Appendix A: Provincial performance summaries

1 **Ontario**

Overall, Ontario is rated **first of the 10 provinces**. Ontario ranks first on road traffic density, second on average drive time to Ottawa, second on average drive time to the US border, first on fatality rate, first on congestion (of five provinces rated), second on transit ridership rates, first on flights per thousand passengers, second on ferry costs per passenger, first on all highway freight measures, first on flights per tonne of air cargo, and second on marine freight accident rate. Ontario scores poorly on highway costs per kilometer (seventh), round trip commuting time (tenth), percent of roads in good condition (tenth), rail freight traffic density (eighth), and rail freight accidents (ninth).

2 **Nova Scotia**

Nova Scotia is rated **second of 10 provinces** overall, very close to Ontario. Nova Scotia is rated third on road traffic density, first in highway pavement condition, second in highway fatality rate, first on round trip commuting time, second on air passenger accident rates, second on truck-related fatality rates, first on rail traffic density (tie), first on rail freight accident rates (tie), second on marine freight costs per tonne, and first on port operating expense ratio. However, Nova Scotia scores sixth on highway costs per kilometer, ninth for drive time to the US border, sixth on transit ridership rate, ninth on transit costs per rider, and seventh on truck road traffic density. It is not ranked on congestion due to lack of data, and the employment per border crossing measure is not applicable.

3 **Quebec**

Quebec is rated **third of the 10 provinces**, also very close to Nova Scotia and Ontario. Quebec ranks first on average drive time to Ottawa from the major cities in the province, first on transit ridership rates, second on transit costs per rider, second on air flights per passenger, second on ferry passenger safety, second on highway freight density, second on air freight efficiency (flights per tonne cargo), and first on marine shipping safety (shipping accidents per thousand tonnes). However, Quebec scores poorly on provincial expenditures on highways (ninth), highway condition (ninth), congestion (fourth of five provinces rated), and ninth on commuting time.

4 Manitoba

Overall, Manitoba scores **fourth of the 10 provinces**. Manitoba scores well on cost of highway system per two-lane kilometer (second), highway condition (third), congestion (second of five provinces rated), and border crossing trade (second). Marine safety for both ferries and marine shipping is good (third and second, respectively). On the other side, Manitoba has low relative road traffic density (eighth), air passenger efficiency (seventh) and safety (eighth), truck accidents/tonne truck cargo (seventh), efficiency of rail (ninth) and air (seventh) freight (flights or kilometer of track/tonne cargo) and rail safety (eighth).

5 New Brunswick

New Brunswick is rated **fifth of the 10 provinces** overall. New Brunswick is relatively close to Ottawa, so it scores well for this measure (third) as well as for road condition (second). New Brunswick also has lowest travel times between work and home (first). Truck-related fatal accident rate is rated second, rail tonnage per kilometer of major track is highest of the 10 provinces (first, tie), rail freight accidents are rated first (tie), and marine port expenses per tonne cargo and expenses/revenue also score well (third). However, a low density road network and expensive roads means poor scores for these measures (ninth and eighth, respectively). The highway fatality rate is ninth. New Brunswick also scores poorly on transit and air passenger measures (ninth on most measures). Truck and air freight efficiency is also poor (seventh and ninth, respectively). This province was not ranked on congestion due to lack of data.

6 Prince Edward Island

Prince Edward Island ranks **sixth of 10 provinces** overall. Prince Edward Island ranks first on average commuting time, first on transit costs per rider, first on air passenger accident rates, third on ferry costs per passenger, and second on truck fatal collision rate. Prince Edward Island scores poorly on highway condition (eighth), transit utilization rate (tenth), and air utilization rate for passengers and freight (tenth). Prince Edward Island was not ranked on congestion or Canada Port Authorities (CPA) operating expenses per tonne cargo and per revenue due to lack of data. Measures of employment per border crossing and rail are also not applicable to Prince Edward Island because it does not share a border with the US and does not have a rail system.

7 Alberta

Alberta's overall rank is **seventh out of the 10 provinces**. Alberta scores well on congestion (third of five provinces rated), urban transit ridership per capita (third) and airport flight utilization (third). However, it rates low on drive time to Ottawa (ninth) and drive time to the US border (eighth) because these measures are based on average travel time from Calgary and Edmonton which are relatively far north. Alberta also scores relatively low

on its percentage of roads in "fair or poor" condition (seventh), operating cost of urban transit (eighth), and truck-involved fatal collisions (seventh). There are no marine services in Alberta, so these measures are not included in the index.

8 Saskatchewan

Saskatchewan is rated **eighth of 10 provinces** overall. It ranks first on provincial expenditures per highway kilometer, third on transit cost per rider, and third on rail safety (accidents per thousand tonnes cargo). Saskatchewan scores poorly on road traffic density (tenth), highway passenger fatality rate (eighth), air passenger accident rate (tenth), and air freight efficiency (seventh). Saskatchewan was not rated on congestion due to lack of data. There are no marine services in Saskatchewan, so these measures are not included in the index.

9 Newfoundland & Labrador

Overall, Newfoundland & Labrador is rated **ninth of 10 provinces.** Newfoundland & Labrador scores first (tie) for rail freight efficiency and rail freight accidents. The province scores third on road cost per kilometer, third on highway fatality rate, first on average commuting time (grouped with other Atlantic provinces), second on truck fatal accident rate (with other Atlantic provinces), first on port expenditures per tonne cargo, and fourth on port operating expense ratio. However, Newfoundland & Labrador rates poorly on drive time to Ottawa and to the US border (eighth and tenth, respectively), transit ridership per capita (eighth), air passenger flights per passenger (eighth) and air passenger accident rate (seventh), truck road utilization (seventh), and ferry costs per passenger (eighth). Newfoundland & Labrador is not ranked on congestion due to lack of data, and the employment per border crossing measure is not applicable because the province does not share a border with the US.

