APPLIED RESEARCH ASSOCIATES, INC.
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ESTIMATION OF ROAD COST ALLOCATION BETWEEN LIGHT VEHICLES AND HEAVY VEHICLES IN CANADA

Final Report

Transport Canada Transports Canada

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1. EXECUTIVE SUMMARY

This report describes a highway cost allocation method and the results of its application to the entire Canadian road network. The method allocates costs of roads to three vehicle types: light vehicles, trucks, and buses. The work is part of an Investigation of the Full Cost of Transportation, a project initiated by Transport Canada in collaboration with Provincial and Territorial transportation agencies.

The cost allocation results were expressed as percentages of the representative annualized road costs that were attributed to light vehicles, trucks and buses. The representative annualized costs were estimated by a preceding study titled *Estimation of the Representative Annualized Capital and Maintenance Costs of Roads by Functional Class* [1]. The preceding study estimated annualized road costs for the entire Canadian provincial and municipal road network in terms of Equivalent Uniform Annual Costs. The estimates were carried out for 196 representative road segments covering 14 different road functional classes in 14 different geographical regions, and for 8 types of costs. In the present study, all these previous cost estimates were allocated to light vehicles, trucks, and buses. For example, 49.9 percent of the total cost for provincial rural collector highways in Southern Ontario was attributed to light vehicles, 48.6 percent to trucks, and 1.5 percent to buses. The addition of the allocation percentages for light vehicles, trucks, and buses always equals 100 percent.

To assess a practical range of cost allocation percentages for buses, two site-specific case studies involving transit bus routes were carried out. Results indicate that in special situations on heavily used transit routes, up to about 30 percent of all road infrastructure costs can be attributed to buses. Cost allocation estimates are very sensitive to the proportion of light vehicles, trucks and buses in the traffic flow. More accurate and complete traffic data would increase the reliability of cost allocation estimates. Specifically, instead of using one representative set of classified traffic volumes for all geographical regions, region-specific traffic volumes should be used.

The report also compares the cost allocation results with the results reported by other North American jurisdictions. The results of this comparison indicate a broad agreement between the study results and the results reported by others.

2. INTRODUCTION

The objective of highway cost allocation studies is to allocate road costs to the categories of highway users who caused them, or who are responsible for them. Consequently, highway cost allocations studies are typically carried out by jurisdictions which adhere to the user-pay policy [2, 3, 4]. The user-pay policy states that users should pay in proportion to the road costs for which they are responsible. The basic methodology developed for highway cost allocation studies is broadly applicable to this endeavour. However, there are several differences between typical highway cost allocation studies and this study.

The basic difference is that typical highway cost allocation studies allocate the expected future road infrastructure expenditures to future users, whereas the present study allocates total road infrastructure costs that occurred in the past to the current users. Another difference which is more subtle is that highway cost allocation studies actually allocate costs so that each user group pays its share. The present study only attributes costs to user groups who caused them. In essence, the present study is only the starting point of a cost allocation study. In this report, the terms (cost) allocation and (cost) attribution are used interchangeably.

On a practical level, highway cost allocation studies are large, detailed studies. The current cost attribution study is only a brief parametric study which is limited in the level of detail. Finally, the cost allocations carried out in this study were completed simultaneously for different jurisdictions. Typical highway cost allocation studies concern a single jurisdiction.

2.1 Estimated Representative Annualized Capital and Operating Costs

The present cost allocation study utilizes the results of the preceding study, *Estimation of the Representative Annualized Capital and Maintenance Costs for Roads by Functional Class* [1]. The preceding study used a 60 year analysis period and assumed that road infrastructure costs are for 2003 road design parameters and for 2003 unit construction costs. For consistency, the present cost allocation study assumes 2003 road usage characteristics (traffic volumes and composition) to allocate road costs.

The total annualized road costs were estimated for one-kilometre-long, one-lane road segments selected to represent the entire Canadian provincial and municipal road network. Altogether, the estimates were completed for 196 representative road segments covering 14 different road functional classes in 14 different geographical regions and for 8 types of costs. In addition, for each of the 196 representative road segments, road costs were estimated for 8 types of costs. In the present study, all these previous cost estimates were allocated to light vehicles, trucks, and buses. The cost allocation results were estimated as percentages of the appropriate road infrastructure costs estimated in the previous study. For example, 49.9 percent of the total cost for provincial rural collector highways in Southern Ontario was attributed to light vehicles, 48.6 percent to trucks, and 1.5 percent to buses. The addition of the allocation percentages for light vehicles, trucks, and buses always equals 100 percent.

The cost allocation estimates were also applied to the annualized costs (Equivalent Uniform Annual Costs) that included all initial road construction costs (for pavements, structures, and all other road infrastructure) and all subsequent maintenance and rehabilitation costs (including the cost for routine maintenance and winter maintenance). The results are reported in the form of Cost Allocation Reporting Sheets of the type shown in Table 7.1 presented at the end of this report. The classification schema used in the preceding study, as well as in this study, is shown in Figure 2.1 and is briefly described in the following paragraphs.

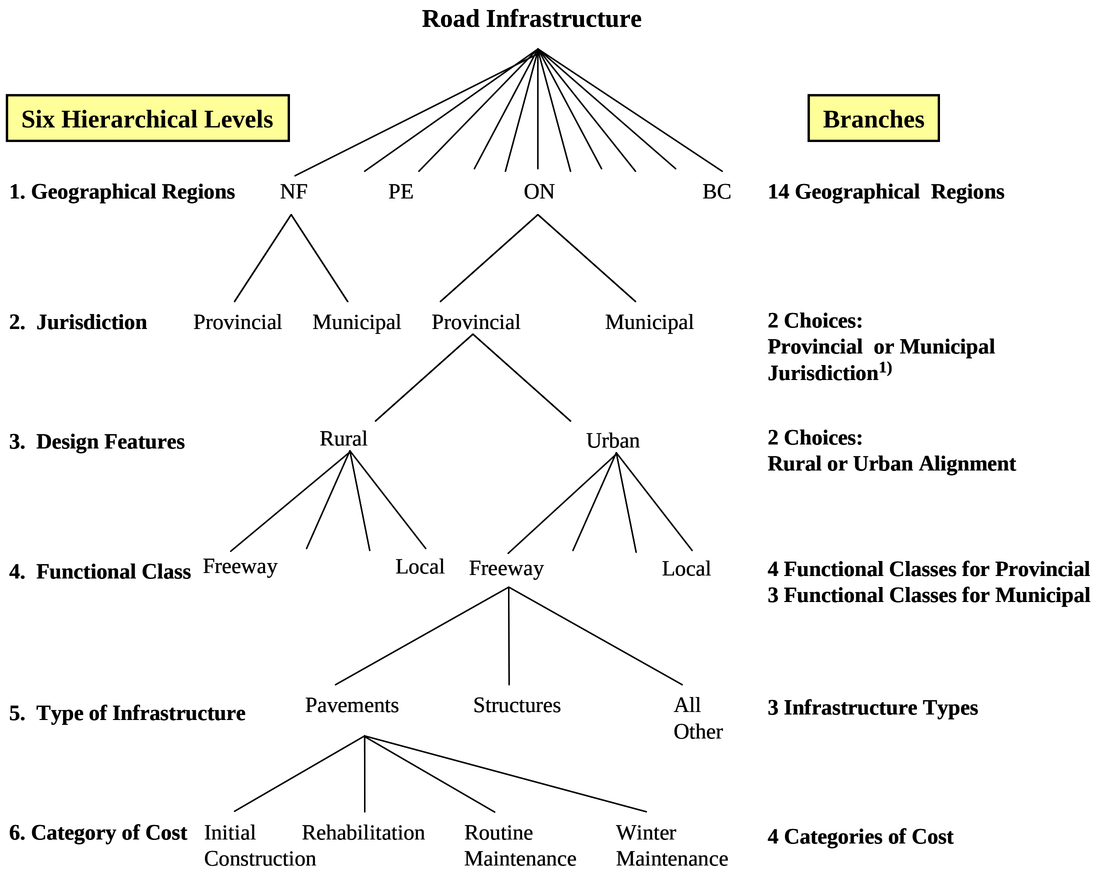

Figure 2.1. Road classification schema.

2.2 Classification Schema for Cost Allocation

Classification by Geographical Region

The classification by geographical region recognizes all ten provinces and one combined "territory". To account for environmental and other differences that exist within a single province, Québec, Ontario, and British Columbia were each subdivided into two regions. Consequently, there were 14 geographical regions.

Classification by Jurisdiction

Classification by jurisdiction divided roads into provincial roads and municipal roads. The federal and territorial roads were included under provincial roads.

Classification by Design Features

Classification by design features divided roads into rural and urban.

Classification by Road Functional Class

The following classification was used for provincial roads:

Freeway	A divided highway with full control of access.
Arterial	A two-lane or a multi-lane road that carries significant volumes of long distance traffic at high speeds. There is a high degree of access control.
Collector	A two-lane or a multi-lane road that balances traffic flow needs with access. Access to the road is governed by traffic flow considerations and by safety concerns.
Local	A two-lane or a multi-lane road that primarily provides access to local land users. Access to the highway is controlled by safety concerns.

The following classification was used for municipal roadways:

Arterial	Resembles a highway going through a municipality.
Collector	Feeds traffic from an arterial to the local roads or vice-versa.
Local	All other roadways that are <u>not</u> residential streets, arterials or collector roads.
Residential	Residential roads and streets provide direct access to residences and were not included in the study.

Types of Costs

The total road infrastructure cost was divided into eight types of costs. The division reflects the three types of road infrastructure (pavements, structures, and all other components), and the basic division of costs between capital costs and operating costs. An example of the type of cost is the pavement maintenance and rehabilitation cost. The definition of the cost types and the methodology used for their estimation is documented in Reference 1.

Classification by Type of Road Infrastructure

Road infrastructure was grouped into three basic infrastructure components: pavements, structures, and all other infrastructure component.

<u>Pavements</u> – Pavements included all pavement layers above the subgrade soil.

<u>Structures</u> – Structures included bridges, road tunnels, large retaining walls, and snow sheds.

<u>All Other Infrastructure Components</u> – All other infrastructure component included all components that were not a pavement or a structure, for example, earth work, culverts, drainage structures, landscaping and fencing, lighting, and safety and traffic control appurtenances.

Classification by Category of Costs

The following four categories of costs were established for this study in view of the budgeting and asset management practices of transportation agencies:

<u>Initial Construction Cost</u> – Initial construction costs are costs incurred during the initial construction of road infrastructure. Initial construction costs were allocated separately for the three basic infrastructure components. The initial construction costs are based on a 60 year analysis period [1].

<u>Maintenance and Rehabilitation (M & R) Cost</u> – Maintenance and rehabilitation costs include all expenditures that provide a measurable and lasting improvement (improvement lasting more than a year)

in the condition of a road infrastructure asset and increase the value of the asset. Typically, during the budgeting process, maintenance and rehabilitation costs are assigned to specific projects and are considered by transportation agencies to be capital costs. Maintenance and rehabilitation costs were allocated separately for the three basic infrastructure components.

Routine Maintenance Cost – Routine maintenance costs include expenditures that do not increase asset value. Typically, routine maintenance costs are not assigned to specific projects, are budgeted as a lump sum, and are considered by transportation agencies to be operating costs. Routine maintenance costs include minor repairs such as filling of potholes, minor guide rail repairs, minor bridge repairs, cutting grass, maintenance of the right-of-way, and the removal of debris. Routine maintenance costs were allocated as a combined cost for all three types of infrastructure.

Winter Maintenance Cost – The cost of winter maintenance includes the cost of the field operations for snow removal and ice control, and the costs of all other associated and supporting activities and facilities. Winter maintenance costs are considered to be operating costs and were allocated as a combined cost for all three types of infrastructure.

2.3 Vehicle Types

Following the terms of reference for this study, the responsibility for road infrastructure costs was attributed to three vehicle classes: light vehicles, trucks, and buses.

Cars or light vehicles (motorcycles, passenger cars and light trucks)

In terms of regulations, cars and light vehicles are defined as vehicles with a Gross Vehicle Weight (GVW), or registered GVW, of 4,500 kg or less. However, Canadian transportation agencies are typically unable to classify vehicles by weight in the field, and classify vehicles by appearance using vehicle classification schema given in the Traffic Monitoring Guide [5]. This schema classifies light vehicles into three categories, (1) motorcycles, (2) passenger cars, and (3) other two-axle, four-tire vehicles. The third category also includes two-axle, four-tire vehicles pulling trailers of any kind. Traffic data provided by Canadian transportation agencies typically lump all three types of light vehicles into one category called "cars". The terms light vehicles and cars are used interchangeably in this report.

Trucks

Typically, trucks are defined as vehicles with GVW exceeding 4,500 kg which are not buses. Canadian transportation agencies classify and report trucks as vehicles with six-or-more tires which are not buses. This definition of trucks will also be used in this study.

Buses

In terms of regulations, bus typically means a motor vehicle designed for carrying ten or more passengers and used for the transportation of persons[1]. For classification purposes in the field, transportation agencies define buses as vehicles manufactured to carry passengers which have at least six tires [5]. The majority of buses on Canadian roads are probably school buses.

Trucks and buses combined are called commercial vehicles (CV).

[1] This definition is used, for example, in the Ontario Traffic Act.

3. GENERAL APPROACH

3.1 Outline of Methodology

The proposed methodology was developed to meet the project objectives recognizing the limitations imposed by the reliability of the cost estimates established by the preceding cost estimation study [1]. The availability and reliability of data required for this study, particularly traffic data characterizing the intensity of road use, was also considered.

The cost allocation methodology is based on the incremental method. The incremental method allocates road infrastructure costs of successively heavier or larger vehicles in increments that correspond to the increasing costs of providing the road infrastructure for these vehicles. For example, for the initial pavement construction, the first increment represents the cost of providing pavement size and thickness (pavement widths and shoulder widths and pavement structure) considered to be adequate for cars only. The first increment is called the base case. The cost for the base case is a common responsibility of all vehicles and is assigned to all vehicle classes on the basis of each class's share of vehicle kilometres of travel adjusted for the vehicle size.

The second increment represents the additional cost of increasing the pavement area and pavement thickness to accommodate commercial vehicles (trucks and buses). This additional cost is assigned to commercial vehicles only. Typically, only two cost increments are used to allocate road infrastructure costs. The first increment (costs for the base case) and the second increment (the costs allocated to commercial vehicles). The allocation of costs among different classes of commercial vehicles is carried out using allocation factors rather than by specific increments. The incremental method permits only one increment of costs to be unambiguously attributed to a single specific vehicle class (the heaviest class). This is because each successively heavier vehicle class benefits from the infrastructure increments occasioned by previous vehicle classes. Considering that there may be several classes of trucks, the explicit application of the incremental methods would require the creation of specific scenarios (base cases) for each truck class. Consequently, allocation factors are used to distribute costs between different truck classes. In this study, the increment for commercial vehicles was distributed between trucks and buses.

The schema of the cost allocation methodology is shown in Figure 3.1. As shown in Figure 3.1, the cost allocation was completed in two steps. In the first step, described in Chapter 4, road infrastructure costs were divided between cars and commercial vehicles. In the second step, described in Chapter 5, the costs allocated to commercial vehicles were divided between trucks and buses.

3.2 Cost Allocators

Cost allocators are measures that are used to distribute the cost of the base case to different vehicle classes, or to distribute the cost of each increment to the individual vehicle classes within that increment. The cost allocators used in this study were Passenger Car Equivalents, percentage of commercial vehicles, and Equivalent Single Axle Loads.

3.2.1 Passenger Car Equivalent Factors

The base case refers to the common facility attributable to all vehicles. The allocation of the base case costs to the two vehicle classes (cars and commercial vehicles) was based on the frequency of use of the two vehicle types and on their impact on road capacity. The 1997 Federal Highway Cost Allocation Study [6] used vehicle miles of travel as the measure of the frequency of use by vehicles, and the Passenger Car Equivalents (PCE) as the measure of the impact of vehicles on road capacity.

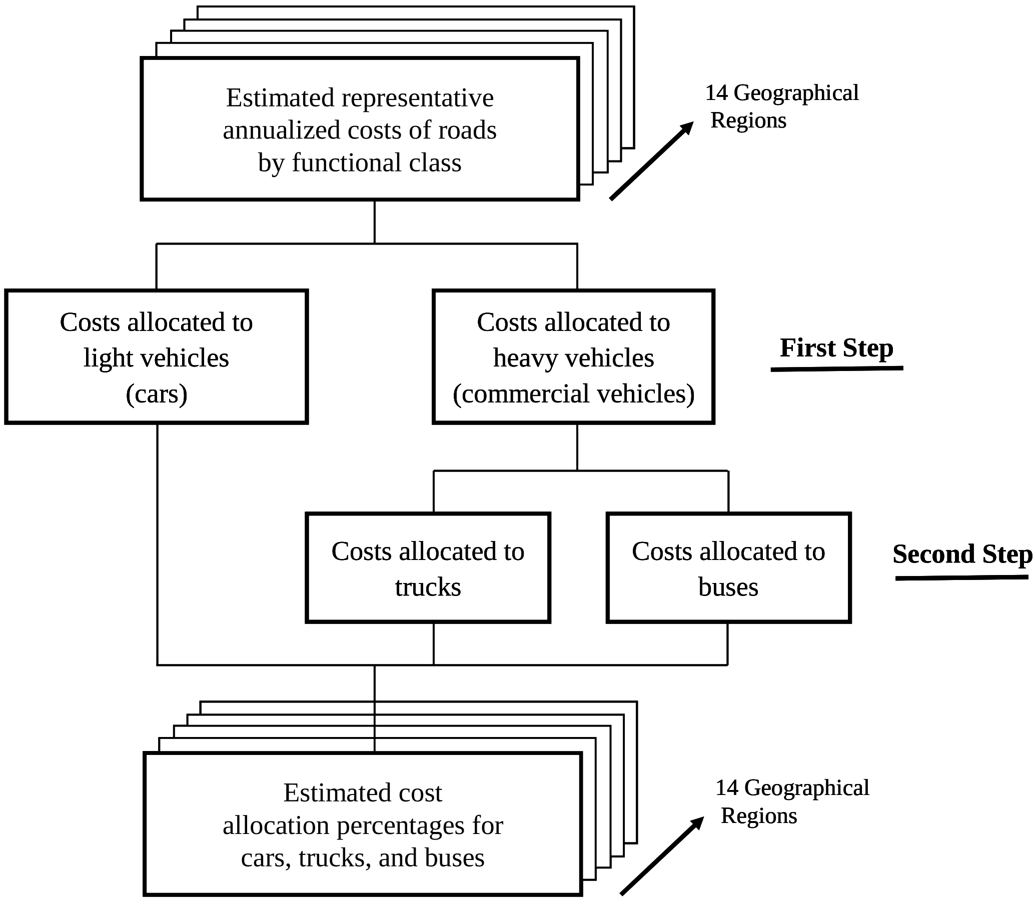

Figure 3.1. Schema of the cost allocation methodology.

