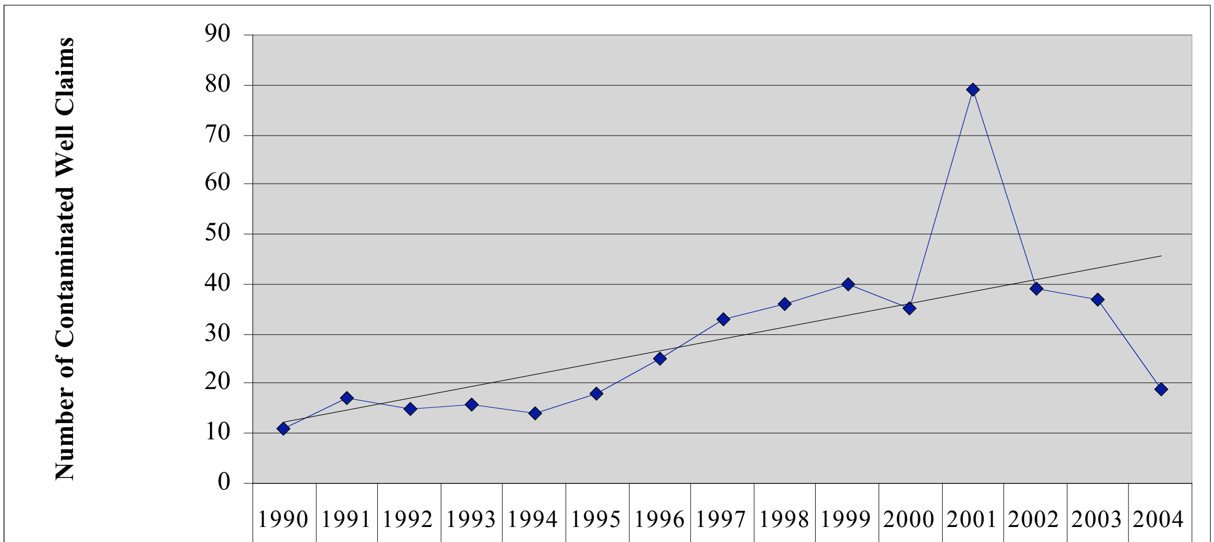
As noted, the Nova Scotia Department of Transportation and Public Works attributes the amount of road salt used to weather conditions and how they affect road conditions.[370] If weather dependence is the sole determining variable, it is difficult to imagine how to reduce the amount of road salt used. Since road salting is a standard maintenance practice that is not related to traffic volumes, decreasing the number of vehicles on roads would not necessarily reduce the tonnage of road salt used each year. Only reducing the number of new roads built would limit the amount of road salt used.[371] Another alternative would be to apply sand instead, a non-toxic substance. This practice is used in areas where well contaminations from salt have occurred.[372] Sand is used less frequently because it is less effective in managing icy roads than salt.

[370] Richard, Paul. Operations Analyst, Highways Operations, Nova Scotia Department of Transportation and Public Works. (Personal communication: December, 2004).
[371] Kind. (2001).
[372] Richard. (December, 2004).

As noted above, one of the major concerns about road salting is its impact on drinking water. The salt spread on roads in wintertime can seep into groundwater and contaminate nearby drinking wells. Trace amounts of zinc, cadmium, and metal toxins in the salt have been detected in drinking water after road salting.[373]

Figure 129 shows the number of claims made to the Nova Scotia Department of Transportation and Public Works (DTPW) for contaminated wells due to road salting from 1990 to 2004. There were fluctuations over time and a recent decline in claims, but, as indicated by the overall trend line (black regression line), the number of contaminated well claims increased considerably over this period as a whole.

Figure 129. Nova Scotia: Number of Claims for Well Contamination from Road Salting, 1990-2004.



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
number of well claims	11	17	15	16	14	18	25	33	36	40	35	79	39	37	19

Source: Personal communication with Steve Newson, Policy Advisor, Nova Scotia Department of Transportation and Public Works. August, 2004.

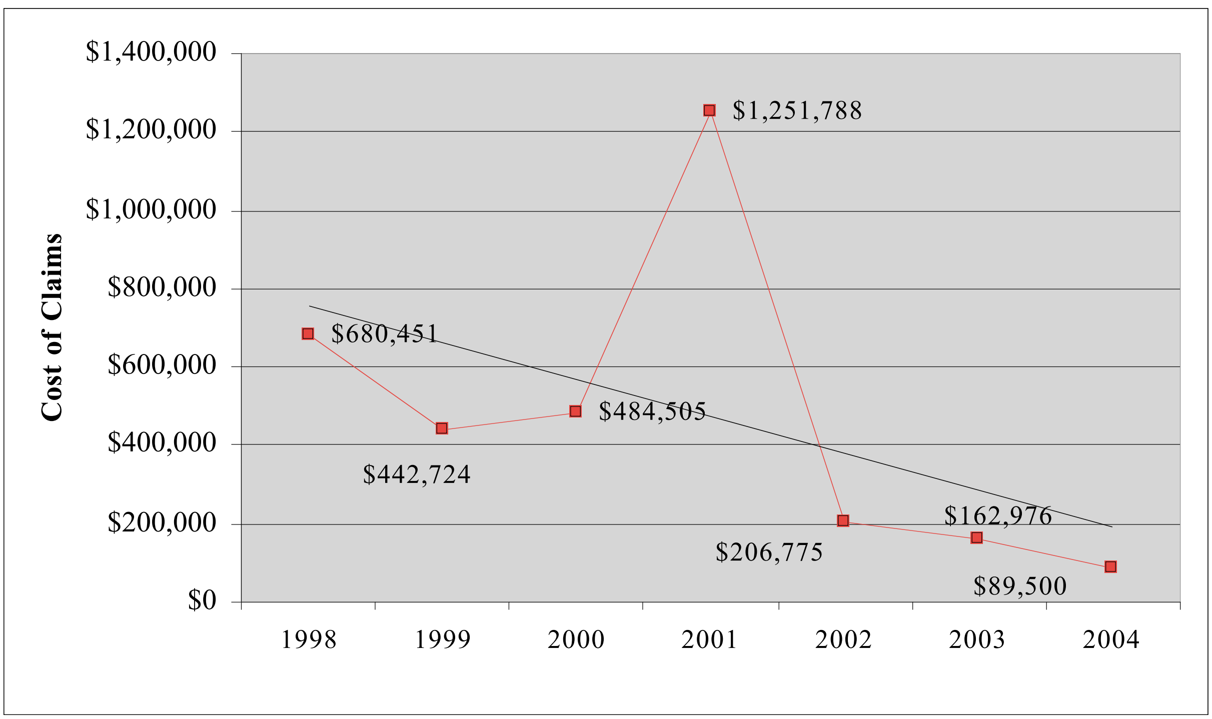
Between 1990 and 1998 there was a 227% increase in the number of well claims, with almost all that increase occurring between 1994 and 1998. In 1998, due to this sharp rise in well contamination claims, the Nova Scotia Department of the Environment instituted two regulations to reduce the impact of road salting on well water. As a result: (1) in areas where wells have been contaminated, the DTPW switched to using sand rather than salt; (2) construction regulations now require new wells to be located at least 20 feet from the nearest road right-of-way.[374]

[373] Kind. (2001).
[374] Wilson. (2000, p. 78).

As Figure 128 shows, these new regulations have not yet reduced the amount of road salt used. In fact, each year since the new regulations has seen quantities of road salt used in roughly equal or greater amounts than the year the regulations came into effect, including two winters (2000-01 and 2002-03) that saw record quantities of road salt used. Nor, aside from a single year (2004) has there been any significant or overall reversal in the number of contaminated well claims. It is too early to tell whether the drop in road salt used in 2003-04 or in well claims in 2004 indicates the beginning of a new trend towards greater sustainability in this indicator, or whether it is simply a function of road and weather conditions in that particular year.

What has changed since the new regulations is an overall decline in the total cost of remediation for contaminated wells (Figure 130, black regression line). The 1998 and 2004 claim figures show an 87% decline (in current dollars) in the annual cost of remediation for wells contaminated by road salt, and the overall trend line also shows a nearly four-fold decline. As noted in the introductory chapter, only physical data (like quantity of road salt applied and numbers of contaminated wells in this case) can be used to assess genuine progress and movement towards sustainability. Costing data cannot be used for this purpose, as higher defensive expenditures may signify either greater damage or greater commitment to remediation.

Figure 130. Nova Scotia: Total Yearly Costs from Claims for Road Salt Contamination of Wells, 1998-2004 (Current CDN$)**.**



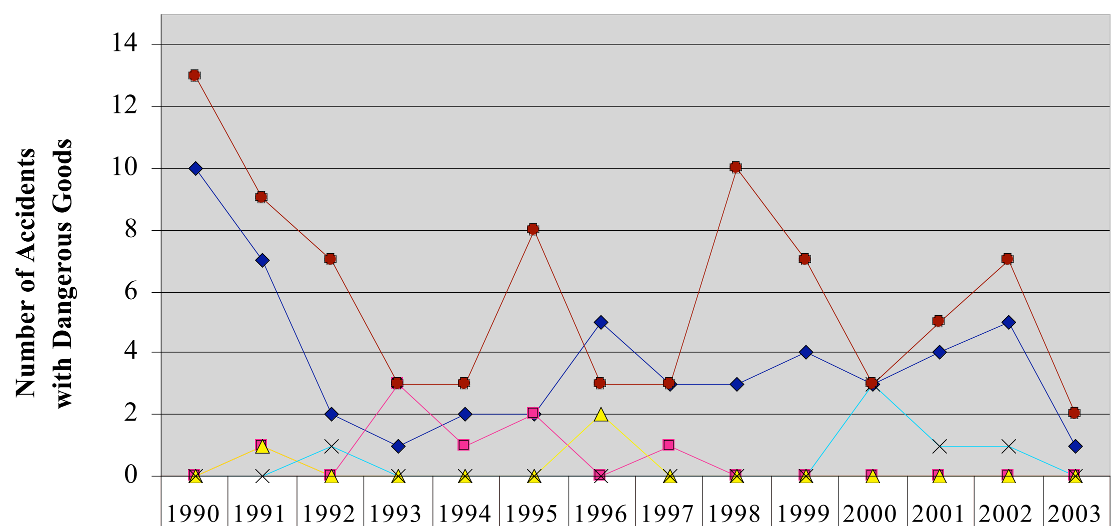
Source: Personal communication with Steve Newson, Policy Advisor, Nova Scotia Department of Transportation and Public Works. August, 2004.

Accidents Involving Dangerous Goods

Figure 131 shows the trend in the number of accidents involving dangerous goods in Nova Scotia, by mode, from 1990 to 2003. As with the national trends (see Figure 126), most accidents involving dangerous goods in Nova Scotia occur on roads and at transportation facilities. Despite fluctuations from one year to the next, the overall number of reported accidents involving dangerous goods is quite low and all modes show either an overall downward trend or a stable trend with minimal occurrence. As noted in the provincial comparison in Figure 125 for the 1990-2002 reference period, the overall number of accidents involving dangerous goods in Nova Scotia declined from 23 to 13 during this period, while Figure 131 below indicates a further sharp drop for 2003 to just three reported dangerous goods accidents (the lowest on record). This indicates a trend toward greater sustainability in this area.

As noted, a qualitative analysis of each occurrence is required to make a more informed assessment, as a single catastrophic accident may have a larger impact than many smaller accidents. However, time and resources did not permit such an analysis for this study, and aggregate data on actual impacts are not available.

Figure 131. Nova Scotia: Number of Accidents Involving Dangerous Goods, by Transport Mode, 1990-2003.



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
road	10	7	2	1	2	2	5	3	3	4	3	4	5	1
rail	0	1	0	3	1	2	0	1	0	0	0	0	0	0
air	0	1	0	0	0	0	2	0	0	0	0	0	0	0
marine	0	0	1	0	0	0	0	0	0	0	3	1	1	0
facility	13	9	7	3	3	8	3	3	10	7	3	5	7	2

Source: Statistics Canada. CANSIM Table 409-0002.

Conclusion

The data available to assess trends in transportation-related water pollution in Nova Scotia, and the impacts of such pollution on the environment, are quite limited. Information was available only for total salt used, for one of the effects of road salting (well contaminations), and for numbers of reported accidents involving dangerous goods. The road salting data for Nova Scotia show an overall increase in the amount of road salt used. The number of well contamination claims since 1996 has been consistently above the levels of the early 1990s, peaking in 2001 at more than double the annual average of the late 1990s and five times the average in the early 1990s.

The year 2004 marked the first significant decline in the number of well contamination claims since 1996, which may possibly signal the beginning of a new trend resulting from road salting policies introduced in 1998, but which may also simply be a function of road and weather conditions in that particular year. As noted, those policies did not appear to have a marked impact on the quantity of road salt used in succeeding years, and the amount of road salt used in 2004 remained higher than that used in 1998 – the year the regulations came into effect. In sum, no conclusion about a new trend can yet be drawn.

Accidents involving dangerous goods did decline between 1990 and 2003, signalling a movement toward sustainable transportation for this particular indicator.

Nevertheless, the key finding for this aspect of sustainable transportation is that the data gaps are presently so substantial that it is difficult to make any conclusive judgements about trends in water pollution due to transportation. A more complete picture would require data on oil spills, waste discharge, crankcase oil drips and disposal, impacts of roadside herbicides, and leaking underground storage tanks—none of which are presently available. It would also require more information on Nova Scotia's transportations accidents involving dangerous goods, citing class of dangerous goods and assessing impacts on the environment; while the road salt indicator would be strengthened if there were extant data on the effects of road salt on surface water and other environmental receptors.

Chapter 8. Recycling and Re-Use of Transportation Materials

The previous chapters have focussed on transport-related discharges to the atmosphere and to water bodies, usually in gaseous and liquid forms. However, transportation systems also create solid wastes and discharges to land and soils. In order to create a more sustainable transport system, therefore, transportation materials need to be recycled and re-used to the extent possible. For this reason, a key component of the CST definition of sustainable transportation that has also been included in this study's definition is that the system "*reuses and recycles its components.*"

Transportation materials that are re-usable and/or recyclable include:

- Tires
- Parts of Derelict Vehicles
- Automotive Batteries
- Oil
- Anti-Freeze
- Bicycles

Reintegrating these materials in the economy is necessary for several reasons. The most obvious is the landfill space that would otherwise be required to dispose of these transportation components, the considerable pollution problems associated with landfills, and the toxicity of many transportation materials.

Another is that secondary production using recycled materials is less polluting than primary manufacturing. For example, recycling steel results in 86% less air pollution than does the creation of new steel.[375] In addition—even when the energy costs of recycling are factored in—recycling still creates substantial resource savings by stemming the economic demand for new materials and extending the useful lifespan of commodities already in circulation.[376]

Compared with the fabrication of new goods, the use of secondary materials realises substantial energy savings. Recycling steel requires only 26% of the energy used to generate new steel. For other metals, gains are comparable or superior. Lead can be recycled with just 35% of the energy needed to create new product. For copper the figure is 15%; for aluminium, a mere five percent.[377] Since all these commodities are used in transportation, these examples demonstrate how—compared to primary production—recycling transportation materials offers substantial energy savings for some of the transportation materials that can be recycled.

[375] Recycling International. Basic facts about recycling. (No date). www.recyclinginternational.com/basicfacts/index.aspx Accessed January, 2005.
[376] Walker, Sally, Ronald Colman, Jeffrey Wilson, Anne Monette and Gay Harley. *The Nova Scotia GPI Solid Waste-Resource Accounts*, p. 39. (GPI*Atlantic*, 2004). www.gpiatlantic.org/pdf/solidwaste/solidwaste.pdf Accessed January, 2005.
[377] Recycling International. Op cit.

Since the mid 1990s, provinces and territories across Canada have instituted legislation banning most transportation materials from landfills. Today, each of the 10 provinces plus Yukon operate coordinated scrap tire, used oil, and car battery recycling programs, all of which are aimed at eliminating these materials from landfills. British Columbia, Alberta, Manitoba, Ontario, Quebec, New Brunswick, and Nova Scotia also have programs for recycling derelict vehicles.

In Nova Scotia, tire recycling and derelict vehicle programs are managed by the Resource Recovery Fund Board (RRFB). At present these two initiatives are the only transportation material recovery efforts in the province that are monitored and for which information is readily available, and they are therefore the main focus of this chapter. Unfortunately, the recycling of car batteries, oil, and anti-freeze is not currently measured or tracked, so trends in these areas, along with percentages of total materials recycled, cannot be reported in this study.

Programs that Re-Use and Recycle Transportation Materials

Tire Recycling Programs

Before tire recycling programs began, huge quantities of scrap tires ended up in landfills, on roadsides, and in wilderness areas, streams, coastal beaches, and natural landscapes of all kinds. A major concern about scrap tires was that any large concentration of them in one place created a major fire and environmental safety hazard. These concerns led to the banning of tires in landfills and their redirection to scrap tire recycling facilities. The benefits of recycling tires include not only extending the life of landfills and reducing environmental hazards, but also conserving natural resources such as energy, water, and crude oil.[378] Additionally, recycling has created new jobs in the collection and transport of used tires, and in their processing into new products.

Used tires are transported to recycling facilities where they are reduced to various sizes of rubber "crumb." This material is then further processed for use as sport surfaces, carpet underlay, garden hoses, shoe soles, mats, wheels, speed bumps, etc.[379]

As noted, all ten provinces and the Yukon now operate centrally coordinated scrap tire recycling programs. Financial support for each of these systems is based on a levy, or environmental fee, charged on new tire purchases in the jurisdiction concerned. Levies for passenger vehicle tires presently range from $2 to $5 per tire, while sales of larger truck tires may involve a higher fee, based on rim size. In some instances, the tire recycling system is managed by a government ministry or department, or by a crown corporation. In other jurisdictions, multi-stakeholder Stewardship Boards or similar agencies carry the central program responsibility.[380]

[378] Resource Recovery Fund Board. Tire Recycling Program. (No date). www.rrfb.com/pages/secondary%20pages/tireprogram.html Accessed January, 2005.
[379] Ibid.
[380] Canadian Association of Tire Recycling Agencies. Tire Recycling in Canada. (No date). www.catraonline.ca/can-rcl.htm Accessed January, 2005.

Derelict Vehicle Recovery Programs

A derelict vehicle is one that is no longer operational due to accident or age. Derelict vehicle recovery programs oversee the dismantling of salvaged automobiles in order to reclaim re-usable parts and components, thus ensuring an efficient automotive recycling system. In a typical automobile recycling facility, inoperative motor vehicles are brought in, and hazardous and recyclable fluids are then properly drained. Undamaged parts are then detached from the vehicle, cleaned, tested, inventoried, and stored in a warehouse until sold. The remaining vehicle hulk is then prepared for scrapping.[381]

According to the Automotive Recyclers' Association, automotive recyclers around the world have provided local employment, consumer service, and environmental conservation for more than 75 years.[382] Automotive recycling serves a vital role in reducing the need for new materials and their cost, while also saving scarce landfill space. For example, the industry recycles over four million motor vehicles annually in the US and Canada alone, thereby saving an estimated 41.6 million litres of oil that would otherwise be required to manufacture new replacement parts.[383] Additional energy and resource conservation is realized by recycling "core" parts to the automotive parts rebuilding industry, while providing economic benefits and savings to both producers and consumers.

In addition to conserving natural resources, automotive recycling plays an important role in reducing air pollution. On-road vehicles contribute up to 35% of the emissions that are involved in smog formation and 18.5% of Canada's total greenhouse gas emissions. Ten to 15% of Canada's fleet consists of older (pre-1988) or poorly maintained vehicles, which generate up to 50% of total emissions.[384] Therefore, taking these older, more polluting vehicles off the road, and recycling their usable non-polluting components, can improve air quality.

The Indicators

Measuring transportation materials recycling practices is difficult because, for the most part, programs are not centrally monitored. Consequently, at an international scale, comparative data are unavailable for the different programs. Comparative provincial statistics were also difficult to retrieve, since there is no reporting mechanism that compares the different transport-related initiatives. Without a comparative database, the only information that could be gathered on a provincial basis was on the types of recycling programs that exist, and parts of this had to be obtained by making separate inquiries of each province (Table 24). Quantitative comparisons of amounts recycled in each province, and of percentages of total tires, oil, batteries and other materials recycled in each jurisdiction, are not currently possible.

[381] Automotive Recyclers Association. No date. What is Automotive Recycling? www.a-r-a.org/resources/whatisautorecycling.htm. Accessed January, 2005.
[382] Ibid.
[383] Ibid.
[384] Environment Canada. What You Can Do: Transportation—Vehicle Scrappage Programs. (December 3, 2003). www.ec.gc.ca/eco/wycd/transportation6_e.html Accessed January, 2005.

Table 24. Transportation Material Recycling Programs by Province/Territory.

	NFD	PEI	NS	NB	QC	ON	MN	SK	AB	BC	YK
Tire recycling	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Derelict Vehicles	-	-	✓	✓	✓	✓	✓	-	✓	✓	-
Used Oil	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Batteries	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Sources: Sally Walker et al. The Nova Scotia GPI Solid Waste-Resource Accounts;
Environment Canada. What You Can Do: Transportation—Vehicle Scrappage Programs;
Canadian Association of Tire Recycling Agencies. Tire Recycling in Canada.

Note: √ = programs exist; - = no program exists

As indicated in Table 24, all provinces plus the Yukon have tire recycling, and used oil and battery recovery programs, and seven out of these 11 jurisdictions also have derelict vehicle recovery initiatives. These programs demonstrate that measures have been put in place by governments across Canada, mostly just within the last decade, to reduce the environmental impact of used transportation materials. As noted, privately run automotive recycling enterprises have been operating much longer.

However, without data on the extent and success of these programs, it is difficult to determine how much progress is being made over time, and which jurisdictions are recycling larger proportions of transportation materials than others. This is unfortunate, as the identification of best practices through such systematic reporting would provide inspiration, incentive, and valuable information to jurisdictions that are currently lagging in their efforts. If reporting on the collection and processing of transportation materials were more comprehensive, more detailed indicators could be created to inform policy and improve practices.

In Nova Scotia, fortunately, good records are available for tire recycling since 1997 and for recovery of derelict vehicles since 2001. Nova Scotia's reporting efforts in these areas may be linked to its leadership role in solid waste resource management, as the first jurisdiction in Canada to divert 50% of its waste from landfills. There are also data for a program that refurbishes bicycles in Halifax. Halifax's Bike Again initiative accepts donations of bicycles, repairing and restoring them as required. Bike Again makes these reconditioned bicycles available to anyone in the Halifax community who needs one. The key additional benefit of this program, in addition to reduction of landfill waste, is that it also helps decrease motorized traffic and promote and publicise an active and sustainable transportation mode.

The indicators examined in this report to analyse re-use and recycling of transportation materials are therefore based on data availability, and include:

- Number of tires recycled
- Number of derelict cars salvaged
- Number of bicycles refurbished

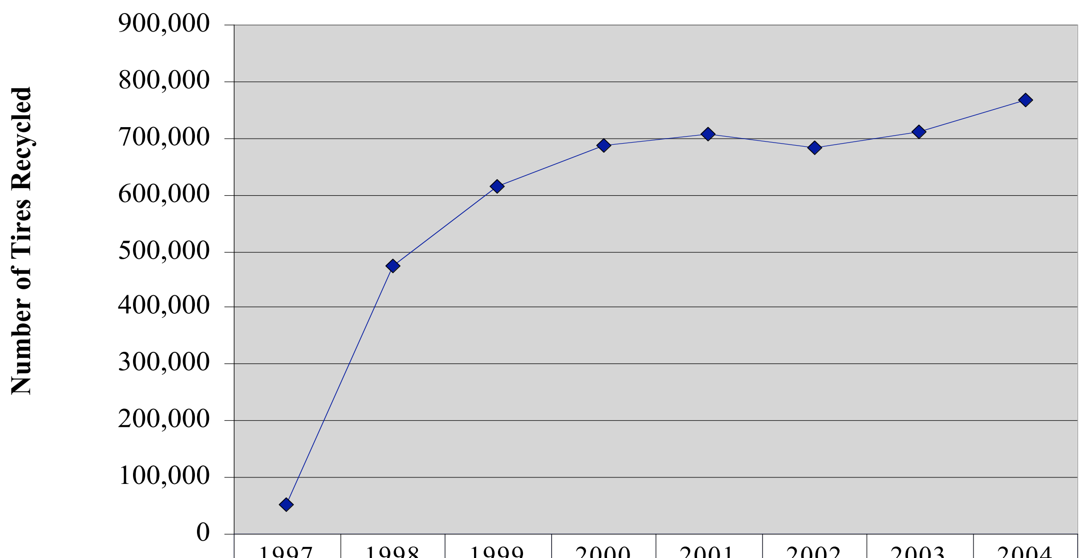
According to the definition of sustainable transportation described in Part One of this report, **increases** in the amount of transportation materials re-used and recycled indicate a more sustainable transportation system.

Trends: Nova Scotia

Tire Recycling

The Resource Recovery Fund Board's tire recycling program started on January 2, 1997, soon after used tires were banned from Nova Scotia's landfills. As illustrated in Figure 132, the number of tires recycled increased dramatically from 1997 to 1998 immediately after the landfill ban and the new program came into effect, and then continued to increase fairly steadily to 2001, as the program matured, became widely accepted, and gained momentum. Since 2001, the number of tires collected has remained fairly stable, though an encouraging 7.7% increase occurred between 2003 and 2004—the most recent year for which data are available. The consistency in the number of tires recycled since 2001 reflects a 90-95% recovery rate of used tires.[385] The success of the RRFB's tire recycling program indicates a positive trend towards a sustainable transportation system in Nova Scotia for this indicator.

Figure 132. Nova Scotia: Number of Tires Recycled, 1997-2004.



	1997	1998	1999	2000	2001	2002	2003	2004
Number of Tires Recycled	53,906	474,063	616,373	687,904	706,117	684,294	712,303	767,333

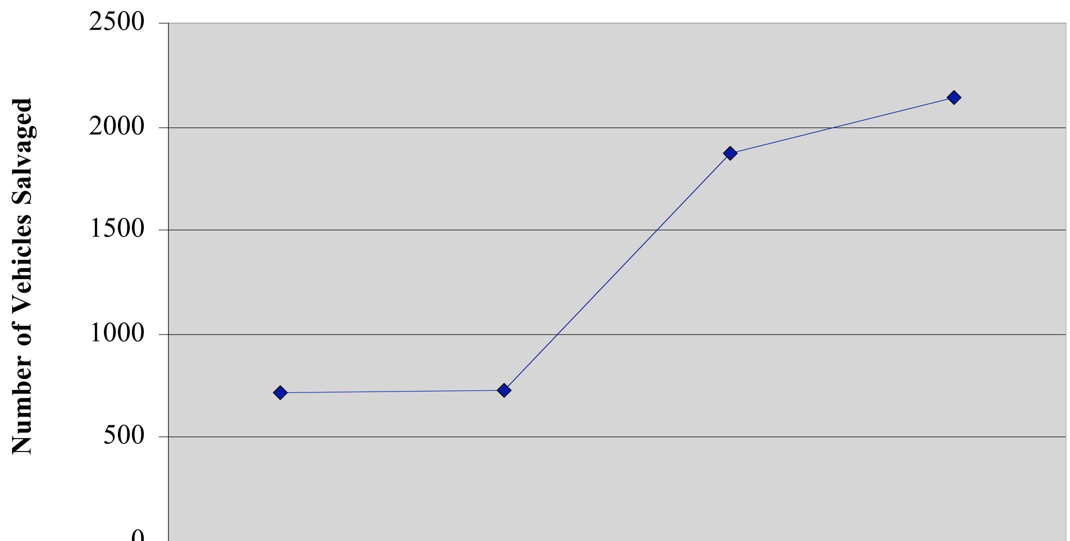
Source: Personal communication with Dale Lyon, Executive Assistant, Resource Recovery Fund Board. January, 2005.

[385] Lyon, Dale. Executive Assistant, Resource Recovery Fund Board. (Personal communication: January, 2005).

Derelict Vehicle Program

The derelict vehicle program of the Resource Recovery Fund Board began in 2000, and functions primarily as an information service. It is operated through a provincial hotline that provides options for individuals looking for ways to recycle their derelict vehicles. The RRFB also works in conjunction with municipalities and/or waste management regions, where the RRFB subsidises 50% of the municipalities' and regions' derelict vehicle recycling program costs.[386] As seen in Figure 133, the number of vehicles salvaged has been increasing annually, and has more than tripled since the program's inception. This indicates a positive trend towards a sustainable transportation system for this indicator.

Figure 133. Nova Scotia: Number of Derelict Vehicles Salvaged, 2000-2004.



	2001	2002	2003	2004
number of vehicles	712	730	1877	2145

Source: Personal communication with Dale Lyon, Executive Assistant, Resource Recovery Fund Board. January, 2005.

Automotive Batteries, Anti-freeze (ethylene glycol), and Used Oil

The Resource Recovery Fund Board transferred control of the used battery program to the Enviro-Depots at the end of the 1997 fiscal year. The Enviro-Depots' current policy on used batteries is that they do not have to accept them, though most still do. The program is not monitored, but batteries were banned from landfills, effective April 1, 1996. Vehicular anti-freeze was banned from landfills as of April 1, 1997—but, like automotive batteries, the disposal

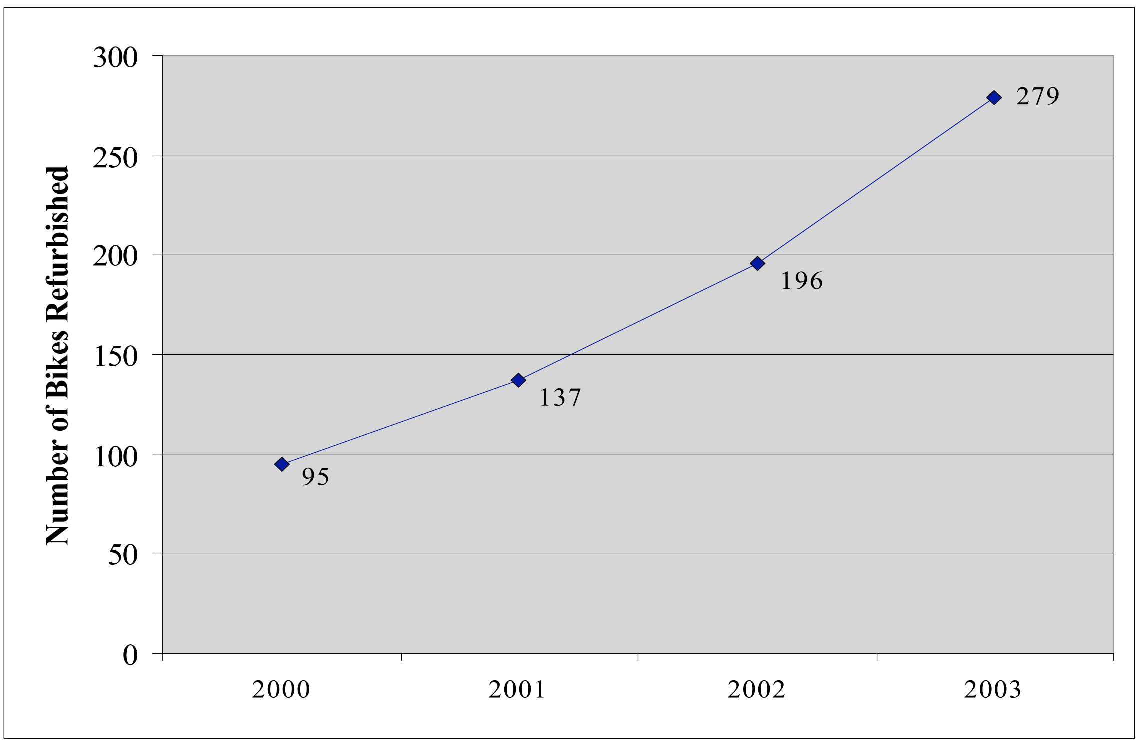
[386] Ibid.

of anti-freeze is not monitored. Used oil was banned from landfills on April 11, 1995.[387] But the Nova Scotia Department of Environment and Labour does not monitor the used oil program; therefore no data are available on the amount of oil collected. This report recognizes that these landfill bans constitute an important step and incentive for effective recovery of these transportation materials, and strongly recommends systematic monitoring and reporting of these important programs so that their success can be properly measured and assessed.

Bike Again—Bicycle Reconditioning Program

The Bike Again Program began in 2000. Since the initiative's inception, the number of bicycles reconditioned through Bike Again has been growing on a yearly basis. Though total numbers remain modest, there has been a 194% increase in the number of bicycles reconditioned since 2000 (Figure 134). In part, this growth was the result of the Bike Again's outreach to other municipalities. In 2003, along with 144 bicycles reconditioned in Halifax, an additional 135 bicycles were refurbished in other parts of the province.[388]

Figure 134. Nova Scotia: Number of Bicycles Reconditioned through the Bike Again Program, 2000-2003.



Source: Personal communication with Susanna Fuller, Founder, Bike Again Program. January, 2005.

[387] Ibid.
[388] Personal communication with Susanna Fuller, Founder, Bike Again Program. January, 2005.

Conclusion

The tire recycling and derelict vehicle programs of the Resource Recovery Fund Board, as well as the Bike-Again Program, have been successful in reducing the amount of transport-related waste entering landfill sites. By volume, tire recycling and derelict vehicle salvage account for the bulk of the transport-related material that can be recycled. The demonstrated success of these initiatives indicates that Nova Scotia has made its transportation system more sustainable through recovering, recycling, and re-using key transportation components. However, the gap in the data on other transportation materials such as car batteries, anti-freeze, and used oil, makes it difficult to evaluate the overall trends for the recycling and re-use of transportation materials. Monitoring of these programs in Nova Scotia could potentially provide useful information for other jurisdictions that are interested in improving and expanding their own transport-related recovery, re-use, and recycling programs

Chapter 9. Land Use and Transportation

Land use refers to how an area's usable surface is treated, including the location and design of buildings, transport facilities, parks, and farms. Transportation facilities and activities affect land use patterns, both directly and indirectly. For example, expanding roads and parking facilities increases impervious surface area and displaces other land uses, including wildlife habitat. In addition, urban fringe highway expansion and generous minimum parking requirements tend to stimulate more dispersed, urban fringe development patterns (commonly called "sprawl), which further increase per capita impervious surface area and habitat loss. Conversely, improving nonmotorized travel conditions and public transit services tends to encourage more compact, urban infill development (commonly called "smart growth"). Table 25 compares these two development patterns.

Table 25. Comparing Sprawl and Smart Growth

Attribute	Sprawl	Smart Growth
Density	Lower-density	Higher-density.
Growth pattern	Urban periphery (greenfield) development.	Infill (brownfield) development.
Activity Location	Commercial and institutional activities are dispersed.	Commercial and institutional activities are concentrated into centres and downtowns.
Land use mix	Homogeneous land uses.	Mixed land use.
Scale	Large scale. Larger residential buildings, blocks, wide roads. Less detail, since people experience the landscape largely at a distance, as motorists.	Human scale. Smaller residential buildings, blocks and roads, care to design details for pedestrians.
Transportation	Automobile-oriented transportation, poorly suited for walking, cycling, and transit.	Multi-modal transportation that supports walking, cycling, and public transit use.
Street design	Streets designed to maximize motor vehicle traffic volume and speed.	Streets designed to accommodate a variety of activities. Traffic calming.
Planning process	Unplanned, with little coordination between jurisdictions and stakeholders.	Planned and coordinated between jurisdictions and stakeholders.
Public space	Emphasis on the private realm (private yards, shopping malls, gated communities, private clubs).	Emphasis on the public realm (streetscapes, pedestrian environment, public parks, public facilities).

Source: Litman, Todd. *Evaluating Transportation Land Use Impacts*. (2004a, p. 2).

Sprawl tends to impose a variety of economic, social, and environmental costs compared with more compact, multi-modal, urban infill development.[389] Smart growth can reduce these costs, providing a variety of direct and indirect benefits.[390]

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[389] Burchell, Robert, et al. *The Costs of Sprawl – Revisited*. (TCRP Report 39, Transportation Research Board, 1998) http://gulliver.trb.org/publications/tcrp/tcrp_rpt_39-a.pdf

The amount of land devoted to transportation facilities (roads, parking lots, railroad rights-of-way, airports, ports, etc.) is an indicator of transportation system sustainability, since increased pavement imposes both direct and indirect economic, social, and environmental costs. The direct ecological damages from roads and their vehicle traffic have been well documented.[391] These include hydrologic impacts; vitiation of unique physical features; road kills and wildlife injuries; and the disturbance, isolation, and loss of wildlife habitat. For example, the available evidence on the subject indicates that if just five percent of a watershed is covered by impermeable surfaces, water quality is seriously degraded.[392]

Wide roads, heavy vehicle traffic, and large parking lots can have various negative impacts on urban environemntal quality and community livability. Wide roads and heavy traffic can create a barrier to pedestrian traffic and degrade the public realm (public spaces where people often interact).[393] Researchers have found a negative correlation between vehicle traffic volumes and measures of neighbourly interactions and activities, including the number of friends and acquaintances residents had on their street, and the area they consider "home territory." Appleyard comments:

> The activities in which people engage or desire to engage in may affect their vulnerability to traffic impact. So many of these activities have been suppressed that we sometimes forget they exist....Children wanting to play, and people talking, sitting, strolling, jogging, cycling, gardening, or working at home and on auto maintenance are all vulnerable to interruption [by traffic]....One of the most significant and discussed aspects of street life is the amount and quality of neighbouring. Its interruption or 'severance' has been identified as one of the primary measures of transportation impact in Britain.[394]

Sprawl tends to increase per capita vehicle-miles travelled and reduce walking, cycling, and public transit use, while smart growth tends to have the opposite effect.[395] As communities become more spread out, they also become more automobile-dependent, as jobs, shopping, recreation, etc. cease to be accessible by options such as walking, cycling, and public transit. This often results in a self-reinforcing cycle of increased automobile use, prompting further road

[390] Litman, Todd. *Understanding Smart Growth Savings* (Victoria Transport Policy Institute, 2004f) www.vtpi.org
[391] Chester, Arnold and James Gibbons, "Impervious Surface Coverage: The Emergence of a Key Environmental Indicator." (*American Planning Association Journal*, Vol. 62, No. 2, Spring 1996, pp. 243-258); Forman, Richard, et al. *Road Ecology: Science and Solutions*. (Island Press, 2003) www.islandpress.com; *NEMO Project* (www.canr.uconn.edu/ces/nemo); Beazley, Karen, Tamaini Snaith, Frances Mackinnon and David Colville. "Road Density and Potential Impacts on Wildlife Species such as American Moose in Mainland Nova Scotia." (*Proceedings of the Nova Scotia Institute of Science*. 2003. 42 [2]: 339-357).
[392] Litman. (2004a, p. 41).
[393] Forkenbrock, David and Glen Weisbrod. *Guidebook for Assessing the Social and Economic Effects of Transportation Projects*. (NCHRP Report 456, TRB, 2001) www.trb.org; Williams, Kate and Stephen Green, *Literature Review of Public Space and Local Environments for the Cross Cutting Review*. Oxford Centre for Sustainable Development. (2001) www.urban.odpm.gov.uk/crosscut/litreview/pdf/litreview.pdf; Untermann, Richard and Anne Vernez Moudon. *Street Design: Reassessing the Safety, Sociability, and Economics of Streets*. (Seattle: University of Washington, 1989).
[394] Appleyard, Donald, *Livable Streets*. (University of California Press, 1981).
[395] Litman, Todd. *Land Use Impacts on Transport*, (Victoria: Victoria Transport Policy Institute, 2005c). http://www.vtpi.org/landtravel.pdf.

and highway expansion, which encourages further sprawl, leading to greater automobile use, and so on.

The increased vehicle use associated with the above pattern is a form of what has been called "*generated traffic*." Generated traffic is the additional vehicle travel that results from road improvements.[396] Lane-miles (the total length of all lanes) are generally found to have a statistically significant relationship with Vehicle Miles of Travel (VMT: the distance people travel in their cars). Research has shown that each additional lane-mile of highway brings an average increase of about 0.3 to 0.6% in VMT in the short run, and from 0.7 to 1.0% in the long term.[397] In other words, within 5 years, about half of the increased roadway capacity will be filled and eventually, about 80% of the increased roadway capacity will be filled.[398] As a result, highway expansion designed to reduce congestion often provides only temporary relief, because newly generated traffic induced by the expansion eventually brings congestion intensity back to earlier levels.

Low-density settlement that contributes to an increase in automobile use, and a resulting increase in the consignment of land to transportation, is in turn linked to growth in many of the indicators (energy consumption, greenhouse gas emissions, air pollution, and water pollution) discussed in previous chapters of this report.[399] Because all these increases are viewed as negative trends from a sustainability perspective, moving the transportation system away from sustainability, settlement patterns and their impact on total transport and motorized transport activity are therefore viewed as "driving forces" (D) in the European Environment Agency's DPSIR model discussed earlier. Conversely, a trend to limit low-density suburban and exurban development and sprawl, and policy responses (R) designed to encourate such a trend, would therefore be an appropriate response to an underying driving force that goes beyond simply addressing symptoms and impacts, and would therefore constitute positive movement toward sustainability.[400]

Other land use factors associated with smart growth, such as increased urban density can also be considered sustainable transportation indicators.[401] Although increased density tends to increase impacts per area of land (acre or hectare), it tends to reduce impacts per capita, since residents tend to use less land and drive fewer miles than occurs in more sprawled locations.

This is not to suggest that transportation facilities and sprawled land use provide no benefits, but most of these benefits are internal, captured by those who use the facilities, while imposing

[396] Litman, Todd. *Generated Traffic and Induced Travel: Implications for Transport Planning*, p. 2. (Victoria: Victoria Transport Policy Institute, 2004b). www.vtpi.org/gentraf.pdf Accessed February, 2005.
[397] Wise, Alison. *Breaking the Gridlock: Real Solutions for Transportation Problems*, p. 10. (Seattle: Washington State Public Interest Research Group and the WashPIRG Foundation, 2000). www.washpirg.org/gridlock/gridlock.pdf
[398] Litman 2004b, p.7
[399] Burchell, et al, 1998; Sustainable Edge Inc. *Demonstrating The Economic Benefits Of Integrated, Green Infrastructure*. Centre for Sustainable Community Development. (Prepared for the Federation of Canadian Municipalities, 2004) http://kn.fcm.ca
[400] May, Anthony, D. *Decision-Makers Guidebook: Developing Sustainable Urban Land Use and Transport Strategies*. PROSPECT - Procedures for Recommending Optimal Sustainable Planning of European City Transport Systems (European Commission, 2003) http://www.ivv.tuwien.ac.at/?id=2550
[401] Litman, 2004a.

external economic, social, and environmental costs borne by society. These impacts are not efficiently priced: that is, motorists generally do not pay the equivalent of rent and property taxes on roadway rights-of-way or for public parking facilities, nor do they pay compensation for the environmental damages caused by the roads they use; and urban fringe residents are not generally charged higher utility rates or taxes to fully cover the extra public service costs of serving dispersed development. As a result, the amount of land devoted to roads and parking facilities, and the amount of sprawl that occurs in many communities is *economically excessive*, that is, more than would occur if transportation and land use markets were more optimal and more accurately priced to reflect their full costs. This excess land use can therefore be considered unsustainable from an economic as well as environmental perspective.

Land Degradation due to Transportation

While this chapter and its indicators focus on transport-related land consumption and the relationship between land use and transportation, it is important to recognise that transportation can also degrade land in serious ways without necessarily paving it over for roads, parking lots, and other transportation uses. To cite just one example, ATV use has been shown to have a significant impact on soils and disruption of wildlife, in addition to water and noise pollution, and other adverse environmental impacts. The Sierra Club provided the following background to its *Conservation Policies on Off-Road Use of Motorized Vehicles* notes that:

> Off-road use of vehicles can present serious and special problems of impact on the environment and incompatibility with other users of the land. Experience has shown that off-road use of vehicles may result in one or more of the following effects:
>
> 1. Physical soil damage, often readily visible, resulting in:
>   a. Erosion, causing soil loss and damage to stream banks, streams, and fish habitat;
>   b. Soil compaction and serious adverse impact on flora and its regeneration; and
>   c. Degradation of trails, including rutting and breakdown of trail edges.
> 2. Disruption of wildlife breeding and nesting habitats, especially of vulnerable species, resulting in loss of young;
> 3. Disturbance of wildlife, leading to weakened physical condition, death, and possible extinction of some species;
> 4. Damage to archaeological, scientific, historical and other significant sites, and damage to natural features, sometimes with irreversible effects, especially on rare features of interest for scientific study;
> 5. Facilitation of illegal hunting, fishing and the taking of game and non-game wildlife;
> 6. Introduction of air and water pollution to areas presently removed from any such sources;
> 7. Excessive noise, which, in close proximity, may result in physiological effects on animals and humans, or may induce anxiety, altering animal behavior patterns, and which, in most circumstances, seriously degrades the solitude of wild areas for other users;

8. Litter: by virtue of mechanization, operators of vehicles carry more gear, with potential to leave more litter;
9. Fire: illegally or improperly operated vehicles can often create a fire hazard on public or private lands.[402]

While time and resources did not permit a full exploration of land degradation due to transportation, or the development of an indicator for this issue, the ATV example cited briefly here demonstrates the importance of doing so in future updates of this study.

The Indicators

Various land use factors affect sustainability:[403]

- Density of people and jobs – increased density tends to reduce per capita land consumption and vehicle travel.
- Land use mix – Increased mix tends to reduce per capita vehicle travel.
- Activity location – increased concentration of commercial and institutional activities into multi-use centres (rather than dispersal of such activities) tends to reduce per capita land consumption and vehicle travel.
- Roadway connectivity – increased connectivity tends to reduce per capita vehicle travel, because a higher degree of connection within the street system shortens route options and encourages greater bicycle and pedestrian use.
- Walkability – increased walkability tends to reduce per capita vehicle travel.

However, reliable data are unavailable for many of these factors. The indicators for evaluating land use impacts in this report are therefore confined to five indicators that help illustrate trends in both land use patterns (one indicator), and in the area occupied by transportation facilities and infrastructure (four indicators). The specific indicators described in this chapter are:

- Urban density
- Land area consumed by automobiles
- Land area consumed by automobiles per capita
- Road density
- Total kilometres of rail track operated

Trends in urban density can serve as an indirect measure of the impact of land use patterns on transportation. Changes in urban density are a measure of shifting land use patterns, with decreases in urban density generally implying increases in sprawl. Because sprawl in turn influences transportation decisions, an increase in sprawl can usually be interpreted as a trend towards greater reliance on automobile use and towards the consignment of more land to transportation in the form of roads, parking facilities, etc.

[402] Sierra Club. *Conservation Policies on Off-Road Use of Motorized Vehicles*. www.sierraclub.org/policy/conservation/offroad.asp (Accessed November 23, 2006).
[403] United States Environmental Protection Agency. *Smart Growth Index (SGI) Model*. (U.S. Environmental Protection Agency, 2002) www.epa.gov/livablecommunities/topics/sg_index.htm

The words "generally" and "usually" qualify the above statements because a decrease in urban density can occur for other reasons, like depopulation, which do not produce sprawl, and because sustainable exurban development could potentially mix residential and commercial uses, locate new employment opportunities close to new residential development, and cluster services to reduce automobile use. These qualifiers emphasise why urban density trends can provide only an *indirect* measure of probable changes in land use patterns. *Direct* measures of land use patterns and of area used for transportation facilities and infrastructure include:[404]

- Land use clustering: average number of major services (grocery, library, school, playing field, etc.) within walking distance of residents; or average walking distance between residences and public services such as schools and retail centers.
- Land use mix: whether a given area is put to different uses (e.g., commercial, residential, educational).
- Roadway scale and connectivity: the size of roads and civic blocks, and the degree of connection within the street system.[405]
- Impermeable surface coverage: the portion of land that is paved for transportation purposes (i.e. roads, parking spaces, etc.).

Unfortunately, data availability for such direct indicators of land use patterns and land area used for transportation are very limited. The only available data were on urban density; land area consumed by cars; road density; and length of rail tracks, so key issues like land use clustering and land use mix could not be explored directly. There are limitations in the data availability even for those indicators that are examined here. In particular, data for road lengths across Canada, including Nova Scotia, cannot be compared from year to year because the methods for estimating road lengths have changed between some years, as part of efforts to improve the data. Due to this measurement inconsistency, trends in road density over time could not be established.

Urban density trends are presented here only for Nova Scotia. International trends could not be determined, and neither Statistics Canada nor the statistical division of the Nova Scotia government track urban density on a county (sub-provincial) basis, thus preventing a comparison of regional sprawl trends in the province.

Land area consumed by automobiles denotes aggregate territory reserved for passenger road vehicles and their supporting apparatus. In the present report, totals for this indicator only include land area reserved for roads and parking, as data on land area occupied by transportation facilities were not available. This indicator was created to estimate the amount of land being used for passenger transportation, per person, in different localities. One problem with this indicator is that it is actually comprised of two separate data sets: kilometres of roads (which include both passenger and freight use) and numbers of vehicles (which include only passenger vehicles).

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[404] Litman. (2004a, p. 2).
[405] Roadway scale and connectivity influence urban transportation system performance. For example, greater street connectivity, a more pedestrian-friendly environment, shorter route options, and more extensive transit service have been found to have a positive impact on reducing per-capita vehicle travel, congestion delays, traffic accidents, and pollution emissions, while roadway supply (lane-kilometres per capita) had no measurable effect on reducing these impacts and costs. (Litman, Todd. *Online TDM Encyclopedia: Land Use Impacts on Transport - How Land Use Patterns Affect Travel Behavior.* Victoria Transport Policy Institute, 2005e. www.vtpi.org/tdm/tdm20.htm)

Land area consumed by automobiles per capita is also presented because it illustrates trends in the amount of land area consumed by passenger vehicles relative to the number of people who can use the transportation system. A decrease in aggregate land area consumed by cars and in land area consumed by cars per person would indicate trends towards sustainability.

Road density is calculated as length (in kilometres) of road per square kilometre of area. It expresses the ratio of ground surface paved for roads to total area of ground surface for the province. Road densities are used instead of road lengths because they account for differences in land available for development and preserved for conservation purposes in each province. Thus, Ontario, for example, has greater road lengths than the Maritime provinces, reflecting its much larger population, but a much lower road density, reflecting its large swaths of undeveloped land in the north. Other factors being equal, lower road density generally indicates preservation of ecological integrity over a larger swath of land area.[406] Trends over time within a given geographical area can yield important information. But meaningful comparison between provinces with vastly different geographies is not possible since the type of land and its suitability for habitation and development affect road density results greatly.

Kilometres of rail track operated measures land used for rail. Track lengths are the only statistics available for this mode. A more accurate indicator of land used for rail would include the aggregate territory involved in the operation of railways—including facilities and railyards—not just the tracks themselves.

No data were available on land used for air or marine transportation.

The data for the indicators were collected from various sources. Provincial urban density figures were obtained from Statistics Canada.[407] International estimates for land area consumed by cars were taken from the Earth Policy Institute.[408] Land area consumed by cars in Canada was calculated by adding the estimated area used for roads (road width x road length) and the estimated area used for parking (size of fleet x 3 parking spaces/vehicle x 30 m^2/parking space).[409] Unpublished data on lengths of rail track operated in each province were provided by Statistics Canada.[410]

Statistics used for calculating land area consumed by cars within Canada are from:

- Transport Canada for length of roads;[411]
- Vanessa Kind MES thesis for average widths of roads and highways;[412] and

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[406] Beazley et al. (2003).
[407] Statistics Canada. *Linking the Environment and the Economy - Indicators and Detailed Statistics*. (Ottawa: Minister of Industry, 2001. Catalogue no.16-200-XKE).
[408] Brown, Lester. Paving the Planet: Cars and Crops Competing for Land. (Earth Policy Institute. February 14, 2001). http://earth-policy.org/Alerts/Alert12.htm Accessed January, 2005.
[409] See Appendix C for details on calculating land area consumed by cars.
[410] Teggart, Francesca. Senior Analyst, Rail Industry, Statistics Canada—Transportation Division. (Personal communication: January 19, 2005).
[411] Transport Canada. *Transportation in Canada: 2003 Annual Report—Addendum*. (Ottawa: Minister of Public Works and Government Services, 2003b). www.tc.gc.ca/pol/en/Report/anre2003/add2003-e.pdf Accessed January, 2005.

- Statistics Canada's Canadian Vehicle Survey, for data on vehicle fleet size.[413]

As noted, an **increase** in urban density generally indicates a trend toward sustainability. **Decreases** in land area consumed by cars and in road density indicate trends toward sustainability.

Interpreting changes in rail track lengths and their meaning is more complicated and ambiguous, and requires careful analysis of the reasons for the changes. A **decrease** in total kilometres of rail line *could* indicate a trend toward sustainability since trains also impose stresses on the environment as do most vehicle classes in that they rely on fossil fuels, produce greenhouse gases, emit air pollutants, etc. Nevertheless, the environmental impact of rail per passenger-km or tonne-km in these respects is not nearly as severe as other forms of passenger or freight carriage. So transportation of people or commodities by rail is generally preferable, from a sustainability perspective, to transportation by car, truck, or plane.[414]

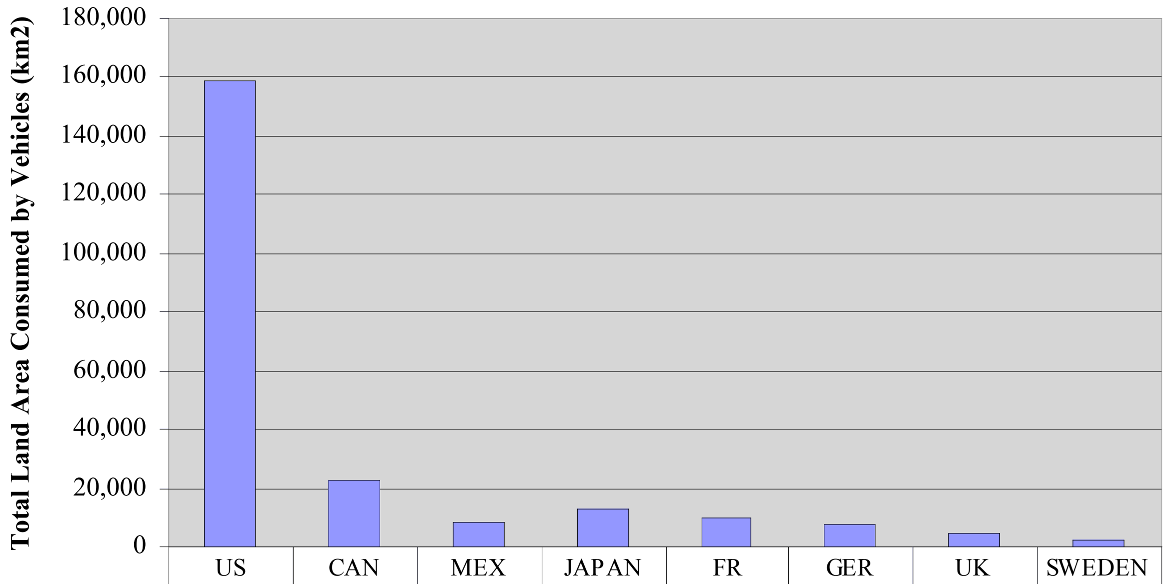
Thus a decrease in rail track would only be viewed as a positive trend towards transportation sustainability if this reflected a *net reduction in total aggregate transport activity*, rather than a shift of traffic to other modes. If the decrease in track denotes a shift to reliance on cars and trucks, then it reflects movement away from sustainability. Track lengths are therefore reported here to provide additional information on land used for transportation purposes, but they are not taken in and of themselves to denote trends towards or away from sustainability. Instead, the data on total transport activity and on transport activity by mode in the previous chapters are used for those interpretations and provide an essential context for the rail length statistics reported here.

Trends: International

Figure 135 records national land area consumed by cars, in 2001, for eight industrialised countries, as reported by the Earth Policy Institute, using Ward's World Motor Vehicle Data (2000) and the United States Central Intelligence Agency's *The World Factbook 2000* (Washington, DC: 2000). Canada had the second highest total of land area consumed by cars and used an estimated 22,757 square kilometres of land for cars. The United States consumed far more land for cars than any other country—nearly 160,000 sq. km. in total. Needless to say, reasonable international comparisons can only be done on a per capita basis, and these are provided in Figure 136 below.

[412] Kind. (2001).
[413] Statistics Canada. *Canadian Vehicle Survey*. (Ottawa: Minister of Industry, 2003. Catalogue no. 53-223-XIE).
[414] See, for example, the Motorized Movement of Freight section in the transport activity chapter of this volume.

Figure 135. Total Land Area Consumed by Motor Vehicles, Selected OECD Countries, 2001 (km^2).



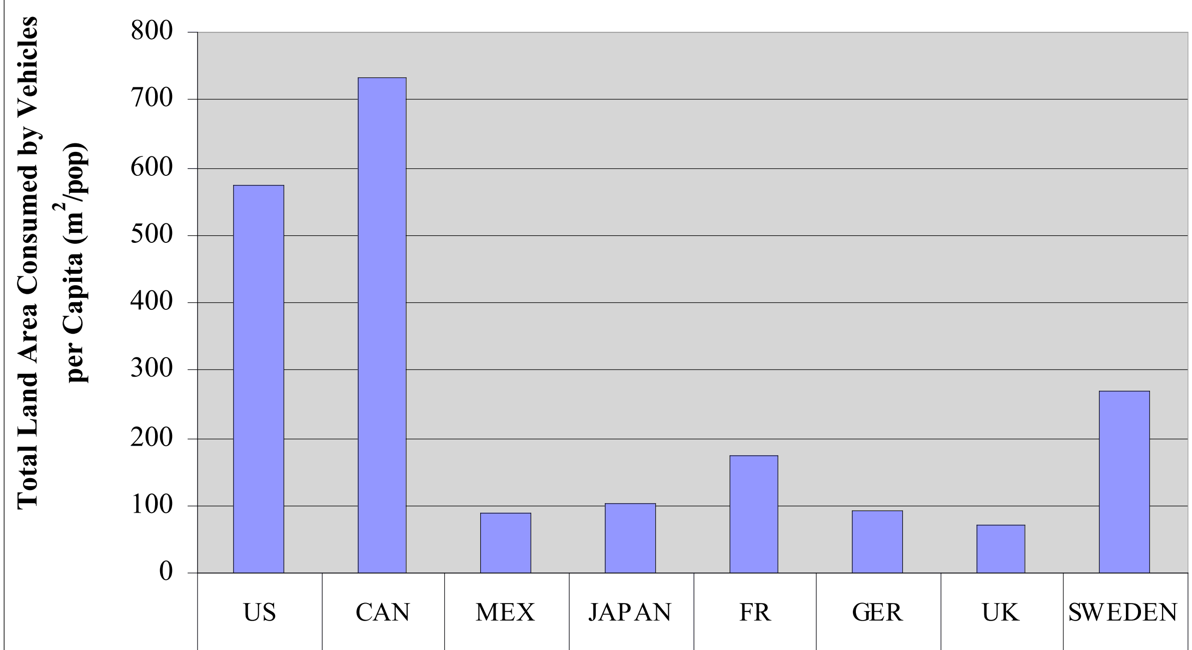
	US	CAN	MEX	JAPAN	FR	GER	UK	SWEDEN
Total area	159,196	22,757	8,628	13,166	10,206	7,497	4,251	2,411

Source: Lester Brown. Paving the Planet: Cars and Crops Competing for Land.[415]

Total population, population density, geography, income, modal mix and other factors all play a role in how much land is consumed by cars.[416] As shown in Figure 136, for example, states that are more densely populated—e.g. Germany, the United Kingdom, and Japan—tend to consume less land area per capita than ones that are less densely populated (e.g. Canada, Sweden, and the US). Canada has the lowest population density of these eight countries and, as indicated in Figure 136, has the highest land area consumed by cars per capita. Relative to the United States—which in absolute terms has the most land dedicated to cars (Figure 135)—Canada uses 28% more land per person for its vehicles. Lower-income countries like Mexico also have fewer cars per capita and correspondingly less road area per capita than most richer countries.

[415] See also: http://earth-policy.org/Alerts/Alert12_data2.htm.
[416] Brown. (2001).

Figure 136. Total Land Area Consumed by Motor Vehicles per Capita, Selected OECD Countries, 2001 (m^2).



	US	CAN	MEX	JAPAN	FR	GER	UK	SWEDEN
Area/Capita	573	734	87	104	173	91	72	268

Source: Lester Brown. Paving the Planet: Cars and Crops Competing for Land.

Trends: Canada

Urban Density

Figure 137 shows a distinct decline in the density of urban areas across the country and in every province for the period 1971-1996, based on Census data. Unfortunately, urban density trends from the 2001 census could not included because Statistics Canada terminated this calculation. In light of the importance of this information to assess transportation sustainability, and because it represents a significant driving force of total transport activity and automobile reliance, a key recommendation of this study is that the tracking and reporting of urban density trends be resumed without delay. The trend towards sprawl that is evident nation-wide makes this recommendation even more urgent.

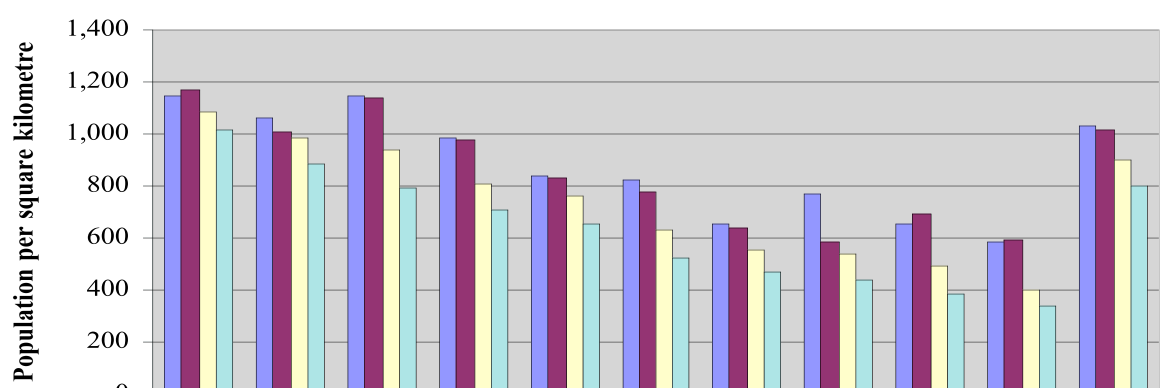
Between 1971 and 1996 the most pronounced shrinkages in urban density were in the Atlantic provinces, where settlement patterns were already more diffuse than in other parts of the country, and where higher proportions of the population reside in rural areas. Nova Scotia's urban density contracted by 36% over this term. Ontario's declined the least, and by 1996 that province's urban density was well above that in any other province. In fact, Ontario and Quebec had virtually identical urban densities in 1971—but, by 1996, Quebec's urban density had shrunk 31%, whereas Ontario's had declined by only 11%.

The decrease in urban density across Canada indicates a trend towards settlement in more dispersed, suburban and exurban communities. This dispersion increases communities' dependence on automobiles and also often increases passenger-kilometres travelled, because amenities and job sites tend to be further away from where the majority of people live. This automobile dependence generally results in expansions in road networks and in the amount of land used for transportation, and in a decline in the viablity of mass transit.

As noted by the Centre for Sustainable Transportation, "the density of urban areas is widely recognized as an important influence on transit service."[417] Decreases in urban densities tend to make public transit systems less viable both logistically and economically. In areas of low population density, it may not be fiscally feasible to offer service, or the frequency and extent of coverage may be too minimal to provide basic convenience and to encourage use.[418]

For all these reasons, the overall decline in urban densities across Canada suggests a movement away from transportation sustainability—from economic, social, and environmental perspectives.

Figure 137. Change in Urban Density (population/land area [km^2] in urban areas with a population of over 1,000 and a population density of at least 400 people per km^2) by Province, 1971-1996.



	ON	BC	QC	MN	AB	NS	SK	PEI	NFD	NB	CAN
1971	1,144	1,058	1,143	988	840	826	652	767	657	584	1,030
1981	1,171	1,005	1,135	975	831	778	637	588	695	590	1,015
1991	1,087	988	937	805	761	631	551	539	489	397	903
1996	1,015	881	791	711	651	525	472	437	381	336	799

Source: Statistics Canada. *Indicators and Detailed Statistics*. (Catalogue no.16-200-XKE).

[417] Gilbert et al. (2002, p. 63).
[418] Ibid.

Road Density

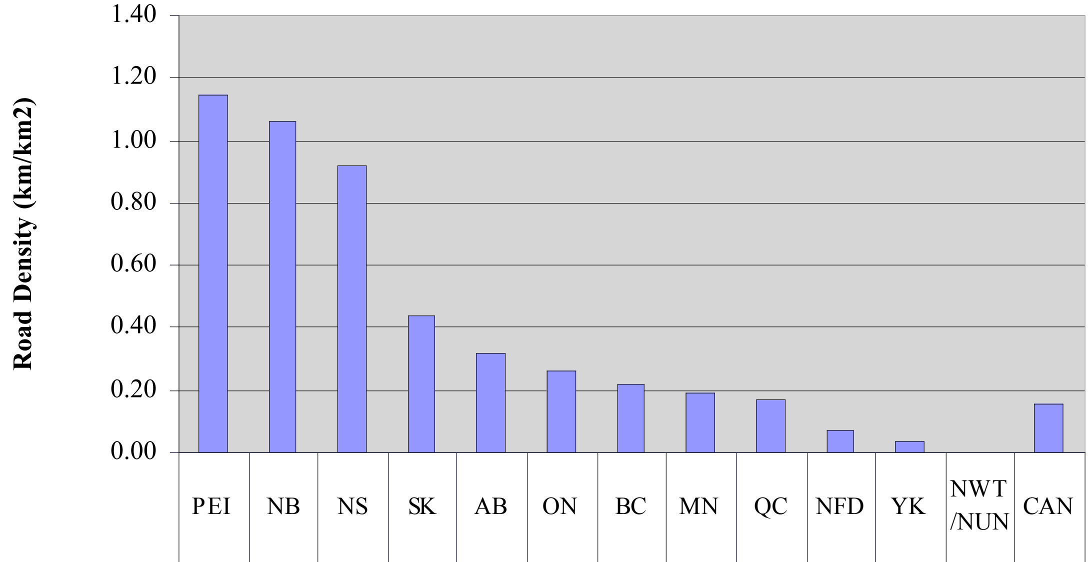
As noted, road density and the distribution of roads in Canada are important indicators of sustainability because of the negative environmental impacts associated with converting soils and natural land features to paved and impermeable surfaces. These impacts include habitat fragmentation that adversely affects wildlife, and loss of prime agricultural land. Figure 138 shows the road density of each province and territory in 2003. The smallest provinces in Canada are the Maritime Provinces,—Prince Edward Island, New Brunswick and Nova Scotia—and these have the highest road densities in Canada.

High road densities have had negative effects on wildlife in the Maritimes. For example, in Nova Scotia overall density is 0.92 kilometres of road per square kilometre. This is above the threshold (0.6 km/km^2) beyond which natural populations of some large vertebrates have been shown to decline, largely due to habitat fragmentation.[419] This implies that animal habitat, including that of the endangered mainland moose, has been compromised by high road density in a significant proportion of the province,[420] a point addressed again in the Nova Scotia section of this chapter below.

In other provinces outside the Maritimes, overall road densities are below this threshold point but only because they have large swaths of relatively undeveloped land areas with few roads in the north. Populations outside Atlantic Canada are concentrated in the south of the country, which has led to dense road infrastructures in the south that are not reflected in the provincial averages below. Although road densities have generally not been quantified by region, they would certainly be very much higher than indicated in Figure 138 if calculated separately for the southern areas of these other provinces. For this reason, and because of the significant geographic and demographic differences between the provinces, it is not possible to create meaningful inter-provincial comparisons based on the results in Figure 138 as to the relative sustainability of these road density patterns.

[419] Beazley et al. (2003).
[420] Ibid.

Figure 138. Road Density, by Province/Territory, 2003 (km of lane-miles/km^2 of land area).



	PEI	NB	NS	SK	AB	ON	BC	MN	QC	NFD	YK	NWT /NUN	CAN
Road Density (km/km2)	1.15	1.06	0.92	0.44	0.32	0.26	0.22	0.19	0.17	0.07	0.03	0.003	0.15

Source: Transport Canada. Transportation in Canada 2003: Annual Report—Addendum; and Statistics Canada. *Environmental Perspectives*.

Land Area Consumed by Automobiles

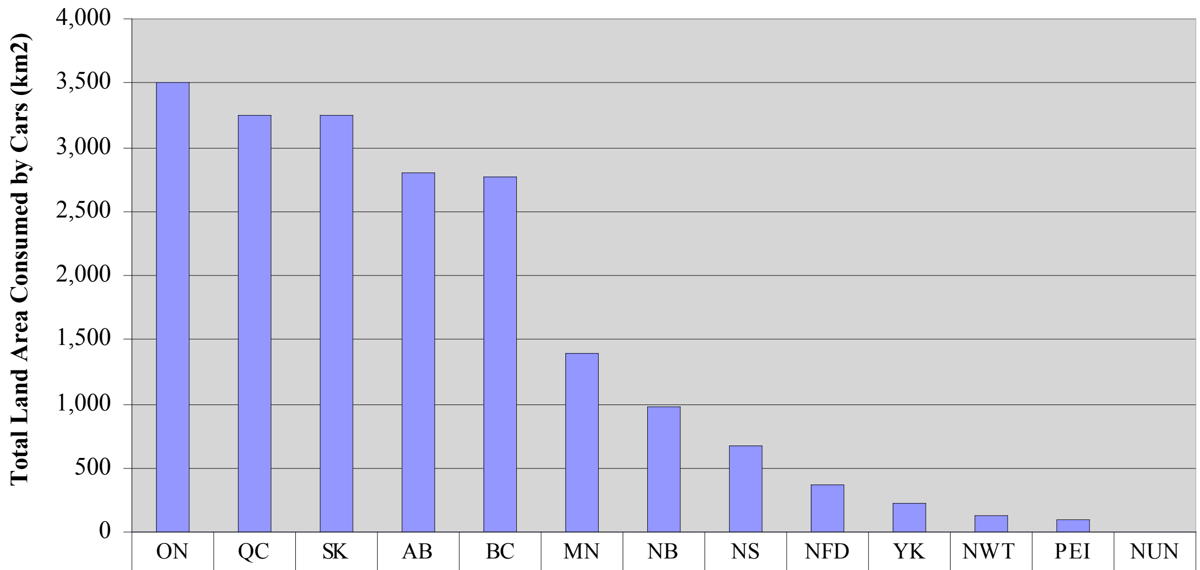
Figure 139 illustrates the total land area devoted to automobile facilities (in this analysis the term *automobile* refers to registered vehicles under 4.5 tonnes weight, which includes some SUVs, minivans and/or light trucks but not all) in each province and territory in 2003. As noted above, the figures account for land used for roads and parking, but not for facilities like gas stations. The length of the road network and the size of the passenger vehicle fleet in each province were used to calculate these totals for roads and for parking, based on studies showing that each passenger vehicle requires an average of three parking places (at home, work, schools, shopping centres, on the street, etc). The data for vehicle fleet size were limited by the vehicle categories given in the Canadian Vehicle Survey. Instead of calculating land area consumed by *all* motor vehicles, the number of registered vehicles under 4.5 tonnes weight was used for the calculation, with the assumption that this accounted for most passenger vehicles. We would have calculated land area consumed by *all* motor vehicles if data were available by vehicle categories, including all cars, light and heavy trucks, vans, SUVs and motorcycles. The calculation methods are explained in Appendix B.

Ontario, Quebec, and Saskatchewan[421] consume the most land for automobiles while Nunavut, Prince Edward Island, and the Northwest Territories consume the least—a reflection of their much smaller population size and, hence, their smaller vehicle fleets. Nova Scotia is at the lower

[421] Saskatchewan's large land area consumed by cars is directly related to its large road network, as opposed to Ontario and Quebec who's large land areas consumed by cars are more of a function of population.

end of the scale for automobile-related land area consumption, using an estimated 670.2 km^2 of provincial land for automobiles. The provincial totals largely reflect population size, so meaningful provincial comparisons require per capita assessments, as given in Figure 140 below.

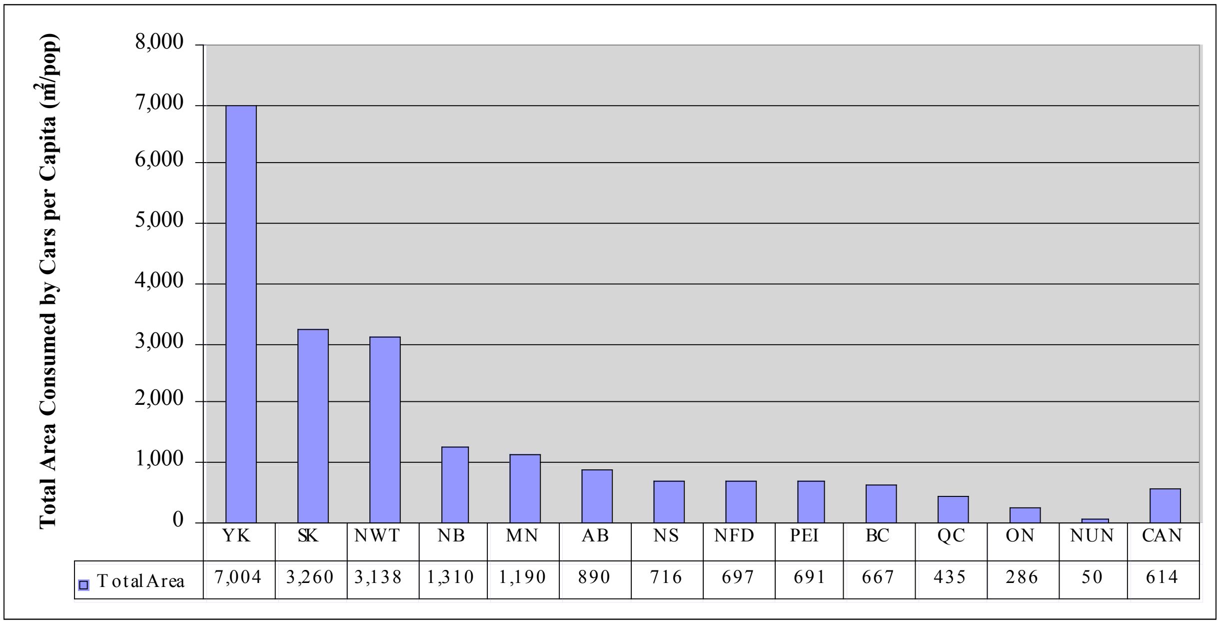
Figure 139. Total Land Area Consumed by Automobiles (km^2), by Province/Territory, 2003.



	ON	QC	SK	AB	BC	MN	NB	NS	NFD	YK	NWT	PEI	NUN
Total Area	3,506	3,256	3,243	2,805	2,765	1,384	983	670	362	218	131	95	1

Source: **Kilometres of Road:** Transport Canada. *Transportation in Canada 2003: Annual Report—Addendum*. **Number of Vehicles:** Statistics Canada. *Canadian Vehicle Survey*.

Figure 140. Total Land Area Consumed by Automobiles (m^2) per Capita, by Province/Territory, 2003.



Source: **Kilometres of Road:** Transport Canada. *Transportation in Canada 2003: Annual Report—Addendum*. **Number of Vehicles:** Statistics Canada. *Canadian Vehicle Survey*. **Population:** Statistics Canada. CANSIM Table 051-0001.

Note: The above reported, land area consumed by automobiles per capita for Canada (614m^2/cap) is different than the international value reported in Figure 136 (734 m^2/cap) due to the following: 1) The international data are based on the use of both automobiles and commercial vehicles while, as a result of limited data availability, the above chart is based on automobiles only; and 2) The international data are based on estimates derived from US figures, while the above values are based on actual data assembled by Transport Canada and Statistics Canada, rather than estimates.

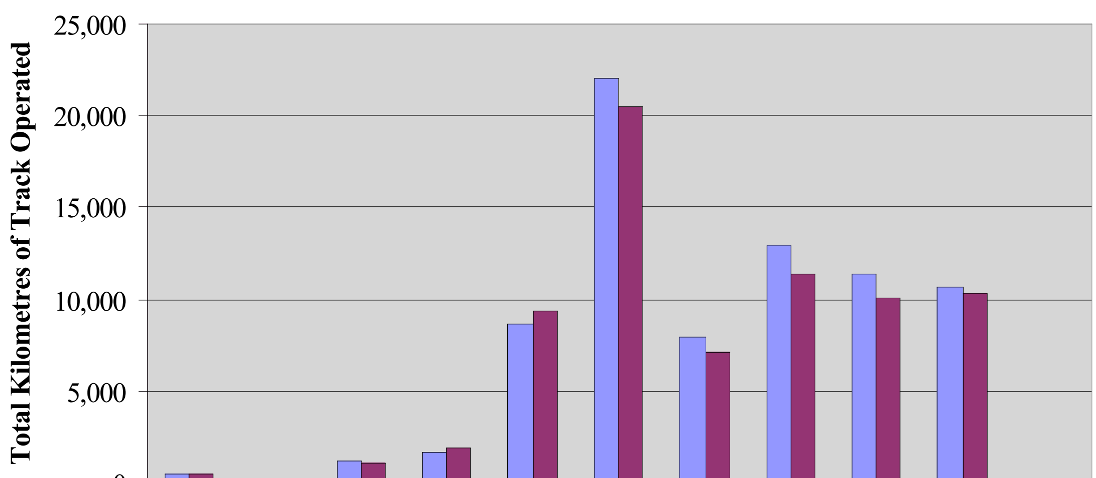
As shown in Figure 140 above, provinces that are more densely populated (Ontario and Quebec) generally consume less land area per capita than provinces and territories that are less densely populated (e.g. Saskatchewan, Yukon, and the Northwest Territories). The importance of population density in influencing per capita land area used for automobiles confirms the findings in the earlier international comparisons of land area devoted to automobile facilities (Figures 135 and 136). There too, it was seen that countries like Germany, the UK and Japan, which are more densely populated, generally consume less land area per capita than ones that are less densely populated. Thus, population density substantially influences total and per capita estimates of land area consumed by automobiles – both internationally and domestically.

But overall provincial population density is not the only determining variable of per capita land area consumed by automobiles. The results in Figure 140 also reflect intra-provincial and regional development patterns. Thus, while Prince Edward Island and Nova Scotia are more densely populated than Ontario and Quebec, the Maritime provinces have higher proportions of their populations living in rural areas. They therefore have more kilometres of roads and registered vehicles per capita than Ontario and Quebec, and thus consume more land area per capita for automobiles (Figure 140). Nunavut has a low population density but also few roads and relatively low per capita vehicle ownership.

Kilometres of Rail Track

The 1996 and 2002 totals for kilometres of operational rail track used in Canada, the provinces, and the Northwest Territories are shown in Figure 141. The numbers are unpublished but were kindly provided for the purposes of this study by Statistics Canada's Transportation Division. Of the eleven jurisdictions that operate rail lines, seven showed declines in the length of operational track being worked. Alberta and Saskatchewan each experienced an 11% contraction – the largest declines during this period. The only provinces to experience increases in kilometres of track operated were New Brunswick (up 14%), Quebec (up 8%), and Newfoundland (up less than one percent). For the reasons noted above, it is not possible to assess these results from a sustainability perspective outside the larger context of the modal mix of transport activity.

Figure 141. Total Kilometres of Rail Track Operated, by Province/Territory, 1996 and 2002.



	NFD	PEI	NS	NB	QC	ON	MB	SK	AB	BC	NWT
1996	525	0	1,143	1,661	8,638	22,037	7,933	12,861	11,340	10,649	143
2002	528	0	1,068	1,892	9,309	20,529	7,167	11,414	10,083	10,343	129

Source: Personal communication with Francesca Teggart, Senior Analyst, Rail Industry, Statistics Canada—Transportation Division. January 19, 2005.

Overall, the total length of rail track in Canada has remained fairly stable over time. Most changes were in short haul tracks, which are often laid temporarily and therefore vary in length from year to year.[422]

[422] Teggart. (January 19, 2005).

