Yukon Greenhouse Gas Emissions: The transportation sector

Final Report

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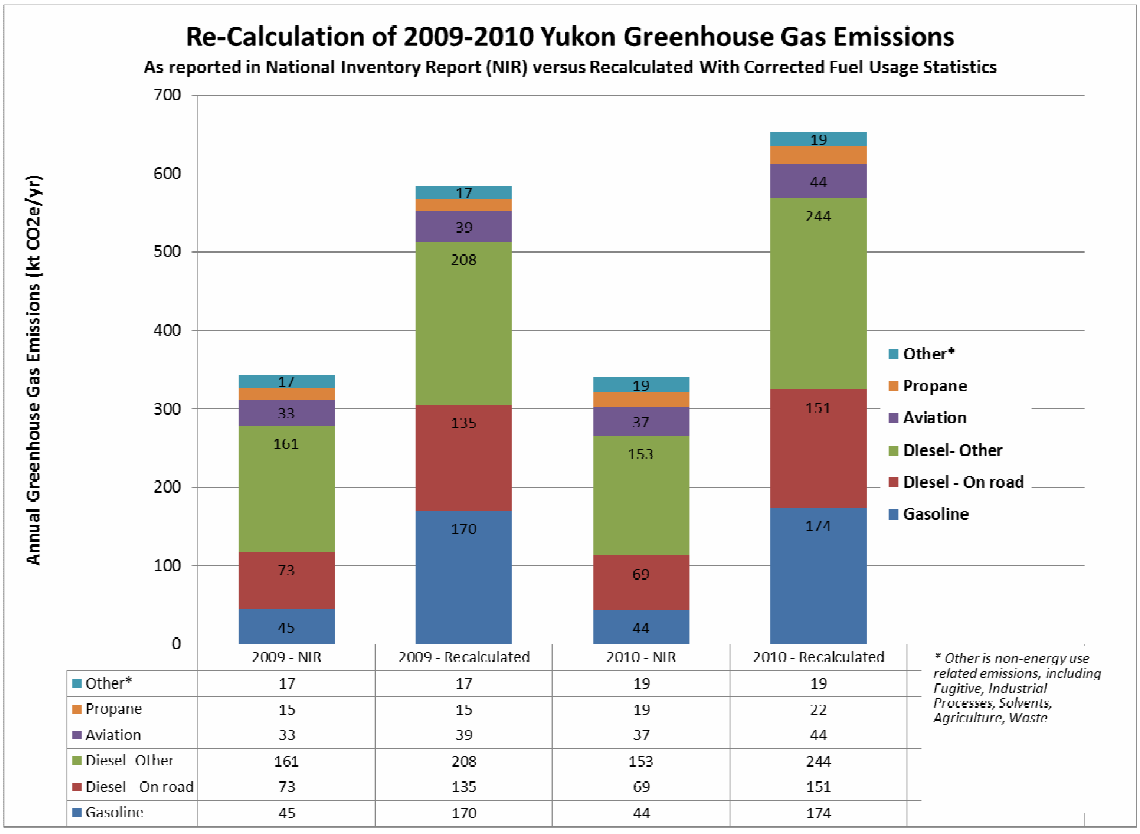
Key Findings: The big picture

The original purpose of this research project was to build on the available knowledge from Environment Canada and previous work done in the Yukon by using a wide variety of data sources in order to produce a clearer and more detailed picture of the sources of greenhouse gas emissions (GHG's) from the transportation sector in the territory. The better picture is necessary as the Yukon Government moves forward towards its commitment to reduce emissions. However, in the course of this research, a number of surprising findings were made with respect to the Yukon's greenhouse gas inventory as it is currently reported in the National Inventory Report.

The most important finding is that Yukon's greenhouse gas (GHG) emissions as reported in Environment Canada's National Inventory Report (NIR) are substantively under reported:

- Actual 2009 emissions (584 $ktCO_2e$) are 70% higher than stated by the NIR (344 $ktCO_2e$)
- Actual 2010 emissions (653 $ktCO_2e$) are 92% higher than stated by the NIR (324 $ktCO_2e$)
- 2011 Yukon greenhouse gas emissions are estimated at 718 $ktCO_2e$ (the 2011 NIR is not available at this time).