In this study, the frequency of use was characterized by the percentage of vehicle volumes for the different vehicle classes rather than by vehicle kilometres of travel. The use of the percentage of classified vehicle volumes was possible because the allocation was completed for the representative one-km long sections with known (or estimated) vehicle volumes classified by vehicle type. Vehicle percentages are directly proportional to the kilometres of travel and are also easier to visualize. The impact on the capacity of the road to carry vehicles was characterized by Passenger Car Equivalent (PCE) factors. Several recent cost allocation studies have used different PCE factors to represent different types of commercial vehicles [6, 7], and this approach was also used in this study.

The concept of PCE used for cost allocation studies is similar to the concept of PCE used for operational analysis of highway capacity. In both cases, PCE factors are used to account for the effect of trucks on highway capacity. The Highway Capacity Manual [8] defines a passenger-car equivalent as, "*The number of passenger cars displaced by a single heavy vehicle of a particular type under specified roadway, traffic, and control conditions.*" However, there are several differences between the use of PCE factors in highway operational analysis and in cost allocation studies:

- For operational analysis, PCE factors are defined for one category of trucks only. Cost allocation studies use different PCE factors for different truck types.

- Operational analysis use PCE factors to estimate the impact of trucks on free flow speed. Cost allocation studies use PCE factors to characterize the amount of highway capacity consumed by trucks. The difference in use becomes relevant in urban areas because the free flow speed on arterial roads in urban areas is governed mainly by signalized intersections. Consequently, PCE factors are not directly used in operational analysis of urban roads and the Highway Capacity Manual does not provide guidance on PCE factors for urban roads.

- For operational analysis, PCE factors apply to general roadway sections. The influence of highway geometry, such as width of lanes and shoulders, is included using separate factors. The PCE factors for cost allocation studies assume and incorporate the existence of typical geometric conditions associated with different road functional classes.

The easiest way to estimate PCE is to consider the space occupied by vehicles of different length. For example, the *Allocation Options* study [9] recommends that PCE be "*estimated by dividing the length of the vehicle in meters by 4.8*". Thus, if a 5-axle tractor with a 53 feet (16.2 m) long semitrailer[2] has the total length of 23 m, and a car has the length of 4.8 m, the corresponding PCE is equal to 4.6 (22.0 / 4.8). The PCE of 4.6 looks reasonable considering a free-flowing traffic on a 2-lane road. On an urban road that frequently operates at capacity, the PCE of 4.6 appears to be high, considering that it is not possible to squeeze 4.6 cars in the space occupied by one slow-moving truck because of the space that would be required between the individual cars. However, as explained before, the Highway Capacity Manual does not provide guidance on PCE factors in urban areas. Consequently, literature review and engineering judgment were used to develop PCE factors in urban areas.

The main considerations affecting the PCE factors include the vehicle length, the vehicle acceleration and deceleration capabilities (measured by weight-to-horsepower ratio), the type of road facility (e.g., the length of longitudinal grades, rural versus urban alignment, multilane versus one lane in each direction), and the type of traffic flow (e.g., free flowing versus congested). Table 3.1 provides a summary of values recommended for PCE by a recent study carried out by Cambridge Systematics [7], as well as PCE values based on the length ratio. In general, PCE values increase with the size of the vehicle, with the increase in road longitudinal grade (and the length of the grade), and with free-flowing traffic conditions. The information provided in Table 3.1 was used to develop PCE recommended for the study and given in Table 3.2.

[2] The container in widespread use in North America is 53 feet long, 9 feet 6 inches high, and 8 feet 6 inches wide. The length of a truck required to transport the container is about 22 m.

Table 3.1. Comparison of values for Passenger Car Equivalents

Vehicle type	Typical maximum vehicle length, m	Typical maximum allowable vehicle length, m	Rural roads[1]				Urban roads[2]		Based on vehicle length ratio[3]
			4-lane		2-lane		Con-gested	Free flow	
			Grade, %		Grade, %				
			0	3	0	4			
			Passenger Car Equivalents (PCE)						
Cars	4.8	6.0	1	1	1	1	1	1	1
2-&-3 axle trucks[4]	10.0	12.5	1.7	8.2	2.5	11.3	2.0 – 2.5	2.5 - 3.5	2.1
4-axle trucks	12.5	12.5							2.6
5-axle trucks	22.0	23.0	1.8	8.9	3.3	11.8	2.0 - 3.0	2.5 - 3.5	4.6
6-axle trucks	23.0	23.0	1.8	8.9	3.3	11.8	2.0 - 3.0	2.5 - 3.5	4.8
7+axle trucks	25.0	25.0	1.8	8.9	3.3	11.8	2.0 - 3.0	2.5 - 3.5	4.8

Notes:
PCE factors for rural and urban highways are based on Reference 7, and assume the vehicle weight to horsepower ratio, in terms of pounds per horsepower, of 200. Reference data given in this table were adjusted to ensure that the effect of trucks on capacity is greater on two-lane roads than on freeways, especially when there is limited sight distance for passing.
1) It is assumed that the length of the grade is 1.2 km.
2) Higher PCE values apply to freeways, lower values to principal arterial roads.
3) For typical maximum vehicle length.
4) Assumes to include buses. The length of transit buses is typically 12.2 m (40 feet).

Table 3.2. Recommended values for Passenger Car Equivalents

Vehicle type	Provincial								Municipal					
	Rural				Urban				Rural			Urban		
	Freeway	Arterial	Collect.	Local	Freeway	Arterial	Collect.	Local	Arterial	Collect.	Local	Arterial	Collect.	Local
Cars	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2-&-3 axle trucks	2.3	2.5	2.5	2.5	2.3	2.3	2.3	2.3	2.5	2.0	2.0	2.2	2.0	2.0
Buses	2.3	2.5	2.5	2.5	2.3	2.3	2.3	2.3	2.5	2.0	2.0	2.2	2.0	2.0
4-axle trucks	3.0	3.3	3.5	3.5	2.8	3.0	3.3	3.5	3.0	3.5	3.5	2.8	3.3	3.5
5-axle trucks	3.3	3.5	3.7	4.0	3.0	3.4	3.5	3.7	3.3	3.7	4.0	3.0	3.5	3.7
6-axle trucks	3.5	3.7	4.0	5.0	3.3	3.5	3.8	4.0	3.5	4.0	5.0	3.3	3.8	4.0
7+axle trucks	3.6	3.8	4.1	5.1	3.4	3.6	3.9	4.1	3.6	4.1	5.1	3.4	3.9	4.1

The PCE factors in Table 3.2 are considered to be typical factors applicable to all 14 geographical regions. However, the computational model contains a provision for inputting separate PCE for all 14 geographical regions. The computational model is described in Chapter 6.

The use of separate PCE for different geographical regions is advisable because, as indicated by data presented in Table 3.1, PCE depend greatly on a longitudinal road grade. For example, PCE for a 5-axle-truck on an at-grade, 2-lane road is 3.3, whereas the corresponding PCE factor on a 4 percent, 1.2 km long grade is 11.8. Thus, the coastal region of British Columbia should have lower PCE than the interior region of British Columbia because the interior region has typically steeper and longer longitudinal road grades. There are also minor differences between the maximum allowable vehicle weights and dimensions between the provinces[3] which also suggest the use of separate PCE factors for different regions.

The PCE factors used in this study are based on the US factors and should be reassessed. The maximum allowable Gross Vehicle Weight (GVW) of trucks in Canada is about 60,000 kg[4]. In the United States, the typical maximum allowable GVW of trucks is 80,000 lb or 36,300 kg, a 40 percent difference. The larger allowable GVW in Canada calls for more powerful tractors (traction engines) and braking systems. If the tractors and braking systems are not proportionately more powerful in Canada, loaded trucks would travel (and accelerate and decelerate) at lower rates. The lower rates should be reflected in Canadian PCE factors.

3.2.2 Composite Passenger Car Equivalency Factors

Different road functional classes tend to serve different types of trucks. For example, as shown in Figure 3.2, typical trucks using rural collector roads are short 2 or 3 axle trucks, whereas typical trucks using rural freeways are long 5-or-more axle trucks. (Vehicle classes plotted on the x-axis of Figure 3.2 are defined in Table 3.6.) For this reason, the composite PCE were estimated by taking into account the typical distribution of vehicles on different functional road classes. The expected vehicle distributions on different road functional classes are given in Table 3.3. Computational model stores composite PCE factors separately for each geographical region.

Vehicle type distributions presented Table 3.3 are typical Canadian vehicle type distributions based on our previous extensive work with LTPP and C-LTPP traffic data [10, 11, 12], on traffic volume data obtained in the course of the previous study [1], and additional traffic data obtained in the course of the present study. The computational model contains a provision for inputting vehicle classification data of the type given in Table 3.3, for all 14 geographical regions.

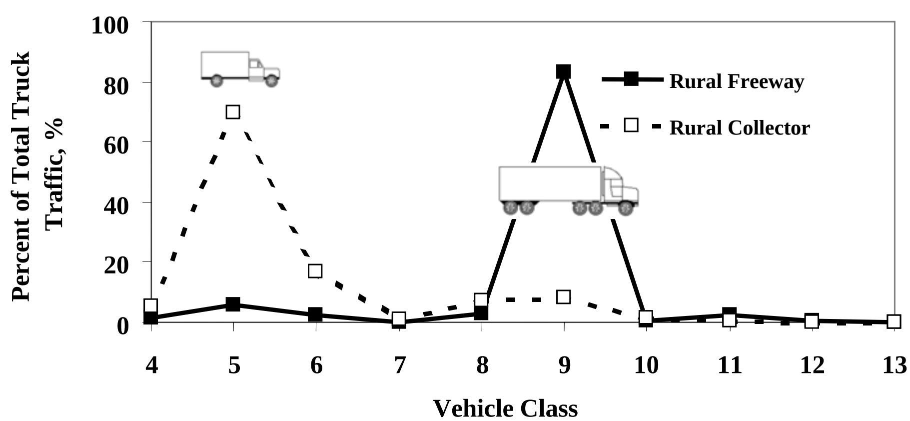

Figure 3.2. Relationship between vehicle type distribution and road functional class.

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[3] The first comprehensive Memorandum of Understanding governing maximum allowable weights and dimensions for heavy vehicles on the National Highway Network was signed in 1988. However, there are still differences in the maximum allowable vehicle weights and dimensions between the provinces. The main differences are between the Provinces east and west of the Ontario-Manitoba border.

[4] In Ontario, the maximum allowable GVW is 63,500 kg (for a 25-m long B-train with 8 axles carrying general freight).

Table 3.3. Recommended vehicle type distributions

Vehicle type	Provincial								Municipal					
	Rural				Urban				Rural			Urban		
	Freeway	**Arterial**	**Collect.**	**Local**	**Freeway**	**Arterial**	**Collect.**	**Local**	**Arterial**	**Collect.**	**Local**	**Arterial**	**Collect.**	**Local**
Percentage of cars, commercial vehicle, and buses														
Cars	75.0	85.0	90.0	95.0	80.0	92.0	95.0	98.0	92.0	95.0	98.0	95.0	97.0	98.0
All CV	**25.0**	**15.0**	**10.0**	**5.0**	**20.0**	**8.0**	**5.0**	**2.0**	**8.0**	**5.0**	**2.0**	**5.0**	**3.0**	**2.0**
Buses only	0.5	0.4	0.3	0.2	0.6	0.5	0.4	0.3	0.7	0.6	0.3	1.0	1.0	0.5
Total vehicles	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Percentage distribution of commercial vehicles														
2-&-3 axle vehicles[1)]	25.0	45.0	90.0	95.0	35.0	65.0	94.0	96.0	65.0	94.0	96.0	75.0	96.0	97.0
4-axle trucks	3.0	3.0	2.0	2.0	3.0	2.0	1.0	1.0	2.0	1.0	1.0	1.0	1.0	1.0
5-axle trucks	47.0	36.0	3.0	2.0	47.0	29.0	4.0	2.5	29.0	4.0	2.5	20.0	2.5	2.0
6-axle trucks	20.0	12.8	4.0	0.8	12.0	3.2	0.8	0.4	3.2	0.8	0.4	3.2	0.4	0.0
7+axle trucks	5.0	3.2	1.0	0.2	3.0	0.8	0.2	0.1	0.8	0.2	0.1	0.8	0.1	0.0
Total commercial vehicles	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

1) 2-&3 axle commercial vehicles 2-&-3 axle trucks and buses

The composite PCE factors take into account both PCE factors for the individual vehicle types given in Table 3.1 and typical vehicle type distributions given in Table 3.3.

The formula used to calculate the composite PCE factors is given by Equation 1.

$$Composite\ PCE = (\sum_{i=1}^{i=5} P_i * PCF_i)/100 \qquad \text{Equation 1}$$

Where:

i = Vehicle type i in Table 3.6.

P_i = The percentage of vehicles in the total traffic flow of the type i. This percentage is based on data given in Table 3.3, second part.

PCE_i = Passenger Car Equivalent for vehicle type i from Table 3.2.

The recommended composite PCE factors are given in Table 3.4. At this time, the composite PCE are assumed to be the same for all 14 geographical regions. However, these values could be adjusted in the model by the user. Table 3.4 was extracted from the computational model and its format shows that the computational model provides for separate composite PCE factors for all 14 geographical regions.

Table 3.4. Composite Passenger Cost Allocation Factors

Gepgraphical Region	Provincial								Municipal					
	Rural				Urban				Rural			Urban		
	Freeway	Arterial	Collector	Local	Freeway	Arterial	Collector	Local	Arterial	Collector	Local	Arterial	Collector	Local
NL	1.52	1.31	1.16	1.08	1.36	1.13	1.07	1.03	1.14	1.06	1.02	1.07	1.03	1.02
PE	1.52	1.31	1.16	1.08	1.36	1.13	1.07	1.03	1.14	1.06	1.02	1.07	1.03	1.02
NS	1.52	1.31	1.16	1.08	1.36	1.13	1.07	1.03	1.14	1.06	1.02	1.07	1.03	1.02
NB	1.52	1.31	1.16	1.08	1.36	1.13	1.07	1.03	1.14	1.06	1.02	1.07	1.03	1.02
QC-1	1.52	1.31	1.16	1.08	1.36	1.13	1.07	1.03	1.14	1.06	1.02	1.07	1.03	1.02
QC-2	1.52	1.31	1.16	1.08	1.36	1.13	1.07	1.03	1.14	1.06	1.02	1.07	1.03	1.02
ON-1	1.52	1.31	1.16	1.08	1.36	1.13	1.07	1.03	1.14	1.06	1.02	1.07	1.03	1.02
ON-2	1.52	1.31	1.16	1.08	1.36	1.13	1.07	1.03	1.14	1.06	1.02	1.07	1.03	1.02
MB	1.52	1.31	1.16	1.08	1.36	1.13	1.07	1.03	1.14	1.06	1.02	1.07	1.03	1.02
SK	1.52	1.31	1.16	1.08	1.36	1.13	1.07	1.03	1.14	1.06	1.02	1.07	1.03	1.02
AB	1.52	1.31	1.16	1.08	1.36	1.13	1.07	1.03	1.14	1.06	1.02	1.07	1.03	1.02
BC-1	1.52	1.31	1.16	1.08	1.36	1.13	1.07	1.03	1.14	1.06	1.02	1.07	1.03	1.02
BC-2	1.52	1.31	1.16	1.08	1.36	1.13	1.07	1.03	1.14	1.06	1.02	1.07	1.03	1.02
TR	1.52	1.31	1.16	1.08	1.36	1.13	1.07	1.03	1.14	1.06	1.02	1.07	1.03	1.02

The composite PCE factors provide a measure for the cost allocation between cars and commercial vehicles for the base case. The allocation to cars and commercial vehicles can be calculated using Equations 2 and 3, respectively.

$$Percent\ \ Allocation\ to\ Cars = \frac{P_{cars}}{Composite\ \ PCE} \qquad \text{Equation 2}$$

Where:

P_{cars} = Percentage of cars in the traffic flow.

$$Percent\ \ Allocation\ to\ Commercial\ Vehicles = 100 - \ Percent\ \ Allocation\ to\ Cars \qquad \text{Equation 3}$$

The resulting allocation percentages for the base case are given in Table 3.5. Table 3.5 is an abbreviated table because it does not list separate numbers for all 14 geographical regions in the way Table 3.4 does, or in the way the computational model list them.

Table 3.5. Composite PCE factors and cost allocation percentages for the base case

Parameter	**Provincial**								**Municipal**					
	Rural				**Urban**				**Rural**			**Urban**		
	Freeway	**Arterial**	**Collector**	**Local**	**Freeway**	**Arterial**	**Collector**	**Local**	**Arterial**	**Collector**	**Local**	**Arterial**	**Collector**	**Local**
Composite PCE for all vehicles	1.52	1.31	1.16	1.08	1.36	1.13	1.07	1.03	1.14	1.06	1.02	1.07	1.03	1.02
Allocation to light vehicles %	49.2	64.8	77.4	88.1	58.8	81.1	88.9	95.4	80.5	90.0	95.9	88.7	94.0	96.0
Allocation to commercial vehicles, %	50.8	35.2	22.6	11.9	41.2	18.9	11.1	4.6	19.5	10.0	4.1	11.3	6.0	4.0

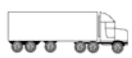
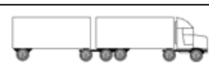
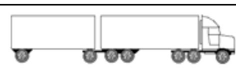
3.2.3 Percentage of Commercial Vehicles

The percentage of commercial vehicles is defined as the percentage of trucks and buses in the traffic flow. Its residual value is the percentage of cars in the traffic flow. The percentages of cars and commercial vehicles by functional class are given in Table 3.3, and were discussed previously in connection with the development of composite PCE factors.

