Quantification of Greenhouse Gases Produced by the Road Transportation Sector in Alberta Using a Traffic Volume Methodology

Alberta
INFRASTRUCTURE AND TRANSPORTATION

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<u>Executive Summary</u>

In 1997, a United Nations conference took place in Kyoto, Japan. The conference resulted in a protocol to the *United Nations Framework Convention on Climate Change.* The protocol called upon countries that ratified the agreement to reduce their greenhouse gas emissions in various industrial sectors including transportation. The report explains that Canada is a key supporter of, and contributor to, the *Kyoto Protocol*. Under the Protocol, Canada has agreed to lower its greenhouse emissions to six per cent below 1990 levels during the first commitment period (2008-2012). Alberta's stance on climate change is discussed in detail. The Alberta government established an emission reduction target based on emissions intensity rather than total emissions reduction, as does the *Kyoto Protocol*. This target has been specified within legislation in *Bill 37: The Climate Change and Emissions Management Act*. By the year 2020, the province aims to reduce GHG relative to Gross Domestic Product (GDP) by 50 per cent below 1990 levels. Both the Government of Canada and the Alberta government proposed to negotiate agreements with specific economic sectors, including electricity, petroleum, transportation, forestry, municipalities and other industries to gain commitment for action to reduce GHG emissions. It is explained that before organizations enter into voluntary agreements with government to reduce transportation GHG emissions, a framework for measuring reductions needs to be established. On the road network, vehicles release GHG and a method for measuring this amount of GHG is needed to establish baseline data for emissions improvement or reduction. This report examines several options for quantifying greenhouse gas emissions produced in the road transportation sector. It briefly discusses three methodologies: quantification using records of taxable fuel sold in Alberta, quantification using information compiled by Alberta Registries on the vehicle makeup in Alberta and quantification using traffic counts on Alberta's provincial highways and within Alberta's two major centers. The last methodology, using traffic volumes, is developed and discussed in detail. Results and analysis from the development of this road transportation GHG emissions quantification methodology are presented and compared to data developed from data sets of taxable fuel sales. Conclusions on the methodology's effectiveness are drawn and suggestions are made for future attempts at establishing baseline greenhouse gas emissions data for comparison.

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1.0- Introduction

In 1997, a United Nations (UN) conference took place in Kyoto, Japan. The conference resulted in a protocol to the *United Nations Framework Convention on Climate Change* (UNFCCC) to reduce greenhouse gas[1] (GHG) emissions in an attempt to manage climate change. The *Kyoto Protocol* established legally binding targets for those industrialized countries that ratify the agreement and the timeframes within which those targets are to be met. The Government of Canada has been a key supporter and contributor to the *Kyoto Protocol* since its inception. Although the Government of Alberta's stance on GHG emissions reduction is less stringent than that imposed by the *Kyoto Protocol*, it also has a plan and framework legislation on climate change management. As part of their plans on climate change both the Government of Canada and the Government of Alberta proposed to negotiate agreements with specific economic sectors, including electricity, petroleum, transportation, forestry, municipalities and other industries to gain commitment for action to reduce GHG emissions. One of the main hurdles to overcome when entering into these sorts of agreements is establishing baseline data or a framework for improvement. In Canada in 2001, the transportation sector was the main contributor of GHG released accounting for 26 per cent of all emissions - mainly comprised of road emissions (EC 2003). Prior to the establishment of agreements between the federal and provincial governments and the transportation sector, baseline data for road vehicle emissions must be established. This report outlines options for achieving this.

2.0-Background

2.1-Kyoto Protocol

In 1992 in Rio de Janeiro the UN *Conference on Environment and Development* (the Earth Summit) agreed on *Agenda 21* and the *Rio Declaration*. The summit brought environment and development issues firmly into the public arena. Along with the *Rio Declaration* and *Agenda 21,* the summit also led to agreement on two legally binding conventions: Biological Diversity and the UNFCCC. More than 155 countries, including Canada, signed the UNFCCC. Since then a number of UN conferences have been held, including one in Kyoto, Japan in 1997. The outcome of that conference was a Protocol to the UNFCCC. The *Kyoto Protocol* has established legally binding targets for those industrialized countries that end up

[1] Gases that are in most cases considered greenhouse gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), carbon tetrafluoride (CF_4), carbon hexafluoride (C_2F_6), and hydrofluoroc arbons (HFCs) (Jacques et al. 1997)

ratifying the agreement and timeframes within which those targets are to be met (UNFCC 2003). The *Kyoto Protocol* is a document that has been signed by about 180 countries and commits 38 industrialized countries to cut their emissions of GHG between 2008 to 2012 to levels that are 5.2 per cent below 1990 levels (EC 2003).

