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"Efficiency - Equity - Clarity"

Induced Travel Impact Evaluation

Evaluating Impacts Of Increasing Roadway Capacity To The Island of Montreal

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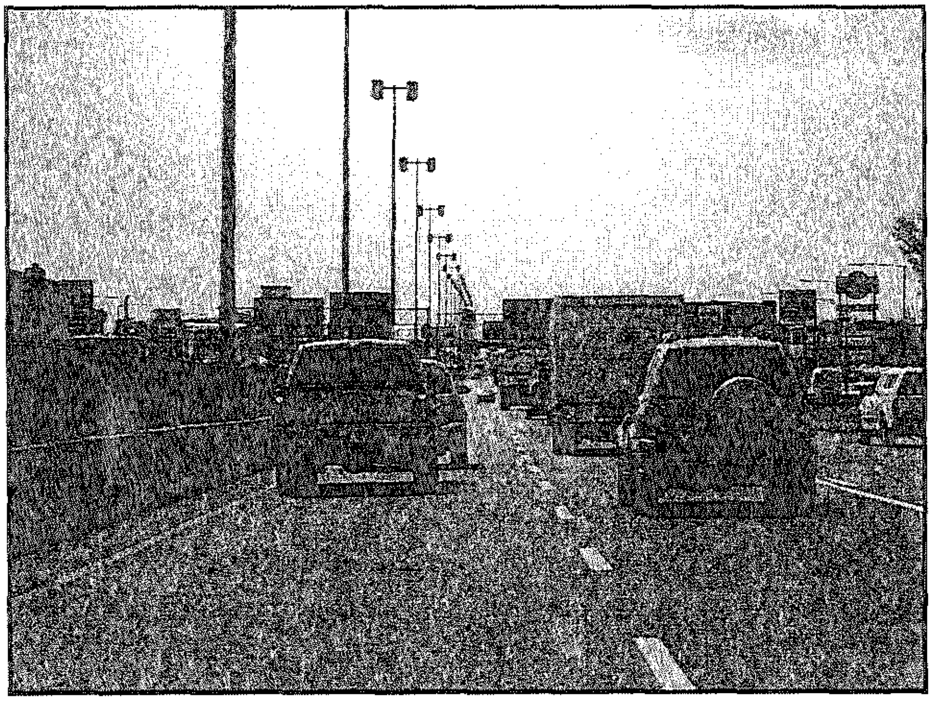


Summary

This report summarizes the types of impacts that are likely to result from increased roadway capacity on Highway 25, between Laval and the Island of Montreal. This study investigates the likely "generated" and "induced" travel effects of increasing urban highway capacity, that is, the additional vehicle travel that would result from this project. It describes the economic, social and environmental impacts that result from induced travel. It discusses the degree to which conventional planning accounts for these induced travel effects. It also describes possible alternative strategies for improving mobility in the Montreal area.

Defining Generated and Induced Travel

In recent years transportation planners, modelers and economists have developed better techniques for evaluating the full effects of transport planning decisions. One issue of concern is the tendency of highway expansion to *generate traffic* (increase peak-period vehicle travel on a particular stretch of road), which consists of *diverted travel* (shifts in time and route) and *induced travel* (increased total motor vehicle travel), as summarized in Table 1. In some situations, highway expansion also stimulates sprawl (automobile-dependent, urban fringe land use), further increasing per capita vehicle travel.

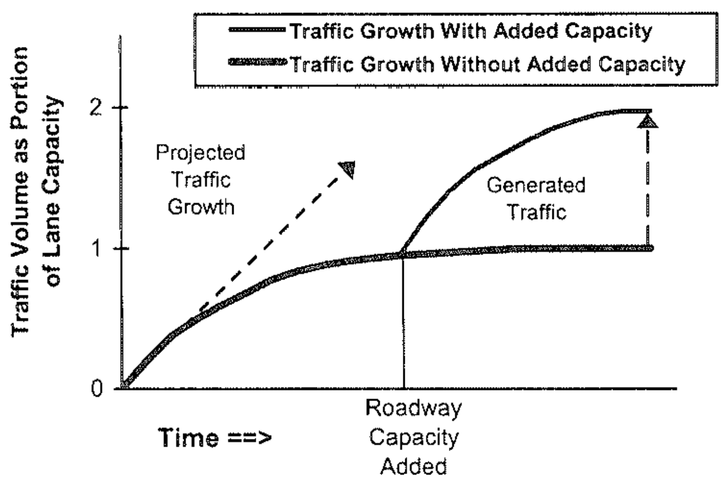
Table 1 **Types of Generated Traffic and Induced Travel** (based on Litman, 2001)