Trends: Nova Scotia

Road Density

Given the large gaps in the data on land use trends in Nova Scotia, a recent research project led by Dalhousie University's Karen Beazley has been most helpful in identifying those areas within the province that have particularly high road densities.[423] Beazley and her collaborators particularly identified areas with road densities greater than 0.6 km/km^2—a concentration known to have negative effects on populations of large vertebrates such as moose, Canada lynx, American marten, and black bear.[424] According to this study, the provincial areas with the highest road densities include:

- the Halifax region;
- the Annapolis Valley;
- coastal regions;
- regions along major thoroughfares, such as Highways 104 and 102;
- and, to a lesser extent, the Cumberland-Colchester area.

A valuable observation by Beazley et al. from a habitat fragmentation and sustainability perspective is that the province is essentially bisected by Highway 101. This effectively segregates southwestern populations of wildlife from other populations northeast of the highway. In addition to this major artery, other roads, and the railway between Nova Scotia and New Brunswick, artificially isolate some species in Nova Scotia from populations in the rest of North America.

Kilometres of Rail Track

Figure 142 below, shows the trend from 1996 to 2002, for aggregate length of rail track in use in Nova Scotia. Totals remained fairly constant during the late 1990s, though there was an overall seven percent reduction in kilometres of rail line operated during this period. The most significant change occurred between 2000 and 2001, when there was a 12% contraction in the length of railway being worked. However, mainline track has remained constant since 1996, and variances in the length operated are due to changes in short haul lines.[425] As noted above, rail length trends cannot be used to indicate a movement either toward or away from sustainability as they may reflect either a change in total transport activity or a modal shift. As well, fluctuations are to be expected for short haul tracks, while mainline changes would have greater significance.

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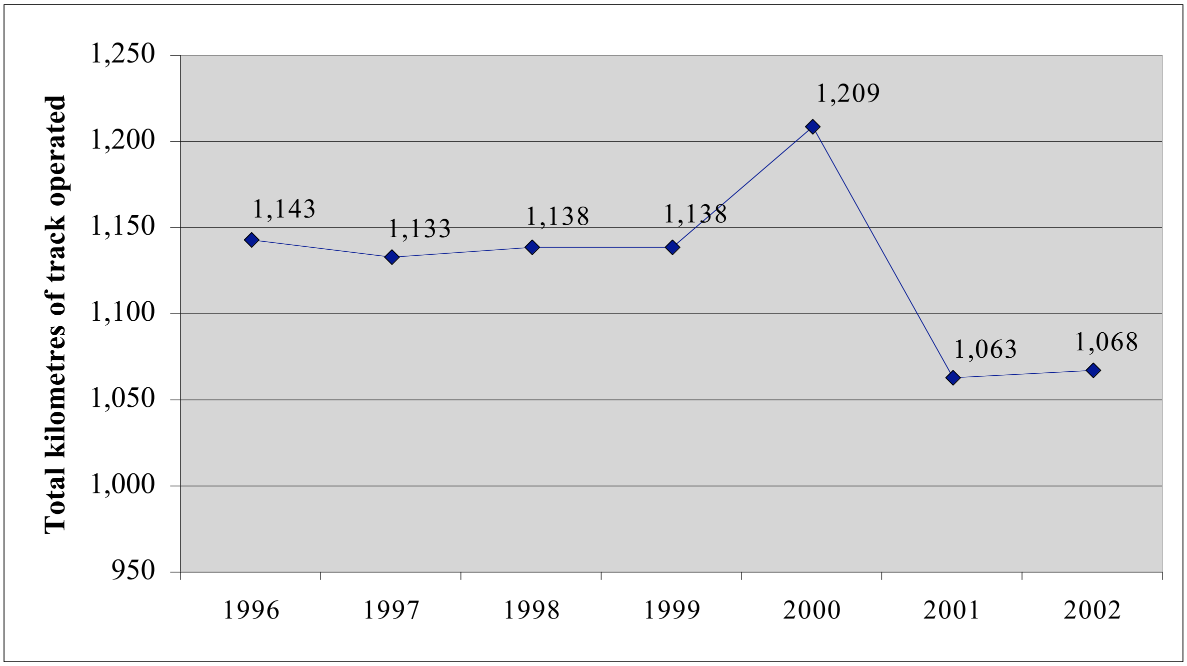
[423] Beazley et al. (2003).
[424] Ibid.
[425] Newson, Steve. Policy Advisor, Nova Scotia Department of Transportation and Public Works. (Personal communication: January 14, 2005).

Figure 142. Nova Scotia: Kilometres of Rail Track in Use, 1996-2002.



Source: Personal communication with Francesca Teggart, Senior Analyst, Rail Industry, Statistics Canada—Transportation Division. January 19, 2005.

Not included in the numbers in Figure 142 are statistics for abandoned railways in the province. Limited data are available concerning these disused lines. Initiatives are under way to convert some of these abandoned tracks to hiking trails. According to Go for Green, a Canadian non-profit organization, the Nova Scotia government currently owns approximately 1,100 km of rail corridor that has been purchased for the purpose of conversion to recreation paths. The government is negotiating the purchase of another 250 km with the Canadian Pacific Railway, and is exploring purchase options on some additional, privately-owned, abandoned lines (amounting to a few hundred km in total). This will provide a substantial basis for the province's Rails to Trails Program.[426]

On the one hand, decommissioning disused railways and converting them to trails reduces the land reserved for motorized transportation and could therefore be interpreted as a trend toward sustainability. On the other hand, a comparison of the aggregate figures on disused rail line above with the figures on rail track in active use in Figure 142 above indicates that the length of abandoned lines considerably exceeds that of active lines. In other words, far more railways have been decommissioned in the province than remain in active use, at the same time that total transport activity has increased sharply. As rail is a considerably more sustainable mode of transportation than most others in terms of energy use, greenhouse gas and pollutant emissions, and other indicators, the decommissioning of railways actually indicates a modal shift towards less sustainable forms of road and air transportation.

[426] Go for Green. Canadian Greenways: Provincial/Territorial Information—Nova Scotia Update. (No date). www.goforgreen.ca/Greenways/n-s.html Accessed January, 2005.

Conclusion

Transportation affects land use both directly, through transportation facilities, and indirectly, by affecting land use development patterns and related impacts. Most transportation land use trends have been away from sustainability.

Urban densities are declining across Canada. Urban density in Nova Scotia declined 36% between 1971 and 1996. The four Atlantic provinces experienced the sharpest declines in urban density of any region in the country (Figure 137). This indicates that communities in Nova Scotia and throughout Atlantic Canada are becoming more dispersed. Canadian statistics appear to indicate a nationwide trend towards greater suburban and exurban sprawl, which typically leads to greater automobile dependency, increases in automobile transportation infrastructure, and a decline in mass transit viability. This trend implies an overall movement away from sustainability.

As noted, comparative intra-provincial data on changes in density within Nova Scotia's different urban areas are not tracked. This data limitation is unfortunate because information of this kind could identify those areas in Nova Scotia that are experiencing the most sprawl, which in turn would indicate where increases in land used for transportation are most likely to occur. This information is crucial for planning and policy purposes if the driving forces behind the currently unsustainable transportation system, with its increases in total transport activity and automobile dependency, are to be adequately addressed.

The present analysis indicates that, relative to other provinces, Nova Scotia's road network is quite dense, as is that of the other two Maritime provinces (Figure 138). However, this comparison is largely an artefact of the large, relatively undeveloped northern regions of other provinces, which lower provincial averages for road density outside the Maritimes. In fact, the southern regions of Ontario, Quebec and other provinces have very high road densities.

More significantly, Beazley et al. have identified the areas in Nova Scotia that have the heaviest road concentrations. Areas with the greatest road density are along the coast, in the Halifax region, in the Annapolis Valley, and along the major thoroughfares, such as Highways 104 and 102. The Cumberland-Colchester district also has a relatively high road density. These areas (and the province as a whole) all far exceed the threshold (0.6 km/km^2) beyond which natural populations of some large vertebrates have been shown to decline. Indeed, the province's high road density may be a significant factor in the decline of the endangered mainland moose.

Because road density data were not available as a time series, it was not possible to determine the trend in road density for the province and to ascertain directly whether it is moving toward or away from sustainability. However, current high levels of road density and the addition of new roadways and highway lanes in the province indicate that current road density levels are unsustainable and apparently increasing. So long as new roads are being built at a faster rate than they are being decommissioned, it can be inferred, even in the absence of specific road density statistics over time, that provincial road density is increasing rather than declining (since total provincial area remains constant). This constitutes further movement away from sustainability for this indicator.

The estimated totals for land area devoted to roads and parking facilities, both total and per capita (Figures 139 and 140), indicate that Nova Scotia consumes more land area for motor vehicles per capita than some other provinces like Quebec, Ontario, and British Columbia that have lower overall population densities because of their vast and much less inhabited northern areas. This runs counter to international findings for other jurisdictions, where higher population densities usually correlate with lower per capita land area use for automobiles (Figures 135 and 136).[427] This is likely due to the higher proportion of the Nova Scotia population living in rural areas, and the large, relatively undeveloped northern areas of Ontario, Quebec, and British Columbia that produce lower overall average provincial population densities.

While these geographical peculiarities and differing regional development patterns limit the utility of inter-provincial comparisons in Canada for this indicator, other comparative data reveal that Nova Scotia has a relatively high proportion of its land devoted to automobile use, By comparison with the selected OECD countries listed in Figure 136, Nova Scotia has 25% more land area per capita consumed by automobiles than the USA, nearly three times as much as Sweden, four times as much as France, eight times that of Germany, and ten times that of the UK. Even allowing for major regional development differences and differences in calculation methods, it is clear that Nova Scotia has a relatively high land area consumed by automobiles by any standards, which in turn has negative implications for sustainability.

The kilometres of rail track operated in Nova Scotia remained fairly constant during the late 1990s, and then dropped due to a decline in short-haul track in use. From 1996 to 2002 there were no significant changes in the amount of land used for mainline rail tracks. For reasons explained above, the rail track trends cannot be used to assess movement toward or away from sustainability.

From one perspective, the conversion of abandoned rail lines to hiking paths by the Rails to Trails Program is a positive movement toward sustainability, since it transfers land from motorized transport to healthy non-motorized transport activities. From another perspective, the massive long-term decommissioning of most of Nova Scotia's railways, the abandonment of track, and the consequent reduction in length of track constitute a movement away from sustainability, as trains represent a more sustainable mode of passenger and freight transport than automobiles, trucks, and planes.[428] While fewer kilometres of track therefore seem to imply a reduction in adverse environmental effects such as fragmentation and disruption of wildlife habitat, this is actually the case only if it is the result of a net reduction in total transport activity, and not if the closure and decommissioning of tracks simply displaces traffic to other modes like trucking that have greater environmental impacts.

All of these different measures have been examined because none of them, independently, adequately conveys either how much land is consumed by transportation or the impacts of changing land use patterns on transportation sustainability. There is a general lack of available data on indicators like land use clustering and land use mix, which could measure the impact of land use patterns on transportation more directly.

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[427] Brown. (2001).
[428] For example, see the comparison of energy efficiency for rail and trucking in *Trends: Canada* in the energy consumption chapter of this volume.

As well, each of the indicators described in this chapter has its own significant shortcomings. For example, the figures used for land area consumed by automobiles are approximate at best, because they are only partial (excluding transportation facilities), and are based on computations rather than direct measurement. In determining land area, estimates were used for the various widths of roads and for the number of parking spaces required per vehicle.[429] In the future, GIS data or measurements from aerial photographs, rather than calculated approximations, would provide a more reliable total estimate of the land area consumed by automobiles.[430] Results would also be more accurate (and likely indicate higher numbers) if records of land occupied by transportation facilities were available and included in the calculations. Despite these shortcomings and the approximate nature of the results, the indicator is used here because even the limited available evidence does offer some insight into the important issue of how much land is consumed by automobiles.

Another example of the data limitations that inhibit the analysis in this chapter is that the accuracy of road length numbers compromises the road density indicator. According to Transport Canada, different methods of measuring road lengths across Canada were used from year to year, even within provinces.[431] This makes it difficult to compare changes in road lengths on an annual basis and, correspondingly, to establish any trend over time for changes in road density. Because of this measurement inconsistency, road densities could only be compared between provinces for a single given year.

It also was impossible to undertake detailed time series analyses for Nova Scotia for the kinds of land use trends that were presented on a national scale, such as the changes in urban density noted in Figure 137. This is because intra-provincial data on changes in urban density in different urban regions of the province are unavailable. As well, Statistics Canada discontinued providing urban density calculations in the 2001 Census, so trends for this important indicator are only available to 1996.

The weakness of the road length statistics and the lack of detailed urban density data for Nova Scotia in particular severely limit the examination and analysis of land use and transportation trends in the province. Many changes of significance in land used for transportation purposes in Nova Scotia could not be adequately documented due to the lack of consistent information over time.

Many of the data limitations noted in this chapter actually constitute data recommendations for the future. As land use patterns are a driving force of the transportation system as a whole, improving data availability and data quality in this important area should be a high priority for improved transportation planning. Fortunately, according to the Nova Scotia Department of Transportation and Public Works, some improvements are in process. For example, road network developments will be tracked more consistently and accurately in the near future.[432] The Nova Scotia Geomatic Centre, a branch of the provincial government, has initiated a new process for

[429] See Appendix C for details on calculating land area consumed by cars.
[430] For more about this technology see www.gis.com/.
[431] Leore, Robert. Economist, Transport Canada—Statistics Division. (Personal communication: January 14, 2005).
[432] Wilson, Greg. Planning Technician, Road Network Information Section, Road Safety, Nova Scotia Department of Transportation and Public Works. (Personal communication: January 24, 2005).

mapping the province's roads using GPS technology to identify new routes.[433] When these data become available, they will enable far more accurate assessments of road density and land used for automobile use.

[433] Smith, David. Supervisor, Database Maintenance Support, Nova Scotia Geomatic Centre. (Personal communication: January 19, 2005). GPS (Global Positioning System) is a navigation technology that can pinpoint any location on the planet (with an accuracy of one or two metres) using information from satellites and their associated ground stations.

Chapter 10. Access to Basic Services

As discussed at the beginning of this report, and in the definitions of sustainable transportation, sustainability has economic, social, and environmental dimensions. This section examines the degree to which the transportation system contributes towards key social objectives, including social equity, safety and health, community liveability, and affordability.

Until recently, transportation systems were evaluated primarily using indicators that measure vehicle traffic, such as roadway level-of-service ratings and average vehicle traffic speeds. In fact, the primary mandate of most provincial transportation departments is still roadway maintenance, repair, and construction. However, planners now increasingly evaluate transportation in terms of *accessibility* (the ease with which people can obtain desired goods and services, and reach activities).[434] Accessibility is affected by *mobility* (the ease with which people and freight can be moved) and by *proximity* (the spatial distribution of destinations, goods, and services). Proximity in turn is conditioned by land use factors such as the location, density, clustering, and connectivity of development. Clustering—i.e. the presence of several different types of destinations, activities, and services close together—can be a strong factor in supporting effective public transit and active transportation (walking, cycling, in-line skating, etc.) in higher density areas, or in increasing accessibility in areas with a mix of transit options and services.

Evaluating transportation system quality based on accessibility rather than just vehicle traffic gives greater consideration to public transit and land use planning practices that create more accessible and multi-modal communities. More compact, mixed development increases accessibility for pedestrians and public transit users while reducing the need to travel by automobile. For example, people with physical disabilities can access more activities, enjoy more opportunities, and bear lower transportation costs if they live in neighbourhoods with good sidewalks and nearby services (stores, restaurants, banks, medical clinics, etc.), and with local transit services that accommodate their needs, than if they live in isolated locations where access to any activity requires an automobile trip.

A key social objective that derives from considerations of accessibility, therefore, is transportation equity, which requires that the transportation system serve all community members, including people who are physically, economically or socially disadvantaged. It gives special consideration to *basic access*, that is, people's ability to access services and activities that are considered essential and socially beneficial. These typically include:[435]

- Emergency services (police, fire, ambulances, etc.).
- Public services and utilities.
- Health care.
- Basic food and clothing.

[434] Litman, Todd. *Online TDM Encyclopedia—Accessibility*. (Victoria Transport Policy Institute, 2005d). www.vtpi.org/tdm/tdm84.htm#_Toc28046124
[435] Litman, Todd. Online TDM Encyclopedia-Basic Access and Basic Mobility. (Victoria Transport Policy Institute, 2005d). www.vtpi.org/tdm/tdm103.htm

- Education and employment.
- Mail and package distribution.
- Freight delivery.
- Social and recreational activities.

The evaluation of basic access requires giving special attention to transportation options that serve disadvantaged groups, taking into account the needs of different users (e.g. people with impaired mobility); varying financial circumstances; and an acceptable level of service to users.[436] This is both a social equity issue, since inadequate transportation can reduce disadvantaged people's opportunities in life, and an economic issue, because inadequate or unaffordable transportation can prevent people from obtaining education and employment, and therefore being economically productive.

Transportation equity is also concerned with the distribution of impacts, such as whether a particular group bears excessive economic costs or environmental risks. For example, transportation equity is concerned with uncompensated accident and pollution risks imposed on a particular group.

The Indicators

As discussed previously, most travel in Canada is presently by private motor vehicle, which imposes a variety of economic and social costs, including costs and risks imposed on future generations. Also, as discussed earlier, various market distortions, such as externalized costs and planning practices that favour automobile travel, produce disparities that are both unfair and economically inefficient, resulting in economically excessive motor vehicle travel. As a result, increased motor vehicle use is considered unsustainable, while shifts to more efficient modes, and improvements in modes that serve non-drivers, is considered to increase sustainability.

Various indicators can be used to evaluate progress toward social equity in the transportation system. No single indicator effectively captures all equity factors, and different communities may have different values and perspectives for evaluating equity. The Centre for Sustainable Transportation has identified two possible indicators that could be useful for assessing overall accessibility: non-motorized transportation in urban areas, and journey-to-work mode share.[437] This report uses employment and education mode share as an indicator of basic access, largely because of data availability. Ideally this analysis would also measure accessibility to other essential services, like shopping and recreation, but data limitations do not permit such an assessment at this time. Access to work and school may be estimated by two methods:

- passenger-kilometres (total distance travelled to work and school divided by the number of passengers); and
- modal split (the proportion of aggregate movement to and from work and school contributed by each mode of transportation).

[436] Litman. (2005d). www.vtpi.org/tdm/tdm84.htm
[437] Gilbert et al. (2002, p. 48).

The Transportation Association of Canada publishes data on non-motorized travel in urban areas as part of its Urban Transportation Indicators reports.[438] These documents provide considerable commentary on and analysis of transportation trends in Canadian urban centres. Halifax Regional Municipality (HRM) was not included in previous editions, so no Nova Scotia specific data were available from this source. HRM was however included in the latest report that was published in 2005, but was not yet available at the time this report was prepared.

The Centre for Sustainable Transportation found it preferable to measure transport activity by passenger-km rather than modal split because the former reveals actual distances travelled and thus assesses proximity to services. However, modal split is used as the basic accessibility indicator for this report for four reasons:

- Reliable data are not available, by province, for passenger-km for non-motorized travel;
- Reliable data for modal split, with a very large sample size, are available from the Journey to Work sections of the 1996 and 2001 Censuses;[439]
- Modal split data provide information in a format that is easily recognized and interpreted by decision-makers and the public alike;
- The 1996 and 2001 Census data on modal split include information on distance travelled to work by each mode, so the important data on distance travelled, which led the CST to select passenger-km measures, are not lost by using the modal split indicators in this case.

As noted, statistics on commuting modes and distances used in this report were taken from the Journey to Work sections of the 1996 and 2001 Censuses. The travel-mode-to-work question was not asked in Census questionnaires prior to the 1996 Census, so commuting distance data are not available in the 1991 Census.[440] Consequently, it was not possible to develop a continuous time series for these indicators for the 1990-2002 period that is the reference period for most indicators examined. However, these results can be updated next year to create a longer time series when the records from the 2006 Census are released.

Statistics from HRM's Planning Services were used to evaluate the trends described in this section. Information on children walking to school was obtained from the Sport and Recreation branch of the Nova Scotia Office of Health Promotion. Other data sources for the following accessibility indicators include the Canadian Fitness and Lifestyle Research Institute's annual surveys of various aspects of Canadians' physical activity levels.

In this study, therefore, basic access is assessed and measured by changes in travel behaviour to work and school using the following indicators:

1) Percentage of population commuting to work

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[438] For more information on the Transportation Association of Canada indicators see www.tac-atc.ca/english%5Fold/productsandservices/ui/intro.asp.

[439] Statistics Canada. *Journey to Work, 2001: Census Technical Report*. (Catalogue no. 92-390-XIE). www12.statcan.ca/english/census01/Products/Reference/tech_rep/journey/offline%20documents/92-390-XIE.pdf This report provides data for both 1996 and 2001.

[440] Statistics Canada. *2001 Census Dictionary*, Appendix D "Historical Comparability of Journey to Work Data." (Ottawa, 2003a. Catalogue no. 92-378-XIE). www12.statcan.ca/english/census01/Products/Reference/dict/appendices/92-378-XIE02002.pdf

- Adults commuting to work by foot
- Adults commuting to work by bicycle
- Adults commuting to work by public transit
- Adults commuting by private vehicle

2) Children commuting to school by foot
3) Average commuting distance
    - Median distance travelled to work (in kilometres)

Data on commuting from Statistics Canada's 1992 General Social Survey (GSS) were considered in attempting to develop a longer time-series. However, before 1998, the GSS sample size for these questions was 10,000, a number insufficient to disaggregate the results to the provincial level. The GSS sample size was subsequently increased to 25,000 in 1998, which does allow for provincial analysis.[441]

10.1 Commute Mode Split

Commute mode split refers to the form of transportation used by people travelling to work or school. This study considers increases in the portion of commuting by alternative modes (walking, cycling, ridesharing, and public transit) to reflect progress towards sustainability, since it indicates a more diverse transportation system and more accessible land use patterns that tend to increase transportation system efficiency and equity. Increased use of alternative modes tends to:

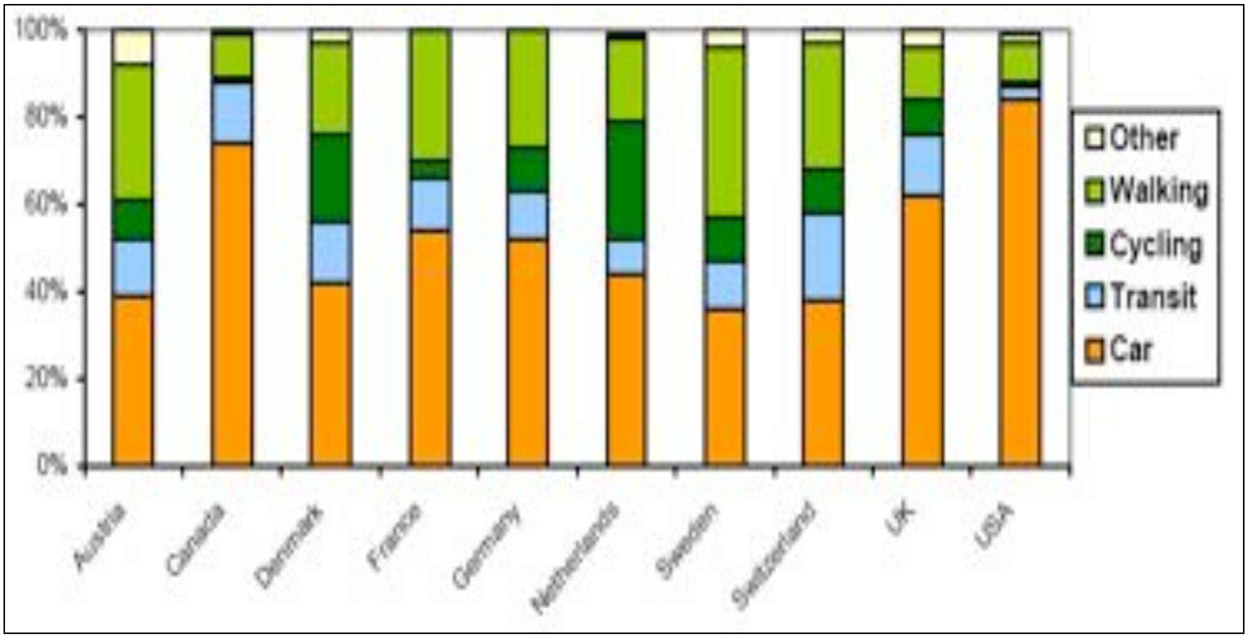
- Reduce traffic congestion, which in turn, improves quality of life, reduces industry costs, and makes cities more competitive and attractive.
- Improve air quality and consequently reduce respiratory illness due to pollution.
- Provide a safer alternative to car travel, thus reducing automobile accidents.[442]
- Abate other environmental impacts, including climate change, natural resource depletion, and water and solid waste pollution, brought on by growth in automobile traffic.
- Increase physical activity and health.[443, 444] Transit travel also tends to increase the amount of time people spend walking, and so increases public health.[445]

[441] Statistics Canada. *The General Social Survey: an overview*. (Catalogue no. 89F0115X). http://www.statcan.ca/cgi-bin/downpub/listpub.cgi?catno=89F0115XIE2001001
[442] Litman, Todd. *Quantifying the Benefits of Nonmotorized Transportation for Achieving Mobility Management Objectives*, p.1. (Victoria Transport Policy Institute, 2004d). www.vtpi.org/nmt-tdm.pdf
[443] Frank, Lawrence, Sarah Kavage and Todd Litman. *Promoting Public Health Through Smart Growth: Building Healthier Communities Through Transportation And Land Use Policies*. (Smart Growth BC, 2006) www.smartgrowth.bc.ca/downloads/SGBC_Health%20Report%20Final.pdf.
[444] World Health Organization. *Physical Activity*. (2003). www.who.int/entity/dietphysicalactivity/media/en/gsfs_pa.pdf Accessed December, 2004.
[445] Besser, Lilah M., and Andrew L. Dannenberg, "Walking to Public Transit: Steps to Help Meet Physical Activity Recommendations," (*American Journal of Preventive Medicine*, Vo. 29, No. 4,2005) www.cdc.gov/healthyplaces/articles/besser_dannenberg.pdf.

Trends: International

Although somewhat dated, Figure 143 analyses modes of transportation in use in the urban areas of 10 different countries. These 1996 data, drawn from John Pucher and Christian Lefevre's study, *The Urban Transportation Crisis in Europe and North America*, show that over three-quarters of urban transportation in Canada and the United States is by car. This contrasts with countries such as Sweden, Austria, Denmark, the Netherlands, and Switzerland, which rely on cycling and walking for 40% or more of all urban travel.

Figure 143. Modes of Transportation in Urban Areas, Selected OECD Countries, 1996.



Source: Todd Litman. Quantifying the Benefits of Non-motorized Transportation For Achieving Mobility Management Objectives.[446]

Table 26 presents 2001 mode split data for selected European cities in the Netherlands, Denmark, Belgium, and Spain. The modal split data from Belgium only includes commute trips (this might partly explain the low percentage of trips on foot or cycling), while information from Denmark, the Netherlands, and Spain includes all kind of trips. Cities of small and medium sized populations (between 100,000 and 600,000) tend to have higher percentages of people using active forms of transportation, like walking and cycling. For example, Vitoria, Spain with a population of 215,000, has 66% of residents walking or cycling.

[446] Original Source: John Pucher and Christian Lefevre. *The Urban Transportation Crisis in Europe and North America*. (London: MacMillan Press, 1996).

Table 26. Mode Split in Selected European Cities (2001)

City	Foot and Cycle	Public Transport	Car	Inhabitants
Amsterdam (NL)	47 %	16 %	34 %	718,000
Groningen (NL)	58 %	6 %	36 %	170,000
Delf (NL)	49 %	7 %	40 %	93,000
Copenhague (DK)	47 %	20 %	33 %	562,000
Arhus (DK)	32 %	15 %	51 %	280,000
Odense (DK)	34 %	8 %	57 %	1,983,000
Barcelona (Spain)	32 %	39 %	29 %	1,643,000
L'Hospitalet (Spain)	35 %	36 %	28 %	273,000
Mataro (Spain)	48 %	8 %	43 %	102,000
Vitoria (Spain)	66 %	16 %	17 %	215,000
*Brussels (BE)	10 %	26 %	54 %	952,000
*Gent (BE)	17 %	17 %	56 %	226,000
*Brujas (BE)	27 %	11 %	53 %	116,000

Source: European Commission. ADONIS: *Analysis And Development Of New Insight Into Substitution Of Short Car Trips By Cycling And Walking*. (Luxembourg: Transport Research, Fourth Framework Programme Urban Transport, 1998).

Note: *Data from Belgian cities are based on commute trips only rather than all trips.

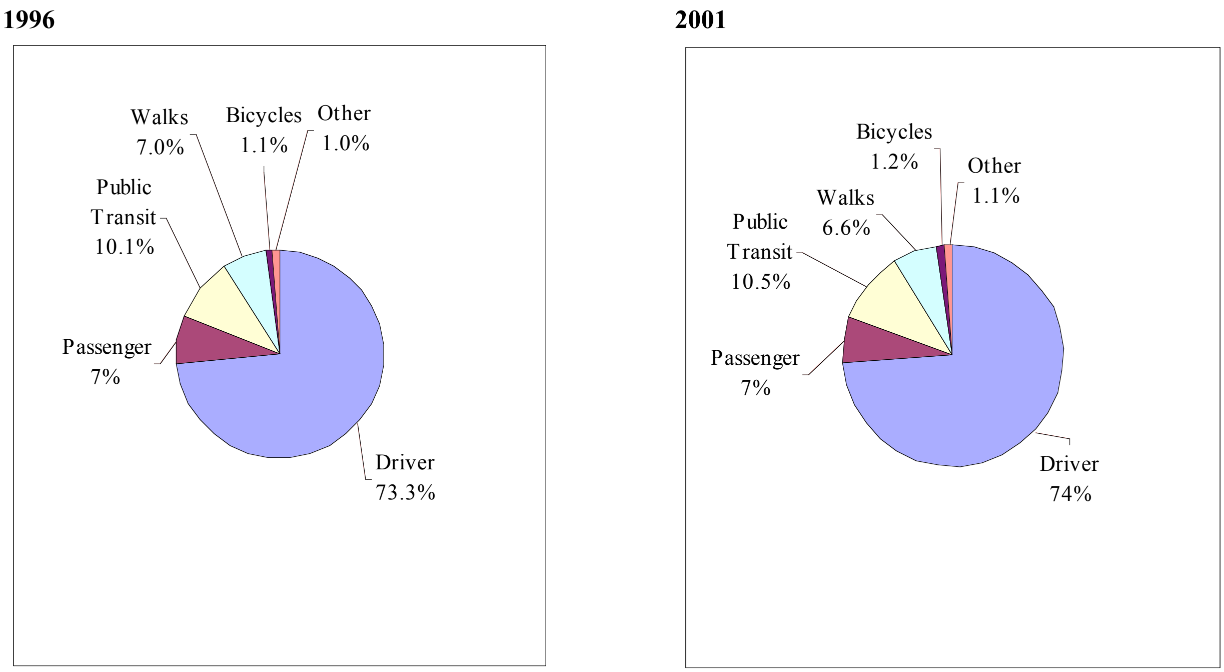
Trends: Canada

Statistics Canada's Census data on commuting patterns are useful in tracking changes in commuting to work by foot, bicycle, and public transit. However, a more comprehensive measure of pedestrian travel in particular would track non-work trips as well as those to work. The available evidence indicates that most walking and cycling journeys are undertaken for shopping or for some form of leisure, whereas commuting to work is among the least popular reasons for engaging in active forms of transportation.[447] Commuting statistics therefore reveal only very partial information on active transportation.

Figure 144 indicates how Canadian commute mode split changed between 1996 and 2001. In fact, little changed during this period. Approximately eighty percent of Canadians commute by automobile. In 2001, 74% of commuters were drivers and only 7% were passengers, indicating that the vast majority of Canadians commute to work alone, and that ride-sharing is very undeveloped in this country. In 2001, the remaining twenty percent of the modal share of transportation to work roughly broke down as follows: 10.5% used public transit, 6.6% walked, 1.2% cycled, and the remaining 1.1% used a motorcycle, taxi, or other form of transportation.

[447] Campbell, Richard and Margaret Wittgens. *The Business Case for Active Transportation*, p. 33. (Gloucester: Go for Green, 2004). www.goforgreen.ca/at/Eng/PDF/at_business_case.pdf

Figure 144. Canada: Modal Share (Percentage) of Transportation to Work (Over 15 years of Age), 1996 and 2001.



Source: Statistics Canada. Census 2001 Analysis Series.

Note: "Other" includes commuting to work by motorcycle, taxi, and other modes not listed.

More comprehensive figures for pedestrian travel are available from other sources, such as the Canadian Fitness and Lifestyle Research Institute (CFLRI). According to the CFLRI, in 2001, 41% of Canadians walked at least occasionally to work or school, or on errands.[448, 449] On average, those who commute by walking, do so for 153 days a year for about 40 minutes.[450] By comparison, Statistics Canada Census data indicate that only 6.6% of Canadians identify walking as their primary commute mode (see Figure 145 below).[451] The CFLRI data represent a broader picture of commuting than the Statistics Canada Census data because they include both active commuting to work and incidental commuting to shops, recreational facilities, and other destinations outside of travel to work. The CFLRI data also include commuting part of the way to a destination (for example walking or cycling to a transit stop), as opposed to the Statistics Canada Census data which focus on the main way to work.

[448] Cameron, C., C.L. Craig, T. Stephens and T.A. Ready. *Increasing Physical Activity: Supporting an Active Workplace*, p. 8. (Ottawa: Canadian Fitness and Lifestyle Research Institute, 2002). www.cflri.ca/pdf/e/2001pam.pdf

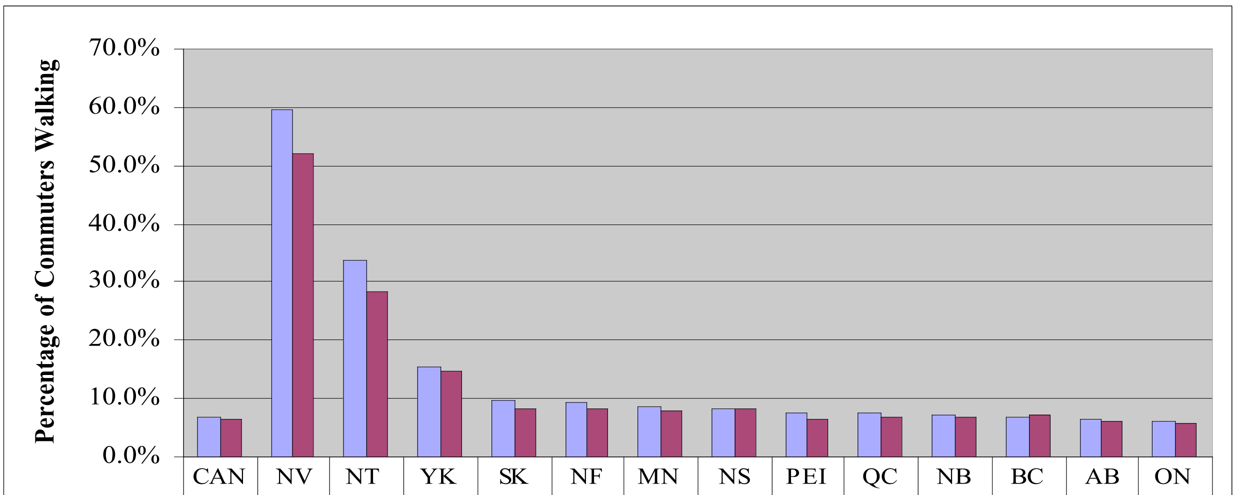
[449] The CFLRI surveyed 4,503 adults across Canada and included both the employed (full-time and part-time) and those not in the labour force (homemaker, student and retired).

[450] Cameron et. al. (2002, p. 8)

[451] The Statistics Canada figures were based on a 20% sample size of Canadian households, and included those who were 15 years of age who worked at some time during the census year, at a usual workplace address or who had no fixed workplace address. The data excluded institutional residents. (Statistics Canada. *2001 Census Dictionary – Population, Journey to Work: Mode of Transportation*, http://www12.statcan.ca/english/census01/Products/Reference/dict/pop080.htm)

While the data on pedestrian commuting from Statistics Canada are limited to those who travel by foot to work, they are used here not only because of their consistency, reliability, and very large sample size, but also because unlike the CFLRI survey, Statistics Canada provides data on both active and non-active modes of transportation, which allow comparisons of modal split and changes over time between modes. As well, outside Statistics Canada, data collection methods, definitions, and results vary widely between organisations, suggesting the need to standardise the protocols used.

Figure 145. Canada: Percentage of Commuters (Employed and Over 15 years of Age) Walking to Work, 1996 and 2001.



	CAN	NV	NT	YK	SK	NF	MN	NS	PEI	QC	NB	BC	AB	ON
1996	7.0%	59.6%	33.6%	15.4%	9.7%	9.2%	8.5%	8.3%	7.4%	7.4%	7.2%	6.9%	6.5%	6.1%
2001	6.6%	52.2%	28.4%	14.8%	8.3%	8.3%	8.0%	8.3%	6.4%	6.9%	6.7%	7.1%	6.2%	5.6%

Source: Statistics Canada. Census 2001 Analysis Series.

Note : The data sample is based on those who were 15 years of age who worked at some time during the Census year, at a usual workplace address or who had no fixed workplace address.

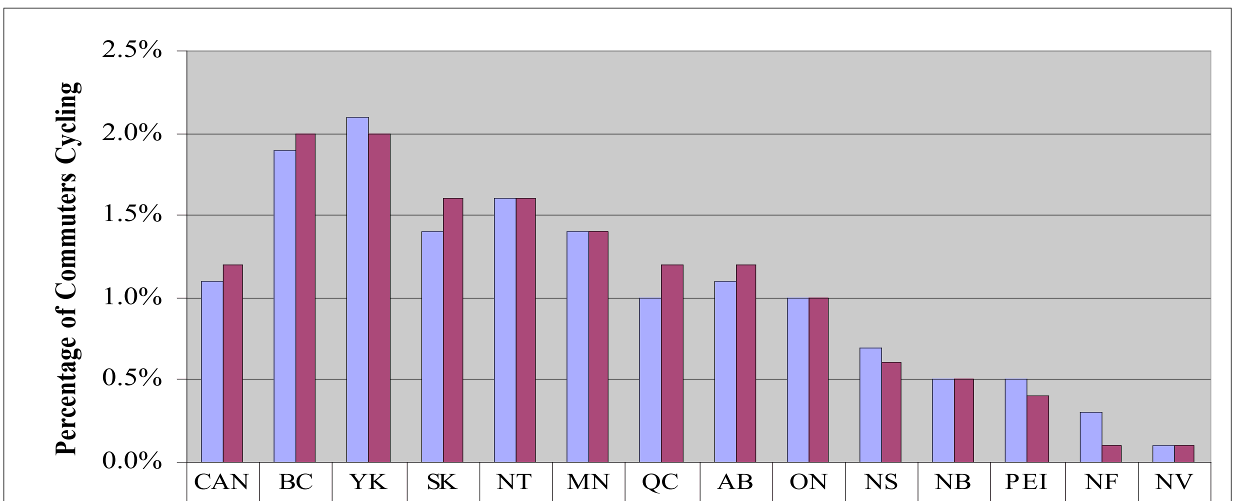
Figure 145 above, shows a slight decrease in the overall proportion of travel to work by foot in Canada: down from seven percent in 1996 to 6.6% in 2001. Walking to work is most prevalent in the three territories, with Nunavut reporting by far the highest proportion of such travel in 2001 (52%). British Columbia was the only province that recorded an increase in walking commutes. The largest proportional decrease in pedestrian commuting among the provinces was in Saskatchewan. But with 8.3% of Saskatchewan commuters still walking to work, the province remains above the national average, and among those with the highest rate of pedestrian commuting in the country.

Statistics Canada found that walking to work is most common among the youngest workers. Thereafter the incidence of pedestrian commuting declines steadily until age 44. After that, the likelihood of walking to work then rises uniformly with age. Women are more likely to walk to work than men.[452]

Figure 146 below shows a small increase in the overall proportion of commutes to work by bicycle: up from 1.1% in 1996 to 1.2% in 2001. These statistics include commuters who were 15 years of age who worked at some time during the census year, at a usual workplace address or who had no fixed workplace address This is much lower than the results obtained by the Canadian Fitness and Lifestyle Research Institute, which used a broader definition of commuting as noted, and which reported that 13% of adults (18 years and over) used a bicycle that year to commute to work or school, or for errands.[453]

Bicycle commuting decreased in all of Atlantic Canada except for New Brunswick, and the region has the lowest overall proportion of bicycle commuting in the country—at less than half the national average. The largest increases in bicycle commuting occurred in Quebec and Saskatchewan, while Alberta and British Columbia saw a slightly lower growth rate in this mode of travel. British Columbia and Yukon had the greatest proportion of workers commuting by bicycle in 2001 (two percent), while the lowest rates were in Nunavut and in Newfoundland and Labrador (0.1%). Men of all ages are more likely to bike to work than women, and commuting to work by bicycle tends to become less common with age for men and women alike.[454]

Figure 146. Canada: Percentage of Commuters (Employed and Over 15 years of Age) Cycling to Work, 1996 and 2001.



	CAN	BC	YK	SK	NT	MN	QC	AB	ON	NS	NB	PEI	NF	NV
1996	1.1%	1.9%	2.1%	1.4%	1.6%	1.4%	1.0%	1.1%	1.0%	0.7%	0.5%	0.5%	0.3%	0.1%
2002	1.2%	2.0%	2.0%	1.6%	1.6%	1.4%	1.2%	1.2%	1.0%	0.6%	0.5%	0.4%	0.1%	0.1%

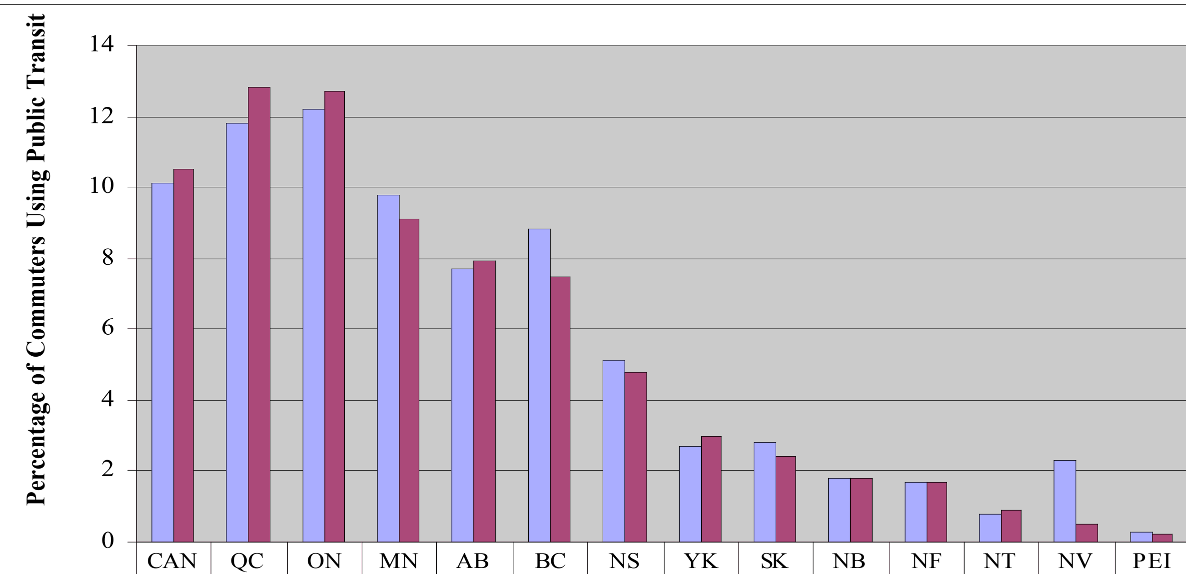
Source: Statistics Canada. Census 2001 Analysis Series.

452 Statistics Canada. *Where Canadians Work and How They Get There*, p. 12. (Ottawa: Minister of Industry, 2003b. Catalogue no. 96F0030XIE2001010). www12.statcan.ca/english/census01/Products/Analytic/companion/pow/pdf/96F0030XIE2001010.pdf
453 Cameron et al. (2002, p. 8).
454 Statistics Canada. (2003b, p.12).

There was a slight increase in the proportion of Canadians travelling to work by public transit: up from 10.1% in 1996 to 10.5% in 2001 (Figure 147). Commuting by this mode was most frequent in Ontario and Quebec (the most populous and densely populated provinces) where nearly 13% of commuters used public transit to get to work. British Columbia recorded the largest decline in transit use among provinces, although a bus strike in Vancouver during the last Census may partly explain the decrease.[455]

As indicated in Figure 147, the Atlantic region has the lowest rate of mass transit use for commuting in the country. Prince Edward Island, which until very recently did not have a public transit system, not surprisingly recorded almost no transit use. The next lowest rates of mass transit commuting in the country were in Newfoundland and Labrador and in New Brunswick (two percent). In Nova Scotia, less than five percent of commuters used public transit in 2001—less than half the national average.

Figure 147. Canada: Number of Commuters (Employed and Over 15 years of Age) Taking Public Transit to Work, 1996 and 2001.



	CAN	QC	ON	MN	AB	BC	NS	YK	SK	NB	NF	NT	NV	PEI
1996	10.1	11.8	12.2	9.8	7.7	8.8	5.1	2.7	2.8	1.8	1.7	0.8	2.3	0.3
2001	10.5	12.8	12.7	9.1	7.9	7.5	4.8	3	2.4	1.8	1.7	0.9	0.5	0.2

Source: Statistics Canada. Census 2001 Analysis Series.

Transit ridership declined throughout most of Canada during the early 1990s.[456] However, ridership has since increased, due to factors that include improved service, increased urbanization, and changing demographics.

455 Ibid., p.19.
456 Kohn, Harold. *Factors Affecting Transit Ridership*. (Statistics Canada, 2000, p.1). www.statcan.ca/english/research/53F0003XIE/53F0003XIE.pdf

Children Walking to School

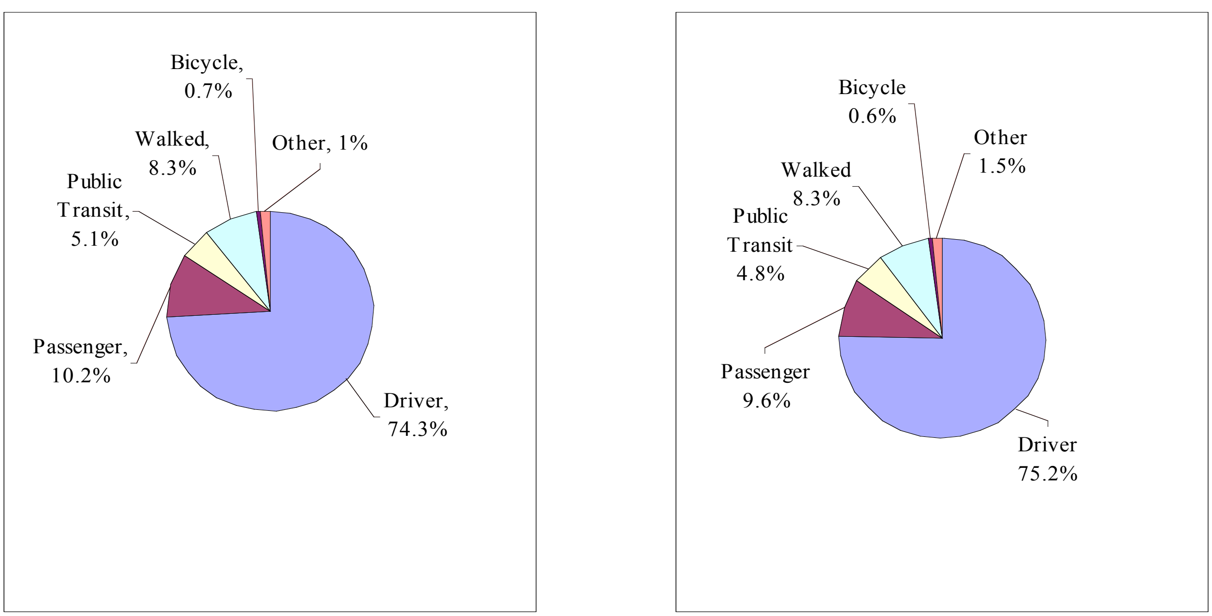
Twenty-eight percent of parents polled by the Canadian Fitness and Lifestyle Research Institute in 2000 reported that their children *always* commuted to school on foot or by bicycle.[457] A 1998 Go for Green study indicated that approximately 36% of Canadian children walked to school *most of the time*.[458] While providing an interesting addition to the Statistics Canada Census data, these data are currently insufficient to construct a national trend for children walking to school, particularly because they lack consistency in definition and collection methodology over time.

Trends: Nova Scotia

Nova Scotia's modal shares for commuting to work in 1996 and 2001 are presented in Figure 148. In both years, just under 85% of Nova Scotian commuters travel by automobile. Of these automobile commuters, in 2001, 89% were drivers and 11% were passengers. The portion of drivers increased during this period by 1.2% while the portion of passengers declined by 5.9%. In other words, there was a decline in carpooling to work between 1996 and 2001. In 2001, the remaining 15% of the commuter modal share roughly broke down as follows: 4.8% used public transit, 8.3% walked, 0.6% cycled and 1.5% used a motorcycle, taxi or other form of transport.

Figure 148. Nova Scotia: Modal Share (Percentage) of Transportation to Work (Over 15 years of Age), 1996 and 2001.

1996 **2001**



Source: Statistics Canada. 1996 Census of Population – Labour Force Activity, Occupation and Industry, Place of Work, Mode of transportation to Work, Unpaid Work, Provinces and Territories in Canada.

Note: "Other" includes commuting to work by motorcycle, taxi, and other modes not listed.

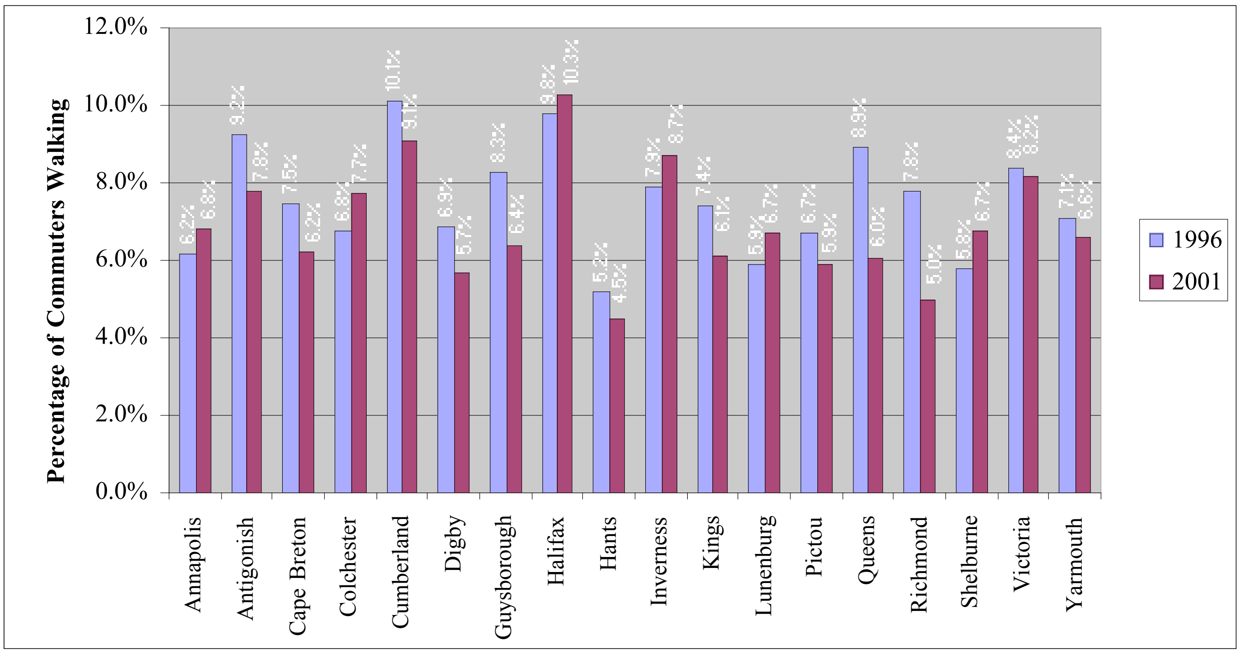
[457] Craig, C.L., C. Cameron, S.J. Russell and A. Beaulieu. *Increasing Physical Activity: Supporting Children's Participation*, p. 29. (Canadian Fitness and Lifestyle Research Institute, 2001). www.cflri.ca/pdf/e/2000pam.pdf

[458] Go for Green and Environics International. (1998, p. 14).

Commuting by Walking

From 1996 to 2001, there was essentially no change overall in the proportion of commuters walking to work in Nova Scotia: in both years about 8.3% used this mode. This is higher than the national average of 6.6% of Canadian commuters walking to work. Fortunately, the Census long form sample size is sufficiently large, being administered to one in every five Canadian households, to provide detailed intra-provincial information on commuting modes. Figure 149 shows trends for pedestrian commuting in each of Nova Scotia's 18 counties.

Figure 149. Nova Scotia: Percentage of Commuters (Employed and Over 15 years of Age) Walking to Work, by County, 1996 and 2001.



Source: Statistics Canada. 1996 Census of Population and 2001 Census of Population: Census Database, Labour Force Characteristics for Nova Scotia, Mode of Transportation to Work.[459]

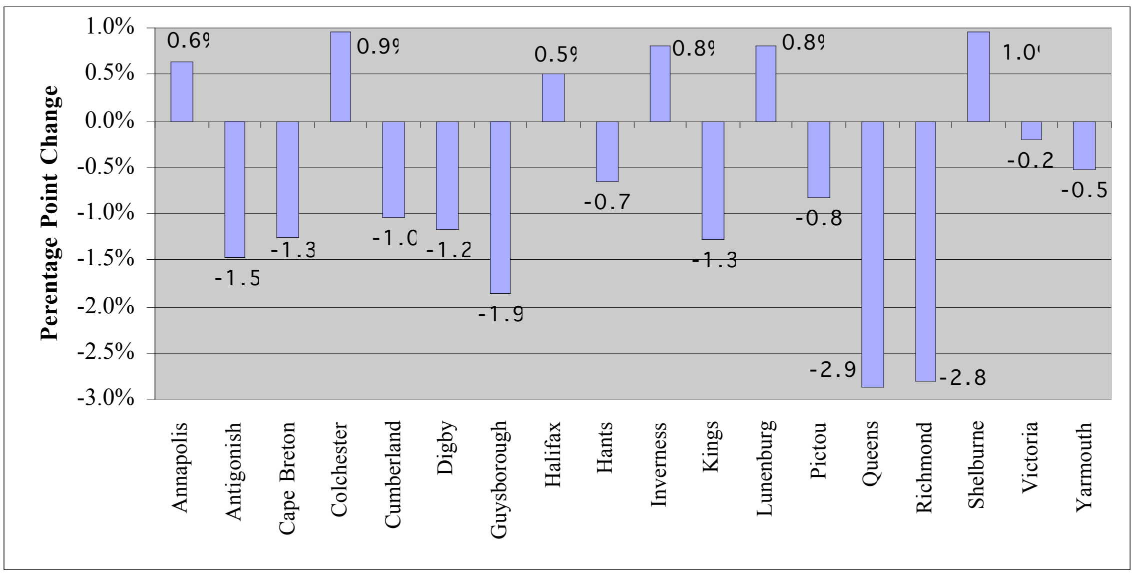
While the overall proportion of Nova Scotia commuters walking to work has remained relatively constant, the provincial average conceals major intra-provincial variations, both in trends over time and in proportions of workers walking to work. A decreasing trend in pedestrian commuting can be observed for several counties (this is more clearly demonstrated in Figure 150 below). There was a general drop in walking to work in 12 of the province's 18 counties: Hants, Richmond, Digby, Pictou, Queens, Kings, Cape Breton, Guysborough, Yarmouth, Antigonish, Victoria, and Cumberland. Of the six that experienced an increase in walking—Halifax, Lunenburg, Shelburne, Annapolis, Colchester, and Inverness—Halifax had the highest rate of pedestrian commuting in the province in 2001, no doubt as a result of its higher urban density.

[459] Obtained from http://estat.statcan.ca/cgi-win/CNSMCGI.EXE?Lang=E&DBSelect=SD16 on November 20, 2004.

More than one in ten Haligonians walk to work; more than double the proportion in Hants County, where only 4.5% walk to work (Figure 149 above).

Although walking to work declined in most parts of the province, the total numerical decline in those areas was counterbalanced by an increase in pedestrian commuting in urban regions with high population densities. In Halifax, for instance, walking increased its share of commuting from 9.8% in 1996 to 10.3% in 2001. When all destinations (not just work) are considered, a Go for Green survey found that approximately 30% of trips originating within the city's urban core were made by foot. This reflects the general pattern among Canadians in mid-sized cities (100,000-one million population) living in close proximity to routine amenities. In rural and smaller communities, by contrast, road trips are far more frequently required to access basic amenities and services.[460]

Figure 150. Nova Scotia: Percentage Point Change in Number of Commuters (Employed and Over 15 years of Age) Walking to Work, by County, 1996 and 2001.



Source: Statistics Canada. 1996 Census of Population and 2001 Census of Population: Census Database, Labour Force Characteristics for Nova Scotia, Mode of Transportation to Work.

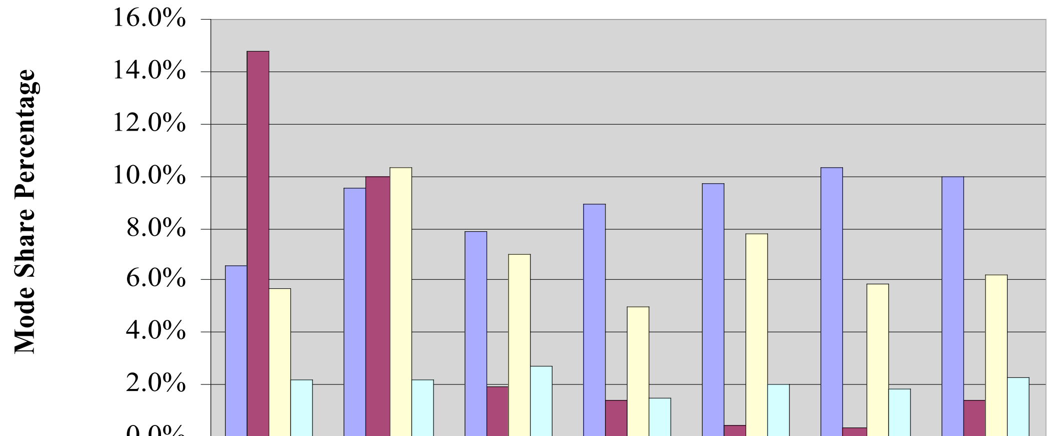
Figure 151 illustrates the modal splits for walking, public transit use, and carpooling in Nova Scotia's larger and smaller urban districts. A separate analysis of trends for Halifax Regional Municipality is included later in this report. The first set of columns in Figure 151 provides the average for these modes for all Canadian Census Metropolitan Areas (population more than 100,000). As seen below, Halifax has higher rates of walking and carpooling to work than other Canadian CMAs, and a lower rate of public transit use. The third set of data in the figure provides the average for these modes for all Canadian Census Agglomerations (populations between 10,000 and 100,000). Kentville, Truro, New Glasgow, and Cape Breton all have higher rates of carpooling to work than other CAs and a lower rate of public transit use. They all also

[460] Go for Green and Environics International. (1998, pp. 5-6).

have lower rates of walking to work, except in Truro, whose pedestrian commuting rate is slightly higher than the CA average.

As well, the proportions of commuters walking, carpooling, and using mass transit must be placed in the context of the overwhelming majority of commuters who still drive to work, which are: 71% of commuters in CMAs across Canada; 81% of commuters in CAs across Canada; 80% of commuters in Cape Breton Regional Municipality; 68% of commuters in the Halifax Regional Municipality; 83% of commuters in Kentville; 82% of commuters in New Glasgow; and 80% of commuters in Truro.

Figure 151. Nova Scotia: Commuting to Work (Employed and Over 15 years of Age) Mode Share for Walking, Carpooling, and Transit Use in Census Metropolitan Areas and Census Agglomerations (2001). [461]



	CMA AVG	Halifax	CA AVG	Kentville	Truro	New Glasgow	Cape Breton
Passenger in private vehicle	6.6%	9.6%	7.8%	8.9%	9.7%	10.3%	9.9%
Transit	14.8%	9.9%	2.0%	1.4%	0.4%	0.4%	1.4%
Walked	5.7%	10.3%	7.0%	5.0%	7.8%	5.9%	6.2%
Other	2.1%	2.2%	2.7%	1.4%	2.0%	1.8%	2.3%

Source: Statistics Canada. 2001 Census of Population: Census Database, Labour Force Characteristics for Nova Scotia, Mode of Transportation to Work.

Note 1: The Cape Breton Census Agglomeration includes Sydney, North Sydney, Sydney Mines, Glace Bay, and New Waterford and not Cape Breton island as a whole.

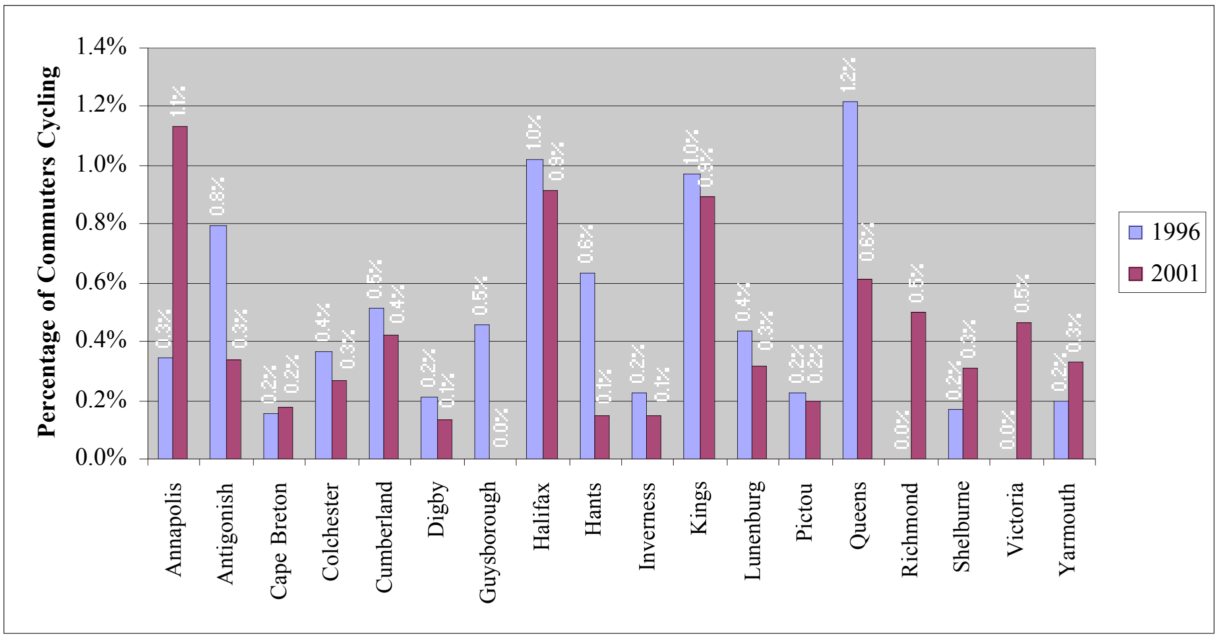
Note 2: "Other" includes commuting to work by bicycle, motorcycle, taxi, and other modes not listed.

[461] A *Census Metropolitan Area* is a region with an urban core with a population of at least 100,000; a *Census Agglomeration* is a region with an urban core with a population of at least 10,000. Statistics Canada. (2003a, p. 96).

Commuting by Bicycle

There was a slight decline in bicycle commuting in Nova Scotia: down from 0.7% of all travel to work in 1996 to 0.6% in 2001. County breakdowns are provided in Figure 152 below, but the proportions bicycling to work are miniscule throughout the province, nowhere exceeding the 1.1% of commuters who bicycled to work in Annapolis County. Distance, weather, and safety concerns may have an impact on the decision to bicycle, though it is not known to what extent these factors influenced the changes seen in Nova Scotia.[462]

Figure 152. Nova Scotia: Percentage of Commuters (Employed and Over 15 years of Age) Cycling to Work, by County, 1996 and 2001.



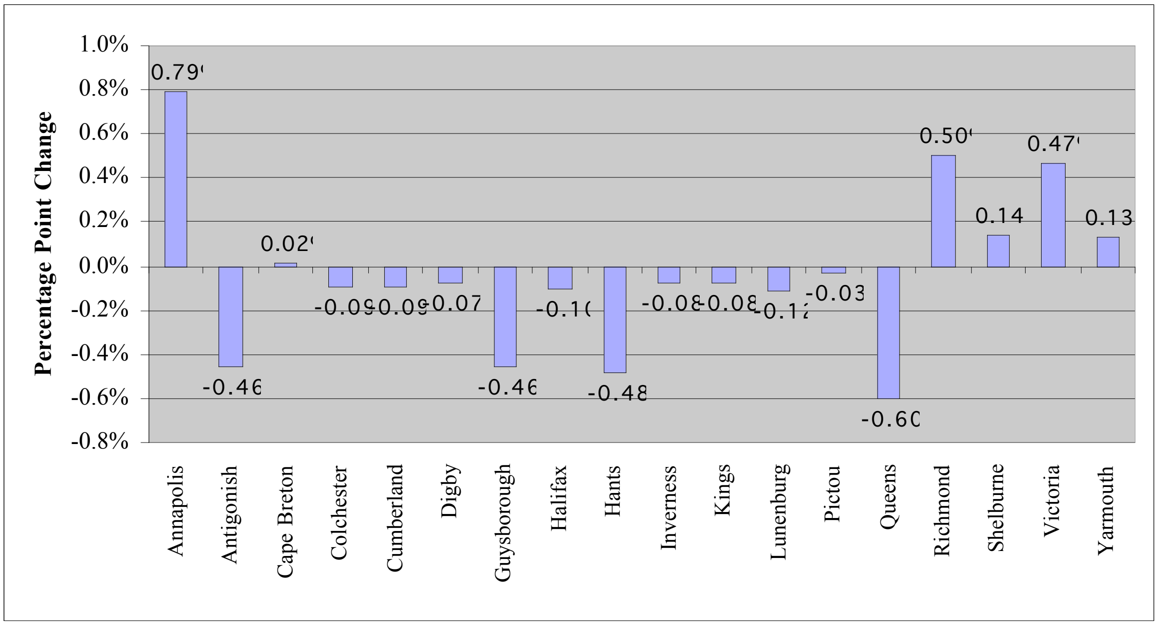
Source: Statistics Canada. 1996 Census of Population and 2001 Census of Population: Census Database, Labour Force Characteristics for Nova Scotia, Mode of Transportation to Work.

As illustrated in Figure 153 below, between 1996 and 2001 the trend in the share of commutes by bicycle in Nova Scotia was one of general decline in most regions of the province. Cycling to work decreased in 12 of 18 counties (Guysborough, Digby, Inverness, Hants, Pictou, Colchester, Lunenburg, Antigonish, Cumberland, Queens, Kings, and Halifax), increasing in the remaining six (Cape Breton, Shelburne, Yarmouth, Victoria, Richmond, and Annapolis).

It is should be noted, though, that the magnitude of the apparent changes may be exaggerated by the small numbers of people involved. In Queens County, for instance, bicycle commuting declined by half between 1996 and 2001. However, as there were a mere 50 commuting cyclists in Queens at the start of the period, this actually represents a shift in the activity of only two dozen or so individuals.

[462] Campbell and Wittgens. (2004, p. 45).

Figure 153. Nova Scotia: Percentage Point Change in Number of Commuters (Employed and Over 15 years of Age) Cycling to Work, by County, 1996 and 2001.



Source: Statistics Canada. 1996 Census of Population and 2001 Census of Population: Census Database, Labour Force Characteristics for Nova Scotia, Mode of Transportation to Work.

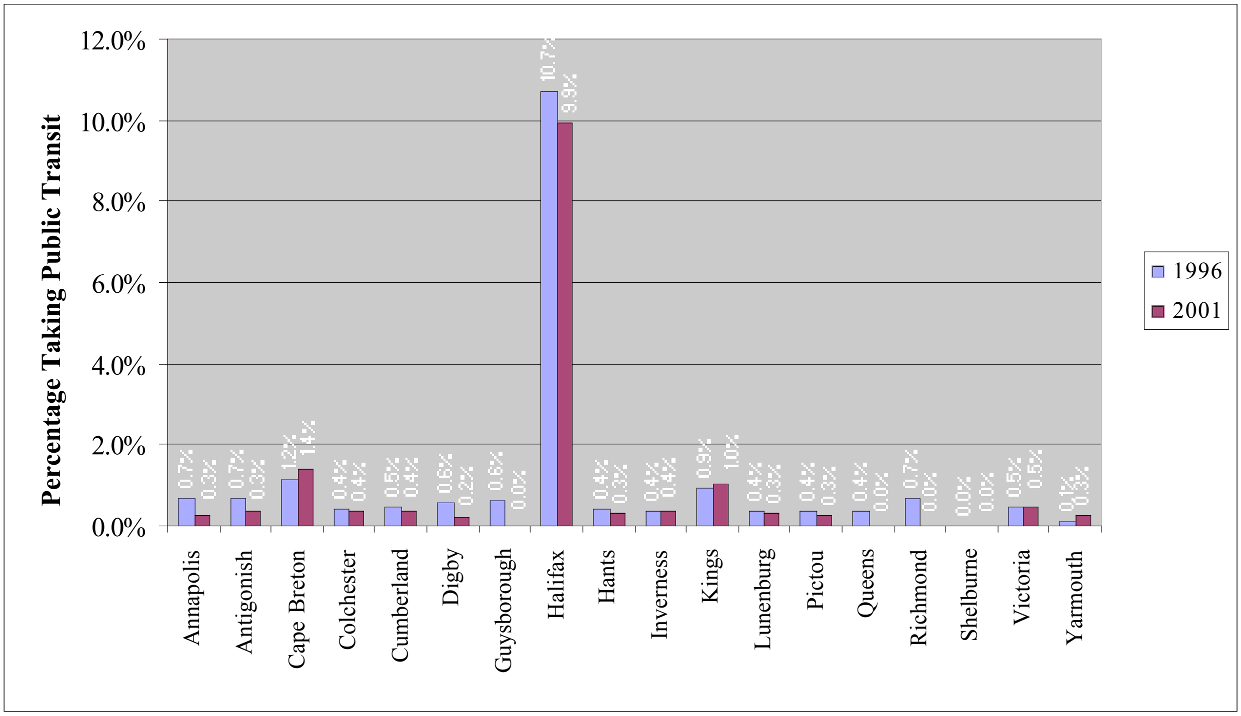
Commuting by Public Transit

Figure 154 shows a generally low level of commuting by public transit in Nova Scotia other than in Halifax Regional Municipality, where about 10% of commuters ride buses to work. In most Nova Scotia counties, public transit service exists only on a few longer distance inter-city routes. In no region of the province except for HRM does public transit commute mode split exceed two percent, and only in Cape Breton Regional Municipality and Kings County does it exceed one percent. Overall, transit use in Nova Scotia declined from 5.1% of commuters in 1996 to 4.8% in 2001. While transit use increased marginally in Kings County and Cape Breton Regional Municipality, it decreased in Halifax Regional Municipality, which has by far the largest public transit system in the province. Of the 18,020 public transit users in Nova Scotia in 2001, 16,905 (94%) are in HRM.

In the 1990s, HRM's Metro Transit boosted fares and reduced service hours, resulting in a drop in ridership of approximately 10% between 1991 and the close of the decade.[463] However, in 2004, Metro Transit reported that ridership had increased by 5.2% since 2002.[464] If this more recent increase is sustained, it should be reflected in the 2006 Census results that will be released next year. With Nova Scotia's largest transit system, changes in HRM have the greatest impact on the overall provincial mode share.

[463] IBI Group. *Metro Transit Strategy: Final Report*, p. 1. (Halifax: 2002).
[464] Gillis, John. "HRM—a transit growth zone." *Chronicle Herald*. December 14, 2004.

Figure 154. Nova Scotia: Percentage of Commuters (Employed and Over 15 years of Age) Taking Public Transit to Work, by County, 1996 and 2001.

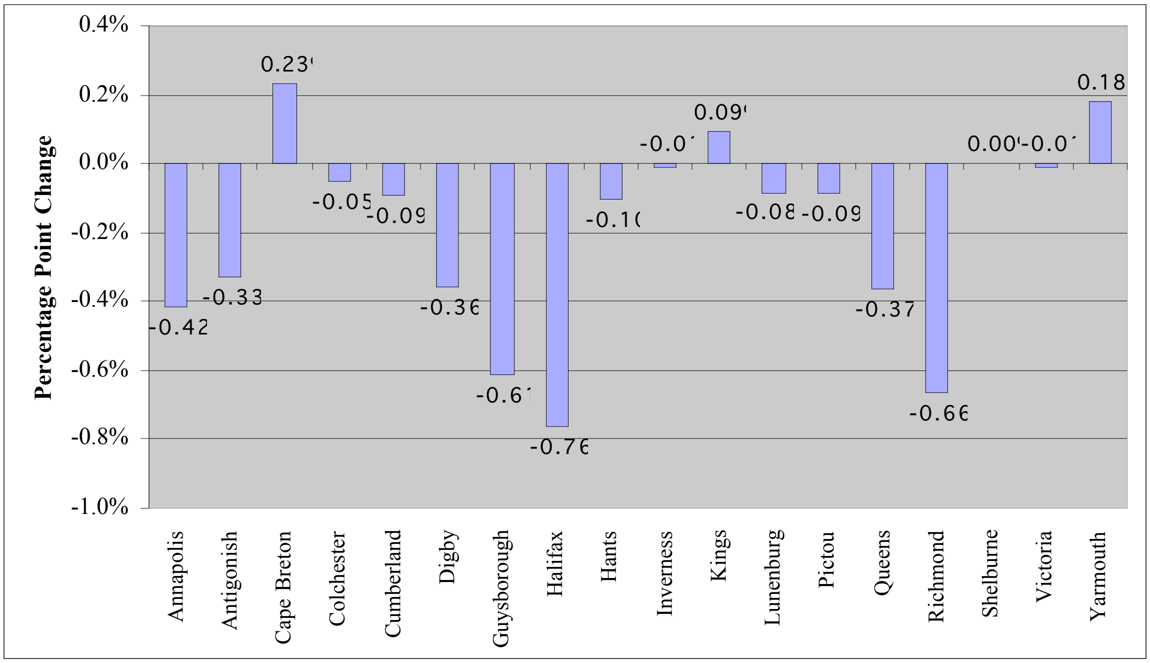


Source: Statistics Canada. 1996 Census of Population and 2001 Census of Population: Census Database, Labour Force Characteristics for Nova Scotia, Mode of Transportation to Work.

The actual *number* of people in Nova Scotia travelling by public transit increased marginally (by one-tenth of one percent), from 17,995 in 1996 to 18,020 in 2001.[465] However, Figure 155 shows a decreasing trend in the *proportion* of commutes to work by transit everywhere in the province except Cape Breton Regional Municipality, Kings County, and Yarmouth. Overall, as noted earlier, there was a decline in the proportion of Nova Scotian commuters using public transit to get to work, from 5.1% in 1996 to 4.8% in 2001. Because HRM has by far the most extensive public transit system in Nova Scotia as noted above, the 0.8 percentage point drop in transit use in HRM between 1996 and 2001 from 10.7% to 9.9%—the largest decline in the province—is almost entirely responsible for the province-wide decline in transit use.

[465] Statistics Canada. Employed Labour Force by Sex, showing Mode of Transportation to Work, for Canada, Provinces and Territories, 1996 Census (20% Sample Data) - *Nation* tables. (Catalogue no. 93F0020XCB1996004).

Figure 155. Nova Scotia: Percentage Point Change in Number of Commuters (Employed and Over 15 years of Age) Taking Public Transit to Work, by County, 1996 and 2001.



Source: Statistics Canada. 1996 Census of Population and 2001 Census of Population: Census Database, Labour Force Characteristics for Nova Scotia, Mode of Transportation to Work.

Land use mix and urban design have been identified as important factors influencing public transit use, and residential and employment density are also considered to be key determinants of transit demand.[466] Further, research suggests that the decision to travel by foot or bicycle in order to reach public transit stops can be influenced not only by distance, but also by the quality of design, and mix of land uses, along transit corridors.[467] As well, the availability of bicycle lanes and of bicycle racks at key transit stations influences bicycle use to reach transit stops, while dedicated bicycle lanes can also make cycling safer, especially when the lanes are physically separated from major roadways.

Although many Canadians already live within walking or cycling distance of routine amenities, including work, school, shopping, recreational facilities, and public transit corridors, many do not avail themselves of active transportation and transit opportunities because of poor design features. Many European countries and cities, with much higher rates of transit use and of walking and bicycle use to reach transit stops than in North America, provide excellent models of urban design features conducive to transit use and active transportation modes.

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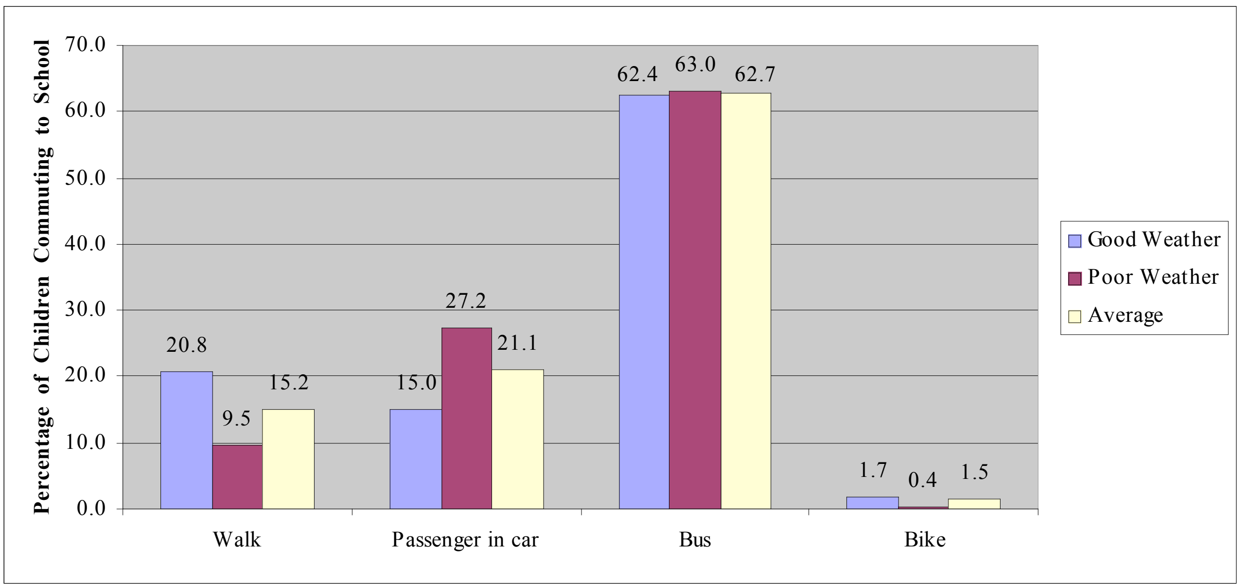
466 Halifax Regional Municipality—Regional Planning. *Transit and Land Use Form*, p.2. (2002). www.halifax.ca/regionalplanning/publications/TransitLandUseForm.pdf

467 Transportation Association of Canada. Urban Transportation Indicators—Survey 2. (1999). www.tac-atc.ca/english%5Fold/productsandservices/ui/intro.asp

Children Walking to School

As noted earlier, statistics were unavailable to develop a national or provincial time-series of children's modes of commuting to school. However, several recent studies provide useful data. Figure 156 illustrates unpublished results from a survey of Nova Scotian children conducted for the Nova Scotia Sport and Recreation agency of the NS Office of Health Promotion (OHP)[468]. The following results were kindly made available to **GPI***Atlantic* specifically for this report.[469] This study found that, across the province, approximately 17% of children (grades 3, 7, and 11) walk or bicycle to school. About 63% take the bus, and 21% are driven to school by car.

Figure 156. Nova Scotia: Children Commuting to School, by Mode, 2001.