2.2-Government of Canada Stance on Climate Change

The Government of Canada has supported this UN process as the most effective means of ensuring global action on climate change. Canada is a key supporter of, and contributor to, the *Kyoto Protocol*. Some of the international mechanisms and the provisions on "sinks", for example, were to a significant degree "made by Canada". Under the Protocol, Canada has agreed to lower its GHG emissions to six per cent below 1990 levels during the first commitment period (2008 - 2012). This amounts to a reduction of 240 million tonnes from our projected "business-as-usual" emissions level in 2010. The *Kyoto Protocol* does not tell Canadians how to meet this target. That is entirely up to Canadians (GC 2002).

Efficiency improvements will have to be made in transportation, as in all sectors. The *Action Plan 2000 Freight Efficiency and Technology Initiative* was launched federally in November 2001 to promote greater efficiencies in the way goods are transported within Canada and to other countries. Working with the provinces, territories and industry, the Government of Canada is negotiating voluntary performance agreements, developing education and awareness programs and launching demonstration projects within all modes of transportation. Provinces are also taking initiatives in this area, as demonstrated by Quebec's mandatory inspection and maintenance program aimed at reducing GHG emissions and smog from heavy-duty vehicle use. Through negotiations with associations and industry, as well as new education and awareness tools, the goal outlined in *Action Plan 2000 Freight Efficiency and Technology* for freight efficiency improvements could be increased. In particular, governments could work with industry and service providers to encourage the purchase and installation of equipment that could cost-effectively reduce emissions. Examples include anti-idling systems for rail and truck services, on-board tire inflation technologies and aerodynamic drag reducers. Action to reduce emissions can be stimulated through technical workshops and publications, preventive maintenance programs, and fuel management practices tailored to commercial vehicles and to municipal partners with responsibility for facilitating the movement of urban goods (GC 2002).

2.3-Government of Alberta Stance on Climate Change

Realizing the need to balance environmental progress with economic prosperity, the Alberta government has established an emissions reduction target based on emissions intensity rather than total emissions reduction. This target has been specified within legislation in *Bill 37: The Climate Change and Emissions Management Act*. By the year 2020, the province aims to reduce GHG relative to Gross Domestic Product (GDP) by 50 per cent below 1990 levels. This is a reduction of about 60 million tonnes of carbon dioxide equivalent gases below expected levels. By 2010, Alberta expects to have achieved an emissions intensity improvement of more than 20 per cent and will have reduced emissions by the carbon dioxide equivalent of about 20 million tonnes below expected, “business-as-usual” levels (GA 2002).

While these figures identify an interim milestone that may be helpful in measuring progress towards a 2020 target, interim targets and agreements are being developed between the Alberta government and key sectors. This framework for pursuing the Alberta target provides a meaningful approach for managing progress in reducing GHG emissions. It avoids “solutions” that simply transfer revenue to other parts of the world through permit purchases, leaving less investment capital in Alberta to further improve reduction efforts. Alberta organizations - industry, municipalities and consumer organizations - are looking for an overall framework under which they can take best-in-class actions to reduce GHG emissions and reduce economic and environmental risks. The Alberta government is committed to providing leadership and increased certainty to these organizations and clearly outlining how it will work in partnership to achieve these reductions (GA 2002).

In May 2002, the Alberta government proposed to negotiate agreements with specific economic sectors, including electricity, petroleum, transportation, forestry, municipalities and other industries to gain commitment for action to reduce GHG emissions. The province is also committing to reducing emissions from its own operations - in effect a sectoral agreement with Albertans - setting an example for others by demonstrating a range of cost-effective actions. These agreements will be based on realistic emission reduction expectations. Industry will be asked to reduce emissions to levels that are consistent with the adoption of best practices (GA 2002).

Before organizations enter into voluntary agreements with government to reduce transportation GHG emissions, a framework for measuring reductions needs to be established. On the road network, vehicles release GHG and a method for measuring the amount of GHG released is needed to establish baseline data for emissions improvement or reduction (GA 2002).

3.0-Possible Methods of Quantifying GHG Emissions

Considering the data that is currently collected, three possible methods exist for the quantification of GHG produced from vehicles on Alberta's roads. The first possible method uses the number of litres of fuel delivered by oil companies at refinery terminals and bulk distribution plants which is collected by Alberta Treasury. The next method uses traffic volume counts collected on provincial roads and within small and large cities. Alberta Infrastructure and Transportation and the cities themselves collect this data. From these data, estimates of GHG can be produced after some assumptions have been made. The last possible method involves using Alberta Registries' registered vehicle data. It involves making several assumptions, and from this data quantifying the amount of GHG produced.