Type	Category	Cost Impacts
Route Change Improved road attracts drivers from other roads.	Diverted trip	Mixed. Depends on conditions
Time Change Reduced peak period congestion attracts off-peak trips.	Diverted trip.	Slight increase
Mode Shift Improved traffic flow attracts travel from other modes.	Induced vehicle travel	Moderate to large increase
Destination Change; Existing Land Use Improved access allows drivers to choose farther destinations.	Induced travel	Moderate to large increase
Destination Change; Land Use Changes Improved access stimulates urban fringe development.	Induced travel	Moderate to large increase
New Trip Improved travel conditions encourage more vehicle trips.	Induced travel	Large increase
Automobile Dependency Synergetic effects of increased vehicle travel and sprawl.	Induced travel	Large increase

This table categorizes types of generated traffic.

Figure 1 illustrates this pattern. Traffic volumes grow until congestion develops, then the growth rate declines and achieves equilibrium, indicated by the curve becoming horizontal. If capacity is added peak-period vehicle traffic increases again.

Figure 1 **How Increased Road Capacity Generates Traffic** (SACTRA, 1994; Litman, 2001)



Where congestion constrains vehicle travel, expanding road capacity will increase peak-period traffic, and often induces an overall increase in vehicle travel.

Induced travel reflects the *price elasticity of travel*, that is, the tendency of travel to increase when its generalized cost (time and financial costs to users) declines. To the degree that roadway improvements make driving cheaper, faster or easier, people tend to make more and longer vehicle trips. The amount of traffic generated by a roadway expansion project, and the portion of generated traffic which consists of induced travel, tends to grow over time, particularly if it stimulates land use changes such as more dispersed urban fringe development.

Roadway capacity expansion does provide benefits, but generated traffic affects the nature of these benefits. It means that benefits consist more of increased peak-period mobility and less of congestion reductions. Accurate transport planning and project appraisal must consider these factors:

1. Generated traffic reduces the predicted congestion reduction benefits of road capacity expansion.
2. The additional travel generated provides relatively modest user benefits, since it consists of marginal value trips (travel that consumers are most willing to forego).
3. Generated and induced vehicle travel increases the following mileage-related costs:
    - *Downstream traffic congestion* – additional traffic congestion on other roads, such as when increased highway capacity increases traffic congestion on surface streets.
    - *Barrier effect* – delays to pedestrians and cyclists due to wider roads and increased vehicle traffic volume and speed. This is particularly large in urban areas.
    - *Parking costs* – additional parking congestion due to increased demand, and costs to businesses and governments when they are forced to increase parking supply.
    - *Urban sprawl* – low-density, automobile-oriented urban fringe development.
    - *Traffic crashes* – per capita traffic crashes.
    - *Air pollution emissions* – per capita vehicle emissions.
    - *Energy consumption* – per capita energy consumption.

Failing to consider all of these factors can significantly affect transport planning decisions. Experts conclude, "*...the economic value of a scheme can be overestimated by the omission of even a small amount of induced traffic. We consider this matter of profound importance to the value-for-money assessment of the road programme*" (SACTRA, 1994). And "*...quite small absolute changes in traffic volumes have a significant impact on the benefit measures. Of course, the proportional effect on scheme Net Present Value will be greater still*" (Mackie, 1996). Ignoring even one of these factors will often change the ranking of various transport improvement options. In particular, ignoring generated and induced travel impacts tends to exaggerate the benefits of roadway capacity expansion and understate the benefits of alternative projects and programs that result in more efficient use of existing roadway capacity.

Evidence of Induced Travel

Perhaps the best evidence of generated and induced travel is to simply observe how people make travel decisions. We often evaluate travel distances based on time rather than kilometres. For example, somebody may describe a location as "twenty minutes from downtown." As travel speeds increase people tend to choose more distant destinations and drive more kilometers. Conversely, when congestion reduces traffic speeds people tend to choose closer destinations and reduce their vehicle kilometers. A significant portion of vehicle travel is discretionary, either because the trip itself is not essential or because it can be shifted to other times, destinations or modes. For example, you might consider driving across town to visit a shop, restaurant or friend, if congestion is modest, but forego the trip if congestion is significant. Thus, increasing roadway capacity allow these *latent demand* vehicle trips, inducing additional vehicle travel.