3.2.4 Equivalent Single Axle Loads (ESAL)

ESALs are used as a measure of pavement damage caused by trucks. The number of ESALs per truck is called the truck factor. The recommended truck factors given in Table 3.6 were developed by Applied Research Associates, Inc. for the Transportation Association of Canada [13]. In this study, ESALs were used as a cost allocation factor for allocating the cost of pavement structure between trucks and buses.

Table 3.6. Recommended truck factors for FHWA vehicle classes

FHWA Vehicle Class	Schema	Truck Factor			
		Western Canada		Eastern Canada	
		Typical	Range[a)]	Typical	Range[a)]
4		1.1	0.3 – 2.2	1.1	0.3 – 2.7
5		0.3	0.05 – 1.7	0.3	0.05 – 2.3
6		0.8	0.07 – 2.3	1.1	0.07 – 2.7
7 [b)]		n/a	n/a	4.0 [c)]	0.2 – 8.0 [c)]
8 [b)]		1.0	0.2 – 3.3	1.1	0.2 – 4.3
9		1.3	0.3 – 3.4	1.6	0.3 – 4.2
10 [b)]		2.3	0.4 – 3.3	4.2 [c)]	0.4 – 6.2 [c)]
11 [b)]		1.2	0.4 – 4.8	1.2	0.4 – 6.4
12 [b)]		1.7	0.5 – 4.8	2.7	0.5 – 6.4
13		2.2	0.5 – 4.8	3.5	0.5 – 6.4

Notes:
Western Canada: Provinces west of the Ontario-Manitoba border.
Eastern Canada: Provinces east of the Ontario-Manitoba border.
n/a Not applicable: This vehicle type may not exist in Western Canada.
a) *The range may not include overloaded axles.*
b) *These types of trucks are relatively infrequent. Truck factors were based mainly on calculations rather than on surveys.*
c) *The configuration may include one or more liftable axles.*

4. COST ALLOCATION BETWEEN CARS AND COMMERCIAL VEHICLES

This chapter provides an outline of the methodology for the allocation of road infrastructure costs between cars and commercial vehicles. This activity represents the first step in the cost allocation methodology presented in Figure 3.1. Cost allocation estimates were carried for eight individual cost types listed in the first column of Table 4.1. These cost types were used in the previous study [1] and were described in Chapter 2. Cost allocation procedures used for the eight cost types are listed in the last column of Table 4.1. The numbers preceding names of cost types in Column 1 and cost items in Column 2 refer to the section numbers where the cost allocation procedure is described.

Table 4.1. Proposed cost allocation between cars and commercial vehicles for the all cost types

Cost type	Cost item	Cost allocation procedure
Cost allocation between cars and commercial vehicles		
4.1. Initial road construction	4.1.1 Additional road width required to for CV	All to CV
	4.1.2 Alignment and other changes required for CV	All to CV
	4.1.3 Base case allocation	To cars and CV
4.2. Initial pavement construction	4.2.1 Additional pavement width required for CV	All to CV
	4.2.2 Additional pavement structure required for CV for	All to CV
	4.2.3 Base case allocation	To cars and CV
4.3. Initial bridge construction	4.3.1 Additional bridge deck area required for CV	All to CV
	4.3.2 Additional bridge structure required for CV	All to CV
	4.2.2 Base case allocation	To cars and CV
4.4. M&R costs for road infrastructure (not including pavements and bridges)		Same split as for Cost Type 4.1
4.5. M&R costs for pavements	4.5.1 M&R due to the additional area required for CV	All to CV
	4.5.2 M&R due to traffic loads	All to CV
	4.5.3 M&R due to the environment	To cars and CV
4.6. M&R costs for bridges		Same split as for Cost Type 4.3
4.7. Cost of routine maintenance		To cars and CV
4.8. Cost of winter maintenance		To cars and CV

4.1 Allocation of Initial Road Construction Costs

Initial road construction costs include all initial road construction costs with the exception of the initial construction costs of pavements and bridges. The initial road construction costs are identical to the "All Other Infrastructure Component" costs defined in Reference 1, Table 24.

The allocation of the initial road construction costs between cars and commercial vehicles was carried out for the following three cost items (Figure 4.1):

- Costs for the additional roadway width required for CV and allocated to CV only.
- Costs for alignment changes and features required for CV and allocated to CV only.
- Costs of the base case allocated to both cars and CV.

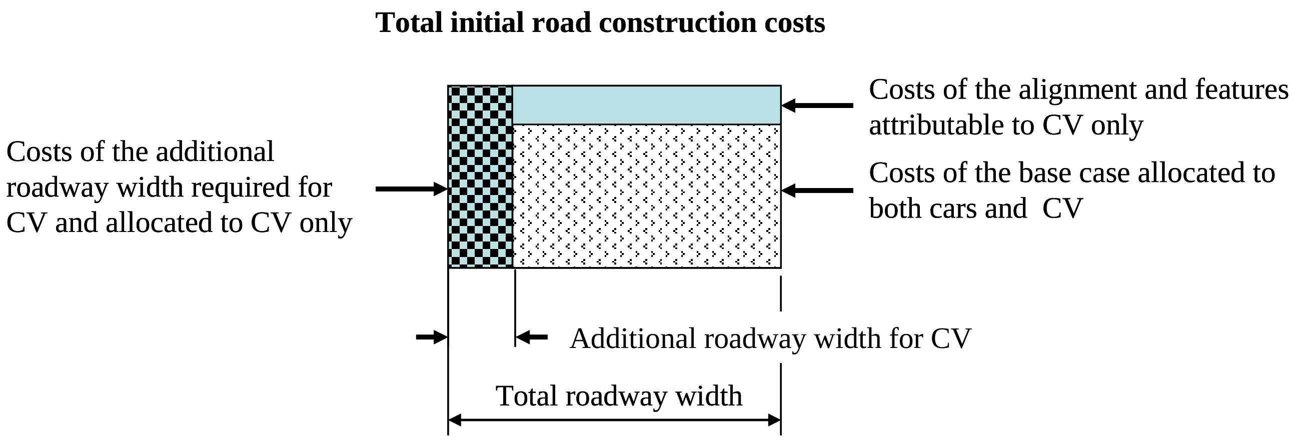


Figure 4.1. Allocation of initial road construction costs.

4.1.1 Costs for the Additional Roadway Width Required for CV

The base case assumes a roadway width that is judged appropriate to accommodate a traffic flow containing cars and associated supporting vehicles. The associated supporting vehicles include emergency response vehicles (e.g., ambulances and emergency-response buses), vehicles required to provide routine and winter maintenance (e.g., high-speed snow plows), and vehicles required for maintenance and rehabilitation operations (e.g., trucks for the transportation of paving materials, trucks for the transportation of construction equipment such as hot-mix pavers, and bucket-trucks used for bridge inspections). It is expected that associated supporting vehicles will use the base case roadway only when necessary for the preservation of the roadway itself.

The roadway width includes the width of the traffic lanes, paved and unpaved shoulders (on both sides), and shoulder rounding. Commercial vehicles require additional roadway width and the cost of the additional roadway width is assigned to CV only. It is assumed that the initial road construction cost is directly related to the roadway width.

General Considerations

Large trucks are about 30 to 40 percent wider than passenger cars. The maximum allowable width of highway vehicles in Canada is 2.8 m for tractors (traction engines) and 2.6 m for a load on the vehicle. In practice, the maximum allowable width applies to commercial vehicles only. Passenger cars are typically about 1.6 to 1.8 m wide. Hummers (and similar 2-axle 4-tire vehicles), which are 1.9 to 2.2 m wide depending on the model, are an exception. The maximum allowable width of trucks can also be increased by three allowances:

- *Equipment allowance* – Rear vision mirrors and required lamps may extend the width of the vehicle in whole or in part beyond either side of the vehicle.
- *Commodity type allowance* – Certain commodities may have a larger allowable total width than 2.6 m, for example raw forest products and hay. Figure 4.2 shows that the width of the load may noticeably exceed the width of the vehicle (trailer).
- *Load covering mechanism allowance* – Load covering mechanism may further extend the allowable vehicle width on either side. In Ontario, the allowable extension is 102 mm.

Figure 4.2. Width of an logging truck in Ontario

Until the late 1950's the typical width of the traffic lane on major arterial highways in Canada was 11 feet (3.35 m). The width was increased to 12 feet (3.66 m) in the 1960's. With the introduction of the metric system in the early 70's, the standard with of the traffic lanes on major arterial roads was set to 3.75 m in the majority of provinces. Several provinces, such as New Brunswick, set the standard width of the traffic lane to 3.70 m. The typical width of traffic lanes on the U.S. Interstate system is still 12 feet. The width of traffic lanes on collector and local roads are typically smaller depending mainly on the expected traffic volumes.

The shoulder widths have also increased over the years, but there are no standard widths for shoulders. It is generally required that the width of the right shoulder on freeways and arterial highways safely accommodates disabled vehicles without significant interruption of the traffic flow. Shoulder widths on urban roads are sometimes designed to provide parking. Shoulder widths on roads with urban alignment are sometimes designed to provide temporary or permanent storage for the snow removed from the traffic lanes and parts of shoulders.

Roadway Width Required to Accommodate Car-Only Traffic

Typical widths of traffic lanes and shoulders for the 14 road functional classes for the mixed traffic (cars and CV) are given in Table 4.2. These widths have been established in the previous study based on agency surveys, design guidelines, manuals, and other similar means. These typical widths have been individually assessed regarding their appropriateness to accommodate car-only traffic (and the associated supporting traffic) taking into account typical car and truck volumes, safety considerations, parking needs, and snow storage needs.

Table 4.2. Reduction in roadway width for the base case (2-lane facility)

Parameter	Provincial								Municipal					
	Rural				Urban				Rural			Urban		
	Freeway	Arterial	Collector	Local	Freeway	Arterial	Collector	Local	Arterial	Collector	Local	Arterial	Collector	Local
Typical widths for cars and commercial vehicles														
Typical traffic lane width, m	7.50	7.50	7.25	7.10	7.50	7.50	7.25	7.10	7.40	7.10	6.00	7.40	7.10	7.00
Typical shldr width[1], m	6.00	6.00	6.00	5.00	5.00	5.00	6.00	2.00	6.00	5.50	2.00	6.00	5.50	3.50
Estimated widths for cars only														
Lane width for cars only, m	7.00	6.75	6.50	6.00	7.00	6.75	6.50	6.25	6.75	6.50	6.00	6.75	6.50	6.50
Shldr width for cars only[2], m	4.00	4.00	4.00	4.00	4.00	4.00	5.00	2.00	4.00	4.00	2.00	4.00	4.00	3.50
Percentage reduction in roadway width														
Percentage reduction[3]	**18.5**	**20.4**	**20.8**	**17.4**	**12.0**	**14.0**	**13.2**	**9.3**	**19.8**	**16.7**	**0.0**	**19.8**	**16.7**	**4.8**

Notes:

[1] Typical shoulder width for both shoulders for all vehicles.

[2] Shoulder width for both shoulders for cars only.

[3] Percentage reduction in the roadway width (combined width of traffic lanes and shoulders) for mixed traffic to obtain the roadway width for cars-only traffic.

The results of the assessment are given in Table 4.2 together with the percentage reduction in the roadway width. According to Table 4.2, the reduction in the roadway width for provincial rural freeways was estimated to be 18.5 percent, whereas the reduction in the roadway width for municipal rural local roads is 0 percent. According to Table 3.3, typical traffic flow on provincial rural freeways contains 25 percent of commercial vehicles whereas the corresponding number on municipal rural local roads is 2 percent. The percentage reductions in the roadway width given in Table 4.2 were used for all 14 geographical regions. However, the computational model can accommodate separate inputs for the roadway width reduction for all 14 geographical regions.

4.1.2 Costs for Alignment Changes and Features Required for Commercial Vehicles

The cost of alignment changes and road features associated exclusively with commercial vehicles were allocated only to commercial vehicles. Alignment changes and road features attributable to commercial vehicles include the following items:

- The requirement for gentle longitudinal gradients. For example, for freeways, the geometric design guideline for the maximum longitudinal gradients of 3 percent or less can be relaxed for car-only freeway facilities in the wet-freeze environment to 6 percent[5].
- Truck climbing lanes, and a large portion of passing lanes.
- Truck inspection stations including the associated on and off ramps and lanes.
- Extra pavement and shoulder width on turning ramps and at intersections to manage pavement and truck body off tracking[6].
- Extra length of acceleration and deceleration ramps and lanes to accommodate trucks.
- Additional costs of safety appurtenances[7].
- Other costs, such as cost of noise barriers[8].

The recommended percentages of the total initial roadway construction costs that were allocated to commercial vehicles only, because of their unique demands on alignment changes and road design features, are given in Table 4.3. The percentages given in Table 4.3 were based on engineering judgment using specific engineering assumptions when possible. For example, according to data presented in Table 4.3, the highest percentage (7 percent) of the total initial roadway construction costs was allocated to commercial vehicles operating on provincial urban freeways.

Table 4.3. Allocation to CV because of alignment changes and design features

	Provincial								Municipal					
	Rural				Urban				Rural			Urban		
	Freeway	Arterial	Collector	Local	Freeway	Arterial	Collector	Local	Arterial	Collector	Local	Arterial	Collector	Local
Percentage of total initial roadway cost attributed to CV	3.0	2.0	1.0	1.0	7.0	4.0	2.0	1.0	2.0	1.0	1.0	3.0	2.0	1.0

The largest impact (due to commercial vehicles) on the initial road costs of urban freeways is probably associated with the length and width of acceleration and deceleration lanes and the width and length of interchange ramps. Based on ARA's asset management experience with urban freeways, about 30 percent of all paved surfaces belong to auxiliary facilities – ramps and acceleration and deceleration lanes. This would indicate that about 30 percent of all roadway costs are attributable to auxiliary facilities. However, auxiliary facilities are generally designed to a standard about 50 percent lower than the main traffic lanes, reducing the 30 percent to 15 percent. In the absence of CV, the length and width of the auxiliary lanes is about 2/3 of the length required for CV. Thus, one third of the 15 percent (5 percent) can be attributed to CV. Considering the other design features attributable to CV, the percentage was set to 7 percent.

[5] The 6 % limitation is dictated by the need to maintain the combined (longitudinal and cross-sectional) pavement surface slope below 8 percent in the wet-freeze environment to avoid sliding of vehicles on ice.

[6] Pavement off tracking is the difference between the track of the truck steering axle relative to the track of the truck rear axle. Off tracking of the truck body is defined in terms of the relative tracks of the front and back corners of the truck body.

[7] For example, concrete median walls are designed to prevent heavy trucks from crossing to the opposite direction.

[8] Typically, sound levels of trucks are 10 to 15 dBA higher than those of cars. Also, the elevated source height of trucks (about 1.5 m above ground) requires higher noise barriers than those needed for cars.

4.1.3 Costs of the Base Case for Initial Road Construction

The cost for the base case for the initial road construction was obtained by subtracting (a) the costs for the additional roadway width required for CV and (b) the costs for alignment changes and features attributable to CV only from the total initial road construction cost. The base case cost was distributed between cars and CV using the cost allocation percentages given in Table 3.5.

4.1.4 Calculation Procedure

The percentage of the initial roadway construction costs allocated to CV (PR_{CV}) was calculated using Equation 4. The remaining percentage was be allocated to cars.

$$PR_{CV} = PW_{CV} + \left\{(100 - PW_{CV})\frac{PR_{CV,A}}{100}\right\} + \left[100 - PW_{CV} - \left\{(100 - PW_{CV})\frac{PR_{CV,A}}{100}\right\}\right]\frac{PB_{CV}}{100} \qquad \text{Equation 4}$$

Where:

PW_{CV} = Percentage of the initial roadway construction costs allocated to CV because of additional width required for CV (from Table 4.2).

$PR_{CV,A}$ = Percentage of the initial roadway construction costs allocated to CV because of alignment changes and design features (from Table 4.3).

PB_{CV} = Percentage of the base case costs to be allocated to CV (from Table 3.5).

4.2 Allocation of Initial Pavement Construction Costs

The allocation of the initial pavement construction costs between cars and commercial vehicles was carried out for the following three cost items (Figure 4.3):

- Costs of the additional pavement width required for CV and allocated to CV only.
- Costs of the additional pavement structure required for CV and allocated to CV only.
- Costs of the base case for the initial pavement construction allocated to both cars and CV.

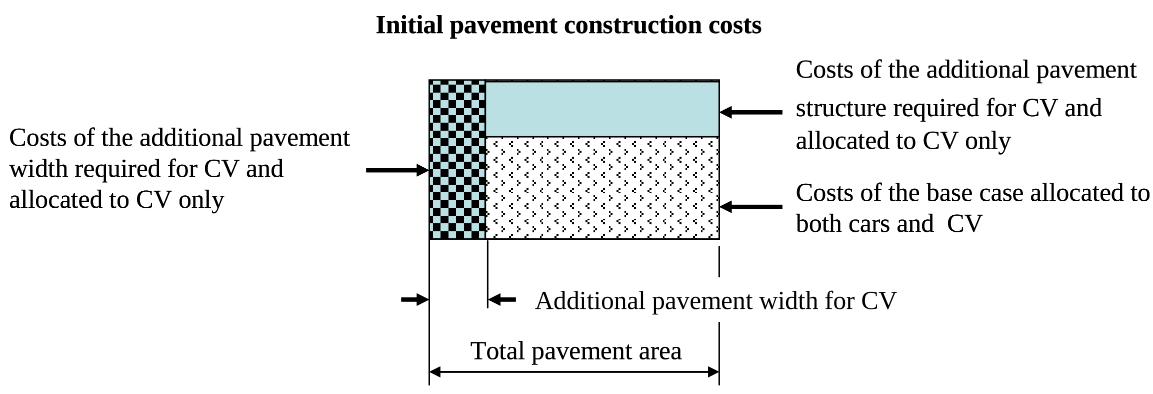


Figure 4.3. Allocation of initial pavement construction costs

4.2.1 Costs of the Additional Pavement Width Required for Commercial Vehicles

The cost of the additional pavement width required for CV is allocated to CV only. The cost of the additional pavement width is allocated in the direct proportion to the width of the roadway required for

CV established in Section 4.1.1. The percentage of the total initial pavement costs allocated to CV is given in Table 3.5.