3.1-Provincial Fuel Sales

Total taxable fuel sales within the province are reported to and collected by Alberta Treasury. Once the number of litres of fuel sold are known, an estimate can be made of the corresponding mass of GHG produced assuming all that fuel is burned. This is done by using a figure for average mass of GHG produced per litre of gasoline or diesel burned.

Difficulties associated with this methodology are that litres of fuel sold in Alberta are not necessarily the number of litres of fuel burned. This is true for two reasons. The first is that non-taxed farm fuel is not accounted for in the number collected by Alberta Treasury. The other is that there may be a significant amount of fuel bought outside of Alberta that is burned in Alberta. Conversely, there may be a substantial amount of fuel bought in Alberta that is burned in other provinces or states. Ideally these two quantities are relatively similar, but in reality this is probably not the case. In any event, this data is not available.

3.2-Alberta Registries Vehicle Data

Currently Alberta Registries keeps track of the make and year of all registered vehicles in the province, but does not require vehicle owners to submit odometer readings each year or at all. Theoretically it would be possible to take each type of vehicle within Registries consideration, assign an appropriate fuel mileage, and try to calculate a fuel consumption and GHG production by estimating the kilometres driven by the "average" truck or passenger vehicle. As compared to the other methods of quantification, this method requires many more assumptions to be made and would most likely lead to much less precise results. As such, no attempt was made to pursue results using this type of methodology.

However, available data showing the number of motor vehicles registered by style of vehicle for 2003 is given in Appendix 1- Data Sets.

3.3-Provincial and Municipal Traffic Volume Counts

Alberta Infrastructure and Transportation collects traffic volumes along all provincial highways. The cities of Edmonton and Calgary also do this within their jurisdictions. From raw vehicle counts, vehicle kilometres driven can be calculated. After vehicle kilometres driven are known, fuel consumption estimates or the number of litres of fuel burned on a given section of road can be calculated. Once the number of litres of fuel burned has been determined, an average number for GHG production per litre of fuel burned can be used to determine the mass of GHG produced on a stretch of road. Emissions intensity, defined in this context as total mass of emissions divided by length of road, is obtained simply by dividing total mass of emissions by the length of that given section of road.

4.0- Methodology for Quantification of GHG by Traffic Volume Counts for Provincial Roads

From now on, the methodology used in this report to estimate GHG using traffic counts will be referred to as the Traffic Volume Methodology. The results of the Traffic Volume Methodology will later be compared to other measurable or collected quantities to assess its validity and accuracy.

4.1-Determining Vehicle Kilometres Driven

Alberta Infrastructure and Transportation keeps a record of Average Annual Daily Traffic (AADT) along provincial highways broken down by highway control section and vehicle type. The length of each control section is also given within the data set. With these three pieces of information, how many million vehicle kilometres (MVKM) traveled on a given control section by a particular kind of vehicle is calculated using formula number [1] given first in variable form and then in unit values. The Weighted (extrapolated from a point count to a link or section count) Average Annual Daily Traffic is multiplied by the length of the control section and then multiplied by 365 to obtain an annual figure (rather than a daily one) and then divided by one million to get a value in MVKM.

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$$MVKM = WAADT \times LS \times 365 \times \frac{1}{1{,}000{,}000}$$

$$MVKM = \left[\frac{vehicles}{day}\right] \times [kilometres] \times [365 days] \times \left[\frac{1}{1{,}000{,}000}\right]$$

[1]

Where, *WAADT = weighted average annual daily traffic*
LS = length of control section
MVKM = million vehicle kilometres travelled

4.2-Segregating Vehicle Kilometres by Vehicle Type

The next necessary step in developing the data for this methodology is segregating the MVKM by vehicle type. This is achieved simply by multiplying the vehicle percentages for a given control section by the according total MVKM. Vehicle percentages are obtained and collected by visual counts done by the province. They are segregated into passenger vehicles, recreational vehicles, buses, single unit trucks and tractor-trailer combinations respectively or PV, RV, BU, SU, TT.