10 British Columbia

Overall, British Columbia ranks **tenth of the 10 provinces**, but it scores better on freight (fourth) than passenger (tenth). British Columbia scores well on ferry costs and accidents (first), drive time to the US border (first), trade productivity of employees (third), truck traffic on the higher road system (third), efficiency of rail freight (fourth) and air freight (third), and on rail accidents per tonne cargo (fifth). But the province scores poorly on cost per two-lane kilometer of roads (tenth), meaning that it spends the most per kilometer of road. British Columbia is also geographically very far from Ottawa, resulting in a rank of tenth for drive time to Ottawa. BC also has the worst fatal accident rate for highway passenger travel (tenth), the most congested highways (fifth of five provinces), long commuting travel time (eighth), high transit costs (tenth) with only average per-capita transit use (fifth), and a poor truck-related accident rate (tenth).

Appendix B: Methodology

This appendix describes the details of each measure used in this report, including its source and calculation, as well as limitations.

Passenger transportation

Highway

Total two-lane kilometer per million vehicle-kilometer = (thousands of two-lane kilometers [2004] × 10^3) ÷ (millions of vehicle-kilometers [2004]). Provincial weighted average = (sum of two-lane kilometer for all provinces) ÷ (sum of vehicle-kilometer for all provinces); territories were not included. Ratio = (provincial value) ÷ (provincial weighted average). Provinces with the lowest ratio have the highest rank.

✺ **Two-lane kilometer:** Data is presented as two-lane equivalent kilometers by road type [freeway **OR** divided highway; primary highway, secondary highway **OR** major arterial; local roads **OR** rural roads (paved and unpaved)] (Statistics Canada, 2006b: text table 1.8).

✺ **Vehicle-kilometer:** Some data should be used with caution (Statistics Canada, various issues—b). Some data in the referenced report (Canadian Vehicle Survey) was marked "use w/caution"; a description of data errors is available at the back of that report.

Cost per two-lane kilometer = (net provincial expenditures in millions of dollars [2004/05] × 10^6) ÷ (thousands of two-lane kilometer of higher level roads × 10^3). Provincial weighted average = (sum of net provincial expenditures for all provinces) ÷ (sum of two-lane kilometer of higher level roads for all provinces). Ratio = (provincial value) ÷ (provincial weighted average). Provinces with the lowest ratio have the highest rank.

✺ **Net provincial expenditures:** Data is given in millions of dollars of government money spent on roads and bridges in each province, updated for the past several years (Transport Canada, 2005b: A46–48). Provincial transfer payments are estimated transfers as reported by the provinces and assumed to go to local governments. Local expenditures are for roads and streets, parking and snow removal and have been adjusted to be at least equal to transfers from federal and provincial governments. Federal transfers to local governments are assumed to be just road-related. Gross provincial expenditures is the sum of provincial expenditures (operations and maintenance), provincial expenditures (capital), and provincial transfer payments.

Net provincial expenditures are gross provincial expenditures minus federal transfers to provinces. Total road and bridge expenditures = (net provincial expenditures + (net local expenditures). There is no data for Nunavut before 1999/2000 because it had not yet been created.

❧ **Two-lane kilometer:** Two-lane kilometer of higher level roads (Statistics Canada, 2006b: text table 1.8) were calculated by summing the freeway **OR** divided highway, primary highway, and secondary highway **OR** major arterial kilometer for each province (local roads are excluded from the total).

Travel time to Ottawa (for each province) = average of the travel time in hours from the major cities in that province to Ottawa. Provincial average is the average of the average travel times for each province. Ratio = (average travel time for each province) relative to (provincial average). Provinces with the smallest ratio have the highest rank.

❧ **Kilometers to Ottawa and travel times:** AAA North American Road Maps for 1989 and 2007. The mileage chart was used to estimate distance and travel time between major cities and to Ottawa. Travel times were converted from hours and minutes into decimal hours using this formula: (hours + minutes) ÷ 60. Travel time from Ottawa to Ottawa (0 hours) was not included in the average travel time for Ontario.

Travel time to US border: calculated in same way as travel time to Ottawa using travel time data from major cities to US/Canada border.

❧ **Kilometers to border and travel times:** AAA North American Road Maps for 1989 and 2007. The *Driving Distance* map was used to determine the distance and travel time to the US border for cities shown on the maps. Where more than one route was available to the border or between cities, the path with the shortest travel time was used. Travel times were converted from hours and minutes into decimal hours using this formula: (hours + minutes) ÷ 60. For cities not near the US border, the travel time to the nearest city plus travel time from that city to the border was used. For road sections not ending at the border, times are estimated from apportioned distances to cities north and south of the US border.

Percent of highways in "fair" or "poor" condition = 100 − (percent of highways in "good" condition [2005 and 2006]). Provincial average = 100 − (average of percent highways in good condition for all provinces [NOT weighted by mileage]). Ratio = (provincial percentage value) relative to (provincial average). Provinces with the lowest ratio rank the highest.

Road condition

Alberta: Percentage of provincial paved highways in "good," "fair," and "poor" condition were reported by the province (Alberta, 2007). Ratings were based on IRI values, using the scale "good" = IRI < 1.5 m/kilometer; "fair" = IRI between 1.5 and 1.89 m/kilometer; and "poor" = IRI ≥ 1.9 m/kilometer for 110 kilometer/hour highways.

British Columbia: The percent of kilometers of main highways whose pavement condition is "good" or "excellent" is supplied by the BC Ministry of Transportation (BC-MT, 2005). Description of how pavement is rated is not given.

Manitoba: Data was taken from a spreadsheet summary of the Manitoba provincial and regional pavement conditions for 2005 and 2006 (Manitoba, 2007). The expressway and bituminous arterial networks are the two highest levels of importance in the Manitoba network, so the kilometers of these two road type in "good," "fair," and "poor" condition by ride were summed, then divided by total kilometers to give percent "good," "fair," and "poor" roads. Ride quality is based on IRI, where, for expressways and bituminous arterials, roads with IRI between 0 and 2.4 are considered to be in "good" condition, while roads with IRI > 2.4 are in "poor" condition.

New Brunswick: Data was taken from a spreadsheet showing the surface distress index (SDI) for 500m road segments classified as arterials, collectors, and paved local roads (New Brunswick, 2007). The length of arterials with an SDI of less than 7.9 (considered to be the major rehabilitation threshold) were summed, as were the collectors with SDI less than 7.2 and paved local roads with SDI less than 6.5. This total was then divided by the total length of roads measured to give a percent of roads in poor condition for arterials, collectors, and paved locals in New Brunswick. Only the percentage of arterials in poor condition were considered, and percent "good" was calculated by taking 100 − (percent "poor").