4.2.2 Costs of the Additional Pavement Structure Required for CV

The costs of the additional pavement structure required for CV was allocated to CV only. The cost of the additional pavement structure was calculated as the difference in costs between the cost of the original pavement structure for all vehicles (established in the previous study [1]), and the cost of the pavement structure designed to accommodate cars only.

Pavement structures designed for cars only are expected to accommodate also the associated traffic (as defined in Section 4.1.1), and to withstand commensurable environmental exposure such as freeze-thaw cycles. Specific pavement structures for cars were developed for each of the 14 road functional classes in all 14 geographical regions. This resulted in the development of 196 separate pavement construction sheets for cars-only traffic. An example of a pavement construction sheet for cars-only traffic, developed for a rural freeway in southern Ontario, is given in Table 4.4. The development of pavement structures for the car-only scenario was based on engineering judgment. The 196 pavement construction sheets for cars-only traffic are included in the electronic version of the computational model described in Chapter 6.

Table 4.4. Cars-only pavement construction sheet for rural freeways in southern Ontario

Region: **Ontario, South**
Category: **Provincial Rural Freeway**
All quantities and costs are for one km of 2-lane highway

Geometric Design

Design feature	Dimension
Width of the two traffic lanes, m	7.50
Total width of both shoulders, m	5.00
Total width of both paved shoulders, m	3.50
Average AC thickness of the paved shoulders, mm	90

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	Dense Friction Course, mm (t)	40	750	$ 68.88	$ 51,660
Binder	Heavy Duty Binder, mm (t)	90	1688	$ 53.91	$ 90,973
Extra layer	HL-8, mm (t)	0	0	$ 49.42	$ -
OGDL	Open Graded Drainage Layer, mm (t)	0	0	$ 45.00	$ -
Base	Granular A, mm (t)	150	5369	$ 13.01	$ 69,855
Subbase	Granular B, mm (t)	300	9356	$ 6.71	$ 62,782
Shoulder	Dense Friction Course, mm (t)	40	350	$ 68.88	$ 24,108
Shoulder	Heavy Duty Binder, mm (t)	50	438	$ 53.91	$ 23,586
Subgrade				$ -	$ -
Subdrains	Includes trenching and outlets, % of occurrence (m)	10	100	$ 18.00	$ 1,800
Drainage	Closed drainage, % of occurrence (m)	10		$ -	$ -
Total					**$ 324,763**

For comparison purposes, the original pavement structure developed for the mixed traffic (that is the pavement structure designed for both cars and CV) is given in Table 4.5. The source of Table 4.5 is the Addendum to Reference 1, Page 92.

Table 4.5. Mixed-traffic pavement construction sheet for rural freeways in southern Ontario

Region: **Ontario, South**
Category: **Provincial Rural Freeway**
All quantities and costs are for one km of 2-lane highway

Geometric Design

Design feature	Dimension
Width of the two traffic lanes, m	7.50
Total width of both shoulders, m	6.00
Total width of both paved shoulders, m	4.50
Average AC thickness of the paved shoulders, mm	120

Initial Pavement Structure

Pavement layer	Description of pavement layer, Amount (Quantity)	Amount	Quantity per km	Price per unit of quantity	Cost
Surface	Dense Friction Course, mm (t)	40	750	$ 68.88	$ 51,660
Binder	Heavy Duty Binder, mm (t)	80	1500	$ 53.91	$ 80,865
Extra layer	HL-8, mm (t)	200	3750	$ 49.42	$ 185,325
OGDL	Open Graded Drainage Layer, mm (t)	10	188	$ 45.00	$ 8,438
Base	Granular A, mm (t)	150	9114	$ 13.01	$ 118,571
Subbase	Granular B, mm (t)	450	15906	$ 6.71	$ 106,726
Shoulder	Dense Friction Course, mm (t)	40	450	$ 68.88	$ 30,996
Shoulder	Heavy Duty Binder, mm (t)	80	900	$ 53.91	$ 48,519
Subgrade				$ -	$ -
Subdrains	Includes trenching and outlets, % of occurrence (m)	10	100	$ 18.00	$ 1,800
Drainage	Closed drainage, % of occurrence (m)	10		$ -	$ -
Total					**$ 632,900**

The comparison of data given in Table 4.4 and Table 4.5, indicates that the total cost for the initial pavement construction for a cars-only structure is 51.3 percent of the corresponding cost for the initial pavement structure for mixed traffic ($324,763 for cars-only versus $632,900 for mixed traffic). The corresponding allocation to CV is 48.7%. The percentage of the costs for the additional pavement structure required for CV only, for all road functional classes and geographical regions, is given in Table 4.6. As expected, data presented in Table 4.6 indicate that, in general, as the percentage of truck traffic decreases (with decreasing road functional class or importance, Table 3.3), a smaller percentage of the additional pavement structure is allocated to commercial vehicles only. For some cases (e.g., municipal urban local roads in Saskatchewan), no additional costs were allocated to trucks only because it was assumed that there is no significant difference in pavement structures for cars-only and mixed-traffic scenarios.

The width of the traffic lanes and shoulders in Table 4.4 (for cars-only) was assumed to be the same as in Table 4.5 (for mixed traffic). This assumption was made for computational efficiency to obtain the percentage difference in the costs attributable to the differences in the pavement structure only. The difference in the roadway width was calculated separately as outlined in Section 4.1.1.

Table 4.6. Percentage cost allocation for additional pavement structure required for CV only

Region	Provincial								Municipal					
	Rural				Urban				Rural			Urban		
	Freeway	Arterial	Collector	Local	Freeway	Arterial	Collector	Local	Arterial	Collector	Local	Arterial	Collector	Local
NL	49.4%	16.5%	30.6%	21.2%	47.9%	24.5%	27.2%	22.0%	7.1%	27.8%	0.0%	5.8%	24.0%	18.4%
PE	29.0%	33.0%	43.8%	0.0%	17.6%	18.1%	28.5%	36.4%	18.2%	17.4%	0.0%	7.5%	16.2%	21.5%
NS	33.8%	22.0%	40.0%	11.7%	32.5%	14.5%	30.9%	14.9%	24.5%	27.0%	0.0%	23.5%	19.6%	16.0%
NB	30.1%	20.1%	12.4%	34.5%	19.7%	30.4%	32.9%	50.3%	15.9%	23.4%	0.0%	17.3%	23.9%	24.9%
QC-1	39.8%	39.2%	21.4%	19.1%	14.8%	20.5%	19.5%	18.4%	22.2%	17.5%	0.0%	13.9%	10.1%	12.4%
QC-2	40.0%	40.3%	36.8%	33.3%	32.1%	41.1%	38.7%	43.0%	40.1%	17.3%	0.0%	15.6%	10.0%	14.6%
ON-1	48.7%	36.2%	31.1%	32.0%	51.0%	31.3%	33.1%	32.8%	22.0%	25.7%	0.0%	22.5%	29.8%	34.2%
ON-2	35.9%	18.8%	23.8%	16.8%	47.4%	35.7%	32.4%	45.4%	30.7%	30.9%	0.0%	30.0%	29.3%	27.3%
MB	22.5%	23.6%	11.1%	34.5%	13.5%	30.1%	6.5%	34.5%	18.4%	6.1%	0.0%	19.2%	4.7%	24.9%
SK	30.6%	42.4%	33.5%	0.0%	22.4%	11.9%	6.2%	27.8%	21.1%	0.0%	0.0%	23.0%	27.9%	0.0%
AB	18.7%	17.7%	18.6%	16.0%	13.6%	13.9%	15.6%	17.3%	18.7%	20.2%	0.0%	20.0%	21.1%	22.0%
BC-1	27.8%	24.9%	20.3%	13.2%	22.2%	23.6%	15.4%	0.0%	24.9%	25.8%	0.0%	13.2%	16.1%	15.1%
BC-2	30.6%	29.3%	23.2%	0.0%	25.8%	27.1%	19.6%	0.0%	28.2%	27.9%	0.0%	27.3%	13.6%	15.3%
TR	5.3%	6.2%	13.6%	0.0%	5.4%	12.9%	13.6%	0.0%	6.2%	0.0%	0.0%	11.1%	12.2%	17.1%

4.2.3 Costs of the Base Case for Initial Pavement Construction

The base case cost for the initial pavement construction was distributed between cars and CV using the cost allocation percentages given in Table 3.5.

4.2.4 Calculation Procedure

The percentage of the initial pavement construction costs allocated to CV (PP_{CV}) was calculated using Equation 5. The remaining percentage was allocated to cars.

$$PR_{CV} = PW_{CV} + \left\{(100 - PW_{CV})\frac{PP_{CV,A}}{100}\right\} + \left[100 - PW_{CV} - \left\{(100 - PW_{CV})\frac{PP_{CV,A}}{100}\right\}\right]\frac{PB_{CV}}{100} \qquad \text{Equation 5}$$

Where:

PW_{CV} = Percentage of the initial pavement construction costs allocated to CV because of additional width required for CV (from Table 4.2).

$PP_{CV,S}$ = Percentage of the initial pavement construction costs allocated to CV because CV require additional pavement strength.

$PP_{CV,S}$ = (Cost of cars-only pavement – Cost of mixed-traffic pavement) * 100.

PB_{CV} = Percentage of the base case costs to be allocated to CV (from Table 3.5).

4.3 Allocation of Initial Bridge Construction Costs

The allocation of the initial bridge construction costs between cars and commercial vehicles was carried out for the following three cost items (Figure 4.4):

- Costs of the additional bridge deck area required for CV and allocated to CV only.
- Costs of the additional bridge structure required for CV and allocated to CV only.
- Costs of the base case bridge structure allocated to both cars and CV.

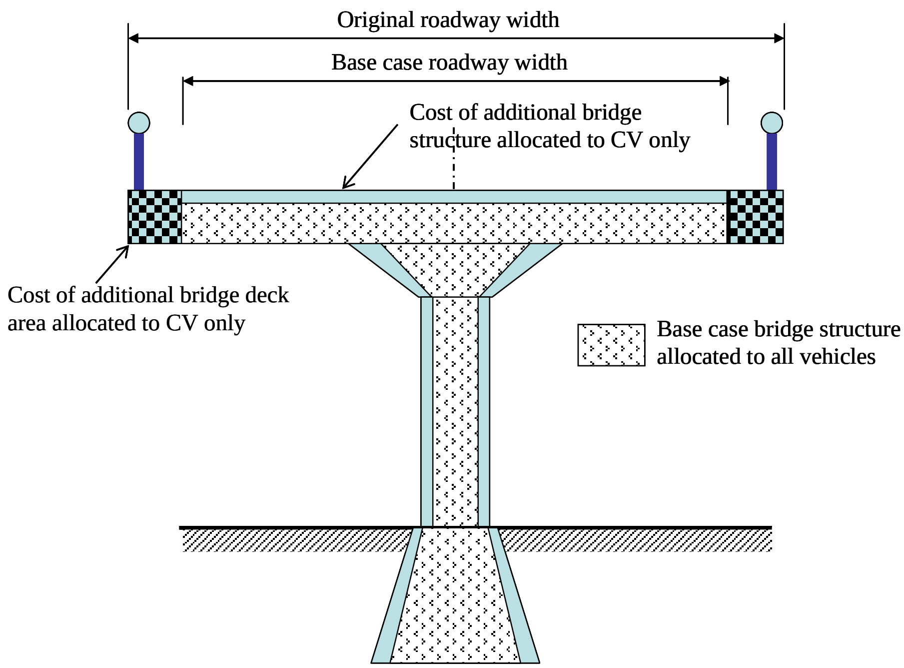


Figure 4.4. Allocation of initial bridge costs.

4.3.1 Costs of the Additional Bridge Deck Area Required for CV

The cost of the additional bridge deck area (bridge width) required for CV was allocated to CV only in the direct proportion to the width of the roadway required for CV established in Section 4.1.1. The percentage reduction in roadway width is given in Table 4.2.

4.3.2 Costs of the Additional Bridge Structure Required for CV

It was assumed that the base case bridges are only strong enough to accommodate cars and associated supporting vehicles. The associated supporting vehicles include emergency response vehicles (e.g., ambulances, emergency-response buses, and 2-axle fire engines), vehicles required to provide routine and winter maintenance (e.g., high-speed snow ploughs), and vehicles required for maintenance and rehabilitation operations (e.g., dump trucks for the transportation of paving materials, loaded trucks transporting construction equipment such as a hot-mix paver, and bucket-trucks used for bridge inspection). Consequently, the appropriate bridge design vehicle for the base case bridge structure would probably be a fully loaded 4-axle dump truck. In addition, the base case bridge structure should withstand wind and seismic loads, and scouring forces of water flows.

The base case bridges represent a theoretical scenario created for allocation purposes only. It was assumed that bridges are designed to the loads given in the Ontario or the Canadian Standards Association Bridge Code. If a bridge is designed to a lesser load, as soon as it is opened it must be posted for its capacity so that it is not used by vehicles beyond the design capacity. Highway agencies typically design any new bridge for the full design load and an amount of traffic appropriate to the use of the road. However, even though a bridge may be on a route that sees little truck traffic, it may still need to be strong enough to allow truck traffic to be diverted to it if a highway carrying high volume of truck traffic is unexpectedly closed.

The estimated additional initial construction cost to strengthen the base case bridges to accommodate mixed traffic is shown in Table 4.7 as the percentage increase in costs. The increase is only for the additional structural strength, not for the additional bridge deck area required to accommodate frequent use by trucks. Table 4.7 also shows the number of 5-or-more-axle trucks per day the bridges are expected to accommodate (and also the corresponding AADT volumes). For example, Municipal Urban Arterial roads are expected to accommodate about three 5-or-more-axle trucks per day.

Table 4.7. Estimated increase in cost required for bridge strengthening

Parameter	**Provincial Roads**								**Municipal Roads**					
	Rural				**Urban**				**Rural**			**Urban**		
	Freeway	**Arterial**	**Collector**	**Local**	**Freeway**	**Arterial**	**Collector**	**Local**	**Arterial**	**Collector**	**Local**	**Arterial**	**Collector**	**Local**
Expected increase in bridge structural costs above that required for the base case, %	8.0	4.0	3.0	2.0	7.0	3.0	2.5	2.0	3.0	2.0	1.0	2.5	2.0	1.0
Average daily number of 5-or-more axle trucks per 2-lane facility	144	31.2	1.6	0.1	124	11.9	0.62	0.06	6.6	0.2	0.0	3.4	0.1	0.0
Typical 2-lane AADT volume	8000	4000	2000	800	10000	4500	2500	1000	2500	1000	500	2800	1200	600

The increase in costs to accommodate additional CV given in Table 4.7 was based on engineering judgement with the following underpinning assumptions:

A) The strengthening costs include the costs of bridge deck and its superstructure, support columns, and bridge foundations (Figure 4.4).

B) The bridge strengthening is required to accommodate 5-or-more-axle trucks and the repetitive loads by all trucks.

C) The cost of bridge strengthening does not include the cost of a larger bridge deck area required to accommodate trucks. The need for a larger bridge deck area is a separate cost item.

D) Because the base case bridges need to accommodate a fully loaded 4-axle dump truck, the structural bridge components spanning less than about 8 m should not require significant strengthening[9].

E) It is estimated that the number of "all concrete" bridges (e.g., cast-in-place concrete slabs or concrete slabs on concrete beams) represents the majority of all bridge types in Canada[10].

F) "All concrete" bridges are not typically designed for fatigue damage, and for these bridges the number of load repetitions is not a significant design consideration. There may be some exceptions, for example for some post-tensioned concrete bridges.

G) All concrete bridges have a larger ratio of the live and dead loads, compared to the steel bridges. Consequently, the cost of concrete bridges is not as sensitive to the changes in the live loads as the cost of steel bridges.

H) Bridges serving lower road functional classes such as collector and local roads tend to be shorter and have shorter spans than bridges serving freeways and arterial roads.

I) Because of the expected shorter spans for bridges on collector and local roads, the majority of these bridges are "all concrete" bridges.

J) The cost of strengthening for all concrete bridges, considering the live to dead weight ratio and fatigue damage considerations, is lower than that for other bridge types.

K) As shown in Table 4.7, bridges serving lower road functional classes are expected to be exposed to a considerably lower number of load repetitions (involving 5-or-more axle trucks) than bridges serving freeways and arterial roads.

L) The additional strengthening costs are only for the initial construction costs. Subsequent maintenance and rehabilitation costs are considered separately.

Improved estimates of costs for the additional bridge structure can be obtained using the methodology described in NCHRP Report 495 [14]. This methodology was developed by estimating the bridge network costs associated with changes in legal and permit gross vehicle weights, axle weights, and axle configurations. However, the use of this methodology requires detailed bridge structural data and needs to be applied to each geographical area separately. These conditions cannot be met within the parameters of this study.

4.3.3 Costs of the Base Case for Initial Bridge Construction

The base case cost for the initial bridge construction is distributed between cars and CV using the cost allocation percentages given in Table 4.2.

4.3.4 Calculation Procedure

The percentage of the initial bridge construction costs allocated to CV (PB_{CV}) is calculated using Equation 6. The remaining percentage is allocated to cars.

$$PB_{CV} = PW_{CV} + \left\{(100 - PW_{CV})\frac{PB_{CV,S}}{100}\right\} + \left[100 - PW_{CV} - \left\{(100 - PW_{CV})\frac{PB_{CV,S}}{100}\right\}\right]\frac{PB_{CV}}{100} \qquad \text{Equation 6}$$

[9] According to the Commentaries to the *Ontario Highway Bridge Design Code*, 3rd addition, the critical loading for deck components and short-span structural components with span length up to 8 m is generally caused by single wheel or axle group loads.