4.3-Determining Fuel Consumption by Vehicle Type

The next step in the analysis process is to determine the litres of fuel consumed by a given vehicle type within a given control section. Fuel economy figures were estimated from two reports released by the USEPA, vehicle classification categories decided by the province and weigh in motion reports also compiled by Alberta Infrastructure and Transportation. To estimate fuel economy of the PV designation within the highway level of service analysis inputs, fuel economy of specific vehicles were chosen from the SUV, light truck and mid-size vehicle categories in the USEPA report. Conservative vehicles or vehicles with poorer fuel mileage were selected when possible. For RV, BU, SU, and TT, estimates were made for the average vehicle weight for each of these categories based on weigh-in-motion reports and then cross referenced with data from USEPA reports to determine appropriate fuel economy values for these different vehicle types. Using old vehicle mileage data and vintage reports from Alberta Registries, an estimate weighted average fuel economy was developed for passenger vehicles. To determine the values for how much fuel is used in litres, formula number [2] is applied. The MVKM is multiplied by the mileage to obtain a volume unit. This is multiplied by one million to convert back from millions of kilometres to kilometres and divided by 100 to convert from litres per 100 kilometres to litres per kilometre.

$$V = M \times MVKM \times 1{,}000{,}000 \times \frac{1}{100}$$

$$V = \frac{litres}{100kilometres} \times million|vehicle|kilometres \times 1{,}000{,}000 \times \frac{1}{100}$$

[2]

Where, *MVKM = million vehicle kilometres*
M = mileage (litres /100 kilometres)
LS = length of control section

4.4-Determining GHG Released per Litre of Fuel Burned

The next step in the analysis is to determine the GHG emissions in kilograms per kilometre of road. The amounts of litres of fuel used by the control section are multiplied by either 2.5 kg or 2.8 kg of GHG produced per litre of gasoline or diesel fuel used respectively (CCS 2003). Environment Canada developed these values. It was assumed that PV and RV were gasoline vehicles and all others were diesel vehicles. The mass of GHG produced by the control section is then finally divided by the length of that control section to obtain an intensity of emissions in kilograms GHG per kilometre of road.

5.0-Available Data

5.1- Provincial Data

The Program Management Branch of Alberta Infrastructure and Transportation compiles a worksheet of traffic volumes along highways on the provincial highway network. This worksheet for 2002 was used in GHG quantification estimation. Data sets in the worksheet include rural or urban distinction, highway number, control section number, from kilometre to kilometre, length of section, AADT and the percent PV, RV, SU, TT and BU. From this compiled data the spreadsheet that includes data developed using the Traffic Volume Methodology was created. Sample data sheets from this calculation for Highway 2 control section 15 (Deerfoot Trail) and of all of Highway 2 are given in Appendix 1- Data Sets.

To achieve the calculation described in section 4.3, numerous available data had to be consulted. To estimate fuel mileage for PV, an average number was developed. In developing this number, it was taken into account that PV are comprised of cars, small trucks and sport utility vehicles and an average fuel mileage was calculated from USEPA mileage reports (EPA 2003). A chart of calculated fuel economy based on vehicle type is given in Appendix 1- Data Sets. It was also taken into account that all the vehicles in the Alberta fleet are not new. A fuel mileage weighted with time was calculated using a makeup of Alberta's fleet age for 2003 and USEPA historic mileage reports (EPA 2003). A chart with the calculation of the weighted passenger fuel mileage based on vehicle fleet age is given in Appendix 1- Data Sets. To develop a fuel mileage for TT, the visual description of vehicle classifications created by Alberta Infrastructure and Transportation was consulted to determine the types of vehicles that make up this vehicle category and the number of axles they have. The Alberta Infrastructure and Transportation vehicle classification images are shown in Appendix 2 – Visual Data. Once a grouping of vehicles was visually determined to make up the tractor-trailer combination vehicle category, weigh-in-motion site reports were consulted to try and determine the average weight of this category. The Edson weigh-in-motion report used to estimate category vehicle weight is given in Appendix 1 – Data Sets. Once an "average" TT vehicle weight was developed, it was used to determine a fuel mileage from a USEPA report on heavy-duty engine emission conversion factors (EPA 1998).

5.2-City of Edmonton Data

City of Edmonton reports give the 2000 average-weekday vehicle kilometres driven. The conversion factor the city reports for conversion from kilometres driven in the average weekday to a value for average annual vehicle kilometres in a given year are 340 days/year rather than the otherwise expected 365 days/year. This conversion factor takes weekend variation into account. The City of Edmonton's 2000 Data for Full Weekday Traffic is shown in Appendix 1 – Data Sets. This data was summarized by City of Edmonton staff based on counts the City compiled in their 2003 report compiling traffic volumes from 1997 to 2002 (CE 2003). The City divides its vehicle kilometre counts into a "City" total and a "Region" total and combines them to obtain a "CMA" or census metropolitan area. The CMA contains St. Albert, Fort Saskatchewan, Sherwood Park, and the Counties of Strathcona, Leduc, Sturgeon, Parkland, and all towns and cities within them. Large variation between the daily vehicle kilometre counts in the Edmonton "City" and the Calgary "City" resulted in the value for the CMA being used for Edmonton as it was much more comparable to values in Calgary "City", which is relatively the same size and population as the Edmonton CMA. This was done apprehensively because the length of road considered in the Edmonton CMA is 10,728 km, compared to 3,292 km in the Edmonton "City" and 1,135 km in Calgary “City”. The vehicle makeup within Edmonton is given in City of Edmonton’s 2000 Data for Full Weekday Traffic and breaks the data down into private vehicles, commercial cars and trucks. It also breaks up the truck data into single-unit trucks and multi-unit trucks.