Contrary to the trends suggested by the NIR, the Yukon's GHG emissions have not been declining, but in fact have been rising. From 2009 to 2010, Yukon's emissions rose 11%. Yukon GDP rose 4%.[1] Nationally GHG emissions rose 0.25% from 2009 to 2010 as reported in the NIR. The re-calculation of the Yukon's emissions is summarized in the figure below.



[1] http://www.eco.gov.yk.ca/fr/pdf/gdp_2010.pdf

How do we know that the NIR report on Yukon's overall emissions is wrong? Because to calculate the amount of fuel consumed in the Yukon, the NIR uses the *Report on Energy Supply and Demand in Canada* (RESD). The data source for the RESD is the monthly Refined Petroleum Products Survey carried out by Statistics Canada that covers all refining companies in Canada along with selected major wholesalers and distributors. Environment Canada is bound by agreement with the United Nations on GHG emissions reporting and is required to use the national energy balance (as represented by the RESD) in its reporting. Unfortunately for the Yukon, the RESD does not present an accurate picture of fuel consumption in the territory due to:

- The significant amount of fuel shipped in from Alberta by secondary distributors (some of which will show up in the Alberta data); and,
- The significant level of fuel imported from Alaska that is not captured in the data.

Environment Canada is aware that its reporting, while accurate on a national scale, is vulnerable to error at provincial or territorial levels. Scott McKibbon of Environment Canada recognizes that the Yukon government is responsible for managing Yukon emissions and the size of the discrepancy in emissions reporting is highly significant for the territory. Further, other jurisdictions are also seeing discrepancies in their emissions reporting.

How confident are we that the recalculated emissions offered here are accurate? Very confident because the recalculation is based on fuel data supplied by the Yukon's Department of Finance. Finance tracks all fuel imported to the Yukon from any source in order to ensure that the appropriate excise taxes are paid or exempted as appropriate. These data also form the basis of Statistics Canada's CANSIM 405-0002, *Road motor vehicles, fuel sales, annual (litres).*

Recommendations

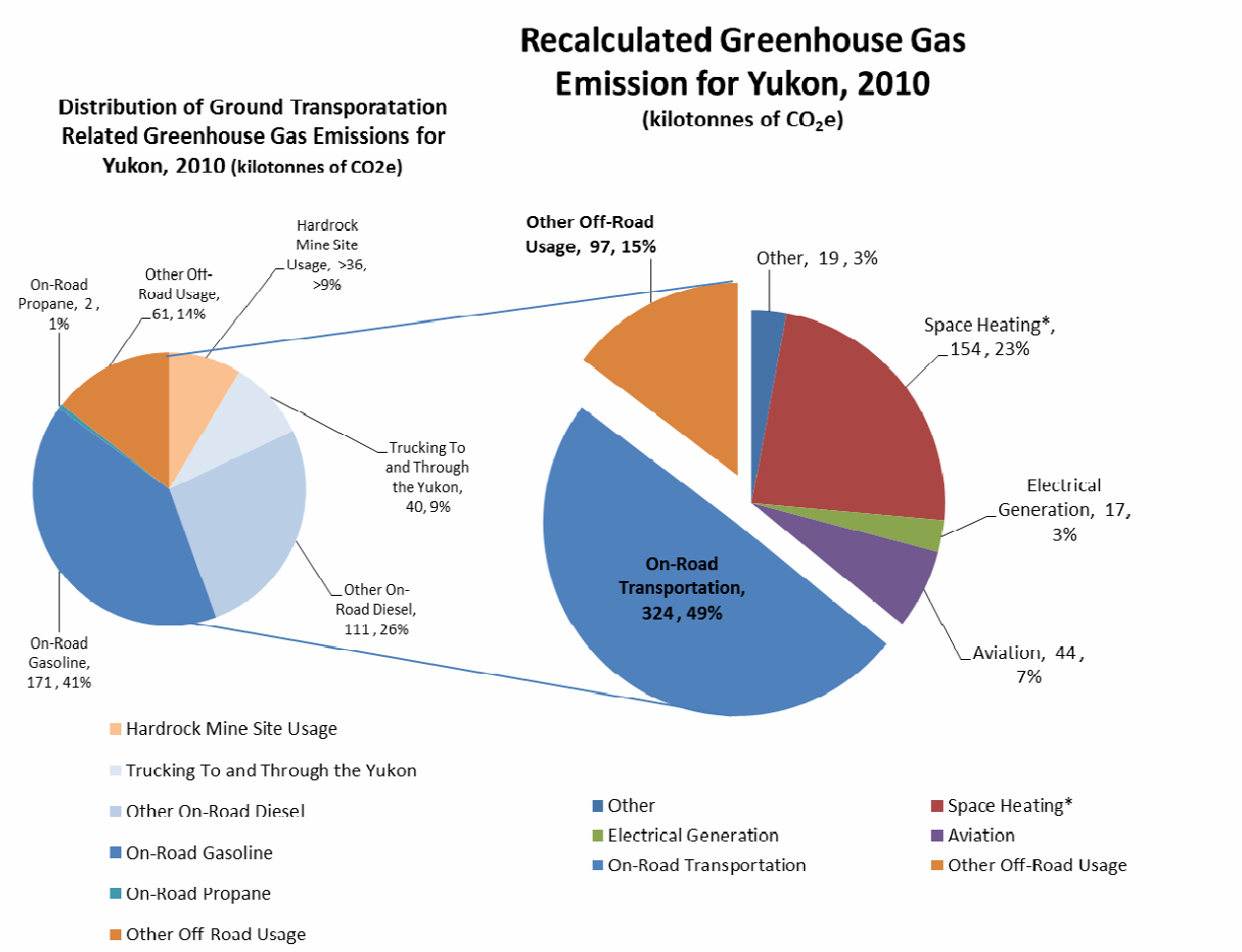
1. The Yukon government has committed itself to manage and reduce greenhouse gas emissions. To be successful in meeting that commitment, emissions must first be accurately reported. We therefore strongly recommend that the reporting of the Yukon's greenhouse gas emissions be based on the high-quality data from the Yukon Department of Finance, not the RESD.