Source: Personal Communication with Michael Arthur, Director of Community Development, Nova Scotia Office of Health Promotion—Sport and Recreation Division. (November, 2004).[470]

The Physical Activity Monitor 2000 of the Canadian Fitness and Lifestyle Research Institute (CFLRI) reported that in Nova Scotia, 24% of children aged five to seventeen walk or bicycle to school each day.[471] This is lower than the national average of 29% reported by the CFLRI, probably due to the higher proportion of Nova Scotians living in rural areas. As noted earlier,

[468] This has since become the Department of Health Promotion and Protection
[469] Arthur, Michael. Director of Community Development, Nova Scotia Office of Health Promotion—Sport and Recreation Division. (Personal communication: November, 2004). The research was done by Phil Campagna, Gary Ness, Roy Rasmussen, Jack Porter and Laurene Rehmann for the NS Office of Health Promotion. Campagna et al. published their findings in 2002 under the title *Physical Activity Levels in Children and Youth in the Province of Nova Scotia*; but the final report does not discuss walking to school specifically. However, the original field findings were extracted by Laurene Rehmann, and made available to **GPI***Atlantic* by Michael Arthur, Director of Community Development for the Office of Health Promotion.
[470] See previous footnote for further details on this study.
[471] Craig et al. (2001, p. 91).

different methods, definitions, and sampling groups used by different organisations have produced widely differing results, so CFLRI results are not comparable to those of the OHP study above.

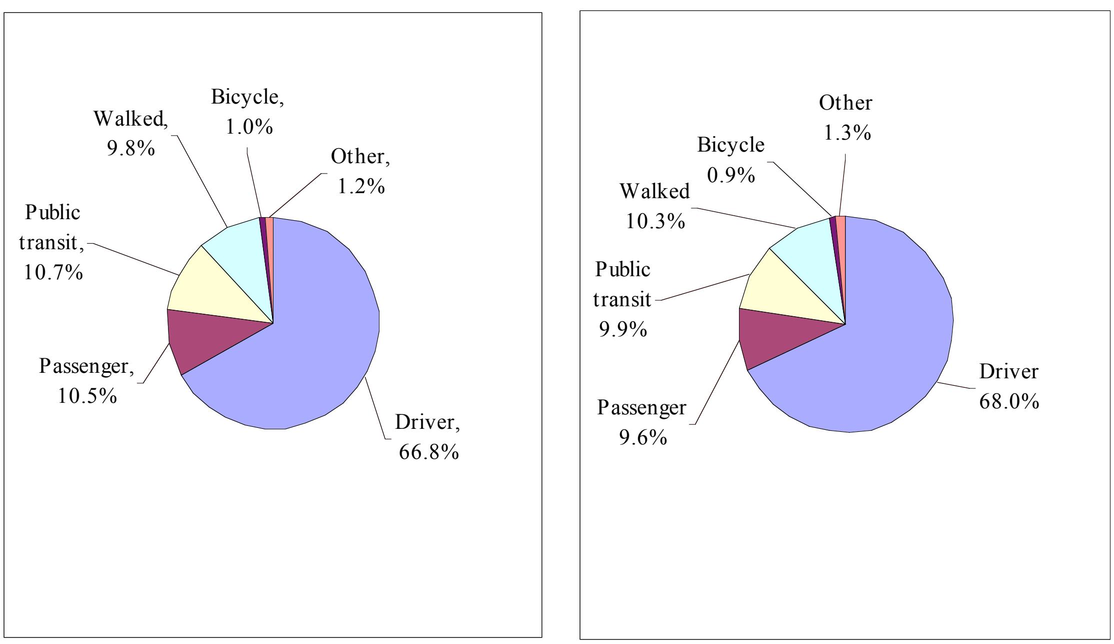
Trends: Halifax

Halifax Regional Municipality is the largest employment locus in Atlantic Canada. As a result, commuting activity in HRM has a strong impact on the overall transportation trends for the province. In 2001, the Halifax Census Metropolitan Area accounted for just over 45% of the employed labour force in Nova Scotia, up from about 43% in 1996.

The proportion of Nova Scotians commuting by foot is greatest in Halifax, where there was an increase from 9.8% in 1996 to 10.3% in 2001 (Figure 157), compared to the provincial average of 8.3% and the national average of 6.6%. Transit use in Halifax declined from 11% to 10% and carpooling (passenger in car) from 10.5% to 9.6%. Travel to work by bicycle also decreased slightly, from 1% in 1996 to 0.9% in 2001. Car driving dominates the system, with more than two-thirds of Halifax commuters still driving to work. In fact, this percentage increased marginally from 67% in 1996 to 68% in 2001.

Figure 157. Travel to Work (Employed and Over 15 years of Age) by Mode of Transportation, Halifax CMA, 1996 and 2001.

1996 **2001**



Source: Statistics Canada. 1996 Census of Population and 2001 Census of Population: Census Database, Labour Force Characteristics for Nova Scotia, Mode of Transportation to Work.

10.2 Commuting Distance

Trends: Canada

The total number of people commuting both in Canada and in Nova Scotia increased during the period 1996-2001, due both to population increase and economic expansion. Additionally, however, the median trip distance to work rose from seven kilometres in 1996 to 7.2 kilometres in 2001 (Figure 158), probably due to continued decline in urban density (Figure 137), and growth of suburban and exurban development. In 2001, Ontario had the highest median commuting distance in the country, at 8.2 km.

Although Nova Scotia maintained one of the highest commuting distance averages in the country, the number did drop from 8.3 km in 1996 (the highest in Canada) to 7.8 km in 2001 (the second highest). New Brunswick and Prince Edward Island also showed slight decreases in median commuting distance, while all other provinces showed increases in commuting distance or remained relatively stable.

The reason for the declines in commuting distance in the three Maritime provinces may be related to their higher rural populations, and continued emigration from rural areas to the urban centres of Halifax, Charlottetown, and southern New Brunswick (Moncton, Saint John, Fredericton). Populations in HRM, Moncton, and Charlottetown grew by 4.7%, 3.7% and 2%, respectively, while the rest of their respective provincial populations declined between 1996 and 2001. Nova Scotia's population declined by 0.1%, New Brunswick's by 1.2%, and Prince Edward Island's by 0.5%, during the same period.[472, 473, 474]

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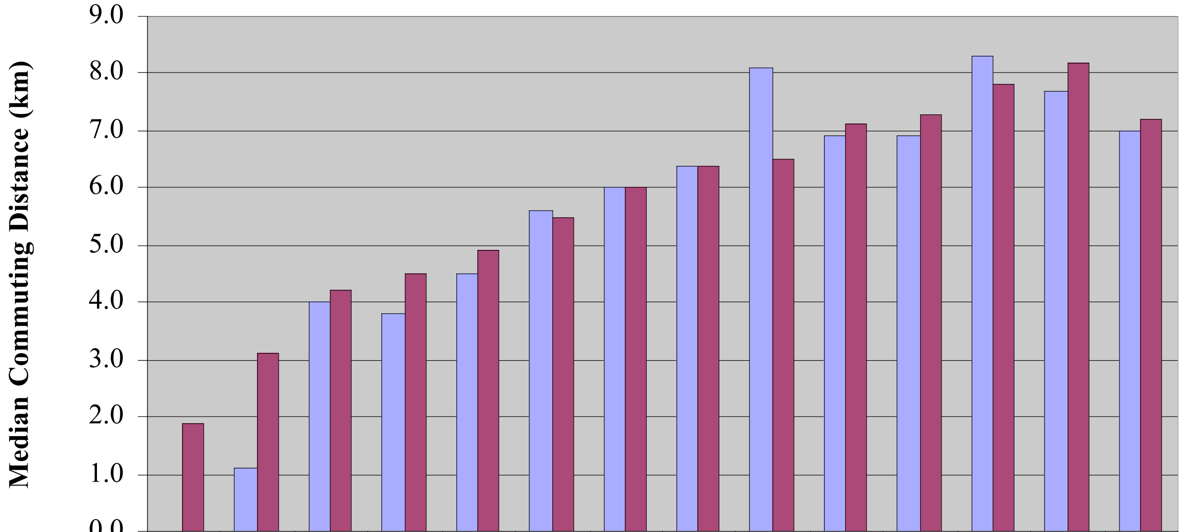
[472] Statistics Canada. *Community Highlights for Halifax (Regional Municipality).* www12.statcan.ca/english/profil01/CP01/Details/Page.cfm?Lang=E&Geo1=CSD&Code1=1209034&Geo2=PR&Code2=12&Data=Count&SearchText=halifax&SearchType=Begins&SearchPR=01&B1=All&Custom= Accessed March 2006.

[473] Statistics Canada. *Community Highlights for Moncton (Census Agglomeration).* www12.statcan.ca/english/profil01/CP01/Details/Page.cfm?Lang=E&Geo1=CMA&Code1=305__&Geo2=PR&Code2=13&Data=Count&SearchText=moncton&SearchType=Begins&SearchPR=01&B1=All&Custom= Accessed March 2006.

[474] Statistics Canada. *Community Highlights for Charlottetown (Census Agglomeration).* www12.statcan.ca/english/profil01/CP01/Details/Page.cfm?Lang=E&Geo1=CMA&Code1=105__&Geo2=PR&Code2=11&Data=Count&SearchText=charlottetown&SearchType=Begins&SearchPR=01&B1=All&Custom= Accessed March 2006.

Figure 158. Median Commuting Distance for the Population Employed and Over 15 years of Age, by Canadian Province/Territory, 1996 and 2001 (km).



	NV	NT	SK	YK	NF	PEI	MN	BC	NB	AB	QC	NS	ON	CAN
1996		1.1	4.0	3.8	4.5	5.6	6.0	6.4	8.1	6.9	6.9	8.3	7.7	7.0
2001	1.9	3.1	4.2	4.5	4.9	5.5	6.0	6.4	6.5	7.1	7.3	7.8	8.2	7.2

Source: Statistics Canada. 1996 Census of Population and 2001 Census of Population: Census Database, Labour Force Characteristics for Nova Scotia, Mode of Transportation to Work.

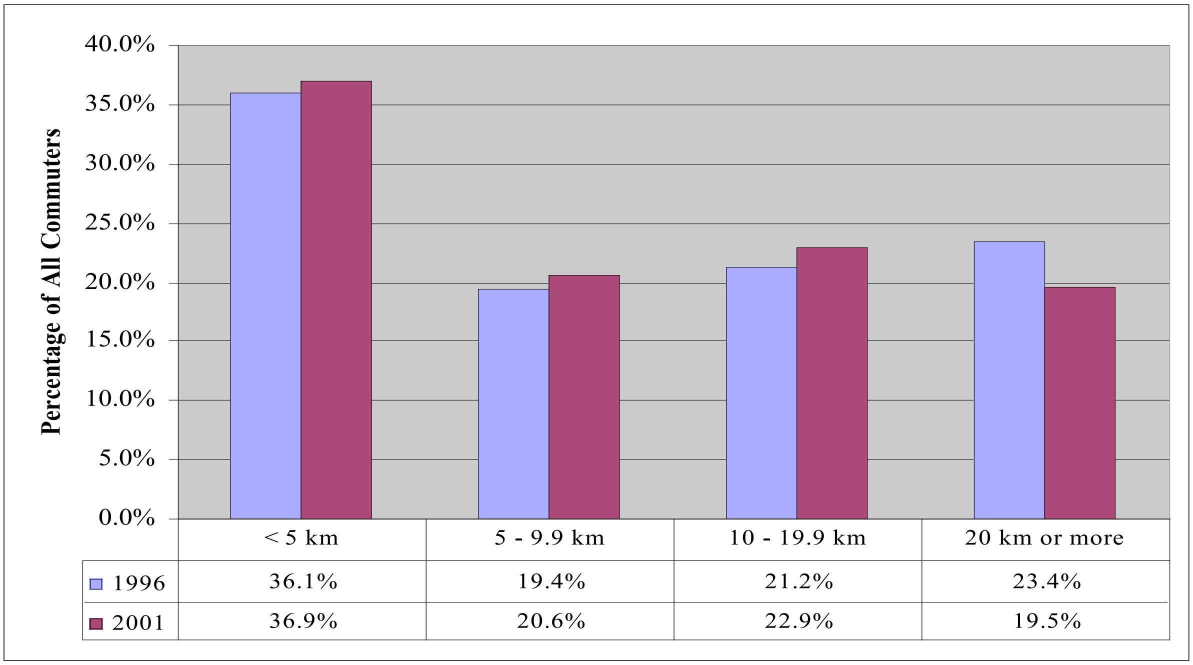
Trends: Nova Scotia

In 2001, more than half (58%) of all commutes in Nova Scotia were under 10 kilometres. As can be seen from Figure 159, there was a slight increase in short haul commutes (less than 5 km) between 1996 and 2001, which account for 37% of all commutes. Shorter distances provide opportunities for travel by active modes (walking and bicycling), at least in good weather.

As already noted, two-thirds of Canadians live within 30 minutes walk of routine destinations such as work. According to the Go for Green and Environics survey, 88% of Atlantic Canadians would like to walk more and 54% would like to bicycle more than they currently do.[475] This suggests the potential for a shift to active modes of transportation through improvements in urban design, addition of bicycle lanes and attractive pathways, and other features that would encourage active transportation.

[475] Go for Green and Environics International. (1998, pp. 7 and 12).

Figure 159. Average Commuting Distances in Nova Scotia, 1996 and 2001 (as a percentage of all commutes).



Source: Statistics Canada. 1996 Census of Population and 2001 Census of Population: Census Database, Labour Force Characteristics for Nova Scotia, Mode of Transportation to Work.

There were also increases in the proportion of medium distance commutes, with the largest increase among all the categories in the proportion of 10-20 km commutes (up from 21% of all commutes in 1996 to 23% in 2001). This is probably due largely to the continued decline in urban density and spread of suburban and exurban sprawl.

However, there was a significant decline in long distance commuting (20 kilometres or greater), which dropped from about 23.4% of all commutes in 1996 to 19.5% in 2001, and is entirely responsible for the overall decline in the median commuting distance in Nova Scotia. This drop in long distance commuting reflects continued rural to urban migration and the growth in HRM's population by 4.7% from 1996 to 2001 as compared to the rest of the province whose overall population declined by 0.1% during this time period.[476]

Slightly more than five percent of Halifax Regional Municipality's workforce resides elsewhere in Nova Scotia: a higher ratio than in any other Census Metropolitan Area in eastern Canada. Consequently there is an elevated commuting flow between HRM and the surrounding counties of Colchester, Hants, Kings, Lunenburg, and even Pictou. However, there was no change in the proportion of long distance commuting within HRM proper; and the median commuting distance

[476] Statistics Canada. *Community Highlights for Halifax.* www12.statcan.ca/english/profil01/CP01/Details/Page.cfm?Lang=E&Geo1=CSD&Code1=1209034&Geo2=PR&Code2=12&Data=Count&SearchText=halifax&SearchType=Begins&SearchPR=01&B1=All&Custom= Accessed March 2006.

for the municipality (6.3 km) also remained constant from 1996 to 2001. This suggests that the decline in long distance commuting may be an indication that former commuters from outside HRM are relocating to HRM. This supports the hypothesis outlined above that the decline in median commuting distance in the Maritimes is probably due to continued rural emigration.[477]

On the surface, a decrease in long distance commuting is a move towards a more sustainable transportation system, as less overall travel is required to reach basic services, such as work, school, or opportunities for recreation. However, a closer examination of settlement patterns and new growth in the province provides further evidence that the shifts in commuting distance patterns are actually the result of continued rural emigration, accompanied by increased suburban and exurban sprawl.

Table 27 shows that, between 1996 and 2001, the suburban and exurban areas of HRM experienced stronger population growth than the urban core, providing further evidence of the spread of sprawl. Suburban population growth in HRM increased by nearly five percent and the outlying western rural (exurban) "commutershed" by 17%, while the urban core grew by less than two percent, and the truly rural parts of HRM saw a decline in population.

Table 27. Population Growth in the Halifax Regional Municipality.

Area	1996 Population	% of HRM Total Population	2001 Population	% of HRM Total Population	% Change (1996-2001)
Urban Core	95,100	28	96,600	27	2
Suburban	168,300	49	176,500	49	5
Rural Commutershed West	31,100	9	36,300	10	17
Rural Commutershed East	38,600	11	40,000	11	4
Rural	9,900	3	9,700	3	-2
HRM Total	**343,000**	**100%**	**359,100**	**100%**	**5%**

Source: Regional Planning—Halifax Regional Municipality. Baseline Report—Population, Housing, Employment, Journey-to-Work.

Notes: *"Urban core*" comprises the Halifax Peninsula and Dartmouth area inside the Circumferential (#111) Highway. *"Suburban"* includes areas of concentrated development surrounding the urban core, including such communities as Beaverbank, Sackville, Bedford, Timberlea, Herring Cove, Eastern Passage, and Cole Harbour. *"Rural Commutershed West"* includes less concentrated areas of development to the west of the Suburban subarea, and the remainder of HRM's western region. It includes communities such as Lucasville, Hammonds Plains, Tantallon, Peggy's Cove, Sambro, and Hatchet Lake. *"Rural Commutershed East*" includes the less concentrated areas of development to the east of the Suburban subarea and includes communities as far east as East Jeddore and Musquodoboit Harbour, Oakfield and the International Airport in the north, and Lawrencetown in the south of the eastern commutershed. "*Rural"* includes the remainder of HRM's eastern region east of the Rural Commutershed East subarea. It includes communities such as Enfield, Lantz, Clam Bay, Sheet Harbour and Ecum Secum.

[477] Service Nova Scotia. Population Growth Components, Commuting Patterns, slide 9. (No date [a]). www.gov.ns.ca/snsmr/muns/plan/presentation/central_growth_3.ppt Accessed December, 2004.

While the overall population of HRM grew by five percent, the number of Nova Scotians living in smaller and mid-sized towns in the province declined—a trend that began in the mid-1970s. This decrease has been accompanied by long-term population growth in the rural commutershed districts surrounding HRM.[478] That population shift, in turn, is linked to stronger employment growth in HRM, where the unemployment rate is below the national average and less than half that of Cape Breton, for example. The particular population shifts and settlement patterns observed suggest a pattern of overall increase in low density exurban and suburban settlement in the Halifax region, accompanied by ongoing emigration from smaller towns and more distant rural areas in the province as a whole.

This type of "sprawl" development, which has led to the major decline in urban density observed in Figure 137 above, tends to consume more land while increasing distances between destinations. It is also difficult to serve viably with public transit, and fosters a greater reliance on travel by personal vehicle. Growth in low density development does not enhance access to basic services, because it limits the modal options available to access work, school, emergency and health services, food, shopping, and recreation. It also increases the environmental costs of accessing those goods and services.

Figure 148 above highlights the increase in the overall proportion of commuting by private vehicle that is the almost inevitable consequence of the population shifts and settlement patterns described above. The percentage of Nova Scotians driving to work by car, truck, or van increased slightly from 1996 to 2001, while the proportion of commuters travelling to work as passengers declined. Though the shifts are small, these two trends are almost certainly linked by the fact that carpooling, too, is more difficult in low-density areas.[479] In general, Nova Scotians are still more likely both to drive to work, and to carpool, than are other Canadians, but current settlement trends indicate that Nova Scotian patterns may converge with Canadian ones.

On the basis of all the evidence noted above, it seems that drivers' share of commutes in Nova Scotia has increased concurrently with growth in the exurban and suburban districts of HRM. As noted, development in such areas is at lower densities than in urban regions and does not foster access to basic services by a variety of transportation modes. Destinations are difficult to reach by foot, bicycle, or public transit (which is less viable in lower density areas), offering residents little choice but to drive. Even carpooling is more difficult than in higher density areas. This type of low-density suburban and exurban settlement also covers more land, makes provision of infrastructure (sewerage, utilities, roads, etc.) and services (schools, emergency response, etc.) more expensive, consumes more energy, and has higher environmental costs.[480] For all these reasons, low density suburban and exurban development is not consistent with a move towards a sustainable transportation system.

Finally, one other factor that may have affected the change in observed commuting habits is a slight change in Nova Scotia's employment profile between 1996 and 2001. The growth in the

[478] Service Nova Scotia. Urban Centres, high Density Rural, Urban vs. Rural Growth, slide 12. (No date [b]). www.gov.ns.ca/snsmr/muns/plan/presentation/rural_vs_urban_1.ppt Accessed December, 2004.
[479] Statistics Canada. (2003b, p. 29).
[480] Gurin, David. *Understanding Sprawl—A Citizen's Guide.* (Vancouver: David Suzuki Foundation, 2003, p. 5). www.davidsuzuki.org/files/Climate/Ontario/Understanding_Sprawl.pdf

number of people working from home, outside the country, or with no usual workplace outpaced the increase in employees commuting to a usual place of work. It is not clear whether and how this employment shift affected the observed changes in commuting habits between the 1996 and 2001 Censuses, or whether these groups consist largely of new workers who were not included in the 1996 Census commute figures. Though no conclusion is reached here, the employment shift is worth noting because it has the potential to reduce the absolute number of commuters, but may increase other types of travel if it leads to more dispersed development patterns.

Conclusion

This chapter evaluates basic access (the ease with which people can reach important services and activities) using commute mode split as an indicator. Increased automobile travel is considered to reduce sustainability, while increased use of alternative modes is considered to support sustainability, since it indicates that the transportation system is more diverse, and so provides relatively good service to non-drivers. Two indicators offer no clear trends in Nova Scotia:

1) Walking commute mode share remained relatively constant at about 8.3% from 1996 through 2001.
2) It was not possible to determine any change in how children commute to school. Though some snapshot data were available for a single year, insufficient data were available to assess trends over time.

The following two indicators, however, suggest a clear, if minor, move away from a more sustainable transportation system between 1996 and 2001:

1) There was a decline in the proportion of commuters travelling to work by public transit, although ridership has increased in more recent years.
2) The total number of bicycle trips to work decreased, and the mode's share fell, although the numbers are too small to indicate a major change.

During this period the provincial median commuting distance declined from 8.3 to 7.8 kilometres, initially suggesting movement towards sustainability. However, a closer analysis of commuting patterns and distances indicates that the decline is likely due almost entirely to rural emigration, and to rural Nova Scotians moving into Halifax Regional Municipality. In fact, the increase in 10-20 km commutes in the province, along with the evidence on settlement patterns and declines in urban density, suggest a trend towards greater suburban and exurban sprawl.

This is supported by evidence indicating an increase in the share of people driving to work, and a decline in carpooling. Population has grown fastest in the suburban and exurban regions of HRM, where access to basic services is more limited than in the more densely populated urban core, and where a much smaller range of transportation options is available. Sprawl makes walking, bicycling, public transit and carpool commuting less viable, and driving to work by private automobile a virtual necessity. In this regard, the observed trends on basic access indicate movement away from sustainability.

Chapter 11. Access to Public Transportation

Public transit is relatively efficient in its use of resources, including vehicles, road and parking facilities, and energy. It also provides basic mobility and provides a catalyst for more compact, accessible land use development. For these reasons, increased access to public transit is considered to contribute to sustainability.[481]

The Indicator

This indicator considers the portion of residents living within 500 metres of transit services—a distance generally considered to be easily walkable.[482] This indicator tends to reflect other sustainability factors. For example, access to public transit can be enhanced by land use and development practices that increase density, clustering of services, and walkability, and that improve parking management and attention to urban design with a view to creating multi-modal communities.[483] These are some of the key considerations in HRM's current long-term regional planning strategy.[484]

The Centre for Sustainable Transportation developed an indicator of the national modal split of passenger travel, which included travel by passenger road vehicles, air, urban transit, school bus, inter-city bus, and train, but did not include water-based movement. CST reported a 15% increase in aggregate motorized transportation between 1990 and 2000, while the population of Canada grew by 11% during the same period, indicating an overall increase in per capita travel by motorized transport. As part of this increase, the CST noted a small rise in the share of travel by urban transit and inter-city bus—from eight percent of total motorized transportation in 1990 to 8.6% in 2000—but the overall share of travel by transit remained relatively stable at about nine percent during this period.[485] This **GPI***Atlantic* report's national trends in modal share of road passenger travel (Figure 16) as well as national trends in transit use as a percentage of total road travel (Figure 18), based on passenger-km travelled, are comparable to the trends reported in CST's indicators.

The comparable transport activity indicators for Nova Scotia in this GPI study have revealed that public transportation (urban transit and inter-city bus) comprised less than four percent of road passenger travel in Nova Scotia (less than half the national average), and that this proportion fell

[481] United Nations Environment Programme/GRID-Arendal. Encyclopedia of Urban Environment-Related Indicators—Access to public transport. www.ceroi.net/ind/display.asp?indID=74 Accessed November, 2004.
[482] Cervero, Robert. *Transit Villages in California: Progress, Prospects, and Policy Reforms*. (Working Paper: Institute of Urban and Regional Development, University of California at Berkeley, 1998). As noted below, the Cape Breton and Kings transit authorities have somewhat different definitions and standards of acceptable transit access than the 500 m standard that is referenced here and used by Metro Transit in HRM.
[483] Transportation Association of Canada. Urban Transportation Indicators—Survey 2. (1999a). www.tac-atc.ca/english%5Fold/productsandservices/ui/intro.asp
[484] Halifax Regional Municipality—Regional Planning. (2002, p. 6).
[485] Gilbert et al. (2002, p. 54).

somewhat in Nova Scotia over the period 1990-2002 from 3.9% of road passenger-km in 1990 to 3.6% in 2002, never rising above four percent during this entire period (Figure 28).

However, these basic modal split indicators do not tell the whole story and have limited utility for policy purposes in and of themselves, unless supported by other indicators with greater explanatory power. Access to public transit is one such indicator that can provide vital information to policy makers and planners seeking to increase ridership.

The Canadian Centre for Sustainable Transportation (CST) uses changes in mode split as an indicator of transportation system sustainability, rather than changes in total ridership or transit service availability. CST does this in order to avoid overlooking overall travel trends (for example, if transit ridership increased, but automobile travel increased by a much larger total amount) or the inefficiency of providing transit service in areas with low demand.

This study accepts the CST argument and indicators, but nevertheless goes beyond the CST modal split indicator that includes transit use to add an additional indicator of *access* to public transit. In accord with the CST reasoning, this transit accessibility indicator does not track ridership. Rather, it builds directly on the modal split indicator by drawing attention to both current and *potential* modal split. Increasing the percentage of the population with access to public transit can positively influence future modal split and thereby improve sustainability. This additional indicator also adds explanatory power and provides policy guidance by pointing to a potential cause of limited transit use.

Regarding the CST's second point on efficiency and environmental benefits, we have noted that sustainability also has social and economic dimensions than can be significantly enhanced by improved access to public transportation. Even if increased transit use were not to bring immediate environmental benefits, greater access to public transit increases the capacity to reach essential services and destinations, particularly for disadvantaged economic groups that may not be able to afford private vehicle ownership and use. Because this benefit has salience for the social and economic aspects of the definition of sustainable transportation used both in this report and by the CST, the access to transit indicator in this chapter addresses the potential for increased transit use to improve fair and equitable access to basic services.

This discussion points to the important, but still limited, utility of the transit access indicator considered here. As noted, the indicator is useful in providing policy makers with essential information on the potential for increasing the transit share of the road passenger modal split, and particularly in addressing the access and equity components of sustainability. As such, it belongs in this section on *social* indicators of transportation sustainability. But the indicator cannot properly evaluate environmental impacts or transit efficiency, and can only provide a comparative perspective on sustainability when considered in conjunction with the earlier modal split indicators. Indeed, a full evaluation of transit system performance is beyond the scope of the present project despite the acknowledged importance of such an evaluation.

Data for this indicator are based primarily on statistics collected by the Canadian Urban Transit Association. One hundred Canadian transit authorities annually provide CUTA with a summary of their yearly operations—though the quality of the reporting varies, with some of the smaller municipalities hampered by the limited resources available to them for consistent and reliable record-keeping.

Data collection for this indicator was supplemented by personal communication with each of the three transit authorities in Nova Scotia: Metro Transit (serving the Halifax Regional Municipality); Cape Breton Regional Municipality Transit Services (serving Sydney, North Sydney, Sydney Mines, New Waterford, Glace Bay, and Dominion); and Kings Transit Authority (serving the Municipality of the County of Kings, and the towns of Berwick, Kentville, and Wolfville). This direct correspondence and communication was necessary for two reasons:

1) Some CUTA reports were unavailable for some years in the study period.
2) Even when available, the CUTA documents had several data gaps in years when the Nova Scotia transit systems only reported partial data, or none at all.

To calculate the proportion of the population with access to transit, the service area population (or *population served* by public transit)[486] was divided by the municipal population.[487] Each transit system defines its own service area population standards. This in turn may depend on the *service standards* being used by the transit authorities. These standards are goals that help guide transit authorities' decision-making, and may include such measures as frequency of service, headway (time intervals between vehicles moving in the same direction on a particular route), and population served.[488] Metro Transit calculates the service area population as the number of HRM residents living within 500 metres of routes;[489] CBRM Transit counts residents living within 2,500 ft (approximately 760 m) of transit routes as the service area population;[490] and Kings Transit uses a measure of 450 m.[491]

CUTA addresses this lack of uniformity in standards and reporting by specifying "typically 400 m from a service route" in its own definition of service area population. This is a general guideline, since there is no consensus on what should be considered an acceptable walking distance to transit service. Most experts recommend a five to ten minute walk to transit service, which typically averages 400 to 800 meters, as an acceptable access standard.[492 493, 494] However, standardized data are not available for all Nova Scotia communities. This report presents trends

[486] This is defined by CUTA as the "population living within the built-up area provided with regular transit service, as defined by local service standards (typically 400 m from a service route)." Canadian Urban Transit Association. *Canadian Transit Fact Book*, p. G-5. (Toronto: 2003).
[487] According to CUTA, transit authorities are supposed to report municipal populations based on Census projections for the year of reporting. However it is unclear whether or not the transit authorities actually do so. Canadian Urban Transit Association. *Canadian Transit Fact Book*, p. G-5. (Toronto: 2003).
[488] Canadian Urban Transit Association. *A Review of Canadian Transit Service Standards*, pp. 1-3. (Toronto: 2001a).
[489] IBI Group. (2002, p. 9).
[490] McKeegan, Michael. Cape Breton Regional Municipality Transit Services. (Personal communication: December 14, 2004).
[491] Poole, David. Planning Technician, Planning Department, Municipality of the County of Kings. (Personal communication: November 9, 2004).
[492] Cervero. (1998).
[493] Go for Green and Environics International. (1998, p. 6).
[494] Litman. (2005d). www.vtpi.org/tdm/tdm84.htm#_Toc28046124

in service area population that are based on the individual transit authority guidelines used to report to CUTA (as noted above). Consequently, it is difficult to compare trends between the different transit systems.

In reviewing the trends on access to transit it is important to take into consideration several data limitations:

1) While this indicator shows how much of the population lives in areas said to be served by transit, it must be noted that it does not *directly* address people's actual ability to reach transit services. The distance to transit services is generally calculated by the shortest possible path. This may differ from the actual walking distance—sometimes by as much as 15-25%—due to street connectivity, barriers, safety concerns, etc. Beyond this, users have differing ages and levels of physical mobility that affect the time required to traverse a given distance.[495]

2) The data on service area population provided by the transit authorities to CUTA are not very reliable since the transit authorities often did not or could not accurately gauge population numbers. Although this limitation was reasonable at one time, today with GIS programs, transit authorities should be well equipped to calculate and report service area populations accurately.

3) As already mentioned, it is not possible to compare the trends in percentage access to transit between transit authorities because of the different distances to transit used. In the future, CUTA should consider asking transit authorities to use the 500 m to transit measure as a common standard so that transit systems can be better evaluated on a comparative basis.

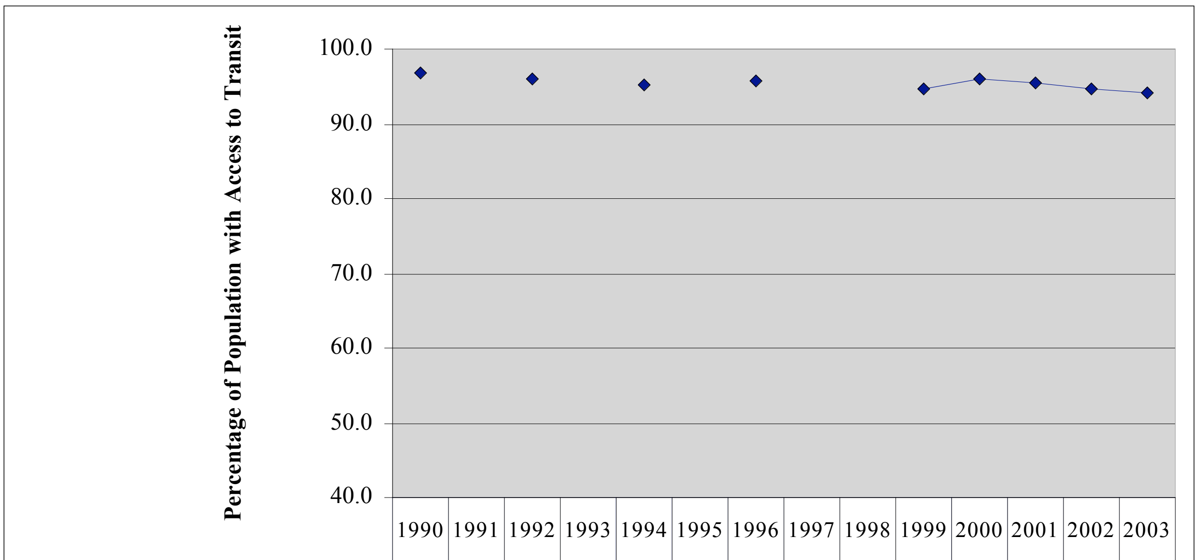
For all these reasons, the inconsistencies in the service area population data therefore severely limit the validity of this indicator. However the data are reported here because the indicator is considered important, and to serve as an example of what can potentially be demonstrated with these kinds of data. The following trends therefore do not reflect accurate measures of access to transit but if, in the future, CUTA were to collect more accurate and consistent data, it would be possible to provide a better assessment of the general degree of access to public transit provided by Canadian transportation systems. These kinds of trends could then be used to help address particular issues such as the true walking distance to transit services, and the kinds of policy initiatives and actions that could be taken to improve access and thus increase mass transit use.

[495] For instance, CUTA notes that Grande Prairie, Alberta, sought to address this question by adopting the following, more defined, service standard: "The 400 metre walking distance should not require pedestrians to cross an arterial road with a speed limit in excess of 70 kph, or railway tracks, unless a controlled crossing is available." Canadian Urban Transit Association, (2001a, p. 5).

Trends: Canada

Access to public transit in Canada's urban areas remained fairly consistent in the period 1990-2003, with about 95% of the country's municipal populations being served by transit services—a high degree of coverage (see Figure 160). The 2.7% decline in access—from 96.8% in 1990 to 94.2% in 2003—may be too minor a change to gauge a shift away from sustainability, but it may also confirm a trend towards suburban and exurban sprawl that puts a gradually increasing proportion of residents beyond the reach of transit services.

Figure 160. Canada: Percentage of Municipal Populations with Access to Transit, 1990-2003.

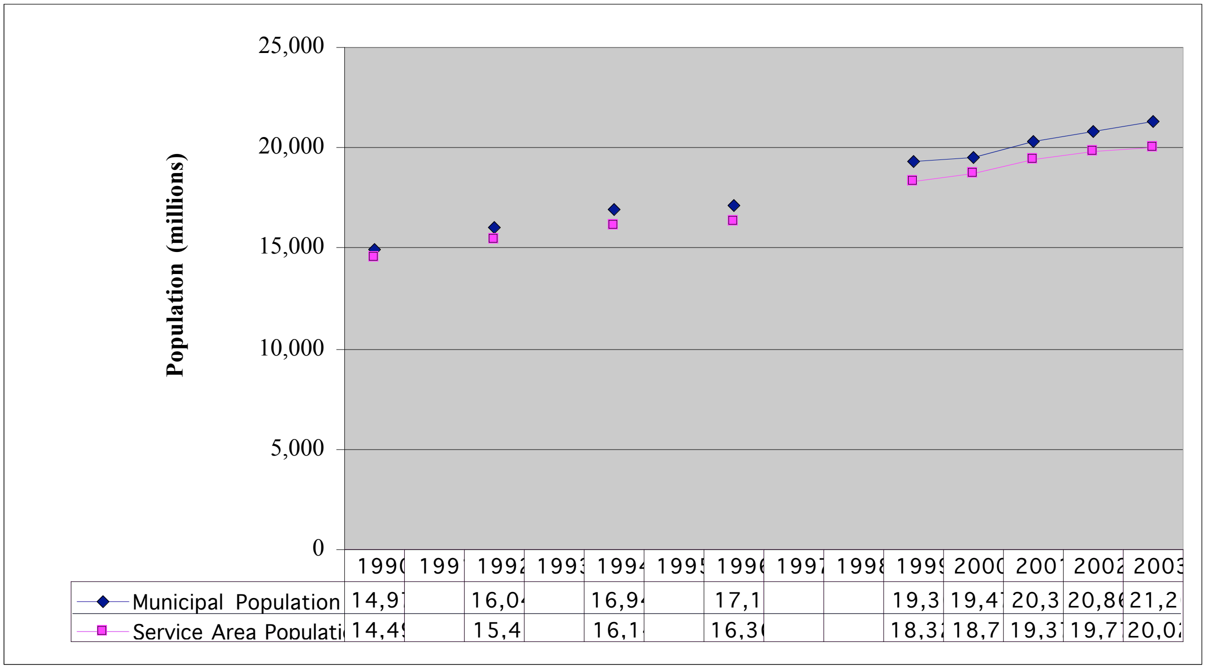


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Percentage of Population with Access to Transit	96.8		96.1		95.3		95.6			94.6	96.1	95.4	94.8	94.2

Source: Canadian Urban Transit Association. *Canadian Transit Fact Book* (1990, 1992, 1994, 1996, 1999-2003); and personal communication with Tammy Siu, Statistics Assistant, CUTA. (November 24, 2004).

Figure 161 shows that access to transit services has generally kept pace with municipal demographic trends. When the two trend lines are compared in terms of the population statistics used to derive the percentages in Figure 160 above, the slight decrease in the percentage of the municipal population served by public transit, noted above, is seen in the gradually growing gap between the two trend lines in recent years (2000-2003).

Figure 161. Canada: Change in Municipal Population and Populations Served by Public Transit, 1990-2003.



Source: Canadian Urban Transit Association. *Canadian Transit Fact Book* (1990, 1992, 1994, 1996, 1999-2003); and personal communication with Tammy Siu, CUTA. (November 24, 2004).

Trends: Nova Scotia

Data were not consistently available for the full study period to assess the degree of access to public transit in the three Nova Scotia municipalities with transit systems. Figure 162 shows the sum of all three municipal populations in the province that had access to public transit, as a portion of the sum of all three municipal populations, for those years when records were available from each of the three transit systems (Halifax; Cape Breton; Kings County). We wish to thank Mike McKeegan of CBRM Transit, Andrew Patterson of Kings Transit, and Amy Power of Metro Transit in Halifax for their assistance in compiling and making available these data for the purposes of this study.

Between 1990 and 2003, and especially in the early 1990s when there were severe cut-backs to transit services, there was a sharp decline in the proportion of Nova Scotians with access to public transit. Aggregate access to transit services in the three municipalities fell by 20% between 1990 and 2003, but more than three-quarters of that decline occurred between 1990 and 1994 alone. Between 2000 and 2003, access fell by six percent. In 1990, nearly all Nova Scotians living in Halifax, industrial Cape Breton, and Kings County (97.2%) lived within the accepted standard for distance to transit, as designated by each transit authority. By 2003, only 77.8% had such access.

However, the decline (or at least a substantial portion of it is most likely attributable to data and reporting inconsistencies in the CUTA statistics. Metro Transit explained that only the data that it has reported to CUTA in the past 5-6 years are reliable. To add further complication, and doubt, the transit authority also explained that it was unable to update service area populations reported to CUTA because the necessary data were not available to the authority.[496]

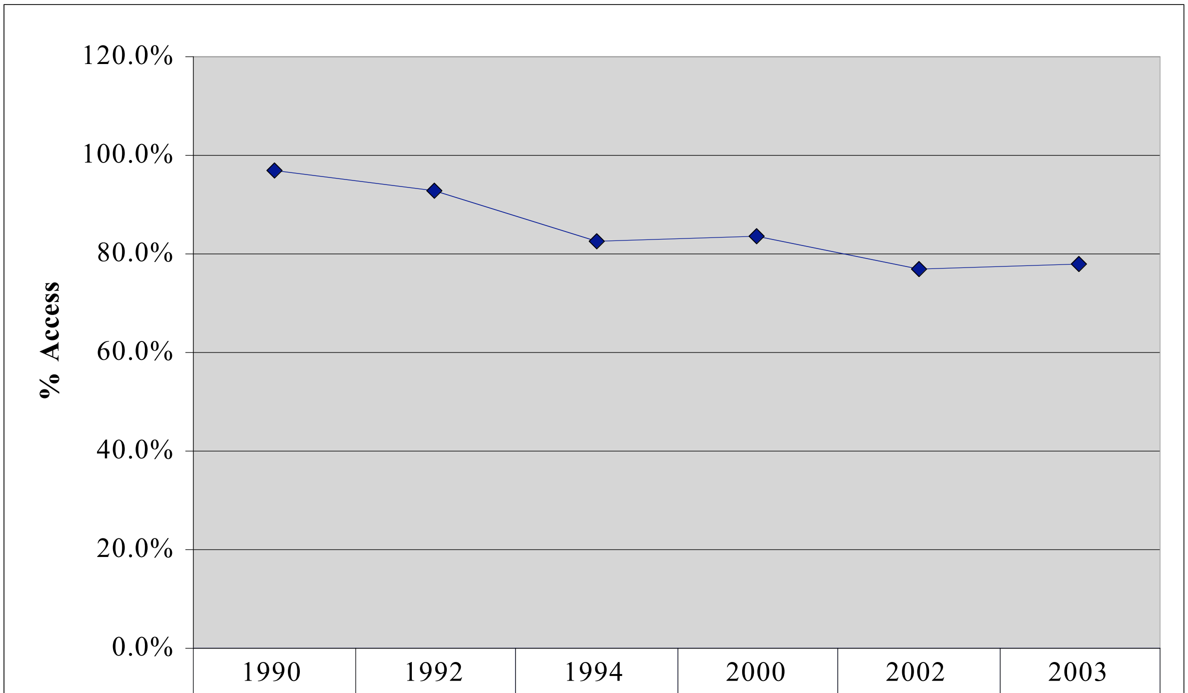
An assessment of trends from 1990 to 2003 is also severely compromised by the municipal mergers in Cape Breton and the Halifax area in the mid-1990s. In 1995 eight municipalities were amalgamated to create the Cape Breton Regional Municipality. The data reported before 1995 includes only the City of Sydney. In 1996 the municipalities in the Halifax region were amalgamated to create the Halifax Regional Municipality, and the Halifax and Dartmouth transit systems were also merged. The data reported before 1996 includes the City of Halifax only. The new HRM boundaries also include rural areas of the former Halifax County, many of which do not have transit service. The following results must therefore all be seriously qualified by these data inconsistencies.

While the aggregate population of the three regions (without adjusting for the municipal amalgamations described above) has grown since 1990, access to transit has decreased substantially. This growth is in large part not growth at all, but is partly a function of new areas being added to the municipal boundaries. While this apparently suggests a move away from sustainability, further analysis (below) shows sharply different trends in the three regions, particularly with respect to population and demographic changes, requiring far more nuanced interpretations of the trends than is possible based on the data in Figure 162 alone. HRM and Kings County saw declines in the percentage of population served by public transit, while CBRM saw an increase, but many of those changes had more to do with demographic trends (like population decline in CBRM) than with changes in the quality and availability of transit service. Indeed, the differences demonstrate the danger of relying simplistically on provincial averages without closer examination of intra-provincial variations.

As well, developments in other parts of Nova Scotia outside these three regions should be taken into account in assessing and interpreting these data. For example, an encouraging development was the 2005 introduction of a new public transit service in the municipality of Liverpool.[497] Such expansion of transit services to populations not previously served will clearly not be reflected in the 2005 aggregate access statistics of the three regions that have traditionally had transit systems, even though access has in fact been extended to new population groups in Nova Scotia. The Liverpool example is provided here for illustrative purposes only to indicate potential challenges in the interpretation of the transit access data. It should be noted that the development of the Liverpool transit service was a pilot project that has since been cancelled due to lack of ridership.

[496] Power, Amy. Transit Planning Technician, Metro Transit. (Personal communication: March 2006).
[497] Ware, Beverley. "Bus Service Up and Running in Liverpool." (Halifax: *Chronicle Herald*. December 12, 2004).

Figure 162. Nova Scotia: Aggregate Percentage of Population with Access to Transit in HRM, CBRM, and Kings County, 1990-2003 (not all years reported).



	1990	1992	1994	2000	2002	2003
% access	97.2%	92.7%	82.4%	83.4%	77.2%	77.8%

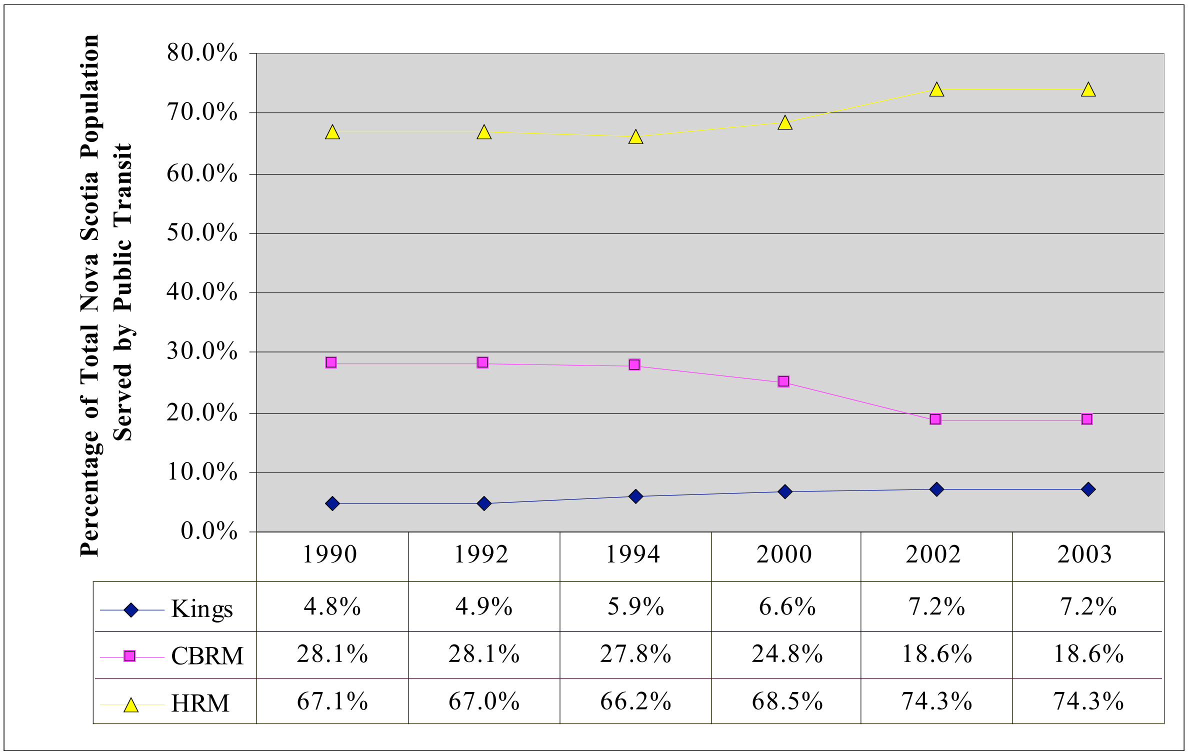
Source: CUTA. *Canadian Transit Fact Book* (1990, 1992, 1994, 2000-2003); and personal communications with: Mike McKeegan, CBRM Transit (December, 2004); Andrew Patterson, Kings Transit (November, 2004); Amy Power, Metro Transit (November, 2004).

Note: As noted above, the decline is most likely attributable to data and reporting inconsistencies in the CUTA statistics by the individual transit authorities. (Amy Power, Metro Transit, personal communication February 2006)

In 2003, Metro Transit accounted for more than three-quarters of the population served by public transit in Nova Scotia (Figure 163). Thus, trends in Halifax Regional Municipality have a strong influence on percentages and figures for the province as a whole. Metro Transit's increase in the share of population served by mass transit was accompanied by a loss in the share served by Cape Breton Regional Municipality Transit.

It is important to note that the trend lines in Figure 163 do ***not*** indicate increases or decreases in the percentage of each municipal population served by mass transit. Thus, a smaller proportion of HRM's population was actually served by public transit in 2003 than in the 1990s, however, this is mostly a function of the incorporation of rural areas of Halifax County into HRM who are not well served by transit. The percentages below therefore simply reflect each of the region's shares of the aggregate Nova Scotia population actually served by public transit in each of the years listed. As such, the figures below reflect demographic trends rather than changes in transit service with both HRM and Kings County increasing their populations (and thus their share of all Nova Scotians served by transit) and CBRM losing population.

Figure 163. Nova Scotia: HRM, CBRM, and Kings County Shares (Percentages) of Total Nova Scotia Population Served by Public Transit, 1990-2003 (not all years reported).



	1990	1992	1994	2000	2002	2003
Kings	4.8%	4.9%	5.9%	6.6%	7.2%	7.2%
CBRM	28.1%	28.1%	27.8%	24.8%	18.6%	18.6%
HRM	67.1%	67.0%	66.2%	68.5%	74.3%	74.3%

Source: CUTA. *Canadian Transit Fact Book* (1990, 1992, 1994, 2000-2003); and personal communications with: Mike McKeegan, CBRM Transit (December, 2004); Andrew Patterson, Kings Transit (November, 2004); Amy Power, Metro Transit (November, 2004).

Metro Transit—Halifax Regional Municipality

Figure 164 shows a declining trend in the percentage of the Halifax regional population with access to transit. In 1990 all Halifax residents had access to transit; by 2003 this had fallen to about 84%, though a part of the change reflects the consequences of municipal amalgamation and inclusion of more rural areas within the HRM boundaries. Thus the 1990 figure is for the City of Halifax only while the 2003 figure is for the much larger HRM. The data for both municipal population and service area population are approximate figures supplied to the Canadian Urban Transit Association by Metro Transit using Census data from Statistics Canada.

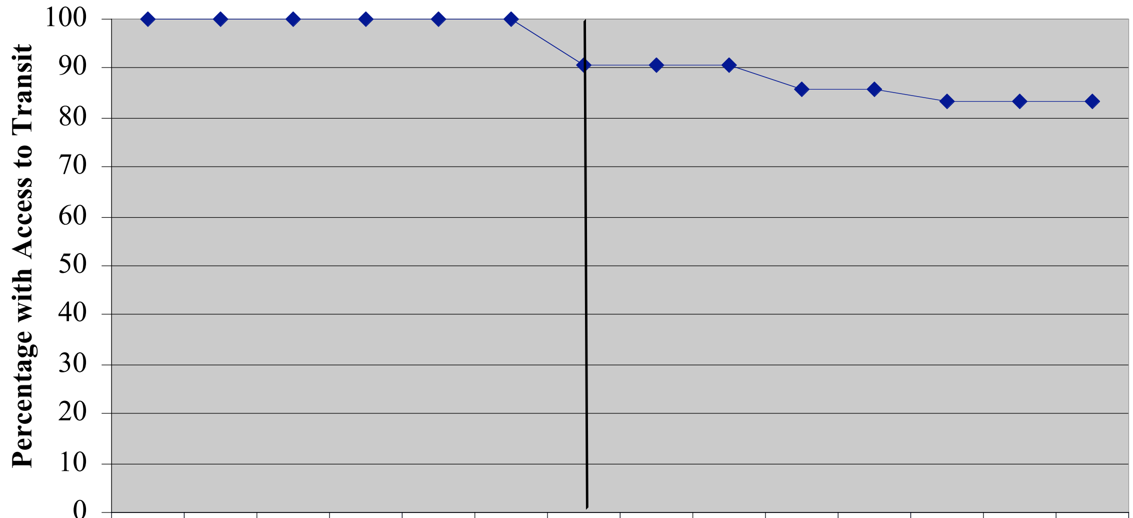
A caveat must be added here on data reliability. Some Canadian municipalities report the same figures for municipal population and service area population to CUTA. This may reflect an estimate of their service area population, an estimate of their municipal population, or simply a lack of data on the former. Alternatively, it may indicate that the entire municipal population has access to public transit. Generally, smaller transit systems in Canada report the same municipal population as service area population, probably due to a lack of reliable statistics and failure to apply clear criteria defining service area population, while many larger municipal transit operations in Canada do in fact provide coverage to virtually their entire municipal area.[498]

Furthermore, municipalities are not required to adhere to the CUTA guideline specifying that the service area population consists of those residents within 500 metres of a transit stop. This is simply a guideline. As already noted, HRM, CBRM, and Kings County all have different definitions of access that in turn differ from the CUTA guideline. The consequence of these different definitions of access is that it is difficult to compare transit systems.

From the data and information available, it is not clear which of the above data uncertainties may apply to the Metro Transit statistics reported below, particularly for the 1990-95 period in which the municipal population and service area population figures reported to CUTA by Metro Transit are identical. Figure 164 appears to indicate that access to public transit in HRM has declined in two or three year intervals, but as already explained (see note for Figure 162), this is quite likely a reflection of some inexact figures being submitted to CUTA.[499] According to Metro Transit, the decline in the number of citizens served by transit in 1996, seen in Figure 164, is an artefact of reporting inconsistencies to CUTA. It undoubtedly also reflects the addition of a larger rural and semi-rural population within the newly amalgamated HRM boundaries rather than any cut in service, since HRM did not make any substantial changes to its service area in 1996 when the Dartmouth and Halifax transit systems were merged. However, the decline in access to transit seen in 1999 and 2001 are most likely attributable to accelerated suburban and exurban development and consequent increases in population in areas outside the transit service area. [500]

[498] Siu, Tammy. Statistics Assistant, Canadian Urban Transit Association. (Personal communication: November 24, 2004).
[499] Power, Amy. Metro Tansit. (Personal communication: February, 2006).
[500] Ibid.

Figure 164. Halifax Regional Municipality: Percentage of Population with Access to Transit, 1990-2001.



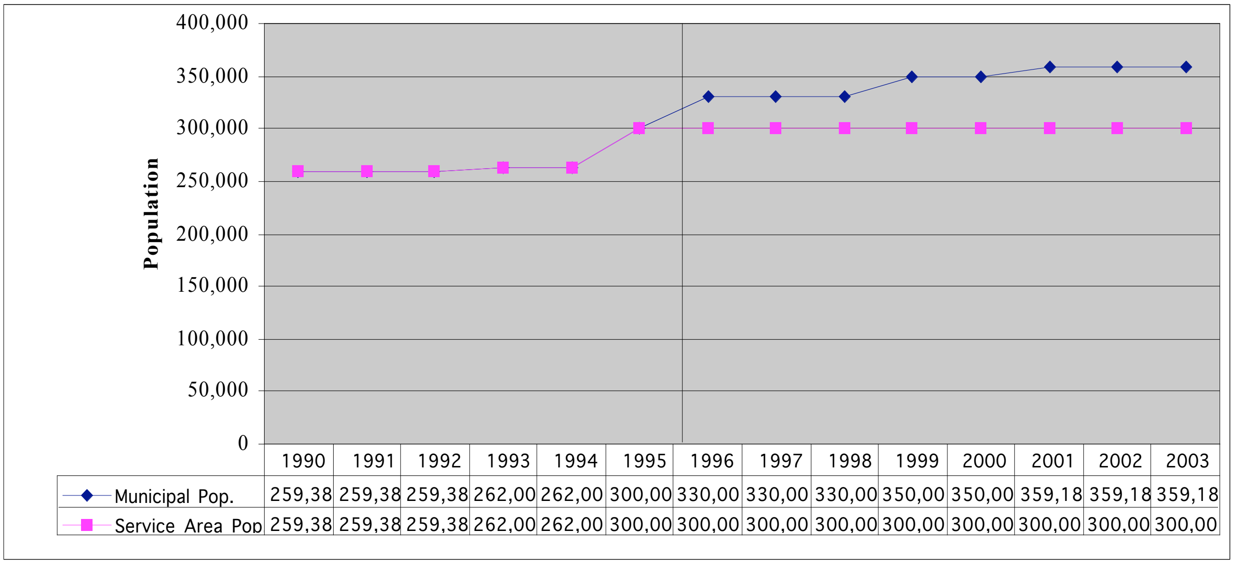
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
% access	100.0	100.0	100.0	100.0	100.0	100.0	90.9	90.9	90.9	85.7	85.7	83.5	83.5	83.5

Source: CUTA. *Canadian Transit Fact Book* (1990, 1992, 1994, 1996, 1999-2003); and personal communications with Tammy Siu, CUTA (November, 2004) and Amy Power, Metro Transit (November, 2004).

Note: In 1996 the municipalities in the Halifax region, which included the more rural and semi-rural areas of Halifax County, were amalgamated to create the Halifax Regional Municipality. The data reported before 1996 include the City of Halifax only. The black line in 1996 represents this change.

Figure 165 shows a growing gap between the municipal population in metropolitan Halifax and the proportion of the population served by transit. There was an absolute growth in the number of HRM citizens served by transit (i.e. located within 500 metres of a transit route) over the course of the study period; but the overall proportion of the population with access to transit decreased concurrently. Again, the apparent increase in municipal population in the mid-1990s largely reflects the effects of HRM amalgamation, though the expansion of the gap in 1999 and 2001 is likely the consequence of accelerated suburban and exurban development.

Figure 165. Halifax Regional Municipality: Population Served by Metro Transit and Municipal Population, 1990-2003.



Source: CUTA. *Canadian Transit Fact Book* (1990, 1992, 1994, 1996, 1999-2003); and personal communications with Tammy Siu, CUTA (November, 2004) and Amy Power, Metro Transit (November, 2004).

Note: In 1996 the municipalities in the Halifax region, which included the more rural and semi-rural areas of Halifax County, were amalgamated to create the Halifax Regional Municipality. The data reported before 1996 include only the City of Halifax. The black line in 1996 represents this change.

Compared with municipalities of similar size elsewhere in Canada, transit accessibility in HRM is below average (Figure 166). Although consistent and comparable data for Canadian municipalities with populations between 150,000-400,000 (also known as group 2 in the CUTA reporting mechanism) were not available before 1999, a slight declining trend (about two percentage points) in transit accessibility across Canada can be discerned thereafter, though access rates in comparable sized cities nationwide remained about 11-12 percentage points higher than in Halifax Regional Municipality.

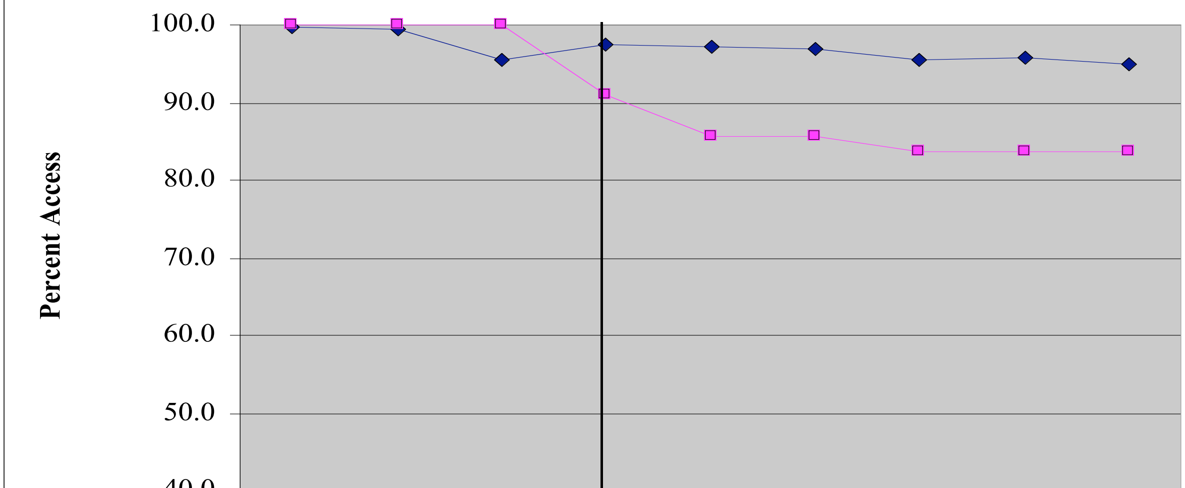
Needless to say, differences between municipalities may be largely attributable to how widely different municipal boundaries are drawn, and the degree to which rural and semi-rural populations are included within the boundaries. As noted, HRM amalgamation is largely responsible for the apparent decline in access in the Halifax region seen in the mid-1990s, since the actual transit service area did not change substantially when the transit systems were merged.

Many other factors can influence proximity to transit and its potential use, including land use planning that promotes mixed use urban and suburban centres; higher densities of employment; residential and other uses along transit corridors; and multi-modal transportation options.[501] Aside from the effects of amalgamation in 1996, the trend noted in Figure 166 may also reflect differing urban development patterns across the various jurisdictions. HRM's new proposed 25-

[501] Transportation Association of Canada. (1999a).

year development plan does incorporate planning principles and strategies specifically designed to increase transit access and use, which, if fully implemented, could help reverse the declining access trends observed.

Figure 166. Access to Transit in Halifax vs. Average 'Group 2' Canadian Municipalities – population 150,000-400,000 – (percent of municipal population), 1990-2003 (not all years reported).[502]



	1990	1992	1994	1996	1999	2000	2001	2002	2003
avg. group 2	99.7	99.5	95.4	97.5	97.0	97.0	95.6	95.8	94.9
Halifax	100.0	100.0	100.0	90.9	85.7	85.7	83.5	83.5	83.5

Source: CUTA. *Canadian Transit Fact Book* (1990, 1992, 1994, 1996, 1999-2003); and personal communications with Tammy Siu, CUTA (November, 2004) and Amy Power, Metro Transit (November, 2004).

Note: In 1996 the municipalities in the Halifax region, which included the more rural and semi-rural areas of Halifax County, were amalgamated to create the Halifax Regional Municipality. The data reported before 1996 include only the City of Halifax. The black line in 1996 represents this change.

Aside from data inconsistencies and the effects of amalgamation, the declining trend in population served by public transit in HRM may also result from service reductions during the 1990s.[503] Metro Transit has since tried to increase service in the fast developing outlying areas of HRM by adding rural and suburban routes, but low population densities make such areas difficult to serve by public transit, reducing overall system efficiency. For example, the western rural commutershed (which includes the Hammonds Plains and St. Margaret's Bay areas)—which grew faster than any other area in HRM—has the lowest proportion of commuters travelling to work by public transit, largely because transit service to the area is so limited.[504]

502 *Average 'Group 2' Canadian Municipalities* denotes municipalities with a population between 150,000 and 400,000.

503 IBI Group. (2002, p.1).

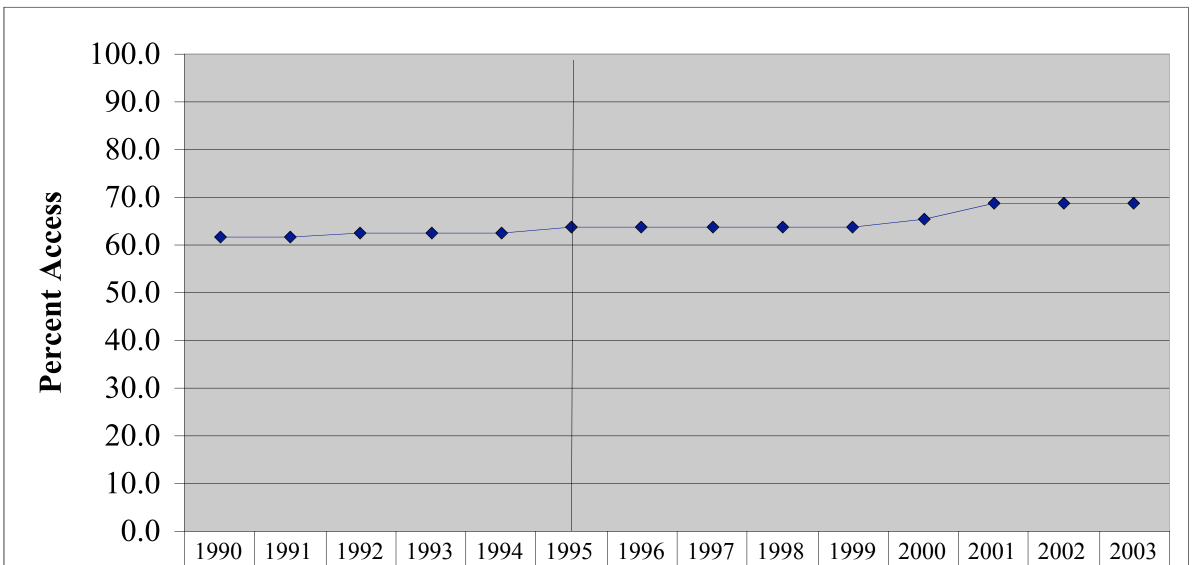
504 Halifax Regional Municipality—Regional Planning. Baseline Report—Population, Housing, Employment, Journey-to-Work. (2004a, pp 1 and 12). www.halifax.ca/regionalplanning/publications/BaselineReport04.pdf

Thus, the fast-growing low-density regions of HRM are also the most difficult to serve by public transit, making the declining access trends difficult to reverse even with the addition of new service routes.

Cape Breton Regional Municipality Transit Services

The overall level of access to transit in Cape Breton Regional Municipality is about 15 percentage points lower than in HRM. However, as can be seen in Figure 167, the proportion of CBRM residents with access to transit rose fairly steadily in the period 1990-2003: to 69% of the CBRM population in 2003, up from 62% in 1990. Though this seems to imply a move towards sustainability, an examination of demographic trends indicates otherwise.

Figure 167. Cape Breton: Percentage of Municipal Population with Access to Transit, 1990-2001.



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
% access	61.7	61.7	62.5	62.5	62.5	63.9	63.9	63.9	63.9	63.9	65.2	68.6	68.6	68.6

Source: Personal communication with Mike McKeegan, CBRM Transit (December, 2004).

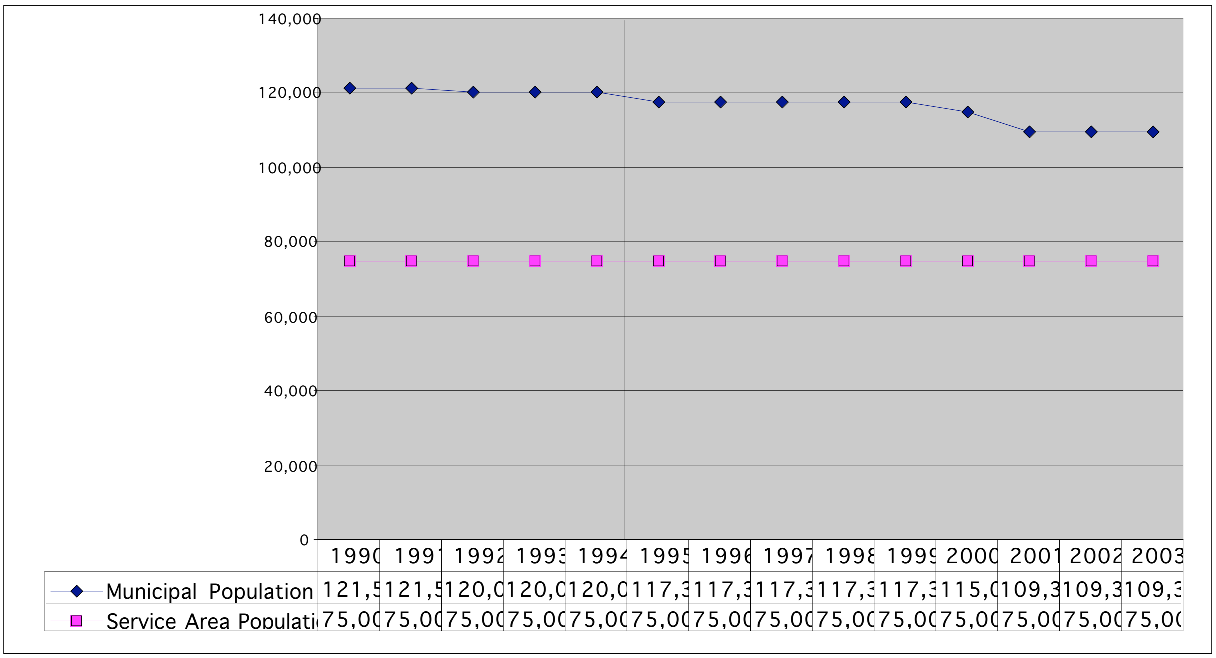
Note: In 1995 eight municipalities were amalgamated to create the Cape Breton Regional Municipality. The data reported before 1995 include only the City of Sydney. The black line in 1995 represents this change.

Figure 168 shows that the numerical population actually served by public transit in CBRM has remained constant at 75,000, and has not changed since the start of the study period in 1990. However, Statistics Canada notes a 9% decline in the population of the CBRM area between 1991 and 2001.[505, 506] This indicates that the proportional increase in access to transit noted in

[505] Statistics Canada. *Electronic Area Profiles*: Profile of Census Metropolitan Areas and Census Agglomerations, 1996 Census (100% Sample Data). (Catalogue no. 94F0048XWE).

Figure 167 is due to the shrinking population base in the service area,[507] rather than reflective of any expansion of transit services. So the apparent increase in the proportion of CBRM residents served by transit does not constitute a move towards a more sustainable transportation system, since access is not in fact increasing for the remaining populace. This also illustrates the potential danger of relying on averages and proportional statistics, without examining trends in both the numerator and the denominator. Indeed in this case, a declining municipal population base may reflect a broader decline in social and economic sustainability, which is a vital component of the definition of sustainable transportation used both in this study and in others, and may reduce the economic viability of the transit system.

Figure 168. Cape Breton: Population Served by CBRM Transit and Municipal Population, 1990-2003.



Source: Personal communication with Mike McKeegan, CBRM Transit (December, 2004).

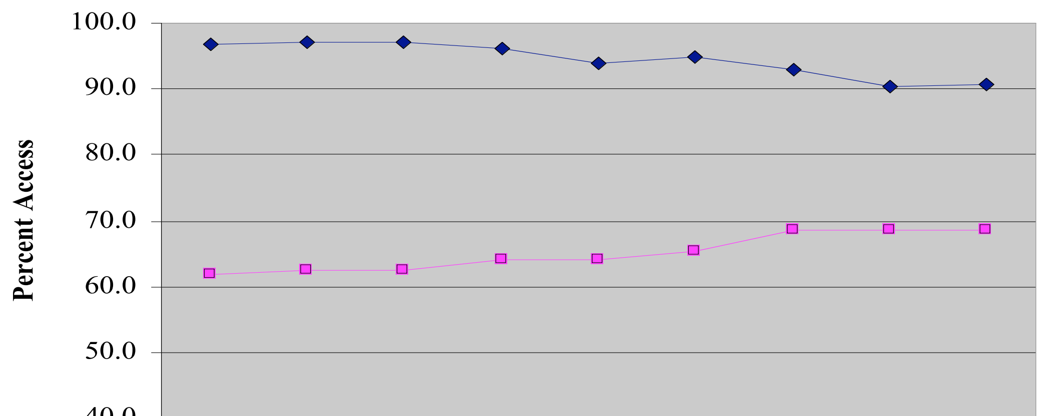
Note: In 1995 eight municipalities were amalgamated to create the Cape Breton Regional Municipality. The data reported before 1995 include only the City of Sydney. The black line in 1995 represents this change.

Many medium-size municipalities with populations between 50,000 to 150,000 (also known as group 3) across Canada have experienced declining transit accessibility, as illustrated in Figure 169. As noted, the percentage of the population served in Cape Breton Regional Municipality is actually increasing, and therefore does not appear to follow the same pattern as other comparable municipalities nationwide. This difference likely reflects the fact that, unlike in CBRM where population has declined, populations in other Canadian medium-size municipalities are not

[506] Statistics Canada. *2001 Community Profiles*: Community Highlights for Cape Breton (100% Sample Data). (Catalogue no. 93F0020XCB1996004).
[507] Service Nova Scotia. Recent Growth, Immigration, Natural Increase, slide 3. (No date). www.gov.ns.ca/snsmr/muns/plan/presentation/central_growth_2.ppt Accessed December, 2004.

declining. Between 1996 and 2001, municipal populations within this population range grew, on average by 2.5% across Canada.[508]

Figure 169. Access to Transit in CBRM vs. Average 'Group 3' Canadian Municipalities – population 50,000-150,000 – (percent of municipal population), 1990-2003 (not all years reported).[509]



	1990	1992	1994	1996	1999	2000	2001	2002	2003
avg. goup 3	96.7	97.1	97.0	96.0	93.9	95.0	92.9	90.4	90.7
Cape Breton	61.7	62.5	62.5	63.9	63.9	65.2	68.6	68.6	68.6

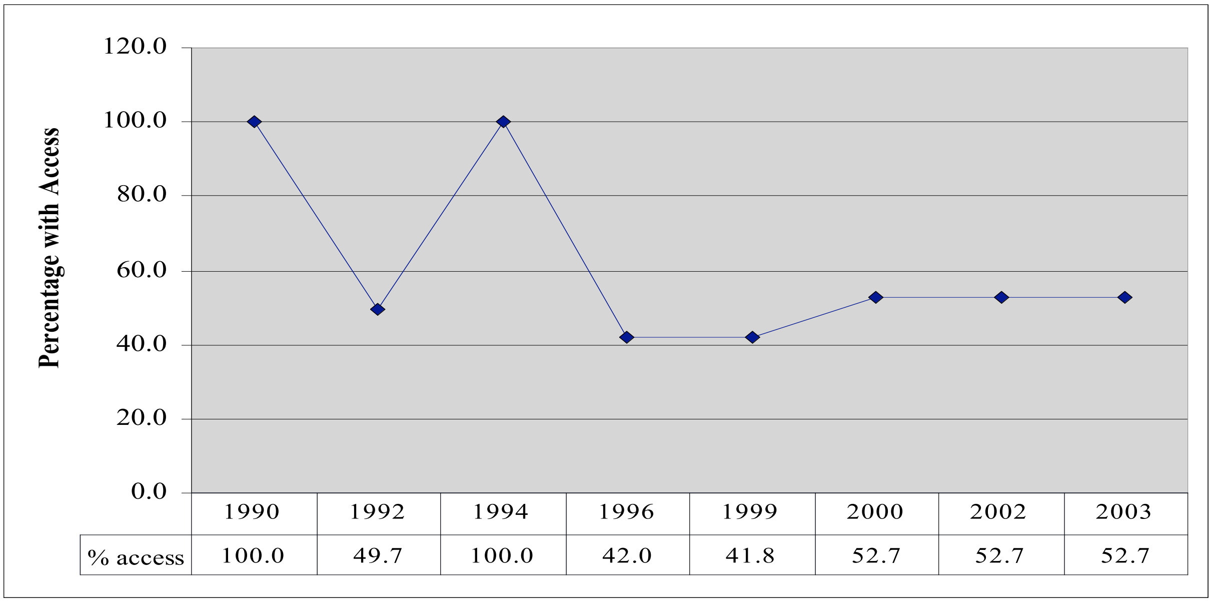
Source: Personal communication with Mike McKeegan, CBRM Transit (December, 2004).

Kings Transit Authority—Kings County

Consistent data were difficult to obtain for the population served by Kings Transit. Some of the information submitted by Kings Transit to CUTA, notably for 1990 and 1994, is likely based on estimates that fail to distinguish the municipal population from the service area population. Judging from the CUTA statistics, access to transit in Kings County seems to have declined from full coverage in 1990 to about 53% in 2003 (Figure 170). But this considerable apparent decrease is certainly due almost entirely to inconsistent reporting practices during the study period. This problem becomes evident when examining the municipal population statistics reported by Kings Transit to CUTA, which show a rapid increase from 18,000 in 1990 to 23,000 in 1994 to 55,000 in 1996 (see Figure 171).

[508] Statistics Canada. *2001 Census - Population and Dwelling Counts, for Census Metropolitan Areas and Census Agglomerations, 2001 and 1996 Censuses.* http://www12.statcan.ca/english/census01/Products/Standard/popdwell/Table-CMA-N.cfm?T=1&SR=76&S=3&O=A (Accessed March 2006).
[509] *Average 'Group 3' Canadian Municipalities* denotes municipalities with a population between 50,000 and 150,000.

Figure 170. Kings County: Percentage of Population with Access to Transit, 1990-2001 (not all years reported).



Source: CUTA. Canadian Transit Fact Book (1990, 1992, 1994, 2000-2003); and personal communications with Andrew Patterson, Kings Transit (November, 2004) and David Poole, Planning Department, Municipality of Kings (November, 2004).

Assuming that the 1999-2003 data are reasonably comparable (a) in reflecting a more consistent municipal population base, and (b) in distinguishing between the municipal population and the service area population, the more recent statistics show a 26% increase in the proportion of Kings residents served by public transit between 1999 and 2000, and no change since that time. The increase in population served by public transit was due to the expansion in Kings Transit service that occurred in 2000, when the Greenwood to Bridgetown route was instituted.[510]

From 1990-94, Kings Transit Authority records for the population served by public transit in Kings County only account for transit routes in the Municipality of the County of Kings, and do not include the towns of Berwick, Kentville, and Wolfville, which are within the Kings County boundaries but have their own town councils and are not, for governance purposes, officially part of the Kings County Municipality.[511] For 1990 and 1994, as noted, the municipal population was also reported to be equal to the service area population in Kings Transit reports to CUTA. The Kings Transit numbers reported by CUTA for this period therefore reflect a lack of both reliable data and consistent definition and reporting methods.

From 1996 onwards the 'municipal' population is reported for all of Kings County, including the towns of Berwick, Kentville, and Wolfville, as well as for the other regions of the county that are not served by transit, and the service area population is distinguished from the population at

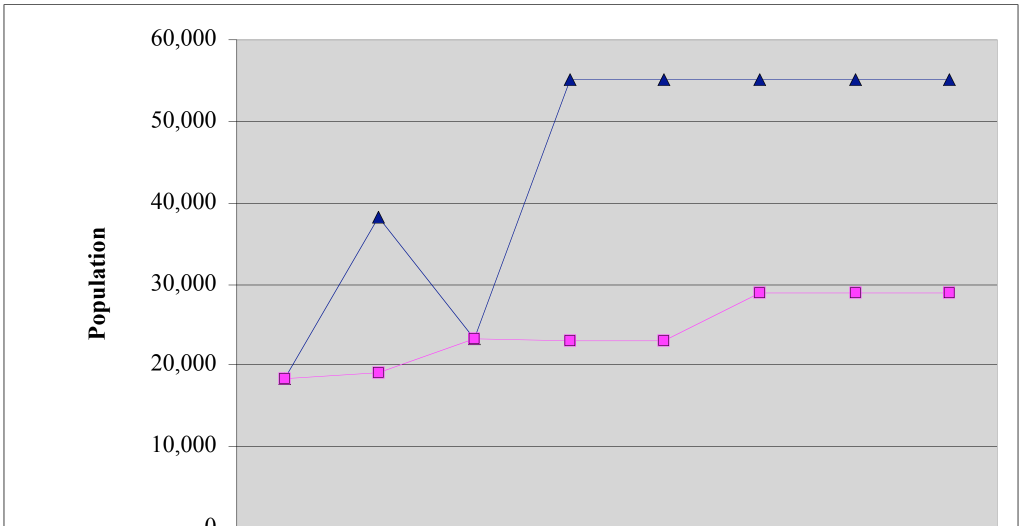
[510] Hackett, Brian. General Manager (current), Kings Transit Authority. (Personal communication: April 2006).
[511] Patterson, Andrew. General Manager (former), Kings Transit Authority. (Personal communication: November, 2004).

large. This change in reporting methods accounts for the sudden, sharp divergence between municipal population and service area population statistics in the CUTA records for 1996, after the two sets of statistics were shown as identical in 1990 and 1994 (see Figure 171.) Due to the difference in reporting procedures and earlier lack of distinction between municipal and service area populations, trends before 1996 could not be considered for analysis here. Figure 171 does show a 26% increase in the Kings County population served by public transit in 2000, which reflects the creation of the new bus route mentioned above.[512] This addition represents a move towards a more sustainable transportation system since it provides a larger proportion of the Kings County population with access to public transit, and thereby increases transportation options for more Kings County residents.