Newfoundland: Data was taken from a spreadsheet of roughness readings just for segments of the Trans-Canada Highway in Newfoundland & Labrador (Newfoundland & Labrador, 2007). Roughness readings from the westbound and eastbound lanes were averaged. The total number of kilometers of road with IRI values of less than 1.5 were summed and divided by the total kilometers to give the percent "good." Likewise, kilometers of road with IRI between 1.5-1.89 were divided by total kilometers to give percent "fair," and kilometers of road with IRI greater than 1.9 divided by total kilometers was used for percent "poor." These IRI boundaries were taken from the *Alberta Infrastructure and Transportation Annual Report 2005–2006* (Alberta, 2007).

Nova Scotia: Road condition is based on IRI values, where "good" roads have an IRI < 1.60, "fair" roads have an IRI between 1.60 and 2.00, and "poor" roads have IRI > 2.00 (Nova Scotia, 2007b). These values only apply to freeways; the ranking IRI values are different for arterials and collectors, which were not included in the final road condition reported. In Nova Scotia, 46.03% of highways had an IRI between 1.01 and 1.20; 9.68% of highways had an IRI between 1.21 and 1.40; and 40.12% of highways had an IRI between 1.41 and 1.60, so the total percent of highways in "good" condition was found by adding together these three percentages. Furthermroe, 1.15% of highways had an IRI between 1.61 and 1.80; and 2.46% of highways had an IRI between 1.81 and 2.00, so these percentages were summed to give the percentage of highways in "fair" condition. Finally, 0.55% of highways had an IRI equal to or greater than 2.01, so this percentage was used as the percentage of highways in "poor" condition.

Ontario: Data presents road condition as percent of roads in "good" condition for 2002–2006 (Ontario, 2007).

Prince Edward Island: Data was taken from a spreadsheet showing surface distress indices (SDI) for road segments of specified lengths and number of lanes of each segment (PEI, 2007b). The total length of road segments with an SDI of less than 6.5 (the major rehabilitation threshold reported for paved local roads for New Brunswick by George Thompson) were added together and divided by the total length of road segments examined to give the percent of roads in "poor" condition for two, three, and four lane roads. The percentage of roads in "good" condition was determined by subtracting the percentage rated "poor" from 100%.

Quebec: The proportion of the roadways in "good" condition for the entire road network under the ministry's control was given as a percentage for 2004/05 and 2005/06 (Quebec, 2006a: 47). The RSSCE is the road network for foreign trade.

Saskatchewan: The percent of the principal highway network in good condition is given in a graph for the years 2002–2005 (Saskatchewan, 2006: 11). The road condition is based on IRI, but a description of the IRI threshold values is not given.

Fatalities per billion vehicle-kilometer: Values for this index were already calculated in the reference source. Provincial average is the (weighted) average of the fatalities per billion vehicle-kilometer for all provinces. Ratio = (provincial value) relative to (provincial average). Provinces with the low-

est ratio have the highest rank. Data shows the number of fatalities in road related accidents per billion vehicle-kilometers (Transport Canada, 2006a).

Congestion: Annual vehicle hours of delay per capita at 70% of capacity threshold. Cities in the same province were averaged to get an average value for each province. This value was divided by the average of vehicle hours of travel (VHT) per capita for all cities to give the ratio. Provinces with the lowest ratio to the overall average were given the highest rank. Provinces for which no data was available were not ranked.

✼ Measures of congestion in the **nine largest urban areas** in Canada and the amount of time and fuel wasted due to delays caused by traffic congestion are detailed by Transport Canada. Annual vehicle hours of delay per capita at 70% of threshold was given for nine major cities: Edmonton, Calgary, Vancouver, Winnipeg, Hamilton, Toronto, Ottawa-Gattineau, Montreal, and Quebec City (Transport Canada, 2007a).

Commuting time: Data is presented as an average round-trip travel time between home and workplace in minutes by region—Atlantic, prairie, Ontario, Quebec, and British Columbia (Statistics Canada, 2006c: 15). All provinces in the same region were given the same average travel time. The provincial average was calculated by taking the average of the travel times of the four regions. The travel time in each province was divided by the provincial average, and this value was ranked such that provinces with the lowest ratio to the average had the best ranking and so on.

Urban transit passenger
Government expenditures per trip = (total provincial and local transit expenditures × 10^6 [2004/05]) ÷ (annual ridership [2004]). Values for each province were compared to the weighted average, (sum of the transit expenditures for all provinces) ÷ (sum of ridership for all provinces), to get the provincial ratio. Provinces with the lowest ratio are ranked the highest.

✼ Expenditures by provincial and local governments adjusted to be at least equal to subsides reported by transit authorities (Transport Canada, 2005b: A49).
✼ Ridership comes from *Quebec Public Transit Policy 2006* (Quebec, 2006b).

Population served per thousand riders = (population served [2004]) ÷ (annual ridership [2004] ÷ 1,000). This is a measure of the number of "served population" needed to generate 1,000 annual riders; essentially, it is the inverse of the ridership per capita rate. Ratio = (provincial value) relative to (total ridership for all provinces divided by total population served in all provinces).

Provinces with the lowest ratio are ranked the highest, that is, they have the smallest population needed to generate 1,000 annual transit trips.

❧ Ridership and population served both come from *Quebec Public Transit Policy 2006* (Quebec, 2006b). Prince Edward Island values for ridership and population served are from a spreadsheet provided by Charlottetown Transit; annual ridership is calculated from monthly ridership for November 2005 to October 2006 (PEI, 2007a).

Air passenger

Flights per thousand passengers: This is a measure of the number of flights "needed" to generate 1,000 annual air passengers. It is a measure of the degree to which the population uses air service. The total number of passenger flights for each province was calculated by summing the number of annual flights for each airport in that province. Note that this number only reflects flights leaving from the top 50 airports in the country, so the actual number of flights (from some small airports) may be slightly larger. Index = (passenger flights [2004]) ÷ (total passengers [2004]) for each province. Ratio = provincial value relative to the provincial weighted average ([sum of all provincial flights] ÷ [sum of all provincial passengers] × 1,000). Provinces with the lowest ratio are ranked the highest.