2. Environment Canada, through Mr. Scott McKibbon, has expressed a willingness to work with the Yukon government in order to ensure accurate GHG emission reporting for the territory. Although Mr. McKibbon has mentioned the need for an exemption from the United Nations agreement on reporting protocols, we recommend that the Yukon government ask Environment Canada to simply provide a separate or supplementary report on emissions for the Yukon before attempting to gain an exemption.

3. If Environment Canada is unable to provide GHG emission reports based on fuel data from Yukon Finance, we recommend that the Yukon government produce these reports itself from the data in order to have an accurate basis on which to meet its commitment to manage and reduce greenhouse gas emissions.

Key Findings: Transportation emissions

From available data we are able to offer an estimate of the distribution of the Yukon's greenhouse gas emissions as shown in the figure below. As noted in the key findings of the big picture, we are very confident of the overall recalculation of total emissions. However, some parts of the distribution of those emissions are still open to question as detailed below the figure.



Issues and calculation methods for the distribution include:

- On-road transportation is based on net sales of motor gasoline and net sales of diesel from Statistics Canada, CANSIM 405-0002 *Road motor vehicles, fuel sales, annual (litres)*. This portion of the distribution is therefore robust.
- The trucking to and through the Yukon piece of on-road transportation is based on data from Yukon Finance, which requires that all through carriers and inter-provincial carriers report the number of kilometres driven in the Yukon and the number of litres of fuel consumed in the Yukon. Therefore the distribution into three segments of on-road transportation is also robust.
- We requested separate data on jet fuel and avgas from Yukon Finance but perceived concerns centered on the *Access to Information and Protection of Privacy Act* prevented the release of

more detailed data by Finance at this time. Emissions from aviation are therefore derived from the difference between the total volume of fuel (either diesel or gasoline) on which excise taxes were paid (from Yukon Finance) and the net sales of diesel and gasoline for motor vehicles (from Statistics Canada). The aviation component of the distribution is therefore robust.

- We requested separate data on heating fuel from Yukon Finance but perceived concerns centered on the *Access to Information and Protection of Privacy Act* prevented the release of more detailed data by Finance at this time. Therefore calculating the distribution of diesel that is exempt from excise tax — heating fuel, off-road industrial use, and electrical generation — required the following:
    - Electrical generation was derived from the YBS reported kWh generated using published conversion factors of 3.71 kWh/litre for YECL and 3.67 kWh/litre for YEC and we judge the result to be robust.
    - The estimate for the amount of diesel used for heating is the weakest of all the distribution estimates presented. Although the quantities total quantity heating fuel consumption for the Yukon in the Report on Energy Supply and Demand (RESD) we have assumed that the percentage of heating fuel relative to total diesel consumption may be representative. The ratio is approximately 30%.
- The estimate of hard rock mine site usage was derived from weigh scale data that allowed us to compare the loaded and unloaded weights of fuel trucks destined for the Minto and Wolverine mine sites (Alexco was not yet operating). The weigh station data were incomplete but we pro-rated the existing data to cover the gaps (checking for timing of the shoulder seasons for the Minto mine). Although a reasonable estimate, this approach is not entirely robust.