During the last decade researchers have developed abundant evidence that under certain conditions roadway capacity expansion induces measurable amounts of additional vehicle travel (see reviews in Goodwin, 1996; Cervero and Hansen, 2000; Litman, 2001; Noland and Lem, 2002).

Several factors affect the amount of travel induced by a particular roadway project:

- Level of congestion and latent demand (that is, how many trips could be made on that corridor if conditions were less congested).
- Degree to which the project reduces congestion and improves vehicle travel conditions.
- The degree to which the highway increases access to potentially developable land.
- The time period analyzed (the amount of travel induced by a project tends to increase over time, and may take many years to fully occur).
- Population and employment growth rates.
- Quality of travel alternatives on the corridor, including other roads and modes.

For example, adding lanes on an uncongested rural highway generally induces little additional travel, but adding lanes on a congested urban highway often induces significant additional vehicle travel by reducing travel costs and stimulating sprawl (dispersed, automobile-dependent, urban fringe development). This sprawl tends to increase per capita vehicle travel in an area. If some residents would otherwise choose less sprawled housing locations, their additional per capita vehicle travel can be considered to be induced by the roadway capacity expansion.

Few transportation modelers, planners or economists question the existence of generated traffic, but there is debate over its magnitude and overall effects. Some argue that induced travel effects are small compared with other factors that increase travel demand, such as population and economic growth. Some argue that roadway capacity expansion provides significant net benefits regardless of generated traffic. It is therefore necessary to develop economic evaluation techniques that take into account all positive and negative impacts.

Evaluating Induced Travel Impacts

Transportation modelers and economists have developed techniques for evaluating the travel impacts, benefits and costs of generated traffic and induced travel (Litman, 2001). Older transportation models use *fixed trip tables* which assume that the number of trips between zones is constant regardless of the roadway capacity and degree of congestion between them. Newer models use *variable trip tables* which recognize that increased road capacity tends to increase the number of trips between zones. *Integrated transportation/land use models* also account for land use changes that result from improved accessibility, such as the location of new development.

Evaluating induced travel requires determining the *base case*, that is, what would happen if a policy or project is not implemented. For example, the induced travel of a roadway project is the additional travel that would not otherwise occur if the project is not implemented. It is usually best to compare the base case with several options, which might include various roadway improvements, transit improvements and mobility management programs.

Once these incremental travel effects are determined their full economic impacts can be calculated, including effects on congestion (congestion often returns within a few years due to generated traffic), the incremental consumer benefits from the additional mobility,[1] and any incremental costs resulting from induced vehicle mileage, such as downstream congestion, parking demand, barrier effects, pollution emissions, energy consumption and sprawl. This analysis should project at least two decades into the future, since some of these effects are long-term and durable.

Roadway capacity expansion can provide various benefits, but these should be evaluated carefully. For example, increased capacity can reduce congestion, and new shortcuts can reduce travel distances, reducing energy consumption and pollution emissions. However, these are generally temporary effects offset over time by induced vehicle travel. Similarly, congestion tends to increase crash frequency but reduces crash severity (due to reduced traffic speeds), so roadway capacity expansion may reduce *crash rates* but increase *casualties rates* (injuries and fatalities), particularly over the long term as total per capita vehicle travel increase.

Analysis is affected by whether impacts are measured *per vehicle-kilometer* or *per capita*. Roadway capacity expansion projects often reduce per-kilometer energy consumption, emission and crash rates, particularly during their first years when congestion is reduced. Impacts should generally be evaluated *per capita* rather than *per vehicle-kilometer*, so they can be compared with other costs and risks. For example, roadway capacity expansion may reduce traffic crashes per 100 million vehicle-kilometers, but increase crashes per capita by stimulating more and faster vehicle travel. Per capita measurements allow this risk to be compared with other public health risks.

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[1] The value of these benefits can be calculated using a technique called "the rule of half," which states that the consumer surplus can be estimated by multiplying the additional travel (in kilometers) by the average reduced costs (in dollars per kilometer) and dividing the total by half, as discussed in *Litman, 2001*.

Evaluating Land Use Impacts

It is important to evaluate the land use effects of roadway capacity expansions. These impacts can be quantified using integrated transportation/land use models, or simply by consulting a variety of local experts to determine how they believe a particular transport project or program is likely to affect development patterns, and the degree to which this reflects the location and type of development that the community wants. It is also useful to evaluate local effects, such as the impacts that transportation facilities will have on the neighborhoods where they are constructed.