Further, the Municipality of Kings County has a growth strategy in place to encourage development at varying urban densities in communities that already have existing services (water, sewage, etc.), rather than in more rural and agricultural regions of the County that lack such municipal services.[513] As noted previously, higher density settlement, which is encouraged in Kings County by the designation of specified "growth centres," enhances the capacity to provide transit services; and most of these designated growth centres are currently served by Kings Transit. In this way, expanded access to public transit services is directly linked to sustainable land use planning in the ways described earlier.

[512] Ibid.
[513] Municipality of the County of Kings. *Municipal Planning Strategy*, section 2.1.8.2. (2002). www.county.kings.ns.ca/comdev/mps/sections/mps-2-1.pdf Accessed November, 2004.

Figure 171. Kings County: Population Served by Kings Transit and Municipal Population, 1990-2003 (not all years reported).

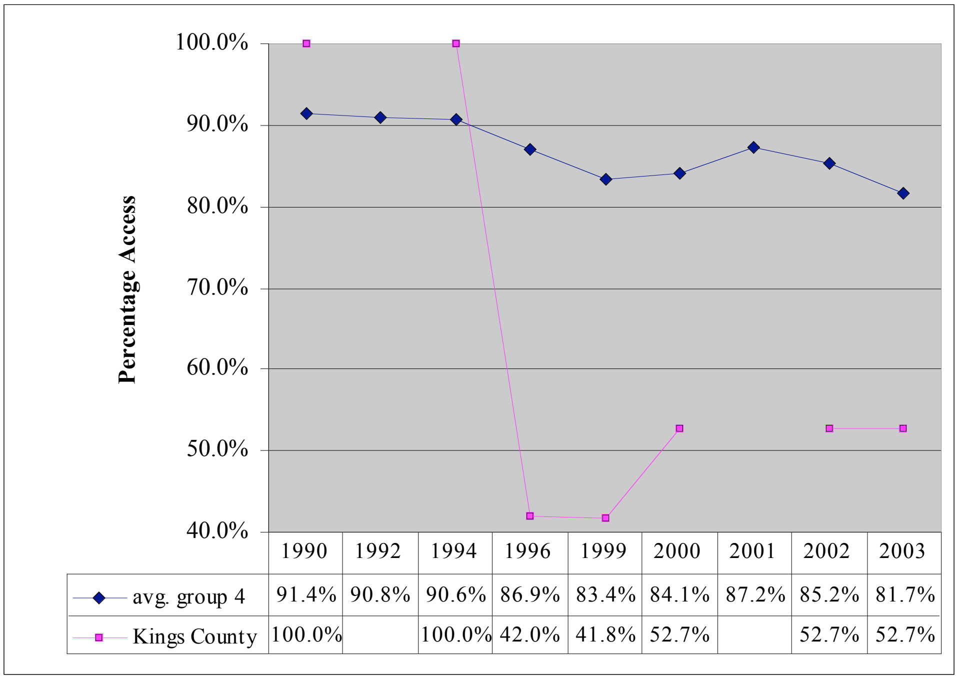


	1990	1992	1994	1996	1999	2000	2002	2003
municipal pop.	18,437	38,266	23,197	55,000	55,000	55,000	55,000	55,000
service area pop.	18,437	19,035	23,197	23,118	23,000	29,000	29,000	29,000

Source: CUTA. *Canadian Transit Fact Book*. (1990, 1992, 1994, 2000-2003); and personal communications with David Poole, Planning Department, Municipality of the County of Kings (November, 2004) and Andrew Patterson, Kings Transit (November, 2004).

Figure 172 shows a brief increase in access to public transit in 2001 in Canadian municipalities with a population of less than 50,000, but a decline since that time. As well, the overall trend since the early 1990s has been towards diminished access in these smaller jurisdictions from more than 90% in the early 1990s to just over 80% in 2003. Despite the 1999 increase in access to public transit in Kings County that resulted from the addition of a new bus route, as noted above, Figure 172 indicates that transit access in Kings County remains on average 37% below the Canadian average for comparable-sized municipalities since 1999. Again, however, demographic realities largely explain this apparent disparity, since the Kings County population statistics extend beyond municipal boundaries and include the county's rural population, so the results are not really comparable.

Figure 172. Access to Transit in Kings County vs. Average 'Group 4' Canadian Municipalities – population <50,000 - (percent of municipal population), 1990-2003 (not all years reported).[514]



	1990	1992	1994	1996	1999	2000	2001	2002	2003
avg. group 4	91.4%	90.8%	90.6%	86.9%	83.4%	84.1%	87.2%	85.2%	81.7%
Kings County	100.0%		100.0%	42.0%	41.8%	52.7%		52.7%	52.7%

Source: CUTA. *Canadian Transit Fact Book*. (1990, 1992, 1994, 2000-2003); and personal communications with David Poole, Planning Department, Municipality of the County of Kings (November, 2004) and Andrew Patterson, Kings Transit (November, 2004).

The aggregate statistics and averages certainly conceal varying scales of urbanization in small Canadian municipalities, and, as noted, the results in Figure 172 likely reflect the much more rural composition and wider municipal boundaries of Kings County compared to most other small municipalities nationwide. In fact, it is quite likely that other municipalities included in the CUTA survey may not service rural routes to the same degree as does Kings Transit.

As noted earlier, the addition of rural and suburban routes tends to reduce transit efficiency, because significant proportions of the population in those areas will remain outside the serviceable distance (400 metres by CUTA standards, 500 m by the HRM standards recommended for use in this report, and 450 m by Kings Transit standards.) However, even though these rural populations outside the specified service distance will not be officially counted as having access to public transit, the new routes clearly do improve transportation options for suburban and rural populations. The new routes may allow residents to drive or be driven to transit stops and thus use public transit, even though they may not walk to these stops (the criterion for defining the service area population.)

[514] *Average 'Group 4' Canadian Municipalities* denotes municipalities with a population of less than 50,000.

Conclusion

The transit access indicator examined in this chapter points to the underlying principle that a more diverse transportation system and more accessible land use patterns tend to increase transportation system efficiency and equity, and so contribute to sustainability. In particular, access to quality public transit service improves accessibility to basic services, particularly for non-drivers. The overall decline in population served by public transit in Nova Scotia between 1990 and 2003 appears to indicate movement away from a more sustainable transportation system, though the conclusion must be modified by the impact on the statistics of HRM amalgamation in particular. According to CUTA records, access to transit has decreased in HRM, dropping from 100% in 1990 to approximately 84% in 2003. But this apparent decline is partly a consequence of the data limitations discussed above as well as the inclusion of rural and semi-rural populations in the new HRM boundaries in 1996. However, the decline is also a function of the expanding suburban and exurban populations in HRM that are not served adequately by transit, and of transit service cuts in the 1990s – both of which do signal movement away from sustainability.

The apparent increase in the proportion of the CBRM population with access to transit turns out, on closer analysis, to reflect the overall decline in population in Cape Breton Regional Municipality rather than any expansion of service or increase in the aggregate numbers of CBRM residents with access to transit. Access to public transit in Kings County increased from about 42% in 1996 to 53% in 2003, largely as the result of the addition of a new bus route in 1999, suggesting a move towards more sustainable transportation in Kings. However, the contribution of this gain in Kings to the overall proportion of Nova Scotians served by public transit was outweighed by the negative trends in Halifax Regional Municipality, with its much larger population.

In the aggregate, even adjusting for the data limitations and statistical artefacts noted above, this indicator shows that current trends (particularly the expansion of suburban and exurban populations with no access to transit) are reducing transportation system sustainability in Nova Scotia. The Halifax Regional Municipality's current planning strategy includes features that can help reverse these trends and increase transport system sustainability in the future.

Chapter 12. Telework

Telework refers to the use of electronic communication to substitute for physical travel, including commuting, business activities, and errands such as shopping and banking.[515] When used to reduce commute trips, it is called *telecommuting*.[516] To the degree that improved telecommunications (such as telephones, the Internet, and video conferencing) substitute for physical travel or improve accessibility for disadvantaged people, telecommuting helps increase transportation system sustainability.

These technologies can have a variety of impacts on travel behaviour. Telecommunications can substitute for physical mobility, reducing total vehicle travel, for example, by allowing people to work from home. On the other hand, telecommunications may increase some types of travel. For example, many telecommuters make additional errand trips that they would otherwise have made while driving home from work, and some people use the option of telecommuting part time to live further from urban areas and thereby to increase their commuting distance. For example, such telecommuters might simply substitute a two-hour commute made two days a week for more frequent shorter commutes if they lived closer to their place of work.[517] Telecommuting by one family member can also increase access to a vehicle by other members of the household. Increased use and availability of communication technologies can also allow the development of more geographically dispersed friendships and professional partnerships, which can result in increased travel when the new acquaintances or partners decide to meet in person.[518] In these ways, the travel stimulation tendency of telework can offset a portion of the vehicle travel reductions achieved by working from home.

Aside from its direct impacts on transport activity, the use of communication technology to work from home has a number of social and economic implications. Here, too, overall impacts are mixed. Working from home can provide various benefits. Employees who telecommute can reduce transportation costs and stress, and realize improvements in quality of life from the more flexible work arrangements.[519] Workers may also save money through reduced expenditures on food (eating at home vs. eating out), business clothing, and dry cleaning.[520] Telecommuters can save time on commuting, which averages 62 minutes per commute day in Canada.[521]

[515] "Telework," Online TDM Encyclopedia. http://www.vtpi.org/tdm/tdm43.htm.
[516] Telework Connection. Benefits to the Environment. (April 11, 2000). www.telework-connection.com/environment-benefits.htmwww.telework-connection.com/environment-benefits.htm Accessed January, 2005.
[517] Litman. (2005b, p. 21).
[518] Ibid.
[519] Canadian Telework Registry. Benefits of Telework. (May 13, 2004). http://telework.vcr-mvr.ca/tele_benefits_e.cfm Accessed January, 2005.
[520] Colman, Ronald. Memorandum prepared for the Nova Scotia Department of Transportation and Public Works. (**GPI***Atlantic*, July 23, 1998).
[521] Clark, Warren. *Traffic report: Weekday commuting patterns*. (Ottawa: Statistics Canada, 2000. Catalogue no. 11-008). www.statcan.ca/english/kits/pdf/social/traff2.pdfwww.statcan.ca/english/kits/pdf/social/traff2.pdf Accessed February, 2005.

Employers can also benefit from increased telecommuting, through reduced costs for office space, employee parking, and company vehicles.[522] Firms may achieve comparative advantage through lower overhead costs and extended customer service hours, particularly when such services are provided electronically. Telecommuting also offers employers a flexible recruitment tool that can be used to attract skilled employees from a wider potential pool in a competitive global labour market. Telecommuting may reduce absenteeism, as employees can use technology to work from home during an illness, or on personal/family need days.[523] Other potential benefits include increased productivity, improved staff retention, and better public relations.

The direct benefits of working from home were reviewed in a survey by Ekos Research Associates. Of the Canadians who worked from home, 68% said that it improved their quality of life; 60% stated that it improved their working hours; 57% noted that it improved their finances; and 56% found that working from home improved their standard of living. Even with respect to career advancement—often considered a drawback of working from home—49% of respondents stated it would have a neutral impact and 36% felt that it would have a positive effect.[524]

Telecommuting can also benefit society at large. To the degree that it reduces vehicle travel, it can reduce congestion, roadway costs, accidents, and pollution emissions. It can increase the availability of jobs in rural areas and reduce the need to migrate to urban centres in search of work.[525] Telecommuting may even improve neighbourhood security by increasing the number of people at home during work hours.[526]

In a previous study **GPI***Atlantic* estimated that considering a wide range of costs, including environmental externalities, telecommuting costs add up to approximately 20% of automobile commuting costs. An analysis of just the internal (user-paid) expenditures found that telecommuting still involves only 30% of the cost of automobile commuting.[527] **GPI***Atlantic* found that "telecommuting just two days per week would save $2,200 annually per employee [in Nova Scotia] when travel time, fuel, parking, accident, air pollution and other environmental and social costs are included."[528]

However, telecommuting can also create problems. Employees may feel pressured to work longer hours when there are fewer boundaries to work, which can increase stress.[529] There is also concern that a growing telecommuting labour force leads to more contract work and fewer full-time positions with benefits. Another perceived drawback is that working from home may reduce

[522] Wolf, Judy. "Telework: An Overview of Benefits." (2002).
www.judywolf.com/articles_pr/articles_news/telework_benefits_overview.html
www.judywolf.com/articles_pr/articles_news/telework_benefits_overview.htmlAccessed January 2005.
[523] Canadian Telework Registry. (2004).
[524] Ekos Research Associates. *Canadians and Working From Home*. (Ottawa: 2001).
www.ekos.ca/admin/press_releases/telework4.pdf
[525] Telework Connection. (2000).
[526] Wolf. (2002).
[527] Colman, Ronald. Memorandum prepared for the Nova Scotia Department of Transportation and Public Works. (**GPI***Atlantic*: July 23, 1998).
[528] Ibid., and Colman, Ronald. "How do we Measure Progress?" (Halifax: *Shambala Sun*. November, 1999).
www.shambhalasun.com/Archives/Features/1999/Nov99/colman.htm Accessed February 2005.
[529] United States Department of Transportation. *Transportation Implications of Telecommuting*, pp. 41-42. (1992).
http://ntl.bts.gov/DOCS/telecommute.html Accessed January, 2005.

career advancement opportunities, although the Ekos survey noted above found that only a small proportion of Canadians who worked from home actually had this experience, while considerably larger numbers reported that working from home either had no adverse impact on career advancement opportunities or actually improved such opportunities.[530] Telecommuting can also potentially reduce the social contact and relationships formed in workplaces, increase isolation, and reduce the learning opportunities that result from employee interaction. From the perspective of the employer, there are concerns regarding the management and supervision of employees in remote locations.

It is important to be aware of the negative aspects of using modern telecommunications to work from home. Nonetheless, some of those potential drawbacks can be overcome by combining telework with workplace commitment—working from home part of the week and travelling to the office for meetings, consultations, and aspects of work that require employee interaction and physical presence. From a transportation perspective, there is substantial evidence that telework can produce significant economic, environmental, and social benefits. On balance, therefore, this study considers improved access to the Internet, as well as an increase in the number of workers working from home, to have the potential to lead to greater sustainability in the transportation sector.

The Indicators

The Centre for Sustainable Transportation does not directly address the potential impact on transport activity of home Internet access, or working from home, in its indicator set. However, the CST has discussed and considered including the proportion of the labour force regularly telecommuting as an addition to its indicator set in the longer term.[531] In this discussion, the CST has drawn attention to the reduced work-related travel that occurs among people involved in telecommuting. It has noted further that although telecommuting may lead to increased non-work travel, as many non-work errands and trips are no longer combined with daily travel to and from work, the end result is still a net reduction of motorized travel among teleworkers.

The CST outlined potential telework-related indicators for future development, including the share of households with a computer and an Internet connection. The conclusion of CST's discussion on this issue was that use of this indicator could encourage more widespread consideration of the impact of telework on transport activity and transport-related energy use, and thereby promote the wider adoption of telecommuting and teleconferencing technologies. An increase in the availability of these technologies would in turn encourage more people to use them, resulting in a potentially significant and environmentally beneficial overall decline in transportation activity.

The indicators considered in this chapter as having the potential to reduce overall transport activity include:

- Percentage of households with Internet, and

[530] Ekos Research Associates. (2001).
[531] Gilbert et al. (2002, p. 83).

- Percentage of the labour force working from home.

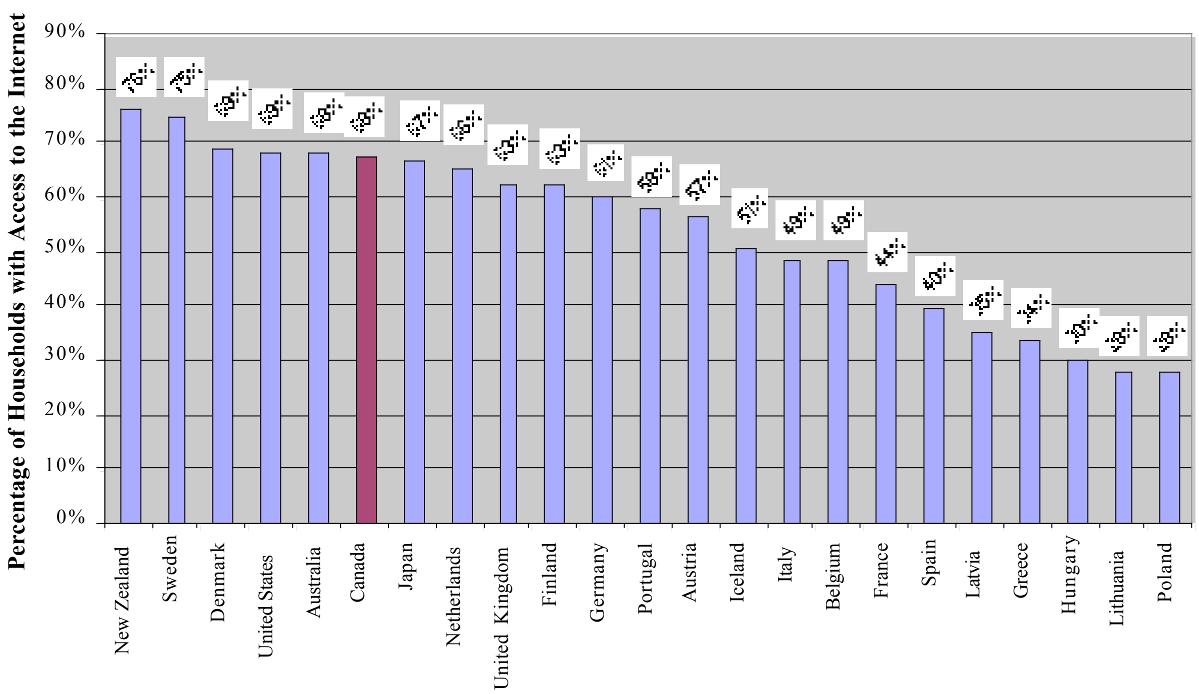
For both indicators, an **increase** over time indicates potential movement towards sustainability.

The data for these indicators came from a variety of sources. International statistics were taken from a report by Millard, Mitchell et al. for the European Commission,[532] as well as from Internet World Stats.[533] The main sources for Canadian data were the Nova Scotia *Statistical Review* and the Statistics Canada Population Censuses of 1996 and 2001.

Trends: International

Figure 173 shows the portion of households with access to the Internet in 23 selected peer countries. Canada has the sixth highest percentage of households having Internet access in mid-2006 (68%), nearly identical to the United States (69%), and just 8 percentage points lower than top ranking New Zealand (76%). Current international data regarding telecommuting or working from home were not found.[534]

Figure 173. Peer Countries: Percentage of Households with Access to the Internet, 2006.



Source*: Internet World Stats*. www.internetworldstats.com/stats.htm

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[532] Millard, Jeremy, Horace Mitchell, et al. *Status Report on European Telework: New Methods of Work 1999*. (European Commission, 1999). www.eto.org.uk/twork/tw99/pdf/tw99def.pdfwww.eto.org.uk/twork/tw99/pdf/tw99def.pdf Accessed January, 2005.

[533] The home page for the statistics is www.internetworldstats.com/stats.htm.

[534] The most recent international data found were from 1999. These data were not presented here because they are outdated, especially for such a rapidly changing reality.

International data regarding telecommuting or working from home are limited. One report that provides a very general overview of international telecommuting numbers is a 1999 study by Millard, Mitchell, and collaborators.[535] Finland had the highest percentage of the workforce telecommuting (9.0%), and Sweden was second with 6.8%, followed by the Netherlands (6.3%) and Denmark (5.9%).[536] This is roughly consistent with the data in Figure 173 above, showing Sweden, Denmark, and the Netherlands with high rates of household Internet access. Among the ten countries analysed by Millard, Mitchell et al., France (1.43%), and Spain (1.54%) had the lowest rates of telecommuting. The EU average is only 2.88%.

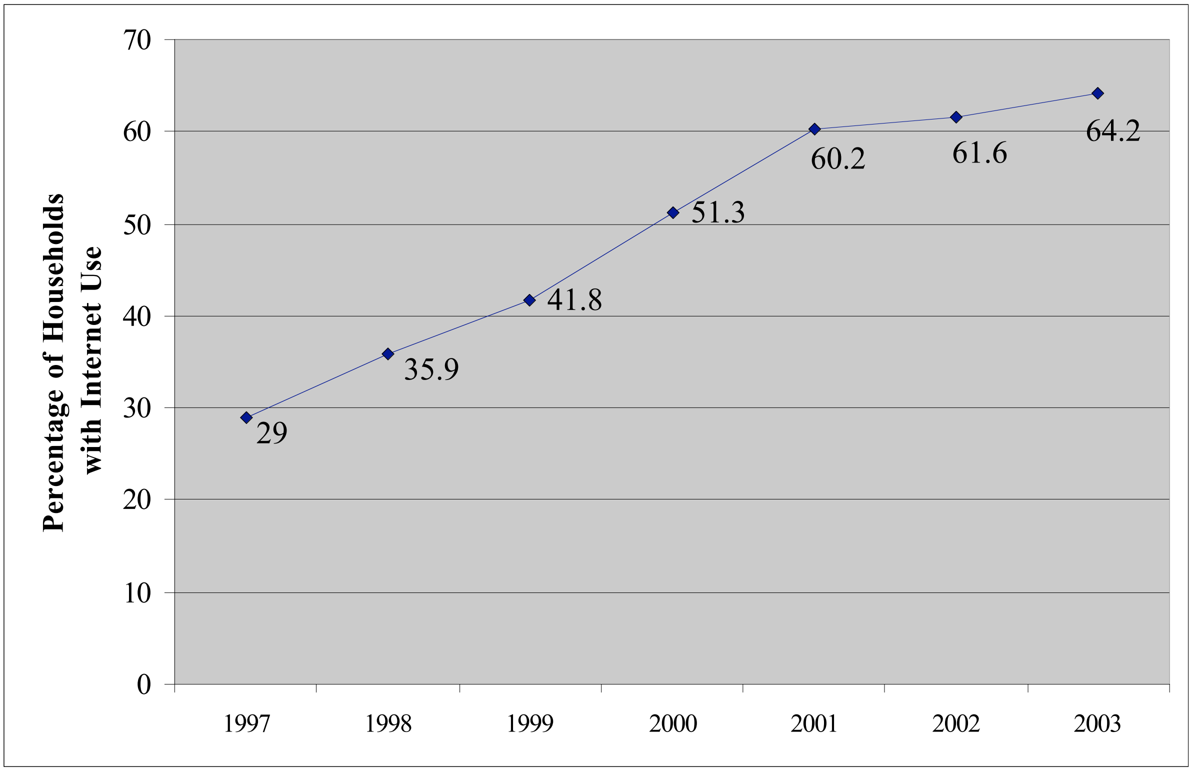
Canada was not included in this study, but the results show that, among European countries, rates of six to nine percent of the workforce telecommuting are relatively high. These European results will help put the Canadian data in the following section into a broader context.

Trends: Canada

An analysis of the percentage of Canadian households with Internet access shows a dramatic increase between 1997 and 2003 (Figure 174). The proportion more than doubled from less than one third of households in 1997 to almost two-thirds in 2003, an increase of over 121%.

[535] Millard, Jeremy, Horace Mitchell, et al. (1999).www.eto.org.uk/twork/tw99/pdf/tw99def.pdf
[536] These figures are based on combining two categories of data used by Millard, Mitchell et al. in their analysis of the European workforce: 1) home-based telework, which refers in this study to individuals who worked a minimum of one full day per week at home and were paid by an employer and 2) individuals who were self-employed and whose normal place of work was an office at home. While self-employed work from a home office may possibly include some non-electronic enterprises, it has become increasingly associated with telecommuting, and is therefore used here, along with employer-paid telework, as a proxy for telework.

Figure 174. Canada: Percentage of Households with Internet Use, 1997-2003.



Source: Nova Scotia Department of Finance. *Nova Scotia Statistical Review 2001* and *2004*.

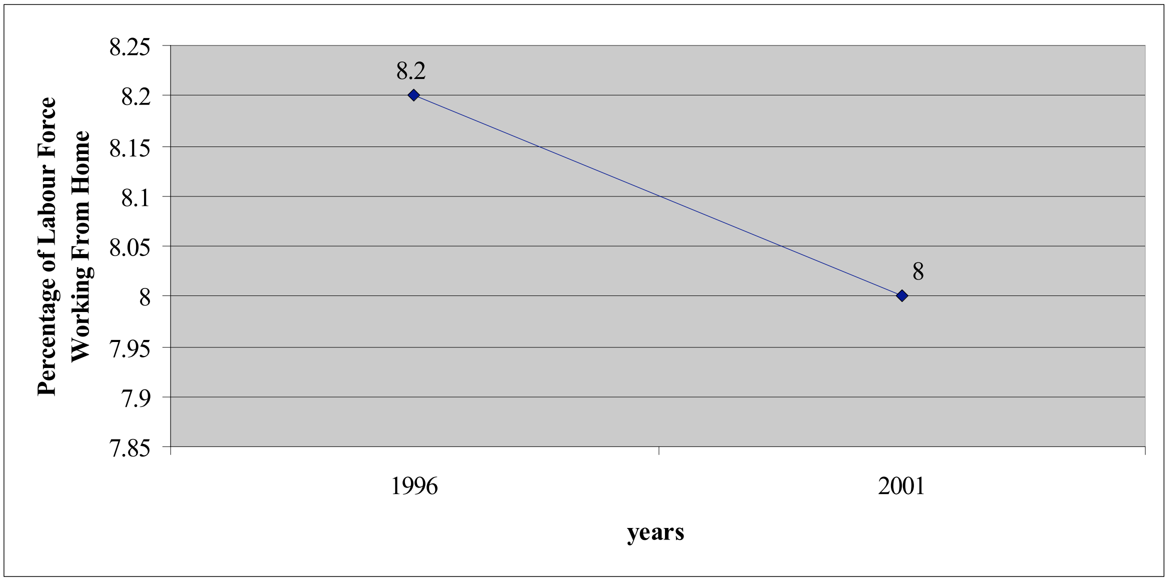
Comparable data on the percentage of the Canadian labour force working from home were collected in the 1996 and 2001 Censuses, limiting the analysis to just these two years (Figure 175). The 1996 Census definition of working at home was "persons whose job is located in the same building as their place of residence; persons living and working on the same farm."[537] The 2001 census definition of working at home was slightly expanded to include "building superintendents and teleworkers who spend most of their work week working at home."[538] The "working from home" definition clearly includes non-electronic enterprises and cannot be equated solely with telework.

Figure 175 shows that the percentage of the Canadian labour force working from home fell very slightly, from 8.2% in 1996 to eight percent in 2001. Although the scale on the graph makes the decline seem more significant than it was, the decrease was quite minimal (2.4%).

[537] Statistics Canada. Definitions and Notes—Employed labour force by place of work, provinces and territories (1996 and 2001 Censuses). (February 8, 2005). www.statcan.ca/english/Pgdb/deflabor40b.htmwww.statcan.ca/english/Pgdb/deflabor40b.htm Accessed February, 2005.

[538] Ibid.

Figure 175. Canada: Percentage of Labour Force Working From Home, 1996 and 2001.



Source: Statistics Canada. Employed Labour Force by Place of Work, by Provinces and Territories (1996 and 2001 Censuses)www.statcan.ca/english/Pgdb/labor40a.htm and www.statcan.ca/english/Pgdb/labor40b.htm.

Note: The scale of the graph exaggerates the decline in persons working from home. In fact, the decrease was quite minimal (2.4%).

Other, independent research has put the number of Canadians working from home slightly higher than the Statistics Canada Census figures shown above. A survey conducted by Ekos Research found that, in late 2000, 11% of employed Canadians primarily worked from home.[539] Furthermore, four in 10 employed Canadians reported that they work from home at least some of the time, whether this is overtime, telework, or time spent on their own business.

Again, care must be taken in comparing the results of different surveys that use different definitions and terms of reference. Nevertheless, it is noteworthy that the Ekos survey also found that the idea of working at home is agreeable to many Canadians. One in two respondents found the idea at least somewhat appealing, while 27% stated that working from home would be "extremely" appealing. This does give some indication of the potential for expanding telework opportunities in Canada, and indicates that such expansion would likely be well received by many employees.

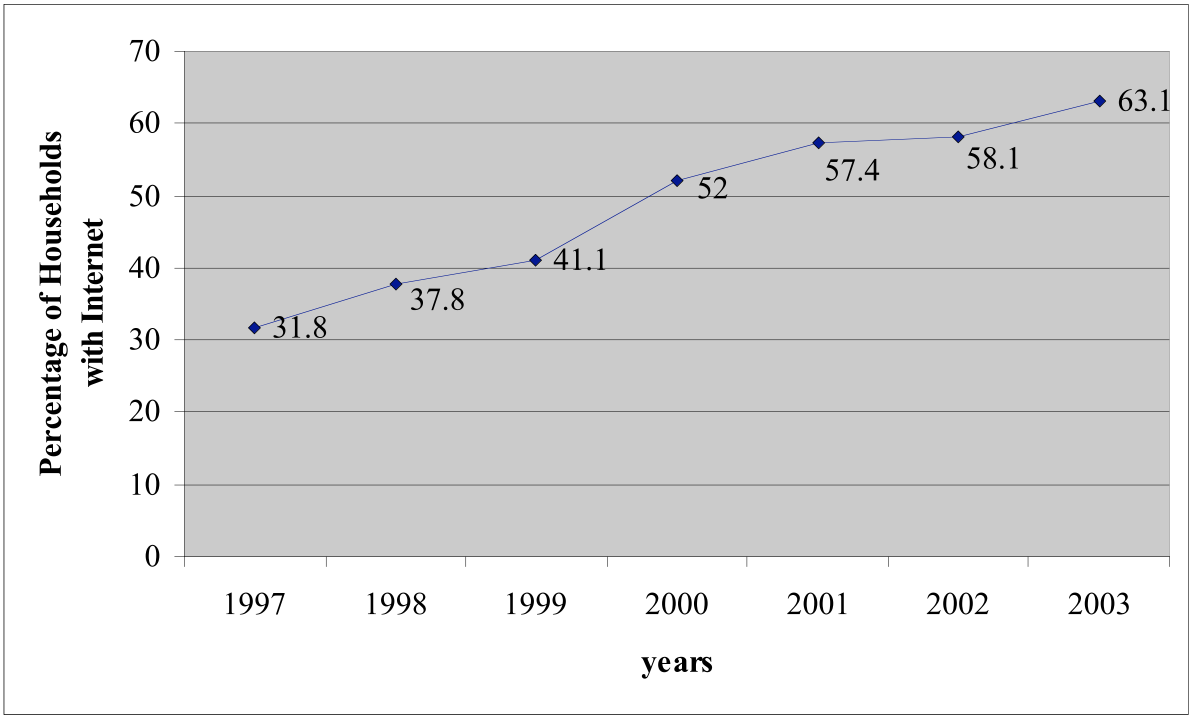
Trends: Nova Scotia

The data for Nova Scotia demonstrate trends similar to those at the national level. Figure 176 presents the first indicator for this section, the percentage of households in Nova Scotia connected to the Internet. In 1997, 32% of households in Nova Scotia had Internet access, and this nearly doubled to 63% in 2003—an increase of over 98%. The provincial percentage was

[539] Ekos Research Associates. (2001).

slightly above the Canadian average in 1997 (Figure 174), and just below the Canadian average in 2003. This increase in household Internet use in Nova Scotia indicates at least a potential for movement towards greater transportation sustainability in the province, as it provides a growing potential for telecommuting and, therefore, for reduced transport activity in Nova Scotia.

Figure 176. Nova Scotia: Percentage of Households with Internet Use, 1997-2003.

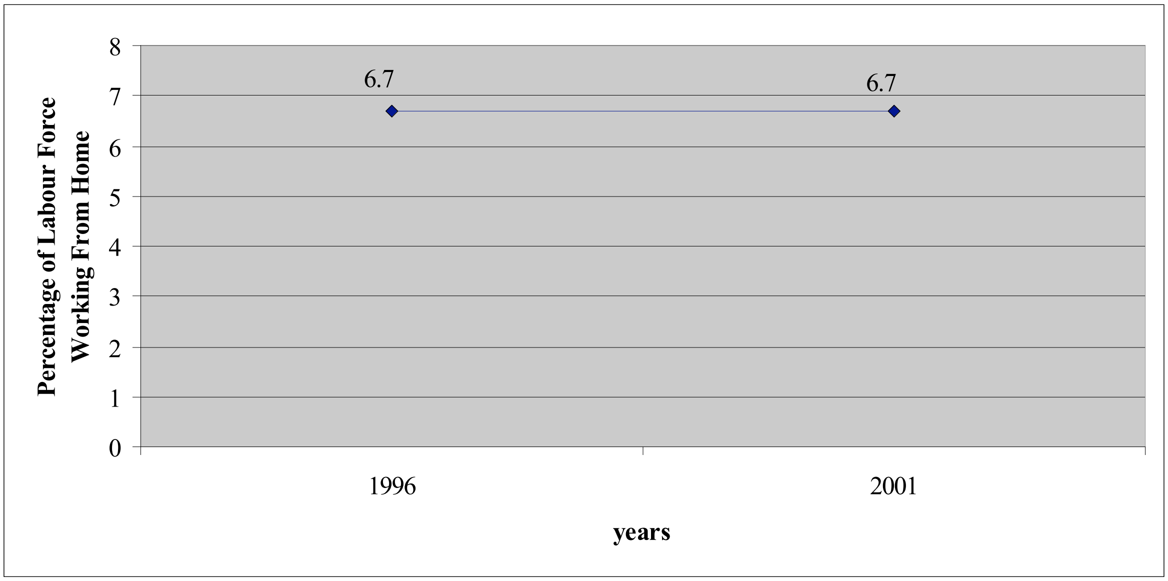


Source: Nova Scotia Department of Finance. *Nova Scotia Statistical Review 2001* and *2004*.

Figure 177 presents the second indicator for this section, the percentage of the Nova Scotia labour force working from home. As with the national data in Figure 175, only two Census years are available, 1996 and 2001, in which this question was asked in comparable ways. The percentage of the Nova Scotia labour force working at home remained steady at 6.7% during this period.

When compared with the national data in Figure 175, Nova Scotia falls 16 to 18% below the Canadian average for both of the years measured. The static results for Nova Scotia for the term studied prevent an assessment with respect to movement towards sustainability, but they do indicate that the considerable potential for telecommuting and reduced transport activity indicated in Figure 176 are not yet being realised. The reasons that increased Internet access is not yet being converted to higher rates of telecommuting merit careful study and consideration, and can provide important information for policy makers concerned to realise this apparently untapped potential to improve transportation sustainability.

Figure 177. Nova Scotia: Percentage of Labour Force Working From Home, 1996 and 2001.



Source: Statistics Canada. Employed Labour Force by Place of Work, by Provinces and Territories (1996 and 2001 Censuses).

Conclusion

Canada had the sixth highest percentage of household internet access in comparison to 23 selected peer countries, for which data were available in 2006 (Figure 173). A national analysis showed that 64% of Canadian households had use of the Internet in 2003, and that this percentage had more than doubled since 1997 (Figure 174).

Canadian data from the 1996 and 2001 Census years indicates that 8.0% of the Canadian labour force worked from home in 2001 compared to 8.2% in 1996 (Figure 175). It is important to note that the Census "working from home" definition clearly includes non-electronic enterprises and cannot be equated solely with telework.

The results for Nova Scotia showed similar patterns, with the proportion of households with Internet access almost doubling from 1997 to reach 63% in 2003 (Figure 176). The proportion of the Nova Scotian labour force working from home remained unchanged between the 1996 and 2001 Census years at 6.7% (Figure 177).

It is clear that the rapid expansion in the number of households connected to the Internet is creating a large and growing latent market for telecommuting work options. This indicates a potential movement towards greater transportation sustainability. Although the results for the percentage of the labour force working from home in Nova Scotia remained stable, the growing number of households with use of the Internet may lead to an increase in the proportion of home office workers in the future. This indicator, on the proportion of the Nova Scotian labour force working from home, will need to be tracked over an extended period as only two years were available for study in this report.

Overall, Internet access, telework, and working from home are considered to increase sustainability by creating the potential for a net reduction in aggregate transport activity. Telework can provide direct social and financial benefits to users. Employers can also benefit from reduced overhead costs, increased productivity, and improved recruitment, since many employees appreciate the flexibility and savings it provides. However, there is some debate as to the overall impacts of telework on transportation, since it tends to stimulate longer (though less frequent) commute trips, dispersed land use development patterns, non-commute vehicle travel, and longer-distance social relationships that can increase total motor vehicle travel. Nevertheless, the Centre for Sustainable Transportation has concluded that, even when all these factors are taken into account, the end result is still a net reduction of motorized travel among teleworkers. The quantification of that net benefit and of the transport activity trade-offs noted in this chapter, is an important task for future research.

Chapter 13. Transportation Accidents

Transport accidents are a leading cause of disability and death.[540] According to a major study conducted by the Harvard School of Public Health, vehicle crashes are the eighth most common cause of death and disability in developed countries, and tenth in developing countries.[541] In the 15-44 age group, traffic accidents are the leading cause of injury and death for men and the fifth most frequent cause for women. Vehicle crashes are projected to become the world's third most common cause of death, if present trends continue.[542] Because they tend to kill and injure people at a much younger average age than most other major medical risks such as cardiovascular diseases and cancer, traffic accidents are a leading cause of potential years of life lost (PYLL), a key measure of risk in population health indicators.[543] Transport accidents also impose economic costs, including property damages, medical and rehabilitation expenses, disability compensation, and lost productivity. Accordingly, reductions in traffic accidents and casualties (people injured and killed) constitute a movement towards transportation sustainability from both social and economic perspectives.[544]

Motor vehicle crash risk can be measured in two different ways, producing two different conclusions about the degree of danger and the effectiveness of various safety strategies.[545] Transportation professionals usually measure crash rates per unit of travel (i.e., injuries and fatalities per billion vehicle-kilometres). Evaluated in this way, crash rates have declined significantly during the last four decades, indicating that traffic safety programs have been relatively successful and should be continued to further increase traffic safety. But per capita vehicle mileage has increased significantly over this period, which has largely offset the decline in per-kilometre crash rates.[546] When fatalities and injuries are measured on a *per capita* basis (e.g., per 10,000 population), as with other public health risks, there has been surprisingly little improvement over this period despite large investments in safer roads and vehicles, increases in the use of crash protection devices, reductions in drunk driving as a result of more severe penalties, and improvements in emergency response and trauma care. Figure 178 compares these two different ways of measuring traffic crash risk, using U.S. data, since comparable time-series data comparing these two assessment methods are unavailable in Canada.

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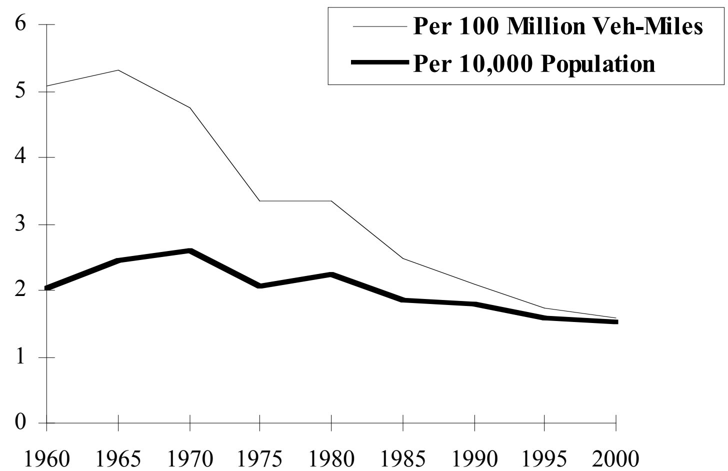
[540] Health Canada and Transport Canada. *Road Safety in Canada—an Overview*. (March 11, 2004). www.hc-sc.gc.ca/datapcb/iad/whd_roadsafety_overview-e.htm Accessed January, 2005.
[541] Murray, Christopher and Alan Lopez (eds). *The Executive Summary of The Global Burden of Disease and Injury Series*, p. 18. (Cambridge: Harvard University Press, 1996). www.hsph.harvard.edu/organizations/bdu/GBDseries_files/gbdsum2.pdf . Accessed January, 2005.
[542] Murray, Christopher and Alan Lopez (eds). *The Global Burden of Disease Publication Series – Section 6: Looking ahead: the health of the world in 2020 Series*, p. 38. (Cambridge: Harvard University Press, 1996). www.hsph.harvard.edu/organizations/bdu/GBDseries_files/gbdsum6.pdf . Accessed January, 2005.
[543] World Health Organization, *World Report on Road Traffic Injury Prevention*. (World Health Organization and World Bank, 2004) www.who.int/entity/world-health-day/2004/infomaterials/world_report.
[544] Litman, Todd. "Traffic Safety," *Transportation Cost And Benefit Analysis*. (Victoria Transport Policy Institute, 2006c). www.vtpi.org
[545] Litman, Todd and Steven Fitzroy. *Safe Travels: Evaluating Mobility Management Traffic Safety Benefits*. (Victoria Transport Policy Institute, 2005) www.vtpi.org
[546] National Highway Traffic Safety Administration. *Traffic Safety Facts 2001*. (National Highway Traffic Safety Administration, 2002). www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/TSF2001/2001occpro.pdf

Figure 178. U.S. Traffic Fatalities



Source: Bureau of Transportation Statistics. *Transportation Safety Data*. (Bureau of Transportation Statistics, USDOT, 2000).

Note: This figure illustrates traffic fatality trends in the U.S. over four decades. Per mile crash rates declined substantially, but per capita crash rates declined little despite significant traffic safety efforts that include expensive measures like highway twinning.

Traffic risks varies significantly by mode and according to how this risk is measured, as indicated in Table 28. For example, public transit travel has only about one-twentieth the fatality risk per passenger-kilometre as automobile travel.[547] Larger, heavier vehicles, such as trucks and SUVs, tend to be safer for occupants in multi-vehicle collisions, but are more likely to harm other road users, and tend to have more single-vehicle crashes, and so are not significantly safer overall.[548] Non-motorized modes (walking and cycling) tend to have relatively high injury rates per mile of travel, but impose minimal risk on other road users. As well, shorter walking or cycling trips often substitute for much longer automobile trips, thereby reducing aggregate crash risks. As a result, the evidence indicates that overall per capita crash rates tend to decline with increased walking and cycling in a community.[549] Walking has about ten times the *per mile* fatality rate as automobile travel, about a 40% higher rate *per hour* of travel, and about the same risk *per trip*.

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[547] Litman, Todd. *Transportation Cost Analysis: Techniques, Estimates and Implications*, p. 5.3-13. (Victoria Transport Policy Institute, 2003c). www.vtpi.org/tca/tca0503.pdf Accessed January, 2005.

[548] Kockelman, Kara Maria and Young-Jun Kweon. "Driver Injury Severity." (*Accident Analysis and Prevention*, Vol. 34, No. 3, 2002, pp. 313-321) www.ce.utexas.edu/prof/kockelman/home.html.

[549] Jacobsen, Peter L. "Safety In Numbers: More Walkers and Bicyclists, Safer Walking and Bicycling." (*Injury Prevention*, Vol. 9, pp. 205-209, 2003). http://ip.bmjjournals.com

Table 28. User Fatality Rate by Mode, United Kingdom.

	Total Deaths	Miles*	Deaths Per Billion Miles Travelled	Annual Trips Per Capita	Deaths Per Billion Trips	Annual Hours Travelled Per Capita	Deaths Per Billion Hours
Walk	767	192	*69*	245	*54*	64	*208*
Bicycle	129	34	*66*	14	*155*	5	*467*
Motorcycle/moped	609	36	*297*	3	*3,170*	1	*7,777*
Car/Van/Lorry	1,880	5,540	*6*	627	*52*	222	*147*
Public Transit	19	1,031	*0.32*	101	*3.3*	69	*4.8*
Totals	3,404	6,833	*8.7*	990	*59.8*	361	*163.8*

Source: Department for Transport. *2003 National Travel Survey* and *Road Casualties Great Britain*. (UK Department for Transport, 2003). Note: This table compares traffic fatality rates for various modes, using mileage, trips, and hours as denominators. This only indicates risk to users, but not to others.

Table 28 only reflects deaths to the mode user. Comprehensive safety analysis also considers risks imposed on others. For this type of analysis, injuries that result from crashes between heavy and light vehicles (including motorcycles, bicycles, and pedestrians), are generally assigned to the heavy vehicle on the assumption that the small vehicle would be less damaged had it crashed with a similar weight vehicle, since this analysis is concerned with physical impacts, not the legal responsibility for the crash. Table 29 indicates transportation accident fatalities both to users and to others, providing a more comprehensive perspective of risk.

Table 29. U.S. Transportation Fatalities, and Fatality Rates per Billion Miles of Travel, by Mode, 2001.

	Fatalities			Veh. Travel	Occupancy	Pass. Travel	Fatality Rate	
	User	Others	Totals	Billion Miles		Billion Miles	User	Others
Passenger Car	20,320	3,279	23,599	1,628	1.59	2,589	7.9	1.3
Motorcycle	3,197	19	3,216	9.6	1.1	10.6	303	1.8
Trucks – Light	11,723	3,368	15,091	943	1.52	1,433	8.2	2.3
Trucks – Heavy	708	4,189	4,897	209	1.2	251	2.8	16.7
Intercity Bus	45		45	7.1	20	142	0.3	-
Commercial Air						-	0.3	
Transit Bus	11	85	96	1.8	10.8	19	0.6	4.4
Heavy Rail	25	6	31	0.591	24	14	1.8	0.4
Commuter Rail	1	77	78	0.253	37.7	9.5	0.1	8.1
Light Rail	1	21	22	0.053	26.8	1.4	0.7	14.8
Pedestrians	4,901	0	4,901	24.7	1	25	198	-
Cyclists	732	0	732	8.9	1	8.9	82.2	-

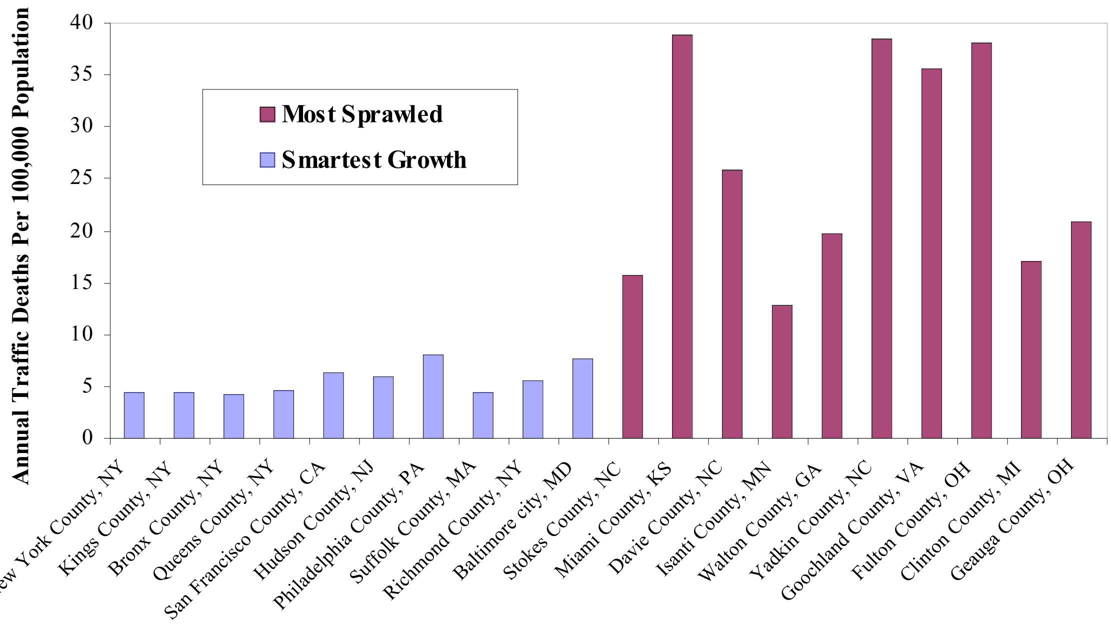
Sources: U.S. Bureau of Transportation Statistics, *National Transportation Statistics*. (2003, Tables 1-32, 2-1 and 2-4); American Public Transportation Association. *Safety Summary By Mode*. (2003). For pedestrian and cycling mileage: Federal Highway Association. *National Bicycling and Walking Study Ten Year Status Report*. (2004).

Note: Assumes 0.7 mile average walking trip and 2.3 mile average cycling trip length. Light truck "Others" deaths are calculated based on a portion of pedestrian deaths, plus 1,282 additional automobile passenger deaths over what would occur if car/truck collisions had the same car occupant fatality rate as car/car collisions, based on analysis by Gayer, 2001. This estimate is conservative because it does not account for the higher per mile collision involvement rates of light trucks compared with passenger cars.

This table indicates traffic fatality rates per billion miles of travel for various modes.

Many factors affect traffic crash and casualty rates, including total per capita annual vehicle travel, driver demographics and behaviour, vehicle and road design, travel conditions, and geographic location. Increased land use density and traffic congestion tend to increase *crash rates per vehicle-kilometre*, but reduce *traffic fatalities per capita*, due to less per capita mileage travelled and less severe crashes at slower speeds. As a result, per capita traffic fatality rates tend to be significantly higher (about four times higher) in automobile-dependent, sprawled communities than in more accessible, "smart growth" communities where residents drive less and rely more on alternative modes of transport, as illustrated in Figure 179.

Figure 179. Annual Traffic Death Rate, per 100,000 Population, in Various U.S. Cities, 2003.



Source: Ewing, Reid, Richard Schieber and Charles V. Zegeer. Urban Sprawl As A Risk Factor In Motor Vehicle Occupant And Pedestrian Fatalities," *(American Journal of Public Health*, 2003, Vol. 93, No. 9, pp. 1541-1545).

Note: The ten communities with the lowest sprawl rating have, on average, about a quarter of the per capita annual traffic fatality rates of the most sprawled communities. (Sprawl rankings as assessed by Reid et al. 2003).

The Indicators

The Centre for Sustainable Transportation tracks transportation accidents primarily through a composite and weighted indicator that accounts for the number of Canadian collisions, fatalities, and injuries since 1990. The CST has released results to 1998. In order to calculate results for this composite indicator, the CST assessed one fatality as being equivalent to seventy injuries. The CST also compared trends in the incidence of collisions, fatalities, and injuries per 100,000 registered vehicles. For both these indicators, the CST obtained its data from Transport Canada's T-facts database.[550]

This study examines a number of safety indicators that all use the number of traffic accidents, injuries, and fatalities as their basis of measurement. Statistics are also analysed by vehicle type. Trends are analysed for different modes of transportation on the basis of the rates per capita at which accidents and casualties (injuries and fatalities) are occurring.

Nova Scotian road accident, injury, and fatality data were mostly obtained from the province's Department of Transportation and Public Works (DTPW). Statistics on rail, marine, and air accidents were taken from Transport Canada's 2002 and 2003 Annual Reports.

Vehicle accident rates—including those involving fatalities or injuries in Nova Scotia—were calculated by multiplying the number of vehicles involved in accidents, as well as the number of vehicles involved in fatalities or injuries, by population figures from Statistics Canada sources. As noted, the raw accident data (numbers of occurrences) were obtained from the Nova Scotia DTPW.

The years for which statistics were available varied, depending on the source and type of data. Most of the national records date back to 1990, although accidents rates only became available as part of Transport Canada's Annual Reports in 2000. The figures provided by the DTPW date back to 1994 for most vehicle types, but there were gaps in the data for off-road vehicles and buses between 1994 and 1995. To ensure comparable provincial statistics for the different vehicle types, trends in this chapter are presented for the period 1996-2003.

The indicators used to analyse transportation accidents in this chapter include:

1. Traffic fatalities per capita (per million or 100,000 population);
2. Traffic injuries per capita (per million or 100,000 population);
3. Number of vehicle accidents involving property damage (provincial data only);
4. Number of air, marine, and rail accidents;
5. Number of accidents involving dangerous goods; and
6. Number of fatalities and injuries involving dangerous goods (national data only).

These indicators largely focus on road transportation, simply because the bulk of transportation accidents occur on roads.[551]

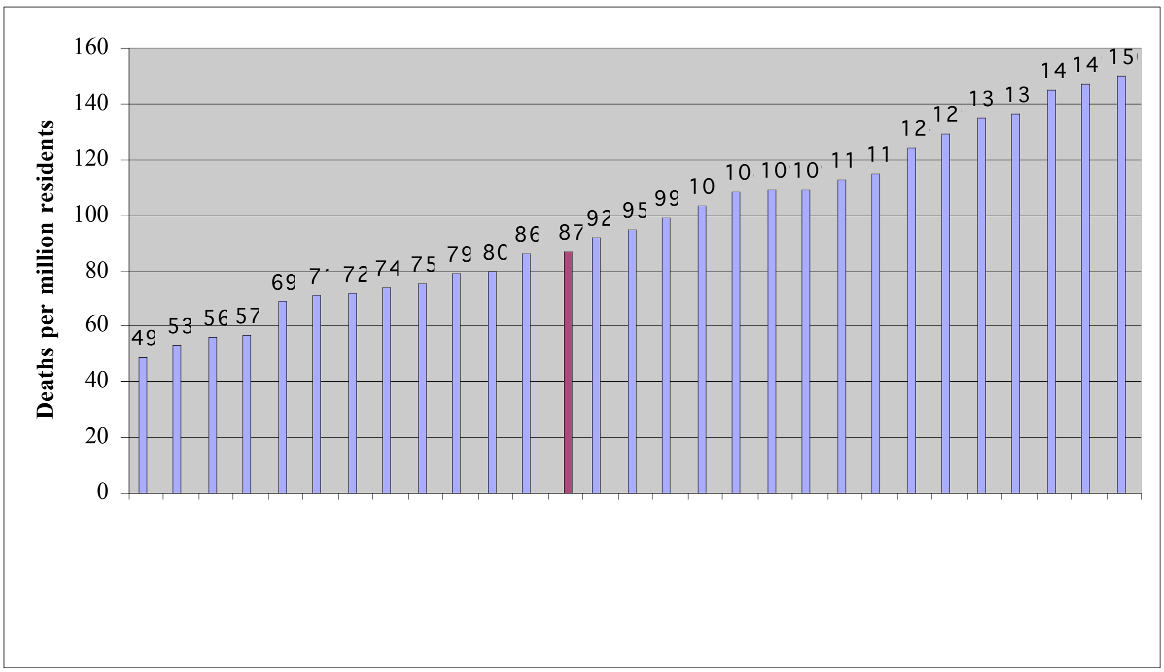
[550] Transport Canada. T-Facts Information System. (November, 21, 2003). www.tc.gc.ca/pol/en/T-Facts3/TFactsmenu_e.asp Accessed July, 2004.
[551] Transport Canada. *Transportation in Canada 2002: Annual Report*, p. 20. (Ottawa: Minister of Public Works and Government Services, 2002a). www.tc.gc.ca/pol/en/Report/anre2002/tc2002ae.pdf Accessed December, 2004.

Trends: International

Traffic Fatalities

Figure 180 records road accident fatalities, per million residents for 29 OECD country members and associates for the year 2004. The Netherlands, Sweden, and Norway had the lowest fatality rates, while Poland, South Korea, and the United States had the highest. Canada, with 87 traffic fatalities per million residents) ranks about average, 78% higher than the lowest ranking country (Netherlands – 49 per million) but 42% lower than the highest ranking country (Poland – 150 per million). As mentioned earlier, although the United States has a low traffic fatality rate per vehicle-mile, it has one of the highest per capita traffic fatality rates among developed countries (145 per million residents) due to high per capita vehicle mileage.

Figure 180. Traffic Fatalities Per Million Residents In OECD Countries, 2004.

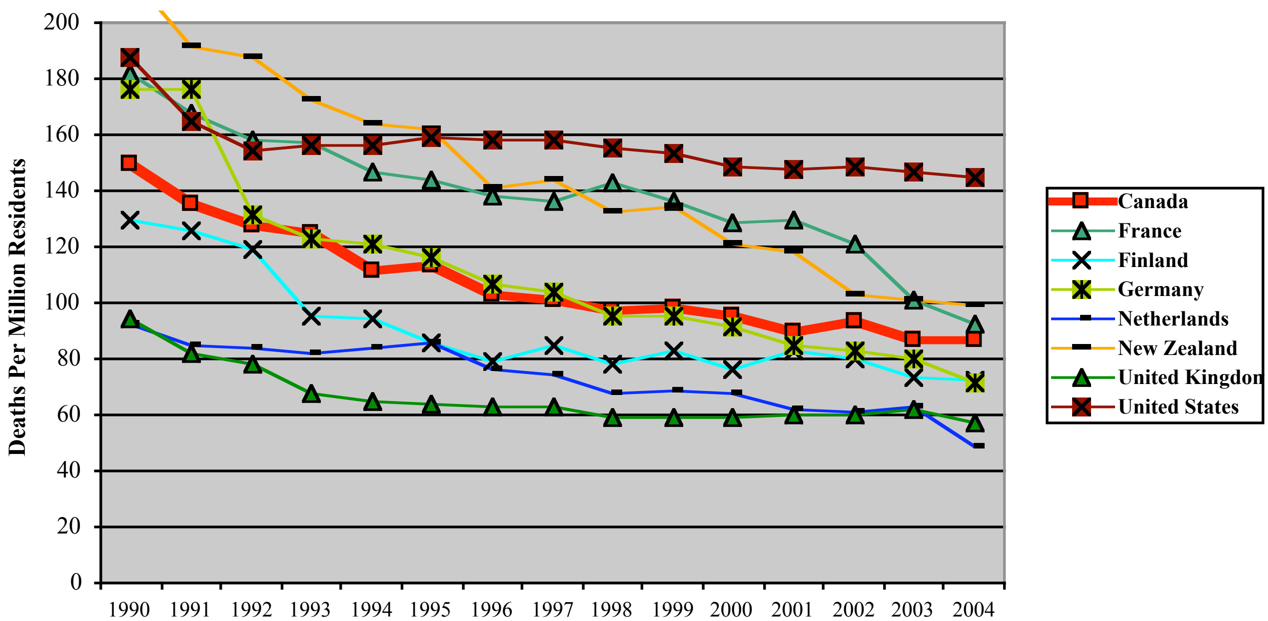


Source: Organization for Economic Cooperation and Development. *Factbook 2006: Economic, Environmental and Social Statistics*. (2006).

Most developed countries significantly reduced their per capita traffic fatality rates during the last decade, as shown in Figure 181. During this period, Canada's fatality rate declined from 150 to 87 deaths per million residents. In the most recent years declines have been small, and some countries have experienced traffic fatality increases, which may reflect increased cellular telephone use by drivers or other trends.[552]

[552] National Highway Traffic Safety Administration. *Motor Vehicle Traffic Crash Fatality Counts and Estimates of People Injured for 2005*. (National Highway Traffic Safety Administration, 2005). www-nrd.nhtsa.dot.gov/pdf/nrd-30/ncsa/ppt/2006/810639.pdf

Figure 181. Traffic Fatalities per Million Residents in Selected OECD Countries, 1990-2004.



Source: Organization for Economic Cooperation and Development. *Factbook 2006: Economic, Environmental and Social Statistics*. (2006).

Trends: Canada

Injuries and Fatalities from Road Accidents

Road accidents casualties (fatalities and injuries) have been steadily declining across Canada since 1990 (Figure 182). Injuries in thousands are shown on the left axis and fatality figures are shown on the right axis. By roughly equating the 1990 base year injury and fatality rates on this chart, the difference between the injury and fatality rates of decline is illustrated. Between 1990 and 2003, road transport fatalities in Canada decreased by 30% and injuries by 16%. Increased seat belt and child restraint use, improved emergency response, reduced rates of impaired driving along with heavy penalties for drunk driving, and improved vehicle and roadway design appear to have contributed to these reductions.[553] Transport Canada has initiated national programs designed to make driving less dangerous, beginning with its Road Safety Vision 2001, released in 1998 and continuing with Road Safety Vision 2010. The goal of Road Safety Vision 2010 is to reduce the incidence of death and of serious injury among road users by 30% by 2008-2010 (as compared with the 1996-2001 figures).[554]

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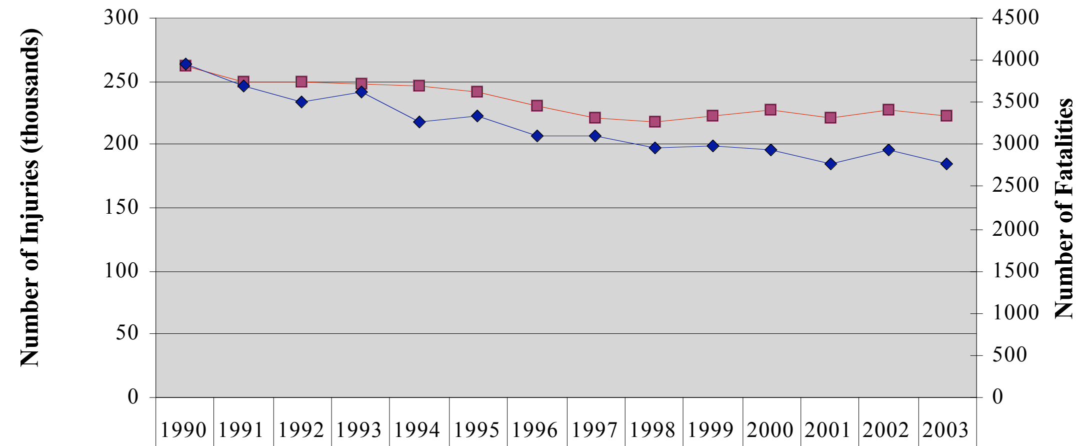
[553] Transport Canada. *2002 Annual Report on Road Safety Vision 2010*. p. 20. (Ottawa: Minister of Transport, 2002b). www.tc.gc.ca/roadsafety/vision/2002/pdf/rsv2002s.pdf Accessed July, 2004.
[554] Ibid.

Figure 182. Canada: Number of Casualties from Road Accidents, 1990-2003.



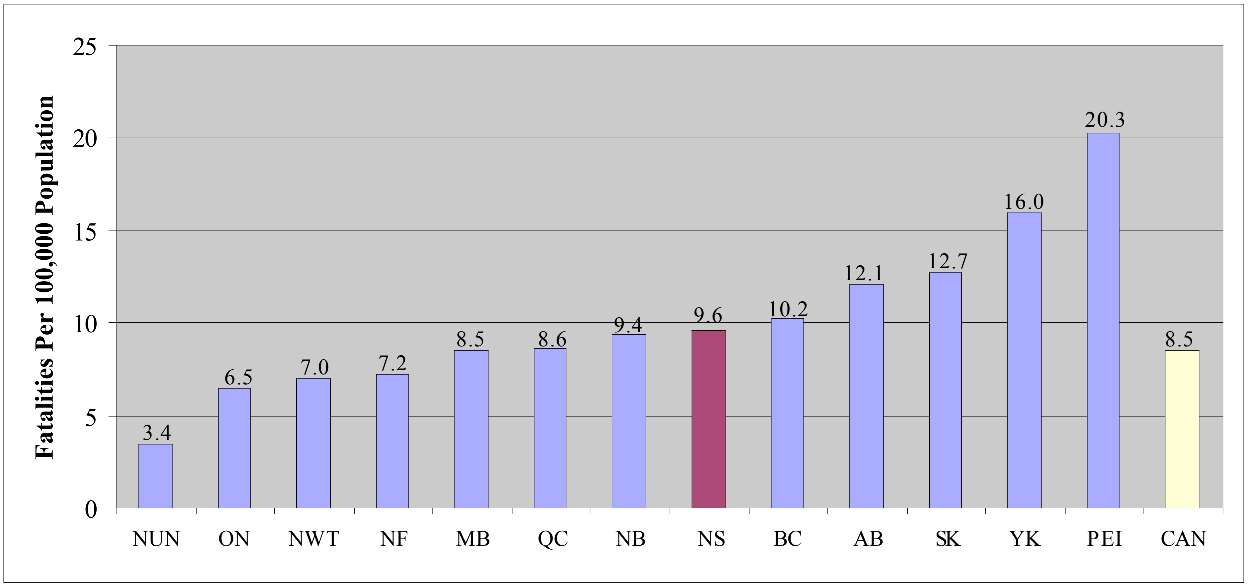
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Injuries (thousands)	263	249	250	248	246	242	231	221	218	223	227	221	228	222
Fatalities	3963	3690	3501	3615	3263	3351	3091	3094	2949	2985	2927	2781	2930	2778

Source: Transport Canada. *Canadian Motor Vehicle Traffic Collision Statistics*.[555]

As shown in Figure 183, Nova Scotia's fatality rate was 13% above national levels in 2004 (9.6 versus 8.5 traffic fatalities per 100,000 residents). Prince Edward Island had the highest number of traffic fatalities per 100,000 residents of any province in the country in 2004—almost 2.5 times the national average – and Ontario had the lowest traffic fatality rate among the provinces – 24% less than the national average. Nova Scotia's 2004 traffic fatality rate was nearly 50% higher than Ontario's. The unusually high PEI rate in 2004 may be a function of the province's small population, so that even a small change in aggregate fatalities can dramatically change the rate per 100,000 population.

[555] Transport Canada. *Canadian Motor Vehicle Traffic Collision Statistics*. (2004a). http://www.tc.gc.ca/roadsafety/tp/tp3322/2004/pdf/st2004e.pdf AccessedSept. 2006.

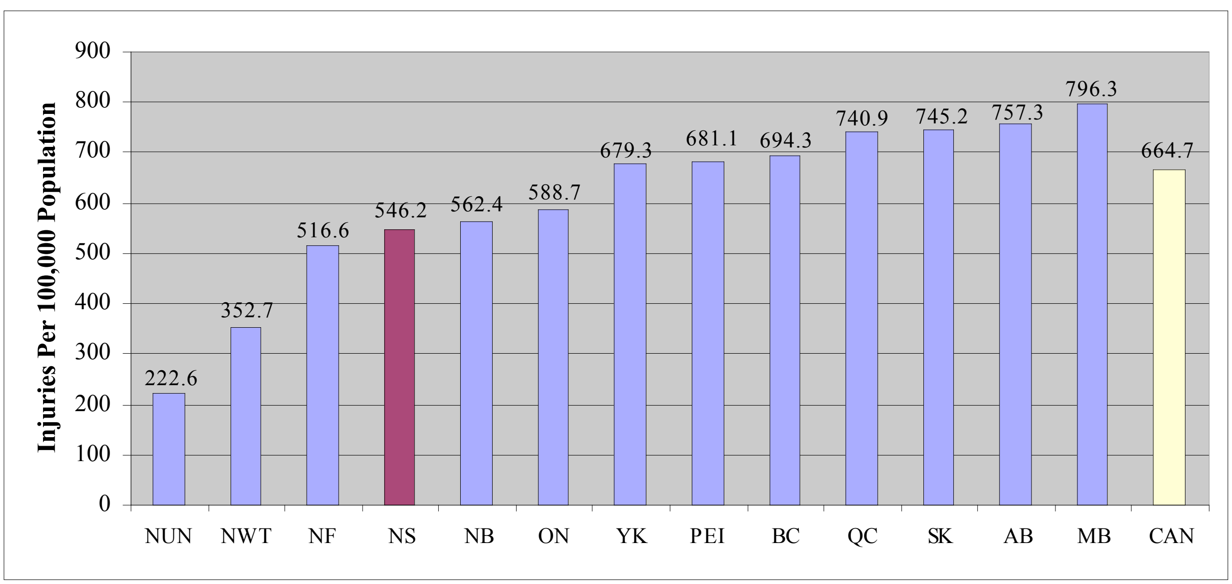
Figure 183. Traffic Fatalities per 100,000 Residents, by Province/Territory, 2004.



Source: Transport Canada, *Canadian Motor Vehicle Traffic Collision Statistics; 2004*. Page 4.

In 2004, Nova Scotia's injury rate for traffic accidents was 18% below the Canadian injury rate (Figure 184). The injury rate for Nova Scotia was 546.2 traffic injuries per 100,000 residents which was the fourth lowest injury rate in the country, and second lowest among all the provinces. The highest traffic injury rate in the country in 2004 was in Manitoba – 20% above the national average.

Figure 184. Traffic Injuries per 100,000 Residents, by Province/Territory, 2004.



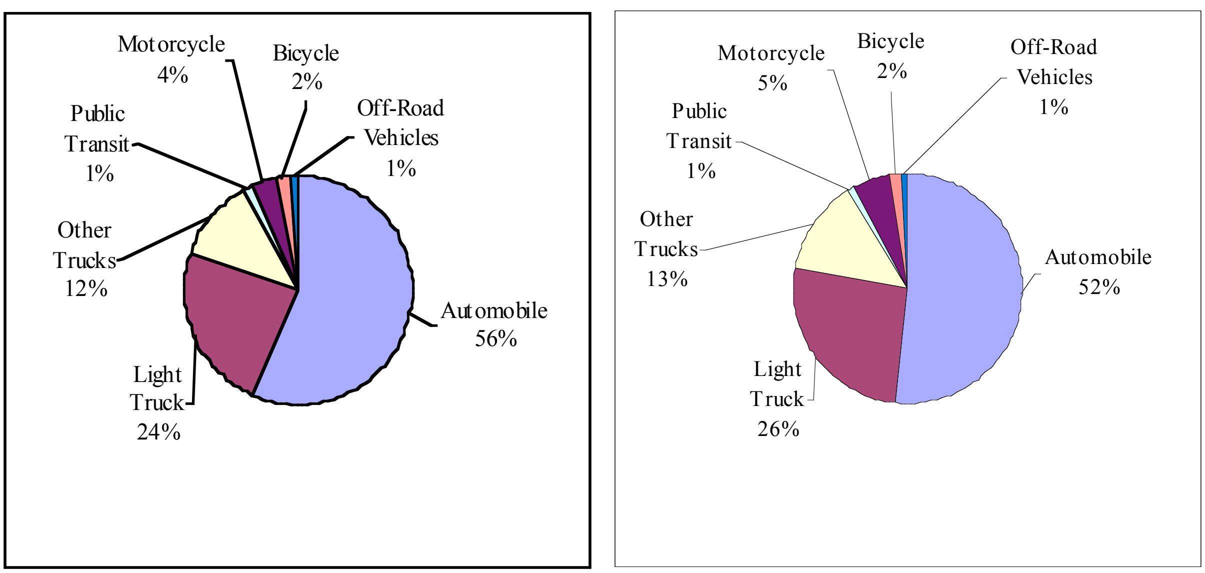
Source: Transport Canada, Canadian Motor Vehicle Traffic Collision Statistics; 2004. Page 4.

In 2004 there were 2,730 deaths in Canada due to motor vehicle collisions—a rate of 8.5 deaths per 100,000 population.[556] In the same year, there were 17,533 serious injuries that required hospital admissions due to traffic-collisions. Traffic accidents are a leading cause of premature death and long-term disability.[557]

Vehicle occupants typically account for approximately three-quarters of all road users killed or seriously injured in Canada. The remaining victims are pedestrians, motorcyclists, and bicyclists.[558, 559] Collisions involving these vulnerable road users claimed 522 lives in Canada in 2001.[560] Figure 185 shows vehicle fatalities by mode, in both 1994 and 2004. As shown, within this ten year span, little has changed in the ratios of the different vehicles involved in fatalities. The most significant changes are seen in the rise in vehicle fatalities in both motorcycles and light trucks, with increases of 1 and 2 percentage points, respectively. The percentage of other trucks involved in fatal collisions also increased by one percentage point. Automobiles accounted for correspondingly fewer fatal collisions (down from 56% in 1994 to 52% in 2004). This shift in responsibility for fatal collisions from cars to trucks reflects the increasingly higher percentage of light trucks (including SUVs, minivans, and pick-up trucks) on the road compared to cars, and the increased reliance on heavy trucks for freight traffic.

Figure 185. Canada: Percentage of Vehicles Involved in Fatal Collisions by Vehicle Type, 1994 and 2004.

1994 **2004**



Sources: Transport Canada. Transportation in Canada –Annual Report, Addendum (2000 and 2004).

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556 Transport Canada. (2004a).
557 Health Canada and Transport Canada. (March 11, 2004).
558 Ibid.
559 Transport Canada. (2004a).
560 Transport Canada. *Road Safety in Canada*, p. 21. (Ottawa: Minister of Transport, 2004b). www.tc.gc.ca/roadsafety/tp/tp13951/2001/pdf/tp13951es.pdf Accessed February, 2005.

Injuries and Fatalities from Off-Road Vehicle Accidents

According to the Task Force on Off-highway Vehicles, which operated under the auspices of the Voluntary Planning Agency – a government funded citizens' policy forum that operates at arm's length to the Nova Scotia government, 283 Canadians died from injuries related to off-highway vehicles, for the years 2001 and 2002.[561] Eleven percent of these fatalities were children between the ages of 1 and 14 years. The Task Force also reported that in 2002, 2,535 Canadians were hospitalized due to ATV injuries alone; 36% of these were children and youth. This represents a 50% increase in the number of injuries due to ATVs between 1997 and 2002. Nova Scotia, New Brunswick, and Alberta had the greatest increases in off-road vehicle accidents.[562]

Voluntary Planning also noted in its report that off-road vehicles are the number one cause of recreation-related major injuries in Canada. In 2002, off-road vehicle accidents accounted for 30% of all major sports and recreation injuries in the country. By comparison, cycling, in which far more Canadians participate, resulted in only 19% of such injuries.[563]

Air, Marine, and Rail Accidents

Air Accidents

The number of air accidents in Canada declined by 17% between 1997 and 2003, from 356 accidents in 1997 to 296 accidents in 2003.[564] Ontario, Quebec, and British Columbia had the most air accidents in both these years, while Nunavut, Prince Edward Island, and Nova Scotia had the fewest (Figure 186).

The average national accident rate (accidents per 100,000 itinerant aircraft movements) was 7.5 between 1997 and 2002.[565] Yukon (26.6), the Northwest Territories (14.9), and Saskatchewan (10.8) had the highest average air accident rates for this period. PEI (3.0), Nunavut (5.2), and New Brunswick (5.1) had the lowest air accident rates over this term. At 6.5 accidents per 100,000 itinerant aircraft movements, Nova Scotia's rate was somewhat below the Canadian average, and the fifth lowest rate of Canada's provinces and territories.[566]

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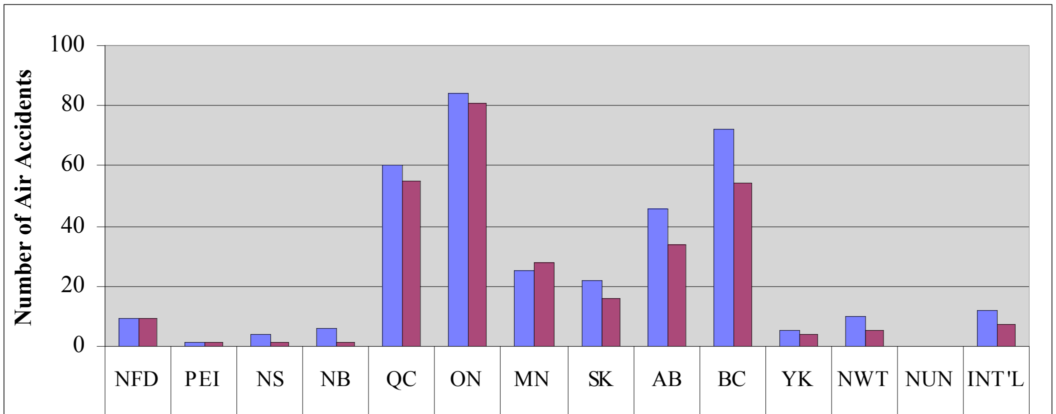
561 Voluntary Planning. *Final Report of the Voluntary Planning Off-highway Vehicle Task Force*, pp. 35-36. (Nova Scotia: Communications Nova Scotia, 2004). www.gov.ns.ca/vp/Task_Force/Task_Force_Reports/OHV_Final_Report.pdf
562 Ibid.
563 Ibid.
564 The statistics for 1997 were taken from Table A4-17 in Transport Canada's *Transportation in Canada 2002: Annual Report—Addendum*. Table A4-17 from *Transportation in Canada 2003: Annual Report—Addendum* was used for 1998-2003.
565 "Itinerant aircraft movement" is defined as including all movement between the top 100 Canadian airports that have Air Traffic Control Towers and Flight Service Stations. Transport Canada, (2003b, p. A62).
566 Transport Canada. (2002c, Table A4-17B).

Figure 186. Number of Air Accidents, by Province/Territory, 1997 and 2003.



	NFD	PEI	NS	NB	QC	ON	MN	SK	AB	BC	YK	NWT	NUN	INT'L
1997	9	1	4	6	60	84	25	22	46	72	5	10	0	12
2003	9	1	1	1	55	81	28	16	34	54	4	5	0	7

Source: Transport Canada. Transportation in Canada 2002: Annual Report—Addendum; and Transportation in Canada 2003: Annual Report—Addendum.

Note: The international column on the right-hand side is the number of air accidents occurring outside Canada involving Canadian aircraft.

Marine Accidents

There was a slight downward trend in the number of Canadian marine accidents between 1998 and 2003, with total accidents averaging 457 incidents per year.[567] The annual toll of marine accident fatalities ranged from 19 to 28 during this period.

Data for this mode are not available on a provincial basis but are provided by Transport Canada by region (Table 30). The Maritimes/Newfoundland area had an average of 171 marine accidents per year: the highest accident rate for the period, reflecting the considerable quantity of marine traffic in the region.

[567] Transport Canada. (2003b, Table A4-13).

Table 30. Canada: Average Number of Marine Accidents per Year, by Region, 1998-2003.

Marine Region	Number of Accidents
Western	165
Maritimes/Newfoundland	171
Central	58
Laurentian	63
Arctic	7
Foreign Waters	13

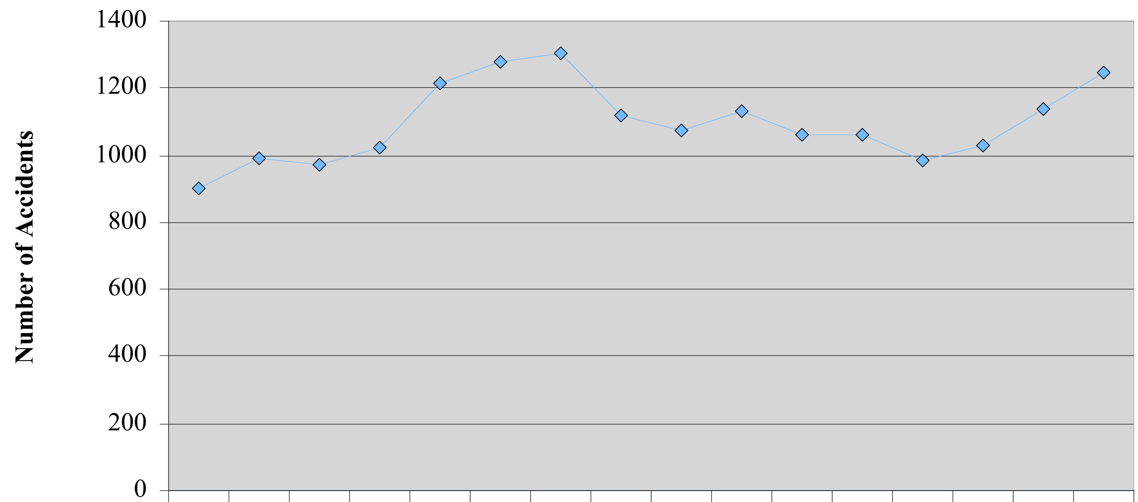
Source: Transport Canada. Transportation in Canada 2003: Annual Report—Addendum, Table A4-14.

Rail Accidents

The number of train collisions and derailments in Canada on the rail networks under federal jurisdiction have fluctuated between 1990 and 2005 (Figure 187). Between 1990 and 1996 the number of train collisions and derailments increased by forty-four percent, and then declined by 25% between 1996 and 2002, from 1,304 to 984.[568] This trend however has since reversed; between 2002 and 2005, rail accidents increased by 27% across Canada. Transport Canada's Direction 2006 aims to reduce the number of railway accidents by fifty percent by 2006.[569]

[568] Ibid., Table A4-3.
[569] Transport Canada. (2002a, p. ii).