❧ Data for a given year comes from the report for the following year, which provides revised data for the previous year—i.e., 2004 data comes from 2005 report; 2003 data comes from 2004 report (Statistics Canada, various issues—a). Flights from the top 50 airports are given for each year; different years may list data for different airports. Total flights for each province is the sum of flights for all airports in that province. Prince Edward Island data comes from the Charlottetown Airport flight schedule (Charlottetown Airport Authority, 2008). Annual number of flights is estimated from number of flights per week and adjusted for number of weeks per years (some flights are seasonal only).

❧ Data for passengers by province, enplaned plus deplaned passenger by type of service (scheduled, charter) or sector (2005; domestic, international) from Statistics Canada (Statistics Canada, various issues—a).

Accidents per million passengers: Index = number of accidents ÷ (number of passengers ÷ 10^6). Ratio = provincial value relative to the provincial weighted average ([sum of all provincial accidents] ÷ [sum of all provincial passengers]). Provinces with the smallest ratio are ranked the highest.

❧ Accidents for aircraft operating under Canadian Aviation Regulations (excluding military and state aircraft, ultralights) data come from *Transportation in Canada Addendum 2005* (Transport Canada, 2005b: A67).

❧ Passengers by province from Statistics Canada *Air Carrier Traffic at Canadian Airports* (Statistics Canada, various issues—a: 51–203).

(Intercity) rail passenger

No index has been calculated for rail passengers because no *provincial* passenger data could be obtained.

Marine (ferry) passenger

Ferry government expenditures per passenger = (provincial and federal government ferry expenditures [2005] $\times$ 10^6) $\div$ (total ferry passengers $\times$ 10^3). Ratio = provincial value relative to ([sum of expenditures for all provinces] $\div$ [sum of passengers for all provinces]). Provinces with the smallest ratio are ranked the highest. Provinces with no ferry services (Alberta and Saskatchewan) are not ranked.

❧ **Ferry passengers:** 2005 data comes from the Canadian Ferry Operators Association (CFOA, 2006: 31). This table lists passengers for private and publicly funded ferries. Passengers for Prince Edward Island are estimated (the text in the CFOA report refers to "in excess of 800,000 passengers ... annually"; 800,000 passengers is used in table 18.) Nova Scotia does not record passenger statistics for its intra-provincial ferry system, only vehicle statistics, provided by Bill Yarn. For Nova Scotia, the number of passengers was estimated from the number of vehicles per year multiplied by the average number of passengers per vehicle, as determined from the 1997–2003 ferry passenger and vehicle data for New Brunswick/Nova Scotia in the Transport Canada Tfacts marine statistics downloadable marine data spreadsheet <http://www.tc.gc.ca/pol/en/T-Facts3/Statmenu_e.asp?type=pu&file=marine&Lang=>. This number is generally about 2.2 persons per vehicle.

❧ **Ferry funding:** Provincial expenditures for BC, Manitoba, Newfoundland, Ontario, and the Northwest Territories come from the Canadian Ferry Operators Association (CFOA, 2006). Provincial expenditures for Nova Scotia (estimated 2004–05 operating budget) are in the *Transportation and Public Works Business Plan 2005–2006* (Nova Scotia, 2005: 13). Quebec provincial expenditures come from Transports Quebec (Quebec, 2007). Federal government expenditures are found in the *Transportation in Canada Addendum 2006*, table A3–3, "Direct Federal Subsidies, Grants, and Contributions, Marine Mode" (Transport Canada, 2006b). Federal money for Marine Atlantic was distributed evenly between the two provinces it serves, Newfoundland and Nova Scotia. Money listed as "ferry services" in BC was allocated to BC. Other ferry services money was divided up among Nova

Scotia, Prince Edward Island, New Brunswick, and Quebec, based on the information in tables A8–11, regarding ferry companies who receive federal money and which provinces they serve. Prince Edward Island and Nova Scotia both are served by two separate companies, therefore they are allocated twice the amount of federal money than the other two provinces are allocated. (X = share of other ferry services; [2X (Nova Scotia)] + [2X (Prince Edward Island)] + X + X = total other ferry services money; X = [total ÷ 6]; therefore Nova Scotia is allocated one third of the total money).

Ferry accidents per thousand passengers: Because ferry accident data is given by region, not province, provinces in the same region are given the same value, and therefore have the same rank. Index = (number of ferry accidents in region) ÷ (sum of ferry passengers [thousands] for all provinces in the region). Ratio = provincial value relative to ([total accidents in all regions] ÷ [total passengers in all provinces]). Provinces with the lowest ratio have the highest rank. Provinces with no ferry service (Alberta, Saskatchewan) were not ranked.

❧ Ferry accidents found in *Transportation in Canada Addendum 2005* (Transport Canada, 2005b: A62). Accidents are given by oceanic regions and type of boat and accident rather than by last port of docking or origin/licensing of ship. Provinces belonging to each region were determined from map from Barbara Prest, Occurrence Data Analyst, Program and Technical Training Services (AMSB), Marine Safety, Safety and Security, Transport Canada.

Freight transportation

Highway

Two-lane kilometer higher level roads per thousand tonnes truck cargo:
This is an inverse measure of traffic density and can be thought of as the number of two-lane kilometers "needed" to generate 1,000 tonnes of annual truck cargo. The calculation is (two-lane kilometers of higher level roads [2004]) ÷ (sum of intra-provincial cargo and inter-provincial cargo by province of origin). Ratio = (provincial value) ÷ ([total two-lane kilometers of higher-level roads] ÷ [total truck cargo for all provinces]). Provinces with the lowest ratios are ranked the highest. Because the tonnes of cargo are given for groups of provinces, each province in the group uses the same value for tonnes of cargo when calculating the ratio to the average, so that all provinces in the same group will have the same rank in this category.

❧ **Truck freight:** Data for Newfoundland, New Brunswick, Nova Scotia, and Prince Edward Island are combined into Atlantic provinces; British Columbia and the territories are combined; Manitoba, Saskatchewan, and Alberta are combined. Data is also given by city of origin. Data for inter-provincial and intra-provincial cargo is summed by province of origin (Statistics Canada, 2005b).