[10] The frequency of occurrence of "all concrete" bridges and bridges with concrete substructures versus steel substructures probably varies with the geographical region.

Where:
PW_{CV} = Percentage of the initial bridge construction costs allocated to CV because of additional bridge deck area required for CV (from Table 4.2).
$PB_{CV,S}$ = Percentage of the initial bridge construction costs allocated to CV because CV require additional bridge strength (from Table 4.7).
PB_{CV} = Percentage of the base case costs allocated to CV (from Table 3.5).

4.4 Allocation of M&R Costs for Road Infrastructure

The maintenance and rehabilitation (M&R) costs for road infrastructure include M&R cost for all road infrastructure components with the exception of pavements and bridges. Thus, this cost is a follow-up M&R cost for the initial road construction discussed in Section 4.1.

The M&R costs for road infrastructure, called *M&R cost for all other road infrastructure* in Reference 1, is typically about 1 to 6 percent of the total infrastructure cost (Appendix E in Reference 1). Considering the relatively small costs for this item, its allocation between cars and commercial vehicles is based only on the usage – on the cost allocation percentages given in Table 3.5. The calculation formula is given in Equation 7.

$$PM\&RRCV = PBCV \qquad \text{Equation 7}$$

Where:
$PM\&R_{CV}$ = Percentage of the M&R costs for road infrastructure allocated to CV.
PB_{CV} = Percentage of the base case costs to be allocated to CV (from Table 3.5).

4.5 Allocation of Pavement M&R Costs

The allocation of the pavement M&R costs between cars and commercial vehicles was carried out for the following three cost items (Figure 4.5):

- Pavement M&R costs due the additional area required for CV and allocated to CV only.
- Pavement M&R costs due to traffic loads allocated to CV only.
- Pavement M&R costs due to the environment allocated to all vehicles.

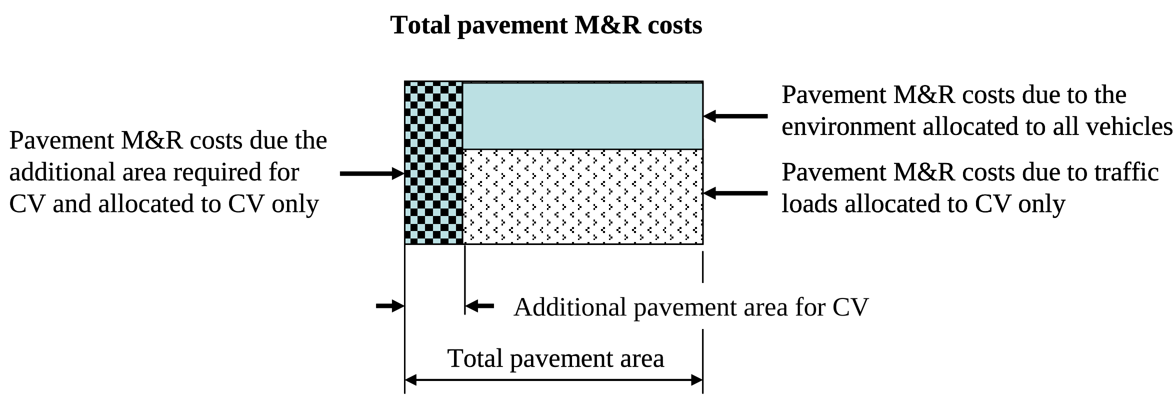


Figure 4.5. Allocation of pavement maintenance and rehabilitation costs.

4.5.1 M&R costs due to the additional pavement area required for CV

The pavement M&R cost for the additional pavement area required for CV is allocated to CV only. The cost is allocated in the direct proportion to the width of the roadway required for CV established in Section 3.1.1 based on the percentage reduction in roadway width given in Table 4.2.

4.5.2 Pavement M&R Costs due to the Traffic Loads

After subtracting the pavement M&R costs required for the additional pavement area, the remaining M&R costs can be divided into (a) M&R costs due to traffic loads and (b) M&R costs due to the environmental exposure. Pavement M&R cost caused by pavement deterioration due to traffic loads were attributed to commercial vehicles only[11]. The rest of the costs are M&R costs due to the environmental exposure, and these costs were attributed to all vehicles.

The proportion of the total M&R cost attributed to the traffic loads was estimated using the results of a recent study carried out by Laval University [15], and engineering judgement. The results of the Laval study, obtained from Reference 9, are summarized in Table 4.8.

Table 4.8. Traffic damage indices for Canadian conditions

Highway classification	Subgrade soil type			
	Fine grained			Coarse
	Wet-freeze environment		Dry-freeze environment	Average conditions
	High frost	Low frost	High frost	
Major highways	0.65	0.70	0.50	0.8
Other highways	0.60	0.65	0.45	0.7
Local roads	0.55	0.60	0.45	0.6
Municipal roads	0.55	0.60	0.45	0.6

The recommended traffic damage indices are given in Table 4.9. The traffic damage index, multiplied by 100 is equal to the percentage of M&R costs allocated to pavement damage due to traffic loads, and thus allocated to CV only. For example, traffic damage index for a provincial rural arterial road in Newfoundland of 0.60 means that 60 percent of the pavement M&R costs is attributed to traffic loads (and thus to CV), whereas the remaining 40 percent of the cost is attributed to the environmental exposure and thus to all vehicles.

The following assumptions were used to develop the recommended traffic damage indices (TDI).

- All other factors being equal, TDI should increase with increasing traffic loads. The highest TDI was allocated to rural freeways in Southern Ontario and in Southern Quebec (Champlain Plain).
- All other factors being equal, TDI should decrease with the increase in moisture (wet-freeze against dry-freeze).
- All other factors being equal, TDI should decrease with the increase in frost depth penetration (high-frost versus low-frost).
- Coarse subgrade soils tend to reduce fatigue damage, but increase low-temperature cracking, particularly in high frost regions.

[11] Number of ESAL per car (the truck factor) is about 0.001. This makes the impact of cars on pavement damage caused by traffic loads insignificant.

- All other factors being equal, TDI should increase with the increase in the road functional class because higher road classes carry more traffic loads.
- All other factors being equal, TDI factors for rural roads should be higher than for urban roads because rural roads carry higher traffic loads (not higher traffic volumes).

Table 4.9. Recommended traffic damage indices

Geographical region	Provincial Roads								Municipal Roads					
	Rural				Urban				Rural			Urban		
	Freeway	Arterial	Collect.	Local	Freeway	Arterial	Collect.	Local	Arterial	Collect.	Local	Arterial	Collect.	Local
NF	0.60	0.60	0.50	0.50	0.55	0.55	0.45	0.45	0.60	0.50	0.50	0.55	0.45	0.45
PE	0.70	0.70	0.60	0.60	0.65	0.65	0.55	0.55	0.70	0.60	0.60	0.65	0.55	0.55
NS	0.65	0.65	0.55	0.55	0.60	0.60	0.50	0.50	0.65	0.55	0.55	0.60	0.50	0.50
NB	0.65	0.65	0.55	0.55	0.60	0.60	0.50	0.50	0.65	0.55	0.55	0.60	0.50	0.50
QE - CP	0.65	0.65	0.55	0.55	0.60	0.60	0.50	0.50	0.65	0.55	0.55	0.60	0.50	0.50
QE - N	0.50	0.50	0.40	0.40	0.45	0.45	0.35	0.35	0.50	0.40	0.40	0.45	0.35	0.35
ON - S	0.70	0.70	0.60	0.60	0.65	0.65	0.55	0.55	0.70	0.60	0.60	0.65	0.55	0.55
ON - N	0.55	0.55	0.45	0.45	0.50	0.50	0.40	0.40	0.55	0.45	0.45	0.50	0.40	0.40
MB	0.60	0.60	0.50	0.50	0.55	0.55	0.45	0.45	0.60	0.50	0.50	0.55	0.45	0.45
SK	0.60	0.60	0.50	0.50	0.55	0.55	0.45	0.45	0.60	0.50	0.50	0.55	0.45	0.45
AB	0.65	0.65	0.55	0.55	0.60	0.60	0.50	0.50	0.65	0.55	0.55	0.60	0.50	0.50
BC - C	0.80	0.80	0.70	0.70	0.75	0.75	0.65	0.65	0.80	0.70	0.70	0.75	0.65	0.65
BC - I	0.65	0.65	0.55	0.55	0.60	0.60	0.50	0.50	0.65	0.55	0.55	0.60	0.50	0.50
TR	0.45	0.45	0.40	0.40	0.40	0.40	0.40	0.40	0.45	0.40	0.40	0.40	0.40	0.40

4.5.3 Pavement M&R Costs due to the Environment

Pavement M&R costs caused by pavement deterioration due to the environmental exposure are allocated to cars and commercial vehicles depending on their usage of the road capacity as outlined in Section 4.1.1 using percentages given in Table 4.9.

4.5.4 Calculation Procedure

The percentage of the pavement M&R costs allocated to CV ($PM\&RP_{CV}$) is calculated using Equation 8. The remaining percentage is allocated to cars.

$$PM\&RP_{CV} = PW_{CV} + \left\{(100 - PW_{CV})\frac{PM\&RP_{CV,T}}{100}\right\} + \left[100 - PW_{CV} - \left\{(100 - PW_{CV})\frac{PM\&RP_{CV,T}}{100}\right\}\right]\frac{PB_{CV}}{100} \quad \text{Equation 8}$$

Where:

PW_{CV} = Percentage of the pavement M&R costs allocated to CV because of additional pavement area required for CV (from Table 4.2).

$PM\&R_{CV,T}$ = Percentage of the pavement M&R costs allocated to CV because of traffic loads (from Table 4.9).

PB_{CV} = Percentage of the base case costs to be allocated to CV (from Table 3.5).

4.6 Allocation of Bridge M&R Costs

The total bridge M&R costs for the mixed traffic were estimated in Reference 1. Considering the relatively small costs for this item (less than 2 percent of the total cost), the allocation of bridge M&R costs between cars and commercial vehicles was carried out in the same proportion as the allocation established for new bridge construction (PB_{CV} calculated by Equation 6).

4.7 Allocation of Routine Maintenance Costs between Cars and Commercial Vehicles

Cost of routine maintenance[12] is related to the size of road infrastructure characterized by parameters such as the traffic lane width and the right-of way width. The size of the road infrastructure is related to the capacity of the road and usage. For this reason, the cost of routine maintenance is distributed between cars and CV according to their usage of the road capacity. The calculation formula is given by Equation 9.

$$PRM_{CV} = PB_{CV} \qquad \text{Equation 9}$$

Where:
PRM_{CV} = Percentage of the routine maintenance costs allocated to CV.
PB_{CV} = Percentage of the base case costs allocated to CV (from Table 3.5).

4.8 Allocation of Winter Maintenance Costs

Cost of winter maintenance is directly related to the size of road infrastructure. Consequently, the allocation of the winter maintenance costs between cars and commercial vehicles was carried out using the same procedure as that used for routine maintenance costs (Section 4.7). It was proposed, in the *Allocation Options* study [9], to allocate winter maintenance costs according to vehicle kilometres of travel. This allocation does not recognize that a typical commercial vehicle consumes a larger portion of road capacity than a typical car and that the larger portion of the road incurs larger winter maintenance costs. The calculation formula is given by Equation 10.

$$PWMCV = PBCV \qquad \text{Equation 10}$$

Where:
PWM_{CV} = Percentage of the winter maintenance costs allocated to CV.
PB_{CV} = Percentage of the base case costs to be allocated to CV (from Table 3.5).

[12] The definition of routine maintenance costs is given in Reference 1.

5. ALLOCATION OF COSTS FOR CV BETWEEN TRUCKS AND BUSES

The previous section described the methodology used for allocating total road infrastructure costs between cars and commercial vehicles. This section deals with the allocation of costs, attributed to CV, between trucks and buses (Second step in Figure 3.1).

The overall share of costs attributed to buses is typically quite small because the bus volumes are small. The 1997 Federal Highway Cost Allocation Study [6] estimated that the number of buses is 0.3 percent of the total number of vehicles and that the buses account for 0.2 percent of the total vehicle miles of travel (VMT). An Indiana study [16] estimated that the buses account for 0.164 percent of the total VMT, and for 0.53 percent of total costs. According to an Arizona study [2], the cost responsibility for buses on urban roads is 0.44 percent (based on VMT) and 0.53 percent on rural roads (based on PCE).

The review of the Canadian Long-Term Pavement Performance (C-LTPP) traffic database[13] [12] and the LTPP database[14] [10, 11] indicates that bus volumes seldom exceed one percent of the total traffic volume and five percent of the total CV traffic volume. However, on some municipal urban arterial and collector roads with transit bus routes, buses may constitute the majority of commercial traffic. For this reason, the cost allocation between trucks and buses was carried out for two cases:

- Overall case where the allocation was based on average bus volumes.
- Segment-specific case where the allocation was carried out for a specific road segment in a specific municipality.

The latter case is used to explore possible range of costs attributable to buses.

5.1 Overall Allocation

The possible cost allocators include:

- Bus traffic volumes.
- Passenger Car Equivalency factors (PCE).
- Equivalent Single Axle Loads (ESAL).

Bus traffic volumes – Bus traffic volume is an important cost allocation factor. However, bus volume data are not readily available and are not included in Reference 1. Bus volume data given in Table 3.3 were developed using engineering judgement.

PCE factors – PCE factors for buses, for a given road functional class, are probably similar to PCE factors for an average truck[15]. Thus, the use of PCE factors does not provide an effective way for allocating costs between trucks and buses.

ESAL – The average number of ESALs per bus (i.e. the Truck Factor for buses) has been estimated to be 1.1 with the range between 0.3 and 2.2). Smaller factors apply to school buses and the large factors to

[13] The database contains classified vehicle volumes for 24 locations covering all Provinces for years between 1990 and 2002.

[14] This database contains classified vehicle volumes (including buses) for over 600 sites in the US and Canada for the period of 1989 to 2004.

[15] There are three basic types of buses: local transit buses, intercity buses, and school buses. Typical length of transit buses is 12.2 m (49 feet), although articulated buses are up to 18.3 m (60 feet) in length. Intercity buses may have 3 axles. All other buses have 2-axles.

intercity buses and transit buses operating in larger municipalities. For a given road functional class, the average truck factors for buses are probably similar to those for trucks.

Considering the uncertainty of bus volumes and the relative ineffectiveness of PCE factors and ESALs as cost allocators, the overall allocation of costs between trucks and buses was carried out in the proportion of buses in the commercial vehicle flow (i.e., in the proportion of vehicle kilometres of travel).

The percentage of the costs allocated to buses (PB_i) was calculated using Equation 11. The remaining percentage was allocated to trucks.

$$PB_i = PCV_i \frac{\%\ Bus}{\%\ of\ CV} \qquad \text{Equation 11}$$

Where:

PB_i = Percentage of costs attributed to buses for cost type i.
i = One of the eight cost types comprising the total infrastructure cost.
% Bus = Percentage of buses in the traffic flow (from Table 3.3).
% of CV = Percentage of CV in the traffic flow (from Table 3.3).

The results of the overall cost allocation for buses are summarized in Cost Allocation Reporting Sheets given in Appendix A. An example of the Cost Allocation Reporting Sheet is given in Figure 7.1.

5.2 Allocation for Specific Road Segments

Urban transit buses can play an important role in the allocation of costs to buses for municipal urban and arterial roads. However, the costs attributable to transit buses depend on local circumstances as illustrated by the following examples.

- Specific traffic lanes on municipal urban arterial roads can be used exclusively by transit buses (e.g., arterial roads connecting busways in the City of Ottawa) or buses may receive preferential treatment (e.g., lanes reserved for buses and carpools in the City of Toronto during peak traffic hours).
- Transit buses in large cities can cause considerable pavement damage. In many jurisdictions, transit buses receive exemptions from the allowable axle weights[16]. Also, transit buses frequently stop and accelerate in the same place causing extensive pavement damage (particularly rutting of the asphalt concrete layer).
- Based on our extensive pavement design work for major Canadian cities, and technical discussions with city engineering staff, the major design consideration for pavement design of arterial roads is the pavement damage caused by transit buses.
- To avoid rutting of asphalt concrete pavements, some municipalities build Portland cement concrete (PCC) pavements in the vicinity of bus stops on all major bus routes. The concrete pavement segment is typically 60 m long and one traffic lane wide. The building of PCC inlays in asphalt concrete pavements increases pavement costs disproportionately because the contractor has to use two different paving technologies.

[16] Transit buses have only two axles to maximize manoeuvrability, even though they may require a real tandem axle to accommodate passenger crush capacity loads. Inter-urban buses have typically 3 axles (single and tandem axle).

- Some municipalities routinely use PCC pavements on arterial roads. The decision to build PCC pavements on arterial and collector roads may be partially motivated by the need to accommodate transit buses.

In order to explore the upper range of the road costs attributable to buses, two specific transit bus routes scenarios were evaluated:

A) Municipal urban collector road that is used by a transit bus route in Brantford, a medium-size municipality in Southern Ontario. The selected road segment is on North Park Street near Highway 403.

B) Municipal urban arterial road that is used by a transit bus route in Toronto, Ontario. The selected segment is Wilson Avenue east of Yonge Boulevard (near Yonge Street).

The evaluation of the segment-specific costs attributable to buses was carried out for the initial pavement construction costs only. Pavement maintenance and rehabilitation costs attributable to buses also increase with the additional buses loads. However, considering the exploratory nature of the analysis and relatively small pavement maintenance and rehabilitation costs, the estimates based on initial pavement costs should provide sufficient information on the potential influence of specific transit bus routes on cost allocation for buses. Other types of costs are not significantly influenced by increased bus volumes and are not included in the analysis.