Figure 187. Canada: Number of Rail Accidents, 1990-2005.



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Number of Accidents	903	990	969	1025	1212	1276	1304	1116	1075	1129	1063	1060	984	1032	1138	1249

Sources: Transportation Safety Board. Rail Occurrence Statistics for December 2005. Transportation Safety Board. Statistical Summary Railway Occurrences 2004 – Table 1. Transportation Safety Board. Annual Rail Occurrence Statistics for 1998 - Railway Occurrences and Casualties 1989 – 1998.

Figure 188 shows that Alberta, Ontario, and Nova Scotia had the largest proportional increases in the number of rail accidents between 1997 and 2004 (by 14%, 13%, and 45% respectively).[570] Despite this increase in the rail accident rate, Nova Scotia's total rail accidents in 2004 still represented only 1.2% of all those in Canada. The Transportation Safety Board reports that among accident classes, train derailments accounted for most of the increases. These derailments included a greater number both of main track incidents (which rose nationwide by 28% between 2004 and 2005) and non-main track incidents (which rose by 20% nationwide in the same period). [571]

Fifty-one percent of all reported rail accidents occurred on non-main tracks and involved either a derailment or collision.[572] Transport Canada notes that these accidents are usually minor. They usually involve trains travelling at slow speeds and pose little risk to the public.[573] Rail accident data are only available for the rail networks under federal jurisdiction.

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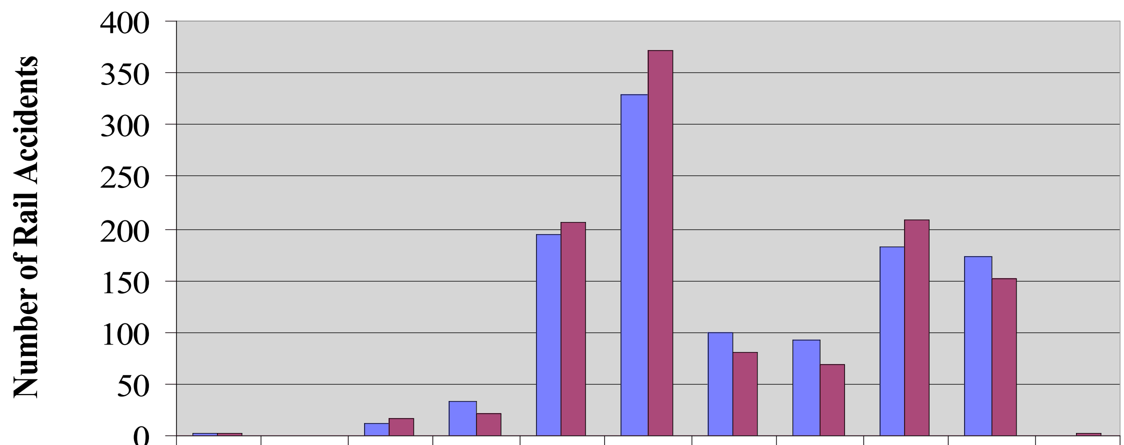
[570] There is a small discrepancy between the number of rail accidents reported by the Transportation Safety Board and Transport Canada. For example, in 2004, Transport Canada reported 1128 rail accidents, while the Transportation Safety Board reported 1138 accidents. It is unclear why there is a discrepancy.
[571] Transportation Safety Board. Rail Occurrence Statistics for December 2005. (March 2006). www.tsb.gc.ca/en/stats/rail/2005_dec/R12_2005_e.xls
[572] Ibid.
[573] Transport Canada. *Transportation in Canada 2003: Annual Report*, p. 19. (2003c). www.tc.gc.ca/pol/en/Report/anre2003/tc2003ae.pdf

Figure 188. Number of Rail Accidents, by Province/Territory, 1997 and 2004.



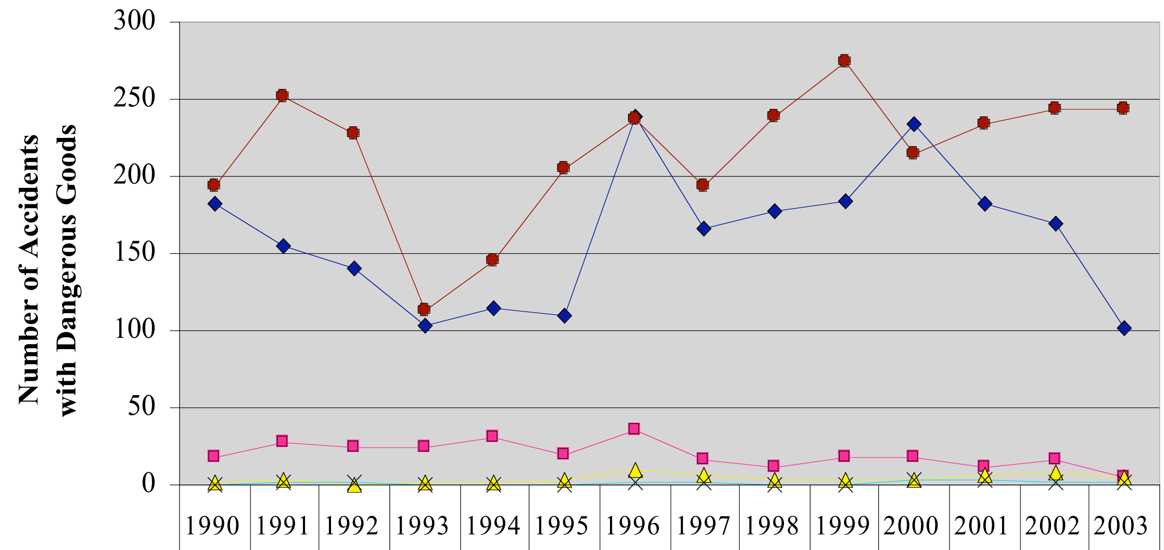
	NFD	PEI	NS	NB	QC	ON	MN	SK	AB	BC	NWT /NUN
1997	2	0	11	32	193	330	100	92	183	173	0
2004	2	0	16	22	205	372	80	69	208	152	2

Source: Transport Canada. Transportation in Canada 2002: Annual Report—Addendum, and Transportation in Canada 2004: Annual Report—Addendum.

Accidents Involving Dangerous Goods

Figure 189 shows the number of accidents involving dangerous goods in Canada, by transport mode, from 1990-2003. These numbers were also provided earlier in Figure 126 in the environmental indicators section, as accidents involving dangerous goods can have impacts on the environment. They are repeated here for the benefit of those referencing only particular chapters rather than the report as whole. Numbers for rail, marine, and air accidents involving dangerous goods remained fairly stable at relatively low levels throughout the 1990-2003 period, but the numbers fluctuated at considerably higher levels for dangerous goods accidents on roads and at transport facilities. On average, 94% of accidents involving dangerous goods occur either on roads or at transportation facilities. For the transportation sector to become more sustainable from a safety perspective, a reduction in the number of dangerous goods accidents in these categories will be required.

Figure 189. Canada: Number of Accidents Involving Dangerous Goods, 1990-2003, by Transportation Mode.



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
road	183	155	140	103	114	109	239	166	178	184	234	182	170	101
rail	17	27	25	25	30	19	35	16	11	18	18	11	16	5
air	2	4	0	1	1	3	9	6	4	3	4	6	8	5
marine	0	2	1	0	0	0	1	1	0	0	3	3	1	1
facility	194	251	228	113	145	205	237	194	239	274	215	234	244	244

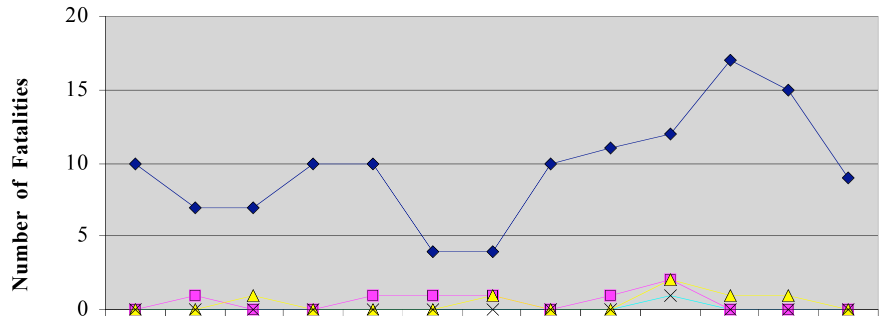
Source: Statistics Canada. CANSIM Table 409-0002.

Number of Fatalities and Injuries from Accidents Involving Dangerous Goods

As shown in Figure 190, the majority of fatal transportation accidents involving dangerous goods occur on roads. While the number of deaths from dangerous goods related road accidents has varied over time, fatalities from rail and facility accidents involving dangerous goods have remained consistently low, at zero or one for most years.[574] A similar trend is seen with the incidence of injuries resulting from accidents involving dangerous goods (Figure 191), where road accidents are again the most common cause of such injuries, followed by injuries occurring at transport facilities. The higher number of fatalities and injuries attributable to accidents involving dangerous goods on roads is a function of the predominance of road transport in general, and truck freight in particular, over other modes.

[574] There were no marine fatalities or injuries reported between 1990 and 2002. (Statistics Canada. CANSIM Table 409-0003).

Figure 190. Canada: Number of Fatalities from Accidents Involving Dangerous Goods, by Mode of Transport, 1990-2002.

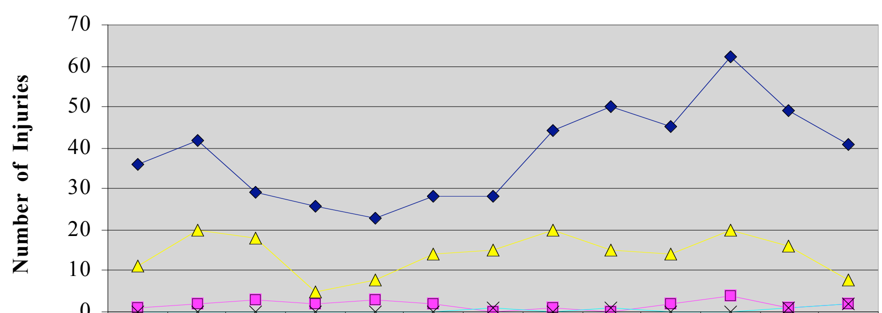


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Road	10	7	7	10	10	4	4	10	11	12	17	15	9
Rail	0	1	0	0	1	1	1	0	1	2	0	0	0
Facility	0	0	1	0	0	0	1	0	0	2	1	1	0
Air	0	0	0	0	0	0	0	0	0	1	0	0	0

Year

Source: Statistics Canada. CANSIM Table 409-0003.

Figure 191. Canada: Number of Injuries from Accidents Involving Dangerous Goods, by Mode of Transport, 1990-2002.



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Road	36	42	29	26	23	28	28	44	50	45	62	49	41
Rail	1	2	3	2	3	2	0	1	0	2	4	1	2
Facility	11	20	18	5	8	14	15	20	15	14	20	16	8
Air	0	0	0	0	0	0	1	0	1	0	0	1	2

Year

Source: Statistics Canada. CANSIM Table 409-0003.

Trends: Nova Scotia

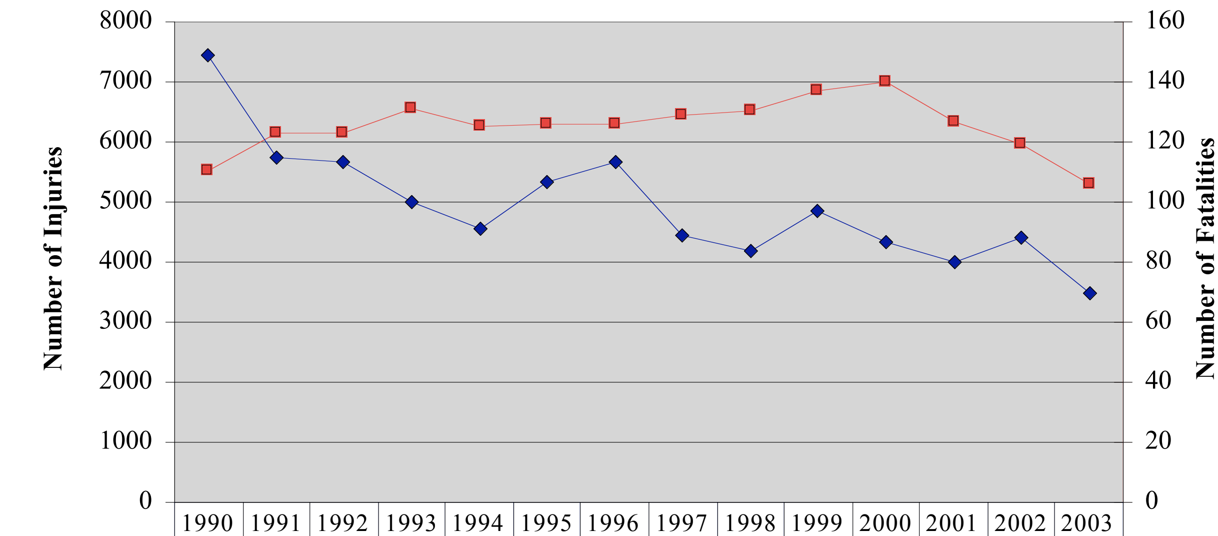
Fatalities and Injuries from Road Accidents

As shown in Figure 192, since 1990 there has been a general decline in the number of deaths from road accidents in Nova Scotia. There was a 24% increase in road traffic fatalities from 1994 to 1996, but from 1996 to 2003 there was a 38% decrease. However, as of December 12, 2004, the number of deaths has risen again (to a total of 87—similar to the levels that prevailed from 1997 to 2002, when the average annual toll was also about 87).[575] It is therefore too early to tell whether the record low road fatality rate of 2003 (70 deaths, or less than half the 1990 toll) was an anomaly, or represents the beginning of a continued drop in road deaths. According to Nova Scotia's Transport Minister, factors involved in the increase in traffic fatalities in 2004 include alcohol, lack of seat belt use, and excessive speed.[576]

For the period 1990-2003, the reduction in traffic-related injuries was much less than that for fatalities. Between 1990 and 2000, there was actually a 26% increase in the number of traffic-related injuries; but thereafter they declined, decreasing by 24% from 2000 to 2003. However, the 2003 road accident injury rate ended up only four percent below that in 1990, so it is too early to tell whether the 2000-03 decline in injuries is the beginning of a long-term trend.

[575] Sellon, Gary. Policy Analyst, Nova Scotia Department of Transportation and Public Works. (Personal communication: December 14, 2004).
[576] Lipscombe, Kristen. "Death on our roads." (Halifax: *Chronicle Herald*, July 29, 2004).

Figure 192. Nova Scotia: Number of Fatalities and Injuries from Road Accidents, 1990-2003, (fatalities on right axis; injuries on left axis)**.**



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Injuries	5534	6151	6155	6548	6260	6292	6311	6452	6529	6867	6999	6327	5949	5291
Fatalities	149	115	113	100	91	107	113	89	84	97	87	80	88	70

Source: Nova Scotia Department of Transportation and Public Works. Indices of Motor Vehicle Collision Information.

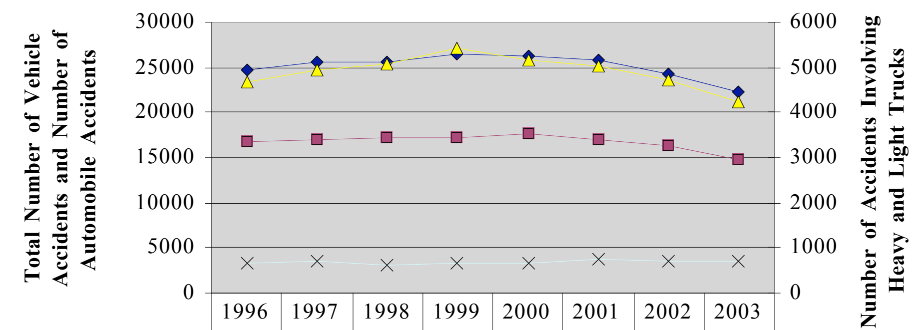
Vehicle Accidents Resulting in Injuries and Fatalities, by Vehicle Type

Altogether there were 22,377 motor vehicle collisions in Nova Scotia in 2003. This annual total of motor vehicle accidents was nine percent lower than 1996 levels, and reflected the fifth straight year of decline in vehicle accident numbers (Figure 193). Nearly 85% of all road crashes involved automobiles or light duty-trucks (including SUVs and minivans).[577]

The number of motor vehicle accidents has declined since 1996 for almost all types of vehicles (Figures 193 and 195). The main exception is off-road vehicle accidents, which have steadily increased in number since 1994 (Figure 195). Heavy truck accidents have also increased somewhat.

[577] Sellon. Op cit. Light-duty trucks include: pickup trucks under 5000 kg, panel vans under 5000 kg, and sport utility vehicles (SUVs). To date, there are no data on accidents involving SUVs specifically, as SUV accidents continue to be categorised together with vans and light-duty trucks.

Figure 193. Nova Scotia: Number of Vehicles Involved in Road Accidents, 1996-2003 (Total and by Type).



	1996	1997	1998	1999	2000	2001	2002	2003
Total Vehicles	24666	25580	25592	26450	26143	25788	24362	22377
Automobiles	16677	17084	17184	17121	17615	17036	16226	14711
Light Trucks	4681	4948	5095	5407	5176	5012	4701	4232
Heavy Trucks	645	685	629	664	676	735	698	701

Source: Nova Scotia Department of Transportation and Public Works. Indices of Motor Vehicle Collision Information.

Automobile and Light Truck Accidents and Fatalities

As shown in Figure 193, the incidence of automobile accidents declined by 12% between 1996 and 2003, while light truck accidents declined by 10%. The decrease in car crashes corresponds with a drop in the number of registered automobiles in the province. However, the total number of vehicles under 4,500 kg (a category which includes both cars and light-duty trucks) increased slightly from 492,001 in 1999 to 519,876 in 2002, with most of the increase due to higher sales of SUVs, minivans, and light trucks.[578] Road accidents involving SUVs, minivans, and light trucks climbed by 16% from 1996 to 1999, but have declined steadily since that time.

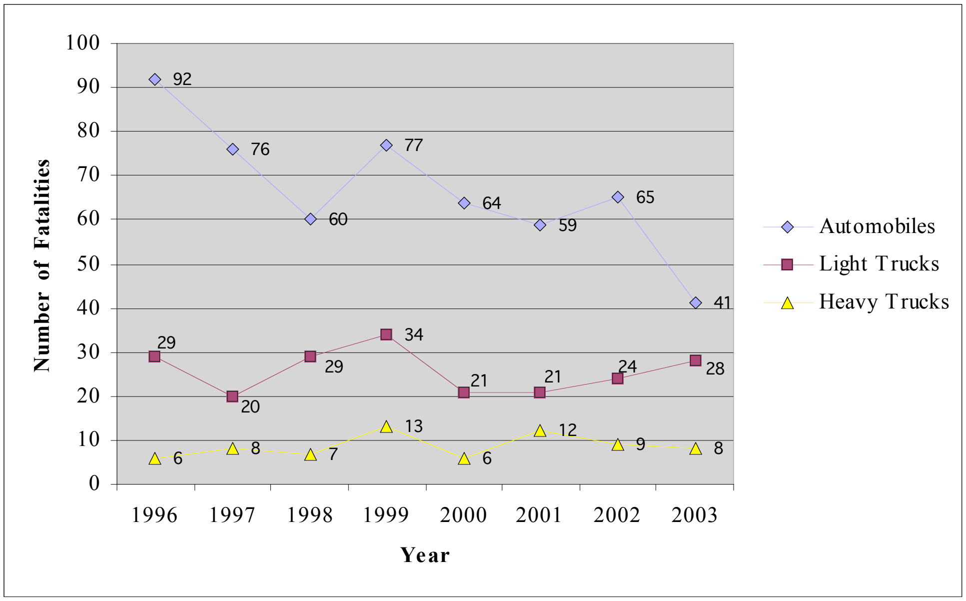
Figure 194 somewhat reflects this change in the composition of the passenger road fleet. While the number of lethal car accidents dropped significantly (by more than half) between 1996 and 2003, the number of fatal accidents involving light trucks, SUVs, and minivans has remained relatively stable and has even increased since 2000. Indeed, the number of light trucks involved in fatal accidents in 2003 (28) was higher than the average for the 1996-2003 period (26).

The 12% decline in automobile accidents and the 55% decline in the number of cars involved in fatalities between 1996 and 2003 appear to indicate movement towards sustainability from a safety perspective. But the light truck fatality trend does not support that conclusion, and the sharp increase in total 2004 road fatalities noted above—back to the levels that prevailed from 1997 to 2002—indicates a need for caution in interpreting the record low 2003 road fatality

[578] Statistics Canada. *Road Motor Vehicle Registrations*, Table 1—Nova Scotia. (Catalogue no. 53-219). and Statistics Canada. *Road Motor Vehicles, Registrations, Annual.* 1999-2002. CANSIM Table 405-0004.

figures. The nine percent *aggregate* decline in the number of vehicles involved in road accidents since 1996, with a history of steady decreases since 1999, provides stronger evidence of movement towards sustainability from a safety perspective

Figure 194. Nova Scotia: Numbers of Automobiles, and Light and Heavy Trucks, Involved in Fatal Accidents, 1996-2003.



Source: Nova Scotia Department of Transportation and Public Works. Indices of Motor Vehicle Collision Information.

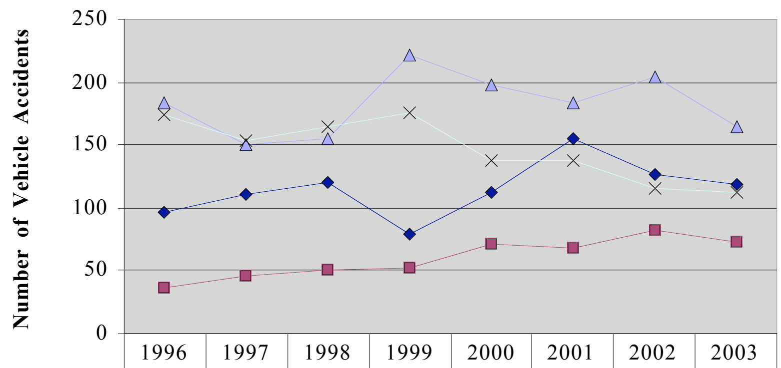
Heavy Truck Accidents and Fatalities

The number of heavy trucks involved in accidents increased by nine percent between 1996 and 2003 (Figure 193), while the number of heavy trucks involved in accidents causing death has remained relatively stable (Figure 194). Neither of these trends signifies movement towards sustainability from a safety perspective.

Buses

The number of bus accidents ranged from a low of 79 in 1999 to a high of 155 in 2001. There was an overall increase in bus accidents for the term, with the exception of one year, 1999 (see Figure 195 below). However, during this period there were no more than two fatal incidents involving buses in any given year, and there were no bus-related fatalities in most years (Figure 196). This increase in bus accidents indicates a trend away from sustainability. On the other hand, the relatively low number of buses involved in accidents, injuries, and fatal collisions indicates that, on average, buses are still considerably safer than automobiles, which have much higher rates of accidents, injuries, and fatalities per capita (Figures 200, 201, and 202).

Figure 195. Nova Scotia: Numbers of Buses, Motorcycles, Off-Road Vehicles, and Bicycles Involved in Road Accidents, 1996-2003.

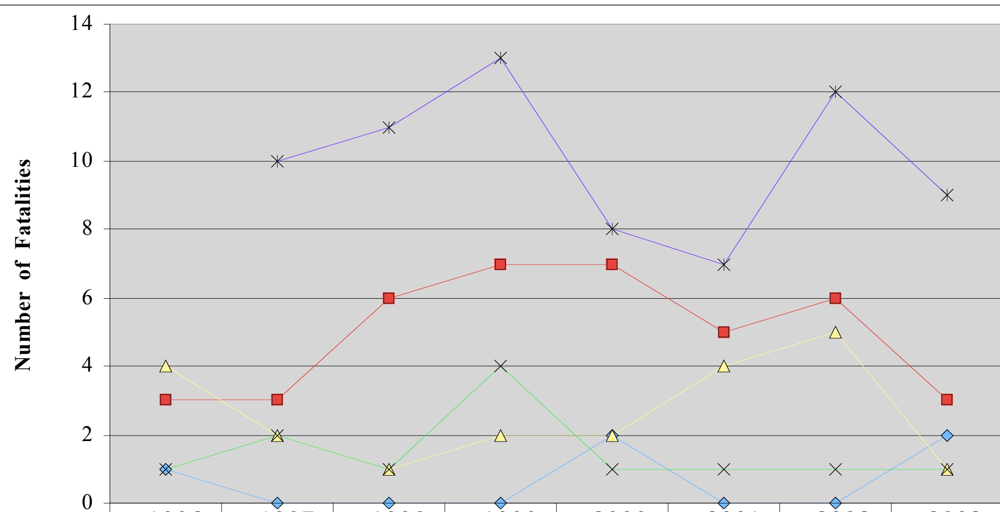


	1996	1997	1998	1999	2000	2001	2002	2003
Buses	96	110	120	79	113	155	126	119
Off-Road Vehicles	37	46	51	53	71	68	82	72
Motor Bikes	184	151	155	222	197	183	204	164
Bicycles	174	154	165	175	137	137	116	112

Year

Source: Nova Scotia Department of Transportation and Public Works. Indices of Motor Vehicle Collision Information.

Figure 196. Nova Scotia: Number of Buses, Motorcycles, Off-Road Vehicles, Bicycles, and Pedestrians Involved in Fatal Accidents, 1996-2003.



	1996	1997	1998	1999	2000	2001	2002	2003
Buses	1	0	0	0	2	0	0	2
Motor Bikes	3	3	6	7	7	5	6	3
Off-Road	4	2	1	2	2	4	5	1
Bicycles	1	2	1	4	1	1	1	1
Pedestrian		10	11	13	8	7	12	9

Source: Nova Scotia Department of Transportation and Public Works. Indices of Motor Vehicle Collision Information.

Off-Road Vehicles

The number of off-road vehicles involved in accidents rose by 95% between 1996 and 2003 (Figure 195 above). There were 991 reported day surgeries and hospital admissions (Figure 197) and 36 fatalities involving off-road vehicles between 1995 and 2004 (Figure 198). The incidence of off-road vehicles involved in accidents resulting in injuries increased by 150% over the period.[579, 580]

According to the Nova Scotia Trauma Registry, there were 122 major trauma accidents caused by ATVs and 29 major trauma accidents caused by snowmobiles between fiscal years 2000-01 and 2004-05 (Figure 199).[581] These numbers are put into better perspective when compared to all trauma-related hospital admissions. The number of children admitted to the IWK Children's Hospital for trauma-related injuries serves as an example of this comparison: - Voluntary Planning reports that in the summer of 2003, fully one quarter of the trauma patients admitted to the IWK Children's Hospital intensive care unit in Halifax were injured by ATVs, which was similar to the number of trauma victims injured in automobile crashes who were admitted to the IWK intensive care unit.[582] The number of ATV accidents is therefore disproportionately high considering that ATVs account for only a small share of passenger transport activity.

As already mentioned, off-road vehicle accidents, especially those involving all-terrain vehicles (ATVs), have increased significantly across Canada. In Nova Scotia, the accident rate for ATVs has increased by 63% since 1996.[583]

A key concern is the number of injuries involving children. From 1995 to 2004, 28% of reported day surgeries or hospitalization for injuries related to ATVs were for children, under the age of 16 years (Figure 197). According to the Voluntary Planning Task Force on Off-Highway Vehicles, a majority of those injuries were serious orthopaedic or head injuries, or both, and about 20% required treatment in the intensive care unit.[584] Six Nova Scotian children died from injuries related to ATVs, between 1995 and 2004 (Figure 198), representing 17% of all ATV deaths in the province.

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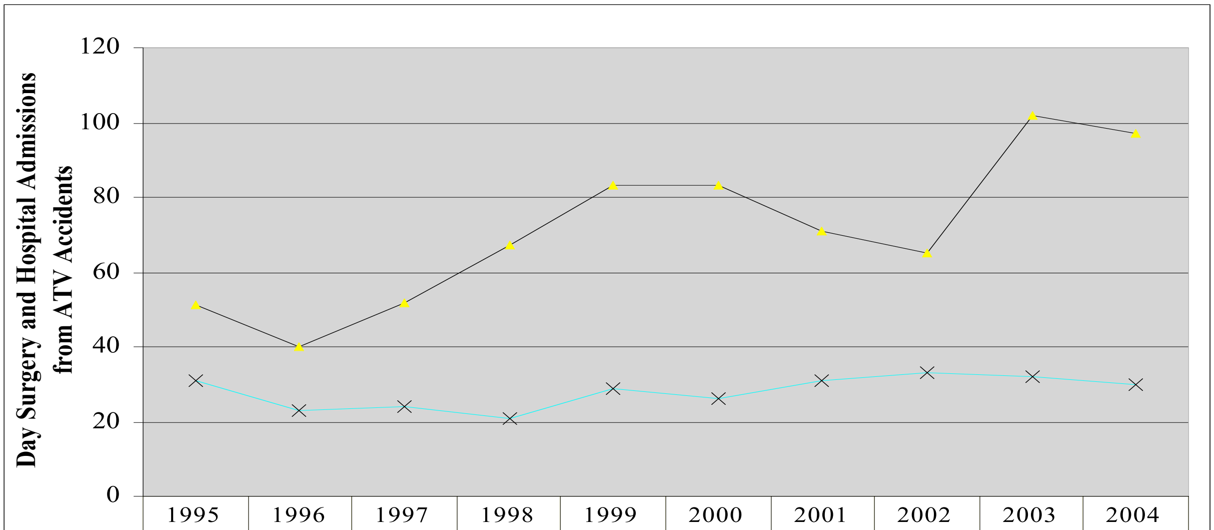
[579] Nova Scotia Department of Transportation and Public Works. Motor Vehicle Collision Statistics. www.gov.ns.ca/tran/publications/publication.asp Accessed July 2004.
[580] Sellon, Gary. Policy Analyst, Nova Scotia Department of Transportation and Public Works. (Personal communication: July, 2004).
[581] Personal communication by Seth Cain with Beth Sealy, Coordinator, Nova Scotia Trauma Registry. July 5, 2006. Note: 'Major Trauma' is defined by three different thresholds: an injury's severity, a tertiary trauma response to the accident, death or continued care after the accident. It does not include discharges from the Emergency Department, or admissions to hospital with injuries that do not meet the above thresholds.
[582] Voluntary Planning. (2004).
[583] CBC News. (February 5, 2003).
[584] Voluntary Planning. (2004).

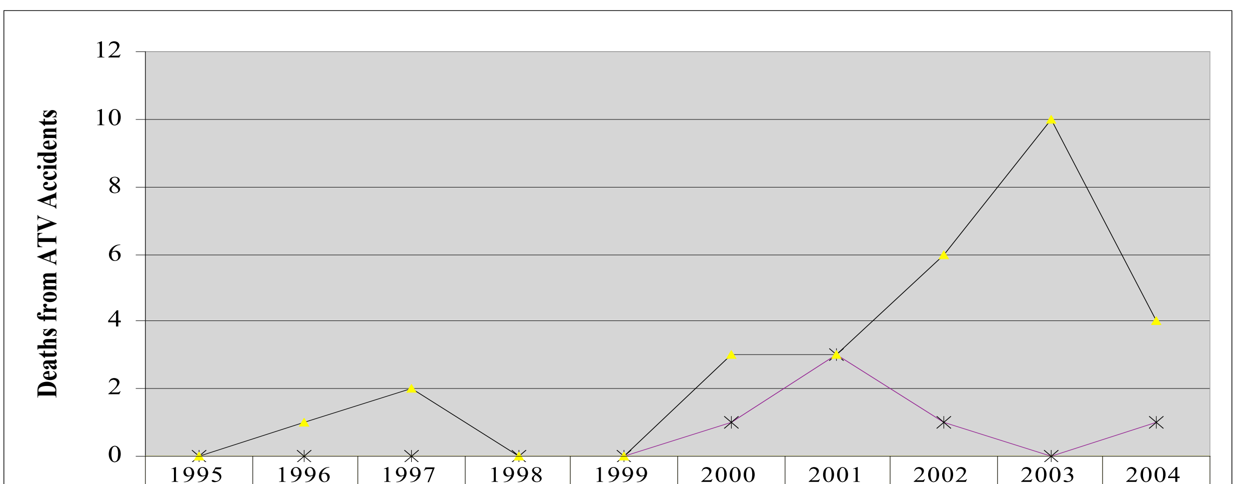
Figure 197. Nova Scotia: Number of Reported Day Surgeries and Hospital Admissions from ATV Accidents, by Age Group, 1995-2004.



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0-16	31	23	24	21	29	26	31	33	32	30
16+	51	40	52	67	83	83	71	65	102	97

Source: Personal Communication by Seth Cain with Maureen Aucoin, Decision Support Analyst, Information Analysis and Reporting, Nova Scotia Department of Health. Abstracted from CIHI Discharge Abstract Database.. November 17 2005.

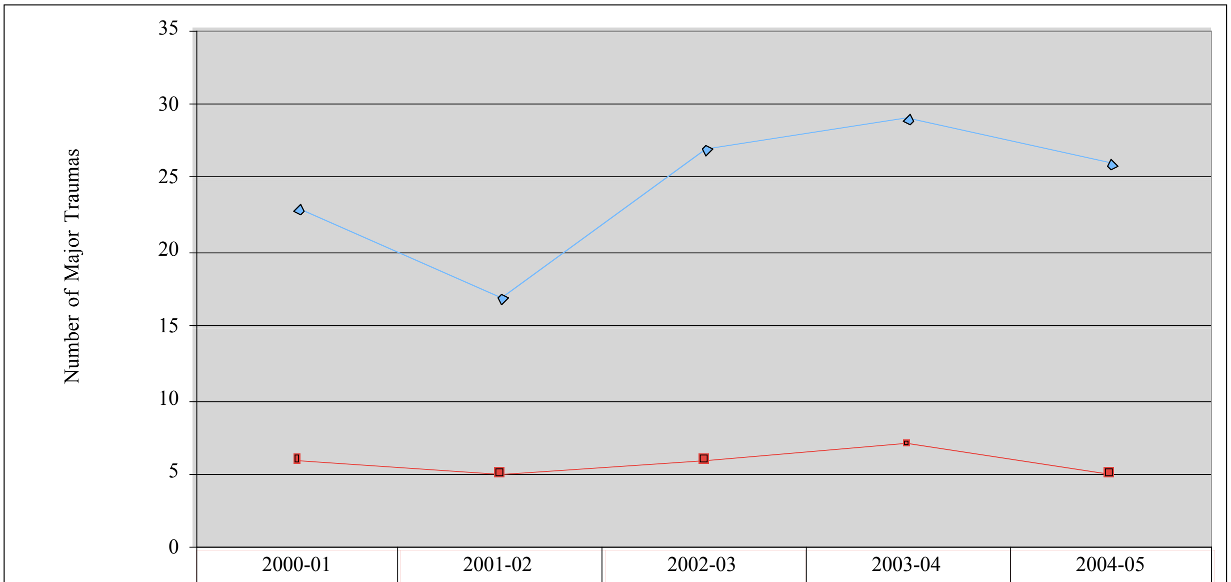
Figure 198. Nova Scotia: Number of Reported Deaths Resulting from ATV Accidents, by Age Group, 1995-2004.



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0-16	0	0	0	0	0	1	3	1	0	1
16+	0	1	2	0	0	3	3	6	10	4

Source: Personal Communication by Seth Cain with Maureen Aucoin, Decision Support Analyst, Information Analysis and Reporting, Nova Scotia Department of Health. Abstracted from Service Nova Scotia. Vital Statistics. November 17, 2005.

Figure 199. Nova Scotia: Number of Major Traumas Resulting from ATV and Snowmobile Accidents, Fiscal Years 2000-01 to 2004-05.



	2000-01	2001-02	2002-03	2003-04	2004-05
ATVs	23	17	27	29	26
Snowmobiles	6	5	6	7	5

Source: Personal communication with Beth Sealy, Coordinator, Nova Scotia Trauma Registry. July 5, 2006.

Note: 'Major Trauma' is defined by three different thresholds: an injury's severity, a tertiary trauma response to the accident, death or continued care after the accident. It does not include discharges from the Emergency Department, or admissions to hospital with injuries that do not meet the above thresholds.

Other Road Users: Motorcyclists, Bicyclists, Pedestrians

In Nova Scotia, in 2003, there were 276 accidents involving bicyclists or motorcyclists (Figure 195 above). The number of accidents involving motorbikes has fluctuated, with 11% more accidents in 2002 than in 1996, for example, and 11% fewer in 2003 than in 1996. Although an overall trend can therefore not easily be determined, motorcycle accident rates since 2000 have generally averaged higher than prior to that date.

Bicycle accidents, on the other hand, have shown a fairly marked decline during the same period, with 2003 rates 36% lower than in 1996. Fatalities remained low in absolute numbers for accidents involving motorcycles and bicycles, with total numbers for both modes fluctuating between four and 11 in any given year, and with no consistent change over the term (Figure 196).

However, in 2004 there was a significant upsurge in pedestrian deaths, with thirteen pedestrians killed in traffic accidents in Nova Scotia in that year, up from nine pedestrian fatalities in 2003

(Figure 199).[585] The fluctuations in pedestrian, motorcycle, and bicycle accidents and fatalities are too great and the overall numbers too small to discern clear trends on these indicators or to draw definitive conclusions on movement towards or away from sustainability for these modes from a safety perspective.

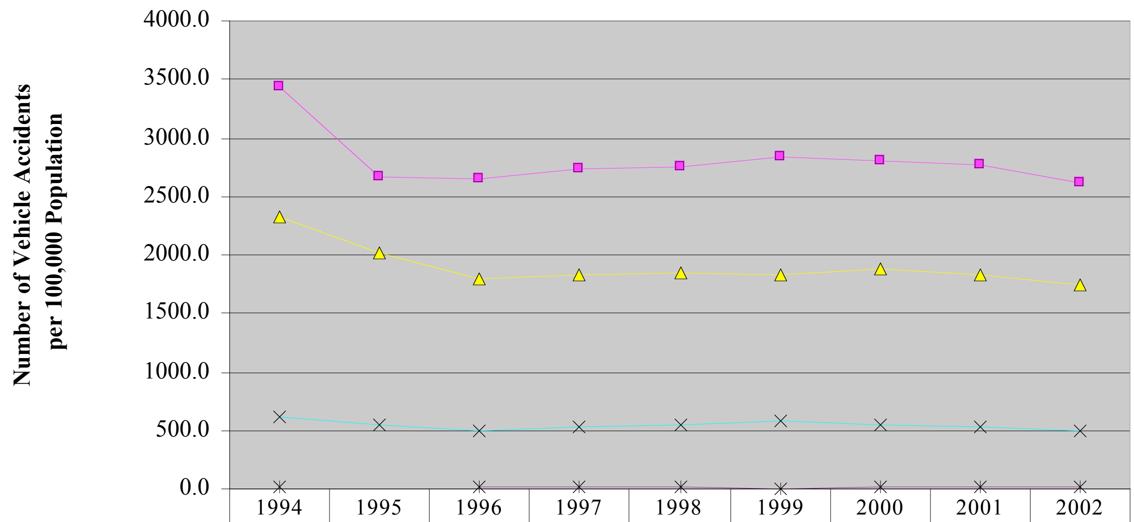
Vehicle Accident and Casualty Rates

While the above charts depict absolute numbers of vehicles involved in accidents and fatalities in Nova Scotia by mode between 1996 and 2003, Figures 200, 201, and 202 below depict the trends in per capita accident and casualty ***rates*** for automobiles, passenger light trucks, and buses[586] in Nova Scotia, over the period 1994-2002.

As shown in Figure 200, automobiles have a higher accident rate than passenger light trucks or buses. Accident rates for cars and light trucks (per 100,000 population) have both declined since about 1994 (by 25% and 19%, respectively), while bus accident rates have remained fairly constant.

[585] Nova Scotia Department of Transportation and Public Works. Weekly Comparison Between Years To Date December 31, 2004. (January 12, 2005). www.gov.ns.ca/tran/FMWKDec31.pdf Accessed February, 2005.
[586] This includes school buses, urban transit, and intercity buses.

Figure 200. Nova Scotia: Number of Vehicles Involved in Accidents per 100,000 Population, by Vehicle Type, 1994-2002.

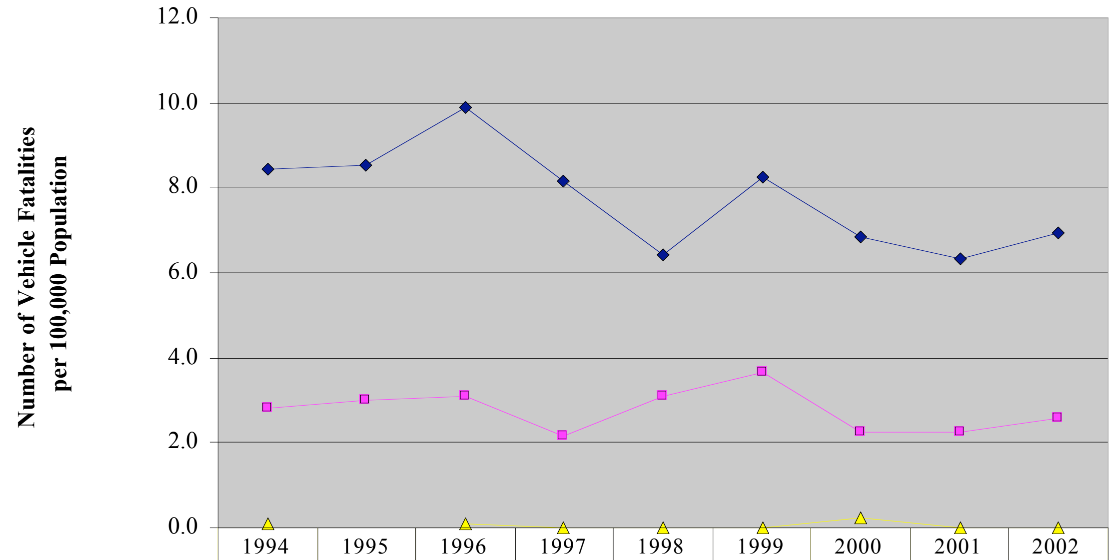


	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total # Accidents	3439.4	2674.4	2648.2	2743.2	2746.2	2832.4	2799.4	2765.8	2607.3
Automobile Accidents	2323.9	2014.7	1790.5	1832.1	1844.0	1833.4	1886.2	1827.1	1736.5
Light Truck Accidents	618.9	550.1	502.6	530.6	546.7	579.0	554.2	537.5	503.1
Bus Accidents	13.4		10.3	11.8	12.9	8.5	12.1	16.6	13.5

Source: Nova Scotia Department of Transportation and Public Works. Indices of Motor Vehicle Collision Information; and CANSIM Table 051-000111 - Estimates of population, by age and sex, Canada, provinces and territories, annual.

Fatality rates for automobiles (per 100,000 population) declined by 17% between 1994 and 2002, while those for light trucks remained fairly constant between 1994-2002 (Figure 201). Bus fatality rates remained very low over this time. The safety benefits of bus travel are related to the fact that people who rely regularly on public transit tend to travel fewer total kilometres than those who drive. The evidence indicates that people tend to increase their annual mileage significantly when they obtain an automobile. For this reason, the safety benefits of bus travel are greater when evaluated on a per capita basis rather than per passenger-kilometre.

Figure 201. Nova Scotia: Number of Vehicles Involved in Fatal Accidents, per 100,000 Population, by Vehicle Type, 1994-2002.

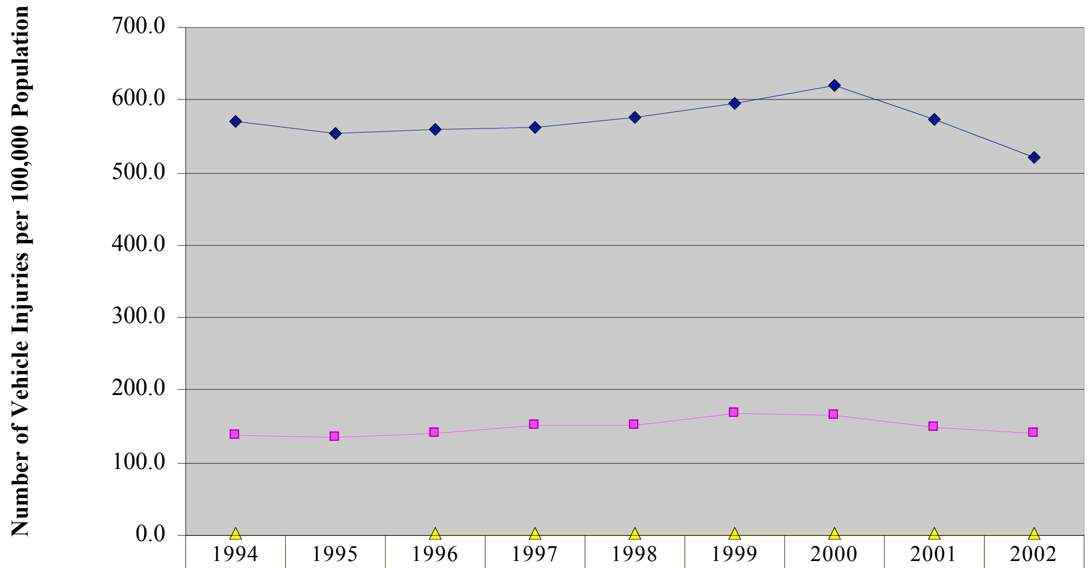


	1994	1995	1996	1997	1998	1999	2000	2001	2002
Automobile	8.4	8.5	9.9	8.2	6.4	8.2	6.9	6.3	7.0
Passenger Light Trucks	2.8	3.0	3.1	2.1	3.1	3.6	2.2	2.3	2.6
Buses	0.1		0.1	0.0	0.0	0.0	0.2	0.0	0.0

Source: Nova Scotia Department of Transportation and Public Works. Indices of Motor Vehicle Collision Information; and CANSIM Table 051-000111 - Estimates of population, by age and sex, Canada, provinces and territories, annual.

Injury rates for automobiles were also significantly greater than those for buses or passenger light trucks. In 2002, injury rates for automobiles were 99% higher than for buses and 73% greater than for passenger light trucks (Figure 202). Injury rates for automobiles (per 100,000 population) did however decline by 9% between 1994 and 2002, while those involving light trucks remained fairly constant during this period (Figure 202). Like the fatality rate trends, bus injury rates remained very low over this time.

Figure 202. Nova Scotia: Number of Vehicles Involved in Accidents Resulting in Injuries, per 100,000 Population, by Vehicle Type, 1994-2002.

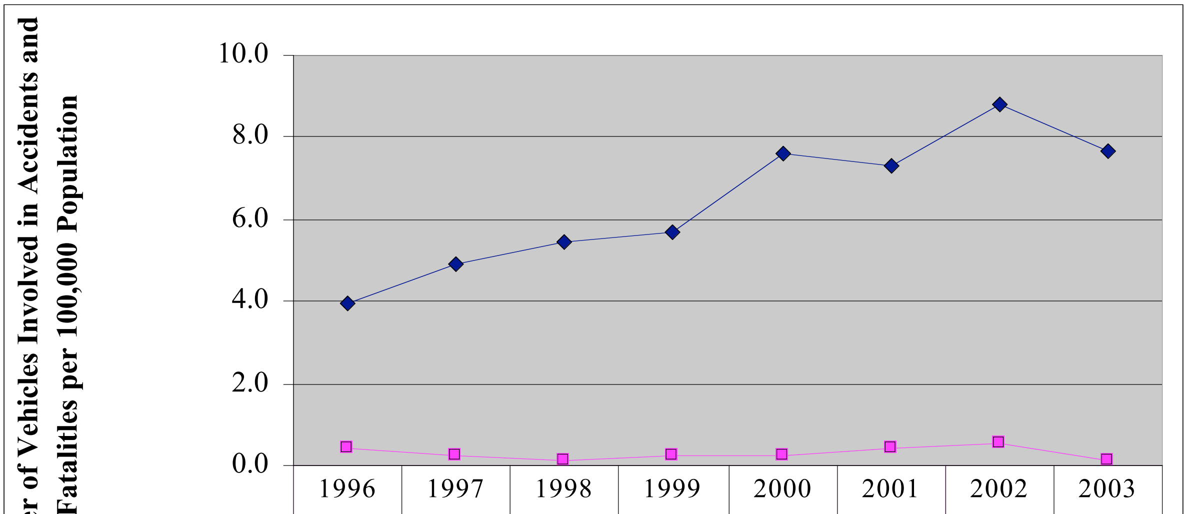


	1994	1995	1996	1997	1998	1999	2000	2001	2002
Automobile	569.8	552.9	560.0	562.2	574.8	594.1	620.7	572.5	521.5
Passenger Light Trucks	139.2	134.0	141.8	150.2	151.4	169.2	164.9	149.6	139.7
Buses	2.7		2.4	2.4	2.6	2.0	2.4	2.7	3.0

Source: Nova Scotia Department of Transportation and Public Works. Indices of Motor Vehicle Collision Information; and CANSIM Table 051-000111 - Estimates of population, by age and sex, Canada, provinces and territories, annual.

The rate of off-road vehicle accidents has risen dramatically since 1996. As shown in Figure 203, there has been a 93% increase in the rate of off-road vehicles involved in accidents (per 100,000 population). Off-road fatality rates have fluctuated from year to year (Figure 203). The increase in the rate of off-road vehicle accidents is clearly related to the increasing popularity and use of ATVs during this period.

Figure 203. Nova Scotia: Number of Off-Road Vehicles Involved in Road Accidents and Fatalities per 100,000 Population, 1996-2003.



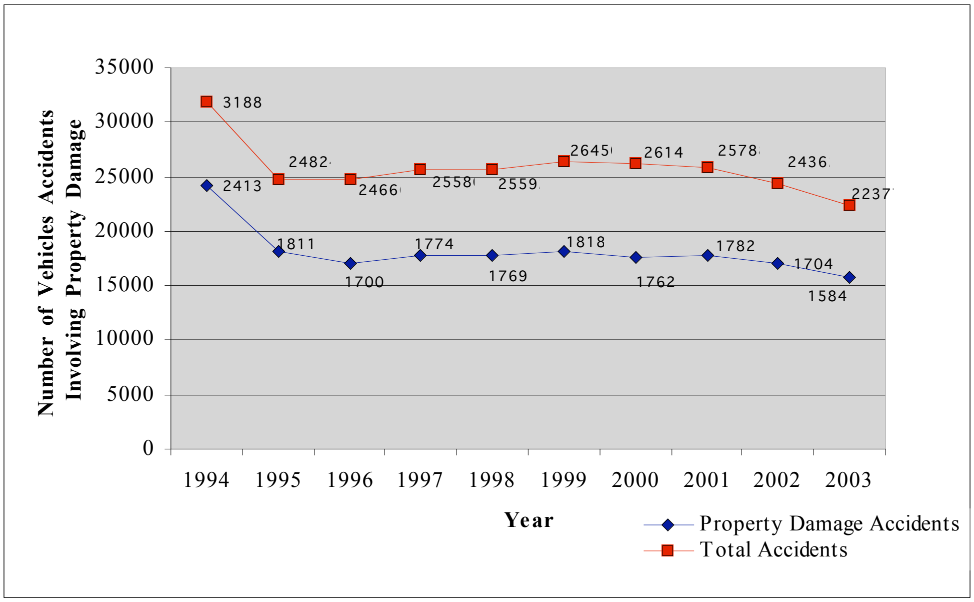
	1996	1997	1998	1999	2000	2001	2002	2003
accidents	4.0	4.9	5.5	5.7	7.6	7.3	8.8	7.7
fatalities	0.4	0.2	0.1	0.2	0.2	0.4	0.5	0.1

Source: Nova Scotia Department of Transportation and Public Works. Indices of Motor Vehicle Collision Information; and, CANSIM Table 051-000111 - Estimates of population, by age and sex, Canada, provinces and territories, annual.

Number of Vehicle Accidents Involving Property Damage

The trend for vehicles involved in accidents resulting in property damage (Figure 204) is similar to that for vehicles involved in accidents in general. Each year, from 1994 to 2003, between 67% and 75% of all reported vehicle accidents involved property damage.

Figure 204. Nova Scotia: Number of Vehicle Accidents Resulting in Property Damage, 1994-2003.



Source: Nova Scotia Department of Transportation and Public Works. Indices of Motor Vehicle Collision Information.

Accidents Resulting in Injuries or Fatalities: Air, Marine, and Rail

Air

There were 9 or fewer air accidents each year from 1997 to 2002 (Figure 205). The annual total of aircraft fatalities in Nova Scotia varied between zero and four during this period (Figure 206).

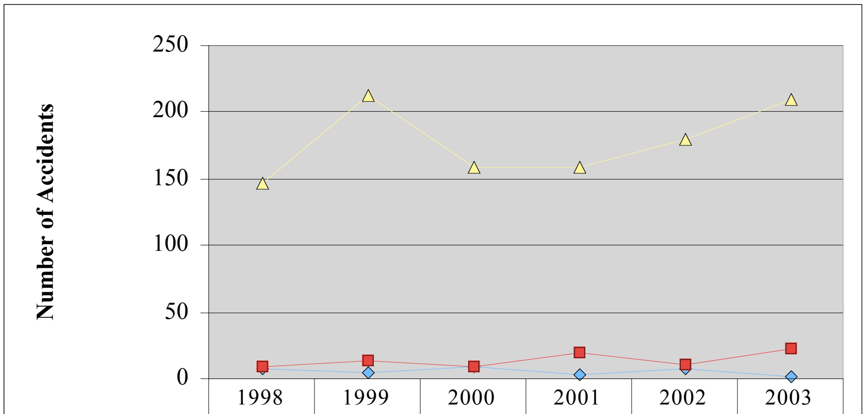
Marine

From 1998 to 2003, marine transport accidents in the Maritimes/Newfoundland region fluctuated, averaging about 171 accidents a year. In 2003, there were 209 marine transport accidents, 43% more than occurred in 1998, and the highest reported number since 1999 (Figure 205). The number of fatalities have been declining since 1998. There were 7 marine transport fatalities in 2003, down from 32 in 1998 (Figure 206). It should be noted that the number of marine accidents and fatalities in Figures 204 and 205 are for the Maritimes/Newfoundland region, and not for Nova Scotia alone.

Rail

The number of rail accidents in Nova Scotia has remained relatively stable, ranging from a high of 22 accidents in 2003 to a low of nine in both 1998 and 2000 (Figure 205).[587] The number of deaths caused by railway accidents remained at or near zero. The greatest number of fatalities for a single year was three, in 2001 (Figure 206).

Figure 205. Nova Scotia: Number of Air, Marine and Rail Accidents, 1998-2003



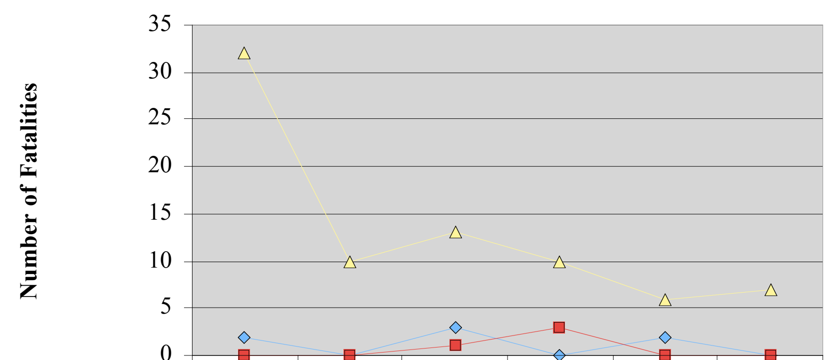
	1998	1999	2000	2001	2002	2003
Air	7	4	9	3	7	1
Rail	9	13	9	19	11	22
Marine	146	212	158	159	179	209

Source: Transport Canada. Transportation in Canada 2003: Annual Report—Addendum.

Notes: 1) The number of marine accidents reported above are for the Maritimes/Newfoundland region. 2) Although not shown here, in 2004 the number of rail accidents in Nova Scotia declined to 16 accidents (see Figure 188).

[587] The number of rail accidents in 2004 declined in Nova Scotia. This is reported in Figure 188, however, due to time and financial constraints, Figures 205 and 206 could not be updated to reflect the 2004 data.

Figure 206. Nova Scotia: Number of Air, Marine and Rail Fatalities, 1998-2003.



	1998	1999	2000	2001	2002	2003
Air	2	0	3	0	2	0
Rail	0	0	1	3	0	0
Marine	32	10	13	10	6	7

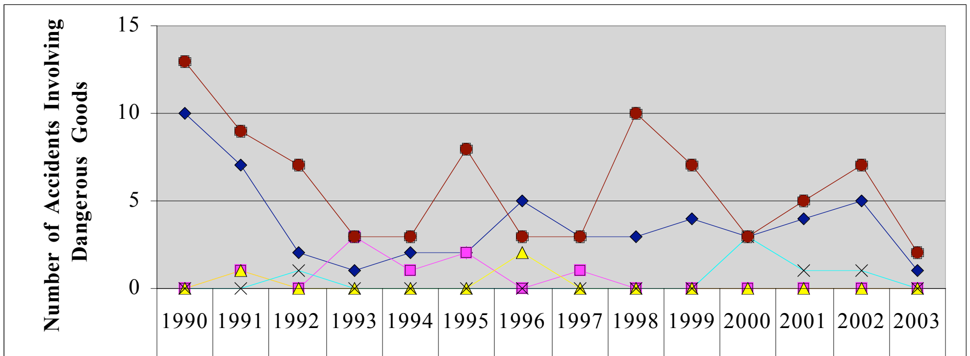
Source: Transport Canada. Transportation in Canada 2003: Annual Report—Addendum.

Note: The number of marine fatalities reported above are for the Maritimes/Newfoundland region.

Accidents Involving Dangerous Goods

Figure 207 shows the trend in the number of accidents in Nova Scotia involving dangerous goods, by mode, from 1990 to 2003. As was the case nationally (see Figure 189), most such accidents occurred on roads or at transportation facilities. The aggregate number of accidents is quite low, and all modes show either stability or a generally downward trend that indicates movement toward sustainability from a safety perspective. Trends in casualties from accidents involving dangerous goods are not available for Nova Scotia.

Figure 207. Nova Scotia: Number of Accidents Involving Dangerous Goods, by Mode of Transport, 1990-2002.



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Road	10	7	2	1	2	2	5	3	3	4	3	4	5	1
Rail	0	1	0	3	1	2	0	1	0	0	0	0	0	0
Air	0	1	0	0	0	0	2	0	0	0	0	0	0	0
Marine	0	0	1	0	0	0	0	0	0	0	3	1	1	0
Facility	13	9	7	3	3	8	3	3	10	7	3	5	7	2

Year

Source: Statistics Canada. CANSIM Table 409-0002.

Conclusion

Traffic accidents impose significant costs on travellers and society. For people in the prime of life, between 1 and 50 years of age, traffic crashes are a leading cause of death and disability. Traffic crashes also impose significant property damages.

Traffic accident risk can be defined in different ways. When measured per vehicle-kilometre, crash rates have declined significantly during the last half-century, suggesting that current safety programs are effective and should be continued. However, when measured on a per capita basis, as with other health risks, declines are smaller, since reductions in per-kilometre rates have been partly offset by increased per capita mileage. When evaluated in this way, traffic safety programs have had more modest benefits. Greater safety gains could have been expected from changes such as increased use of seatbelts and child restraints, reduced rates of impaired driving, improved vehicle and roadway design, and improved emergency response. Conventional safety strategies, such as shifts to heavier vehicles and use of airbags, tend to improve safety for the occupants of a particular vehicle but may increase risk for others, either because they increase risk directly (e.g. the increased impact of a heavier vehicle on a pedestrian, bicycle, motor bike, or smaller vehicle), or because the feeling of greater protection encourages drivers to drive more *intensively*, taking more small risks – a phenomenon called *offsetting behaviour*.[588]

[588] Chirinko, Robert and Harper, Edward Jr. (1993) "Buckle Up or Slow Down? New Estimates of Offsetting Behavior and their Implications for Automobile Safety Regulation." *Journal of Policy Analysis and Management*, Vol. 12, No. 2, pp. 270-296.

Described differently, the evidence indicates that one of the largest factors affecting peoples' chance of being a vehicle crash casualty is the amount that they drive, particularly on higher speed suburban and rural roads.[589] This understanding significantly expands the range of traffic safety strategies beyond conventional measures like airbags and road improvements to include policies and programs that reduce vehicle travel distances and speeds, encourage use of alternative modes, and create more accessible communities. The potential benefits are significant: residents of "smart growth" communities have about a quarter of the per capita traffic fatality rate as otherwise comparable people living in sprawled communities. "Smart growth" land use planning therefore has positive implications for sustainability from multiple perspectives, since planning strategies that support resource conservation and transportation efficiency are also traffic safety strategies. Increased safety appears to be one of the largest potential benefits of smart growth, and smart growth is likely to be among the most cost effective ways to improve traffic safety.

Canada's per capita traffic fatality rate is relatively low compared with peer countries. It is significantly lower than in the United States, but higher than in several European countries, including the United Kingdom, Germany, and the Scandinavian countries. Like most developed countries, Canada's traffic fatality rate has declined significantly during the last two decades, although the rate of decline has decreased in recent years.

ATV accidents have increased significantly during the last decade. Heavy truck accidents, injuries, and fatalities have shown no improvement. Bus accidents also increased, though on a comparative basis of passenger-kilometres travelled, bus travel remains considerably safer than other road transport modes.

There are significant problems with traffic accident data in Canada. Canadian accident data are significantly less comprehensive or accessible than what is available in the United Kingdom, the United States, or some other OECD countries. Transport Canada takes more than a year to release basic data, and fails to standardize statistics between jurisdictions. Discrepancies between federal and provincial classifications of vehicle types also limited the comparison of accident trends by vehicle type

[589] Frank, Lawrence, Sarah Kavage and Todd Litman, (2006)

Chapter 14. Non-motorized Transportation

"Non-motorized" (or "active") transportation refers to walking and bicycling, and their variations, such as travel by skateboarding, in-line skating, cross-country skiing, canoeing, kayaking, or using a wheelchair.[590] Non-motorized travel is an important form of transportation and recreation.[591] Most trips, even those by automobile or public transit, involve walking links. Walkability has been identified in many studies as an important factor in community liveability. Often, the best way to increase transit travel is to improve walking conditions between transit stops and destinations. Non-motorized travel is particularly important for people who are economically, physically, or socially disadvantaged.

Non-motorized travel is often the most practical way to improve physical fitness and public health. [592] Canadian research indicates that 2.5% of current health care expenditures can be attributed to physical inactivity. In 2002, the Canadian health care budget was $112 billion, meaning that as much as $2.8 billion could be saved if all Canadians were physically active.[593] GPI Atlantic has estimated that if just 10% fewer Nova Scotians were physically inactive, the province could save an estimated $24.7 million.[594] And if just 10% fewer residents of HRM over the age of 12 were physically inactive, there would be an economic saving of $4.75 million.[595]

In summary, improving walking and cycling conditions, and increasing non-motorized travel, can help provide the following benefits:

- reduced traffic congestion;
- reduced parking problems;
- consumer cost savings;
- reduced crash risk to other road users;
- increased health and fitness;
- reduced air and noise pollution;
- energy conservation;
- improved public realm (public spaces where people interact) and increasing social cohesion (interactions between people in a community); and
- improved mobility options for non-drivers.[596]

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[590] Campbell, Richard and Margaret Wittgens. *The Business Case for Active Transportation: The Economic Benefits of Walking and Cycling*, p. 4. (Go For Green, 2004). www.goforgreen.ca/at/eng/PDF/at_business_case.pdf Accessed February, 2005.
[591] Litman, Todd. *Economic Value of Walkability*, p. 2. (Victoria Transport Policy Institute, 2004c). www.vtpi.org/walkability.pdf Accessed February, 2005.
[592] Frank, Lawrence, Sarah Kavage and Todd Litman, (2006)
[593] Campbell.and Wittgens. (2004, p. 27).
[594] Colman, Ronald, *The Cost of Physical Inactivity in Nova Scotia.* (GPI Atlantic, 2002). http://www.gpiatlantic.org/pdf/health/inactivity.pdf
[595] Walker, Sally, and Ronald Colman, *The Cost of Physical Inactivity in Halifax Regional Municipality,* (GPI Atlantic, 2004). http://www.gpiatlantic.org/pdf/health/inactivity-hrm.pdf
[596] Ibid, p 1.

However, non-motorized transportation tends to be undercounted and undervalued in conventional transportation planning. Transportation statistics typically indicate that non-motorized travel represents only a very small proportion of total movement. But the actual amount is usually much greater, since conventional surveys often ignore short trips, recreational trips, travel by children, non-commute travel, and non-motorized links to trips that involve a motor vehicle.[597]

The Indicator

The Centre for Sustainable Transportation has not yet produced an indicator related to non-motorized travel because of problems regarding standardization of the data that are currently collected. The CST does suggest the development of future indicators, such as the mode share of non-motorized travel, or total passenger-kilometres of travel by non-motorized modes.[598]

The CST considers journey-to-work mode shares that include walking and bicycling as a potential indicator of non-motorized transportation. This indicator would be based on information provided by Statistics Canada's Census data on commuting, as in Chapter 10.1 of this study, above. At the time of its first round of indicator development, CST only had access to one year of this Census data (1996) and did not develop this indicator any further. A related indicator proposed by the CST is simply the percentage of workers who walk to work. This indicator was also not pursued because of a lack of adequate time series data.

Lastly, the CST considers the length of sustainable infrastructure for non-motorized travel, such as sidewalks and paths, as a potential indicator that could be developed in the future. This would be based on statistics provided by the Transportation Association of Canada, and could include non-motorized transportation infrastructure such as the length of bicycle lanes and continuous walkways. As above, insufficient data were available for the adoption and implementation of this indicator.

Similar data limitations prevented **GPI***Atlantic* from fully developing indicators to represent progress in non-motorized transport beyond the commuting data presented in Chapter 10.1 above. But, in recognition of the important role of non-motorized travel in a sustainable transportation system, a general discussion based on available data is provided below. The following section describes some of the pertinent statistics that are available and draws on relevant data previously presented on indicators of access to basic services. Attention will also be drawn to areas that require further information that would allow for appropriate indicators of non-motorized transportation to be developed in the future.

While the obstacles facing the development of active transportation are considerable, the available evidence indicates that the benefits of facilitating it, as summarised briefly above, are substantial. As a result, an **increase** in non-motorized travel can be considered a movement towards sustainable transportation.

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[597] Litman, Todd. *Quantifying the Benefits of Nonmotorized Transportation for Achieving Mobility Management Objectives*, p. 2. (Victoria Transport Policy Institute, 2004d). www.vtpi.org/nmt-tdm.pdf Accessed February, 2005.
[598] Gilbert et al. (2000, p. 58).

Trends: International

Although recent international statistics on non-motorized transportation were not available, some general observations can be made based on the limited data that do exist. As was noted in the 1996 data from Figure 143 (Chapter 10 of this report), non-motorized transportation is much more common in European cities than in North America. People in Sweden, Austria, Denmark, the Netherlands, and Switzerland, rely on cycling and walking for 40% or more of all urban travel whereas in Canada and the US, non-motorized transport accounts for less than 10% of all urban travel.

Trends: Canada

The only comparable and reliable national data currently providing some indication of the level of non-motorized transportation in Canada are derived from the commute mode split statistics in the 1996 and 2001 Censuses. While this may only be a small proportion of non-motorized trips, it is the best measure of non-motorized transport activity currently available. Some of these data were presented in Chapter 10 above (Section 10.1).

It should be noted that walking and bicycling can be important components of non-work related trips, such as those for recreation or shopping. A survey conducted by Environics in 1998 found that 33% of respondents "at least sometimes" walk to a routine destination for leisure/recreation, and 31% do so "at least sometimes" for shopping/errands.[599] Eighteen percent of respondents cycle at least sometimes to a routine destination for leisure/recreation. These numbers should also be considered when reviewing the data on Canadians commuting to work.

The previous indicators on basic access, in Chapter 10 above, presented the available Canadian statistics on walking and cycling to work. These 1996 and 2001 Census data recorded a decline in the number of Canadians walking to work: from 7% in 1996 to 6.6% in 2001. Halifax, however, has the third highest proportion of commuters walking to work among major Canadian cities. In 2001, the Census Metropolitan Areas with the highest proportion of commuters walking to work were Kingston (10.4%); Victoria (10.4%); and Halifax (10.3%).[600] Walking is often combined with other modes, such as public transit. For example, although walking was the *primary* mode of transportation for only seven percent of urban commuting trips in Canada in 1992 nearly three times as many commuting trips included a walking component.[601] This indicates how walking may be undercounted and undervalued in commonly used travel data.

Some survey research has also been conducted to identify why Canadians do not use walking as a mode of transportation more often. Distance was found to be the primary deterrent for 47% of respondents. Other barriers identified included time (19% of respondents); weather (18%); inconvenience (11%); and health/disability (11%).[602] But survey responses indicate that a large

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[599] Go For Green, Environics. (1998, p. 4).
[600] Statistics Canada. Getting to work on bicycle or foot, Census 2001. (February 24, 2003). www12.statcan.ca/english/census01/Products/Analytic/companion/pow/ftorbike.cfm Accessed February, 2005.
[601] Statistics Canada. *General Social Survey*. 1992. Cited in Litman. (2004a, p. 2).
[602] Go For Green, Environics. (1998, p. 6).

majority of Canadians are interested in walking more regardless of the hurdles identified. Eighty-two percent of Canadians stated that they would ideally like to walk more than they presently do.[603]

Canadian data on commuters bicycling to work showed a marginal increase from 1.1% in 1996 to 1.2% in 2001. The Census Metropolitan Areas showing the highest proportion of commuters bicycling to work were Victoria (4.8%); Saskatoon (2.5%); Kingston (2.2%); Ottawa-Hull (1.9%); and Vancouver (1.9%).[604]

The identified barriers to cycling are similar to those for walking, with a few exceptions. Canadians mentioned distance and weather as the two primary drawbacks to bicycling: 31% and 27% respectively. The other barriers included time (17%); traffic/safety or bad roads (14%); and laziness/inconvenience (12%).[605]

When the issue of safety was addressed directly, 53% of respondents viewed cycling as dangerous due to vehicular traffic. This concern was found to be more common among women, and among people living in larger urban centres. These results also illustrate the importance of addressing the planning, design, and infrastructure needs noted above that would encourage greater use of non-motorized transportation. Despite all of these deterrents, 66% of Canadians say they would ideally like to cycle more than they presently do.[606] Bicycle lanes, ideally separated from motorized transportation, can certainly encourage considerably higher rates of bicycling than at present, and are likely a highly cost-effective investment when full costs (including energy savings, reduced pollution and greenhouse emissions, etc.) are taken into account.

An important consideration for active transportation is the distance that Canadians commute to work. Generally, the shorter the trip, the more likely that transportation modes such as walking or bicycling will be considered viable options. The median commuting distance for Canadians in 2001 was 7.2 kilometres,[607] up from seven kilometres in 1996.[608] Although the increase is small, it likely reflects the continued spread of low-density suburban and exurban sprawl in Canada, which has significant adverse consequences for non-motorized transport options, since Canadians have identified distance as the primary barrier to both cycling and walking.

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[603] Ibid., p. 7.
[604] Statistics Canada. (February 24, 2003).
[605] Go For Green, Environics. (1998, p. 16).
[606] Ibid., p. 11.
[607] Statistics Canada. Commuting Distance (km) (9), Age Groups (7) and Sex (3) for Employed Labour Force 15 Years and Over Having a Usual Place of Work, for Canada, Provinces, Territories, Census Metropolitan Areas 1 and Census Agglomerations, 2001 Census - 20% Sample Data. Catalogue No. 97F0015XCB2001001. (January 25, 2005). http://www12.statcan.ca/english/census01/products/ [For complete URL, see bibliography]. Accessed February, 2005.
[608] Statistics Canada. Employed Labour Force by Sex, Showing Commuting Distance to Work for Persons Having a Usual Workplace Address, for Canada, Provinces and Territories, 1996 Census (20% Sample Data). Catalogue No. 93F0027XDB96018. (March 2, 2005a). www.statcan.ca/english/census96/mar17/commut/dist1.htm Accessed March, 2005.

Trends: Nova Scotia

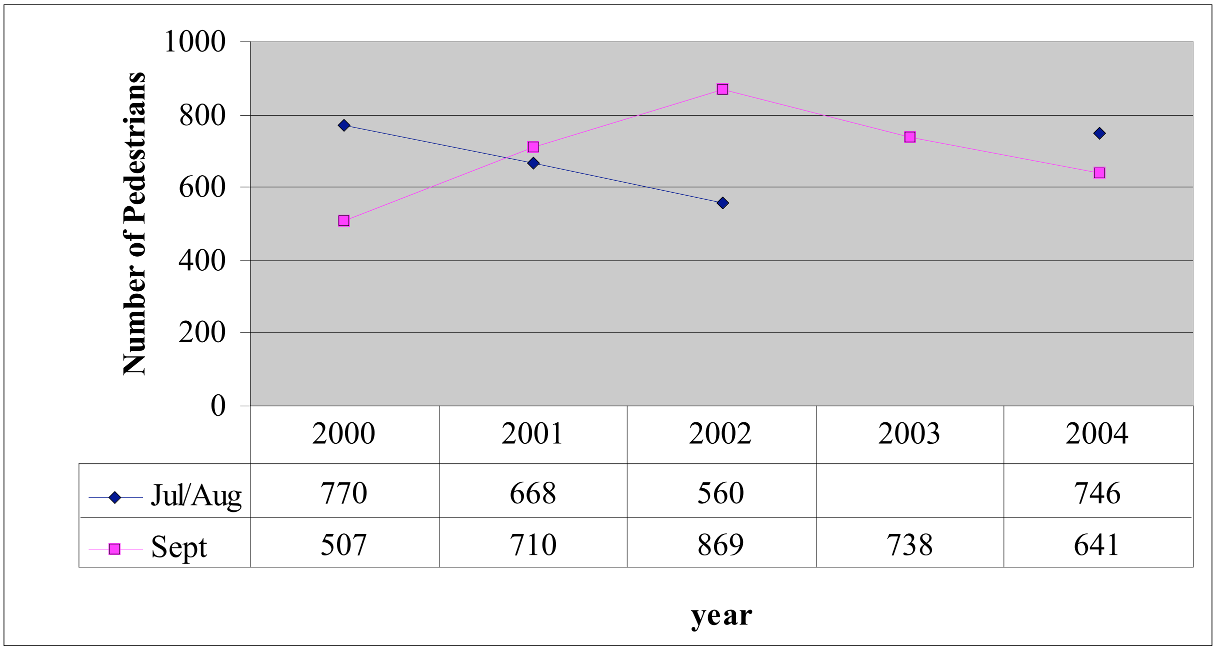
Comparable data regarding the use of non-motorized transportation to commute to work are provided by Census statistics at the provincial level as well. As with the national figures, some of this information has already been presented in the basic access indicators in Chapter 10 above, and will therefore be reviewed only briefly in this section. Additional data are provided where possible. Most available statistics on non-motorized transportation in Nova Scotia measure only specific trips for purposes such as travel to work and school. No reliable aggregate data are available for the overall use of walking and bicycling as transport modes in the province.

The Census data demonstrate that from 1996 to 2001, walking to work remained steady at 8.3% of Nova Scotian commuters. This is above the Canadian average of seven percent in 1996 and 6.6% in 2001.[609] As mentioned above, Halifax was among the top three Census Metropolitan Areas in Canada for this indicator, with 10.3% of commuters walking to work in 2001 (up from 9.8% in 1996).[610, 611] As noted in the previous chapter on access to basic services, children in Nova Scotia also often walk or bicycle to school, though fewer reliable and comparable time-series data are available for that indicator.

Another partial measure of pedestrian activity in the Halifax Regional Municipality is the number of people who walk across the Macdonald Bridge, one of the principal routes into the Halifax downtown area. The Halifax-Dartmouth Bridge Commission has conducted a 24-hour count of foot traffic on the bridge twice yearly since 2000. The tallies are conducted only on days that have favourable weather conditions, and are made once in July or August, and then again in September. The results are shown in Figure 208.[612] These numbers indicate a relatively high volume of pedestrian traffic. For the July/August counts, the year 2000 saw the highest number of pedestrians (770) using the bridge in a 24-hour period. The lowest number recorded was 560, in 2002. For September, the fewest pedestrians crossed in 2000 (507), and the most in 2002 (869). The trends for pedestrian traffic on the Macdonald Bridge are fairly stable, with no discernible trend towards more or less pedestrian use over time.

[609] Statistics Canada. (February 24, 2003).
[610] Ibid.
[611] According to Statistics Canada's *Census Database, Labour Force Characteristics for Nova Scotia, Mode of Transportation to Work*, those included in the Census commuting data are the population 15 years of age and over, excluding institutional residents, who worked at some time at a usual workplace address, or had no fixed workplace address.
[612] Data were not available for July/August, 2003.

Figure 208. Number of Pedestrians Crossing Halifax's Macdonald Bridge, 2000-2004.



	2000	2001	2002	2003	2004
Jul/Aug	770	668	560		746
Sept	507	710	869	738	641

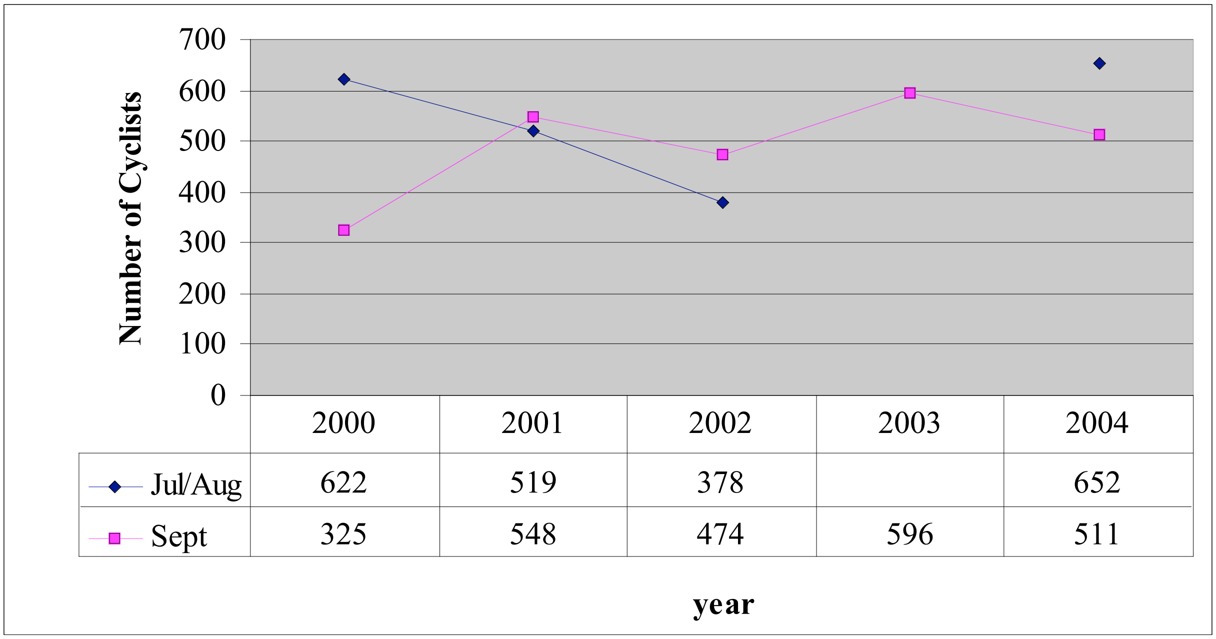
Source: Personal communication with Cheryl Bidgood, Communications Officer, Halifax-Dartmouth Bridge Commission. (February 3, 2005).

Cycling as a commuting mode has a much lower participation rate in the Halifax Regional Municipality—and in Nova Scotia generally—than does walking. The percentage of Nova Scotian commuters cycling to work fell from 0.7% in 1996 to 0.6% in 2001.[613] A similar decline was noted among those commuters travelling by bicycle in the HRM: from one percent in 1996 to 0.9% in 2001. The small numbers may be related, at least partly, to the paucity of safe bicycle paths in HRM, and to the other deterrents identified in the Environics survey referenced above.