5.3-City of Calgary Data

As mentioned before, there is large discrepancy between the City vehicle kilometres for Edmonton and those for Calgary. The same method used to calculate GHG emissions for the province’s roads (as outlined in section 4.0) was used to calculate values for the cities of Edmonton and Calgary. Summaries of these calculations are shown in Appendix 1 – Data Sets. The City of Calgary has compiled the typical daily and annual vehicle kilometres traveled for Calgary from 1963 to 2001 and this data is shown in Appendix 1 – Data Sets. The conversion factor (as described in the previous section) is 328.75 days/year rather than the expected 365 days/year. The City of Calgary report failed to further divide vehicle kilometres driven by type of vehicle. It was assumed in calculation that the vehicle makeup was the same as Highway 2 control section 15 or Deerfoot Trail, for which the province compiles data and has numbers. Average traffic volumes and associated vehicle make-ups for Highway 2 control section 15 are found in Appendix 1 – Data Sets.

5.4-Small Urban Municipalities

There are two difficulties associated with collecting traffic counts data in small cities and towns. The first is that not all cities and small towns collect data extensively. They often store the data in visual format, making it very difficult to manipulate and do subsequent calculations. The City of Red Deer, for instance, has extensive traffic data but only makes it available in a visual format readable in Microstation format and not in a more useful tabulated format. The other associated difficulty is that a relatively large number of cities represent a relatively small portion of the total provincial traffic volume. Collecting this data is a time-consuming process. While it is possible, there is doubt as to whether the data already accumulated for the province and the major cities would change significantly with the addition of this new data. Another factor that questions if it’s worthwhile to collect counts in these cities and towns for GHG quantification purposes is that in many cities and towns the majority of traffic is on a major route, which is a provincial highway. These counts are already accounted for in the Alberta Infrastructure and Transportation traffic volume counts. An example of this is Highway 63, a provincial highway that runs through Ft McMurray.

6.0-Results of Analysis

6.1-Provincial Results Using the Traffic Volume Methodology

Once available data was compiled and analysis had been completed, Geomedia 5.0 mapping software was used to create maps of GHG emissions intensity. A colour was associated with a range of intensity, each value for emissions intensity for a control section was associated with the correct colour and coloured lines were plotted to represent emissions intensity in a graphical format. Maps were developed for the province, the Edmonton area, the Calgary area and the province for emissions from TT only. Mapping capabilities were not available for roads inside the cities themselves. Resulting maps for the province, the province TT, Edmonton and Calgary can be seen in Figures 1, 2, 3, and 4 respectively. Full printouts of the maps can be viewed in Appendix 2 – Visual Data. As can be seen from Figure 4, Calgary, the region of greatest intensity, is Highway 2 control section 15 or Deerfoot Trail, with an emissions intensity of 413,569.6 tonnes/kilometre/year.

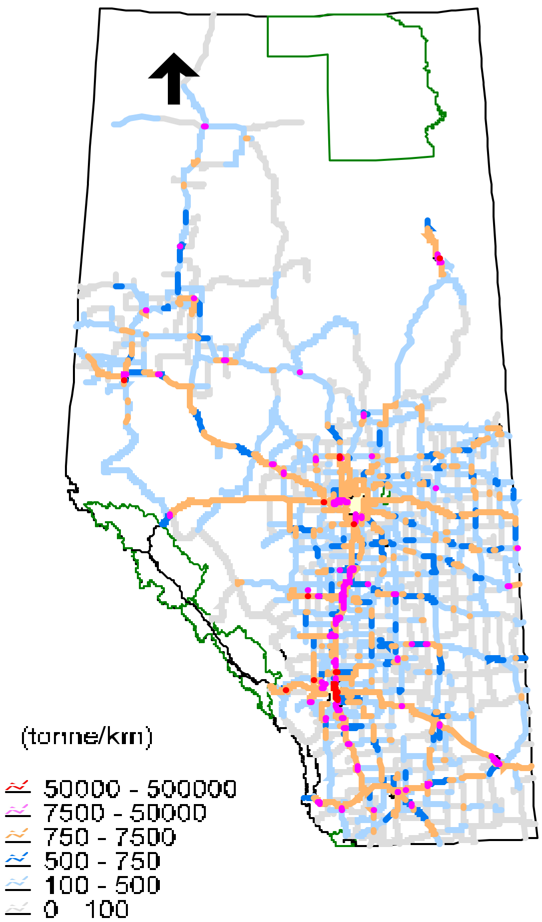

Figure 1 – Greenhouse Gas Intensity from all Vehicles on Alberta Provincial Highways