The results of the scenario evaluation and the procedure used are summarized in Table 5.1 and in Table 5.2. According to Items 10 and 11 in Table 5.2, the allocation of the initial pavement costs to buses, for a specific road section with a transit bus route in Brantford, increased from 15 percent (obtained for the overall allocation) to 31.8 percent. The corresponding increase in the percentage of allocated costs for a transit bus route in Toronto was from 9.0 to 47 percent. According to Items 12 and 13, the total cost allocation to buses, for a specific road section with a transit bus route in Brantford, increased from 11.3 percent (obtained for the overall allocation) to 13.9 percent. The corresponding increase in the percentage of the total allocated costs for a transit bus route in Toronto was from 7.7 to 32.6 percent. These increases do not include the potential additional increase due to the site-specific allocation of pavement maintenance and rehabilitation costs[17].

The large increase in the percentage of costs allocated to the Toronto transit route is due to the pavement structure incorporating a 225 mm thick Portland cement concrete base. The concrete base is required to accommodate bus traffic loads and to minimize pavement rutting.

The calculations summarized in this section are exploratory in nature and are based on many assumptions and simplifications. They are intended only to explore the possible range in cost allocation percentages for buses for municipal roads with transit bus routes.

[17] Also not included is the additional cost occasioned by the presence of several partial bus bays at bus stops for Case B (Wilson Avenue in Toronto). A partial bus bay is defined as a short additional right lane built at an intersection, on the “arrival” side of the intersection. Partial bus bays also facilitate merging of vehicles turning right at intersections.

Table 5.1. Traffic loads for the transit bus routes scenarios

Item or Note No.	Condition	Bus study section	
		Case A Brantford	**Case B Toronto**
1	Bus headways during workday peak periods, minutes	20	5
2	Total length of the peak period per average work day, hours	3	6
3	Bus headways during workday off-peak periods, minutes	30	15
4	Total length of the peak period per average work day, hours	8	11
5	Total number of buses per average workday	25	118
6	Average number of ESAL per average bus	1.0	4.0
7	Total average number of ESAL imposed by buses per work day	25	472
8	Total average daily number of ESAL imposed by all commercial vehicles	45	562
9	Percentage of total ESALs imposed by buses	55.5%	84%
10	Total annual number of ESAL per design lane	12,900	205,100
11	Is the representative (existing) pavement structure adequate for traffic loads?	Yes	No
12	Representative annualized initial pavement construction cost, $	$15,138	$18,005
13	Cost of the additional pavement structure to accommodate buses, $	None	$8,594

Notes

1. *There are several bus routes on Wilson Avenue. The selected headway is a combined average headway for all bus routes.*
6. *Selected ESAL values take into account the damaging effect of buses on asphalt concrete pavement layers because of frequent stops at the same location.*
7. *Assumes vehicle type percentages given in Table 3.3 and daily traffic volumes of 600 vehicles for Case A and 3000 vehicles per average work day for case B*
10. *Annual number was obtained by multiplying average workday number by 300. This takes into account lower level of bus service on weekends and holidays.*
11. *It is assumed that for Case A, the representative pavement structure defined in Reference 1 for municipal urban collector road in Southern Ontario is adequate. In other words, it is assumed that the existing pavement design can carry the expected traffic loads, including bus loads. For Case B, the representative pavement structure (defined for a municipal urban arterial road in Reference 1) is inadequate. The pavement structure used by the City of consists of 225 mm thick Portland cement concrete base with 90 mm of asphalt concrete on top, and 150 mm of Granular A base below.*
12. *Representative annualized initial pavement construction costs reported in Reference 1 for Southern Ontario (Appendix E, Page 7). For Case A, the cost is for municipal urban collector road in Southern Ontario. For Case B, the cost is for municipal urban arterial road in Southern Ontario.*
13. *The unit costs for asphalt concrete and granular base layer material are those used in Reference 1. The cost of PCC was assumed to be $50.00 per meter square.*

Table 5.2 Cost allocations for transit bus routes scenarios

Item or Note No.	Condition	Bus study section	
		Case A Brantford	**Case B Toronto**
Cost for the additional pavement width			
1	Percentage of the cost of the additional pavement width required for CV	16.7	19.8
2	Percentage of the cost of the additional pavement width required for buses only using site-specific bus volume data	5.0%	6.0%
Cost for additional pavement structure			
3	Percentage of the initial pavement construction cost required for CV only	45.1%	44.8%
4	Percentage of the initial pavement construction cost attributable to buses only.	55.5%	84%
5	Percentage of the initial pavement construction costs required for buses	25.0%	37.6%
6	Cost of the additional pavement structure required to accommodate buses expressed as the percentage of the total initial pavement cost.	None	95%
7	Cost of the additional pavement structure to accommodate buses expressed as the percentage of the total road cost.	None	22.0%
Cost for the base case			
8	Percentage of the base cost allocated to CV	6.0%	11.3%
9	Percentage of the base cost allocated to buses only using site-specific bus volume data	1.8%	3.4%
Total initial pavement construction costs			
10	Representative percentage of the total initial pavement costs allocated to buses	15.0%	9.0%
11	Site specific percentage of the initial pavement costs allocated to buses not including additional initial pavement cost	31.8%	47.0%
12	Total representative percentage of costs attributable to buses	11.3%	7.7%
13	Total site specific percentage of the initial pavement costs allocated to buses including the additional pavement costs expressed as the percentage of the total road cost.	13.9%	32.6%

Notes

1. PW_{CV} *in Equation 4.*
2. *Based on volume of all CV versus volume of buses only. Assumes that 30% of all CV are buses for both cases.*
3. *Based on the representative results.* $PP_{CV,,S}$ *defined for Equation 4.*
4. *The percentage is based on the ESAL values for all CV and for buses only given in Table 5.1.*
5. *Based on percentages for Items 3 and 4.*
6. *Refer to Items 12 and 13 in Table 5.1.*
7. *The total annualized road cost is $39,147 and $34,678 for Case A and Case B, respectively.*
8. PB_{CV} *in Equation 4.*
9. *Same as Item 2.*
10. *According to the data provided in Figure 7.1.*
11. *Based on site-specific allocation (Addition of Items 2, 5, and 9).*
12. *According to the data provided in Figure 7.1.*
13. *Refer to Note 7. The calculation assumes that 50 percent of the cost of the PCC base is attributable to buses. In other words, the concrete base is part of the base case.*

6. COMPUTATIONAL MODEL

The Excel-based computational model developed by ARA for the calculation of representative annualized costs described in Reference 1 was expanded to include the estimation of cost allocations for cars, trucks, and buses. The schema of the expanded computational model is shown in Figure 6.1. The electronic version of the cost allocation model was submitted together with this report.

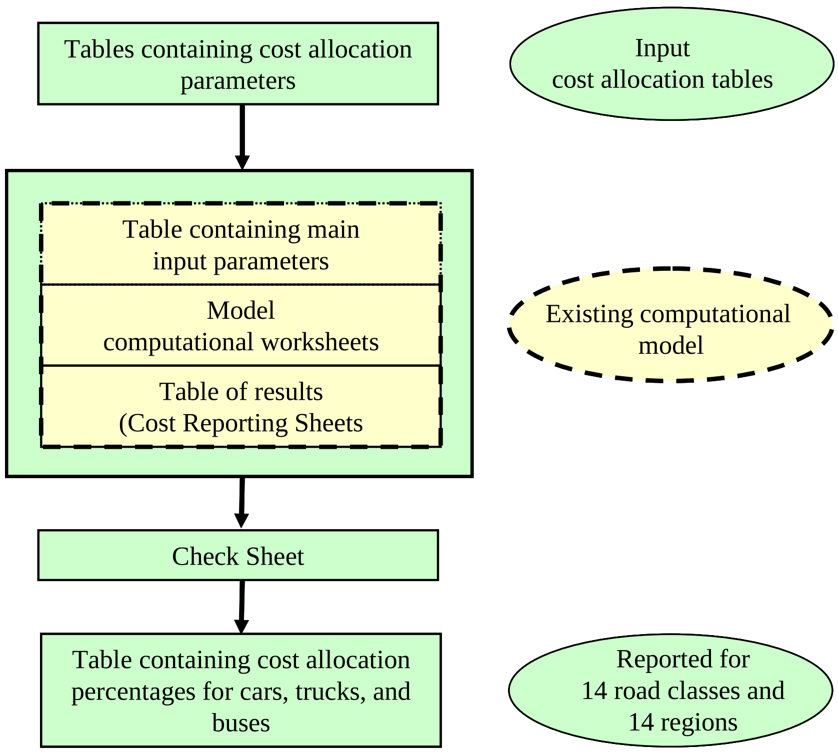


Figure 6.1. Conceptual schema of the Cost Allocation Model.

6.1 Model Description

The model for calculation of allocation percentages (cost allocation model) was created as an additional Microsoft Excel workbook attached to the model for the calculation of representative annualized costs. The additional workbook contains 12 worksheets described in Table 6.1.

Table 6.1. Worksheets included in the Cost Allocation Model

Worksheet name	Description
Cost Summary	Contains the summary results of the computational model estimating representative annualized cost of roads. The estimated annualized costs are used to calculate average cost allocation factors.
PCE	Contains Passenger Car Equivalency (PCE) factors and vehicle distributions. Calculates composite PCE factors and base case allocation percentages.
Pavement	Contains pavement-related factors. Calculates the percentage of the initial and the maintenance & rehabilitation pavement costs allocated to commercial vehicles.
Bridges	Contains bridge-related factors. Calculates the percentage of the initial and the maintenance & rehabilitation costs for bridges allocated to commercial vehicles.
Roadway Infrastructure	Contains factors for other infrastructure. Calculates the percentage of the initial and the maintenance & rehabilitation costs for roadway infrastructure allocated to commercial vehicles.
Routine and Winter Maintenance	Calculates the percentage of routine and winter maintenance costs allocated to commercial vehicles.
Summary cars	Calculates allocations for cars for the eight types of costs. Contains allocation summary for cars.
Summary CV	Calculates allocations for CV for the eight types of costs. Contains allocation summary for CV.
Summary Bus	Calculates allocations for buses for the eight types of costs. Contains allocation summary for buses.
Summary Trucks	Calculates allocations for trucks for the eight types of costs. Contains allocation summary for trucks.
Check Sheet	This worksheet is a used a quality check to ensure that all costs are accounted for in the analysis.
Provincial Reporting sheets (NL, PE, NS, etc.)	There are 14 worksheets, one for each geographical region, containing detailed cost allocation results. These 14 worksheets are given in Appendix A.

Each of the above worksheets contains input tables containing computational parameters for all 196 representative road sections. An example of the layout of the computational parameters is shown in Table 3.4. Most of the computational parameters do not have geographical region-specific parameters at this time. However computational model enables separate entries for all 196 representative road sections.

The layout of the computational model facilitates versatility with an easy to use interface. The additional functional features of the computational model include:

- Automated linkage between input values and calculated results. Changes in any input computational parameters, for example the percentage of buses in the traffic flow on provincial rural arterials in Saskatchewan, are automatically reflected in the end results.

- Modular design. Computational tasks are grouped in specific worksheets for clarity and ease of future modifications.

- Suitability for sensitivity analysis. An example sensitivity analysis is presented in Chapter 7.

- Aggregation of allocation percentages across the entire road network of parts of the network.

6.2 Instructions for User

When modifying the model, the user should proceed from left to right through the series of the 12 worksheets. The following provides a brief description of the worksheets from the computational viewpoint. The basic description of the worksheets is given in Table 6.1.

Cost Summary

This spreadsheet does not contain any cells that require input. It contains the results of the previous calculations which should be verified.

PCE

This worksheet is used to calculate the composite PCE factors. There are 14 tables of inputs corresponding to the 14 geographical regions. The first 7 tables are used to estimate the PCE for individual truck types. The next seven tables contain the traffic volume distribution for the different vehicle types. The results are presented in terms of cost percentages allocated to cars and commercial vehicles for the base case road infrastructure.

Pavement

The pavement worksheet has three tables of inputs for the representative road sections. The first is the percent reduction in total roadway width that is applicable for the base case. The second table is the percent reduction in cost due to the reduced pavement structural capacity. The last table of inputs is for the traffic damage index which represents the percentage of pavement damage caused by traffic loads (and not by environmental factors). The remainder of the sheet contains results of calculations for the allocation of initial pavement construction costs and pavement M&R costs.

Bridges

The bridges worksheet has one table of inputs for the 196 representative road sections. The reduction in bridge structural capacity, together with the reduction in road width and the distribution of base case costs, is used to estimate the cost allocation for bridges. The same cost allocation percentage is used for the initial bridge costs and for M&R bridge costs.

Roadway Infrastructure

The roadway infrastructure worksheet has one table of inputs for the 196 representative road sections. The additional road design features required for CV, together with the reduction in road width and the distribution of base case costs, is used to estimate the cost allocation for roadway infrastructure. The same cost allocation percentage is used for the initial and M&R costs of road infrastructure.

Routine and Winter Maintenance

The cost allocation is based solely on the distribution of base costs. Separate cost allocation tables are provided for routine maintenance and for winter maintenance.

Summary Cars

Summarizes all car allocations results contained in the previous worksheets. Results are disaggregated for the 196 representative road sections. A percent allocation of the total cost is also provided as a weighted average using the EUAC (Equivalent Uniform Annual Costs) as the weighting factor.

Summary CV, Summary Bus, Summary Trucks

Similar to *Summary Cars***.**

Check Sheet

This spreadsheet is used as a check to confirm that the distributions presented in the summary sheets account for all costs. The distributions are summed and all values presented in this worksheet should be equal to 100 percent.

Cost Allocation Reporting Sheets

The 14 worksheets representing the 14 geographic regions summarize the results in the similar format as that used previously for the estimation of representative annualized costs. The worksheets are given in Appendix A.

Pavement Construction Sheets

Fourteen additional workbooks contain the 196 pavement construction sheets for cars-only traffic described in Section 4.2.2. The results of these workbooks have been summarized in an additional worksheet (*Pavement Summary.xls*) for ease of reference and use in the computational model.

7. ESTIMATED COST ALLOCATION RESULTS

7.1 Results

Estimated cost allocation percentages are reported separately for all geographical regions using the format of Cost Allocation Reporting Sheets. There are 14 Cost Allocation Reporting Sheets, one for each geographical region. An example of the Cost Allocation Reporting Sheets is shown in Figure 7.1 for Southern Ontario (ON-1). All Cost Allocation Reporting Sheets are given in Appendix A.

The cost allocation percentages given in the Cost Allocation Reporting Sheets are the percentages of the representative annualized costs (Equivalent Uniform Annual Costs) given in Reference 1, Appendix E. All costs were attributed to cars, trucks, and buses. For example, referring to Figure 7.1, 49.9 percent of the total cost for provincial rural collector highways in Southern Ontario was attributed to light vehicles, 48.6 percent to trucks, and 1.5 percent to buses. The addition of the allocation percentages for cars, trucks, and buses always equals 100 percent.

Because the cost allocation percentages are very sensitive to the intensity of use (to the proportions of cars, trucks and buses), road functional classes serving traffic with high percentage of trucks have high allocation rates for trucks. For example, 68.7 percent of all costs for provincial rural freeways in Southern Ontario were allocated to trucks. Trucks on provincial rural freeways represent 25 percent of all vehicles. On the other hand, only 5.9 percent of all costs for municipal rural local roads in Southern Ontario were allocated to trucks. Trucks on municipal rural local roads represent only 2 percent of all vehicles. Moreover, trucks using local roads tend to be much smaller than trucks using rural freeways.

7.2 Comparison with Other Cost Allocation Studies

A number of highway cost allocations studies were carried out by transportation agencies in the U.S.A. We are not aware of any full-scale cost allocation studies carried out by a Canadian transportation agency. All past Canadian cost allocation studies were either partial studies [17] or theoretical studies [18].

The results of several cost allocation studies are compared with the results obtained in this study in Table 7.2. The results in Table 7.2 obtained in this study are for the provincial highway networks only. It is expected that the characteristics of Canadian provincial highway networks are comparable to the characteristics of networks managed by US state highway agencies. Overall, according to data shown in Table 7.2, there is a broad agreement between the results of this study and the results reported by other agencies. It should be noted that cost allocation percentages obtained in this study and reported in Table 7.2 include initial costs of building road infrastructure. These costs are typically not included in cost allocation studies carried out by U.S. state highway agencies.

Data presented in Table 7.2 provide also the opportunity to compare cost allocation results for different Canadian jurisdictions. However, it should be recalled that the intensity of use (vehicle class distributions) was assumed to be identical for all geographical regions, and the intensity of use has a significant influence on cost allocation percentages. The use of the same vehicle distribution data tends to suppress potential differences between geographical regions.