The number of cyclists crossing the Macdonald Bridge is provided in Figure 209. While somewhat less than the volume of pedestrian traffic, a significant cohort of cyclists still uses the bridge when the weather is good. The most bridge crossings by cyclists in July/August occurred in 2004, and the most crossings in September occurred in 2003. Again, no data are available for July/August, 2003.

[613] Statistics Canada. (February 24, 2003).

Figure 209. Number of Cyclists Crossing Halifax's Macdonald Bridge, 2000-2004.



	2000	2001	2002	2003	2004
Jul/Aug	622	519	378		652
Sept	325	548	474	596	511

Source: Personal communication with Cheryl Bidgood, Communications Officer, Halifax-Dartmouth Bridge Commission. (February 3, 2005).

As with the pedestrian traffic statistics in Figure 208 above, it is difficult to discern clear trends from these data, or to draw specific conclusions, as it is unknown what percentage of the cyclists are commuters, and how many are using their bicycles for recreation or other purposes. Nonetheless, Figures 208 and 209 do indicate that significant numbers of HRM residents will avail themselves of non-motorized transportation options when conducive bicycle lanes and pedestrian walkways are available.

The bicycle lane on the Macdonald Bridge is one factor among many that contribute to making cycling in the Halifax Regional Municipality a viable transportation alternative. In July, 2002, public consultations identified the best things about bicycling in the HRM. These included:

- reasonably moderate weather that potentially allows for year-round cycling;
- bicycle accommodation on the ferry;
- cycling can be faster than the bus;
- the compact urban area is easy to travel in; and
- quiet side streets.[614]

These advantages help to offset some of the major deterrents to cycling in HRM, including a general lack of adequate supporting infrastructure like bicycle paths. Nevertheless, the primary barriers identified in the 1998 Canadian survey conducted by Environics and referenced above

[614] EDM Environmental Design and Management Limited and Alta Planning and Design. *Blueprint for a Bicycle Friendly HRM: Halifax Regional Municipality Bicycle Plan*, p. 7. (Halifax: 2004). www.halifax.ca/cycling/HRMBikePlanText.pdf Accessed February, 2005.

were distance, weather, and time. In the HRM, according to the 2002 consultations, these conditions are somewhat favourable and can be used to encourage greater use of active transportation options.

As noted in Chapter 10 and in the Environics survey data noted above, commuting distance is another factor influencing the quantity and potential of non-motorized transport use. Census data on commuting distance are available at the sub-provincial level. The median commuting distance in the HRM was 6.3 kilometres in 2001, the same as in 1996.[615, 616] This compares to a median commuting distance of 7.8 kilometres for Nova Scotia as a whole.[617]

As mentioned previously, a shorter commuting distance would be expected to encourage greater use of non-motorized transportation, such as cycling or walking. This thesis is supported by the finding that 30% of the HRM commuters who live in the urban core of Halifax use walking as their primary means of travel to work—nearly three times the proportion as in HRM as a whole, including its suburban and rural commutershed regions.[618]

An additional method of assessing non-motorized transportation, also considered by the CST as a potential future indicator, is the quality and quantity of infrastructure available, including sidewalks for pedestrians and bicycle paths for cyclists. Unfortunately, current and comprehensive data on this infrastructure are not available at the provincial level. In the past, provincial records were kept of the length of paved and unpaved sidewalks in Nova Scotia, but these data have not been maintained since 1995. Statistics for the most recent year for which complete records are available are provided in Table 31. As with so much of the data on active transportation, the numbers below are inadequate and insufficient to draw specific conclusions or to discern trends.

Fortunately, an inventory of sidewalk and pathway length for the Halifax Regional Municipality has been initiated, which should provide much more satisfactory time series data on this indicator in the future. Although incomplete, the count to date shows that the region has 757 kilometres of sidewalk, and 41 kilometres of walkways.[619] The length of sidewalk in the HRM appears to have increased since the last tally, which reported 688 paved kilometres of sidewalk in 1998.[620] Future analysis should assess these trends on a per capita and per household basis, and should take into account factors like connectivity and continuity that would encourage use of these paths for commuting to work and school, and for access to shopping, recreation, and other services and amenities.

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[615] Statistics Canada. (March 02, 2005a).
[616] Statistics Canada. Commuting distance, by census metropolitan areas (1996 Census). (March 2, 2005b). www.statcan.ca/english/Pgdb/labor41a.htm Accessed February, 2005.
[617] Nova Scotia Department of Finance. (2004, p.187).
[618] Halifax Regional Municipality—Regional Planning. (2004a, p.12).
[619] Reashor, Ken. Manager, Traffic and Right-of-Way Services/Traffic Authority, Halifax Regional Municipality. (Personal communication: January 21, 2005).
[620] Nova Scotia Department of Municipal Affairs. *Annual Report of Municipal Statistics for Fiscal Year Ended March 31, 1999*. (Halifax: 2000).

Table 31. Nova Scotia: Kilometres of Paved and Unpaved Sidewalks, 1995.

	1995	
	Paved	Unpaved
Cities	712.8	0
Municipalities	237.5	4.8
Towns	585.7	136.7
TOTAL	**1,536**	**141.5**

Source: Nova Scotia Department of Municipal Affairs. Annual Report of Municipal Statistics for Fiscal Year Ended March 31, 1995.

The provision of appropriate infrastructure, such as sidewalks and bicycle lanes, is an important component of any strategy to encourage greater use of non-motorized transportation. The presence of bicycle paths in the United States has been found to increase the tendency or likelihood of adults to cycle.[621]

Recent research by the Heart and Stroke Foundation of Canada has shown that limited infrastructure, particularly in rural regions and in the suburbs, discourages active transportation, and thus can have an adverse impact on health. According to Dr. Anthony Graham, spokesperson for the Foundation: "The evidence is conclusive: our car-dependent habits are killing us."[622]

The Heart and Stroke Foundation study found that communities with smaller populations are less likely to have public transit, bicycle paths, and sidewalks.[623] The study's survey results showed that higher proportions of Canadians living in major urban centres "find their community convenient to walk or bike in"; "walk or bike to do daily chores"; are "at a healthy weight"; and use "walking, biking, or public transit" as their primary means of travelling to work, than Canadians living in smaller or less densely populated communities.[624]

Conclusion

Non-motorized transportation plays an important role in a sustainable transportation system. It is inexpensive and healthy, saves energy, and produces a wide range of environmental benefits (including reduced air pollution and greenhouse gas emissions.) It provides both transportation

[621] Dill, Jennifer and Theresa Carr. "Bicycle Commuting and Facilities in Major U.S. Cities." *Transportation Research Record 1828* Transportation Research Board (2003, pp. 116-123). www.des.ucdavis.edu/faculty/handy/ESP178/Dill_bike_facilities.pdf.
[622] Heart and Stroke Foundation. 2005 Report Card on Canadians' Health—Has the Suburban Dream Gone Sour? (Toronto: February 10, 2005). ww1.heartandstroke.ca/Page.asp?PageID=33&ArticleID=3832&Src=news Accessed February, 2005.
[623] Picard, Andre. "Heart and Stroke Report Card Exercised Over Suburban Sloth." (Toronto: *The Globe and Mail*. February 11, 2005).
[624] Heart and Stroke Foundation. (February 10, 2005).

and recreation. It provides access to other modes, such as public transit. The benefits of non-motorized travel have been explicitly recognized in Halifax Regional Municipality's present long-term planning process and in specific submissions to the HRM planners.[625]

International comparisons indicate that people in Canada and the US drive more and use non-motorized modes less than in most other countries. In many European cities, walking and cycling account for more than a third of urban trips. At the national level, the number of commuters either walking or cycling to work has declined while the median commuting distance has increased, although surveys indicate that many Canadians would like to walk and cycle more than they do now, but are discouraged by inadequate infrastructure.

In Nova Scotia, the percentage of commuters walking to work remained constant during the 1996-2001 study period at 8.3%, with Halifax ranking among the top three Census Metropolitan Areas in Canada for the proportion of commuters walking to work (10.3%). At the same time, a decline was noted for the very small percentage of commuters bicycling to work in Halifax, a trend that holds true for the province overall. Some supplementary data on non-motorized bridge traffic in Halifax, and on the length of sidewalks in HRM and Nova Scotia, were presented to provide a few more details on bicycling and walking in the province.

However, the numbers provided above do not allow a comprehensive analysis of non-motorized transportation in Nova Scotia. It is difficult to discern clear trends or draw specific conclusions from much of the information because of significant gaps in the data. But even this cursory examination is helpful in illustrating the type of information that is required to present a more complete overview of active transportation. Based on the discussion above, recommendations can be made to improve and expand future data collection and analysis in this important area.

Firstly, future data collection should allow for a more nuanced understanding of variations in the travel modes associated with commuter trips. For example: allowing a respondent to list walking (and distance walked) as a *secondary* mode of transportation—in order to get to and from public transit for instance—would serve to create a more complete picture than data on *primary* mode of transport alone. This additional information would also help to address the problem of under-representing and therefore undervaluing non-motorized transportation in research, planning, and policy. Such additional information will hopefully translate into increased government awareness of the important role of active modes such as walking and cycling, and of the provision of appropriate infrastructure conducive to their promotion.

The second recommendation is to collect commuter data more regularly, and to include information on transportation to school. The five-year time span between Census collections has hitherto limited effective analysis of trends for the commuting indicators to only two years – 1996 and 2001, though 2006 Census data will be available next year. Even more importantly, initiatives aimed at increasing non-motorized transportation currently have to wait a fairly long time to determine if change is occurring and if there is effective uptake of new infrastructure. For example, provision of bicycle lanes should provide much quicker evidence of the impact of such

[625] See Walker, Sally and Ronald Colman, *The Cost of Physical Inactivity in Halifax Regional Municipality,* GPI Atlantic, Halifax. 2004. Prepared for the Nova Scotia Heart and Stroke Foundation, and presented to the HRM planning hearings. This report was referenced by the planners in announcing their recommendations to Council.

investments on commuting patterns and behaviours than Census cycles allow. This may necessitate additional local surveying at more frequent intervals or following investment in new infrastructure.

Another data recommendation relates to the timing and nature of record-keeping for non-motorized transportation infrastructure. The available data are sparse and incomplete, with the most recent available provincial data on sidewalks dating to 1995. Information on the quantity and quality of infrastructure to support bicycling and walking should be no less of a priority than data on roadways, and should be compiled on a regular basis using a standardised format. This would allow for the development of indicators and effective analysis of trends to assess the availability and accessibility of a viable active transportation infrastructure in Nova Scotia. Reporting regularly on such data would generally raise the public profile of active transportation and thereby encourage its use.

Given the very substantial social, economic, and environmental benefits that stem from walking, cycling, and other active transport modes, this is an area that clearly needs much greater attention than it has received to date. Results from survey research and public consultations presented above show that Nova Scotia, and Halifax in particular, have an opportunity to overcome present obstacles to active transportation to a large degree. The small size of Halifax, and its relatively moderate climate year-round, make it relatively easy for people to get around on bicycle or foot. These attributes can be used to advantage—especially since Atlantic Canadians have also indicated a significant interest in expanding their use of non-motorized transportation: 88% are interested in walking more, and 54% would like to cycle more.[626]

As noted, residents of European cities with comparable climates have much higher walking and bicycling rates, and there is little doubt that an improvement in infrastructure such as bicycle lands would raise rates of active transportation here. The results presented in this chapter, even with the limited data available, show that an increase in active transportation would be welcome, and that policy commitments to improve supporting infrastructure would likely be both cost-effective from a full-cost accounting perspective, and also very well received by the public.

[626] Go For Green, Environics. (1998).

Chapter 15. Neighbourhood Quality of Life

In general, increased vehicle traffic reduces neighbourhood liveability, by: [627]

- Reducing road safety;
- Degrading walking conditions;
- Increasing traffic noise;
- Decreasing interactions between neighbours;
- Reducing property values

Local street design and traffic management practices can affect traffic speeds and volumes, and therefore the quality of life in neighbourhoods.[628] Municipalities commonly use certain road design strategies, known collectively as *traffic calming*, to reduce the impact of rising traffic levels, and to improve quality of life in residential districts. Traffic calming projects can range from minor alterations such as laying speed bumps or reducing speed limits, to major changes on the order of rebuilding entire street networks.[629] While these initiatives generally do improve neighbourhood quality of life, traffic calming efforts may lead to less desirable consequences, including displacing traffic onto other streets; impeding emergency vehicles; and frustrating drivers.[630, 631]

Traffic calming practices are common in Nova Scotia, particularly in the Halifax Regional Municipality, the most heavily populated part of the province. Recently HRM implemented a Neighbourhood Short-Cutting Policy that addresses concerns about traffic issues in neighbourhoods. The aim of this regulation is to improve neighbourhood quality of life in problematic areas by reducing the infiltration of commuter traffic into residential districts.[632] As a result of the policy, procedures are now in place to ensure that key traffic problems are addressed. Volume, speed, and collision data are collected when a potential traffic problem is identified. If it is determined that a problematic situation exists, suitable traffic calming measures are put in place, as outlined by the policy.[633]

In short, traffic levels influence the social fabric of neighbourhoods. By monitoring traffic volumes, speeds, and noise levels, municipalities can identify residential areas negatively affected by traffic, and put in place measures to alleviate the impacts that result from increases in traffic.

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[627] Litman, Todd. *Traffic Calming Benefits, Costs and Equity Impacts*, pp. 7-17. (Victoria Transport Policy Institute, 1999). www.vtpi.org/calming.pdf
[628] Appleyard, Donald. *Livable Streets*, (Berkeley: University of California Press, 1981).
[629] Litman. (1999, p. 2).
[630] Wheeler, Stephen. *Livable Communities: Creating Safe and Livable Neighborhoods, Towns, and Regions in California*, p. 23. (Berkeley: Institute of Urban & Regional Development. IURD Working Paper Series. 2001. Paper WP-2001-04). http://repositories.cdlib.org/iurd/wps/WP-2001-04
[631] Litman. (1999, pp. 20-21).
[632] Halifax Regional Municipality—Engineering and Transportation Services. *Neighbourhood Short-Cutting Policy*, p. 1. (Halifax: 2004c). www.halifax.ca/traffic/calming/SCPSep04.pdf
[633] Ibid. p. 4.

The Indicator

GPI*Atlantic* was unable to find examples of an indicator that is being effectively used to measure either the effect of transportation on neighbourhood quality of life or the impact of traffic calming measures on neighbourhood quality of life. The following section therefore offers a preliminary consideration of how such indicators might be developed to measure the effect of transportation on a neighbourhood.

Traffic volumes, speeds, and noise levels could be measured directly and checked against recommended thresholds. For example, traffic volumes could be compared to accepted norms for residential districts in order to identify problematic traffic areas. The same could be done with other recommended road standards.

Indirect indications of traffic effects on neighbourhoods could include trends in local road safety, walking conditions (which are discussed in this report's section on non-motorized transportation in the previous chapter), neighbourly interactions, crime rates, property values, and relocation rates. These must be considered indirect impacts, because traffic is clearly not the only factor that affects these trends and conditions.

Most of the data needed to operationalize these indicators are not readily available, and it was beyond the scope of this report to gather them. In addition, there are no agreed methods for isolating the particular impacts of traffic on the conditions and trends noted above. One exception, where some data are available, is information on trends in traffic volumes in some parts of Halifax Regional Muncipality. Trends are therefore presented here for some "local" streets (i.e. side-streets) in HRM as well as for some of the larger "collector" routes in Halifax and Dartmouth.

Traffic volumes are presented for two reasons:

1) To determine if traffic volumes are above recommended levels; and
2) To demonstrate the effect of traffic calming programs on traffic volumes.

While sufficient data are not available to compile aggregate indicators for HRM on these outcomes, the available information can be considered both representative of the kinds of problematic impacts that heavy traffic can have on residential neighbourhoods and suggestive of the kind of indicators that could eventually be developed to assess these important issues.

Comparisions are made between selected HRM traffic volumes and the traffic volumes recommended by the Transportation Association of Canada (TAC). The TAC recommendations were chosen because HRM's transportation sector uses them as a guide for traffic management. The effect of traffic calming programs on traffic volumes is demonstrated by comparing trends for streets that have had traffic calming and for others that have not, both before and after the selective traffic calming programs were implemented.

HRM's Public Works and Transportation Services (PWTS) department kindly provided unpublished data on street traffic volumes in the municipality for the purposes of this study. PWTS has compiled data on traffic volumes for various streets between 1996 and 2004, but not every route was monitored on a yearly basis; therefore there are gaps in the trends presented. PWTS also helped identify which streets to use as representative examples for this report. These roads were chosen based on the department's knowledge of areas within HRM that currently have or in the past have had traffic problems.[634, 635]

As noted, these trends and comparisons by no means serve as aggregate indicators of how transportation affects neighbourhood quality of life in HRM. In order to produce such an indicator for HRM, a far more comprehensive analysis of traffic volumes, speed, and noise will be needed. Instead the following section presents selected examples of traffic volumes in order to highlight how this factor could inform future studies and lead to development of suitable indicators for this important subject area.

Trends: Halifax Regional Municipality

Traffic Volumes

Table 32 outlines the different road classifications and associated traffic volumes used by the HRM, as recommended by TAC. Road classifications are based on the physical characteristics of a roadway that make it capable of handling traffic. Such things as road width, design speed (how sharp the curves are, etc), adjacent land uses, etc. are considered when allocating recommended traffic volumes. In addition to the TAC recommendation, HRM has found it necessary to split collectors into minor and major to better characterize the variety of street designs in the city.[636]

Table 32. Transportation Association of Canada's Recommended Traffic Volumes for Urban Roads (vehicles per day).

	Traffic Volume (vehicles/day)	
Road Classification	**TAC Recommendation**	
Residential local	< 1000	
Residential collector	minor: < 12,000 (HRM)*	Major: < 20,000 (HRM)*
Arterial	minor: 5000-20,000	major: 10,000-30,000
Expressway	> 10,000	

Source: Transportation Association of Canada. *Geometric Design Guide for Canadian Roads*; McCusker, David. Manager of Traffic and Transportation Services, Halifax Regional Municipality. (Personal Communication: February 27, 2005).

* Note: The above minor and major residential collector traffic volumes have been defined by HRM, not TAC. TAC recommends traffic volumes for residential collectors to be <8000 vehicles/day. Thus the recommended traffic volumes for collectors set by HRM are considerably greater than those set by TAC, even for minor collectors.

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[634] Taylor, Alan. Transportation Planner, Halifax Regional Municipality—Public Works and Transportation Services. (Personal Communication: February 16, 2005).
[635] McCusker, David. Manager of Traffic and Transportation Services, Halifax Regional Municipality. (Personal Communication: February 10, 2005).
[636] McCusker, David. Manager of Traffic and Transportation Services, Halifax Regional Municipality. (Personal Communication: February 27, 2006).

By comparing the TAC recommendations to actual weekday traffic volumes on selected streets in HRM, it is possible to determine if traffic volumes exceeded recommended levels. Table 33 presents traffic volumes for selected streets currently classified as "local" in HRM, and Table 34 identifies those currently classified as "collector" streets.[637]

Table 33. Traffic Volumes and Proposed Road Reclassifications for Selected Local Streets in Halifax Regional Municipality, 2001. (TAC Local Street Recommendation = <1,000/day)

		Road Classification		
Street Name	**2001 Avg. Weekday Traffic Volumes (# of vehicles)**	**Current**	**Proposed**	**Above TAC Recommendations?**
Armview Ave.	3,943	local	local	Yes
Bayview Rd.	12,387	local	minor collector	Yes
Allan St.	3,085	local	local	Yes
Basinview Dr.	3,363	local	minor collector	Presently above

Sources: Personal Communication with Leonard Bugbee, Traffic Analyst, Halifax Regional Municipality—Public Works and Transportation Services. (February 16, 2005); and Transportation Association of Canada. *Geometric Design Guide for Canadian Roads*.

Table 34. Traffic Volumes and Proposed Road Reclassifications for Selected Collector Streets in Halifax Regional Municipality, 2004 (TAC collector recommendation = <8,000/day)

		Road Classification		
Street Name	**2004 Avg. Weekday Traffic Volumes (# of vehicles)**	**Current**	**Proposed**	**Above TAC Recommendations?**
Oxford St. (between Coburg Rd and Waegwoltic Ave., NB)	22,860	Collector	Major collector	Yes
Jubilee Rd. (between Oxford and Cambridge St., EB)	18,881	Collector	Major collector	Yes
Victoria Rd. (between Highfield Park Dr. and Hwy 111, SB)	7,100	Major collector	Arterial	No
Windmill Rd. (between Geary St. and Wyse Rd., NB)	20,812	Collector	Major collector	Yes
Woodland Ave. (between Hwy 111 and Mic Mac Dr./Lancaster Dr., EB)	17,398	Major collector	Expressway	Yes

Sources: Personal Communication with David McCusker, Manager of Traffic and Transportation Services, Halifax Regional Municipality. (February 10, 2005); and Transportation Association of Canada. *Geometric Design Guide for Canadian Roads*. [Note: NB = Northbound; EB = Eastbound; SB = Southbound]

[637] Road classifications, such as "local" and "collector" are defined by the traffic volumes recommended by TAC, as outlined in Table 32 above. As noted, the division into minor and major collector categories is HRM's and not TAC's, but the general TAC guideline for collectors of <8,000 vehicles per day is used in Table 34, rather than HRM's own guidelines of < 12,000 vehicles/day for minor collectors and < 20,000/day for major collectors..

On eight of the nine streets examined, weekday traffic volumes exceeded the TAC's recommendations (Tables 33 and 34). The four local streets exceed the 1,000 vehicle/day TAC guideline by three to 12 times, while four of the five collector streets have traffic volumes two to three times the TAC recommended 8,000 vehicle/day maximum. Bayview, Oxford, Jubilee, and Windmill are the most problematic of the streets examined, because they have the highest weekday traffic volumes relative to those recommended by TAC. In absolute numbers, Oxford Street has the highest traffic volume of the nine streets examined here, with an average of 22,860 vehicles per weekday recorded in the northbound approach to Coburg Street in 2004.

The examples illustrate the presence of major traffic problems in these (and certainly other) neighbourhoods of Halifax Regional Municipality, and indicate that the impact of transportation patterns on neighbourhood quality of life may be a major issue facing the region. Certainly the magnitude of disparity between current traffic volumes and TAC recommended guidelines for maximum volumes indicates that this issue is worthy of tracking and monitoring systematically and on a regular basis.

As Tables 33 and 34 indicate, seven of the nine streets examined are undergoing reclassification as higher order streets. These reclassifications generally result from the need to "rationalize" initial classifications. The road classifications in HRM were inherited from the period prior to amalgamation of the region, and at a time when classifications were not done consistently or were not done at all. The proposed reclassifications are either the result of a road that: a) is improperly classified to begin with, or b) has had physical changes made to it that increase its load capacity.[638] Interestingly, even with these reassignments, Bayview Rd. and Oxford St. will still exceed recommended weekday volumes for these types of streets, and Windmill Rd. will be just over the recommended capacity. By contrast, reclassifying Basinview Dr. and Jubilee Rd. as higher order streets, as proposed by HRM, suggests that the routes will henceforth fall within TAC's recommended traffic volumes. Street reclassification by no means eliminates the ever increasing traffic problems in HRM. However, it does provide a more consistent mapping of road volume capacities. With these updates, city planners are better equipped to assess traffic in the region.

The Effect of a Traffic Calming Program

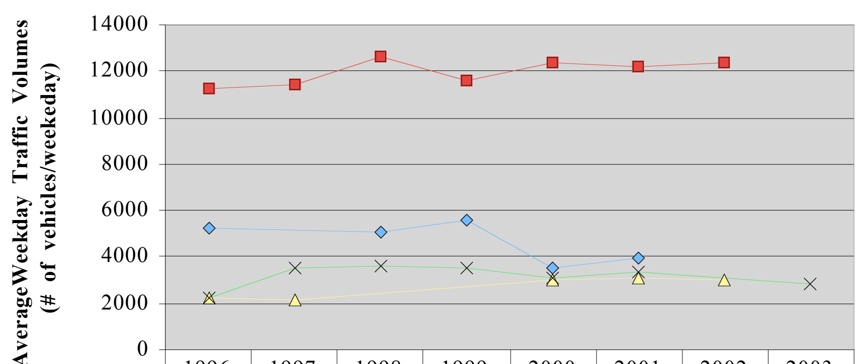
Figure 210 shows the average weekday traffic volumes on selected local routes in HRM between 1996 and 2003. Three of the four streets examined show fairly constant traffic volumes for this period. By contrast, traffic volumes on Armview Avenue suddenly dropped quite dramatically—by 36%, from 1999 to 2000. This marked decline was the result of a traffic calming program put in place in 2000 designed to discourage commuters from using this shortcut through residential streets.[639] The very inexpensive traffic calming program consisted mainly of

[638] McCusker, David. Manager of Traffic and Transportation Services, Halifax Regional Municipality. (Personal Communication: February 27, 2006).
[639] Taylor. (February 16, 2005).

strategic placement of speed bumps on residential streets onto which commuters formerly turned from Quinpool Rd.

The other streets listed in Figure 210 are known within the HRM Public Works and Transportation Services department as problematic areas, but measures to reduce traffic volumes on these routes have not yet been implemented.[640] This example demonstrates the positive effect traffic calming can have on traffic volumes. The Armview Avenue experiment was not without problems and controversy, displacing traffic to other streets and frustrating many commuters. As well, traffic volumes in 2001 rose by 11% over the 2000 low point (the year the program was first implemented), as some commuters returned to the area despite the new disincentives. But the program remains in place five years later, and is still regarded as relatively successful.

Figure 210. Average Weekday Traffic Volumes on Selected Local Streets in the Halifax Regional Municipality, 1996-2003*.



	1996	1997	1998	1999	2000	2001	2002	2003
Armview Ave.	5233		5058	5569	3543	3950		
Bayview Rd.	11248	11453	12647	11572	12387	12205	12363	
Allan St.	2241	2119			3032	3085	3020	
Basinview Dr.	2223	3562	3628	3500	3099	3363		2821

Year

Source: Personal Communication with Leonard Bugbee, Traffic Analyst, Halifax Regional Municipality—Public Works and Transportation Services. (February 16, 2005).

Note: For all four streets depicted in Figure 210, data are not available for some years. The HRM has a set of major roads that are counted on a regular basis. However, the above streets are not included in these "regular" counts. The counts listed above were considered "special" counts that were taken in response to particular traffic issues. According to HRM, the missing years are most likely due to the need to wait for a period to reassess traffic volumes, as defined by the particular traffic study, or else no count was deemed necessary in that particular year. (Personal Communication with Alan Taylor, Transportation Planner, Halifax Regional Municipality—Public Works and Transportation Services. (March, 2006).

[640] Ibid.

Conclusion

In an effort to illustrate the potential impacts of transportation systems on residential neighbourhoods at least partially, examples of traffic volumes on designated local and collector streets were presented. Traffic volumes were well above recommended maximum levels on eight of the nine roads examined. This suggests that high traffic volumes in HRM are an issue in various localities and are likely affecting the quality of life of some residents. The evidence indicates that this issue is of sufficient importance to required systematic and regular monitoring, tracking, and policy attention in transportation policy and planning.

Some of the identified problems can at least be mitigated, and adverse trends possibly reversed, with traffic calming programs. In the year following implementation of traffic calming measures on Armview Avenue, a 36% decline in traffic volume was recorded, though traffic volumes crept up by 11% the following year (2001) as many commuters decided they would rather deal with traffic bumps than be stuck in traffic on Quinpool Rd. At the time when these data were collected, the most recent traffic counts on Armview were from 2001, so it was not possible to assess the longer-term success of this traffic calming program.

In the future, a more thorough investigation of traffic volumes, speed, and noise in Halifax Regional Municipality should certainly be undertaken, in order to understand the impact of traffic on neighbourhood quality of life more accurately and comprehensively. This would entail gathering more comprehensive traffic data and assessing trends on a much larger sample of local and collector streets in HRM than was presented in this section. Traffic calming programs could also be expanded, building on the apparent effectiveness and success of experiments conducted to date.

Chapter 16. Government Spending on Public Transportation

How much governments spend on public transportation directly affects the quality and coverage of transit services. Historically, provincial governments across Canada funded a large proportion of both the operational and capital costs of public transit. However, since 1999, provincial funding has decreased significantly. As a result, public transit providers have become more reliant on municipalities and alternative revenue sources.[641] With less provincial funding, Canadian transit authorities have often been forced to cut services and raise fares.[642]

Government spending on public transportation is therefore a limiting factor in the capacity to maintain competitive and appealing transit systems, and an indirect indicator of public transit access and quality. It is "indirect" because it measures an *input* rather than an *outcome*. A direct relationship between government spending on health care, education, transportation, or any other public service can never be assumed to equate to better health, education, transportation, or other public service outcomes. This is because of the large number of potential intervening variables, including type and quality of management practices, which may affect ultimate outcomes. Nevertheless, the quantity of government spending on public transportation is at least a key *condition* of its potential availability and quality. If governments allocated a greater percentage of transportation budgets to public transit, then it would be possible to improve infrastructure and access to transit, and to make it more affordable. That, in turn, would encourage more people to use these systems and ultimately to get more people out of their cars—a key measure of movement towards sustainability.

As discussed previously, improved transit service and increased transit travel tend to support sustainable transportation. In light of these benefits, an increase in the percentage of government funding directed to public transit relative to the total road transportation budget would very likely indicate a trend toward a more sustainable transportation system.

The Indicator

This indicator measures the extent to which governments are investing in public transit, relative to total on-road transportation spending. The added value of presenting the trend as a function of total on-road transportation spending is that it not only demonstrates how much governments are spending on public transit but also highlights the difference between spending on transit and spending on overall road transportation. This is important because it is possible for government transportation spending to provide perverse incentives for motorized road transportation in

[641] McCormick Rankin Corporation. *Urban Transit in Canada: Taking Stock*, p. 51. (Ottawa: Transport Canada, 2002). www.tc.gc.ca/programs/environment/utsp/transitstudies/docs/Taking%20Stock.pdf Accessed March, 2005.
[642] Canadian Urban Transit Association. *Investing in Transit: Canada at the Crossroads*, p. 3. (Toronto: 2001b). www.cutaactu.ca/pdf/issue_paper.pdf Accessed March, 2005.

general and private vehicle use in particular, which may move the transportation system away from sustainability. Examining public transit spending as a proportion of total road transportation spending can at least point towards such analysis. Ideally this indicator would also include information on the portion of transportation expenditures devoted to non-motorized modes (sidewalks and paths). However this was not possible due to limitations in data availability.

All of the data used to measure and assess this indicator are from an addendum to Transport Canada's 2003 annual report, which includes public transit and total on-road transportation expenditures by province from fiscal year 1990/91 through fiscal year 2001/02.[643] These figures include federal, provincial, and local expenditures. Unlike most sections of this report, data are not presented on either an international or a national scale due to issues of comparability. Theoretically, comparable provincial data obtained from a federal data source should allow for very interesting inter-provincial comparisons of public transit spending as a proportion of total transportation spending, which could reveal which provinces have greater or lesser funding commitments to public transit. For the reasons explained below, however, such an inter-provincial comparison is not yet possible.

The Centre for Sustainable Transportation recommended this particular indicator as a short-term future addition to its first set of Sustainable Transportation Performance Indicators. The CST did not include the indicator in its initial group of indicators because it discovered some key inconsistencies in Transport Canada's figures for transportation spending and revenues when the yearly reports were compared.[644] As a result of these discrepancies, the CST was reluctant to present the time series data and trends in its initial indicator set.

In response to these concerns, **GPI***Atlantic* collected records of provincial and municipal government spending on road transportation and public transportation in Nova Scotia, directly from the provincial sources. The Nova Scotia Department of Transportation and Public Works provided statistics on provincial expenditures on roads and bridges from fiscal year 1993/94 through fiscal year 2003/04. Service Nova Scotia provided municipal operating expenditures for 1993/94 through 2001/02. HRM's Metro Transit provided access to GPI researchers, for the same years, to the *Transit Fact Book* put out annually by the Canadian Urban Transit Association (CUTA). This publication is issued only to members of CUTA. The CUTA documents provided figures for municipal capital expenditures on transit.

Unfortunately, gaps and ambiguities remained. The operating expenditure numbers reported to Service Nova Scotia by the different municipalities were often incomplete, as was the capital spending reported to CUTA. Moreover, it was unclear which expenditures were included in these totals. Due to these problems, it was decided that, despite the CST's justified reservations, Transport Canada's numbers would in fact be more representative and reliable than the provincial, municipal, and CUTA statistics for Nova Scotia that were separately assembled by the report authors. Statistics from the addendum to Transport Canada's most recent annual report (2003) were therefore used, since this annex incorporates adjustments to correct prior mistakes

[643] Transport Canada. *Transportation in Canada 2003—Addendum*. (Ottawa: Minister of Public Works and Government Services, 2003b). www.tc.gc.ca/pol/en/Report/anre2003/add2003-e.pdf
[644] Gilbert et al. (2002, p. 81).

and data gaps.[645] Those adjustments address some of the CST's concerns, at least in part, making the federal data more usable now than at the time they were first considered by the CST.

In calculating total government expenditures on road transportation, records for road, bridge, transit and other disbursements were added. According to Transport Canada, "other expenditures" for transportation include "overhead expenses and some expenditure on communication at the local level."[646] These expenditures were included in the total for road transportation on the assumption that "local level" expenditures refer to municipal expenditures. In Nova Scotia, these municipal expenditures would certainly be related almost entirely, if not wholly, to road transportation, since municipalities spend most of their transportation budgets on this sector, and since other non-road transportation modes, like rail, marine, and air transport, are not generally within municipal jurisdiction.

Based on the definition and goals of sustainable transportation used in this report, as well as in the CST and EU formulations, and on the reasoning above, a trend that indicates an increase in the portion of government spending on public transit relative to total on-road transportation is considered a sign of movement towards greater transportation sustainability. As explained, this is based on the recognition that more funding has the potential to improve the accessibility and infrastructure of transit systems, and thereby to provide the benefits noted above.

Trends: Nova Scotia

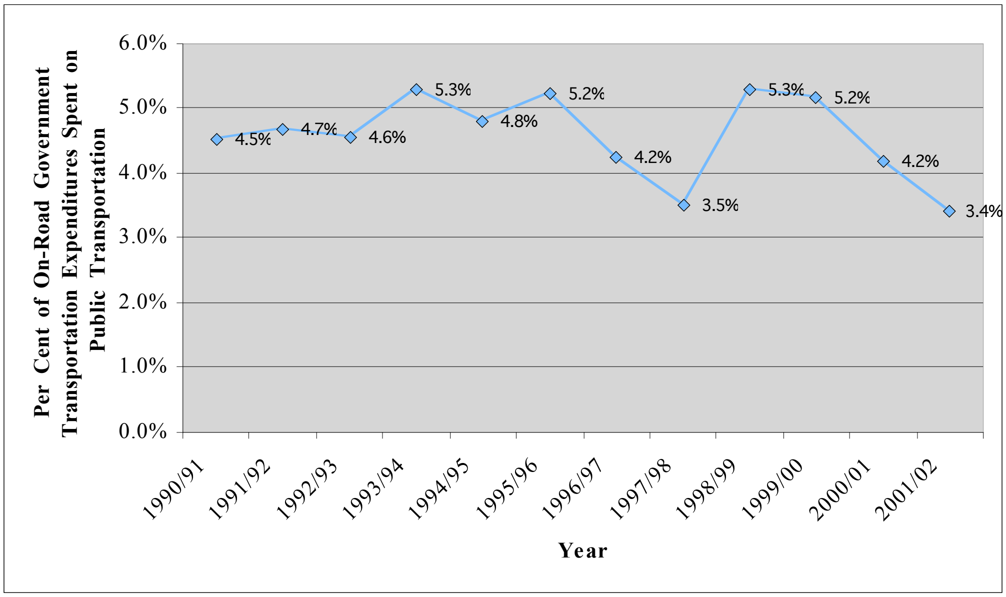
Government Spending on Public Transit as a Percentage of Total On-Road Transportation Expenditures

Figure 211 shows the trend for government spending on public transit in Nova Scotia as a proportion of total on-road transportation expenditures, for fiscal years 1990/91 through 2001/02. Government contributions to public transit were minimal in comparison to those for on-road transportation. Over this period, disbursements for public transit ranged between 3.4% and 5.3% of total road transportation spending. Moreover, within this time frame there was a 24% decline in government contributions to transit systems as a proportion of total road transportation spending. For the most recent years—between fiscal years 1999/00 and 2001/02—the decline was 35%. These trends indicate movement away from sustainability.

Current public funding practices tend to favour automobile transportation over public transit. This indicates both horizontal inequity, since transit-dependent residents receive a relatively smaller portion of public investment than motorists, and vertically inequity, since transit-depend people tend to be economically, physically, and socially disadvantaged. Although public transit services receive more subsidies per passenger-kilometre than motorists, transit users tend to travel far fewer annual kilometres than motorists, and so receive less public support per capita.[647]

[645] Transport Canada (2003b, p. A46 ff.).
[646] Ibid., p. A49.
[647] Litman, Todd. *Evaluating Public Transit Benefits and Costs*. Victoria Transport Policy Institute. (2006g). www.vtpi.org

Figure 211. Nova Scotia: Government Spending on Public Transit as a percentage of Total Government Spending on Road Transportation, 1990/91-2001/02.



Sources: Transport Canada. Transportation in Canada 2003: Annual Report—Addendum, Table A3-6.

Conclusion

Government spending on public transit in Nova Scotia is low and declining in comparison to overall funding for road transportation. This has limited transit agencies' ability to improve and expand services, and has led to fare increases that reduce ridership. This is both inefficient, because declining investment in transit services increases automobile travel and associated congestion problems, infrastructure costs, and environmental impacts, and unfair, since people who rely on public transit receive relatively less public funding per capita than motorists.[648,649,650] This is a move away from sustainability.

Between 2005 and 2010, municipalities in Nova Scotia are due to receive $142 million from federal fuel tax revenues.[651] Hopefully, this new source of funding will be directed, at least in part, to improving public transit infrastructure in the province. Dedicating a prescribed portion of provincial and municipal revenues from vehicle registration fees, parking charges, and road tolls to transit funding could also improve public transportation options in the province. Analogous measures have been implemented successfully in Quebec, British Columbia, and Alberta.[652] This

[648] Litman (2006g).
[649] Beimborn, Edward, and Robert Puentes. *Highways and Transit: Leveling the Playing Field in Federal Transportation Policy*. (Brookings Institute, 2003). www.brookings.edu
[650] Giuliano, Genevieve. *The Role Of Public Transit In The Mobility Of Low Income Households*. (MeTranst Transportation Institute, 2001). www.metrans.org/research/final/99-11_Final.pdf
[651] Finance Canada. A New Deal for Canada's Communities. (February 23, 2005). www.fin.gc.ca/budget05/pamph/pacome.htm
[652] Canadian Urban Transit Association. (2001b, p. 3).

suggests that such funding approaches should be considered in Nova Scotia in order to improve provincial transit systems.

BULLETIN

Just as this report went to press, the Government of Canada announced a significant investment in Nova Scotia's public transit systems. This investment is directly consonant with one of this report's key recommendations. Following is the press bulletin released on 24 November, 2006:

Government of Canada Invests $37.5 million in Transit in Nova Scotia Service Nova Scotia and Municipal Relations November 24, 2006 11:05

Eleven public transit systems in Nova Scotia will be improved thanks to the Government of Canada's investment of $37.5 million.

The announcement was made today, Nov. 24, by Peter MacKay, Minister of Foreign Affairs and ACOA, on behalf of Lawrence Cannon, Minister of Transport, Infrastructure and Communities, and Jamie Muir, Minister of Service Nova Scotia and Municipal Relations.

These investments towards public transit infrastructure will help reduce traffic congestion and improve air quality, as well as help reduce carbon dioxide and other greenhouse gas emissions.

Transit services that will benefit from the federal funding include Metro Transit in Halifax Regional Municipality, Cape Breton Transit, Kings Transit (Kings County and surrounding area), and eight other community transit organizations. Eligible capital investments may include the purchase of buses and accessible transit vehicles, the construction of new terminals and maintenance facilities, and the acquisition of improved computerized systems for transit services.

"Reliable and efficient public transit is key to ensuring environmentally sound, vibrant, and healthy communities," said Mr. MacKay. "The Government of Canada recognizes that improving public transit use can help reduce congestion, lower automobile emissions, and make our communities more liveable by supporting their economic, social, and cultural development."

"Today's investments will help improve our public transit systems in both urban and rural Nova Scotian communities," said Mr. Muir. "They support healthy, vibrant, sustainable communities, as well as help protect our environment. They also reduce isolation through better access to employment, education, medical services, and community and social events."

The funds include more than $11.7 million from the Canada-Nova Scotia Agreement on the Transfer of Federal Public Transit Funds, and $25.8 million to Nova Scotia through the federal Public Transit Capital Trust.

Service Nova Scotia and Municipal Relations will administer the distribution of these funds, primarily based on ridership. Public transit providers will likely receive funding before March 31, 2007.

"We are delighted that the Canadian government is investing in public transit systems throughout Nova Scotia," said Russell Walker, president of the Union of Nova Scotia Municipalities. "Larger transit services, which include HRM, Kings, and CBRM, will be able to provide improved services, and rural communities will be able to enhance accessible services to seniors, persons with disabilities, and the disadvantaged."

Through Budget 2006, the Government of Canada has provided $1.3 billion in dedicated funding for public transit across Canada. Nationally, $900 million was provided through the Public Transit Capital Trust and $400 million was committed through the Public Transit Fund.

Chapter 17. Household Spending on Transportation

In conventional accounts, transportation is typically the second largest category of household expenditures, after housing. In fact, however, the real portion is often higher than official statistics indicate, since 10-15% of "household" costs are devoted to residential parking and driveways (i.e. the portion of mortgage and rent expenses attributable to off-street parking), and to property taxes devoted to local roads, which are actually transportation costs. When full transportation costs are taken into account, including externalities like the portion of federal and provincial taxes devoted to roads, accident costs, and other transport-related expenditures, transportation is seen to be the largest household cost.[653]

In this section we consider only direct household spending on transportation, and not additional, indirect, taxpayer-funded transport costs or other externalities. But even in terms of direct expenditures, transportation can be a major financial burden, particularly for lower-income households. As a guideline, transportation can be considered affordable if it consumes less than 20% of moderate- and lower-income household's budgets.[654]

Many of the strategies that help achieve other sustainability objectives also help increase transportation affordability. The evidence shows that transportation tends to be more affordable in communities with diverse transportation systems, and less affordable in automobile-dependent areas.[655] For example, one study found that households in automobile-dependent communities spent over 20% of their budgets on transportation, while those with more diverse transportation options spent less than 17%.[656]

The Indicators

This chapter explores trends for household spending on transportation in Nova Scotia by income quintile. "Quintile" means one-fifth, so an income quintile is calculated by dividing all households equally into five income groupings. The "top quintile" or "fifth quintile" refers to the top fifth of income groups—the fifth of households with the highest incomes, and the "bottom quintile" or "first quintile" refers to the bottom fifth of income groups—the fifth of households with the lowest incomes. When transportation spending by quintile is reported, it refers to the *average* spending on transportation for that particular quintile of income groups. If spending by

[653] The assessment of transportation costs as the largest category of costs borne by a typical household is based on the fact that many non-market, external, and indirect costs of transportation are not conventionally counted in household cost accounting. The often overlooked transportation costs include the costs of roads (paid in part by households in the form of property, income, and other taxes), off-street residential parking facilities (generally paid by mortgage and rent payments), uncompensated crash damages, the costs of travel time and congestion delay, resource externalities, and negative environmental impacts.
[654] Litman. (2005d). www.vtpi.org/tdm/tdm106.htm
[655] Litman. (2005d). www.vtpi.org/tdm/tdm22.htm
[656] McCann, Barbara. *Driven to Spend: The Impact of Sprawl on Household Transportation Expenses*, p. 13. (Washington: Surface Transportation Policy Project and The Center for Neighborhood Technology, 2000). www.transact.org/PDFs/DriventoSpend.pdf

"decile" (or one-tenth of income groups) were being reported, the average for the top and bottom deciles would be higher and lower (respectively) than the average reported for the top and bottom quintiles.

All of the data used in this indicator are from Statistics Canada's *Survey on Household Spending* from 1997 through 2002. Unlike most other sections of this report, the transportation spending statistics by quintile cannot presented on an international scale because comparable quintile data are not available at this level. Time and resources also did not permit an inter-provincial comparison at the national level for this study, though it is recommended here that future updates of this report include such a Canada-wide analysis. In this chapter we focus on the Nova Scotia data as a first step in the development of these household spending indicators.

The Centre for Sustainable Transportation has evaluated provincial trends for *average* household expenditures on transportation, but it did not present or analyse these trends by income quintile.[657] In this report, for the reasons outlined above, it was considered important to focus on spending patterns by quintile in order to address the question of whether transportation expenditures are equitably distributed across different income brackets, or whether they impose particular hardships on lower income groups. As already discussed, it is considered inequitable and therefore unsustainable if lower income earners are spending an excessive proportion of their household budgets on transportation.

The indicators used to represent household transportation spending patterns by quintile are as follows:

1. Total transportation expenditures as a proportion of total household expenditures.
2. Public transportation expenditures as a proportion of total transportation expenditures.

Both indicators are presented as percentages in order to demonstrate the share of spending being allocated to transportation in general, and to public transportation in particular. Presenting the indicators in this way also allows for important comparisons and analyses across quintiles, since these percentages can be calculated by quintile from data in Statistics Canada's Surveys on Household Spending.

To calculate the different transportation expenditures as percentages, the following data were collected from the Survey on Household Spending (SHS):

- Total transportation expenditures, which are the sum of the following categories reported in the SHS:
    a. Household spending on private transportation
    b. Household spending on public transportation
- Total household expenditures, which are reported as total current consumption in the SHS.

For this analysis it is necessary to define "affordability" and "equity" quantitatively. Based on the available evidence in the relevant literature we defined these as follows: a) Transportation is considered "affordable" relative to overall household budgets when households spend less than

[657] Gilbert et al. (2002, pp. 78-80).

20% of their budgets on transportation; and b) Transportation is considered "equitable" when lower income households spend no greater a proportion of their budgets on transportation than higher income earners. Trends in spending that show improvements in affordability and equity according to these criteria are therefore taken as reflecting a movement towards sustainability.

Because the evidence indicates that the availability of diverse transportation options is an important input into both affordability and equity, particularly for low-income groups, further analysis takes into account the proportion of total household transportation spending dedicated to public transportation—also by quintile group. From the outcome perspective considered earlier, a movement away from automobile dependence towards greater reliance on public transportation is seen as a movement towards greater transportation sustainability for all the social, economic, and environmental reasons discussed in previous sections of this report. From an "input" rather than "outcome" perspective, therefore, a trend that shows an increasingly high proportion of public transportation *spending* as a proportion of total household transportation spending could also be considered a movement towards greater transportation sustainability.

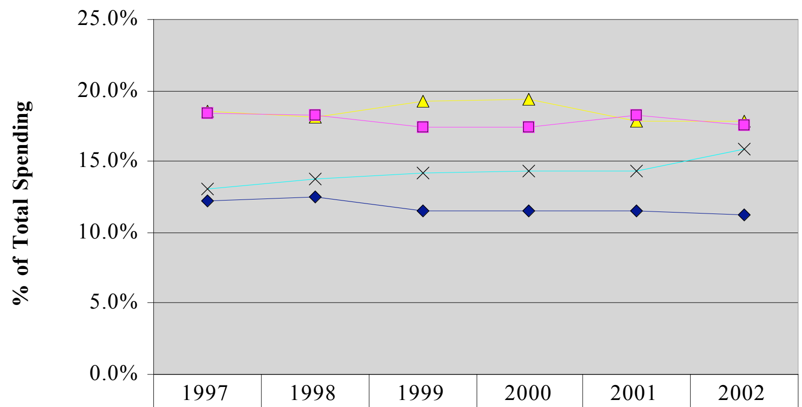
However that statement must be qualified by the fact that this household spending indicator must be considered in conjunction with the government spending indicator. Greater government investment in public transportation might include a lowering of fares that would increase access, affordability, and ridership while reducing household expenditures on public transportation. In other words, an increasingly high proportion of household transportation spending devoted to public transportation is probably only a good indicator of movement towards sustainability in cases where government expenditure on public transportation is relatively low – as the evidence presented in the previous chapter indicates is currently the case.

Trends: Nova Scotia

Figure 212 provides some context on spending patterns in Nova Scotia by situating household expenditures on transportation in relation to other expenditures. Between 1997 and 2002, the top four household expenditures in Nova Scotia were, consistently, personal taxes, shelter, transportation, and food, in that respective order. As noted above, transportation rises to the top of the list when indirect costs are also considered. But here we consider only direct household expenditures. Of the four top household direct expenditures, transportation was the only one that rose throughout the period. There was an overall 21% increase in transportation expenditures when calculated as a proportion of total household spending. In 1997, transportation costs accounted for 13% of total household expenditures. By 2002, they accounted for 16% of total spending.

In other words, Nova Scotians' transportation costs have been rising at a faster rate than other major household expenses. In fact, these top four household expenditures, considered together and in the aggregate, have remained relatively constant throughout this period, constituting between 62% and 63% of total household spending, and rising by less than one percentage point from 1997 to 2002, as a proportion of total household expenditures. But because food, shelter, and taxation expenditures all fell between 1997 and 2002, the substantial increase in transportation spending alone accounts for the slight aggregate increase of these four top items as a proportion of total household spending. Another way of expressing this is that the proportion of household disposable income available for *discretionary* (i.e. non-essential) spending fell during this period, almost solely because of the increase in transportation costs.

Figure 212. Nova Scotia: Top Four Household Expenditures as a percentage of Total Spending, 1997-2002.



	1997	1998	1999	2000	2001	2002
Personal Taxes	18.5%	18.2%	19.2%	19.4%	17.8%	17.9%
Shelter	18.4%	18.2%	17.4%	17.5%	18.3%	17.6%
Transportation	13.1%	13.7%	14.1%	14.3%	14.3%	15.9%
Food	12.2%	12.4%	11.5%	11.5%	11.6%	11.2%

Year

Source: Statistics Canada. *Survey on Household Spending*. (1997-2002).

Transportation Expenditures as a Percentage of Household Spending by Quintile

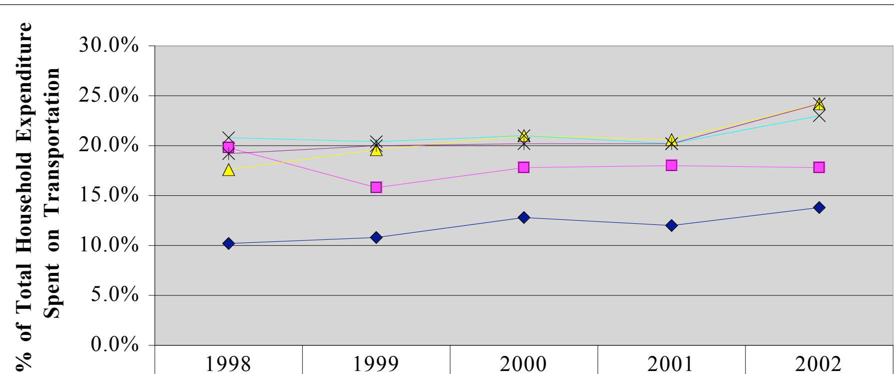
Figure 213 shows the trends in total transportation expenditures as a percentage of total household expenditures, by income quintile, between 1998 and 2002 in Nova Scotia. As mentioned, the first quintile is the lowest income quintile and the fifth quintile is the highest. People in the three highest income quintiles (i.e. the top 60% of households) have consistently spent similar portions of their income on transportation. These households have also spent a higher proportion of their total household budgets on transportation than those in the two lowest income quintiles (the bottom 40%). Thus, in 2002, the transportation expenditures of Nova Scotia's top three income quintiles constituted about 23% or 24% of their total household spending, while the second quintile spent just 18% of its budget on transportation, and the bottom quintile only 14%.

The relatively low portion of low-income household expenditures devoted to transportation reflects those households' relatively low rates of automobile ownership, and the large portion of that income group that are unemployed or retired. Vehicle-owning lower-income households, particularly those with members who commute, tend to spend a relatively large portion of household budgets on transportation, but this is offset in the average numbers for this income group when these vehicle-owning households are grouped with other low-income households that do not own a vehicle.

All income groups in Nova Scotia, except the second quintile, saw transportation costs rise as a proportion of their total household spending. The lowest income quintile sharply increased its spending on transportation from 10.2% of total household spending in 1998 to 13.7% in 2002.

Transportation affordability trends are in fact moving away from sustainability for two reasons. First, between 1998 and 2002, as noted, the vast majority of Nova Scotian households, including the lowest-income groups, were spending an increasingly high proportion of their budgets on transportation. Secondly, in 2002, the top three income quintiles in Nova Scotia spent nearly one quarter of their household budgets on transportation—well above the 20% level established as the threshold of affordability for the purposes of this study. Even at higher income levels, affordability is still an issue that affects quality of life and discretionary income, while for the lowest quintile, the one-third (3.5 percentage point) rise in transportation expenses as a proportion of total household spending likely caused hardships in the form of cut-backs in other necessities. These rising expenditures—especially for the poorest and for those that have most recently seen transportation consume more than 20% of total household budgets—indicate that transportation is becoming less affordable across the income spectrum.

Figure 213. Nova Scotia: Transportation Expenditures as a Percentage of Total Household Expenditures, by Income Quintile, 1998-2002.



	1998	1999	2000	2001	2002
1	10.2%	10.8%	12.9%	12.0%	13.7%
2	19.8%	15.8%	17.7%	18.0%	17.7%
3	17.6%	19.6%	21.0%	20.7%	24.2%
4	20.7%	20.5%	21.0%	20.2%	23.0%
5	19.2%	20.0%	20.2%	20.2%	24.1%

Year

Source: Statistics Canada. *Survey on Household Spending*. (1998-2002).

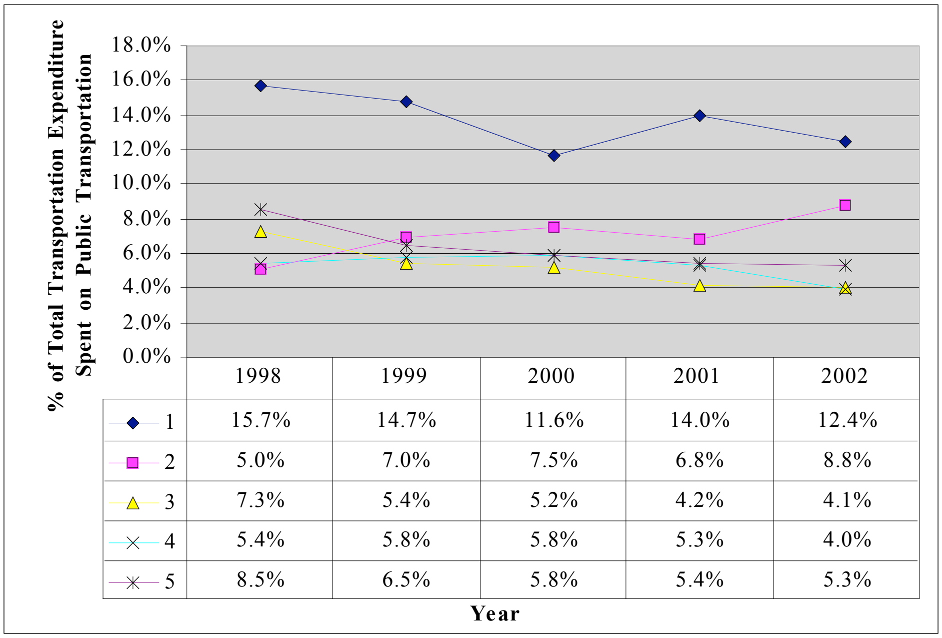
Public Transportation Expenditures as a Percentage of Total Transportation Expenditures

Figure 214 illustrates how much Nova Scotians spent on public transportation as a proportion of their total transport expenditures, between 1998 and 2001. Across quintiles, only a small percentage of household transportation budgets is spent on public transportation. Not surprisingly, those in the lowest quintile allocated a greater portion of their transport dollars to public transportation than those in higher income quintiles who are more able to afford to own and maintain private vehicles. Since they have less disposable income available for major purchases like automobiles, those in the lowest quintile use public transportation more frequently than those in higher income brackets. For example, in 2002, the poorest Nova Scotians (those in the lowest two quintiles) were spending about two to three times as high a proportion of their transportation expenditures on public transit as those in the higher quintiles.

Notwithstanding these differences, the lowest quintile's transportation spending patterns shifted quite sharply between 1998 and 2002, with public transportation spending among the poorest fifth of Nova Scotian households declining by 21% when calculated as a proportion of total transportation expenditures. This indicates that, like the top three income quintiles, the lowest-income groups were spending steadily less on public and more on private transportation.

Interestingly, the only income group to buck this trend was the second income quintile, which increased its public transport spending as a proportion of total transport spending. This would also explain why this was the only income group to decrease its total transportation spending as a percentage of its household budget while all other groups spent steadily more on transportation. Considerable further analysis is required to assess the causes of these trends, including the impact on household spending decisions of increases in transit fares.

Figure 214. Nova Scotia: Public Transportation Expenditures as a percentage of Total Transport Expenditures, by Income Quintile, 1998-2002.



	1998	1999	2000	2001	2002
1	15.7%	14.7%	11.6%	14.0%	12.4%
2	5.0%	7.0%	7.5%	6.8%	8.8%
3	7.3%	5.4%	5.2%	4.2%	4.1%
4	5.4%	5.8%	5.8%	5.3%	4.0%
5	8.5%	6.5%	5.8%	5.4%	5.3%

Source: Statistics Canada. *Survey on Household Spending*. (1998-2002).

Conclusion

Household transportation costs are an important component of sustainability. Excessive transportation costs are an economic burden that displaces other types of expenditures. In its impact on disposable and discretionary income, an increase in transportation costs is even greater than a reduction in wages (which at least lowers taxes), and is particularly burdensome on lower-income households that lack travel options and so must bear vehicle ownership costs.

Household spending on transportation as a proportion of total household expenditures increased sharply in Nova Scotia between 1997 and 2002 (Figure 212). This was the largest proportionate increase of any major category of household expenditure. According to Statistics Canada, this was largely due to an increase in motor vehicle expenditures.[658]

The trends for total spending on transportation as a percentage of total household expenditures, by quintile (Figure 213), provided some insight into differences and similarities in transportation spending patterns across different household income brackets in Nova Scotia. The trends indicated that, overall, households in higher income quintiles spent proportionately more of their income on transportation than those in lower quintiles. The relatively small portion of transport expenditures in the lowest income class reflect the relatively large portion of poor households in that group that do not own a vehicle, and so spend very little on transportation. However, low-

[658] Statistics Canada. "Survey of Household Spending." (*The Daily*: December 17, 2003). www.statscan.ca/Daily/English/031217/d031217b.htm

income households that do own a vehicle tend to spend relatively large amounts of their budget on transportation, particularly if they have members who commute.

Transportation was becoming less affordable overall, as indicated in the increases in transportation spending as a portion of total household budgets in four of the five income quintiles. In particular, by 2002, the top three quintiles were spending well over 20% of their household budgets on transportation. This portion has probably increased further during the last few years due to rising fuel prices, which represent a relatively large portion of expenditures among lower-income motorists. Improving public transport and active transportation modes allows households to reduce their expenditures on transportation, increasing affordability.[659]

Trends in public transportation spending patterns (Figure 214) indicated that most Nova Scotian households were spending less of their transportation budgets on public transportation and an increasing proportion on automobiles. The lowest quintile saw its public transportation spending drop by 21% as a percentage of its total transportation spending, reflecting increased automobile costs and therefore increases in total transportation expenditures.

Sustainable transportation strategies can therefore help increase affordability by improving affordable travel options (walking, cycling, ridesharing, public transit, and delivery services), creating more accessible communities, and locating affordable housing in accessible areas. Strategies like unbundling parking, pay-as-you-drive vehicle insurance and registration fees, parking cash out, transit benefits, and tax discounts for zero-vehicle households can provide savings and financial incentives to reward people who reduce their vehicle ownership and use. See the recommendations section of this report for more details of such examples of "Win-Win" strategies that can improve transportation sustainability while increasing affordability.

[659] Litman. (2005d). www.vtpi.org/tdm/tdm106.htm

PART IV: FULL-COST ACCOUNTS OF NOVA SCOTIA'S PASSENGER ROAD TRANSPORTATION

Introduction to Full-Cost Accounting

Economic Evaluation

Economic evaluation (also called *economic analysis* or *appraisal*) refers to methods for determining the economic value of a policy, project, or program. Economic evaluation is common in everyday life. Virtually any consumer, business, or public policy decision involves some sort of economic analysis. For minor decisions like balancing the cost of eating out against alternative uses of that money it may be sufficient to perform such analysis quickly in one's head or to use standard guidelines. But when making major decisions it is helpful to follow a more explicit and comprehensive process to ensure that all significant impacts (costs, benefits, and equity effects) are considered. For major public projects, economic evaluation may involve quantification and monetization (measuring in monetary units) of a wide range of direct and indirect impacts for a more comprehensive benefit/cost analysis.[660]

However, conventional benefit/cost analysis has been criticized for being biased in favour of easy-to-measure direct economic impacts at the expense of more difficult-to-measure social, environmental, and indirect economic impacts. In recent years economists have therefore developed better techniques for quantifying and *monetizing* non-market impacts (resources that are not normally traded in a competitive market), so that their value can properly be acknowledged and incorporated into economic evaluation.

The explicit recognition that the human economy and society depend for their functioning on the effective flow of ecosystem services leads **GPI***Atlantic* to assign full value to Nova Scotia's natural resources and to recognize the complete range of goods and services they provide as benefits to the economy. In the same way, wastes from the human economy and society that cannot be successfully absorbed and assimilated by the ecosystem are recognized as costs. These can be monetized based either on their *damage costs*—tabulating the value of losses incurred—or on *remediation costs*—such as costs of pollution clean-up and environmental restoration. Though there are major methodological and data challenges in estimating these benefits and costs, their value is explicitly acknowledged to the extent possible in the GPI natural resource accounts for forests, soils, fisheries, and water resources, and in studies on energy, air quality, greenhouse gas emissions, and solid waste resource management.

The Gross Domestic Product (GDP), by contrast, makes no such distinction between economic activities that provide benefits and those that incur or offset costs. In fact, GDP actually counts many types of damages and losses as contributions to economic growth and prosperity. For example, the *Exxon Valdez* increased Alaska's GDP more by spilling its oil than if it had delivered its cargo safely to port, because it caused massive expenditures for cleanup, lost fuel replacement, ship repair, legal fees, and other expenditures, which were all measured as economic growth.[661] Similarly, crime, accidents, sickness, war, resource depletion, and natural

[660] Litman, Todd. *What's It Worth? Life Cycle and Benefit/Cost Analysis for Evaluating Economic Value*. (Presented at Internet Symposium on Benefit-Cost Analysis, Transportation Association of Canada, 2001). www.vtpi.org.

[661] While environmental disasters certainly shift expenditures dramatically by activity, sector, and region, their effect on cumulative national GDP is less certain. How the *Exxon Valdez* affected the US economy as a whole depends, for example, on whether oil spill clean-up workers were displaced from other activities, or whether new employment was created at the margins of a previously under-utilized work force. (Robert Smith, Statistics Canada.

disasters all signify a decline in wellbeing and make society worse off overall, because they damage valuable resources, but they increase GDP by stimulating expenditures on prisons, hospitals, weapons, cleanup costs, and so on. Our economic growth statistics, in short, are inaccurate indicators of our actual wellbeing that ignore valuable resources such as health, social supports, community, volunteer work, clean air and water, and ecological integrity. This failure to distinguish benefits and costs sends misleading signals to policy makers.

By contrast to GDP-based measures of progress, the *Genuine Progress Index* (*GPI*) counts losses from crime, sickness, accidents, natural resource depletion, and climate change as costs, rather than gains, to the economy. The same principle is applied in this study. Unlike GDP-based measures of progress, the GPI recognizes that accidents, pollution, greenhouse gas emissions, and depletion of non-renewable resources are costs, and so, correspondingly, improved safety, environmental quality, and resource efficiency provide benefits. Cost/benefit analysis, as used in the GPI, corresponds far more closely to common-sense perceptions of wellbeing that recognize declines in crime, sickness, accidents, and pollution as improvements in quality of life than current accounting systems like the GDP that count all expenditures as economic benefits.

Externalities

Externalities are the uncompensated effects an activity imposes on other individuals or groups.[662] Transportation facilities and activities impose a variety of economic, social, and environmental externalities.[663] For example, congestion delays, parking subsidies, pollution damages, and accident risk that motor vehicle travel imposes on other people are external costs. Since consumers do not bear these costs directly, they tend to undervalue those impacts when making decisions on what type of vehicle to purchase or what mode to use when making a particular trip. For example, when parking facilities are subsidized, consumers will tend to drive more and rely less on alternative transport modes than if parking costs are borne directly by users. Neglecting these costs results in inefficient resource allocation and inflates the demand for goods with high external costs. Economic efficiency requires that externalities be internalized so that prices (what people pay directly to for a good or service) reflect the full marginal costs of producing that good or service, unless a subsidy is specifically justified. This is sometimes called the *polluter pays* principle, particularly when applied to environmental externalities.

Full-cost accounting involves quantifying and monetizing all of the impacts associated with an activity, including non-market external costs. This process can be challenging. There are many types of external, non-market costs associated with transportation for which money is a poor valuation tool, and some monetization techniques are complex.[664] As well, raw data and physical information on many of these costs are currently limited as illustrated, for example, in the indicator chapter on transport-related water pollutants. But the non-market effects of economic

Personal communication: October 3, 2000). What the example fundamentally illustrates, however, is simply that many activities that contribute to the GDP may signify a decline in wellbeing rather than an improvement.

[662] Harris, J.M. *Environmental and Natural Resource Economics: A Contemporary Approach*. (Boston: Houghton Mifflin, 2001).

[663] Colman, Ronald. *Measuring Sustainable Development: The Nova Scotia Genuine Progress Index: Framework, Indicators and Methodologies*, p. 18. (**GPI***Atlantic*, 1998a). www.gpiatlantic.org/pdf/general/framework.pdf

[664] Litman, Todd. *Transportation Cost and Benefit Analysis*. (Victoria Transport Policy Institute, 2006d). (www.vtpi.org).

activity are, nonetheless, no less real than many costs that are conventionally counted. Quantifying these costs to the extent possible at least allows them to be given the attention they deserve in policy analysis and other decisions.

Principles of Full-Cost Accounting

The Genuine Progress Index is intended to be a practical tool and aid to decision-making that provides a more comprehensive analysis of impacts than is provided by conventional measures of progress and market-based accounting procedures, and that includes impacts that are indirect, non-market based, and external to the user. It is both a macro-economic instrument for establishing benchmarks and measuring overall social progress, and a micro-economic tool for comprehensive, project level evaluation. For example, the assessment tools described in this report can help determine whether a community is making progress toward long-term, sustainability goals, and also whether specific policies and programs help support these long-term goals.

There is growing appreciation of the value that full cost accounting methods can contribute to improve policy and planning analysis. In 1992, the Nova Scotia Round Table on Environment and Economy urged that full-cost accounting be adopted as the essential basis of any strategy of sustainable development for the province—but this has not yet happened, and the report and recommendations of the multi-stakeholder Round Table have been forgotten. Instead, the continued designation of social and environmental costs as “externalities” or “intangibles” merely shifts the burden of payment from the producer and consumer of the product to the general populace, including future generations. The *Nova Scotia Environment Act*, Part One, Section 2 (c) affirms “the polluter-pay principle, confirming the responsibility of anyone who creates an adverse effect on the environment to take remedial action and pay for the costs of that action.” The GPI method can help make this section of the Act a reality.

There are several stages in the application of full-cost accounting to decision-making.

1. Identify the categories of impacts (benefits and costs) to be considered, and define the relationship between a particular activity (such as driving) and impacts (such as congestion delay, accidents, and pollution emissions.)

2. Quantify these impacts, usually in physical units such as hours of congestion delay, numbers of traffic deaths, and tonnes of pollution emissions.

3. Monetize impacts by applying appropriate unit costs, such as cents per minute of delay, million of dollars per premature death, and dollars per tonne of a particular emission representing the damage costs attributable to that emission.

4. Total the impacts of a particular activity and convert them into common *reference units* suitable for comparison and analysis, such as cents per vehicle- or passenger-kilometre.

5. Incorporate this information into specific policy and planning decisions to assess the cost-effectiveness of particular actions. For example, when comparing possible transportation

improvement strategies, full-cost accounting allows total costs and externalities to be considered, not just direct, internal costs. Similarly, this information can be used to calculate efficient pricing and subsidies, and whether a particular policy is equitable, taking into account non-market externalities.

6. Incorporate this information into strategic planning and evaluation, and sustainability analysis. For example, use estimates of total premature deaths, resource depletion, and greenhouse gas emissions to indicate whether a community is making overall progress toward strategic goals such as improved health, economic sustainability, and climate stability.

Full-Cost Accounting in the Transportation Sector

A number of research projects have applied full-cost accounting analysis to transportation planning. One of the earliest methods for analysing the costs and benefits of alternative transportation modes in the United States came from the American Association of State Highway Officials in 1952. This study considered factors such as safety; comfort and convenience; fuel costs; operating costs; and vehicle ownership costs.[665] In 1975, a project in California developed cost data from the San Francisco Bay area, including a range of external costs, which were used for comparisons between car, bus, and rail transport.[666] In the 1990s numerous studies were carried out on the full costs of transportation in different jurisdictions in both the United States and Canada, and the methods of deriving non-market costs and benefits have become more sophisticated.[667, 668, 669, 670]

In its Fifth Action Programme of 1992, the European Community also called for the adoption of full-cost accounting methods, so that the consumption and use of environmental resources are recognized as part of the cost of production and are reflected in market prices.[671] In its 2001 "Transport Policy for Europe's Citizens," the European Commission endorsed infrastructure charging, which takes into account external costs and encourages the use of the least polluting modes of transport. These Canadian, US, and European assessments, goals, and strategies clearly require reliable methods of estimating the external costs and benefits of transportation.

[665] Sacramento Transportation and Air Quality Collaborative. Transportation Costs Primer. (No date). www.sactaqc.org/Resources/primers/Primer_Transportation_Costs.htm Accessed December, 2004.
[666] Keeler, T.E., L.A. Merewitz, and P. Fisher, *Full Costs of Urban Transport* (Berkeley: Institute of Urban and Regional Development, University of California, 1975).
[667] KPMG, *The Cost of Transporting People in the British Columbia Lower Mainland*, Transport 2021/Greater Vancouver Regional District (Vancouver; www.gvrd.bc.ca), (March 1993).
[668] Delucchi, Mark. *Annualized Social Cost of Motor Vehicle Use in the United States, Based on 1990-1991 Data*. (Institute of Transportation Studies, University of California at Davis,1996); summarized in "Total Cost of Motor-Vehicle Use." (*Access,* No. 8, Spring 1996, pp. 7-13). www.uctc.net
[669] IBI Group, *Full Cost Transportation Pricing Study*. (Toronto: Transportation and Climate Change Collaborative, November 1995).
[670] For references on more full-cost studies see Litman, Todd. *Transportation Cost and Benefit Analysis – Liturature Review*. (Victoria Transport Policy Institute, 2003c). http://www.vtpi.org/tca/tca02.pdf
[671] European Community. *Towards Sustainability: a European Community programme of policy and action in relation to the environment and sustainable development*, p. 95 ff. (1992). http://europa.eu.int/comm/environment/env-act5/5eap.pdf

Fortunately the transportation sector is an area of the economy for which full-cost accounting methods are already well developed and where several excellent practical applications of the methods exist.

Transport Canada has committed to sustainable transportation planning that reflects full-cost accounting principles. In its 2004-2006 sustainable development strategy, Transport Canada explicitly recognizes the importance of full-cost accounting, which is defined as "an accounting method that determines total value or final price by internalizing non-market values such as environmental costs and benefits," and describes cost internalization as a fundamental economic principle.[672] Cost internalization is described as a process "whereby the costs of transportation reflect, to the extent possible, their full economic, social and environmental impacts."[673] Transport Canada is sponsoring research to develop practical full cost accounting tools.[674]

The Victoria Transport Policy Institute (VTPI) has conducted comprehensive analyses of full-cost accounting for transportation. After a thorough review of existing costing studies in transportation, VTPI developed a framework for the full-cost accounting of passenger road transportation, published as *Transportation Cost and Benefit Analysis: Techniques, Estimates and Implications*.[675] This work provides default monetized estimates of 20 cost categories, with separate estimates for 11 travel modes (or their equivalent, in the case of telework) under three travel conditions (urban-peak, urban-off-peak, and rural) expressed in US dollars per vehicle-mile, and for some categories, per passenger-mile.[676]

GPI*Atlantic* has used VTPI's work as a template for this full-cost accounting section of the current report, itemizing all but two of VTPI's cost categories in applying the method to transportation in Nova Scotia (Table 35). The excluded categories are *Equity and Option Value* (also called *Transportation Diversity Value*, which refers to the value of having a variety of transportation options available) and *Land Use Impacts* (which includes consideration of whether transportation decisions support strategic land use planning objectives). These categories were excluded because these impacts are particularly difficult to quantify and monetize, and because Nova Scotia data in these areas is currently severely limited. It should be emphasised here that these omissions should not be taken as signifying that these two categories are unimportant, and it is hoped that future data and methodological improvements will allow their incorporation in future updates of this report.

672 Transport Canada. *Sustainable Development Strategy 2004-2006*, p. 70. (Ottawa: Minister of Transport, 2004c). www.tc.gc.ca/programs/environment/sd/sds0406/docs/TC%20SDS_E3.pdf Accessed December, 2004.
673 Ibid, p. 67.
674 Transport Canada, *Investigation of the Full Costs of Transportation: A Discussion Paper*. (Economic Analysis Policy Group, Transport Canada, 2003). www.tc.gc.ca/pol/en/aca/fci/menu.htm
675 Litman, Todd. *Transportation Cost and Benefit Analysis: Techniques, Estimates and Implications*. (Victoria Transport Policy Institute, 2003c). www.vtpi.org/tca
676 According to Litman: "What most people call *problems*, economists call *costs*.…The term *cost* is more neutral. *Problem* implies something is flawed and must be corrected, while *cost* recognizes that solving a problem involves tradeoffs." (Litman, 2003c, p. 1-5 [emphasis in original]). www.vtpi.org/tca/tca01.pdf

Table 35. Categories Used for Full-Cost Accounting of Nova Scotia Transportation.

Costs
(1) Vehicle Ownership and Operation
(2) Travel Time
(3) Parking
(4) Congestion
(5) Traffic Services
(6) Noise
(7) Energy and Resource Consumption
(8) Climate Change
(9) Air Pollution
(10) Water Pollution
(11) Waste Disposal
(12) Roadway Development
(13) Roadway Land Use
(14) Crashes
(15) Barrier Effect

VTPI developed a set of "generic" cost values based on an analysis of numerous studies performed throughout North America, and in some cases, in other parts of the world. VTPI recommends adjusting these values when appropriate to reflect specific circumstances more accurately. For example, vehicle operating cost values should be adjusted to reflect current fuel costs in the jurisdiction under study, and parking costs should be adjusted to reflect prevailing land and construction costs in an area. Because of data limitations, this study has relied largely on VTPI cost values, except where more definitive local data were readily available. Future updates of this section should make further adjustments that account for specific Nova Scotian conditions, as further local data become available and as research capabilities and resources permit.

VTPI's costing framework primarily reflects passenger travel. It does not include a complete set of freight transport cost values.[677] While many of the default costs are transferable to freight transport, some adjustment is needed, and some of the data needed for analysis of freight transport are missing. For example, as noted earlier in this report, **GPI***Atlantic* was unable to obtain records for tonne-kilometres of goods moved in Nova Scotia by rail, marine, or air transport.[678] Lacking these data and specific freight transport cost values, we decided not to calculate overall freight costs at this time. However, by using **GPI***Atlantic*'s previous work on the cost of greenhouse gas and air pollutant emissions attributable to freight transport in Nova Scotia, it was possible to include some cost estimates for road freight transport in the calculations at least for this pair of cost categories.

Another point of divergence between the cost accounting in this study and that of VTPI is that the cost accounting for accidents here also includes all vehicular traffic, rather than passenger movement only. In this instance, the VTPI cost estimate was not used because **GPI***Atlantic* had

[677] This study does present results on indicators of freight transportation in the previous section, and the VTPI report used as a template for this section does describe several freight cost studies in its "Literature Review" chapter (www.vtpi.org/tca/tca02.pdf) , and includes information on specific freight impacts in other chapters.
[678] See *Reporting on Trends in Sustainable Transportation*, this volume.

access to the actual numbers of road transportation injuries and fatalities in Nova Scotia. These accident statistics were then monetized using the costing methodology adopted by Anielski Management Inc. for its study of traffic safety in Alberta.[679]

GPI*Atlantic* has generally followed VTPI's framework. In some cases this was not appropriate, or was impossible due to inadequate data. VTPI provides cost estimates for 11 transport modes, including walking, cycling, telecommuting, and various forms of automobile and public transit. However, our analysis does not, for example, include "electric bus/trolley," since none are currently operating in Nova Scotia, nor do we include "electric car," since there are very few such vehicles in the province, though both are included in the VTPI analysis. Walking, cycling and telecommuting are also not accounted for in this analysis.

Unless otherwise noted, cost estimates for Nova Scotia, for those costs where direct provincial data were not readily available, are extrapolated from other cost studies and are derived as follows:

Based on a wide-ranging review of copious evidence and numerous transportation costing studies, the Victoria Policy Transport Institute has derived cost estimates for each of 20 transportation impacts and for 11 different modes of passenger transportation. These costs are expressed by VTPI on a per vehicle-kilometre basis (or on a per passenger-kilometre basis where appropriate) to allow aggregation using a common metric, and comparison between cost estimates for different impacts. For this GPI study for Nova Scotia, 15 transportation impacts have been examined (as already explained above) for four different modes of motor vehicle transportation (automobiles, light trucks - including SUVs, minivans, and pick-up trucks, buses, and motor-cycles). Two cost categories and seven modes of transportation (including non-motorized modes) were not examined here due to data limitations and methodological challenges.
For most of the cost categories considered here, the VTPI estimates per vehicle-kilometre (or per passenger-kilometre for travel time) are shown in Column 3 of those tables that are based on these estimates. These VTPI estimates, based on the evidence and literature examined, were then multiplied by the number of kilometres travelled annually within Nova Scotia by each of the four passenger transportation modes, in order to derive the total cost estimates for each mode and each impact . Column 4 of most of the tables below summarizes the costs for each cost category. Those Column 4 totals were then summed to assess the total cost of each transport-related impact (congestion, traffic services, noise, etc.) in Nova Scotia attributable to motor vehicle passenger transportation in the province. The totals in Column 4 were then divided by the Nova Scotia population (934,507 in 2002) in order to assess per capita costs (Column 2).

This section focuses on transportation *costs* and so does not provide all of the information needed for cost-benefit analysis. This focus on costs is not intended to ignore transportation benefits, though a comprehensive monetization of these benefits was not possible here, due to limited resources. At the same time, cost analysis ***is*** often the basis for quantifying incremental benefits. For example, improved mobility is often measured in terms of travel time cost savings, and improved safety is measured based on reduced crash costs. Of course, transportation provides many benefits to users and society. In total, these benefits are huge. However, the

[679] Anielski Management Inc. (2004).

evidence also demonstrates that, beyond a certain optimal level, additional mobility provides declining and eventually negative marginal benefits. As a result, the greatest benefits to society may result from policies that increase transportation system efficiency and so reduce total vehicle travel.[680]

Studies have shown that non-automobile transportation services tend to provide special types of benefits, such as those described below:

- ***Mobility and accessibility benefits***. This refers to the benefits that result when improved transportation options allow people who are physically or economically disadvantaged to travel more and access more services and activities. For example, improved walking and cycling conditions, improved ridesharing, and efficient public transit services, can allow people with physical disabilities or low incomes to better access medical services, shops, education, employment, and people, and therefore enjoy more economic and social opportunities.

- ***Efficiency and cost reduction benefits***. This refers to the benefits that result when improved transportation options allow people to shift travel to more efficient and affordable modes. For example, improved walking, cycling, and public transit service may allow commuters to drive less, and therefore reduce vehicle costs, traffic congestion, road and parking facility costs, accidents, and environmental damages.