❧ **Two-lane kilometer:** Data is taken from Statistics Canada, *Human Activity and the Environment: Annual Statistics 2006* (Statistics Canada, 2006b: text table 1.8). Two-lane kilometers of higher level roads were calculated by summing the freeway **or** divided highway, primary highway, and secondary highway **or** major arterial kilometers for each province (local roads are excluded from the total).

Truck accidents per million tonnes of cargo = (number of fatal collisions involving heavy trucks [2003]) ÷ (million tonnes of cargo). Because the tonnes of freight shipped are given for groups of provinces rather than individual provinces, the index was calculated for each province by taking the sum of the accidents for all provinces in the group divided by the cargo shipped for that group of provinces. Therefore, all provinces in the same group have the same index value. Ratio = (index for the province) relative to ([sum of accidents in all provinces and territories] ÷ [sum of cargo shipped in all provinces and territories]). Territories were included because the cargo data for British Columbia includes the territories.

❧ **Truck accidents:** Data provided by Transport Canada (Transport Canada, 2007c).

❧ **Truck freight:** Data provided by Statistics Canada (Statistics Canada, 2005b).

Total employment per border crossing: This is a measure of the extent of each province's US trade, relative to its total employment. It is calculated as (the total number of employed persons in the province) ÷ (number of US border crossings in each province). Ratio = index ÷ ([sum of total employment for all provinces] ÷ [sum of border crossings for all provinces]). Provinces with the lowest ratio are ranked the highest. Provinces that do not share a border with the US were not ranked.

❧ **Employment:** Data provided by Statistics Canada (Statistics Canada, 2007a).

❧ **Border crossing:** Data is given by Transport Canada for the top 20 border crossings for trucks (Transport Canada, 2005b: A86). The total border crossing for each province was calculated by summing the border crossings for the locations in that province. Two-way traffic volumes were estimated by doubling one-way flows northbound into Canada.

Air

Total flights per tonnes of cargo = (total arriving plus departing flights for scheduled and major charter service at top airports [2005]) ÷ (total tonnage of cargo loaded and unloaded [2005]). Total flights were used because, in addition to strictly cargo flights, cargo is often carried on passenger flights. Ratio for each province = (value of the index for that province) relative to ([sum of total flights for all provinces] ÷ [sum of tonnes of cargo for all provinces]). Provinces with the lowest ratio are ranked the highest.

❧ **Flights:** Data provided by Statistics Canada, *Air Carrier Traffic at Canadian Airports,* 2001–2005 (Statistics Canada, various issues—a). Provincial totals are calculated by summing the number of flights for all airports in that province.

❧ **Cargo:** Tonnage of cargo loaded and unloaded on major scheduled services and major charter services by airport data from Statistics Canada (Statistics Canada, various issues—a). The top 20 airports are given for each year, so different years may list data for different airports. Note that Montreal Dorval Airport is now Pierre Elliott Trudeau International Airport. Provincial totals are calculated by summing the tonnes of cargo for all airports in that province.

Rail

Kilometers first main track per tonnes of cargo = (total kilometers first main track [2005]) ÷ (volume of rail traffic in each province, in thousands of originating tonnes [2005]). The total rail traffic (tonnes) in each province is the originating tonnage from each province (this measure does not include the "through" traffic moving through provinces, and is thus an understatement of traffic that most likely affects intermediate provinces such as Manitoba

and Saskatchewan). The originating traffic in each province is divided by the kilometers of first-line track (major track) to obtain a rail traffic density measure. The performance index is then the reverse of this; that is, ([kilometers of first-line track] ÷ [originating tonnes]) relative to [(total kilometers of first line track in all provinces) ÷ (total originating tonnes in all provinces)]. Provinces with the lowest ratio are ranked the best.

✠ **Kilometers of track:** Data for kilometers of first main track operated is provided by Statistics Canada (Statistics Canada, 2007e).

✠ **Tonnes of cargo**: Data for rail transportation, origin, and destination of commodity transported is provided by Statistics Canada (Statistics Canada, 2007e: table 13).

Rail accidents per thousand tonnes of originating freight = (rail accidents [2005]) ÷ (volume of rail traffic, as calculated above, in thousands of tonnes [2005]). Ratio = (index for each province) ÷ ([sum of rail accidents for all provinces] ÷ [sum of tonnes of originating rail freight for all provinces]). Provinces with the lowest ratio are ranked the highest.

✠ **Accidents:** Data provided by Transport Canada (Transport Canada, 2005b: A57).

✠ **Tonnes of Cargo:** Data for rail transportation, origin, and destination of commodity transported is provided by Statistics Canada (Statistics Canada, 2007e: table 13).

Marine

Cost per tonne cargo = (Canada Port Authorities operating expenditures in thousands of dollars) ÷ (total international + domestic shipping tonnes, in thousands of tonnes). Ratio = (index for each province) ÷ ([sum of all Canada Port Authorities operating expenditures] ÷ [sum of tonnes shipped for all provinces]). Provinces with the smallest ratio are ranked the highest. Provinces with no port facilities (Alberta, Saskatchewan) were not ranked, as well as provinces for which no data was available (Manitoba, Prince Edward Island).

✠ **Canada Port Authorities expenditures:** Canada Port Authorities financial profiles are given for particular ports for 2004 (Transport Canada, 2005b). Provincial totals are summed from individual port operating expenditures.

✠ **Cargo by province:** Data provided by Statistics Canada (Statistics Canada, various issues—c: tables 12, 13). "Total tonnage handled" was used but the data do not appear to include ballast (ballast plus cargo does not equal this value.) Total tonnes shipped were calculated by summing international and domestic tonnes given in the *Shipping in Canada* report.

Shipping accidents per thousand tonnes handled: Shipping accidents are given by maritime region, not by province. To calculate the index for each province, the number of shipping accidents for the province's maritime region was divided by the total international + domestic shipping tonnes, in thousands of tonnes, for all provinces in that region. All provinces in a particular region will have the same index and therefore the same rank. Ratio = (index for each province) ÷ ([sum of all shipping accidents in all regions] ÷ [sum of tonnes shipped for all provinces]). Provinces with the smallest ratio are ranked the highest. Provinces with no port facilities (Alberta, Saskatchewan) were not ranked.