Table 7.1. Example of Cost Allocation Reporting Sheet for Southern Ontario

Ontario - South

Pavements - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	20.6	77.8	1.6	25.4	72.4	2.2						
Arterial	32.9	65.3	1.8	47.9	48.8	3.3	50.4	45.3	4.3	55.2	35.9	9.0
Collector	42.2	56.0	1.7	51.6	44.5	3.9	55.7	39.0	5.3	54.9	30.0	15.0
Local	49.5	48.5	2.0	58.2	35.6	6.3	95.9	3.5	0.6	60.1	29.9	10.0

Pavements - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	12.0	86.2	1.8	15.2	82.3	2.5						
Arterial	11.8	85.9	2.4	14.8	79.9	5.3	11.8	80.4	7.7	13.8	68.9	17.2
Collector	15.6	81.9	2.5	19.2	74.3	6.5	16.4	73.6	10.0	18.4	54.4	27.2
Local	16.3	80.4	3.3	20.1	67.9	12.0	19.7	68.3	12.0	21.1	59.2	19.7

Bridges - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Bridges - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	38.9	59.9	1.2	48.2	50.3	1.6						
Arterial	50.5	48.1	1.3	66.9	31.0	2.1	63.3	33.5	3.2	69.0	24.8	6.2
Collector	60.7	38.2	1.2	75.6	22.4	2.0	74.2	22.7	3.1	76.7	15.5	7.8
Local	72.0	26.9	1.1	85.7	12.2	2.1	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - M&R Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Routine Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Winter Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Total Road Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	29.9	68.7	1.4	37.9	60.2	1.9						
Arterial	41.7	56.8	1.6	56.9	40.4	2.7	55.5	40.6	3.9	61.5	30.8	7.7
Collector	49.9	48.6	1.5	63.2	33.9	2.9	63.6	32.0	4.4	66.2	22.5	11.3
Local	58.5	39.8	1.7	70.8	24.8	4.4	93.1	5.9	1.0	72.1	20.9	7.0

Table 7.2. Comparison of results with other agencies

Agency	Percentage of the total cost		
	Light vehicles	Trucks	Buses
Arizona, 1999-20032]	57.4	42.0	0.6
FHWA, 1997[1)] [6]	59.2	40.1	0.7
Texas, 1995 [19]	50.6	47.7	1.7
Virginia, 1991 [4]	54.7	43.3	2.0
NL	55.9	42.7	1.5
PE	49.6	48.6	1.8
NS	54.7	43.8	1.5
NB	57.2	41.1	1.8
QC-1	44.7	53.8	1.5
QC-2	47.2	51.0	1.8
ON-1	39.1	59.3	1.6
ON-2	50.5	48.1	1.4
MB	46.4	52.0	1.5
SK	50.7	47.9	1.4
AB	50.4	48.2	1.4
BC-1	50.8	47.8	1.4
BC-2	53.9	44.4	1.7
TR	52.7	46.0	1.3
NL	55.9	42.7	1.5
PE	49.6	48.6	1.8

[1)] Similar results were obtained by the 1982 U.S. Federal Highway Costs Allocation Study

7.3 Sensitivity Analysis

Cost allocation estimates are based on a number of assumptions expressed in the form of cost allocation factors and parameters contained in the computational model. A separate set of parameters is provided for each of the 196 representative sections. If any of the input parameters is questionable (for example a traffic pavement damage index for provincial rural arterial roads in Alberta), the user can easily change the parameter, rerun the computational model, and assess the impact of the change on the results.

Conventional sensitivity analysis was carried out to assess the impact of excluding initial road construction costs from the total cost allocation estimates. Transportation agencies typically do not include past construction costs (or sunk costs) in the cost allocation estimates. The results of cost allocation that excludes initial construction costs are also useful when comparing the results of this study with the results reported by others.

The analysis was carried out for the Southern Ontario geographic region. All initial construction costs (for pavements, bridges, and other road infrastructure) were excluded from the allocation estimates and the results were compared with the original allocation estimates incorporating total costs. By excluding all initial costs, the cost allocation applies only to maintenance and rehabilitation costs. The exclusion of all initial construction costs represents about 76 percent of the annualized costs (EUAC).

The results of the sensitivity analysis, shown in Figure 7.1 and Figure 7.2 for cars and buses, respectively, indicate that there is no clear trend or substantial difference between the cost allocation percentages based on all costs and the cost allocation percentages based on maintenance and rehabilitation costs only.

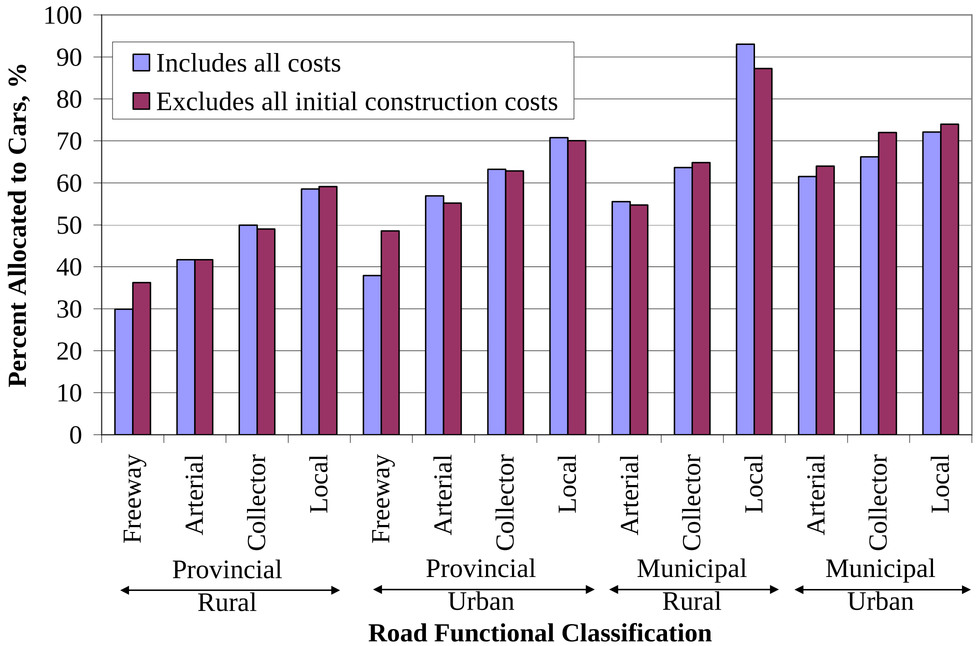


Figure 7.1. Cost allocation to cars for Southern Ontario.

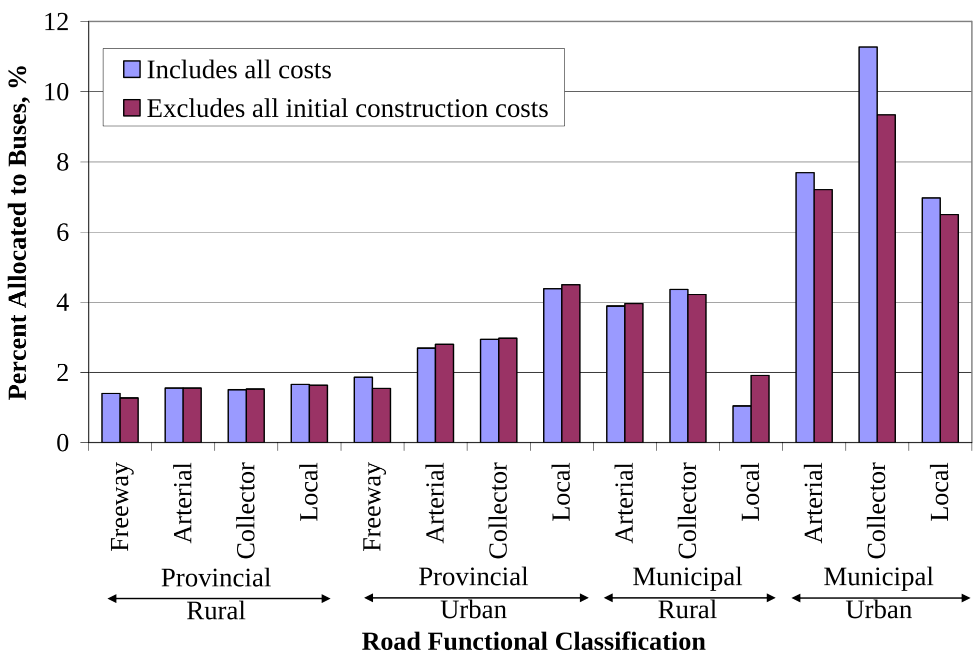


Figure 7.2. Cost allocation to buses for Southern Ontario.

The differences in cost allocations for the individual road classes are also relatively minor. The largest difference between costs allocations with and without the initial costs (about 5 percent) was for provincial urban freeways. This difference probably occurred because Ontario Ministry of Transportation builds a fairly substantial initial pavement structure on urban freeways. This probably results in atypically high initial pavement construction costs and atypically low maintenance and rehabilitation costs.

Overall, considering all road classes combined, the percentage of costs allocated to cars was within 2 percent when all costs were included in the allocation compared to the allocation percentage when only maintenance and rehabilitation costs were included in the allocation.

8. RECOMMENDATIONS

1. Cost allocation estimates should be updated when improved information and data become available. Any updating should also consider updating of the estimates of the representative annualized road costs.

2. Cost allocation estimates are very sensitive to the proportion of light vehicles, trucks and buses in the traffic flow. Better traffic data are the key to improving cost allocation estimates. Traffic data should be improved by securing additional traffic data from provincial and municipal agencies. Specifically, instead of using one representative set of classified traffic volumes for all geographical regions, region-specific traffic volumes should be used. Similarly, the use of region-specific PCE factors (instead of representative PCE factors applied uniformly to all regions) and all other cost allocation parameters is recommended.

3. The reliability of cost allocation estimates would benefit from dividing trucks into at least two truck types, light trucks and heavy trucks. Preferably, the FHWA vehicle classification should be used for future cost allocation studies.

4. Passenger Car Equivalency (PCE) factors that account for the influence of trucks on road capacity used in this study are based on the US factors and should be reassessed. The maximum allowable Gross Vehicle Weight (GVW) of trucks in Canada is about 60,000 kg. In the United States, the typical maximum allowable GVW of trucks is 80,000 lb or 36,300 kg, a 40 percent difference. The larger allowable GVW in Ontario calls for more powerful tractors (traction engines) and braking systems. If the tractors and breaking systems are not proportionately more powerful in Canada, loaded trucks would travel (and accelerate and decelerate) at lower rates. The lower rates should be reflected in Canadian PCE factors.

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APPENDIX A

PROVINCIAL COST ALLOCATION REPORTING SHEETS

Newfoundland and Labrador

Pavements - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	20.3	78.1	1.6	27.0	70.8	2.2						
Arterial	43.0	55.4	1.5	52.6	44.4	3.0	60.0	36.5	3.5	67.0	26.4	6.6
Collector	42.5	55.8	1.7	56.1	40.4	3.5	54.1	40.4	5.5	59.5	27.0	13.5
Local	57.3	41.0	1.7	67.5	27.6	4.9	95.9	3.5	0.6	74.5	19.1	6.4

Pavements - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	16.0	82.3	1.7	19.5	78.1	2.4						
Arterial	15.7	82.1	2.2	19.0	75.9	5.1	15.8	76.8	7.4	17.8	65.8	16.4
Collector	19.5	78.1	2.4	23.5	70.4	6.1	20.5	70.0	9.5	22.5	51.6	25.8
Local	20.3	76.5	3.2	24.5	64.1	11.3	24.6	64.1	11.3	25.8	55.7	18.6

Bridges - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Bridges - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	38.9	59.9	1.2	48.2	50.3	1.6						
Arterial	50.5	48.1	1.3	66.9	31.0	2.1	63.3	33.5	3.2	69.0	24.8	6.2
Collector	60.7	38.2	1.2	75.6	22.4	2.0	74.2	22.7	3.1	76.7	15.5	7.8
Local	72.0	26.9	1.1	85.7	12.2	2.1	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - M&R Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Routine Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Winter Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Total Road Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	31.7	67.0	1.4	40.2	58.0	1.8						
Arterial	49.2	49.5	1.4	63.9	33.8	2.3	62.1	34.6	3.3	68.7	25.0	6.3
Collector	55.1	43.5	1.3	69.7	27.9	2.4	65.8	30.1	4.1	71.4	19.1	9.5
Local	66.2	32.5	1.4	78.1	18.6	3.3	92.8	6.1	1.1	80.8	14.4	4.8

Prince Edward Island

Pavements - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	28.5	70.1	1.4	42.7	55.6	1.7						
Arterial	34.6	63.7	1.7	57.1	40.2	2.7	52.8	43.1	4.1	65.9	27.3	6.8
Collector	34.5	63.6	2.0	55.1	41.3	3.6	61.9	33.5	4.6	65.7	22.9	11.4
Local	72.7	26.2	1.1	55.1	38.2	6.7	95.9	3.5	0.6	71.8	21.2	7.1

Pavements - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	12.0	86.2	1.8	15.2	82.3	2.5						
Arterial	11.8	85.9	2.4	14.8	79.9	5.3	11.8	80.4	7.7	13.8	68.9	17.2
Collector	15.6	81.9	2.5	19.2	74.3	6.5	16.4	73.6	10.0	18.4	54.4	27.2
Local	16.3	80.4	3.3	20.1	67.9	12.0	19.7	68.3	12.0	21.1	59.2	19.7

Bridges - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Bridges - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	38.9	59.9	1.2	48.2	50.3	1.6						
Arterial	50.5	48.1	1.3	66.9	31.0	2.1	63.3	33.5	3.2	69.0	24.8	6.2
Collector	60.7	38.2	1.2	75.6	22.4	2.0	74.2	22.7	3.1	76.7	15.5	7.8
Local	72.0	26.9	1.1	85.7	12.2	2.1	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - M&R Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Routine Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Winter Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Total Road Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	32.7	66.0	1.3	45.4	52.9	1.6						
Arterial	39.3	59.1	1.6	60.0	37.5	2.5	53.4	42.5	4.1	65.2	27.8	7.0
Collector	43.0	55.3	1.7	63.7	33.4	2.9	61.8	33.6	4.6	69.0	20.7	10.3
Local	71.3	27.5	1.1	66.7	28.3	5.0	91.9	6.9	1.2	75.6	18.3	6.1

Nova Scotia

Pavements - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	26.6	72.0	1.5	35.0	63.1	2.0						
Arterial	40.2	58.2	1.6	59.6	37.8	2.5	48.8	46.8	4.5	54.4	36.4	9.1
Collector	36.8	61.3	1.9	53.3	42.9	3.7	54.8	39.8	5.4	63.0	24.7	12.3
Local	64.2	34.3	1.4	73.6	22.4	4.0	95.9	3.5	0.6	76.7	17.4	5.8

Pavements - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	14.0	84.2	1.7	17.3	80.2	2.5						
Arterial	13.7	84.0	2.3	16.9	77.9	5.2	13.8	78.6	7.5	15.8	67.4	16.8
Collector	17.5	80.0	2.5	21.4	72.4	6.3	18.4	71.8	9.8	20.5	53.0	26.5
Local	18.3	78.4	3.3	22.3	66.0	11.7	22.1	66.2	11.7	23.4	57.4	19.1

Bridges - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Bridges - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	38.9	59.9	1.2	48.2	50.3	1.6						
Arterial	50.5	48.1	1.3	66.9	31.0	2.1	63.3	33.5	3.2	69.0	24.8	6.2
Collector	60.7	38.2	1.2	75.6	22.4	2.0	74.2	22.7	3.1	76.7	15.5	7.8
Local	72.0	26.9	1.1	85.7	12.2	2.1	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - M&R Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Routine Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Winter Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Total Road Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	34.7	64.0	1.3	44.2	54.1	1.7						
Arterial	47.1	51.4	1.4	64.1	33.6	2.2	55.7	40.4	3.9	62.1	30.3	7.6
Collector	51.6	47.0	1.5	67.2	30.2	2.6	61.4	34.0	4.6	68.5	21.0	10.5
Local	68.4	30.3	1.3	78.4	18.4	3.2	92.9	6.0	1.1	75.6	18.3	6.1

New Brunswick

Pavements - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	28.0	70.5	1.4	41.6	56.6	1.8						
Arterial	41.2	57.2	1.6	48.6	48.2	3.2	54.3	41.7	4.0	58.8	32.9	8.2
Collector	53.7	44.9	1.4	51.8	44.4	3.9	57.5	37.4	5.1	59.6	26.9	13.5
Local	47.7	50.2	2.1	43.0	48.4	8.5	95.9	3.5	0.6	68.6	23.6	7.9

Pavements - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	14.0	84.2	1.7	17.3	80.2	2.5						
Arterial	13.7	84.0	2.3	16.9	77.9	5.2	13.8	78.6	7.5	15.8	67.4	16.8
Collector	17.5	80.0	2.5	21.4	72.4	6.3	18.4	71.8	9.8	20.5	53.0	26.5
Local	18.3	78.4	3.3	22.3	66.0	11.7	22.1	66.2	11.7	23.4	57.4	19.1

Bridges - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Bridges - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	38.9	59.9	1.2	48.2	50.3	1.6						
Arterial	50.5	48.1	1.3	66.9	31.0	2.1	63.3	33.5	3.2	69.0	24.8	6.2
Collector	60.7	38.2	1.2	75.6	22.4	2.0	74.2	22.7	3.1	76.7	15.5	7.8
Local	72.0	26.9	1.1	85.7	12.2	2.1	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - M&R Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Routine Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Winter Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Total Road Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	34.5	64.2	1.3	46.1	52.3	1.6						
Arterial	46.1	52.5	1.4	58.2	39.2	2.6	58.4	37.9	3.6	65.3	27.8	6.9
Collector	57.9	40.9	1.3	64.8	32.4	2.8	65.4	30.5	4.2	70.4	19.7	9.9
Local	61.2	37.3	1.6	61.7	32.6	5.8	93.2	5.8	1.0	77.4	17.0	5.7

Quebec - Champlain Plain

Pavements - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	24.2	74.3	1.5	44.1	54.2	1.7						
Arterial	31.4	66.8	1.8	55.4	41.8	2.8	50.2	45.4	4.4	61.3	31.0	7.7
Collector	48.2	50.3	1.6	62.1	34.9	3.0	61.9	33.6	4.6	70.4	19.7	9.9
Local	58.8	39.5	1.6	70.6	25.0	4.4	95.9	3.5	0.6	80.1	14.9	5.0

Roadway Infrastructure - M&R Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Pavements - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	14.0	84.2	1.7	17.3	80.2	2.5						
Arterial	13.7	84.0	2.3	16.9	77.9	5.2	13.8	78.6	7.5	15.8	67.4	16.8
Collector	17.5	80.0	2.5	21.4	72.4	6.3	18.4	71.8	9.8	20.5	53.0	26.5
Local	18.3	78.4	3.3	22.3	66.0	11.7	22.1	66.2	11.7	23.4	57.4	19.1

Routine Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Bridges - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Winter Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Bridges - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	38.9	59.9	1.2	48.2	50.3	1.6						
Arterial	50.5	48.1	1.3	66.9	31.0	2.1	63.3	33.5	3.2	69.0	24.8	6.2
Collector	60.7	38.2	1.2	75.6	22.4	2.0	74.2	22.7	3.1	76.7	15.5	7.8
Local	72.0	26.9	1.1	85.7	12.2	2.1	95.0	4.3	0.8	90.5	7.2	2.4