- ***Economic productivity and development benefits.*** This refers to the benefits to individuals and society if improved transportation system efficiency reduces costs and stimulates economic activity, such as employment, business productivity, and increased property values and tax revenues.

- ***Fitness and public health benefits.*** This refers to the benefits that result when more people are able to achieve the level of physical activity required for basic health (20-30 minutes a day of moderate physical activity, such as walking and cycling).

This categorization of benefits indicates the types of benefits that can in fact be demonstrated by a costing analysis. In other words, a comparative assessment of costs and potential cost reductions by transport mode can point to the benefits attributable to particular types of transportation. So a costing analysis certainly does not exclude consideration of a wide range of transportation benefits.

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[680] Litman, Todd. *Socially Optimal Transport Prices and Markets*. Victoria Transport Policy Institute (2006b). www.vtpi.org/opprice.pdf.

Full-Cost Accounts for Passenger Road Travel in Nova Scotia

1. Vehicle Ownership and Operation

Vehicle expenditures are one of the most obvious and visible of all transportation costs, and the category most familiar to people. This category includes ownership costs, such as depreciation, financing, insurance, licensing and registration fees, and taxes; and operating costs, such as fuel, oil, tires, maintenance and repairs, road tolls, and user-paid parking fees. These are internal (borne directly by users) market (involves commonly traded goods) costs.

Estimates of these costs are available from various sources, including the Runzheimer Canada consultancy,[681] which are published by the Canadian Automobile Association (CAA).[682] However, these figures are national averages, only reflect the first six years of a vehicle's operating life, and ignore various expenses such as parking, tolls, citations for traffic and parking violations, and repair costs after six years. They therefore tend to overstate depreciation and insurance costs, and understate other costs, such as repairs.

A more accurate source of information is Statistics Canada's household expenditure survey, which collects data on consumer expenditures, including transportation.[683] As discussed in Chapter 17 in this report, on Household Spending, the portion of total household expenditures devoted to transportation (primarily automobiles) increased in Nova Scotia between 1997 and 2002 (Figure 212). By contrast other major household expenditure categories declined as a proportion of total spending during this period.

The survey indicates that in 2003, Nova Scotia households spent an average of $8,099 on transportation, representing 15% of total household expenditures, of which $7,607 is for private transportation and $491 is for all forms of public transportation, primarily air travel (51%), local public transit (25%), taxi (9%), and various other modes. These percentages reflect national averages, since disaggregated data, by transportation mode are not provided for each province.

Table 36 breaks down the private vehicle expenditures by category. It indicates that approximately 32% of total expenditures are variable costs (increase with the amount a vehicle is driven each year), including fuel, repairs, and parts replacement, and 68% are fixed costs like car payments, registration, and insurance.

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681 Runzheimer Canada. Projected Ownership and Operating Costs for Selected 2002 Model Cars—Canadian. (January 3, 2002). www.runzheimer.com/corpc/news/scripts/010302c.asp Accessed December, 2004.
682 Canadian Automobile Association. *Driving Costs 2004 Edition*. (Ottawa: 2004). www.caa.ca/e/automotive/pdf/driving-costs-04.pdf
683 Statistics Canada. *Spending Patterns in Canada 2003*, Catalogue no. 62-202-XIE. 2005. www.statcan.ca/english/freepub/62-202-XIE/0000362-202-XIE.pdf.

Table 36. Private Vehicle Expenditure Categories, Canada, 2003

Purchase & lease	46%
Insurance & registration	19%
* Fuel	22%
* Maintenance & repairs	7%
* Tires, batteries, other auto parts	3%
Other private transportation	3%
Total private transportation	*100%*

Source: Statistics Canada. *Spending Patterns in Canada 2003*, Catalogue no. 62-202-XIE. 2005. www.statcan.ca/english/freepub/62-202-XIE/0000362-202-XIE.pdf. Based on Table 8.

* Indicates variable cost

Table 37. Nova Scotia: Transportation Expenditures, 2002, (2002 CDN$).

	Per Household	Per Capita	Household Total
Private Transportation	$7,440	$2,988	$2,685,012,879
Pubic Transportation (local)	$120	$48	$43,326,585
Total	$7,560	$3,036	$2,728,339,464

Source: Statistics Canada. *Spending Patterns in Canada 2003*, Catalogue no. 62-202-XIE. 2005. www.statcan.ca/english/freepub/62-202-XIE/0000362-202-XIE.pdf.

Note: The spending data above have been converted 2002 Canadian dollars for consistency and comparability with other data sets.

Using the information in Tables 36 and 37, we calculated vehicle ownership, operating, and total costs, as illustrated in Tables 38-40. In 2002, vehicle ownership and operating costs in Nova Scotia totalled nearly $2.8 billion, or $3,000 per capita. [684]

These costs, tabulated from Tables 38-40 below, are slightly lower than the private consumer expenditures reported by Statistics Canada above. Differences between the two expenditures include:

1) Tables 38-40 below, use operating expenditures reported by Transit Authorities for transit costs instead of only the consumer fare costs reported in Statistics Canada's household expenditure data above. Transit fares cover less than two-thirds of operating costs, but our purpose in this section is to assess the full costs of vehicle ownership and operation. For this reason, the actual transit operating costs are used in this cost assessment.

The Canadian Transit Fact Book, 2002, for Nova Scotia, reports total direct operating expenses as $33,480,147, of which total fare and advertising revenues are $21,464,226 (64%) and subsidies from municipal governments are $12,015,921 (36%).

[684] Per vehicle costs were also calculated for all cost categories, however they were not included in this report. Please contact GPI Atlantic at info@gpiatlantic.org if you are interested in these figures.

2) The remaining difference between the cost totals used here and those reported by Statistics Canada is a result of rounding off the numbers for the various costs and converting household costs to per capita costs.

Another important note is that this costing study has a separate cost category for parking costs. However, some (but not all) of the internal parking costs are included in the vehicle ownership and operating costs reported in Table 37 above - namely the out-of-pocket expenses - and are therefore not counted again in the internal parking costs, in section 3 below, in order to avoid double-counting.

Statistics Canada includes the following spending categories in its household transportation expenditures for private vehicles: Purchase of automobiles and trucks; purchase of automotive accessories; rented and leased automobiles and trucks (including rental fees, gas, and other fuels and other expenses, as well as all leasing fees); operation of owned and leased automobiles and trucks (including gasoline and other fuels, tires, batteries, and other automotive parts and supplies, maintenance and repair, garage rent and parking,[685] driving lessons, drivers' licences and tests); private and public vehicle insurance premiums; registration fees (including insurance if part of registration), and other automobile and truck operation services.[686]

In addition, Statistics Canada includes the following public transportation expenditures: 1) City or commuter bus, subway, street car and commuter train; 2) taxi; 3) airplane; 4) train; 5) highway bus; 6) other passenger transportation; 7) household moving, storage, and delivery services.[687] However, the public transportation costs listed in Table 37 above have been discounted to reflect public transit costs only, since these account for 25% of the total public transportation costs.[688] Airline costs represent 51% of public transportation costs, and are therefore not included in this assessment of vehicle ownership and operating costs. Taxi costs are also not included in the public transportation costs in Table 37 since specific vehicle data relating to taxis are not available and were therefore not included in our costing analysis.

Table 37 does not include that portion of internal (user-paid) parking costs that is more indirect - i.e. the proportion of mortgage and rent payments attributable to off-street residential parking - of which the user may be less aware. For this reason, this report has a separate cost category for those internal (user-paid) parking costs not included in Statistics Canada's ownership and operating figures.

As indicated in Table 40 below, vehicle ownership and operating costs for Nova Scotia in 2002 averaged 28¢ per vehicle-kilometre driven. It should be noted that the total vehicle ownership and operating costs, based on Statistics Canada household expenditure data, and used for these

[685] The parking costs included by Statistics Canada are out-of-pocket expenses only, and do not include the costs of off-street residential parking included in mortgage and rent payments. Those additional parking costs are included in Section 3 below.
[686] Statistics Canada. *Spending Patterns in Canada 2003*, Catalogue no. 62-202-XIE. (2005: Table 8). www.statcan.ca/english/freepub/62-202-XIE/0000362-202-XIE.pdf.
[687] Statistics Canada. *Spending Patterns in Canada 2003*, Catalogue no. 62-202-XIE. (2005: Table 8). www.statcan.ca/english/freepub/62-202-XIE/0000362-202-XIE.pdf.
[688] Ibid.(Tables 1 and 8)

calculations (nearly $2.8 billion/year or $3,000 per capita) are low compared to the CAA cost estimates for 2002, which total over $4.7 billion, or $5,000 per capita in Nova Scotia.[689]

Table 38. Nova Scotia: Vehicle Ownership Costs, 2002, (2002 CDN$).

Vehicle Ownership Costs	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$1,329	$0.18	$1,241,542,277
Van/SUVs/light trucks	$564	$0.18	$526,984,652
Diesel buses*	$13	$0.28	$12,015,921
Motorcycles	$8	$0.19	$7,293,824
Totals	$1,913	$0.18	*$1,787,836,674*

Source: Vehicle-kilometres from Natural Resources Canada—Office of Energy Efficiency. Comprehensive Energy Use Database – Transportation Sector: Nova Scotia, Tables 30 and 40.

Note: *Ownership costs for diesel buses are derived from the operating subsidy statistics reported by CUTA (CUTA Transit Factbook 2002)

Table 39. Nova Scotia: Vehicle Operating Costs, 2002, (2002 CDN$).

Vehicle Operating Costs	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$721	$0.10	$673,808,139
Van/SUVs/light trucks	$306	$0.10	$286,004,395
Diesel buses*	$23	$0.51	$21,464,226
Motorcycles	$2	$0.04	$1,562,962
Totals	$1,052	$0.10	*$982,839,723*

Source: Vehicle-kilometres from Natural Resources Canada—Office of Energy Efficiency. Comprehensive Energy Use Database – Transportation Sector: Nova Scotia, Tables 30 and 40.

Note: *Operating costs for diesel buses are derived from the direct operating expenses reported by CUTA (CUTA Transit Factbook 2002)

Table 40. Nova Scotia: Total Vehicle Ownership and Operating Costs, 2002, (2002 CDN$).

Totals	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$2,050	$0.28	$1,915,350,416
Van/SUVs/light trucks	$870	$0.29	$812,989,048
Diesel buses	$36	$0.79	$33,480,147
Motorcycles	$9	$0.23	$8,856,786
Totals	*$2,965*	*$0.28*	*$2,770,676,397*

Source: Vehicle-kilometres from Natural Resources Canada—Office of Energy Efficiency. Comprehensive Energy Use Database – Transportation Sector: Nova Scotia, Tables 30 and 40. Note that Table 40 is an addition of the totals in Tables 38 and 39 above.

[689] These costs are based on the Canadian Automobile Association and have been extrapolated from national figures. *Driving Costs 2004 Edition*. (Ottawa: 2004). www.caa.ca/e/automotive/pdf/driving-costs-04.pdf

2. Travel Time

Travel Time Costs refers to the value of time spent on transport. Various studies have monetized travel time costs and travel time savings in different transport modes.[690, 691] Travel time costs are highly variable, depending on type of trip, travel conditions, and traveller preferences. A portion of travel time is *paid* (also called *on-the-clock* or *commercial* travel time) and so its economic value can be calculated directly, but most is *personal* and so its value reflects consumers' preferences and resources. Some travel has very high time costs, while other travel has very low or zero costs (i.e. people positively value some time spent travelling and would not want to reduce it). For example, one day a person would pay generously for faster travel when rushing to an important event, but the next day spend their free time enjoying a pleasant stroll or drive.

Travel time costs are important for many types of transportation project evaluation, for example when calculating the value to society of improving a highway or public transit services. However, it is generally not very useful to aggregate total travel time costs, since a significant portion of travel is enjoyable, and people tend to maintain a relatively constant travel time budget, which means that travel time savings in one area are generally devoted to additional travel in another. We therefore calculate total travel time costs for illustrative purposes only, based on VTPI default values, but acknowledge that in most applications, more specific time values should be applied, which may be higher (when evaluating on-the-clock travel, or travel in congested stop-start commuting conditions) or lower (for travel under comfortable and enjoyable conditions). Table 41 below summarizes the assumptions used for estimating travel costs, based on a division into four categories reflecting the different types of realities described above.

[690] Mackie, P. et al., *Values of Travel Time Savings in the UK*, Institute for Transport Studies. (University of Leeds, 2003). www.its.leeds.ac.uk/working/downloads/VOTSummary.pdf
[691] Wardman, Mark. "The Value of Travel Time: A Review of British Evidence." (*Journal of Transport Economics and Policy*, Vol. 32, No. 3, Sept. 1998, pp. 285-316).

Table 41. Travel Time Cost Categories

Category	Description	Cost Value	Portion of Total Travel
Paid	Travel by employees when they are being paid, including business people travelling to meetings and customers, trades people travelling to job sites, and freight vehicles transporting goods	150% wage rates (to account for wages, benefits, vehicle and freight time values).	5% (commercial travel)
Personal, high cost	Personal travel during which travellers experience significant discomfort or frustration, such as driving in congestion or being a pedestrian or transit passenger in uncomfortable and/or overcrowded conditions.	50% wage rates for drivers, 35% of wage rates for passengers.	20%. This is typical for urban-peak commute and errand travel that occurs under congested or unpleasant conditions.
Personal, medium cost	Personal travel during which travellers experience no particular discomfort, but which is still undertaken out of necessity in order to accomplish defined non-travel tasks.	25% wage rates for adults.	50% This is typical of errand trips (shopping, chauffeuring non-drivers, etc.) that do not experience congestion.
Zero-cost travel time.	Travel undertaken for pleasure during which travellers experience enjoyment, and so would not pay at all to reduce their travel time.	No cost.	25%. This is typical for recreational travel and for a portion of other personal travel (as described above).

Source: Litman, Todd. "Travel Time Costs." (2003c). www.vtpi.org/tca/tca0502.pdf.

Based on the principles and costing methods outlined in Table 41 above, Table 42 summarizes Nova Scotia's estimated vehicle travel costs. For these purposes, the Victoria Transport Policy Institute's prior estimates, which are based in turn on an extensive review of the relevant literature and evidence, have been extrapolated to Nova Scotia according to passenger-kilometres travelled in the province. Based on the estimates, vehicle travel time costs in Nova Scotia in 2002 totalled $1.1 billion, which translates to over $1,200 per capita. Travel time costs represented the second highest costs of transportation in Nova Scotia in 2002 after combined vehicle ownership and operating costs (section 1 above).

Table 42. Nova Scotia: Vehicle Travel Costs, 2002, (2002 CDN$).

Travel Time Costs	Per Capita	Per Passenger-Kilometre	Total
Automobiles	$802	$0.068	$749,380,262
Van/SUVs/light trucks	$354	$0.068	$330,865,989
Diesel buses	$76	$0.159	$71,347,187
Motorcycles	$3	$0.068	$3,178,023
Totals	*$1,236*	*$0.071*	*$1,154,771,462*

Source: Passenger-kilometre data are from Natural Resources Canada—Office of Energy Efficiency. Comprehensive Energy Use Database – Transportation Sector: Nova Scotia, Tables 30 and 40.

3. Parking

A typical private vehicle is parked 23 hours each day and uses several parking spaces each week. There are estimated to be two to four off-street parking spaces per vehicle, plus various on-street parking spaces, for each motor vehicle (including one space at the residence, one at the worksite, and a share of parking spaces at various other destinations).[692] A typical off-street parking space has an annualized value of $600-1,200, including the value of land, construction, maintenance, and operating expenses.[693, 694]

Most parking costs are borne indirectly, incorporated into building rents and mortgages (for residential parking), as a component of employee benefits (for worksite parking), and through taxes (for publicly-supplied parking). As well, "free" parking provided at a shopping centre, for example, represents an external cost borne by the business that owns and operates the parking area. That business cost is presumably passed on to consumers in the form of higher prices, again effectively hiding the real costs of parking.

Statistics Canada's household expenditure survey indicates that direct user-paid out-of-pocket parking fees total $77 annually per household. [695] But this represents only a small portion of the actual costs of parking.

Table 43 provides one estimate of total annualized parking costs per vehicle in the United States, indicating that parking costs an average of about $US3,000 per vehicle, of which approximately three-quarters is external (i.e. not paid by users). Although Table 43 is in US dollars, which are presently worth about 10% more than Canadian dollars, Nova Scotian urban parking costs are probably somewhat lower than in the average US city due to relatively lower land values. Since these two factors tend to offset each other we will apply the cost values in Table 43 to Nova Scotian urban areas as if they were in Canadian dollars.

As well, Table 43 reflects urban conditions, where land values are high and a portion of parking is structured. Since Nova Scotia is relatively rural, with lower land values, the values in Table 43 have been reduced by a third for application to Nova Scotia in Tables 44-46 below.

Table 43 includes the costs of on-street parking, which are included in the "Roadway Costs" section of this analysis. This table also includes 'out-of-pocket' parking costs that are paid by users directly. 'Out of pocket' costs refer to residential parking expenses not included in aggregate mortgage and rent payments (for example separate rental of a garage space), as well as paid parking when away from home. These out-of-pocket parking costs are included in the "Vehicle Ownership and Operating Costs" section of this analysis. These two portions of parking costs (on-street parking and out-of-pocket expenses) are therefore excluded from the following estimates in Tables 44-46 to avoid double counting.

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[692] Shoup. Donald. *The High Cost of Free Parking*. (Planners Press, 2005).
[693] Litman. (2003c, p. 5.4-1). www.vtpi.org/tca/tca0504.pdf Accessed March, 2005.
[694] Russo, Ryan. *Assessing and Communicating the Costs of Parking.* (2001). http://dcrp.ced.berkeley.edu/students/rrusso/parking/Developer%20Manual/Costs
[695] Statistics Canada. (2005, Table 8).

Table 43. Estimated Annualized Parking Costs Per Vehicle – Urban Conditions (USD)

	Spaces Per Vehicle	Annual Cost Per Space	Paid Directly By Users	Directly-Paid Costs	External Costs	Total Costs
Residential	1	$600	100%	$600	0	$600
Non-res. off-street	2	$800	5%	$80	$1,520	$1,600
On-street	2	$400	5%	$40	$760	$800
Totals	5			*$720 (24%)*	*$2,280 (76%)*	*$3,000 (100%)*

Source: Litman, T. "Parking Costs" (Victoria Transport Policy Institute, 2003c, Table 5.4-5) www.vtpi.org/tca/tca0504.pdf.

Note: This table shows an estimate of annual parking costs per vehicle and their distribution. It indicates that users only pay directly for about a quarter of total parking costs. The remaining parking costs are borne indirectly through taxes, and through reduced wages and additional costs for goods and services to the extent that such subsidized parking represents additional employer and business costs that are passed on indirectly to employees and customers. Thus users (as well as non-users like transit-using employees who do not avail themselves of employer-provided parking) may in fact pay these costs indirectly, but they are generally unaware that they are doing so.

It should also be noted that out-of-pocket parking costs are only part of (and not synonymous with) the costs noted in Table 43 as "paid directly by users." Thus, the portion of off-street residential parking covered by mortgage and rent payments is counted in Table 43 as a cost "paid directly by users," even though it is not an out-of-pocket expense, and even though home-owners and renters may not directly relate to the fact that a portion of their mortgage and rent payments in effect covers the costs of providing residential parking.

VTPI estimates that compact cars, motorcycles, and bicycles are (respectively) 5%, 25%, and 95% cheaper to park than an average automobile, SUV, or light truck (since they take up proportionately less space). Bus parking at the bus garage is equivalent to residential parking. Parking for a full size (40-ft) bus is estimated at about 2.5 times larger than for an average automobile. It is assumed for the purposes of this costing exercise that buses do not incur any external costs because they are not parked on the street, at shopping centres, or at the workplaces of transit riders.

Tables 44 through 46 describe the internal, external. and total (internal plus external) parking costs for Nova Scotia in 2002, using VTPI's generic estimates, which are based in turn on an extensive review of the relevant literature and evidence, and are extrapolated to Nova Scotia according to vehicle-kilometres travelled in the province and according to the assumptions noted above. Total parking costs for 2002 were a little over $679 million, or $727 per capita.

Table 44. Nova Scotia: Estimated Internal Costs of Parking, 2002, (2002 CDN$).

	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$152	$0.021	$141,866,439
Van/SUVs/light trucks	$64	$0.021	$60,216,585
Diesel buses	$1	$0.018	$781,853
Motorcycles	$3	$0.070	$2,679,084
Totals	*$220*	$0.021	*$205,543,960*

Sources: Victoria Transport Policy Institute. (2003c, p. 5.4-5). www.vtpi.org/tca/tca0504.pdf. Vehicle-kilometres are from Natural Resources Canada—Office of Energy Efficiency. Comprehensive Energy Use Database – Transportation Sector: Nova Scotia, Tables 30 and 40

Table 45. Nova Scotia: Estimated External Costs of Parking, 2002, (2002 CDN$).

	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$355	$0.049	$331,749,211
Van/SUVs/light trucks	$151	$0.049	$140,814,168
Diesel buses	$0	$0.000	$0
Motorcycles	$1	$0.027	$1,041,975
Totals	*$507*	$0.049	*$473,605,354*

Sources: Victoria Transport Policy Institute. (2003c, p. 5.4-5). www.vtpi.org/tca/tca0504.pdf and; Natural Resources Canada—Office of Energy Efficiency. Comprehensive Energy Use Database – Transportation Sector: Nova Scotia, Tables 30 and 40

Table 46. Nova Scotia: Estimated Total (Internal plus External) Costs of Parking, 2002, (2002 CDN$).

	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$507	$0.070	$473,615,650
Van/SUVs/light trucks	$215	$0.071	$201,030,753
Diesel buses	$1	$0.018	$781,853
Motorcycles	$4	$0.098	$3,721,058
Totals	*$727*	$0.070	*$679,149,314*

Sources: Victoria Transport Policy Institute. (2003c, p. 5.4-16). www.vtpi.org/tca/tca0504.pdf and; Natural Resources Canada—Office of Energy Efficiency. Comprehensive Energy Use Database – Transportation Sector: Nova Scotia, Tables 30 and 40.

4. Congestion

Traffic congestion is defined as the incremental delay that a vehicle imposes on other road users when traffic volumes on a facility approach capacity.[696] Congestion increases travel time and stress, and increases energy consumption and air pollution. As defined here it is an external cost. Because the additional delay and fuel consumption costs of congestion are also included in the vehicle operation and travel time cost categories of this analysis, it is inappropriate to add congestion costs to these other cost categories when calculating the total costs of road transport, as this would result in double-counting. Congestion costs values are therefore provided here for illustrative purposes and are mainly useful for evaluating external costs and optimal road user fees. Congestion costs vary significantly depending on location, time, and vehicle type. In particular, a recent study indicates that Light Trucks/Vans/SUVs impose somewhat more congestion than an average car.[697] An adjustment factor which reduces car's costs by 10% and increases Trucks/Vans/SUVs by 20% was incorporated into the costs in Table 47 below. Congestion occurs primarily under urban-peak commuting conditions.

A recent (2006) study by Transport Canada estimated that traffic congestion costs in major Canadian cities total between $2.3 billion and $3.7 billion (2002 Canadian dollars).[698] More than 90% of this cost consists of delay to motorists (drivers and their passengers), about 7% represents the value of additional fuel consumed, and about 3% represents the value of GHGs emitted. The study estimates that excess GHG emissions attributable to congestion in Canada add 1.2 to 1.4 megatonnes of GHGs due to the atmosphere each year.

None of the cities studied in the Transport Canada report are located in Nova Scotia. The smallest city studied is Hamilton, Ontario, which has a regional population about twice that of Halifax. Its congestion costs were estimated to range from $6.6 to $17 million annually. Because congestion costs tend to increase exponentially with city size, they are probably considerably smaller in Nova Scotia, in proportion to its smaller metropolitan area and more rural population. We therefore assume that the province's total congestion costs are about equal to those of the city of Hamilton alone, or $6.6 to $17 million, the mid-point of which is $11.8 million. This indicates that congestion costs in Nova Scotia likely averaged about $13 per capita in 2002, as summarized in Table 47, but may be much higher for urban commuters in HRM.

[696] Litman. (2003c, p. 5.5-1). www.vtpi.org/tca/tca0505.pdf Accessed March, 2005.
[697] Kockelman, Kara M. *Effects of Light-Duty Trucks on the Capacity of Signalized Intersections*. Journal of Transportation Engineering, 126: 6 (2000, pp. 506-512) www.ce.utexas.edu/prof/kockelman/home.html.
[698] Transport Canada. *The Cost Of Urban Congestion In Canada*. (Transport Canada, 22 March 2006). www.tc.gc.ca/programs/Environment/EconomicAnalysis/docs/summary.pdf

Table 47. Nova Scotia: Estimated Average Congestion Costs, 2002, (2002 CDN$).

Congestion Costs	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$8	$0.001	$7,426,732
Van/SUVs/light trucks	$4	$0.001	$4,140,612
Diesel buses	$0.14	$0.003	$128,460
Motorcycles	$0.05	$0.001	$46,182
Totals	*$13*	$0.001	*$11,800,000*

Sources: Transport Canada. *The Cost Of Urban Congestion In Canada*. (Transport Canada, 22 March 2006). www.tc.gc.ca/programs/Environment/EconomicAnalysis/docs/summary.pdf. Vehicle-kilometres are from Natural Resources Canada—Office of Energy Efficiency. Comprehensive Energy Use Database – Transportation Sector: Nova Scotia, Tables 30 and 40

5. Traffic Services

Traffic service costs are the costs of the public services required to accommodate vehicle traffic, including law enforcement, emergency response, planning, courts, street lighting, parking enforcement, and driver training.[699] The need for these services, and therefore their costs, tend to increase with motor vehicle traffic, and with higher vehicle speeds, both of which may increase the risks imposed on others.[700] Transport 2021 estimated that transport-related "protective services," including traffic law enforcement and emergency service costs (based on 10% of police and 5% of fire department costs), average 0.4¢ per vehicle-kilometre in Vancouver, BC.[701]

There is little research on these costs specific to Nova Scotia. We use the Victoria Transport Policy Institute's default estimate, which is based on an extensive review of the relevant literature and evidence, that traffic services not funded by vehicle user fees average about 0.7¢ per vehicle-kilometre. As with other results, future refinement of these estimates should take Nova Scotian conditions, like the particular costs of provincial and municipal traffic services and the rural-urban mix in this province, into account in adjusting the estimates. Traffic services funded by user fees, such as dedicated portions of automobile registration fees, are not included here, as they are already counted among the vehicle ownership and operating costs.[702]

Extrapolating from the VTPI estimates per vehicle-kilometre according to the number of vehicle-kilometres driven in Nova Scotia, Table 48 outlines these estimated costs by vehicle class for Nova Scotia in 2002. The total cost of traffic services amounted to over $66 million or approximately $71 per capita.

Table 48. Nova Scotia: Estimated Average Traffic Service Costs, 2002, (2002 CDN$).

	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$50	$0.007	$46,545,345
Van/SUVs/light trucks	$21	$0.007	$19,462,754
Diesel buses	$0	$0.007	$289,833
Motorcycles	$0	$0.007	$260,494
Totals	*$71*	*$0.007*	*$66,558,426*

Sources: Victoria Transport Policy Institute. (2003c, p. 5.4-16); Vehicle-kilometre data are from Natural Resources Canada—Office of Energy Efficiency. Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 30, 35 and 40.

[699] Litman. (2003c, p. 5.8-1). www.vtpi.org/tca/tca0508.pdf Accessed March, 2005.
[700] International Council for Local Environmental Initiatives. *Uncovering Auto Subsidies: Calculating How Much Your Local Government Spends Subsidizing Cars*, (Cities for Climate Protection, International Council for Local Environmental Initiatives, 1997). www.iclei.org/co2/auto/cars.htm
[701] KPMG, *Cost of Transporting People in the British Columbia Lower Mainland*. (Vancouver: Greater Vancouver Regional District, 1993, p. 29).
[702] Litman, (2003c, p. 5.8-3). www.vtpi.org/tca/tca0508.pdf Accessed March, 2005.

6. Noise

Traffic noise is annoying and disruptive to rest, work, and social activities, has been shown to cause stress and reduce productivity, and causes people to make major lifestyle accommodations, such as reducing activities on sidewalks, front lawns, and porches, and even moving to quieter but more isolated suburban locations.[703] Frequent exposure to high noise levels can contribute to cardiovascular disease, immune system disorders, and hearing loss.[704] Research by the Centre for Sustainable Transportation suggests that children may be especially vulnerable to damage from noise. [705] Motor vehicle traffic is a major source of urban noise. [706] Rail and air traffic also produce significant but more localized noise costs.

Vehicular noise emissions vary depending on geographic conditions (noise impacts and attendant costs are greater where more people are located close to roadways), traffic conditions (higher speeds, frequent stops, and inclines increase noise), and vehicle types (motorcycles, buses, and large trucks tend to produce more noise than most other vehicles).[707, 708] As noted, freight vehicles have not been included in these estimates, though future work in this area should attempt to do so.

The estimated costs of vehicle noise, by vehicle class and on a per vehicle-kilometre basis, were developed by VTPI based on a wide range of noise cost studies. The results of VTPI's estimates per vehicle-kilometre are shown in Table 49. Extrapolating these estimates to Nova Scotia according to the number of vehicle-kilometres driven by different vehicle classes, the total estimated cost to Nova Scotia of transport noise in 2002 is seen to be a little over $63 million or approximately $67 per capita. Future refinements of these estimates will need to account for particular Nova Scotian conditions, including its rural-urban mix and the proximity of residential areas to areas of high traffic noise.

Table 49. Nova Scotia: Average Noise Cost Estimate, 2002, (2002 CDN$).

	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$44	$0.006	$41,373,640
Van/SUVs/light trucks	$19	$0.006	$17,300,226
Diesel buses	$1	$0.030	$1,288,146
Motorcycles	$2	$0.061	$2,315,500
Totals	*$67*	*$0.006*	*$62,277,512*

Sources: Victoria Transport Policy Institute. (2003c, p. 5.11-11). Vehicle kilometres driven in Nova Scotia by vehicle class are from Natural Resources Canada—Office of Energy Efficiency. Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 30, 35 and 40.

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[703] Federal Highway Administration. *Highway Traffic Noise in the US; Problem And Response*. (Federal Highway Administration, 1997). www.nonoise.org/library/highway/probresp.htm
[704] Fong, Siu and Marina Johnston, pp. 7-9. *Health Effects of Noise*. (Toronto: City of Toronto, 2000). www.city.toronto.on.ca/health/hphe/pdf/noiserpt_attachmentmarch23.pdf
[705] Gilbert, Richard and Catherine O'Brien. *Child- and Youth-Friendly Land-use and Transport Planning Guidelines*, p. 16. (Mississauga: Centre for Sustainable Transportation, 2005).
[706] Federal Highway Administration. (1997).
[707] Litman, T. (2003c, pp. 5.11-2 and 5.11-6).
[708] Federal Highway Administration. (1997).

7. Energy and Resource Consumption

Transportation is resource intensive.[709, 710] Motor vehicle travel is one of the largest and fastest growing consumers of fossil fuels, and consumes other non-renewable natural resources, including steel, lead, iron, aluminium, and rubber used to manufacture vehicles, parts, and facilities.[711]

Exploration, extraction, processing, and distribution of these resources imposes various external costs.[712] These include environmental impacts, the depletion of non-renewable resources, the public subsidization of private enterprise, and, in some cases, macro-economic instability (e.g. when fuel prices rise dramatically sometimes in response to political conditions in the fuel exporting countries).[713] External costs may also include special subsidies and tax reductions awarded to the petroleum industry.[714]

The depletion of non-renewable resources is considered to produce long-term costs, in so far as it can be considered inequitable to future generations if it deprives them of significant benefits due to current inefficient consumption.[715]

Macro-economic costs (costs to economic productivity and development) may stem from the costs to a region of importing essential resources from other areas, since consumer expenditures on petroleum and automobiles tend to provide far less regional employment and business activity than most other types of consumer expenditures, as illustrated in Table 50 below. Indeed, mass transit has been shown to produce four times the regional spin-off income and 7.5 times the number of regional jobs per dollar invested as spending on cars.

Macro-economic costs may also derive from oligopolistic pricing practices, as well as from the insecurity of dependence on imports from unstable regions of the world.[716]

Described differently and more positively, resource conservation can provide various economic, social and environmental benefits by reducing petroleum production, distribution and consumption, and associated costs.[717]

[709] Natural Resources Canada, *Transportation: Canada's End User Energy Markets*, Natural Resources Canada. (2002). www2.nrcan.gc.ca/es/ener2000/online/html/chap4d_e.cfm
[710] Litman. (2003c, pp. 5.11-12). http://www.vtpi.org/tca/tca0512.pdf
[711] Ibid., p. 5.12-5.
[712] *ExternE; Externalities of Energy*, European Commission (http://externe.jrc.es).
[713] Taylor, Amy, Matthew Bramley and Mark Winfield. *Government Spending on Canada's Oil and Gas Industry: Undermining Canada's Kyoto Commitment*. (Pembina Institute, 2005). www.pembina.org
[714] United Nations Environment Programme. *Energy Subsidies: Lessons Learning In Assessing Their Impacts And Designing Policy Reforms*. (2003). www.unep.ch/etu/publications/energySubsidies/Energysubreport.pdf
[715] Ibid., p. 5.12-3. See also the section on peak oil production in Lipp, Judith and Seth Cain. *The Energy Accounts for the Nova Scotia Genuine Progress Index*. (GPI Atlantic, 2005). Available at www.gpiatlantic.org.
[716] Greene, David and N.I. Tishchishyna. *The Costs of Oil Dependence: A 2000 Update*. (Oak Ridge National Laboratory, US Department of Energy, 2001) www-cta.ornl.gov/publications
[717] Natural Resources Canada, *Sustainable Development: Energy and the Economy*, Natural Resources Canada. (2002). www2.nrcan.gc.ca/es/ener2000/online/html/chap2e_e.cfm.

Table 50. Regional Economic Impacts of $1 Million USD Expenditure

Expenditure Category	Regional Income	Regional Jobs
Automobile Expenditures	$307,000	8.4
Non-automotive Consumer Expenditures	$526,000	17.0
Transit Expenditures	$1,200,000	62.2

Source: Miller, Jon, Henry Robison, & Michael Lahr. *Estimating Important Transportation-Related Regional Economic Relationships in Bexar County, Texas*. (San Antonio: VIA Transit, 1999). www.viainfo.net

Note: This table demonstrates the estimated economic impacts (spin-off income and jobs) of consumer expenditures in Texas.

The cost estimates for transportation-related resource consumption per vehicle-kilometre travelled are based on a wide range of studies reviewed by VTPI that monetize the value of these various costs.[718] VTPI's literature review indicates that resource consumption external cost estimates for the United States range from $25 billion to $150 billion dollars US annually, depending on which costs are included and which assumptions and analytical methods are used.

From this set of estimates, VTPI selected a medium to high level cost estimate to ensure that as many of the associated transport-related energy and resource consumption costs as possible were included, and then assessed the costs on a vehicle-kilometre basis to facilitate comparison and application by various jurisdictions. Use of a medium to high level estimate is also justified by application of the precautionary principle, which holds that in cases of serious or potentially irreversible damage, that could be caused, for example, by resource depletion and the advent of peak oil, lack of scientific certainty should not be a cause for inaction.

The results of VTPI's vehicle-kilometre cost estimate for energy and resource consumption, extrapolated to Nova Scotia according to vehicle-kilometres driven in the province, are shown in Table 51. The total amounted to almost $200 million or approximately $213 per capita.

Table 51. Nova Scotia: Average External Resource Consumption Cost Estimate, 2002, (2002 CDN$).

	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$134	$0.018	$125,155,262
Van/SUVs/light trucks	$75	$0.024	$69,633,410
Diesel buses	$4	$0.096	$4,083,423
Motorcycles	$0	$0.008	$289,437
Totals	*$213*	*$0.020*	*$199,161,533*

Sources: Victoria Transport Policy Institute. (2003c, p. 5.12-12) and; Natural Resources Canada—Office of Energy Efficiency. Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 30, 35 and 40.

718 Litman, 2003c, p. 5.12-7.

As with other cost estimates in this section, results are based on various US and Canadian studies that do not necessarily reflect Nova Scotian circumstances. Depending on the assumptions, the above cost estimate of a little $200 million could be regarded as either too high or too low to reflect actual costs in Nova Scotia.

For example, it could be argued that American military expenditures to protect foreign oil supplies, included in some US studies on energy and resource consumption costs, should not apply here since these costs are not directly borne by Nova Scotians. However, petroleum is a fungible (substitutable) commodity traded in a global market. As a result, the consumption of petroleum products in Nova Scotia does bear a share of the costs (military or otherwise) incurred to ensure a steady supply of oil in other countries (such as the USA). From this perspective, the global nature of the petroleum market justifies the inclusion of these security-related costs in Nova Scotian cost estimates.

The $200 million cost estimate in Table 51 above is actually probably less than the full cost of transportation-related energy and resource consumption in Nova Scotia because it excludes freight transport. Resource consumption external costs would likely be much higher if road freight impacts were added to the passenger transportation totals in Table 51.

8. Climate Change

Greenhouse Gases (GHGs) are gases that increase the amount of solar energy retained in the atmosphere and that thereby affect the earth's climate. Climate change can cause various types of impacts. First-order impacts are the direct consequences for environmental processes linked to the atmosphere and climate, such as increased temperatures, changes in wind patterns, sea level rise, droughts, extreme weather activity, and habitat shifts. Second-order impacts occur in those economic sectors that are most dependent upon natural resources, such as forestry and fisheries. Third-order impacts are ripple effects from the first- and second-order impacts, such as reduced employment and productivity, loss in recreational and amenity values, and impacts on resource sector suppliers. The largest costs and losses attributable to climate change are likely to be non-monetary, including species extinctions, reduced ecological integrity, and loss of human life.

Estimating greenhouse gas emission costs is particularly challenging. Though produced locally, these emissions have worldwide impacts, so the costs of Nova Scotian and North American greenhouse gas emissions are incurred globally, causing damages and risks in distant regions, such as flooding in Bangla Desh or Tuvalu.[719] For this reason, GHG cost estimates attributable to transportation in Nova Scotia cannot be expressed only as costs *to* Nova Scotia, because they are not borne entirely by Nova Scotians. Since CO_2 has an atmospheric life of 100-200 years, the impacts of GHG emissions today will largely be borne by future generations with uncertain future costs.

These elements combine to make the establishment of a single dollar value in 2002 Canadian dollars for projected future climate change damage costs very difficult. However, such a value is important, indeed essential, to help determine how much society should be willing to "pay" to reduce such emissions. As this value increases, additional emission reduction policies and programs become justified. This was the basic conclusion of the recent Stern report released by the UK government – namely that a 1% investment of current global GDP in greenhouse emission reductions is essential to avoid a much larger potential cost (up to 20% of global GDP) in the future. Similarly, the 2001 GPI Nova Scotia Greenhouse Gas Accounts also found that investments in greenhouse gas emission reductions are highly cost-effective when weighed against the potential damage costs of climate change.

Despite the challenges of establishing precise monetary values for projected climate change damage costs, the effort to do so still accords far more closely with scientific reality than the methods of conventional market-based accounting systems, which implicitly assign a monetary value of zero to the cost of greenhouse gas emissions, by excluding non-market factors, ipso facto, from the accounts. For further discussion and analysis of greenhouse gas emissions from the Nova Scotian transportation system, see the indicator chapter (Chapter 4) in Part 3 of this volume.

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[719] For a more detailed explanation of the relationship between local emissions and global costs, see Walker, Sally, Anne Monette and Ronald Colman. *The Nova Scotia Greenhouse Gas Accounts for the Genuine Progress Index.* (**GPI***Atlantic* and Walker Environmental, 2001). Available at www.gpiatlantic.org.

As described earlier in this report, cost values can be calculated based either on estimates of damages caused by an activity or on the costs of avoiding an impact. When calculating climate change damage costs, a wide array of impacts must be considered and understood. Any assessment of the future impacts of climate change must consider the long-term effects of current greenhouse gas emissions on ecosystems; markets; agriculture; forestry; fisheries; coastlines; human adaptation; global weather systems; human health and disease; sea-level rise; and the comparative vulnerability of developing and developed nations. As a result of these many variables, cost estimates tend to vary widely. Climate change damage costs are generally assessed using a variety of climate change models that predict future impacts. See the 2001 GPI Nova Scotia Greenhouse Gas Accounts for a description of some of the assumptions involved in making those estimates.

Recently, society has begun to create an economic valuation system for greenhouse gas emissions through the creation of carbon trading markets and government regulations, most notably in relation to the Kyoto Protocol. This assignment of per tonne dollar values for carbon emissions provides one possible technique for calculating GHG emission costs for use in this analysis.

As in the following chapter on transport-related air pollution costs, the methodology and data sources used here differ from those employed by the Victoria Transport Policy Institute. Instead, the method used here, and the results, rely directly on the data presented in the greenhouse gas indicator chapter (Chapter 4, Part 3) and the emission intensity chapter (Chapter 6, Part 3) of this report. The current chapter also draws heavily on prior efforts by **GPI** *Atlantic* in *The Nova Scotia Greenhouse Gas Accounts for the Genuine Progress Index,* released in 2001, to estimate the costs of greenhouse gas emissions in this province, adapting that work for the transportation sector in particular.[720]

Following the format of the other full-cost accounting sections of this document, as well as the previous work done by **GPI***Atlantic* in this area, this chapter only presents damage cost estimates associated with road transport-related GHG emissions. An extensive analysis related to the prevention and mitigation costs associated with greenhouse gas emissions is beyond the scope of this project and is therefore not included here.[721]

As mentioned, the estimation of a composite damage cost for greenhouse gas emissions is contingent on the suppositions made – many of which are themselves the outcome of the assumptions underlying various climate change models. These underlying premises will typically include modelling and predictions of future emissions levels under several economic and population growth scenarios, their interaction with a wide range of climatic factors and atmospheric conditions, the resulting environmental, social and economic impacts; the overall timeline selected; and the net present valuation of future monetary costs and benefits (the discount rate selected). Variations in these assumptions can dramatically change the outcome of the GHG damage cost estimates. The challenge, then, is to make reasonable assumptions with respect to each of these factors.

[720] Walker et al. (2001).
[721] For a brief discussion of the prevention costs see Walker et al. (2001).

GPI*Atlantic*'s previous work on greenhouse gas emissions has adopted two fundamental principles to meet some of the challenges described above. First, the *precautionary principle*, explicitly acknowledged in Nova Scotia's Environment Act, specifies that when serious and potentially irreversible damage may result, lack of full scientific certainty will not preclude action to prevent such damage. This principle justifies the inclusion of high-end cost estimates reflecting more pessimistic assumptions and scenarios, along with middle-end and low-end estimates. Concerning distributive questions (who should bear the costs), **GPI***Atlantic* takes the view that the responsibility lies with the emitter, and that costs can only be assessed on a global basis.[722]

Thus, **GPI***Atlantic*'s previous work on greenhouse gas emission costs used a pair of low and high-end damage cost estimates to reflect the varied numbers that are found in the literature on climate change cost estimates. These estimates included a low cost estimate of $41.44 (CDN 2002) per tonne of CO_2 equivalent emissions, and a high marginal damage cost estimate of $1,134 (CDN 2002) per tonne of CO_2 equivalent emissions.[723] The vast difference between the two values reflects the contrasting assumptions behind the cost estimates. The low number represents lower-bound estimates of damage costs based on highly conservative and more optimistic assumptions and on the potential for effective human adaptation to climate change. The higher cost estimate factors in the potential for more severe and irreversible consequences of global climate change, including severe damage to infrastructure and catastrophic surprises that may occur as certain thresholds are passed.

Since the release of the GPI*Atlantic* Greenhouse Gas Accounts in 2001, an article was published by the leading German climate change economist, Richard Tol, who reviewed 28 independent studies covering 103 estimates of marginal damage costs for carbon dioxide equivalent emissions.[724] Tol's research analyzes and organizes 103 estimates based on a number of factors including the magnitude of the cost estimates, the range of uncertainty in the results, the discount rate used in each study to calculate net present value, the time horizon studied, and whether or not the work was peer-reviewed. After analyzing and reviewing the estimates, Tol concluded that the damage costs of carbon are unlikely to exceed a value of $77.42 (2002 CDN) per tonne (the mean of all the peer-reviewed studies he examined), and are very likely to be significantly lower.[725]

At the time that Tol's analysis was published, the *GPI Energy Accounts* were being researched and written, and it was decided at that time to adopt Tol's suggested high and low end cost

[722] For more detailed explanations of the rationale underlying this and other principles in the GPI accounting methods for GHG damage costs, see *The Nova Scotia Greenhouse Gas Accounts for the Genuine Progress Index* (Walker et al. 2001. Available at www.gpiatlantic.org.)
[723] Original estimates in *The Nova Scotia Greenhouse Gas Accounts for the Genuine Progress Index* (Walker et al. 2001) were presented in Canadian 1997 dollars and were $38 and $1,040. These estimates were converted here to 2002 Canadian dollars using the Bank of Canada Inflation Calculator - www.bankofcanada.ca/en/inflation_calc.htm (accessed March, 2005). This conversion allows direct comparisons with the estimates used in this study.
[724] Tol, Richard. "The marginal damage costs of carbon dioxide emissions: an assessment of the uncertainties." (*Energy Policy* [33], pp. 2064-2074. April 2, 2004). www.uni-hamburg.de/Wiss/FB/15/Sustainability/enpolmargcost.pdf Accessed March, 2005.
[725] Based on the conversion of the $50 (1995 US) estimate, which represents the mean of all of the peer-reviewed studies, as highlighted in the author's concluding remarks.

estimates because his review was more recent than the estimates used in the 2001 GPI Greenhouse Gas Accounts, and his costing is consistent with mainstream economic analysis. However, for reasons discussed below, we have decided here to reinstate our previous 2001 cost estimates, in addition to Tol's estimates, giving a wider range of possible costs.

The key reason for this decision is that recent evidence gives new credibility to previous high-end cost estimates that were previously regarded as unrealistic. The UK Parliamentary Office of Science and Technology, citing conclusions from the United Nations Intergovernmental Panel on Climate Change, for example, points to "growing evidence that stress put on the climate system by rising atmospheric GHG levels might trigger rapid, irreversible changes in climate."[726] Even more recently, scientists at the Max Planck Institute for Meteorology have found climate change to be occurring more rapidly than ever, and they predicted that within the next 100 years the sea ice in the North Pole region may completely melt in the summer, sea levels could rise by up to 30 centimetres, and extreme weather events in Europe will increase in frequency and strength.[727] In sum, new models suggest that the increasing greenhouse gas concentrations in the atmosphere may have compound and more severe effects than previously predicted, indicating that higher damage cost estimates may indeed be appropriate.

Similarly, in releasing his major report to the UK Government, former World Bank chief economist, Sir Nicholas Stern, recently warned: "The scientific evidence points to increasing risks of serious, irreversible impacts from climate change associated with business-as-usual paths for emissions." Stern refers to a recent WHO estimate that "Just a 1°C increase in global temperature above pre-industrial levels could double annual deaths from climate change to at least 300,000." And he references evidence that "by the middle of the century 200 million people may become permanently displaced due to rising sea levels, heavier floods and more intense droughts." His report notes that: "Damage to infrastructure from storms will increase substantially from only small increases in event intensity. Changes in soil conditions, from droughts and permafrost melting, will influence the stability of buildings."

Doing nothing and continuing with business as usual, warns the Stern Report, would lead to a reduction in global per capita consumption of at least 5% now and forever. But this prediction is based on conservative scenarios. The report notes that the planet may be even more sensitive to an increase in global temperatures than previously thought, because the carbon sinks that absorbed greenhouse gases are no longer as effective as they were and feedback effects have increased. The Stern Report warns that this and other factors "would increase the total cost of BAU [business-as-usual] climate change to the equivalent of around a 20% reduction in consumption per head, now and into the future." In sum, the effects of climate change could cost the world between 5% and 20% of GDP, the report concludes. With no action, the report warns, each tonne of carbon dioxide we emit will cause at least $US85 of damage.[728]

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[726] Parliamentary Office of Science and Technology, "Postnote: Rapid Climate Change," July, 2005, number 245, London, UK. Available at www.parliament.uk/documents/upload/POSTpn245.pdf. Accessed 24 January, 2006.
[727] Max Planck Institute for Meteorology, "Climate Change More Rapid than Ever," *Space and Earth Science.* September 30, 2005. Available at www.physorg.com/news6891.html. Accessed 24 January, 2006.
[728] Citations from Stern Report are from David Adam and Larry Elliott, writing in The Guardian, Tuesday October 31, 2006. Available at http://environment.guardian.co.uk/climatechange/story/0,,1935616,00.html#article_continue. Accessed 25 November, 2006.

GPI*Atlantic's* commitment to the precautionary principle requires that a high estimate for marginal damage costs attributable to greenhouse gas emissions be included, at least to reflect a reasonable upper range of possible damages. Higher damage cost estimates are generally the result of more pessimistic forecasts of the consequences of climate change. These more negative forecasts are now being borne out in some of the more recent scientific literature, summarized above. This means that by including this upper range of cost estimates, consideration is given to the possibility of catastrophic damages when key thresholds are passed, of extreme damage scenarios and potential infrastructure destruction, and impacts that would be permanent or irreversible.

It should be noted that most of the cost estimates referenced by Tol were based on earlier evidence, which lacked access to more recent scientific findings, such as land-based ice-sheet disintegration and ocean acidification. Furthermore, as recent reports have stated, many of the impacts are only now beginning to be studied and therefore, past cost estimates would not have been informed by this more recent knowledge. In 2001, the IPCC noted that there was greater clarity and less uncertainty about the impacts of climate change than in previous years. In 2006, five years later, there is even more clarity and less uncertainty.

Therefore, based on more recent scientific findings, and the gravity of the situation, it can be argued that many of the estimates reviewed by Tol were in fact too low. In fact, both the IPCC's 2001 report and a more recent report out of the UK's House of Lords Economic Affairs committee in 2005 remarked on how low many of the recent cost estimates were. The House of Lords report remarked that "the monetized estimates do not seem to be consistent with the more alarming pictures of global warming damage painted in much of the scientific literature."[729] Tol acknowledged that his review may underestimate true costs:

> Overall, the current generation of aggregate estimates may understate the true cost of climate change because they tend to ignore extreme weather events; exclude low probability/high consequence scenarios, such as shut down of the thermohaline circulation or a collapse of the west-Antarctic ice sheet; underestimate the compounding effect of multiple stresses; and ignore the costs of transition and learning.[730]

In addition to these exclusions outlined by Tol above, there are additional factors that could explain why many of the estimates reviewed by Tol were much lower than GPI*Atlantic's* highest damage cost estimate:

- Ignoring or arbitrarily valuing externalities, non-market values, and natural resources would result in a lower cost estimate. Costanza (et. al.) listed 17 key services provided by natural ecosystems, few of which have been considered in most monetary valuations of the effects of climate change.[731] The valuation of the existence of species and ecosystems

[729] House of Lords Economic Affairs Committee. 2005. The Economics of Climate Change, Vol 1: Report. House of Lords, London, p. 53.
[730] Tol, Richard. (2004, pp. 2067).
[731] According to Costanza (et. al.), the world's ecosystems provide the following 17 goods and services: gas regulation, climate regulation, disturbance regulation, water regulation, water supply, erosion control and sediment retention, soil formation, nutrient cycling, waste treatment, pollination, biological control, refugia (or locations of isolated or relict populations of once widespread animal or plant species), food production, raw materials, genetic

is extremely difficult. Tol and others resolve the dilemma by assigning small arbitrary values, or zero value. This omission alone could lower cost estimates by orders of magnitude. In addition, the IPCC's Second Assessment Report (SAR) stated that indirect health effects could far exceed direct effects, and yet these indirect effects, such as disease and starvation, are not always included in cost estimates.[732]

- The monetary impact of climate change also varies depending on the treatment of a "statistical life." For example, Hohmeyer and Gaertner, whose study was reviewed by Tol, valued a "statistical life" at $1 million, regardless of the country of origin. Tol and others, on the other hand, assign value based on income. For example, Tol assumes the average statistical life to be worth $250,000 plus 175 times the average per capita income, thus ranging from $299,000 to $3.4 million. Similarly, some estimates assign lower values to damage incurred in the Third World.[733]

- Many critics argue that there are inherent problems in applying discount rates in environmental accounting and that discounting is inappropriate when evaluating climate change damage because of the long time involved and its intergenerational nature. Essentially, when we use high discount rates we are saying that the future value of costs and benefits is low. Conversely, if a high value is placed on costs and benefits for future generations, the discount rate is low. However, if the rights of future generations are equal to those of the present one, then discounting should not apply at all. The discount rate chosen also has an enormous impact on the outcome of studies, particularly with a long time range (50 years or longer). Generally, studies with a low discount rate have higher cost estimates, and visa versa.[734] [735]

- Many of the earlier models did not account for positive feedback effects or for the effects of removing certain pollutants such as sulphate aerosols from the atmosphere. New evidence indicates that these could contribute to faster warming and more drastic impacts than previously forecast or anticipated. These effects are now being built into global circulation models, but this was not done in sufficient detail in the earlier models on which many of the studies Tol reviewed were based.[736]

In addition to the factors discussed above, there are still other compelling reasons for selecting medium and high-end cost estimates that exceed Tol's upper limit. In Tol's review, the peer

resources, recreation, and culture. Costanza and his colleagues estimated the average value of ecosystem services to be US$33 trillion/year. Costanza, R., R. DeArge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. V. O'Neill, J Paruelo, R. G. Raskin, P. Sutton, and M. van den Belt. 1997. *The Value of the World's Ecosystem Services and Natural Capital*. Nature, 387: 253-260.

[732] Ackerman, Frank and Ian Finlayson. 2005. *Monetized Impacts of Climate Change: Why are the numbers too small?* Evidence submitted to the Stern Review. Available at http://www.hm-treasury.gov.uk/media/E79/EB/climatechange_tufts_1.pdf. Assessed February, 2006.

[733] Meyer, Aubrey and Tony Cooper. (1995).

[734] Environment Canada. *The Canada Country Study: Climate Impacts and Adaptation*. Nicola Mayer and Wendy Avis (eds.). (Ottawa: Environment Canada, 1998c). Available at http://dsp-psd.pwgsc.gc.ca/collection/En56-119-7-1998E.pdf. Accessed February, 2006. Also, Ackerman and Finlayson (2005, p. 8).

[735] For a further critique on the use of discount rates in environmental accounting please refer to *The Nova Scotia Greenhouse Gas Accounts for the Genuine Progress Index*. Walker et al. (2001).

[736] Meyer and Cooper (1995, p. 9).

reviewed studies provided cost estimates that were typically much lower than those provided by studies that were not peer reviewed. According to Tol, while he believed the peer-reviewed articles used better methods and the results were thus more certain, he acknowledged that one possible explanation of why the peer-reviewed studies provided such low cost estimates was that the results may also have been shaped by the referees of the journals.[737] It was noted that referees might be unwilling to publish any cost estimates that do not fall within the bounds of what is considered to be the general consensus.

It is also interesting to note that results may also be shaped by the authors according to their discipline and training. For example, one survey of a small sample of climate change experts that included economists and others who worked in the field of natural sciences found that estimates for damages from climate change made by the former group were invariably lower than those given by the natural scientists. The economists also consistently offered lower estimations of the rate at which climate change could be expected to occur. [738]

Based on this critique, GPI*Atlantic* selected the following very wide cost range, in 2002 Canadian dollars:

- The *low-end estimate* is $24 (2002 CDN) per tonne.[739] This was chosen as it is the mean of all of the estimates in Tol's review that used a "pure rate of time preference" (discount rate) of three percent. As stated by Tol, this number corresponds to a "social discount rate of 4-5%, close to what most western governments use for longer term investments."[740, 741]

- The *medium-range estimate* used for the marginal damage cost of carbon dioxide equivalent emissions is $159 (2002 CDN) per tonne.[742] This number was selected as it represented the mean of the entire 103 cost estimates reviewed in Tol's study. As such, it represents and gives weight to a range of cost estimates and does not distinguish the estimates based on their varied assumptions. (It should be noted that Stern's estimate of $US85 or $Cdn96 is closest to this mid-range estimate).

- The *high end estimate,* which includes the potential for the more catastrophic climate change impacts, including positive feedback effects and irreversible damages, is $1,134 (2002 CDN) per tonne based on Bein and Rintoul's analysis.[743]

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[737] Tol. Richard. (2004).
[738] Survey was conducted by William Nordhaus of Yale University (Nordhaus, W. "Expert Opinion on Climate Change." *American Scientist*, Vol. 82, January-February, 1994, 45-51). Richard Tol and William Nordhaus are both economists.
[739] The estimate that appeared in Tol's review was $16 (1995 $US). This has been converted to 2002 $CDN for comparison purposes.
[740] Tol. (2004).
[741] For a more detailed discussion of discount rates see Walker et al. 2001.
[742] The estimate that appeared in Tol's review was $104 (1995 $US). This has been converted to 2002 $CDN for comparison purposes.
[743] Bein, Peter and Donald Rintoul. "Shadow Pricing Greenhouse Gases," p. 5. (*Proceedings of the Third Biennial Conference of the Canadian Society for Ecological Economics Nature, Wealth and the Human Economy in the Next Millennium*, 1999). www.sdri.ubc.ca/documents/shadow_pricing.pdf

These estimates reflect the wide range and variety of estimates in the literature. Research regarding the assumptions used in establishing the damage costs of greenhouse gas emissions has shown that even small changes in the assumptions can greatly alter the final cost estimates. This means that minor shifts in assumptions can result in estimates that differ by orders of magnitude. Therefore the high, medium, and low damage cost estimates used in this study for greenhouse gas emissions reflect the sensitivity of the results to those assumptions.

The results of the GHG cost estimation methods, and application of high, medium, and low-end estimates described above, are shown in Table 52. Unlike most of the costing data presented in the section, these climate change costs include both road passenger and road freight costs because the existing data sources did not allow freight transport to be separated from passenger transport. In all three cases, the per tonne marginal cost estimates are multiplied by the tonnes of greenhouse gas emissions generated by the Nova Scotia transportation system in 2002 (as outlined in the chapter on greenhouse gas emissions, in Part 3, Chapter 4 of this volume). The resulting low cost estimate is nearly $99 million, the medium range estimate is $654 million and the high estimate exceeds $4.6 billion (2002 CDN). Based on the mid-range costs, this translates to $700 per capita.

Table 52. Nova Scotia: GHG Marginal Damage Cost Estimates, 2002, ($C2002).

	Low	Medium	High
Cost Estimates ($C2002 per tonne)	$24	$159	$1,134
Road Transportation Emissions (tonnes CO_2 equivalent)	4,120,000	4,120,000	4,120,000
Total	*$98,880,000*	*$654,297,200*	*$4,672,492,000*

Climate Change - Medium Value	Per Capita	Per Vehicle-Kilometre	Total
Totals	*$700*	*$0.067*	*$654,297,200*

Sources: *Damage cost estimates:* (HIGH) Bein, Peter and Donald Rintoul. "Shadow Pricing Greenhouse Gases." (Proceedings of the Third Biennial Conference of the Canadian Society for Ecological Economics Nature, Wealth and the Human Economy in the Next Millennium, 1999). www.sdri.ubc.ca/documents/shadow_pricing.pdf; (LOW and MEDIUM) Tol, Richard. "The marginal damage costs of carbon dioxide equivalent emissions: an assessment of the uncertainties." (Energy Policy [33], pp. 2064-2074. April 2, 2004). www.uni-hamburg.de/Wiss/FB/15/Sustainability/enpolmargcost.pdf; *Transportation emissions:* Matin et al. *Canada's Greenhouse Gas Inventory 1990-2004*, Annex 10.

Note: These climate change costs include both road passenger and road freight costs because the existing data sources did not allow freight transport to be separated from passenger transport.

9. Air Pollutants

The sources and impacts of air pollution from the transportation sector in Nova Scotia have been reviewed in considerable detail in Part 3 of this report. The present section uses the results from that earlier analysis to provide monetized cost estimates for air pollutants from Nova Scotia's transportation sector.

While a number of costing methodologies can be used to assess air pollution costs, including estimates of control or mitigation costs, this study focuses specifically on the damage costs attributable to transport-related air pollution, for the sake of consistency with other estimates.[744] The damage cost estimate here includes factors such as the cost of cardiovascular illnesses, increased health care expenditures attributable to transport-related air pollution, and the costs associated with general environmental degradation (e.g. reduced crop yields). Varied assumptions about the impacts of air pollution on health and the environment help to explain the disparate cost estimates found in the literature.

As in the previous chapter, the methodology used here is based on pollution emission data from the air pollution section of this report (Part 3, Chapter 5) multiplied by unit cost values from Monette and Colman's *The Ambient Air Quality Accounts for the Nova Scotia Genuine Progress Index* (2004).[745]

Monette and Colman's air pollution cost estimates were also taken from a general and broad-based review of the literature, and so do not necessarily reflect local conditions. The estimates do, however, include emission costs from truck freight in Nova Scotia, and are structured to allow distinctions between the costs of different types of transport-related pollutants for different road vehicle types. To that extent at least, the data are indeed more local than generic, composite estimates, since the data used here account separately for the Nova Scotia-specific emissions of each transport-related pollutant.

Table 53 presents damage costs estimates from the literature per tonne of air pollutant emissions, providing both a low and high estimate for each of five transport-related criteria air contaminants. The rationale for presenting both high and low end estimates is similar to that described in the previous chapter on the cost of GHG emissions, and represents the variability of the cost estimates in the literature.

These estimates, taken from the earlier *GPI Air Quality Accounts for Nova Scotia,* are based largely on Canadian data, and on American studies where Canadian data were not available. For reasons explained in some detail in the *Air Quality Accounts,* they are regarded as reasonable estimates for air pollution costs in Nova Scotia, though some adjustment for local conditions, like the greater sensitivity to acid rain of Nova Scotian soils, should be made.

[744] While pollution control and other costs can be calculated, the damage costs approach was selected in conformity with the method used for previous work done by **GPI***Atlantic* (Monette and Colman [2004]).
[745] Monette and Colman. (2004).

The range book-ended by the low and high values in Table 53 reflects the variability found in the literature on damage costs attributable to air pollution in Canada. For SO_x and NO_x, higher estimates were chosen, due to the fact that eastern Canadian soils are more susceptible to acidification than those in other parts of the country.[746]

Table 53. Nova Scotia: Estimated Damage Costs of Air Pollutant Emissions, 2002, ($C2002/tonne).

Pollutant	$C2002/tonne	
	Low	High
CO	$2	$6
PM	$2,210	$5,400
SOx	$1,440	$11,000
NOx	$1,470	$12,990
VOCs	$2,090	$8,600

Source: Adapted from Table 19 in Monette and Colman (2004).

Table 54 presents the tonnes of on-road pollutant emissions by mode for Nova Scotia in 2002. HDDV refers to heavy-duty diesel vehicles; LDDV: light-duty diesel vehicles; LDGT: light-duty gasoline trucks; LDGV: light-duty gasoline vehicles; and HDGV: heavy-duty gasoline vehicles. Results here do not include pollutant emissions from off-road vehicles. For a detailed description and analysis of the pollutant emissions generated by the Nova Scotia transportation sector, see the air pollution indicator section (Part 3, Chapter 5) in this volume.

Table 54. Nova Scotia: Tonnes of On-Road Air Pollutants, by Mode, 2002.

	CO	TPM	SOx	NOx	VOCs
HDDV	3,083	424	348	13,580	590
LDDV	275	42	23	288	131
LDGT	71,311	67	113	3,633	4,172
LDGV	81,770	87	129	4,270	5,028
HDGT	1,427	5	5	260	102
Motorcycle	311	0.80	0	31	41

Source: Personal communication with Brett Taylor, Emissions Inventory Information Analyst, Environment Canada. July 20, 2004.

Notes: 1) HDDV refers to heavy-duty diesel vehicles; LDDV: light-duty diesel vehicles; LDGT: light-duty gasoline trucks; LDGV: light-duty gasoline vehicles; and HDGV: heavy-duty gasoline vehicles. 2) Costs for total particulate matter (TPM) are provided here, and are thus based on emission statistics that are different than those separately reported for PM2.5 and PM10 in the Air Pollution Chapter in Part 3, Chapter 5.

Table 55 combines the information in Tables 53 and 54 above, by multiplying the tonnes of pollutant emissions for each mode and each of five transport-related criteria air contaminants by

[746] Monette and Colman (2004, p. 26). For a detailed explanation of the literature review and methodology for assessing air pollution damage costs, see pp.151-158 of that report.

both the high and low cost damage cost estimates for each pollutant. Nitrogen oxides and volatile organic compounds are the two pollutants that generate the highest transport-related damage costs attributable to air pollution.

Table 55. Nova Scotia: On-Road Air Pollutant Damage Cost Estimates, 2002, ($C2002).

	CO		TPM		VOCs	
	Low	High	Low	High	Low	High
HDDV	$6,400	$19,000	$937,000	$2,289,000	$1,230,000	$5,073,000
LDDV	$600	$1,700	$92,000	$226,000	$273,500	$1,130,000
LDGT	$149,000	$446,000	$149,000	$363,000	$8,703,000	$35,860,000
LDGV	$171,000	$512,000	$192,0000	$468,000	$10,490,000	$43,220,000
HDGV	$3,000	$9,000	$11,000	$27,000	$212,000	$872,000
Motorcycle	$600	$2,000	$2,000	$4,000	$86,000	$350,000
Total	*$330,600*	*$989,700*	*$1,382,355*	*$3,378,000*	*$20,994,500*	*$86,505,000*

	SOx		NOx	
	Low	High	Low	High
HDDV	$501,000	$3,810,000	$19,970,000	$176,400,000
LDDV	$33,000	$250,000	$423,000	$3,730,000
LDGT	$163,000	$1,240,000	$5,343,000	$47,180,000
LDGV	$185,000	$1,410,000	$6,280,000	$55,400,000
HDGV	$7,000	$50,000	$380,000	$3,400,000
Motorcycle	$600	$4,000	$46,000	$403,000
Total	*$889,600*	*$6,764,000*	*$32,442,000*	*$286,513,000*

Note: Costs for total particulate matter (TPM) are provided here, and are thus based on emission statistics that are different than those separately reported for PM2.5 and PM10 in the Air Pollution Chapter in Part 3, Chapter 5.

The resulting high and low cost estimates for each pollutant were combined to produce the total overall damage cost estimates attributable to transport-related air pollution, as presented in Table 56. The low cost estimate is slightly more than $56 million, while the high estimate is over $384 million. These numbers were simply added and divided by two to obtain a mid-range estimate of $220 million.

Table 56. Nova Scotia: Combined Damage Cost Estimates for On-Road Transportation Air Pollutant Emissions, 2002, ($C2002).

	Low ($C2002)	Medium ($C2002)	High ($C2002)
Total Air Pollutions	$56,045,000	$220,097,000	$384,148,000

These estimates under-represent total transportation air pollution costs because they exclude upstream (or pre-tailpipe) emissions, including pollutants generated during vehicle manufacture and servicing, and pollutants from fuel exploration, extraction, production, and distribution. They also exclude emissions from other transport sectors and off-road vehicles. These emissions were not included because the necessary data are unavailable in a format suitable for evaluating transportation sector emissions in Nova Scotia. The inclusion of these emissions would also increase the total cost values in Table 56.

In contrast to the other estimates in this full-cost accounting section, however, the numbers presented above *do* include emissions generated from freight transport. This was possible due to the comprehensive emissions data provided by Environment Canada, as described in Part 3 of this report, along with cost estimates for each of five criteria air contaminants presented in the earlier GPI Air Quality Accounts.

The estimated mid-range cost total for 2002 was just over $220 million, or about $236 per capita, as summarized in Table 57. Of course, actual costs vary significantly depending on the type of vehicle and the conditions in which it is driven.

Table 57. Nova Scotia: On-Road Transportation Air Pollutant Emission Unit Costs, 2002, ($C2002).

Air Pollution	Per Capita	Per Vehicle-Kilometre	Total
Totals	*$236*	*$0.023*	$220,097,000

10. Water Pollution

As discussed in the chapter on water pollution indicators in Part 3, motor vehicles, roads, and parking facilities are all major sources of water pollution.[747] Moreover, they are also a source of hydrological disruptions such as loss of wetlands, increased flooding, shoreline modifications, and a general increase in impervious surfaces.[748] These impacts can impose various costs, including surface and ground water contamination (including drinking water sources), increased flooding and flood control costs, wildlife habitat damage, reduced fish stocks, loss of unique natural features, and aesthetic losses.[749]

No existing estimate incorporates all identified impacts of transport-related water pollution. However, based on the available evidence in several studies, the Victoria Transport Policy Institute estimates water pollution costs at about 1.0¢ per vehicle-kilometre travelled. But this is considered to be a lower-bound estimate because it excludes costs of residual runoff, shoreline damage, leaking underground storage tanks, reduced groundwater recharge, and increased flooding due to pavement having replaced porous soil surfaces.[750]

On a per vehicle-kilometre basis, the transport-related water pollution cost is estimated to be the same for cars, vans, light trucks, buses, and motorcycles. Table 58 outlines water pollution costs extrapolated by vehicle class for Nova Scotia in 2002, using the VTPI estimates per vehicle-kilometre and the number of kilometres driven by each type of vehicle in Nova Scotia that year. The estimated cost total for 2002 was just over $96 million or $103 per capita.

Table 58. Nova Scotia: Estimated Water Pollution Costs, 2002, (2002 CDN$).

Water Pollution	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$72	$0.010	$67,232,166
Van/SUVs/light trucks	$30	$0.010	$28,112,868
Diesel buses	$0	$0.010	$418,647
Motorcycles	$0	$0.010	$376,269
Totals	*$103*	*$0.010*	*$96,139,949*

Source: Victoria Transport Policy Institute. (2003c, p. 5.15-7); vehicle-kilometres are from Natural Resources Canada—Office of Energy Efficiency. Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 30, 35 and 40.

[747] Litman. (2003c. p. 5.15-1). www.vtpi.org/tca/tca0515.pdf Accessed March, 2005.
[748] Chester Arnold and James Gibbons, "Impervious Surface Coverage: Emergence of a Key Environmental Indicator," *American Planning Association Journal*, Vol. 62, No. 2, Spring 1996, pp. 243-258.
[749] Litman. (2003c, p. 5.15-1). www.vtpi.org/tca/tca0515.pdf Accessed March, 2005.
[750] Ibid., pp. 5.15-6 and 5.15-7.

11. Waste Disposal

Motor vehicle use produces various kinds of liquid and solid waste that impose a variety of environmental, human health, aesthetic, and financial costs.[751] For example, oil can cause water pollution, and used tires can be a fire hazard. Other solid waste costs result from the improper disposal of batteries, derelict cars, and other harmful materials that are by-products of vehicle production, maintenance, and use.[752] External costs include various damages caused by the waste, and any public resources devoted to their proper disposal not borne by user fees. Although related, the costs and risks associated with the transport of hazardous materials are not considered in the costs presented here.[753] The provincial government currently spends more than $2.2 million on safe disposal of tires and derelict vehicles, and this can be considered a cost of transport-induced waste disposal.[754]

The recycling indicators presented in Part 3 of this report illustrated some of the encouraging trends for better treatment of vehicular waste, such as the recycling of used tires and the derelict vehicle program. Due to limited data availability, however, it was not possible to present composite trends on the improper disposal of vehicular waste in Nova Scotia.

The Victoria Transport Policy Institute's (VTPI) cost analysis was used to estimate the cost of both improper and proper waste disposal in Nova Scotia. The VTPI estimate for the cost of waste disposal for all motor vehicle types was 0.2¢ per kilometre, for cars, vans, light trucks, buses, and motorcycles.[755]

Table 59 outlines Nova Scotian waste disposal costs in 2002, extrapolated from the VTPI per vehicle-kilometre estimates and based on the number of vehicle-kilometres driven in Nova Scotia in each vehicle class. For 2002, total waste disposal costs in Nova Scotia were estimated at almost $15 million, or $16 per capita.

Table 59. Nova Scotia: Estimated Waste Disposal Costs, 2002, (2002 CDN$).

Waste Disposal	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$11	$0.002	$10,343,410
Van/SUVs/light trucks	$5	$0.002	$4,325,057
Diesel buses	$0	$0.002	$64,407
Motorcycles	$0	$0.002	$57,887
Totals	*$16*	*$0.002*	*$14,790,761*

Sources: Victoria Transport Policy Institute. (2003c, p. 5.16-3); vehicle-kilometres are from Natural Resources Canada—Office of Energy Efficiency. Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 30, 35 and 40.

[751] Litman. (2003c, p. 5.16-1). www.vtpi.org/tca/tca0516.pdf Accessed March, 2005.
[752] *United States Environmental Protection Agency - Waste Division* (www.epa.gov/epaoswer/osw/topics.htm).
[753] Litman. (2003c, p. 5.16-1).
[754] Lyon, Dale. Executive Assistant, Resource Recovery Fund Board. (Personal communication: January, 2005).
[755] Litman. (2003c, p. 5.16-1).

12. Roadway Development Costs

Roadway Development Costs refer to government expenditures to build and maintain roadway facilities, and are comparable to VTPI's *Roadway Facility Costs* category.[756] Information on these expenditures is available in Transport Canada's annual reports. The Nova Scotia government spent $181 million on roadway development in fiscal 2001-2, and local governments spent an additional $157 million, for a combined total of $338 million.[757]

This figure likely understates total government road expenditures, since, as Transport Canada cautions: "Many provinces have moved to unconditional grants to local governments. For this reason, transportation transfers may be under reported."[758] Transfer payments from the provinces to municipalities averaged $9-17 million annually for the decade prior to fiscal 1999-2000,[759] and the federal government spent $2.3 billion nationally on transportation in fiscal 2001-2, of which Transport Canada's budget made up over two-thirds.[760] Transport Canada provides no further information on these funds, but it is possible that a portion was spent on Nova Scotia roadway projects.

On the other side of the ledger, VTPI notes that fuel taxes, tolls, and other imposts dedicated to road works must be subtracted from the costs for this category before a final result is given, in order to avoid double-counting, since these types of costs are already included in the vehicle ownership and operating category.[761] Transport Canada lists gross transportation spending by all levels of government in 2001-2 as $18.3 billion. For the same year, "[s]pecific tax revenues from transport users," which include federal excise fuel taxes, and provincial motive fuel taxes and licence fees, are given as $13.3 billion.[762] This indicates that approximately 27% of roadway expenditures were funded from general revenues, which is similar to rates in other countries.[763,764]

We assume here that Nova Scotia has the same portion of general tax funding of roadways as that noted above – namely that 73% is funded by dedicated tax revenues and fees from transport users and 27% is funded from general revenues. Subtracting 73% (100% - 27%) from Nova Scotia's $338 million total roadway expenditures indicates that over $91 million in general tax revenues are spent on roads (Table 60).

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756 Litman. (2003c, p. 5.6-1).
757 Transport Canada. (2003b, p. A44, Table A3-6).
758 Ibid.
759 Ibid.
760 Transport Canada. *Transportation in Canada 2003: Annual Report*, p. 11. (Ottawa: Minister of Public Works and Government Services, 2003c). www.tc.gc.ca/pol/en/Report/anre2003/tc2003ae.pdf
761 Litman. (2003c, pp. 5.6-5,9).
762 Transport Canada. (2003c, p. 11).
763 Puentes, Robert and Ryan Prince. *Fueling Transportation Finance: A Primer on the Gas Tax*, Center on Urban and Metropolitan Policy. (Brookings Institute, March 2003). www.brookings.edu/es/urban
764 Hamilton, Booz Allen. *Surface Transport Costs and Charges Study*. (Ministry of Transportation New Zealand, 2005). http://www.transport.govt.nz/assets/PDFs/surface-transport-main-report.pdf

Table 60. Nova Scotia: Government Spending on Roads and Bridges, 2001-2, (2002 CDN$).

Provincial Expenditures - Operations and Maintenance	$130,000,000
Provincial Expenditures - Capital	$51,000,000
Net Provincial Expenditures	**$181,000,000**
Local Expenditures	**$157,000,000**
Sub-Total	**$338,000,000**
Less 73% (financed by user taxes and fees)	-$246,740,000
Total	**$91,260,000**

Source: Transport Canada. Transportation in Canada 2003: Annual Report—Addendum. (2003b, p. A44).

The estimated roadway cost total of $91 million averages about $98 per capita, as summarized in Table 61.

Table 61. Nova Scotia: Government Spending on Roads and Bridges Unit Costs, 2001-2, ($C2002).

Roadway Costs	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$68	$0.009	$63,819,541
Van/SUVs/light trucks	$29	$0.009	$26,685,892
Diesel buses	$1	$0.023	$993,494
Motorcycles	$0.38	$0.009	$357,170
Totals	*$98*	$0.009	*$91,260,000*

13. Roadway Land Value

The amount of land devoted to motorized transportation was explored in the land use indicator section in Part 3 of this report. This section considers the value of that land, and the opportunity cost of using land for transportation facilities rather than for other productive uses. This value can be considered equivalent to the rent that road users would pay for roadway land, or at a minimum, the equivalent of property taxes on that land.[765]

Land devoted to road rights-of-way is often considered a sunk cost, with no rent or property taxes charged to users. Economic neutrality requires that land should be priced and taxed at the same rate as for competing uses.[766] This is particularly true in urban areas where the opportunity cost of land is high, and the value of land is affected by the accessibility of its location. Failure to charge for roadway land under-prices space-intensive modes (such as single-occupant automobile travel compared with transit, ridesharing, cycling, and walking), under-prices road transport relative to rail (which does pay rent and taxes on rights-of-way), under-prices roads compared with other land uses, and under-prices transport relative to other goods. As Lee states:

> "Land in highway right-of-way has alternative uses, and this value is included in published figures only when the purchase of new land is a part of current expenditures. Normally, any long-lived business investment is expected to earn a rate of return at least equal to the interest rate on borrowed funds."[767]

A recent (2006) study for Transport Canada provides a methodology for monetizing the value of this roadway land.[768] Unfortunately, the study did not provide sufficient information or data sources to apply that methodology to Nova Scotia in this present report, and time and resources did not permit the investigation required to obtain the necessary information. Hopefully, future updates of this report will use these methods. In the interim, an estimate of roadway land values for Nova Scotia has been derived from VTPI's extensive review of the literature on this subject.

The VTPI estimate is mainly based on American land values. This raises some uncertainty in applying the VTPI estimate to Nova Scotia, since land values differ greatly by locality. Despite this ambiguity, VTPI-based roadway costs are here extrapolated to Nova Scotia on the assumption that there is merit in providing some estimation of what the costs might be, rather than assigning no cost at all to land values. As with parking costs, the VTPI cost estimate is adjusted downward by 33% to reflect the relatively lower land values in Nova Scotia compared with national and US averages. Future updates of this work should use local data on roadway

[765] Litman. (2003c, p. 5.7-1).
[766] Anas, Alex, Richard Arnott and Kenneth Small, *Urban Spatial Structure*, University of California Transportation Center (Berkeley: No. 357, 1997). www.uctc.net
[767] Lee, Douglass. *An Efficient Transportation and Land Use System*, Volpe National Transportation Research Center (Cambridge,1992) http://ohm.volpe.dot.gov
[768] Clarence Woudsma, Todd Litman, and Glen Weisbrod, *A Report On The Estimation Of Unit Values Of Land Occupied By Transportation Infrastructures In Canada*, Transport Canada (www.tc.gc.ca/pol/en/aca/fci/transmodal/menu.htm), 2006.

land values (not presently available) based on the methodology recently developed by Transport Canada.

The roadway land cost estimates for Nova Scotia are presented in Table 62. The average cost applied to all motor vehicles is 1.2¢ per vehicle-kilometre in 2002 Canadian dollars. That estimate is then multiplied by the number of vehicle-kilometres travelled in Nova Scotia to derive an extrapolated value for this province.

This cost is applied on the basis of vehicle-kilometres travelled, because the volume of transport activity drives the demand for roads. Vehicle use is estimated to account for 75% of total annual roadway land values. The other 25% represents the portion of the road system that provides *basic access,*[769] and is therefore not included in the cost estimates below.[770] Roadway land value costs are highly dependent on location. For example, urban areas have much higher land market values than rural areas, while areas with great environmental significance have higher non-market values.[771]

Extrapolating the VTPI estimates to Nova Scotia, roadway land value costs for Nova Scotia in 2002 are estimated to amount to $117 million or $125 per capita.