For example, if a regional strategic plan emphasizes the value of smart growth, infill development and urban containment; and if local community plans emphasize urban redevelopment and creating more walkable, multi-modal neighborhoods; then specific transport projects and programs can be evaluated according to whether they support or contradict these objectives.

In the past, urban highway projects have contributed significantly to sprawl (low-density, automobile-oriented, urban fringe development). Because destinations are dispersed and there are few travel alternatives, people who live and work in such areas tend to drive significantly more annual kilometers than residents of more compact and multi-modal communities ("Land Use Impacts on Transport," VTPI, 2005). To the degree that a highway project stimulates sprawl it can be considered to leverage additional vehicle travel, which is a form of induced travel.

Conversely, just as highway capacity expansion can leverage land use changes that increase per capita vehicle travel, transit improvements (and probably some other mobility management strategies) tend to leverage land use changes that reduce vehicle travel by helping to create more compact, mixed communities where residents own fewer cars and are walk for more local errands (Litman, 2005).

Some land use impacts can be quantified by projecting incremental differences in per capita vehicle travel, per capita pavement area, and various additional infrastructure costs associated with sprawl. Dispersed, urban fringe development tends to increase the costs of providing utilities, road and parking facilities, school transportation, consumer transportation, and various other public services (Burchell, et al., 1998; Ewing, Pendall and Chen, 2002; Litman, 2004). However, care is needed to accurately define the base case, that is, the land use patterns and household location decisions that would occur without the proposed project. For example, restrictions on urban fringe development may cause some households to move even farther into rural areas, or even to move to other cities with low density development patters.

Safety and Health Impacts

There are several public safety and health impacts affected by transportation planning decisions (Litman, 2003; "Health and Fitness," VTPI, 2005).

Increased vehicle travel and sprawled land use patterns tend to increase per capita traffic casualties (injuries, disabilities and deaths), because there is more driving at higher speeds, and higher-risk drivers (such as teenagers and seniors) drive more since they have fewer travel options. Traffic accidents are a leading cause of death and disability for people in the prime of life, and so cause a large reduction in Potential Years of Life Lost (PYLL) and Disability Adjusted Life Years (DALYs), and lost productivity. Per capita traffic fatality rates increase with per capita vehicle mileage, and automobile-oriented, sprawled communities have much higher per capita traffic fatality rates as transit oriented communities (Ewing, Pendall and Chen, 2002).

A second health risk results from vehicle emissions. Many factors affect the human health impacts of vehicle pollutants, including emission rates per vehicle mile, per capita mileage, and exposure (the number of people located in areas where emissions are concentrated). Increased automobile travel tends to increase per capita vehicle emissions, although higher density land use patterns and increased congestion may increase people's exposure to certain harmful emissions (those that have localized risks, such as CO and air toxics). Motor vehicle air pollution probably causes a similar order of magnitude of premature deaths as traffic crashes, although air pollution deaths tend to involve older people and so cause relatively smaller reductions in Potential Years of Life Lost or Disability Adjusted Life Years.

A third category of health impacts concerns the effects that transport planning can have on physical activity and fitness. In recent years, public health officials have become increasingly alarmed at declining physical fitness, excessive body weight, and resulting increases in diseases associated with a sedentary lifestyle among the general population. About ten times as many people die of these diseases than in vehicle crashes, although those deaths tend to involve older people.

There are many ways to be physically active, but many, such as sports or exercising in a gym require special time, money and skill, which discourages most people from participating regularly over their full lifetime. Many experts believe that more *Active Transport* (walking and cycling, and their variants such as running and skating, also called *Nonmotorized Modes* and *Human Powered Transport*) is the most practical and effective way to improve public fitness. Active transport is declining in most developed countries. Various studies suggest that policies that improve walking and cycling conditions, encourage active transportation, and create more multi-modal communities can increase public fitness and health (Frank, 2004).

All three of these health risk tend to increase with per capita vehicle travel. To the degree that a particular highway capacity expansion project increases per capita vehicle travel and stimulates sprawled development patterns it tends to increase these health problems.

Evaluating This Project

It is not possible to predict exactly how much traffic will be generated and how much travel will be induced by the proposed Highway 25 project based just on available information. However, this project has several attributes which suggest that these effects will be significant, particularly over the long term.