Total Road Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	32.3	66.3	1.4	47.1	51.3	1.6						
Arterial	40.5	57.9	1.6	61.5	36.1	2.4	56.6	39.6	3.8	66.1	27.1	6.8
Collector	54.0	44.6	1.4	68.5	29.0	2.5	66.4	29.6	4.0	73.5	17.6	8.8
Local	64.1	34.5	1.4	76.1	20.3	3.6	92.9	6.0	1.1	80.8	14.4	4.8

Quebec - Nord

Pavements - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	24.1	74.4	1.5	35.1	62.9	1.9						
Arterial	30.8	67.4	1.8	41.1	55.2	3.7	38.7	55.9	5.4	60.1	31.9	8.0
Collector	38.7	59.4	1.8	47.3	48.5	4.2	62.0	33.4	4.6	70.5	19.7	9.8
Local	48.5	49.4	2.1	49.3	43.1	7.6	95.9	3.5	0.6	78.0	16.5	5.5

Pavements - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	20.1	78.3	1.6	23.8	73.9	2.3						
Arterial	19.6	78.3	2.1	23.3	71.9	4.8	19.7	73.2	7.0	21.7	62.6	15.7
Collector	23.4	74.3	2.3	27.8	66.5	5.8	24.6	66.4	9.0	26.6	48.9	24.5
Local	24.4	72.6	3.0	29.0	60.3	10.6	29.5	59.9	10.6	30.5	52.2	17.4

Bridges - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Bridges - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	38.9	59.9	1.2	48.2	50.3	1.6						
Arterial	50.5	48.1	1.3	66.9	31.0	2.1	63.3	33.5	3.2	69.0	24.8	6.2
Collector	60.7	38.2	1.2	75.6	22.4	2.0	74.2	22.7	3.1	76.7	15.5	7.8
Local	72.0	26.9	1.1	85.7	12.2	2.1	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - M&R Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Routine Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Winter Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Total Road Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	34.5	64.2	1.3	45.1	53.3	1.6						
Arterial	43.0	55.5	1.5	57.7	39.7	2.6	55.8	40.3	3.9	67.3	26.2	6.5
Collector	50.4	48.2	1.5	63.2	33.9	2.9	68.2	28.0	3.8	74.6	17.0	8.5
Local	59.1	39.3	1.6	66.4	28.5	5.0	93.5	5.5	1.0	81.5	13.9	4.6

Ontario - South

Pavements - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	20.6	77.8	1.6	25.4	72.4	2.2						
Arterial	32.9	65.3	1.8	47.9	48.8	3.3	50.4	45.3	4.3	55.2	35.9	9.0
Collector	42.2	56.0	1.7	51.6	44.5	3.9	55.7	39.0	5.3	54.9	30.0	15.0
Local	49.5	48.5	2.0	58.2	35.6	6.3	95.9	3.5	0.6	60.1	29.9	10.0

Pavements - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	12.0	86.2	1.8	15.2	82.3	2.5						
Arterial	11.8	85.9	2.4	14.8	79.9	5.3	11.8	80.4	7.7	13.8	68.9	17.2
Collector	15.6	81.9	2.5	19.2	74.3	6.5	16.4	73.6	10.0	18.4	54.4	27.2
Local	16.3	80.4	3.3	20.1	67.9	12.0	19.7	68.3	12.0	21.1	59.2	19.7

Bridges - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Bridges - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	38.9	59.9	1.2	48.2	50.3	1.6						
Arterial	50.5	48.1	1.3	66.9	31.0	2.1	63.3	33.5	3.2	69.0	24.8	6.2
Collector	60.7	38.2	1.2	75.6	22.4	2.0	74.2	22.7	3.1	76.7	15.5	7.8
Local	72.0	26.9	1.1	85.7	12.2	2.1	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - M&R Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Routine Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Winter Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Total Road Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	29.9	68.7	1.4	37.9	60.2	1.9						
Arterial	41.7	56.8	1.6	56.9	40.4	2.7	55.5	40.6	3.9	61.5	30.8	7.7
Collector	49.9	48.6	1.5	63.2	33.9	2.9	63.6	32.0	4.4	66.2	22.5	11.3
Local	58.5	39.8	1.7	70.8	24.8	4.4	93.1	5.9	1.0	72.1	20.9	7.0

Ontario - North

Pavements - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	25.7	72.8	1.5	27.3	70.6	2.2						
Arterial	41.9	56.5	1.5	44.8	51.7	3.4	44.8	50.4	4.8	49.8	40.2	10.0
Collector	46.7	51.7	1.6	52.1	44.0	3.8	51.8	42.4	5.8	55.4	29.7	14.9
Local	60.6	37.9	1.6	47.3	44.8	7.9	95.9	3.5	0.6	66.4	25.2	8.4

Pavements - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	18.0	80.3	1.6	21.7	76.0	2.4						
Arterial	17.6	80.2	2.2	21.2	73.9	4.9	17.8	75.0	7.2	19.7	64.2	16.1
Collector	21.4	76.2	2.4	25.6	68.4	5.9	22.5	68.2	9.3	24.6	50.3	25.1
Local	22.4	74.5	3.1	26.8	62.2	11.0	27.1	62.0	10.9	28.1	53.9	18.0

Bridges - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Bridges - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	38.9	59.9	1.2	48.2	50.3	1.6						
Arterial	50.5	48.1	1.3	66.9	31.0	2.1	63.3	33.5	3.2	69.0	24.8	6.2
Collector	60.7	38.2	1.2	75.6	22.4	2.0	74.2	22.7	3.1	76.7	15.5	7.8
Local	72.0	26.9	1.1	85.7	12.2	2.1	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - M&R Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Routine Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Winter Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Total Road Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	34.8	63.9	1.3	42.6	55.6	1.7						
Arterial	47.0	51.6	1.4	60.2	37.3	2.5	57.5	38.8	3.7	63.0	29.6	7.4
Collector	52.8	45.8	1.4	65.1	32.1	2.8	63.4	32.2	4.4	67.5	21.6	10.8
Local	62.8	35.8	1.5	69.1	26.3	4.6	93.3	5.7	1.0	76.8	17.4	5.8

Manitoba

Pavements - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	31.1	67.5	1.4	44.8	53.5	1.7						
Arterial	37.7	60.6	1.7	48.8	48.0	3.2	52.7	43.2	4.1	57.5	34.0	8.5
Collector	54.5	44.1	1.4	72.1	25.6	2.2	70.4	26.0	3.5	74.7	16.9	8.4
Local	47.7	50.2	2.1	56.7	36.8	6.5	95.9	3.5	0.6	68.6	23.6	7.9

Pavements - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	16.0	82.3	1.7	19.5	78.1	2.4						
Arterial	15.7	82.1	2.2	19.0	75.9	5.1	15.8	76.8	7.4	17.8	65.8	16.4
Collector	19.5	78.1	2.4	23.5	70.4	6.1	20.5	70.0	9.5	22.5	51.6	25.8
Local	20.3	76.5	3.2	24.5	64.1	11.3	24.6	64.1	11.3	25.8	55.7	18.6

Bridges - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Bridges - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	38.9	59.9	1.2	48.2	50.3	1.6						
Arterial	50.5	48.1	1.3	66.9	31.0	2.1	63.3	33.5	3.2	69.0	24.8	6.2
Collector	60.7	38.2	1.2	75.6	22.4	2.0	74.2	22.7	3.1	76.7	15.5	7.8
Local	72.0	26.9	1.1	85.7	12.2	2.1	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - M&R Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Routine Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Winter Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Total Road Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	34.3	64.4	1.3	46.7	51.7	1.6						
Arterial	43.6	54.9	1.5	60.1	37.4	2.5	56.7	39.5	3.8	64.2	28.6	7.2
Collector	56.9	41.8	1.3	73.5	24.4	2.1	69.5	26.8	3.7	74.5	17.0	8.5
Local	54.8	43.4	1.8	69.0	26.3	4.6	93.6	5.5	1.0	75.7	18.2	6.1

Saskatchewan

Pavements - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	27.8	70.7	1.4	40.2	58.0	1.8						
Arterial	29.7	68.4	1.9	61.5	36.1	2.4	51.0	44.8	4.3	54.8	36.2	9.0
Collector	40.8	57.5	1.8	72.4	25.4	2.2	75.0	22.0	3.0	56.5	29.0	14.5
Local	72.7	26.2	1.1	62.4	31.9	5.6	95.9	3.5	0.6	91.4	6.5	2.2

Pavements - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	16.0	82.3	1.7	19.5	78.1	2.4						
Arterial	15.7	82.1	2.2	19.0	75.9	5.1	15.8	76.8	7.4	17.8	65.8	16.4
Collector	19.5	78.1	2.4	23.5	70.4	6.1	20.5	70.0	9.5	22.5	51.6	25.8
Local	20.3	76.5	3.2	24.5	64.1	11.3	24.6	64.1	11.3	25.8	55.7	18.6

Bridges - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Bridges - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	38.9	59.9	1.2	48.2	50.3	1.6						
Arterial	50.5	48.1	1.3	66.9	31.0	2.1	63.3	33.5	3.2	69.0	24.8	6.2
Collector	60.7	38.2	1.2	75.6	22.4	2.0	74.2	22.7	3.1	76.7	15.5	7.8
Local	72.0	26.9	1.1	85.7	12.2	2.1	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - M&R Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Routine Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Winter Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Total Road Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	32.1	66.6	1.4	43.9	54.4	1.7						
Arterial	35.0	63.3	1.7	62.5	35.1	2.3	52.9	42.9	4.1	61.2	31.1	7.8
Collector	48.2	50.3	1.6	71.7	26.0	2.3	72.5	24.2	3.3	66.1	22.6	11.3
Local	73.2	25.7	1.1	71.5	24.2	4.3	92.8	6.1	1.1	89.7	7.7	2.6

Alberta

Pavements - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	32.6	66.1	1.3	44.8	53.6	1.7						
Arterial	42.5	56.0	1.5	60.1	37.4	2.5	52.5	43.4	4.2	57.0	34.4	8.6
Collector	49.9	48.6	1.5	65.1	32.1	2.8	59.8	35.3	4.8	61.8	25.5	12.7
Local	61.1	37.3	1.6	71.6	24.2	4.3	95.9	3.5	0.6	71.3	21.5	7.2

Pavements - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	14.0	84.2	1.7	17.3	80.2	2.5						
Arterial	13.7	84.0	2.3	16.9	77.9	5.2	13.8	78.6	7.5	15.8	67.4	16.8
Collector	17.5	80.0	2.5	21.4	72.4	6.3	18.4	71.8	9.8	20.5	53.0	26.5
Local	18.3	78.4	3.3	22.3	66.0	11.7	22.1	66.2	11.7	23.4	57.4	19.1

Bridges - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Bridges - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	38.9	59.9	1.2	48.2	50.3	1.6						
Arterial	50.5	48.1	1.3	66.9	31.0	2.1	63.3	33.5	3.2	69.0	24.8	6.2
Collector	60.7	38.2	1.2	75.6	22.4	2.0	74.2	22.7	3.1	76.7	15.5	7.8
Local	72.0	26.9	1.1	85.7	12.2	2.1	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - M&R Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Routine Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Winter Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Total Road Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	35.4	63.3	1.3	47.1	51.3	1.6						
Arterial	45.7	52.9	1.4	63.4	34.3	2.3	55.5	40.6	3.9	63.7	29.0	7.3
Collector	53.7	44.9	1.4	69.7	27.9	2.4	63.0	32.6	4.4	69.5	20.3	10.2
Local	63.5	35.1	1.5	75.9	20.5	3.6	92.1	6.7	1.2	76.9	17.4	5.8

British Columbia - Coastal

Pavements - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	29.0	69.6	1.4	40.3	57.9	1.8						
Arterial	38.7	59.6	1.6	53.3	43.8	2.9	48.5	47.0	4.5	61.7	30.6	7.7
Collector	48.8	49.6	1.5	65.3	31.9	2.8	55.6	39.0	5.3	65.7	22.8	11.4
Local	63.2	35.4	1.5	86.5	11.4	2.0	95.9	3.5	0.6	77.6	16.8	5.6

Pavements - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	8.0	90.1	1.8	10.8	86.5	2.7						
Arterial	7.8	89.7	2.5	10.6	83.8	5.6	7.9	84.0	8.1	9.9	72.1	18.0
Collector	11.7	85.7	2.6	15.0	78.2	6.8	12.3	77.2	10.5	14.3	57.1	28.6
Local	12.2	84.3	3.5	15.6	71.7	12.7	14.8	72.5	12.8	16.4	62.7	20.9

Bridges - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Bridges - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	38.9	59.9	1.2	48.2	50.3	1.6						
Arterial	50.5	48.1	1.3	66.9	31.0	2.1	63.3	33.5	3.2	69.0	24.8	6.2
Collector	60.7	38.2	1.2	75.6	22.4	2.0	74.2	22.7	3.1	76.7	15.5	7.8
Local	72.0	26.9	1.1	85.7	12.2	2.1	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - M&R Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Routine Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Winter Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Total Road Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	33.9	64.8	1.3	44.5	53.9	1.7						
Arterial	44.0	54.5	1.5	59.6	37.9	2.5	52.9	43.0	4.1	64.1	28.7	7.2
Collector	53.4	45.2	1.4	69.4	28.2	2.4	60.9	34.4	4.7	70.1	19.9	10.0
Local	64.4	34.1	1.4	80.5	16.6	2.9	93.6	5.4	1.0	78.4	16.2	5.4

British Columbia, Interior

Pavements - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	27.8	70.7	1.4	38.4	59.7	1.8						
Arterial	36.5	61.8	1.7	50.9	46.1	3.1	46.4	48.9	4.7	51.7	38.6	9.7
Collector	47.1	51.3	1.6	62.1	34.9	3.0	54.0	40.4	5.5	67.7	21.5	10.8
Local	72.7	26.2	1.1	86.5	11.4	2.0	95.9	3.5	0.6	77.4	16.9	5.6

Pavements - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	14.0	84.2	1.7	17.3	80.2	2.5						
Arterial	13.7	84.0	2.3	16.9	77.9	5.2	13.8	78.6	7.5	15.8	67.4	16.8
Collector	17.5	80.0	2.5	21.4	72.4	6.3	18.4	71.8	9.8	20.5	53.0	26.5
Local	18.3	78.4	3.3	22.3	66.0	11.7	22.1	66.2	11.7	23.4	57.4	19.1

Bridges - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Bridges - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	38.9	59.9	1.2	48.2	50.3	1.6						
Arterial	50.5	48.1	1.3	66.9	31.0	2.1	63.3	33.5	3.2	69.0	24.8	6.2
Collector	60.7	38.2	1.2	75.6	22.4	2.0	74.2	22.7	3.1	76.7	15.5	7.8
Local	72.0	26.9	1.1	85.7	12.2	2.1	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - M&R Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Routine Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Winter Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Total Road Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.3	62.4	1.3	46.0	52.4	1.6						
Arterial	46.0	52.6	1.4	61.7	35.9	2.4	53.7	42.2	4.1	61.8	30.5	7.6
Collector	53.9	44.7	1.4	69.6	28.0	2.4	61.6	33.8	4.6	71.8	18.8	9.4
Local	72.1	26.8	1.1	82.1	15.2	2.7	93.7	5.3	0.9	79.3	15.6	5.2

Territories

Pavements - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	38.0	60.8	1.2	49.0	49.5	1.5						
Arterial	48.4	50.2	1.4	60.7	36.8	2.5	60.6	36.0	3.4	63.3	29.4	7.3
Collector	53.0	45.6	1.4	66.7	30.6	2.7	75.0	22.0	3.0	68.7	20.8	10.4
Local	72.7	26.2	1.1	86.5	11.4	2.0	95.9	3.5	0.6	75.8	18.2	6.1

Pavements - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	22.1	76.4	1.6	26.0	71.8	2.2						
Arterial	21.5	76.4	2.1	25.4	69.9	4.7	21.7	71.4	6.9	23.7	61.1	15.3
Collector	23.4	74.3	2.3	25.6	68.4	5.9	24.6	66.4	9.0	24.6	50.3	25.1
Local	24.4	72.6	3.0	26.8	62.2	11.0	29.5	59.9	10.6	28.1	53.9	18.0

Bridges - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Bridges - Maintenance and Rehabilitation Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	36.9	61.8	1.3	48.2	50.3	1.6						
Arterial	49.5	49.1	1.3	67.6	30.3	2.0	62.6	34.1	3.3	69.4	24.5	6.1
Collector	59.4	39.3	1.2	75.2	22.8	2.0	73.5	23.3	3.2	76.7	15.5	7.8
Local	71.3	27.6	1.1	84.8	12.9	2.3	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - Initial Construction Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	38.9	59.9	1.2	48.2	50.3	1.6						
Arterial	50.5	48.1	1.3	66.9	31.0	2.1	63.3	33.5	3.2	69.0	24.8	6.2
Collector	60.7	38.2	1.2	75.6	22.4	2.0	74.2	22.7	3.1	76.7	15.5	7.8
Local	72.0	26.9	1.1	85.7	12.2	2.1	95.0	4.3	0.8	90.5	7.2	2.4

Roadway Infrastructure - M&R Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Routine Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Winter Maintenance Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	49.2	49.8	1.0	58.8	39.9	1.2						
Arterial	64.8	34.3	0.9	81.1	17.7	1.2	80.5	17.8	1.7	88.7	9.0	2.3
Collector	77.4	21.9	0.7	88.9	10.2	0.9	90.0	8.8	1.2	94.0	4.0	2.0
Local	88.1	11.5	0.5	95.4	3.9	0.7	95.9	3.5	0.6	96.0	3.0	1.0

Total Road Costs

Functional Class	Provincial						Municipal					
	Rural			Urban			Rural			Urban		
	C %	T %	B %	C %	T %	B %	C %	T %	B %	C %	T %	B %
Freeway	38.8	60.0	1.2	48.3	50.1	1.6						
Arterial	50.4	48.3	1.3	66.1	31.7	2.1	63.2	33.6	3.2	68.4	25.3	6.3
Collector	59.8	39.0	1.2	73.6	24.3	2.1	74.3	22.6	3.1	74.8	16.8	8.4
Local	71.9	27.0	1.1	84.5	13.2	2.3	94.1	5.0	0.9	84.0	12.0	4.0