❦ **Shipping accidents:** Accidents are given by oceanic regions and type of boat and accident rather than by last port of docking or origin/licensing of ship (Transport Canada, 2005b: A62). Provinces included in each region were determined from a map provided by Barbara Prest, Occurrence Data Analyst, Program and Technical Training Services (AMSB), Marine Safety, Safety and Security, Transport Canada.

❦ **Cargo by province:** Data provided by Statistics Canada (Statistics Canada, various issues—c: tables 12, 13).

Canada Port Authorities operating expenses per revenues = (sum of Canada Port Authorities operating expenses for all ports in province [2004]) ÷ (sum of Canada Port Authorities operating revenues for all ports in province [2004]). Ratio = (provincial value) ÷ ([total CPA operating expenses for all ports] ÷ [total CPA operating revenues for all ports]). Provinces with the lowest value are ranked the highest.

❦ **Canada Port Authorities expenditures per revenues:** Canada Port Authorities financial profiles are given for particular ports for 2004 (Transport Canada, 2005b).

Roll-up and weighting

The individual ratios for measures describing each transportation mode were then summed and divided by the total number of measures. This provides a modal average.

These modal ratios were then weighted using the percent of the total share of traffic (passenger trips, or tonnes) for passenger and freight transportation. Two different weight bases were used: for passenger travel, number of trips taken; for freight, number of tonnes of goods transported. Modal passenger trip data are available for air, transit, marine, and rail; highway passenger trips were estimated using data on passenger-kilometer multiplied by an estimated average trip length of 10 kilometers. For freight, originating tonne data are available for truck, air, rail, and marine. Pipeline tonnes were not included. These shares are shown in table B1.

There is no *theoretically correct* way to weight passenger transportation travel against freight transportation, since they describe different dimensions of transportation demand. Therefore, any weighting assumed is subjective. In this study, a weighting of 90% passenger and 10% freight is assigned; in other words, about 10 times as much weight to the passenger side as the freight side. This is actually somewhat less than the empirical weights based on traffic (about 49.95 billion passenger trips annually, versus 924 million tonnes of freight annually). This gives slightly more weight to the freight side than the actual share, 98/2. While other weights might be assigned (for instance, 50/50 passenger and freight), that would probably give inordinately greater weight to freight, and particularly to marine shipments. These weights, although somewhat subjective, seem reasonable for this first study.

The mathematical structure of this method is as follows:

M_{imp} = measure "i" for mode "m," province "p"
N_m = number of measures in mode "m"
R_{imp} = performance ratio for province "p,s" measure to 10-province mean
= $M_{imp} \div M$, where M is the aggregate (weighted) mean of M over the 10 provinces.
W_m = weight for mode "m," determined empirically.

$$\text{Grand Ratio}_{province} = [(\sum_{mode}^{N} R_{imp}) \div N_m] \times W_m \times 0.90 \quad \text{(passenger travel)}$$

$$+ [(\sum_{mode}^{N} R_{imp}) \div N_m] \times W_m \times 0.10 \quad \text{(freight traffic)}$$

Modal shares

❦ Air passenger trips is the total air passengers for 2004 from Statistics Canada, 51–203: *Air Carrier Traffic at Canadian Airports* (Statistics Canada, various issues—a).

❦ Transit passenger trips is annual ridership for 2004 from *Quebec Public Transit Policy 2006* (Quebec, 2006b).

❦ Marine passenger trips is the sum of ferry passengers for the provinces, which comes from the *Canadian Ferry Operators Association 2005 Annual Report* (CFOA, 2006: 31) and various provincial transportation ministries.

❦ The total rail passenger trips for 2004 comes from *Transportation in Canada Addendum 2005* (Transport Canada, 2005b: A81).

❦ Billions of passenger-kilometer data used to estimate highway passengers trips comes from *North American Transportation in Figures*, BTS00-05, 2000. US Department of Transportation, Bureau of Transportation Statistics. North American Transportation Statistics Database <http://nats.sct.gob.mx/nats/sys/index.jsp?i=3>, table 8.1: "Domestic passenger travel by mode in billions of passenger-kilometers."

❦ Truck originating tonnes is provided by Statistics Canada (Statistics Canada, 2005b).

❦ Total originating tonnes of rail freight comes from Statistics Canada (Statistics Canada, 2007e: table 13).

❦ The total originating tonnes of marine freight is provided by Statistics Canada (Statistics Canada, various issues—c).

General provincial data

Population
Statistics Canada (2006a). *Annual Demographic Estimates: Canada, Provinces and Territories 2005–2006*. Catalogue No. 91-215-XWE.

Population by major city
❧ Demographia (2007). *Demographia World Urban Areas (World Agglomerations) & Population Projections* (March). <http://www.demographia.com/db-worldua.pdf>.
❧ Statistics Canada (2007c). *Population of census metropolitan areas (2001 Census boundaries).* Summary table.

Urban/rural population
Statistics Canada (2007d). *Population urban and rural, by province and territory*. Summary table.

Gross domestic (provincial) product
Statistics Canada (2005a). *Canadian Economic Observer* (August). Catalogue No. 11-010-XWB.

Land area
Statistics Canada (2007b). *Land and freshwater area, by province and territory.* Summary table.

Employment
Statistics Canada (2007a). *Distribution of employed people, by industry, by province 2006*. Summary table.

Appendix C: Literature review

This short literature review summarizes the primary academic and professional literature related to Canadian transportation policy since about 2000. It is not intended as a critique of that policy but rather as a quick reference to major materials describing recent trends in Canadian transportation.

General

Canadian national transportation policy differs somewhat from that of other countries. In most countries, the federal role in "provincial" (sub-national) and urban transportation issues is substantial. In Canada, that role is more limited, focusing primarily on *inter*-provincial movement of passengers and freight and less on provincial or urban transportation (Heaver and Waters, 2005). Historically, national transportation policy focused on unifying the nation through modal connectivity, and then, more recently, moved to strengthen economic activity and trade. Over time, Canadian national transportation policy has shifted from a carrier/operator-based focus to one based largely on maintaining policy independence for provinces and urban areas. However, that does not preclude federal involvement in major projects such as Pearson Airport-Toronto passenger rail service (Westell, 2000). Transport Canada provides an annual summary of the issues in its annual report (Transport Canada, 2006). Broad issues regularly reviewed include competition and privatization, modal industries, preservation of urban rail corridors, trucking, e-business, environmental impacts, and the vision for national transportation (Flemming et al., 2001).