Table 62. Nova Scotia: Estimated Roadway Land Value Costs, 2002, ($C2002).

Roadway Land	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$88	$0.012	$81,919,808
Van/SUVs/light trucks	$37	$0.012	$34,254,448
Diesel buses	$1	$0.012	$510,106
Motorcycles	$0	$0.012	$458,469
Totals	*$125*	*$0.012*	*$117,142,831*

Sources: Victoria Transport Policy Institute. (2003c, p. 5.7-9); Vehicle-kilometres from Natural Resources Canada—Office of Energy Efficiency. Comprehensive Energy Use Database: Transportation Sector—Canada, Table 30, 35 and 40.

[769] *Basic Access* refers to people's ability to access goods, services, and activities that society considers high value (also called *essential* or *lifeline* goods and services). *Basic mobility* refers to physical travel that provides basic access. Basic access typically includes: emergency services (police, fire, ambulances, etc.), public services and utilities, health care, basic food and clothing, education and employment (commuting), mail and package distribution, freight delivery, and a certain amount of social and recreational activity. From Victoria Transport Policy Institute: TDM Encyclopedia. www.vtpi.org/tdm/tdm103.htm. Accessed February 8, 2006.
[770] Ibid., p. 5.7-9.
[771] Ibid., p. 5.7-8.

14. Crashes

Crash costs refer to the economic value of damages (also called *losses*) caused by vehicle *crashes* (also called *collisions* and *accidents*). Crash costs include *internal costs*, which are damages and risks to the individual travelling by a particular vehicle or mode, and *external costs*, which are uncompensated damages and risks imposed by an individual on other people. Table 63 lists major crash cost categories, including market and non-market costs.

Table 63. Major Categories of Crash Costs

Market	Non-Market
Property damages to vehicles and other objects.	Pain and suffering to crash victims.
Lost income.	Lost quality of life to crash victims.
Emergency response services.	Uncompensated grief and lost companionship to crash victims' family and friends.
Medical treatment costs.	Reduced non-motorized mobility.*
Crash prevention and protection expenditures.	

Source: Litman. (2003c, p. 5.3-8). www.vtpi.org/tca/tca0503.pdf

Note: * Reduced non-motorized mobility refers to the fact that as motor vehicle traffic risk increases, people become afraid to walk and bicycle, and so reduce their travel by these modes, either becoming less mobile overall or shifting to motorized modes. So even if pedestrian/cycle crash injuries decline there may be a cost in terms of their reduced mobility.

There is some variability between different studies in calculating these crash costs, since the cost estimates are dependent on the research and methodologies used to assign values, such as the value placed on a lost life. The overall cost of vehicle accidents also varies depending on which costs are included in the total, and particularly on whether indirect productivity losses attributable to road accidents are added to direct costs like hospital expenses and property damage.

A report on traffic safety in Alberta by Anielski Management Inc. was used as a basis for calculating the cost of accidents in Nova Scotia.[772] Anielski's costs in turn are based on numerous studies of crash costs conducted by Ted Miller,[773] including development of crash cost values for British Columbia and US jurisdictions. Based on this evidence, Anielski's estimated costs are as follows (all figures in 2002 CDN$):

One fatality	= $3.0 million
One injury	= $100,000
Single major property damage	= $6,800

[772] Anielski Management Inc. *Alberta Traffic Safety Progress Report: Key Indicators and Trends*, p. 13. (Alberta Motor Association, 2004).
[773] See for example: Miller, Ted R., John G. Viner, et al. *The Costs of Highway Crashes,* Washington, DC: The Urban Institute and Federal Highway Administration, 1991. See Anielski Management Inc (2004) for other references for Miller.

These figures reflect both direct and indirect costs, with direct costs including health care costs, insurance, and car repairs, and indirect costs reflecting the costs that result from the loss of productivity of those injured or killed, based on estimates of lost income.[774] Due to data limitations, Anielski's analysis only considers costs from vehicle accidents that cause more than $1,000 in property damage , and so his study under-states total costs.[775]

GPI*Atlantic* uses Anielski Management's values because they reflect Canadian conditions. Productivity losses per crash may be higher in Alberta due to higher wage rates there, but it is unlikely that health care, insurance, and car repair costs differ substantially between the two provinces. Future refinements to this study might adjust productivity loss values in particular to reflect such differences. For the purposes of this study, no such adjustments have been made, and the results in Table 64 simply reflect the $3 million, $100,000, and $6,800 values for loss of life, injuries, and major property damage used in the Alberta traffic safety study. Table 64 therefore presents estimated accident costs for Nova Scotia in 2002. The total cost of vehicle accidents in Nova Scotia in 2002 is estimated to amount to almost $975 million, which averages $1,043 per capita or about 10¢ per vehicle-kilometre (Table 65), making it one of the largest transportation costs.

Table 64. Nova Scotia: Estimated Accident Costs, 2002, (2002 CDN$).

Type of Accident	Number of Accidents	Cost
Fatalities	88	$264,000,000
Injuries	5949	$594,900,000
Accidents causing property damage	17042	$115,885,600
Total		**$974,785,600**

Sources: Anielski Management Inc. *Alberta Traffic Safety Progress Report: Key Indicators and Trends*. (Alberta Motor Association, 2004, p. 13); and Nova Scotia Department of Transportation and Public Works. Indices of Motor Vehicle Collision Information (2002).

This present study does not compare crash costs by vehicle type or mode, but it does apply estimates that about 2/3 of crash costs are "internal" (that is, the risks and costs are directly borne by the person who decides to travel) and about 1/3 are "external." (Table 65) External costs refer to costs that are imposed by one road user on others, or are borne indirectly, for example, by businesses that lose productivity when an employee is killed or injured in travel, or by taxpayers if they bear costs for underinsured drivers).[776]

[774] Ibid.
[775] Anielski Management Inc., 2004, p. 47.
[776] Litman. (2005d, p. 5.13-2.)

Table 65. Nova Scotia: Estimated Accident Costs, 2002, (2002 CDN$).

Crash Costs	Per Capita	Per Vehicle-Kilometre	Total
Internal Costs	$695	$0.066	$649,857,067
External Costs	$347	$0.033	$324,928,533
Totals	*$1,043*	*$0.100*	*$974,785,600*

Sources: Anielski Management Inc. *Alberta Traffic Safety Progress Report: Key Indicators and Trends*. (Alberta Motor Association, 2004, p. 13); Vehicle-kilometres from Nova Scotia Department of Transportation and Public Works. Indices of Motor Vehicle Collision Information (2002).

15. Barrier Effect

The *Barrier Effect* (also called *severance*) refers to delays and discomfort that vehicle traffic imposes on non-motorized modes (pedestrians and cyclists).[777] It is an external cost, equivalent to traffic congestion costs, but since conventional congestion cost estimates ignore delays to pedestrians and cyclists, the inclusion of barrier effect costs allows more comprehensive analysis of total delay costs.[778]

The barrier effect has direct and indirect impacts. It causes delay and discomfort for people who walk and cycle, which reduces mobility for non-drivers, and shifts travel from non-motorized to motorized modes, thereby creating additional costs and contributing to the cycle of increased automobile use and further degradation of non-motorized travel.[779]

The barrier effect tends to be inequitable because many people who are physically, economically, or socially disadvantaged rely significantly on non-motorized travel, and so are particularly harmed by risk, discomfort, and delay to these modes. The barrier effect also affects non-human life. Roads and motor vehicle traffic often fragment wildlife habitat and isolate animal populations.[780] For example, Nova Scotia's mainland moose population is presently threatened in this way, undermining the province's efforts to protect its natural resources and wildlife habitat.[781]

Table 66 extrapolates from VTPI's cost guidelines, which in turn are based on an extensive review of the literature on full transportation costs, to estimate the monetary value of the barrier effect in Nova Scotia at close to $68 million in 2002, or $72 per capita. The following figures were arrived at by multiplying the total vehicle-kilometres travelled by each vehicle class in the province (in 2002) by the average contribution of each transport mode to the barrier effect (as estimated by VTPI on a per vehicle-kilometre basis).

VTPI assesses the contribution of diesel buses to the barrier effect at 2.5 times the rate of an automobile per vehicle-kilometre, due to their greater mass, although their barrier effects tend to be smaller on a per passenger-kilometre basis.[782] Had freight transport been included in these calculations, heavy trucks would also clearly contribute disproportionately to the barrier effect.

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[777] Litman. (2005d, p. 5.13-2.). See also the land use indicator chapter, this volume.
[778] In this instance *external* signifies "affecting *other users* of the transportation system." This is a slightly different and more restricted usage than in most of the other sections of this full-cost accounting exercise, where the term "external cost" or "externality" is used to describe costs borne by anyone other than those responsible for the impacts.
[779] Transport planners tend to undercount and undervalue walking transport, because many travel surveys ignore the walking links of motorized trips, short trips, travel by children, and non-commute travel (Litman, op. cit., p. 5.13-2).
[780] Litman's framework includes the environmental impacts of roadways under the "Land Use Impact Costs" category. But that category is not quantified in this study, so roadway barriers to wildlife can be considered in this category of barrier effect costs. Noss, Reed. *Ecological Effects of Roads*, Wildland CPR. (1995) www.wildrockies.org
[781] Colman. (1998a, p. 5).
[782] Litman. (2005d, p. 5.5-2).

Table 66. Nova Scotia: Estimated Barrier Effect Costs, 2002, (2002 CDN$).

Barrier Effect	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$50	$0.007	$46,545,057
Van/SUVs/light trucks	$21	$0.007	$19,462,399
Diesel buses	$1	$0.017	$1,350,391
Motorcycles	$0	$0.007	$260,491
Totals	*$72*	*$0.007*	*$67,618,338*

Sources: Victoria Transport Policy Institute. (2003c, p. 5.13-5); Vehicle-kilometres from Natural Resources Canada—Office of Energy Efficiency. Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 30, 35 and 40.

Summary: Full-Cost Accounts for Road Transportation

This chapter summarizes the estimates of road transportation costs in Nova Scotia. Some of these costs are well recognized, like the costs to consumers of owning and operating vehicles, and the costs to governments of building and maintaining transportation facilities. Other costs are indirect, borne through time delay (for congestion) building rents (for subsidized parking), uncompensated injuries (from accident externalities) and environmental degradation (from pollution emissions and resource externalities).

Table 67 below summarizes the distribution of these costs. It indicates that a significant portion of total costs are either internal fixed (borne by users as a fixed cost) or external (not directly borne by users). The 61% of costs that are not internal variable costs help to hide the true costs of road transportation for the reasons explained earlier, thereby distorting the transportation market and encouraging forms of transportation that are unsustainable. Road passenger transportation per capita in Nova Scotia was an estimated $7,598 in total economic, social and environmental costs, in 2002.

Table 67. Nova Scotia: Per Capita Road Passenger Transportation Costs, 2002, (2002 CDN$).

	Internal-Variable	Internal-Fixed	External
Vehicle Ownership		$1,913	
Travel Time	$1,236		
Vehicle Operation	$1,052		
Climate Change**			$700
Internal Crash	$695		
External Parking			$507
External Crash			$347
Air Pollution			$236
Internal Parking		$220	
Resource Externalities			$213
Land Value			$125
Water Pollution			$103
Road Facilities			$98
Barrier Effect*			$72
Traffic Services			$71
Noise			$67
Waste			$16
Operating Subsidy*			$13
Congestion*			$13
Totals*	$2,982 (39%)	$2,133 (28%)	$2,483 (33%)

Note: The totals listed above do not include the costs marked with a *. The operating subsidy is accounted for in the vehicle ownership costs, and the barrier effect and congestion costs are accounted for in the Travel Time costs. Netting these costs out of the total avoids double counting.

Figure 215 illustrates these costs in descending magnitude. Vehicle ownership is the largest cost category, followed by travel time, and vehicle operation. Costs associated with climate change are also quite significant, and are the fourth largest cost. The other external costs are generally smaller but numerous, and so total externalities are significant in magnitude – accounting for fully one-third of all road transportation costs.

Figure 215. Per Capita Road Passenger Transportation Costs – By Cost Distribution

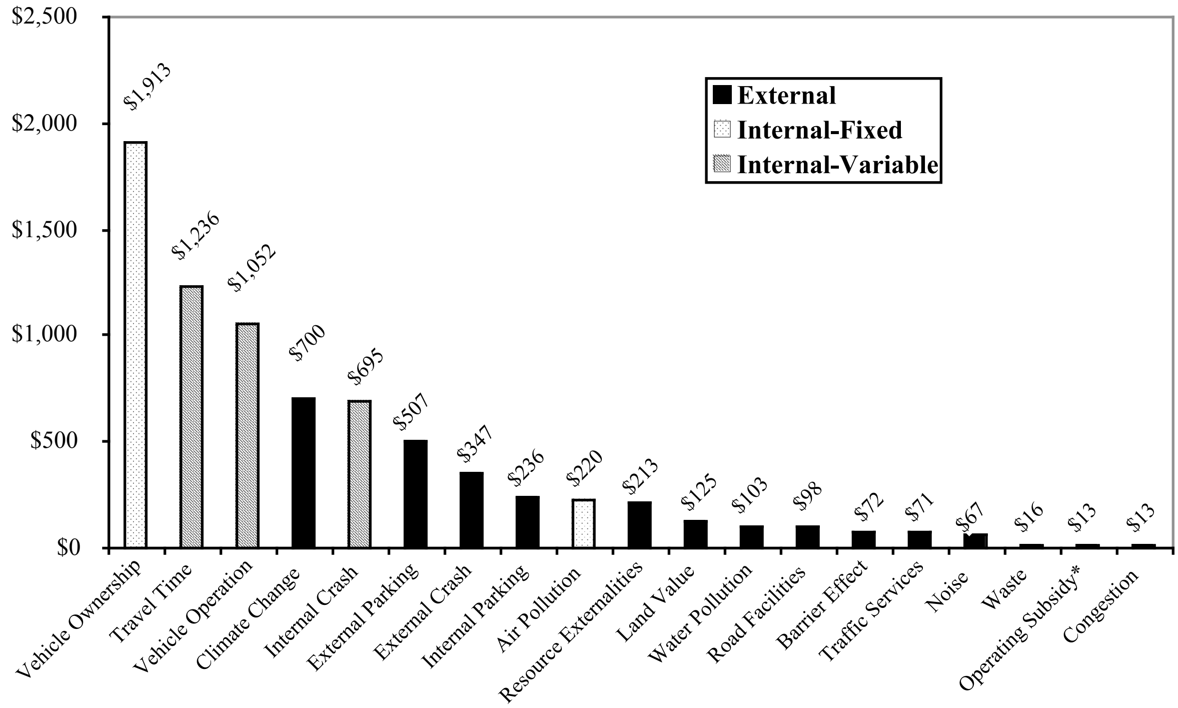


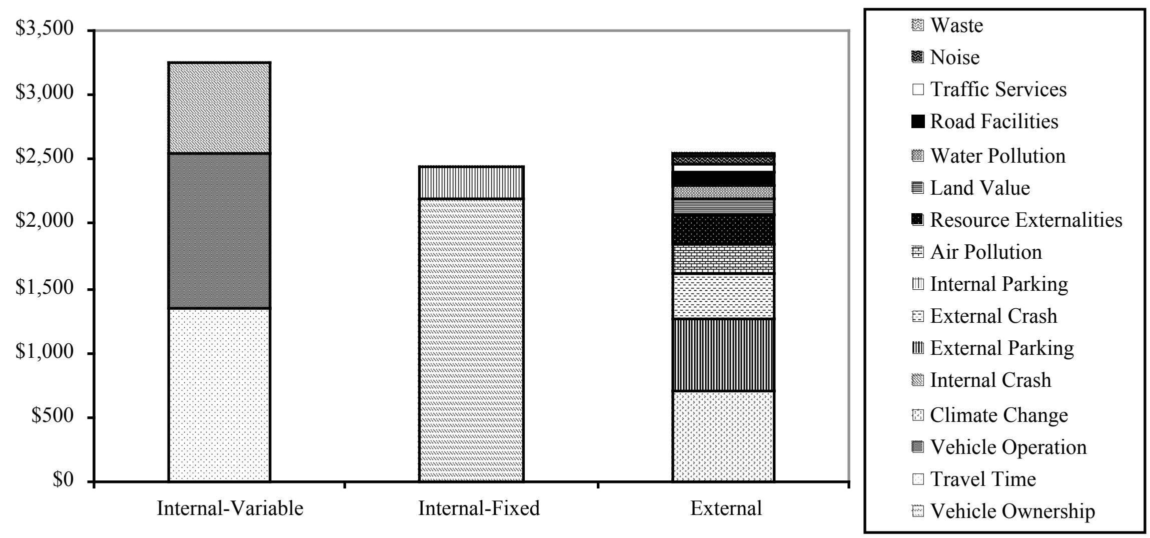
Figure 216 illustrates the distribution of these costs, indicating that approximately a third of costs are internal-variable (39%), a third are internal-fixed (28%), and a third are external (33%). This has important implications for transportation policy analysis, since internal-variable costs are the most efficient and equitable way of pricing transportation. Internal-fixed costs, such as residential parking, vehicle insurance, registration fees, and vehicle financing charges, encourage consumers to increase their mileage in order to get their money's worth from these expenditures. External costs are both inefficient, leading to economically excessive motor vehicle travel, and inequitable, since they represent costs imposed by one actor on others.

Described differently, transportation market reforms that convert fixed costs to variable costs and that internalize currently external costs (such as Pay-As-You-Drive vehicle insurance, and Parking Cash Out and road pricing systems), could reduce total vehicle traffic and make consumers and businesses better off overall, by increasing transportation system efficiency and equity.[783] In addition, this cost analysis highlights some of the often-overlooked impacts that

[783] VTPI. *Online TDM Encyclopedia*. (Victoria Transport Policy Institute, 2006). www.vtpi.org/tdm

should be considered in transportation planning decisions, such as additional parking and accident costs that result from induced vehicle travel (which can be avoided if travel shifts to alternative modes), and the delay and risk that motor vehicle traffic imposes on non-motorized travel.

Figure 216. Per Capita Road Passenger Transportation Costs – By Cost Distribution



Note: Operating subsidy costs, congestion and barrier effect costs are not listed in the above figure to avoid double counting. The operating subsidy is accounted for in the vehicle ownership costs and the barrier effect and congestion costs are accounted for Travel Time costs.

Table 68 outlines the magnitude of the costs by the four different modes of passenger road transportation considered in this full cost accounting exercise. Because automobiles are more numerous, they impose the greatest total costs, over $3,800[784] per capita in 2002. The largest transportation costs for all modes are from 1) the combined costs of vehicle ownership and operation and 2) travel time costs. They account for 39% and 16% of transportation costs, respectively. Costs associated with climate change are the third largest cost, at 9% of the total per capita costs of transportation. Figure 217 provides a visual representation of the magnitude of the costs by the different modes.

[784] The per capita cost for automobiles does not include climate change, air pollution or crash costs since the separate modal costs for cars, buses, light trucks, and motor cycles could not be calculated from the methods and data sources used for these particular cost estimates. Only the total road passenger transportation costs for these cost categories were assessed.

Table 68. Per Capita Transportation Costs by Mode, 2002 ($C2002).

	Automobiles	Van/SUVs/light trucks	Diesel buses	Motorcycles	*Totals*	% of Total
Vehicle Ownership	$1,329	$564	$13	$8	*$1,913*	25%
Vehicle Operation	$721	$306	$23	$2	*$1,052*	14%
Operating Subsidy*			$13		*$13*	0.2%
Travel Time	$802	$354	$76	$3	*$1,236*	16%
Internal Crash**					*$695*	9%
External Crash**					*$347*	5%
Internal Parking	$152	$64	$1	$3	*$220*	3%
External Parking	$355	$151	$0	$1	*$507*	7%
Congestion*	$8	$4	$0.14	$0.05	*$13*	0.2%
Road Facilities	$68	$29	$1	$0.38	*$98*	1%
Land Value	$88	$37	$1	$0.49	*$125*	2%
Traffic Services	$50	$21	$0.31	$0.28	*$71*	1%
Air Pollution**					*$236*	3%
Climate Change**					*$700*	9%
Noise	$44	$19	$1	$2	*$67*	1%
Resource Externalities	$134	$75	$4	$0.31	*$213*	3%
Barrier Effect*	$50	$21	$1	$0.28	*$72*	1%
Water Pollution	$72	$30	$0.45	$0.40	*$103*	1%
Waste	$11	$5	$0.07	$0.06	*$16*	0.2%
*Totals**	*$3,825*	*$1,653*	*$121*	*$21*	*$7,598*	100%

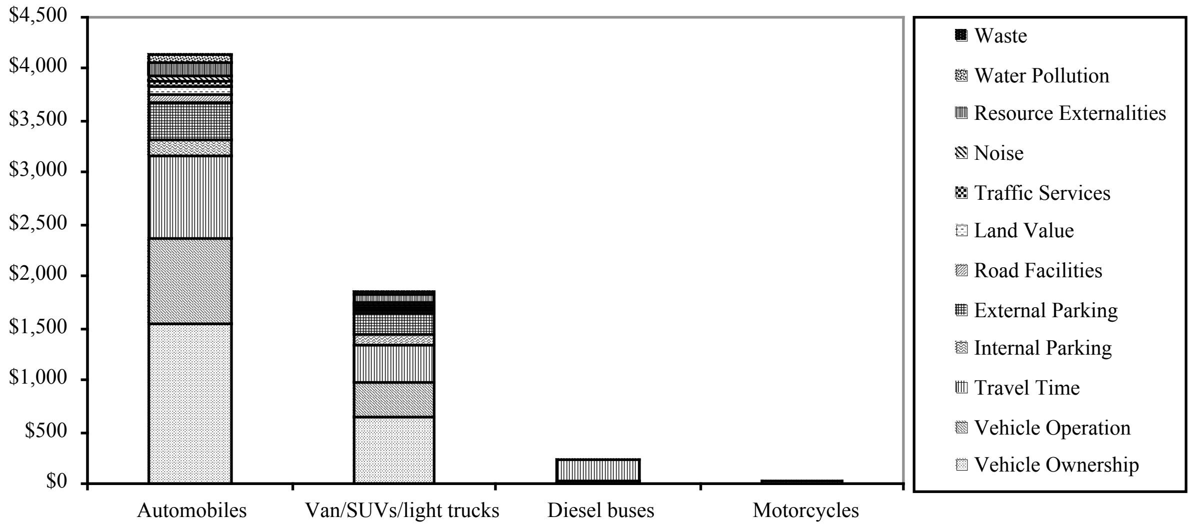
Notes:

*Congestion, the barrier effect, and operating subsidy costs are presented here for illustrative and comparative purposes only. They have been netted out of the totals in order to avoid double-counting, since congestion and the barrier effect are actually sub-components of the travel time costs and operating subsidy is a sub-component of vehicle ownership costs.

**The per capita cost estimate for both air pollution and climate change are based on their respective mid-range estimates.

Please also note that the per capita modal totals above do not include air pollution, climate change, or internal and external crash costs, because the separate modal costs for cars, buses, light trucks, and motor cycles could not be calculated from the methods and data sources used for these particular cost estimates. Only the total road passenger transportation costs for these cost categories were assessed. (Note also that the climate change and air pollution costs are the only ones that also include freight transport costs, as the existing data sources for those categories did not allow freight transport to be separated from passenger transport.) Because the separate modal costs for these particular categories were not assessed, the modal totals on the bottom line for columns 2-5 do not add up to the total road transport cost in column 6.

Figure 217. Per Capita Transportation Costs – By Mode



Notes:

1) Crash, Air Pollution and Climate Change costs are not included in this figure because only total costs were calculated for these costs and not modal costs.

2) Congestion, the barrier effect, and operating subsidy costs are not presented in the figure above in order to avoid double-counting, since congestion and the barrier effect are actually sub-components of the travel time costs and operating subsidy is a sub-component of vehicle ownership costs.

Table 69 provides a summary of all the estimated costs of road transportation in Nova Scotia for 2002. The table also provides both the low and high estimates, where available. The total full cost of transportation for Nova Scotia ranged between just over $6.4 billion on the low end, and over $13.3 billion on the high end, in 2002.

Most of the difference between the low and high end estimates is explained by the vastly different scenarios of potential climate change damages in the literature. The low-end costs, amounting to just $99 million in total for road passenger transportation in Nova Scotia, represent a very conservative (optimistic) scenario. They are based on a damage cost estimate of $24/tonne of CO_2 equivalent emissions, which amounts to just one-quarter of the estimate recently provided by the Stern Report in the UK. The high-end estimate, on the other hand, foresees catastrophic surprises, irreversible impacts, and massive damages to infrastructure as a result of accelerated climate change.

Table 69. Nova Scotia: Estimated Costs of Road Passenger Transportation, 2002 ($C2002).

	Total Costs (million$)	
	Low	High
Vehicle Ownership	$1,788[1]	$3,648[2]
Travel Time	$1,155	$1,155
Vehicle Operation	$983[1]	$1,112[2]
Climate Change**	$99	$4,672
Internal Crash	$650	$650
External Parking	$474	$474
Air Pollution**	$56	$384
External Crash	$325	$325
Internal Parking	$206	$206
Resource Externalities	$199	$199
Land Value	$117	$117
Water Pollution	$96	$96
Road Facilities	$91	$91
Barrier Effect*	$67	$67
Traffic Services	$67	$67
Noise	$62	$62
Waste	$15	$15
Operating Subsidy*	$12	$12
Congestion*	$12	$12
Total Costs:	$6,382	$13,273

Notes:

* Congestion, Operating Subsidy, and Barrier Effect costs are presented here for illustrative and comparative purposes only. They have been netted out to in order to avoid double-counting, since congestion and the barrier effect are actually sub-components of the travel time costs and operating subsidy costs are a part of vehicle ownership costs.

**Three different costs were calculated for both the Climate Change and Air Pollution cost categories: low, medium, and high costs. The above table reports the low and high costs. The medium range costs ($654 million for transport-related climate change costs, and $220 million for transport-related air pollution costs, which are here recommended for use), are reported and explained in the climate change and air pollution cost sections.

[1] These costs are based on the VTPI costing methods.

[2] These costs are based on the CAA costing methods.

Discussion

This study is one of the few attempts to apply full-cost accounting methods to transportation in Canada, and therefore to explore methods for more comprehensive analysis of transportation impacts, including many that are often overlooked and undervalued in conventional transportation policy and project evaluation. Considerable work remains to improve these estimates, to apply derived estimates more specifically to Nova Scotia conditions, and to develop practical tools so that the results can be applied to day-to-day policy and planning decisions.

These estimates are based on the best data and methodologies available. They reflect various degrees of variability and uncertainty. Some costs vary significantly depending on geographic location, vehicle type, and travel conditions. For example, congestion costs occur mainly under urban-peak travel conditions, and some vehicles impose more crash costs than others. Some monetized estimates have a wide range, either because they are inherently difficult to quantify and monetize, because few of the necessary data are available, because there are few previous studies on which to build, or because they depend on projections and assumptions that lack certainty and precision.

However, it is worth noting that many of the cost and benefit values commonly used in current highway project evaluation, such as monetized estimates of travel time savings and traffic accident reductions, also contain similar degrees of uncertainty, since they too require monetization of non-market impacts and extrapolation from a limited set of primary data. Quantifying and monetizing other economic, social, and environmental impacts of transportation at least allows a more comprehensive and balanced evaluation by allowing more impacts to be considered explicitly.

Some of the cost estimates in this section, including vehicle ownership and operating costs, accidents, roadway development, and greenhouse gas and air pollutant emissions, are based on cost values specific to Nova Scotia, previously developed by Transport Canada, Environment Canada, Natural Resources Canada, the NS Department of Transportation and Public Works, and other agencies and organisations.

Where such provincial values were unavailable, cost estimates for Nova Scotia were developed based on "generic" values estimated by the Victoria Transport Policy Institute on the basis of a very extensive review and analysis of the existing evidence from previous transportation cost studies in Canada, the United States, and other countries. Those generic estimates were then adjusted to reflect Nova Scotia travel activity (vehicle-kilometres driven in the province) and conditions (for example by adjusting parking and roadway value costs downward by 33% to reflect lower land values in Nova Scotia).

Because of the acknowledged uncertainties and derived nature of these values, the cost estimates presented here should be considered general indicators of the economic burden of transportation in the province. This analysis should provide a model and impetus for further research needed to achieve Transport Canada's goal of accounting for the full costs of transportation. Future updates of this study should also adjust the generic cost estimates more accurately to Nova Scotia conditions.

Impacts Not Monetized

A number of impacts that are probably significant in magnitude were not monetized in this study, due to technical constraints. This is not to suggest that these impacts are unimportant or should be ignored in decision-making. Rather, given the available information and resources, they will need to be considered and analyzed qualitatively rather than quantitatively. However, in the future, it may be possible to quantify and monetize these additional transport-related impacts. Below are a few such impacts that deserve consideration and additional research.

First, transportation facilities and activities often affect land use patterns, which in turn can have significant economic, social, and environmental impacts. For example, wider roads and larger parking facilities, and more automobile-oriented transportation systems, tend to encourage dispersed, urban fringe development, commonly called "sprawl." Such development, in turn, tends to increase the costs of providing public services, reduces travel options (particularly for non-drivers), increases per capita vehicle travel, increases impervious surface area, and reduces green space. Conversely, transportation policies and programs designed to reduce automobile use and encourage alternative transport modes tend to encourage more compact, mixed development, commonly called "smart growth," which provides a variety of economic, social, and environmental benefits that have been noted in this study. These land use impacts should be considered when evaluating transportation policies and programs.

Second, transportation diversity (the quantity and quality of travel options available in a particular situation) has important equity and economic efficiency impacts. In general, a more diverse, multi-modal transportation system is more equitable, because it improves economic opportunity for disadvantaged people, and it also tends to be more economically efficient because it allows people to choose the best travel option for each trip, and increases non-drivers' productivity.

Third, transportation decisions can significantly impact public health, not only due to accident risk and pollution exposure, but also through their impact on levels of physical activity. Health professionals are increasingly concerned about the health problems resulting from inadequate physical activity. Although there are many possible ways to be physically active, including sports and working out at a gym, one of the most practical ways for people to maintain lifelong fitness is to walk and bicycle regularly for transportation and recreation.[785]

Described differently, transportation and land use planning decisions that improve walking and cycling conditions and encourage use of these modes can provide significant health benefits.[786] A 2004 report prepared by **GPI***Atlantic,* and presented to HRM planners by the Heart and Stroke Foundation of Nova Scotia, demonstrated the health benefits of a municipal planning strategy that encouraged walking and cycling, and estimated the health care savings of a 10% reduction in physical inactivity in HRM.[787]

Certain transportation policies and land use patterns tend to increase active transport. Since most transit trips involve walking links, including those to and from transit stops, people who ride transit are more likely to achieve minimum recommended levels of walking activity than people who travel primarily by automobile.[788] See **GPI***Atlantic's* two reports on The Cost of Physical

785 Frumkin, Howard, Lawrence Frank and Richard Jackson. *Urban Sprawl and Public Health: Designing, Planning, and Building For Healthier Communities*. (Island Press, 2004). www.islandpress.org

786 Frank, Lawrence, Sarah Kavage and Todd Litman. *Promoting Public Health Through Smart Growth: Building Healthier Communities Through Transportation And Land Use Policies*. (Smart Growth BC, 2006) www.smartgrowth.bc.ca/downloads/SGBC_Health%20Report%20Final.pdf.

787 Walker, Sally, and Ronald Colman. *The Cost of Physical Inactivity in Halifax Regional Municipality,* (**GPI***Atlantic*, 2004). http://www.gpiatlantic.org/pdf/health/inactivity-hrm.pdf

788 Besser, Lilah M., and Andrew L. Dannenberg, "Walking to Public Transit: Steps to Help Meet Physical Activity Recommendations." (*American Journal of Preventive Medicine*, Vo. 29, No. 4, 2005) www.cdc.gov/healthyplaces/articles/besser_dannenberg.pdf.

inactivity in Nova Scotia and The Cost of Physical Inactivity in Halifax Regional Municipality for a quantification of the impacts of the health risks of sedentary living, including relative risk ratios for heart disease, hypertension, diabetes 2, colon cancer and a range of other diseases, and monetary estimates of the direct health care costs and indirect productivity losses attributable to physical inactivity in Nova Scotia.[789]

Fourth, many of the external costs of transportation may reduce economic productivity, employment, and property values in ways describe in more detail in this report. Described differently, a more diverse and efficient transportation system can provide various economic development benefits:

- Reduced automobile traffic can reduce roadway and parking facility costs, allowing taxes to be reduced or increased investment in public services.
- Reduced automobile traffic tends to reduce traffic accidents, and therefore saves lives, and reduces injuries, damage costs, and productivity losses due to premature death or disability.
- More efficient transportation can reduce costs to businesses. For example, reducing automobile trips reduces parking costs, and reduced vehicle traffic reduces congestion which in turn reduces distribution costs.
- More compact development patterns tend to provide efficiencies of agglomeration and reduced public service costs.
- Energy conservation tends to increase local economic activity, since fuel purchases provide less regional employment and business profits than other types of consumer expenditures.
- Reductions in air and noise pollution tend to increase nearby property values, which in turn can increase productivity and tax revenues.

Many of these impacts result from specific cost savings and economic benefits identified in this study, so adding these economic development benefits to other cost savings could result in double counting of benefits. However, it is important to recognize that policies and programs which increase transportation system efficiency can provide significant, indirect economic benefits. These are often overlooked in conventional policy and business analysis when the full range of economic, social, and environmental benefits and costs of transportation is not properly considered.

For example, the cost savings to businesses that result when commuters shift from driving to alternative modes are often overlooked in evaluations of investments in walking, cycling, and public transit infrastructure. Similarly, businesses sometimes oppose market reforms, such as congestion and parking pricing, because they focus on short-term incremental costs but overlook

[789] Colman, Ronald. *The Cost of Physical Inactivity in Nova Scotia.* (**GPI***Atlantic*, 2002). http://www.gpiatlantic.org/pdf/health/inactivity.pdf; and Walker, Sally, and Ronald Colman. *The Cost of Physical Inactivity in Halifax Regional Municipality,* (**GPI***Atlantic*, 2004). http://www.gpiatlantic.org/pdf/health/inactivity-hrm.pdf

the longer-term savings and productivity benefits that result from reduced congestion and parking costs.

Fifth, transportation decisions often affect *community cohesion* (the quantity and quality of interactions among people in a community)[790] and *social inclusion* (people's ability to participate adequately in society, including in education, employment, public services, and community and recreational activities).[791] Community cohesion and social inclusion have been shown to provide a variety of indirect benefits, including increased personal security, reduced crime, increased local property values, increased opportunity and social equity, and increased economic productivity. More research is needed to understand the diverse ways in which transportation policy and planning decisions affect these objectives, the total value to society of these community level impacts, and how such community outcomes can be effectively incorporated into transportation evaluation.

Evaluating Non-market Costs

While **GPI***Atlantic* fully acknowledges the paradox of trying to quantify many priceless and irreplaceable non-market values (like the biosphere's life-support services) for which money is a poor valuation tool, it also recognizes that these analytical methods can be useful in helping decision-makers understand the value of non-market goods and services and in helping identify strategies that can move the economy towards sustainability.[792]

A note must be added on the sheer *magnitude* of the costs summarised in Table 69. By comparison with the $6.4-13.3 billion (low end to high end range) estimate of road passenger transportation costs in Nova Scotia, Nova Scotia's GDP for the fiscal year 2001-2 was approximately $28.8 billion.[793] This means that the cost of road passenger transportation alone was equivalent to as much as 22% of the province's Gross Domestic Product for the year at the low end and 46% at the high end.

This result reflects the fact that GDP accounts only for market transactions, while many costs in Table 69 (including some of the largest, such as travel time, climate change costs, and the pain and suffering caused by traffic accidents) reflect non-market costs. Indeed, as noted, the high end estimates for transportation costs are based on the more pessimistic and catastrophic climate change damage scenarios recently predicted by scientists. Nevertheless, even though GDP does not include many of the costs considered in this full cost accounting analysis, the comparison with GDP is still useful for illustrative purposes, because it demonstrates the severe limitations of conventional market-based accounting practices, and their capacity to distort policy priorities by hiding huge and vital costs.

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[790] *Social Exclusion & Transport Toolkit* (www.geocities.com/transport_research/socexclu0.htm).
[791] Lucas, Karen (2004), *Running on Empty: Transport, Social Exclusion and Environmental Justice*, Policy Press (www.bris.ac.uk).
[792] See Reid, Mooney, et al. (2005, p. 16 ff.).
[793] Nova Scotia Department of Finance. (2003, p. 112).

Clearly the full-cost accounting results are enormous sums that far exceed conventional estimates of the size and economic burden of the transportation sector. For example, in 1989 a national Royal Commission on passenger transportation in Canada concluded that Canadians devoted resources “equivalent to 16% of gross domestic product” to transportation *in total*.[794] That is consistent with the data presented in Part 3 of this study, showing that households in 2002 spent about 16% of their household budgets on transportation (Figure 212 above).

However, such estimates significantly understate total transportation costs because they overlook indirect and non-market impacts. The enormity of the sums presented in Table 69 can justify policies and programs that help create a more efficient transportation system that reduces the total economic, social, and environmental costs of transportation. Specific strategies for increasing transportation system efficiency are described in the next section of this report.

Evaluating Benefits

This analysis focuses on transportation *costs*. This is not to ignore the very significant benefits provided by transportation. However, the benefits of many transportation improvements are measured in terms of marginal reductions in costs, such as reductions in travel time, accidents, and vehicle operating costs, so a more comprehensive cost framework naturally allows a more comprehensive analysis of benefits. For example, a comprehensive cost framework can indicate transport options that minimize total transportation costs, or provide benefits that are currently overlooked or undervalued, such as reduced barrier effect (delay to pedestrians), energy conservation, and pollution emission reductions. The transportation costing analysis is similar in its approach to cost of illness studies that demonstrate the potential benefits and cost savings that can achieved through health promotion strategies that reduce risk behaviours and disease incidence. In short, a consideration of benefits is by no means excluded, and is in fact encouraged, through proper analysis and use of costing studies.

Disaggregating Costs

Further work is needed to develop a framework for evaluating costs and benefits of different transport modes and mobility management programs. Due to limited data, it was not possible to disaggregate many of the costs examined by mode and travel condition. More analysis will be needed to develop models that accurately determine how these costs vary between larger and smaller vehicles, private and public transportation modes, motorized and non-motorized modes, and between urban-peak, urban off-peak, and rural conditions. Fortunately, current research for Transport Canada’s “Full Cost Investigation of Transportation in Canada” project may provide much of the information needed for such finer disaggregation.[795]

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[794] Hyndman, Louis. *Directions: the final report of the Royal Commission on National Passenger Transportation* (volume 1), p. 2. (Ottawa: Minister of Supply and Services, 1992).
[795] Transport Canada. *Full Cost Investigation of Transportation In Canada*. (2003-2006). www.tc.gc.ca/pol/en/aca/fci/transmodal/menu.htm

Special care is needed when evaluating and comparing the benefits and costs of different modes, and when evaluating mobility management programs that cause travellers to shift modes.[796, 797]

For example:

- Although public transit tends to have relatively high external costs per passenger-kilometre travelled, transit users tend to travel relatively fewer annual kilometres, so the external *per capita* cost of transit travel tends to be lower than that of automobile travel.
- Although non-motorized travel tends to have a relatively high accident risk per passenger-kilometre, people tend to walk and cycle relatively few annual kilometres compared to automobile users. Thus, a short walking or cycling trip often substitutes for a longer automobile trip. As well, non-motorized travel imposes minimal risk to other road users and provides health benefits. For these reasons, increased non-motorized travel tends, in aggregate, to increase overall safety and health.
- If a vehicle has excess capacity, the marginal cost of accommodating an additional passenger is minimal, so policies and programs that encourage ridesharing and public transit use tend to have much lower *marginal* costs than their average costs.

This analysis indicates some important points concerning the distribution of transportation costs. Economic efficiency and equity require that prices (what consumers pay for a good or service) reflect the full incremental cost of providing that good or service, unless a subsidy is specifically justified. A major portion of road passenger transportation costs in Nova Scotia is either fixed (28%) or external (33%), which indicates a market distortion that under-prices motorized travel, resulting in economically excessive mobility. Described differently, current transportation markets fail to return to individual consumers the cost savings that result when they reduce their vehicle travel or in other ways decrease the transportation costs they impose. This violates key market principles, and by increasing resource consumption, it contradicts sustainability principles and practices.

This is actually good news, since it means that various market reforms can help increase efficiency, equity, and sustainability. It means that there is not necessarily a contradiction between economic objectives (such as employment and productivity), social objectives (such as improved mobility for non-drivers, and increased affordability), and environmental objectives (such as energy conservation, pollution and greenhouse gas emission reductions, and wildlife habitat preservation). On the contrary, *Win-Win Transportation Solutions* help achieve economic, social, and environmental objectives together by improving travel options, providing incentives to use transportation resources more efficiently, and creating more accessible communities.[798]

[796] United Kingdom Department for Transport. *Guidance on the Methodology for Multi Modal Studies (GOMMMS)*. (Transport Analysis Guidance Website, 2003). www.webtag.org.uk
[797] Litman, Todd. *Evaluating Public Transit Benefits and Cost*. (Victoria Transport Policy Institute, 2005g). www.vtpi.org
[798] Litman, Todd. *Win-Win Transportation Solutions*. (Victoria Transport Policy Institute, 2005f) www.vtpi.org

PART V: RECOMMENDATIONS

GPI*Atlantic*'s analysis of the state of Nova Scotia's transportation system points to recommendations on two fronts: policy initiatives for improving transportation sustainability in Nova Scotia, and suggestions for strengthening future research in this field. The latter category highlights crucial data gaps and suggests directions for research that can further develop the indicator set presented in this study. The policy recommendations weigh possible *responses* to some of the factors that currently undermine sustainability objectives. This is in line with the DPSIR (driving force-pressure-state-impact-response) model used by the European Environment Agency and discussed in Part Two above, which assesses whether policy responses actually address the driving forces of a transportation system or merely its symptoms and impacts.

Improving Indicator Research

Improved and expanded data collection would greatly facilitate transportation system performance evaluation and planning. Canada and Nova Scotia currently lack standardized, comprehensive, and comparable time series data on vehicle travel, crashes, transportation program expenditures, energy consumption, travel patterns, transit ridership, and other transportation activities, collected at regular time intervals and suitable for evaluating conditions, tracking trends, comparing geographic areas, and other types of analysis. Such statistics are collected regularly in the US[799] and the United Kingdom.[800]

Particularly sparse provincial-level information is available on rail, marine, and air transportation. Some of the most critical data gaps concerning rail, marine, and air transport are tonne-kilometre and energy intensity figures, as well as data on land area used for rail, air, and marine facilities. As a result of such gaps, it was not possible to compare the different transport modes and their impacts adequately, or to indicate whether and the extent to which these modes are moving towards sustainability. For example, it is often argued that moving freight by train rather than truck would improve transport efficiency and reduce ecological impacts. While there is much evidence in favour of this hypothesis at the national level, it is harder to make the case for Nova Scotia specifically because the relevant statistics are not made available on a provincial (or even regional) basis.[801] Without this information and basic evidence, there remains the possibility that local conditions make rail a less appropriate choice for Nova Scotia.

In this case, interestingly, the problem is not that this rail, marine, and air transportation information does not exist. This information is in fact compiled by government agencies at taxpayer expense, but is not released publicly on grounds that the data are proprietary and their release could be harmful to industry. **GPI***Atlantic* takes the position that basic information on transportation activity is vital to the public interest, since it has broad economic, social, and environmental impacts, and is vital for policy and planning decisions. Though it is often claimed that public release of this information would undermine competitiveness, releasing such

[799] Federal Highway Administration - Office of Highway Information Management. *Highway Statistics*. (United States Department of Transportation, 1996). www.fhwa.dot.gov/ohim

[800] Transport Statistics Great Britain. www.dft.gov.uk/transtat

[801] For a summary of the evidence in support of rail see: David Suzuki Foundation. *Taking the High Road: Sustainable Transportation for the 21st Century*, pp. 7-8. (1999). www.davidsuzuki.org/files/trans_eng.pdf Accessed April, 2005.

information would more likely increase competition and market efficiency, provided that all firms face the same reporting and data distribution requirements. If necessary, data could be withheld from the public for one year, perhaps during a three-year transition period, to allow firms time to adjust to the new requirements.

Land use indicator data were particularly deficient. Minimal standardized and recent data are available on population density, road density, road lengths, sidewalk lengths, and land use area devoted to transportation facilities across Canada or within Nova Scotia. This made it impossible to generate working indicators on land use for Nova Scotia. It is particularly infortunate that, after 25 years (1971-1996) of collecting and releasing Census data on urban density in Canada, Statistics Canada decided to stop producing those data after the 1996 Census. As a result, after a quarter century of rapid suburban and exurban sprawl development, as evidenced by steadily declining urban density, we have had no systematic way of tracking this trend for the last ten years and will have no way of doing so in the future unless Statistics Canada reinstates its urban density tracking.

It would also be useful to have better data for evaluating *accessibility* – the ease with which people can reach desired goods, services and activities. As discussed in the land use chapter in Part 3, movement towards sustainability requires the close integration of land use and transportation planning. A first step in this process is collecting more complete baseline data on land use in the province, and assessing how that land is being used. The following indicators would contribute to this assessment:[802]

- Land use clustering: average number of major services (grocery, library, school, playing field, etc.) within walking distance of residents; or average walking distance between residences and public services such as schools and retail centers.

- Land use mix: whether a given area is put to different uses (e.g., commercial, residential, educational).

- Roadway scale and connectivity: the size of roads and civic blocks, and the degree of connection within the street system.

- Impermeable surface coverage: the portion of land that is paved for transportation purposes (i.e. roads, parking spaces, etc.).

Rather than relying on calculated approximations, the use of GIS data or measurements from aerial photographs could greatly improve data quality and provide usable figures for the land area consumed by motor vehicles in Nova Scotia. Such data would also provide municipalities with a blueprint of how land is being used, so that they can decide where improvements are needed. For example, a land use clustering assessment would help determine how and where amenities should be zoned so that they are easily accessible by non-motorized transport users and public transit. Transportation infrastructure assessments can also help monitor how communities are growing. With this information, planners could assess whether particular kinds of growth should continue and be encouraged, or whether alternate development plans are needed.

[802] Litman. (2004a, p. 2).

A major goal of sustainable transportation strategies is to improve the conditions and infrastructure for non-motorized transportation modes, such as walking and cycling, as well as telecommuting. However, to date, other than Census statistics on commuting to work, data collection on non-motorized travel has been periodic, inconsistent, and subject to major definitional problems. There is a need for more complete data sets on non-motorized transportation, including cycling and walking for non-work purposes, and use of active transport modes in combination with public transit. Without reliable and consistent monitoring and data collection in these areas, it is not possible to estimate total passenger-kilometres travelled in Nova Scotia by walking or bicycling, which in turn prevents trend and cost comparisons with motorized transport modes. Measures of infrastructure accessibility are also needed. As with the land use indicators suggested above, planners could use these kinds of data on walking and bicycling to determine the types and extent of infrastructure and support structures (like bicycle lanes and walkways) needed to promote non-motorized travel.

There are also several key indicators that were not explored in this report. While by no means an exhaustive list, potential indicators that demand attention, and that are recommended here as suggesting possible future research directions, include:

1) Full modal comparison of costs of transportation borne by users;
2) Transport patterns of young people; and
3) Special needs access to public transit.

On the recommendation of its Advisory Committee, **GPI***Atlantic* initially did intend to include an economic indicator that reflected the cost of transportation borne by users. The intention behind this indicator was to discover the extent to which municipalities or transport users carried the burden of paying for the cost of different transportation modes. However, we could not find adequate information on municipal transportation expenditures, since municipal budget data are not presently collected in one place in an integrated, standardized form. **GPI***Atlantic* lacked the resources needed to collect this information separately from each municipal government, as would be required for this indicator, and to organize it in a format suitable for analysis. There is no particular barrier to such data collection, and the province could simply establish standard reporting requirements for municipal governments to ensure that it is regularly reported in consistent form. The provincial government could then collect this information and make it publicly available. This would provide useful information at minimal cost.

In the meantime, the breakdown of costs into internal-fixed, internal-variable, and external, in the concluding summary of the previous costing section, does at least give a general indication of the proportion of passenger transport costs borne by users. More detailed analysis of user-borne costs by mode would require the additional research noted in the previous paragraph.

This report did not quantify transportation system diversity or evaluate the quality of mobility available for people who are physically, economically, or socially disadvantaged.[803] Such analysis could help identify existing inequities in the transportation system, and identify ways to

[803] This omission was pointed out to by advisory committee member and reviewer Brian Smith, Chief Administrative Officer for Kings County, Nova Scotia. (Personal communication: April 19, 2005).

improve disadvantaged people's opportunities and transportation affordability. As noted in the chapter on public transit access in Part 3 of this report, current reporting protocols may exaggerate the proportion of the population served by public transit, because the standard used is simply the distance from residents' homes to the nearest bus stop, which gives inadequate consideration to the quality of service and the needs of people with mobility impairments.

We believe that it would also be beneficial to determine trends in the transport patterns of young people in Nova Scotia, including information on school travel patterns; opportunities for walking, cycling and public transit travel by young people; the mobility barriers they face; and the degree to which they are using physically active modes of transportation sufficiently to derive physical fitness and health benefits. The Canadian Centre for Sustainable Transportation has created a planning framework that can help evaluate these factors.[804]

We also found insufficient data on water pollution attributable to vehicles, spills, and runoff from roads and parking lots. The only indicators that could be considered in this category were numbers of well claims for road salt contamination, the sum of monetary damages awarded to people whose wells were contaminated by road salt, and the number of accidents involving dangerous goods (which is not a clear indicator for this category).

Nova Scotia's Resource Recovery Fund Board keeps track of tire recycling and salvaging of derelict vehicles. But statistics are not recorded for recycling and disposal of other transportation components such as car batteries, oil, and anti-freeze. Although these materials are banned from landfills, little is known about the degree of compliance with these prohibitions.

These examples illustrate some of the data gaps and limitations encountered in researching this study. Other examples are given throughout the report. Improved data collection and availability in a wide range of areas related to transportation would provide critical evidence to policy makers and planners interested in improving the efficiency and sustainability of the transportation system.

Policy Reforms

The principal purpose of this report is to expand on the conventional understanding of transportation in Nova Scotia in a way that can assist policy makers in moving the system towards greater sustainability and efficiency. To that end, this report has assembled the province's most comprehensive inventory yet of transport's multiple effects on the economy, society, and environment of the province. This task, undertaken over several years, has shed light on the massive scope of the transportation system, including many economic, social, and environmental impacts that are often overlooked. The various indicators and trends presented in Part 3 of the report are intended to provide an evaluation framework that can better inform transport policy and planning decisions.

[804] For a summary of the project and links to detailed reports see: cst.uwinnipeg.ca/completed.html..

This type of analysis can help identify appropriate policy innovations by shining a spotlight on currently unmeasured and overlooked impacts. There is no doubt that Canada and Nova Scotia are making progress toward more comprehensive evaluation of transportation impacts, such as Transport Canada's *Investigation of the Full Costs of Transportation*[805] and HRM's Municipal Planning Strategy and its associated transportation plans and programs that encourage greater use of alternative transport modes and more accessible land use development. The recent announcement of federal support to Nova Scotia transit systems, noted in this report, is also an important step towards more comprehensive and sustainable transportation planning. At the same time, the evidence in this study quite clearly indicates that the current transportation system is fundamentally unsustainable, and that many trends are actually showing further movement away from sustainability.

One important finding of this study is that existing transportation market distortions result in economically excessive motor vehicle travel, which undermines sustainable development objectives. In a more optimal market, the evidence indicates that people would drive less, rely more on alternative transport modes, place a higher value on locating in multi-modal communities, and be better off overall as a result. Reductions in automobile travel, particularly in urban areas, can help achieve many planning objectives, including reduced traffic congestion, road and parking cost savings, consumer cost savings, improved accessibility for non-drivers, reduced accidents, energy conservation, pollution emission reductions, and improved fitness and health.

More comprehensive planning, which considers a wider range of impacts and objectives, can strengthen the justification for efforts to improve transportation system efficiency. In general, such planning involves improving travel options (walking, cycling, ridesharing, public transit, telework, and delivery services), providing incentives to use the most efficient transport option for each trip, and creating accessible, multi-modal land use development. There are many specific ways of achieving these objectives, generally called *mobility management* when referring to transportation innovations, and *smart growth* when referring to land use innovations, although, since transportation and land use affect each other significantly, they involve many of the same strategies. Below are some examples of specific policies and programs that encourage more efficient and sustainable transportation. For information on these strategies see the *Online TDM Encyclopedia* (www.vtpi.org/tdm).

Provincial Strategies

Least-Cost Transportation Planning

Least-Cost Planning means that programs to reduce demand are considered equally with programs to increase capacity, that all significant impacts are included in the analysis, and that the public is involved in developing and evaluating alternatives. This allows demand management strategies to receive appropriate consideration and investment.

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805 Transport Canada, *Investigation of the Full Costs of Transportation: A Discussion Paper*, Economic Analysis Policy Group. (Transport Canada, 2003a) www.tc.gc.ca/pol/en/aca/fci/menu.htm

Prioritizing Transportation

Prioritizing Transportation involves explicit consideration of transportation impacts, with the goal of giving higher value trips and lower cost modes priority over lower value, higher cost trips. For example, emergency vehicles, public transit, and freight vehicles tend to have relatively high value per vehicle-mile, and so can be given priority over private automobile travel. Transit, rideshare vehicles, bicycling, and walking generally cost society less per passenger-trip than single occupant automobile travel (in terms of road space, parking costs, crash risk imposed on other road users, and pollution emissions), and so should receive priority. In some jurisdictions this priority is given in the form of special traffic lanes devoted to public transit and rideshare vehicles, and in dedicated bicycle lanes and walkways.

Pay-As-You-Drive Vehicle Insurance and Other Distance Based Fees

Converting vehicle insurance and registration fees from fixed charges to per-mile fees approximately doubles variable vehicle expenses. For example, a motorist who now pays $1,000 per year for insurance and registration might instead pay 5¢ per vehicle-kilometre travelled in the year. This provides a significant financial incentive to reduce driving, while making these charges more fair and affordable. This change alone is predicted to reduce vehicle travel by approximately 12%, reduce crash rates by a greater amount, increase equity, and save consumers money. If fully implemented, this innovation alone could achieve about 40% of the transport-related GHG emission reductions required by the Kyoto Accord.

Revenue-Neutral Tax Shifting

Since governments require taxes to raise revenues, many economists recommend shifting taxes away from socially desirable activities like employment to those that are harmful or risky. For example, a revenue-neutral shift from employment and general sales taxes to resource consumption taxes could reduce pollution while increasing economic productivity and employment. Such tax shifts provide economic benefits because higher fuel prices encourage energy efficiency and technological innovation, reduce the economic costs of imported petroleum, and encourage employment and investment, which stimulates economic development.

Road Pricing

Road Pricing means that motorists pay directly for driving on a particular road or in a particular area. Road pricing can be used to reduce traffic congestion, and to charge motorists directly for their roadway costs, which is fairer than current practices that result in substantial cross-subsidies. As noted in the previous paragraph on revenue-neutral tax shifting, current motorists would not be worse off overall as a result of such innovations, as their increased driving costs would be offset by reduced income and other taxes. In this way, road pricing mechanisms encourage shifts in transportation behaviour without reducing the wellbeing of the populace.

Reform Motor Carrier Regulations

Many jurisdictions limit transportation service competition and innovation. Private bus, and shuttle and shared taxi services are often prohibited or restricted in order to maintain monopolies for existing service providers. Regulations should be minimized and focused to address specific safety and other problems while encouraging more competition, consumer choice, and innovation.

Regional and Local

Local And Regional Transportation Demand Management (TDM) Programs

TDM programs include a wide variety of services, including rideshare matching, transit improvements, bicycle and pedestrian facility improvements, parking management, and promotion of alternative transport modes. These programs can provide significant financial savings to governments, businesses, and consumers, as well as environmental benefits.

Land Use Policy Reforms

Current development and land use practices tend to encourage dispersed, urban fringe development, which reduces travel options and increases the amount of travel needed to reach destinations. Access Management, Smart Growth, New Urbanism, and Location Efficient Development are related strategies that help create more efficient land use patterns that improve transportation diversity and create more liveable communities. Many Smart Growth policy reforms are justified on both efficiency and equity grounds, including infrastructure investment policies that favour urban redevelopment over sprawl, and zoning codes that encourage development of compact, mixed-use urban villages. Residents of more accessible communities tend to drive less and rely more on alternative transport modes, which in turn helps to solve a variety of transportation problems.

More Flexible Zoning Requirements

Parking and road requirements dictating access to business establishments are often inflexible, overly generous to drivers, and costly to business. There are many ways to reduce the amount of land devoted to roads and parking without constraining mobility. Local governments can reduce parking requirements for businesses that have travel management programs or that are located in areas with good transit service. For example, shared parking allows significant reductions in parking requirements.

Parking pricing and *cash out* (allowing commuters who are offered a subsidized parking space to choose its cash equivalent if they use an alternative mode) tends to reduce demand by 10-30%. Location efficient development allows households to avoid paying for residential parking spaces they do not need. These strategies provide direct economic and environmental benefits.

Commute Trip Reduction Programs

Commute Trip Reduction (also called *Employee Trip Reduction* or *Vehicle Trip Reduction*) programs give commuters resources and incentives to reduce their automobile trips. CTR programs typically include improved transportation options, such as ridesharing, flextime, telecommuting, and guaranteed ride home programs, and incentives such as parking management, commuter financial incentives, and TDM marketing programs. Commute trip reduction programs often reduce automobile commutes by 20-40% at a particular worksite.

Parking Management

Parking Management includes a variety of policy reforms and planning practices that encourage more efficient use of existing parking facilities. Table 84 lists various parking management strategies, indicates the typical range of reductions in parking requirements they can provide, and indicates which strategies have also been shown to reduce total vehicle traffic. A comprehensive and cost-effective parking management program can typically reduce parking requirements in an area by 20-40%, and supports other sustainable transportation and land use management strategies.

Table 84. Parking Management Strategies

Strategy	Description	Typical Reduction	Traffic Reduction
Shared Parking	Parking spaces serve multiple users and destinations.	10-30%	
Parking Regulations	Regulations favour higher-value users such as service vehicles, deliveries, customers, quick errands, and people with special needs.	10-30%	
More Accurate and Flexible Standards	Adjust parking standards to more accurately reflect demand in a particular situation.	10-30%	
Parking Maximums	Establish maximum parking standards.	10-30%	
Remote Parking	Provide off-site or urban fringe parking facilities.	10-30%	
Smart Growth	Encourage more compact, mixed, multi-modal development.	10-30%	✓
Walking and Cycling Improvements	Improve walking and cycling conditions to expand the range of destinations serviced by a parking facility.	5-15%	✓
Increase Capacity of Existing Facilities	Increase parking supply by using otherwise wasted space, smaller stalls, car stackers, and valet parking.	5-15%	
Mobility Management	Encourage more efficient travel patterns, including changes in mode, timing, destination, and vehicle trip frequency.	10-30%	✓
Parking Pricing	Charge motorists directly and efficiently for using parking facilities.	10-30%	✓
Parking cash out	Allow commuters who are offered a subsidized parking space to choose its cash equivalent if they use an alternative mode	10-30%	✓
Improve Pricing Methods	Use better charging techniques to make pricing more convenient and cost effective.	Varies	✓
Financial Incentives	Provide financial incentives to shift mode.	10-30%	✓
Unbundle Parking	Rent or sell parking facilities separately from building space.	10-30%	✓
Parking Tax Reform	Tax parking facilities and their use.	5-15%	✓
Bicycle Facilities	Provide bicycle storage and changing facilities.	5-15%	✓
User Information	Provide convenient user information on parking availability and price.	5-15%	✓
Improve Enforcement	Ensure parking regulation enforcement is efficient, considerate, and fair.	Varies	
Transportation Management Assoc.	Establish member-controlled organizations that provide transport and parking management services in a particular area.	Varies	✓
Overflow Parking Plans	Establish plans to manage occasional peak parking demands.	Varies	
Address Spillover Problems	Use management, enforcement, and pricing to address spillover problems.	Varies	
Parking Facility Design and Operation	Improved parking facility design and operations to help solve problems and support parking management.	Varies	

Note: This table summarizes a wide range of parking management strategies, including some described in this report. It indicates the typical reduction in the amount of parking required at a destination, and whether a strategy helps reduce vehicle traffic, thereby also providing congestion, accident, and pollution reduction benefits.

Mobility Management Marketing

Mobility Management Marketing involves various activities to improve consumers' knowledge and acceptance of alternative travel modes, and to provide products that better meet travellers' needs and preferences. Effective marketing programs can significantly increase use of alternative modes, and reduce automobile travel by 5-15%.

The most effective marketing programs promote a variety of travel options rather than just one mode (such as ridesharing or public transit), since this allows consumers to choose the option that best suits their needs. For example, about half of the trips reduced by TravelSmart programs in Vancouver, Portland (Oregon), the UK, Australia, and elsewhere shift to walking, with smaller shifts to cycling, ridesharing, and public transit.[806] Individual mode shifts may appear small, typically consisting of just a few percentage points, but their total impacts are significant, and comparable in magnitude to much more expensive infrastructure improvement programs designed to encourage use of alternative modes.

Transportation Management Associations

Transportation management associations provide services such as rideshare matching, transit information, and parking coordination in a particular area, such as a commercial district or mall. This achieves more efficient use of resources and allows businesses of all sizes to participate in commute trip reduction programs.

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[806] The Greater Vancouver Transportation Authority describes its TravelSmart program (the first of its kind in Canada) in this way: "TravelSmart is an innovative approach to reducing car travel. Many people are interested in using transit, cycling, walking and ridesharing, but may need more information to better use these travel modes. Through a combination of information, incentives, and rewards TravelSmart encourages people to think more about their transportation options and allows them to make more informed travel choices. There are several key principles of TravelSmart:

- *Target interested households*. TravelSmart focuses on households that indicate that they are interested in increasing their use of alternative transportation.
- *Offer personalized support and resources*. Direct contact and individualized information, tailored to meet households' specific travel needs, is an effective means to encourage people to think more about their travel choices.
- *Focus on households*. By focusing on households, TravelSmart addresses the full range of trips originating from home, not just the work commute trip. Participants can start by considering alternative transportation for small trips, close to home.
- *Reward those who already use alternative transportation modes.* Households that already regularly use public transit, cycle or walk are offered a small reward to encourage their continued use of these modes.

This type of individualized marketing program was first developed in the nineties in Munich, Germany by Social data an international transportation and social research institute. The program has since been brought to a number of other countries in Europe as well as Australia and the United States, with great success.

For more details on the Greater Vancouver Transportation Authority's TravelSmart program, see http://www.translink.bc.ca/Plans_Projects/Urban_Showcase/TravelSmart/default.asp. Accessed 27 November, 2006.

Freight Transport Management

Freight Transport Management includes various strategies for increasing the efficiency of freight and commercial transport. This can include improving distribution practices so that fewer vehicle trips are needed, shifting freight to more resource efficient modes (such as from air and truck to rail and marine), improving freight services (particularly of more efficient modes such as marine, rail, and – for small local packages – bicycle), better siting of industrial locations to reduce shipping distances and allow better coordination among industries, improving vehicle operation and implementing fleet management to reduce impacts such as noise and air pollution, and reducing the total volume of goods that need to be transported. Because freight vehicles tend to be large, energy-intensive, and high polluting, a relatively small improvement in freight efficiency can provide significant benefits.

Location Efficient Development and Mortgages

Location Efficient Development consists of residential and commercial development in areas with mixed land use and good transportation choices (walking and cycling conditions, transit, and carsharing services). These features result in reduced automobile ownership and use (10-30% reductions are typical), which provides transportation and parking cost savings to consumers. Location Efficient Mortgages recognize these potential savings in credit assessments, giving home-buyers an added incentive to choose location efficient residences.

School and Campus Transport Management

These programs help overcome barriers to the use of alternative transport modes, and provide positive incentives for reduced driving to schools and to college or university campuses. *School trip management* usually involves improving pedestrian and cycling access, promoting ridesharing, and encouraging parents to use alternatives when possible. *Campus trip management* programs often include discounted transit fares, rideshare promotion, improved pedestrian and cycling facilities, and increased parking fees. These programs often reduce car trips by 15-30%.

Car-sharing

Car-sharing provides affordable, short-term (hourly and daily rate) motor vehicle rentals in residential areas. This gives consumers a convenient and affordable alternative to private ownership. Because it has lower fixed costs and higher variable costs than private vehicle ownership, car-sharing encourages users to limit their vehicle use to those trips in which driving is truly the best option, and use alternative modes as much as possible. Drivers who join such organizations typically reduce their mileage by 40-60%.[807]

[807] For details on car share programs, see http://www.eartheasy.com/live_car_sharing.htm. Accessed 27 November, 2006.

By 2004, the 1,534 members of British Columbia's Co-operative Auto Network (CAN) – a highly successful car-sharing co-operative – shared 81 vehicles, parked at various locations throughout Vancouver and nine other cities in BC. CAN's 1534 members were reported to have taken 1,227 cars off the road, putting just 81 car share vehicles on in return. The average CAN member drives 1,400 km a year, compared to a greater Vancouver average of 6,000 to 24,000 km, producing 10 to 36 times fewer pollutants and greenhouse gases.[808]

Montreal's Communauto has 3,500 members who share 170 vehicles, and Boston's ZipCar has 4,200 members who share 131 vehicles. But carsharing originated in Europe. In Switzerland, Mobility Car Sharing, a professionally-run country-wide service with 65,000 customers who share 1,700 vehicles in 390 communities, is growing by 7,500 customers a year. In 1991, five European car sharing companies formed the umbrella organization, European Car Sharing (ECS). Since then the membership has grown 50% to 60% annually. Today ECS has 40 groups with members in 550 towns in Denmark, Germany, Italy, Norway, and Switzerland.

Transit Improvements

There are many ways to improve public transit service and encourage transit ridership, including additional routes, expanded coverage, increased service frequency, and longer hours of operation; HOV (high occupancy vehicle) priority; comfort improvements; reduced and more convenient fares; improved rider information and marketing programs; Transit Oriented Development (TOD – which results in land use patterns more suitable for transit); improved security; and special event services.

Non-Motorized Transport Improvements

Pedestrian and bicycle improvements are important for developing a more balanced transportation system. Residents of communities with good walking and cycling conditions drive less and use transit and rideshare options more. There are many specific methods for accommodating and encouraging non-motorized transport, including improvements to sidewalks, trails and paths, street crossings, and bicycle parking facilities.

Traffic Calming and Traffic Speed Reductions

Traffic Calming includes various strategies to reduce traffic speeds and volumes on specific roads. Typical strategies include traffic circles at intersections, speed bumps, sidewalk bulbs that reduce intersection crossing distances, raised crosswalks, and partial street closures to discourage short-cut traffic through residential neighbourhoods. Traffic Speed Reductions include a variety of design, enforcement, and education programs to reduce vehicle traffic speeds. This increases road safety and community liveability, creates a more pedestrian- and bicycle-friendly

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[808] Dauncey, Guy, "Car Sharing in Vancouver," *Earth Future*, May, 2004. Available at http://www.earthfuture.com/community/carsharevancouver.asp. Accessed 27 November, 2006.

environment, and can reduce automobile use, particularly when matched with other TDM measures.

Road Space Reallocation

Road Space Reallocation involves shifting more road space to specific transportation activities like transit use or bicycle lanes, and managing roadways to encourage more efficient and equitable transportation. Road Space Reallocation often involves trade-offs between convenient automobile parking and improved mobility by alternative modes. Reallocating urban arterial parking lanes to transit, HOV, or cycling lanes, or increased sidewalk space, tends to help achieve equity and efficiency objectives by improving mobility options for non-drivers and encouraging travellers to shift from automobile use to more space-efficient modes such as transit, ridesharing, cycling, and walking.

Concluding Remarks

This study investigates the overall sustainability of Nova Scotia's transport system. It indicates that many trends are leading away from sustainability. Per capita vehicle travel, traffic accidents, consumer expenditures on transportation, energy consumption, pollution emissions, and land use sprawl are all high and either steady or increasing, while transportation options for non-drivers are declining. The study's full-cost accounting exercise indicates that Nova Scotians bear far higher transportation costs than is conventionally acknowledged, and that many of these costs are external (not borne by users), which is economically inefficient and inequitable.

There are also positive trends and opportunities manifesting throughout Canada, like Vancouver's TravelSmart and car-share programs noted above, from which Nova Scotia can learn. Changing consumer preferences and planning practices are beginning to support more sustainable transport and land use patterns. These include urban redevelopment, growing consumer preference for more accessible residential locations, improved walking and cycling conditions, reinvestment in public transit, and various programs that encourage use of alternative transport modes. Some communities are demonstrating that it is possible to improve transportation options, redevelop urban neighbourhoods, increase use of alternative transport modes, and reduce driving in ways that benefit consumers.

Although few Nova Scotians want to give up automobile travel altogether, at the margin (compared with their current travel patterns), many would prefer to drive less and rely more on alternative transport modes, provided that they are convenient, comfortable, and safe to use.

This is good news. It indicates that appropriate policies can create a more sustainable transportation system which better satisfies people's needs, and supports a wide range of economic, social, and environmental goals.

This report provides specific recommendations for improving transportation system efficiency and equity. We identify approximately two dozen specific and proven Win-Win Transportation

Solutions, which are cost-effective, technically feasible, market reforms that help solve transportation problems by increasing consumer options and removing market distortions. The available evidence indicates that these strategies can be the basis for a truly sustainable transportation system. If implemented, more residents would choose to drive less, rely more on alternative transport modes, and be better off overall as a result. By enumerating and quantifying the impacts and costs of driving, this GPI study demonstrates that such a reduction in driving would provide a wide range of economic, social, and environmental benefits.

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APPENDICES

APPENDIX A - THE KYOTO PROTOCOL

In 1992, various countries around the world signed the United Nations Framework Convention on Climate Change (UNFCCC) to help deal with global climate change. Over 175 states have ratified and so are legally bound by the convention, which took effect on 21 March, 1994. The goal of the convention is to stabilize greenhouse gases in the atmosphere at concentrations that would "prevent dangerous anthropogenic interference with the climate system."[809] In other words, the convention aims to ensure that human production of greenhouse gases is confined to a level that does not threaten to cause serious harm to human society and the biosphere.

The UNFCCC permits countries to weaken or strengthen the treaty to reflect scientific advances, and it encourages countries to agree to more specific actions, such as reducing emissions of greenhouse gases by a given amount. Countries make these commitments by adopting "protocols" to the convention, of which the 1997 Kyoto Protocol is the most important to date. The Kyoto Protocol shares the principles of the UNFCCC but contains new resolutions that are stronger and more detailed than those set out in the convention. The protocol's complexity reflects the difficulty the world has in controlling its greenhouse gas emissions, and also the various political and economic interests that are affected by the Kyoto agreement.[810]

The Kyoto Protocol only became legally binding after at least 55 states (including developed countries which together account for at least 55% of 1990 CO_2 emissions produced by the industrialized world) ratified it. With the 2005 accession of the Russian Federation, the percentage of emissions accounted for reached 61.6%, crossing the 55% threshold and allowing the protocol to come into force. The notification to the United Nations by the Russian Federation caused the protocol to enter into international law on February 16, 2005.[811] Unfortunately, the largest global emitter of GHGs, the United States, has refused to ratify the protocol.

Unlike the 1992 convention, the Kyoto Protocol sets explicit targets for greenhouse gas reductions for the countries that have ratified it. Kyoto sets an overall target of reductions to 5.2% below 1990 levels, averaged over a four-year commitment period from 2008-2012, for all developed countries. However, each country within that group of developed countries has different reduction targets, so that some states must reduce emissions by more than 5.2%, while others can maintain or even increase emissions above their 1990 levels. Thus the European Union must reduce its emissions to eight per cent below 1990 levels, Canada to six per cent below 1990 levels, and Russia to zero per cent (meaning Russia must not exceed its 1990 emissions levels). Meanwhile Iceland, for example, may increase its emissions to 10 per cent above 1990 levels.[812]

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809 United Nations Framework Convention on Climate Change. *United Nations Framework Convention on Climate Change*: Article 2. (1992). http://unfccc.int/resource/conv/conv.html Accessed July, 2004.

810 United Nations Environment Programme. Understanding Climate Change: A Beginner's Guide to the UN Framework Convention and its Kyoto Protocol. (1999). www.unep.org/dec/docs/info/ccguide/beginner-99.htm Accessed June, 2004.

811 Associated Press. "Russia Formally Accedes to Kyoto Protocol." (Nairobi: November 18, 2004).

812 United Nations Framework Convention on Climate Change. *Kyoto Protocol to the United Nations Framework Convention on Climate Change*, p. 23. (1997). http://unfccc.int/resource/docs/convkp/kpeng.pdf Accessed July, 2004.

The Kyoto Protocol also includes suggested mechanisms for countries to meet their targets, and outlines acceptable methods on how to reduce emissions. For example, Article 2 of the protocol states that "in order to promote sustainable development," each country should implement policies such as:

(i) Enhancement of energy efficiency in relevant sectors of the national economy;
(ii) Protection and enhancement of sinks and reservoirs of greenhouse gases not controlled by the Montreal Protocol, taking into account its commitments under relevant international environmental agreements; promotion of sustainable forest management practices, afforestation and reforestation;
(iii) Promotion of sustainable forms of agriculture in light of climate change considerations;
(iv) Research on, and promotion, development and increased use of, new and renewable forms of energy, of carbon dioxide sequestration technologies, and of advanced and innovative environmentally sound technologies;
(v) Progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors that run counter to the objective of the Convention and application of market instruments;
(vi) Encouragement of appropriate reforms in relevant sectors aimed at promoting policies and measures which limit or reduce emissions of greenhouse gases not controlled by the Montreal Protocol;
(vii) Measures to limit and/or reduce emissions of greenhouse gases not controlled by the Montreal Protocol in the transport sector; and
(viii) Limitation and/or reduction of methane emissions through recovery and use in waste management, as well as in the production, transport and distribution of energy.[813]

The protocol permits emissions trading, which allows countries that meet and exceed their required reductions to sell "emissions credits" to countries that cannot meet their required reductions. It also allows for joint implementation projects, where states can invest in greenhouse gas abatement projects in other countries and count those reductions towards reaching their own targets.

Many international organizations emphasize the importance of the Kyoto Protocol as an important first step in combating climate change. Indeed, the inclusion of explicit emissions targets, and the ability to punish countries that do not reach their targets, are seen as fundamental elements in effectively reducing the global emissions of GHGs. Compliance is monitored by a Compliance Committee that determines whether countries have met their emissions targets or reporting requirements. If a country fails to meet its emissions reductions targets, it must make up the difference in the next commitment period, plus an additional deduction of 30%. The country will also not be allowed to make transfers under emissions trading and is required to develop a compliance action plan to ensure that it will meet its targets in the next commitment period.[814]

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[813] Ibid., p. 2.
[814] United Nations Framework Convention on Climate Change. Compliance under the Kyoto Protocol. http://unfcc.it/kyoto_mechanisms/compliance/items/3024.php Accessed April 18, 2006.

Despite these measures, there are some important criticisms being levelled at the protocol. Non-ratification of the protocol by the United States severely limits the scope of the accord, since the US is the world's largest producer of greenhouse gases, accounting for 24% of global emissions.[815] Furthermore, the global 5.2% reduction the protocol calls for can only be considered a first step, since global emissions must be reduced by a much greater amount to achieve a stabilization of the Earth's climate. According to the Intergovernmental Panel on Climate Change, for emissions to stabilize at 450 ppm (parts per million), 650 ppm, or 1000 ppm, global anthropogenic CO_2 emissions would need to be reduced to below 1990 levels within decades, a century, or two centuries respectively and continue to decline thereafter. Even with such drastic cuts, the planet's climate would continue to respond to past emissions well into the 22nd century.[816]

Given predictions of the potentially catastrophic consequences of climate change, why are some countries not ratifying the Kyoto Protocol, or not taking the necessary steps to reach emissions targets? As the American philosopher Stephen M. Gardiner points out, trying to motivate global action on environmental issues can be very challenging. Gardiner emphasizes the "intergenerational problem"—the difficulty of making decisions on issues where the impacts will be felt not by society today, but primarily by future generations. There is very little incentive to change our behaviour, Gardiner writes, if we will not experience the consequences of those changes ourselves—and more importantly, if we will not feel the effects of neglecting to change.

In Gardiner's view, the Kyoto Protocol "does little to protect future generations. On the contrary, it seems—at best—to be a prudent wait-and-see policy for the present generation, narrowly defined."[817] Because the people who have the most power to change the world's approach to climate change stand to gain the least from environmental protection in the short term, so are not invested in doing so, those who stand to gain the most (like Bangladesh, Tuvalu and other states particularly vulnerable to sea level rise) have little or no say in global decision-making.

What Gardiner's article points to is the need for a certain level of altruism and ethical responsibility in making decisions about the environment, above and beyond the political and economic factors that play a large part in any global initiative. Central to this approach is the concept of sustainable development, which underpins the work of **GPI***Atlantic*.

Sustainable development requires the recognition that the world has finite natural resources and a limited regenerative capacity, including a limited ability to absorb wastes generated from anthropogenic sources. This knowledge must be used to guide the global approach to climate change so that, in the words of the World Commission on Environment and Development, we cease "compromising the ability of future generations to meet their own needs."[818]

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[815] Fischlowitz-Roberts, Bernie. Carbon Emissions Climbing. (Earth Policy Institute, 2002). www.earth-policy.org/Indicators/indicator5.htm Accessed January, 2005.

[816] Houghton, J.T., Y. Ding, D.J. Griggs, Noguer, P.J. van der Linden, X. Dai, K. Maskell and C.A. Johnson. *Climate Change 2001: The Scientific Basis*, p. 17. (Cambridge: Cambridge University Press, 2001). www.grida.no/climate/ipcc_tar/wg1/pdf/WG1_TAR-FRONT.PDF Accessed July, 2004.

[817] Gardiner, Stephen M. "The Global Warming Tragedy and the Dangerous Illusion of the Kyoto Protocol." (*Ethics & International Affairs*. Winter, 2004. 18: 1). www.carnegiecouncil.org/viewMedia.php/prmTemplateID/5/prmID/1121

[818] World Commission on Environment and Development. (1987).

APPENDIX B - METHOD FOR CALCULATING LAND AREA USED BY AUTOMOBILES

Area of Roads:

1) Area of Roads = Road Width (0.012 km) x Road Length
2) Area of Highways = Highway Width (0.021 km) x Highway Length
3) Total Area of Roads = Area of Roads + Area of Highways

Estimated Area of Parking:

1) Size of Fleet x 3 parking spaces/vehicle x 30 m^2/parking space

The estimate of an average three parking spaces per vehicle is from the Earth Policy Institute and reflects average parking requirements at home, work, shopping and commercial districts, schools, on the street, etc. This estimate does not include mulit-level or underground parking area.

Total Area Consumed by Cars = Area of Land used for Roads + Area of Land used for Parking

Sources of Data:

1) Road Lengths—Transport Canada Annual Reports (note: numbers are inconsistent)
2) Road Widths— Kind, Vanessa. *Measuring Progress Towards Sustainable Transportation*. (Halifax: Dalhousie University, 2001. Unpublished thesis
3) Size of Vehicle Fleet—Canadian Vehicle Survey (1999-2003); Road Motor Vehicle Registration (1997-1998)
4) Method of Calculation—Earth Policy Institute (http://earth-policy.org/Alerts/Alert12_data3.htm)

APPENDIX C - THE NOVA SCOTIA GENUINE PROGRESS INDEX: LIST OF COMPONENTS

Time Use:
- Economic Value of Civic and Voluntary Work
- Economic Value of Unpaid Housework and Childcare
- Work Hours
- Value of Leisure Time

Natural Capital:
- Soils and Agriculture
- Forests
- Marine Environment/Fisheries
- Energy
- Air
- Water

Human Impact on the Environment:
- Greenhouse Gas Emissions
- Sustainable Transportation
- Ecological Footprint Analysis
- Solid Waste

Living Standards:
- Income and its Distribution
- Debt and Assets
- Economic Security Index

Social Capital:
- Population Health
- Educational Attainment
- Costs of Crime