As previously mentioned, each emission intensity range was assigned a colour on the map. To get an idea of the total mass of emissions in each of these ranges, the mass of emissions in each range was calculated and the results are summarized in Table 1. Emission intensity ranges are also associated with their graphical colour in this table and are shown in order of descending intensity. From the summary in Table 1 it can be seen that the three ranges of greatest intensity constituted 79.8 per cent of the total emissions by mass on accounted provincial roads, whereas they only constituted 31.3 per cent of the number of control sections. Table 2 shows the distribution of total emissions by mass with vehicle type. From the summary in this table, it is evident that passenger vehicles are the biggest contributors to GHG emissions, making up 62.3 per cent of the

total emissions by mass on provincial roads. Passenger vehicles combined with tractor-trailer combinations make up the majority of emissions by mass, constituting 83.5 per cent of the total.

Table 1 – GHG Mass Distribution by Emissions Intensity Range

Number of Control Sections Within Range of Emissions Values	Colour on Map	Emissions Intensity Range (tonnes/kilometre)	% of total mass of annual provincial GHG emissions
27	RED	50000-500000	29.3
114	PINK	7500-50000	10.2
509	ORANGE	750-7500	40.3
153	DARK BLUE	500-750	4.97
719	LIGHT BLUE	100-500	12.7
556	GRAY	0-100	2.6

Table 2 – Distribution of Total Mass of GHG Emissions by Vehicle Type

Vehicle Type	Percentage of Total Emissions By Mass	Total Emissions by Mass (tonnes)
%PV	62.3	14368160.1
%RV	4.3	981775.6
%BU	2.5	576127.5
%ST	9.7	2244590.2
%TT	21.2	4876368.7

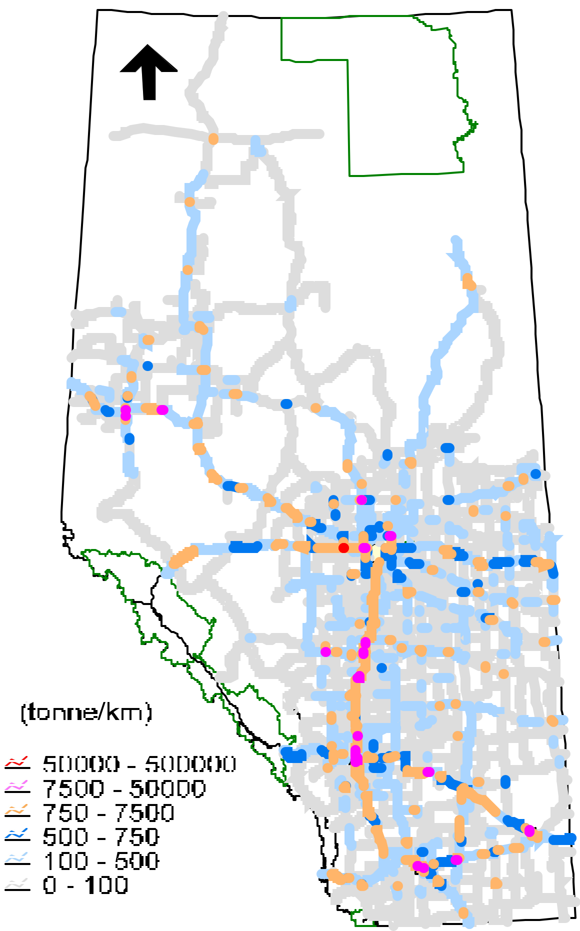

Figure 2 – Greenhouse Gas Intensity from Tractor-Trailer Combinations on Alberta Provincial Highways