Modes
Beginning in the 1960s, regulatory reform focused on commercializing and decentralizing government roles and deregulating commercial transportation services (Montiero, 2001). Regarding rail services, the general trend has been toward privatization and liberalization, beginning in 1967 with the National Transportation Act, and continuing in 1987 with Class I railroads gaining freedom to consolidate network operations and abandon unprofitable branches (Law et al., 2001). However, problems with key services such as carrying agricultural grain from central Canada to ocean ports have driven recent reviews of the effectiveness of rail operations (Nolan and Fulton, 2000) and created calls for greater competition in the rail sector (Nolan and Fulton, 2001). Others have called for a return to some regulation for safety reasons (Benedict, 2007) or because of concerns

about monopolistic advantages over dependent freight shippers (Tougas, 2006). Ontario recently dropped plans to privatize its only north-south railway (*Vancouver Sun*, 2004, March 3), but privatization plans for British Columbia have gone ahead (Beatty, 2004, March 12).

Regarding air transportation, the 1995 Open Skies Agreement between Canada and the US resulted in more liberal air carrier operations (Montiero, Krause, and Downs, 2002). However, adverse air carrier operating circumstances before and after September 11, 2001 (9/11) eventually resulted in just one national air carrier and some calls for auctioning excess airport capacity to encourage more carriers to come in (Brander and Cook, 2000; Jordan, 2001). Some have attributed the consolidation largely to deregulation and its opportunities for increasing returns to scale and higher productivity (Ouellette, Petit, and Vigeant, 2005), but others have observed that some less efficient airlines have survived while other more efficient airlines have folded (Oum and Lu, 2001). Since 9/11, air policy's fundamental bases (Canadian ownership, reciprocal agreements, deregulation, and user pay) have also come under scrutiny (Ward, 2002). Eastern Canada has lost competitive services, and fares are being reviewed (Van Praet, 2003, November 7). In the meantime, some airports are expanding to accommodate increased traffic post 9/11 (*Airports International Magazine*, 2004a). Toronto and Montreal have made recent major investments in land-side facilities (McCormick, 2004; *Airports International Magazine*, 2004b).

Regarding marine shipping, shifts in world trade patterns have pressed provinces to increasingly institute "tonnage taxes" to combat ship owners leasing flag rights to open registries (Brooks and Hodgson, 2005). Consideration is also being given to coastal ("short sea") shipping as a way of alleviating trucking pollution and road congestion (Brooks and Frost, 2004). Most recently, the possibility of the opening of the arctic for shipping has generated some discussion of "ownership rights" of shipping lanes.

Truck traffic has increased and now constitutes the majority of freight traffic in several provinces (Barton and Chow, 2004); however, it still constitutes less than 25% of originating freight tonnage. New US rules (Fischer, 2006) charge truckers a fee when entering the US from Canada.

Urban

Canadian urban areas regularly conduct travel assessments and summarize the characteristics of urban travel (Paez, 2007; Hemily, 2004b; Pucher, 2006; Miller and Shalaby, 2003) as well as develop transportation planning and operation organizations suited to the multi-government needs of their regions (Kar, 2001). As in other major cities worldwide, traffic modeling systems are used to develop estimates of congestion costs for delay, fuel, and air quality (Kriger et al., 2007). They formed the basis of the congestion

assessments reported in this report. The stated primary goal of several urban transportation plans is to improve transit competitiveness and reduce auto dependence (Soberman, 2002; Ottawa-Carleton Transportation Commission, 1998). Even though private car use is increasing relative to transit use, cities are spreading out and private auto use is becoming more prevalent as a share of personal travel.

Since the Second World War, major Canadian urban transit operations have become almost exclusively government operated, but some services are still being subcontracted to private operators (Bellon, 2006). Ridership is flat or declining on most systems but rising on several (Miller, 2003). Nationwide, transit travel accounts for about 3% of trips. Costs are rising virtually everywhere (Lampert, 2003, September 22; Royson, 2005, January 14) and fares are covering just 40–50% of costs (Outhit, 2007, February 24). Some argue that "profit" is impossible, given the declining densities of Canadian cities (Hall, 2002, May 20). They are spreading out, following international trends of increasing auto ownership and suburban land becoming accessible (Buehler and Pucher, 2005), but they are still considerably denser and have higher transit and walk-bike use rates than comparable US cities. Operational improvements such as integrated fares (Hemily, 2004a) and integrated schedules and services (Kalinowski, 2007a) have proven difficult to implement, with two-hour commutes and long waits for suburb-to-core travel. Some regions have initiated "dialogues" on transportation operations to encourage discussions focusing on performance and customer service (Briggs and Jasper, 2001). Others have focused on calls for consideration of "sustainable" transport—primarily urban transit and inter-city rail service (Brender and Golden, 2007; Kennedy, 2002; Briginshaw, 2005). Others are investing heavily in rapid transit services after the defeat of freeway proposals (Preece, 2006). Ottawa, well known for its extensive bus rapid-transit system (Borsuk et al., 2007), is also extending light rail services. Vancouver has developed a three-line bus rapid transit system that carries 10% of system ridership (Lambert, 2003). Toronto is considering the construction of seven new light rail lines, at a cost of $6.1 billion (CA$), for new capacity to address rising ridership (Brown, 2007), but this may bring some of its service into competition with the Canadian Northern (CN) and Canadian Pacific (CP) freight railroads (Robl, 2007). Federal gas taxes for urban transit (*Passenger Transport*, 2005, March 7; Molony, 2002, January 26), a US policy since the late 1970s, are taking hold in Canada, too. However, some doubt the ability of transit improvements to keep up with population growth (Kidd, 2006, September 10; Gillespie, 2003, January 20).

Parking taxes are seen as a central element of control of auto traffic. But efforts to significantly raise parking fees in Ontario, Edmonton, Montreal, Calgary, and Vancouver have met with considerable resistance (Wallner and Laires, 2007). In the Toronto area, companies have been urged to institute parking fees for employees and provide incentives for transit use (Chung and

Keung, 2002, August 16). A recent "pay by cell phone" parking system for downtown Vancouver is reported to be quite successful, but parking is tight and expensive there (Yong, 2007).