This project is located on a busy corridor with considerable latent travel demand, that is, potential trips currently constrained by traffic congestion. Increasing highway capacity will allow some vehicle trips to shift from off-peak to peak or from other routes. In addition, this route will improve access to suburban and semi-rural areas north of Montreal, which is likely to stimulate more sprawl. As a result of these factors, within a few years the highway is likely to be congested and there will be more total vehicle-kilometers of travel in the area.

By creating a new barrier to pedestrian and cycling traffic along its route, and adding more vehicle traffic to surface streets, this project is also likely to degrade nonmotorized travel conditions. Since most public transit trips include walking links, this can also reduce public transit ridership.

This is not to say that this project would provide no benefits. As a highway improvement and shortcut it will reduce travel times, traffic congestion and operating costs for some trips. During the short term (its first few years) it may reduce total vehicle mileage, traffic congestion on parallel roadways, and truck traffic on city streets. The increased mobility provided by this project will benefit people who want to make more peak-period vehicle trips, such as households that may be able to choose a home farther from Montreal than would otherwise be possible. Reduced congestion can improve public transit bus service speeds and reliability, and reduce bus operating costs. But many of these benefits are likely to be offset over the long run by induced vehicle travel and urban sprawl.

There are two questions to consider when evaluating the Autoroute 25 project. First is whether this project is cost effective, that is, its benefits exceed its costs. The second is whether it is more cost effective than other possible transportation improvement options. It is therefore important to consider a full range of alternative improvements and compare them with this project in terms of return on investment, benefit/cost ratios and net benefits. Although this project will affect a relatively small portion of total vehicle travel in the region (at best, by providing a shortcut it will shorten a small portion of regional trips) it represents a significant portion of transportation investments in the region. It is therefore important to ask whether this money could be used in other ways that better support overall regional transportation and land use planning objectives.

Alternative Solutions

There may be other possible ways of improving mobility and accessibility in the Montreal region that avoid the negative impacts of generated and induced travel. These involve improving transport alternatives such as *public transit* and *ridesharing*, and providing incentives to encourage more efficient use of existing roadway capacity. These strategies can benefit both those who change their travel patterns, and people who continue driving, who benefit from reduced traffic and parking congestion. Improving travel options on a corridor tends to reduce roadway congestion by encouraging travelers to shift from driving to alternative modes. As roadways reach capacity, even a small percentage shift can provide significant congestion reduction benefits.

There are many possible ways of improving public transit service on this corridor, by improving bus and ridesharing more convenient and attractive. Below are some specific strategies for improving transit service and increasing ridership ("Transit Encouragement," VTPI, 2005).

- Provide grade separated transit and transit priority traffic control systems.
- Increase service coverage, frequency, reliability, and rider comfort.
- Improve *user information*, including guides, maps and real-time vehicle information.
- Improve access to stations and stops, with better walking conditions, park & ride lots, etc.
- Reduce fares and offer bulk discounts for groups such as students and employees.
- Implement personalized marketing programs.

By themselves these improvements and incentives will probably cause a small to moderate shift from automobile to transit. Larger shifts generally require additional support and incentives to encourage discretionary travelers (people who have the option to drive or use other modes) to change their travel patterns, including commute trip reduction programs at worksites, commuter financial incentives such as *parking cash out* (employees who are offered subsidized parking may choose to receive its cash equivalent instead), parking pricing, road pricing, pay-as-you-drive vehicle insurance and registration fees (premiums and fees are prorated by mileage) transit oriented development (housing and worksites located near transit stations), pedestrian and cycling improvements, carsharing, and marketing campaigns (VTPI, 2005).

These programs and incentives provide a variety of benefits, including congestion reduction, road and parking cost savings, consumer cost savings, reduced crashes, improved mobility for non-drivers, reduced energy consumption and pollution emissions, improved public health, and support for strategic land use objectives (such as urban redevelopment and reduced sprawl). Although their individual impacts may appear small, usually affecting just a few percent of total vehicle travel, the total benefits of an integrated program can be large, often repaying their costs many times over.

Evaluation Checklist

The following are factors that should be considered when evaluating this project ("Comprehensive Transport Planning," VTPI, 2005).