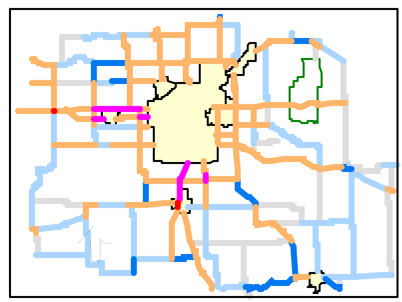

Figure 3 – Greenhouse Gas Intensity in Edmonton Surrounding Area

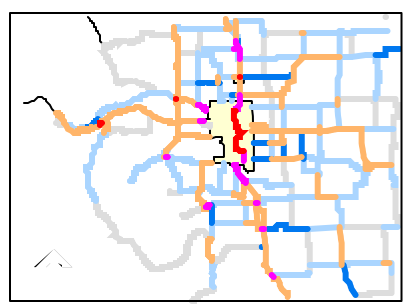

Figure 4 – Greenhouse Gas Intensity in Calgary Surrounding Area

Table 2 shows that 83.5 per cent of emissions come from PV and TT by the Traffic Volume Methodology. This figure is similar to the 70 per cent figure estimated in Environment Canada's Climate Change Plan for Canada. According to Environment Canada's report, two-thirds of road emissions are released in urban areas. Table 3 shows total GHG emissions mass estimated by the Traffic Volume Methodology in Edmonton, Calgary and the province's rural and urban roads, then gives a rural and urban split quantification. As seen in the table, the Traffic Volume Methodology shows that 64.5 per cent of emissions are urban - again, not dissimilar from Environment Canada's numbers. Table 4 summarizes the total fuel consumption, GHG emissions by mass and associated road length in kilometres for Edmonton, Calgary, provincial roads and then adds them together to get a total. Table 6 summarizes taxable volumes of fuel sold in 2001 and 2002 in Alberta, which were obtained from Alberta Treasury. The volume of fuel sold in 2002 is 7 billion litres. The Traffic Volume Methodology estimates an approximate value for consumed fuel in 2002 to be 11.8 billion. It should be noted, however, that values used to formulate this estimate are from 2000 in Edmonton and 2001 in Calgary; both the most recent data available. Possible reasons for this discrepancy between fuel consumption and fuel sales are described in section 3.1 of this report.

Table 3 – Total Emissions for Edmonton, Calgary and the Province Using Traffic Volume Methodology and Rural/Urban Split

Region	Total Emissions by Mass (tonnes)
URBAN	
Edmonton (2000)	3,341,973.8
Calgary (2001)	4,194,319.3
Provincial Urban Roads (2002)	12,178,274.4
Total Urban	19,714,567.5
RURAL	
Provincial Rural Roads (2002)	10,868,747.7
Total Rural	10,868,747.7
Grand Total (Total Rural +Total Urban)	30,583,315.2
% Urban (Total Urban/Grand Total)	64.5
% Rural (Total Rural/Grand Total)	35.5

Table 4 – Total Emissions and Fuel Consumption for Edmonton, Calgary and the Province Using Traffic Volume Methodology

	Fuel Consumed (litres)	Road Length (Kilometres)	Total Emissions By Mass (tonnes)
Edmonton (2000)	1,310,940,495	10,728.0	3,341,973.8
Calgary (2001)	1,635,886,456	1,135.0	4,194,319.3
Province (2002)	8,888,933,695.2	28,660.2	23,047,022.1
Total	11,835,760,646.2	40,523.2	30,583,315.2

6.2-Comparison of Traffic Volume Methodology Estimates to Actual Provincial Fuel Sales

Table 5 compares the total CO_2 equivalent emissions from the road transportation sector calculated by two methods. The two methods compared are the Traffic Volume Methodology and Environment Canada's method of quantifying GHG emissions using fuel sales. A bit of difficulty existed in correlating numbers from two different sets of vehicle groupings. Different kinds of vehicles considered by Environment Canada were grouped to make up the Alberta Infrastructure and Transportation categories of PV, TT, RV, BU, and SU, and are clearly grouped in the left hand column of Table 5. The percentages of road transportation emissions that are attributed to any particular type of vehicle are similar in both methods. For instance, PV percentages are similar to the Traffic Volume Methodology (calculating 62.3 per cent of the total emissions) and the Environment Canada number (reporting 57.6 per cent of total emission). Numbers for TT are off quite a bit. The expected reason for this dissimilarity is apparent: Environment Canada does not have groupings for BU, SU or any types of RV except motorcycles. If the numbers for RV, BU and SU from the Traffic Volume Methodology were added to the TT numbers from this same methodology, they would account for 37.7 per cent of total emission, which is similar to the 42.3 per cent for TT accounted for by the Traffic Volume Methodology.