However, road improvements are not being forgotten, even as gasoline taxes are diverted to other needs, particularly transit (McGran, 2004, September 21; Lu, 2004, May 19). A recent federal review estimated road "facelift" needs at $17 billion; but, of $4.7 billion in gasoline taxes collected, only $190 million went to roads (Royson, 2002, January 26). Widening projects are regularly put forward (Singer, 2003, January 16; Ritchie, 2003, January 17). To bridge the gap between road needs and revenues, provinces and federal authorities are looking at toll roads as a means of providing some additional capacity (Perreaux, 2002, July 11). So far, however, this has not resulted in a "rush" to toll roads or other innovative pricing mechanisms (Nix, 2002), even though tolls are rising on major routes (*Toronto Star*, 2004, January 8). Other operational approaches are also being pursued. Ontario, for instance, has recently reviewed the opportunities for "intelligent transportation systems" (Ontario Ministry of Transportation, 2005) in congestion relief, safety, border crossings and Intelligent Transportation Systems (ITS) delivery. The 2006 collapse of the Laval overpass in Quebec and the 2007 Minneapolis I-35W bridge collapse have spurred governmental review of bridge safety and condition (O'Reilly, 2007). Computer models of capital and maintenance costs are being developed for different road classes and regions of Canada, with the intent of making better project selections (Swan et al., 2007).

Appendix D: Provincial economic trends

This appendix provides a brief overview of recent population, employment, and gross domestic product trends. It is not intended as an economic assessment but rather as background against which the report can be viewed.

Population

Between 1991 and 2006, the population of Canada increased by 19.5% to 32.6 million persons (figure D1 and table D1). Eight of the 10 provinces and two of the three territories experienced an increase in population; Newfoundland & Labrador, Saskatchewan, and the Northwest Territories experienced declines in population. While Ontario and Quebec have the highest populations overall, the two western provinces of British Columbia and Alberta experienced the most rapid growth, both by approximately 32%. Manitoba and the Atlantic provinces (excluding Newfoundland & Labrador) experienced a less than 10% increase in population for the same 15 year period. Saskatchewan's population rose between 1991 and 2001, but then sunk between 2001 and 2006 for an overall population decline of 0.4%. Newfoundland & Labrador's population declined 11% between 1991 and 2001. The Northwest Territories' population declined 27% between 1991 and 2001, but this is primarily due to the creation of Nunavut, a new territory. Nunavut's population has increased by 9.5% since 2001.

Employment

Data for 2001 and 2006 show that employment rose 22.9% in the 10 provinces of Canada to 16.5 million jobs between those years, compared with a 5.2% increase in population over the same period (table D2). Ontario has the highest employment, followed by Quebec, British Columbia, and Alberta. But Alberta experienced the greatest percent increase in employment, with a rise of 30% between 2001 and 2006. British Columbia's employment rose by 29% (figure D2). The other provinces experienced a rise in employment between 17% and 25%.

Gross domestic product

Overall, the 10 provinces reported a 31.4% change in gross domestic product (GDP) between 1999 and 2004; currently, the Canadian GDP is about $ 1.29 trillion. Ontario has the highest provincial GDP, which increased by 26.5%; a similar increase in GDP was also experienced by Prince Edward Island, Manitoba, and Quebec. These numbers are in nominal dollars and are not

adjusted for inflation. Alberta and Newfoundland had the biggest increases in GDP (60%), while New Brunswick had the smallest increase (22.7%). Refer to figure D3 and table D3.

Table D1: Population for the Canadian provinces and territories, thousands

	1991	1996	2001	2006	1991–2006 percentage change
Alberta	2,546	2,697	3,057	3,376	32.6
British Columbia	3,282	3,725	4,078	4,310	31.3
Manitoba	1,092	1,114	1,151	1,178	7.9
New Brunswick	724	738	750	749	3.5
Newfoundland & Labrador	568	552	522	510	−10.3
Nova Scotia	900	909	932	934	3.8
Ontario	10,085	10,754	11,898	12,687	25.8
Prince Edward Island	130	135	137	139	6.7
Quebec	6,896	7,139	7,397	7,652	11.0
Saskatchewan	989	990	1,000	985	−0.4
10 provinces	**27,211**	**28,752**	**30,922**	**32,520**	**19.5**
Northwest Territories	589	64	41	42	−27.4
Nunavut	—	—	28	31	9.5*
Yukon	28	31	30	31	12.3
Canada	**27,297**	**28,847**	**31,021**	**32,623**	**19.5**

*Population change from 2001-2006.

Table D2: Employment trends

	Employment, all industries, thousands		
	2001	**2006**	**Percent change**
Alberta	1,437	1,871	30.2
British Columbia	1,700	2,196	29.1
Manitoba	494	587	18.8
New Brunswick	304	355	17.1
Newfoundland & Labrador	177	216	22.1
Nova Scotia	373	442	18.4
Ontario	5,274	6,493	23.1
Prince Edward Island	58	69	18.2
Quebec	3,200	3,765	17.7
Saskatchewan	392	492	25.3
10 provinces	**13,409**	**16,484**	**22.9**
Yukon	14	—	NA
Northwest Territories	18	—	NA
Nunavut	9	—	NA
Canada	**13,450**	**16,484**	**22.6**

Table D3: Gross domestic product (GDP) trends

	GDP at market prices, billions of dollars			
	1999	**2001**	**2004**	**Percent change**
Alberta	117.1	151.3	187.4	60.1
British Columbia	120.9	134.1	156.5	29.4
Manitoba	31.9	35.2	40.3	26.0
New Brunswick	19.0	20.7	23.4	22.7
Newfoundland & Labrador	12.2	14.2	19.6	60.6
Nova Scotia	23.1	25.9	30.0	30.3
Ontario	409.0	453.9	517.6	26.5
Prince Edward Island	3.2	3.4	4.0	26.6
Quebec	210. 8	230.7	267.0	26.7
Saskatchewan	30.8	33.3	40.5	31.4
10 provinces	**978.0**	**1,102.7**	**1,286.2**	**31.5**
Northwest Territories	—	—	—	—
Nunavut	—	—	—	—
Yukon	—	—	—	—
Canada	**982.4**	**1,108.2**	**1,293.2**	**31.6**