- Benefits from reduced vehicle mileage (since it is a shortcut).
- Benefits from reduced congestion on this highway and parallel roads, taking into account the effects of generated traffic and the tendency of this benefit to decline over time.
- Consumer surplus benefits from increased mobility (calculated using the *rule-of-half*).
- Impacts of downstream congestion, as increased highway capacity increases traffic on surface streets.
- Parking and roadway facility costs, as increased vehicle trips add parking demand and traffic on other roads.
- Barrier effect impacts of the highway and increased vehicle traffic on surface streets on the mobility and safety of walking and cycling.
- Effects of induced travel on per capita traffic accidents.
- Effects of induced travel on per capita energy consumption and pollution emissions.
- Environmental and aesthetic impacts of the project.
- Congestion and other negative impacts during project construction.
- Effects of this project on land use patterns, and whether these support or contradict regional and local land use planning objectives, such as minimizing sprawl and encouraging urban redevelopment.
- Effects of this project on the amount of walking and cycling that occurs in the area, and the associated public health impacts.
- The net benefits (total benefits minus total costs) of this project compared with other possible ways of improving transportation in the region, and whether other strategies may be more cost effective and beneficial overall.

Conclusions

This report provides an overview of generated traffic and induced travel, and how these factors can be considered in transport project evaluation. *Generated traffic* refers to additional peak period travel on a particular roadway resulting from capacity expansions. A portion of generated traffic consists of travel shifted from other times and routes. *Induced travel* refers to an increase in total vehicle travel resulting from a roadway improvement due to shifts from other modes, and longer and more frequent trips.

Conventional planning often causes self-fulfilling prophecies: roadway capacity is expanded to accommodate projected growth, the added capacity fills with generated traffic, this stimulates more vehicle ownership and automobile-oriented land use. If roadways are not expanded and resources are invested in mobility alternatives, traffic growth will be reduced and more multi-modal transportation and land use patterns will be created.

Generated traffic and induced travel can have significant impacts on the benefits of a highway project. They tend to change the nature of roadway capacity expansion benefits from congestion reduction to increased mobility, and increase various costs, including downstream congestion, road and parking facility costs, barrier effects on nonmotorized travel, crashes, pollution emissions and sprawl. By stimulating dispersed, urban fringe development, highway capacity expansion can induce vehicle travel indirectly, and have other undesirable land use impacts.

This is not to suggest that highway capacity expansion provides no benefits and should never be implemented, but it suggests that the full, long term benefits and costs of urban highway projects should be carefully evaluated and compared with alternative transportation improvement options which may avoid generated traffic and induced travel impacts, and so provide greater total benefits.

This paper does not attempt a detailed evaluation of the Autoroute 25 project. It simply identifies factors that should be considered in such an evaluation. Because that project would increase capacity and reduce travel costs in a congested urban area, it is likely that it will generate significant amounts of traffic, induce more vehicle travel, and stimulate urban sprawl. As a result, it is important that these factors be considered in project evaluation.

Transportation improvement strategies that encourage more efficient use of existing roadway capacity, by improving travel options and giving discretionary travelers incentives to use alternative modes for some trips, can also reduce congestion on this corridor and provide additional benefits in terms of reduced downstream congestion, reduced parking costs, improved mobility for non-drivers, reduced per capita crashes and pollution emissions, and support for strategic land use objectives. These options should be considered for implementation as possible ways to defer, reduce or avoid the Autoroute 25 project.

About the Author

Todd Litman is founder and executive director of the Victoria Transport Policy Institute, an independent research organization dedicated to developing innovative solutions to transport problems. His research is used worldwide in transport planning and policy analysis.

Todd has written or co-written numerous guides and technical manuals dealing with transport and land use planning issues. His article, "Generated Traffic: Implications for Transport Planning," was the first article on this subject published in the *ITE Journal*. It has been widely cited by transportation professionals.

Mr. Litman is author of the *Online TDM Encyclopedia*, a comprehensive Internet resource for identifying and evaluating mobility management strategies. He has worked on numerous studies that evaluate the costs and benefits of various transportation services and activities. He authored *Transportation Cost and Benefit Analysis: Techniques, Estimates and Implications*, a comprehensive study of transport impacts, which provides cost and benefit information in an easy-to-apply format.

Todd is active in several professional organizations, including the Institute of Transportation Engineers, the Canadian Centre for Sustainable Transportation, and the Transportation Research Board (TRB, a section of U.S. National Academy of Sciences). He is a member of the TRB Economic Committee, and serves as chair of the TRB Sustainable Transportation Indicators Subcommittee. He is a member of the Editorial Advisory Board of *Transportation Research A*, a professional journal.

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