Table 5 – Comparison of Total Road Transportation CO_2 Equivalent Emissions by Mass Determined Using the Traffic Volume Methodology to Environment Canada Compiled Data

Environment Canada Compiled Data (2001)			Traffic Volume Methodology (2002)		
	kt CO_2 equivalent	% of total		kt CO_2 equivalent	% of total
gasoline automobiles	4883				
light duty gasoline trucks	6124				
light duty diesel vehicles	34.9				
Light duty diesel truck	158				
PV	11199.9	57.6		14368.2	62.3
heavy duty gasoline trucks	1116				
heavy duty diesel vehicles	7118				
TT	8234	42.3		4876.4	21.2
motorcycles	27.1				
RV	27.1	0.1		981.8	4.3
BU	-	-		576.1	2.5
ST	-	-		224.5	9.7

Table 6 – Provincial Fuel Sale Volumes by Region from 2001 and 2002

Region	2001 (litres)	2002 (litres)
Edmonton	1,387,345,000	1,426,909,000
Calgary	1,669,962,000	1,750,930,000
Province (includes Edmonton and Calgary)	6,960,730,145	7,053,583,584

The Traffic Volume Methodology, in most cases, yielded similar data to that of other methods to quantify GHG road emissions data. In future baseline quantification endeavours it should be noted that no one method is ideal, and each has its strengths and weaknesses. Perhaps the most important thing to understand when undertaking these sorts of quantification exercises to end up with baseline data is that while there is a need for accuracy, it is secondary to the need for consistency in methodology over time. Essentially, if the same quantification mistakes are made time after time, although they may not be perfectly defining the emissions quantity, they will be “comparing apples to apples”.

7.0-Conclusion

The provincial map developed by the Traffic Volume Methodology shows the most intense areas of GHG intensity to be along primary highways, particularly on the Highway 2 corridor between Edmonton and Calgary and on Deerfoot Trail in Calgary. The methodology also shows that 68.7 per cent of all control sections in the province have emissions intensities of 750 tonnes/km/year or less. Furthermore, 27 control sections or 1.3 per cent of the provincial total have emissions intensities greater than 50,000 tonnes/km/year. It was also determined that 62.3 per cent of the total road transportation GHG emissions are created by PV and 64.5 per cent of road transportation emissions are produced in urban areas. The Traffic Volume Methodology also estimates that 11.8 billion litres of fuel were consumed on Alberta's roads in 2002.

Several conclusions have been drawn from the process of developing and executing this methodology. Most traffic counts in small cities and towns are not easily obtained or are in formats not easily manipulated in subsequent calculations. In general, the Traffic Volume Methodology yielded GHG emissions quantities that were relatively consistent with other methods such as fuel sales records. After examining several possible methodologies, it was concluded that the most critical factor in using baseline data as a basis for comparison is that the exact methodology used to establish the baseline data be used to develop subsequent data sets.

8.0-References

City of Edmonton (CE). 2003. Traffic Volumes Average Annual Weekday Monitoring 1997-2002. City of Edmonton. Transportation and Streets.

Climate Change Solutions (CCS). 2003. http://www.climatechangesolutions.com/english/individuals/stories/transport/tdi2.htm . <opened May 21, 2003> Climate Change Solutions. TDI Diesel Technology.

Environment Canada (EC). 2003. http://www.ec.gc.ca/pdb/ghg/whatsnew1_e.cfm. <opened August 14, 2003> Environment Canada. Greenhouse Gas Division.

Environment Canada (EC). 2003. http://www.ec.gc.ca/climate/overview-e.html. <opened August 14, 2003> Environment Canada. Climate Change Overview.

Government of Alberta (GA). 2002. Albertans and Climate Change: Taking Action. Government of Alberta. Alberta Environment. Edmonton, AB.

Government of Canada (GC). 2002. Climate Change Plan for Canada. Government of Canada. Cross Ministry Initiative on Climate Change. Ottawa, ON.

Jacques, A., Neitzert, F., and Boileau, P. 1997. Trends in Canada's Greenhouse Gas Emissions (1990-1995). Pollution Data Branch, Air Pollution Prevention Directorate, Environment Canada, Ottawa, ON.

United Nations Framework Convention on Climate Change (UNFCC). 2003. http://unfccc.int/resource/convkp.html. <opened August 14, 2003>. United Nations Framework Convention on Climate Change. The Convention and Kyoto Protocol.

United States Environmental Protection Agency (EPA). 1998. Update Heavy-Duty Engine Emission Conversion Factors for MOBILE6: Analysis of BSFCs and Calculation of Heavy-Duty Engine Emission Conversion Factors, EPA 420-P-98-015. Air and Radiation, USEPA, USA.

United States Environmental Protection Agency (EPA). 2003. Model Year 2003 Fuel Economy Guide, DOE/EE-0271. Office of Energy and Renewable Energy USEPA, USA.

United States Environmental Protection Agency (EPA). 2003. http://www.epa.gov/otaq/fereport.htm. <opened August 14, 2003>. United States Environmental Protection Agency. Transportation and Air Quality. Fuel Economy Guide Report Files.

Appendix 1 – Data Sets

Appendix 2 – Visual Data