Recommendations

1. We strongly recommend that the Climate Change Secretariat work with the Department of Finance to ameliorate concerns related to the *Access to Information and Protection of Privacy Act* and produce disaggregated data on fuel usage in the Yukon. In particular, having reliable data for the proportion of heating fuel within the total for diesel fuel would be valuable. The Department of Finance data are high-quality and key to understanding and managing the largest source of greenhouse gas emissions in the Yukon.

2. We recommend that the Climate Change Secretariat work with the Department of Highways and Public Works to ensure that the weigh station data going forward is available in complete years. The data supplied for this project was valuable but suffered for being incomplete for each year. Further the data will be extremely useful going forward in efforts to manage a variety of transportation emissions.

3. To better improve the understanding of off-road diesel transportation (and of industrial use in general) we recommend engaging in primary research with the Yukon's operating mines and other industrial operations to disaggregate their fuel use between transportation on-site, electrical generation, and other use. As a first step, Yukon Energy Mines and Resources could require, as part of their quartz mining licence, that operating mines report annually on total fuel consumption broken down into fuel consumed to generate electricity, fuel consumed for heating and fuel consumed by vehicles on site.

4. It is recommended that Yukon government's corporate emissions receive further work, particularly by the Fleet Vehicle Agency for light vehicles and Highways and Public Works for heavy equipment. Data are available but need further work and analysis.

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1 Introduction

The purpose of this research project is to build on the available knowledge from Environment Canada and previous work done in the Yukon by using a wide variety of data sources in order to produce a clearer and more detailed picture of the sources of greenhouse gas emissions (GHG's) from the transportation sector in the territory. The better picture will be valuable and necessary as the Yukon Government moves forward towards its goal of reducing emissions. Designing and implementing effective reduction programs requires a good knowledge of where those programs should be focussed.

Environment Canada's National Inventory Report (NIR) on greenhouse gas emissions shows that the transportation sector is responsible for the majority of the Yukon's GHG's and the sector's share is substantially higher here than for Canada as a whole. However, very little is known about the how and where this sector's emissions are coming from. The National Inventory data breaks down the transportation sector into three Yukon-relevant sub-sections: aviation, road transportation and off-road transportation. Under road transportation the most significant contributor is heavy duty diesel vehicles, responsible for over one third of road transportation emissions. Off-road diesel use is also a significant contributor at just under 20% of transportation emissions. We wish to further understand where transportation related emissions come from and to inform the management and development of strategies to reduce these emissions.

1.1 Approach

Our general approach to the task of producing a more detailed and accurate picture of the Yukon's transportation sector and its GHG's was to:

- Look very closely at all of the data and approaches used to calculate GHG's and not take the data or approaches as a given;
- Do as much as possible to cross-check data by finding and using alternative data sets and sources; and,
- Although we had a number of ideas on where to find the needed data and how to use it from the beginning, we wished to remain flexible in our approach and open to following up alternative means of achieving the project goal.

More specifically, our approach included the following:

- To complete a canvas of the Yukon Government to find any relevant work that has already been completed or is underway. The intention was to avoid re-doing research.
- Because heavy duty diesel vehicles are such a significant emissions contributor according to the National Inventory, we focussed considerable effort on this sub-sector. Questions we began with included: How much of the trucking sector is directly tied to mining, both hauling in fuel and other necessities and hauling out ore? How much consists of through traffic to and from Alaska versus supplying the Yukon with goods? Are the large tour buses from the cruise ships a significant factor? We began with the following list of sources to help answer these questions: Yukon traffic count data, Yukon weight scale data, fuel sales data, Yukon fuel excise tax data, border crossing data, and standard fuel consumption averages data.
- Off-road diesel use is a significant source of emissions and therefore warranted effort to better determine specific sources. We wished to look at the likeliest largest users of this fuel (the territory's three operating mines) to determine, if possible, how much each contributes to this sub-sector and whether we can estimate how much is used in mobile versus stationary equipment.

1.2 Transportation emissions: the National Inventory Report (NIR)

An overview of the Yukon's greenhouse gas emissions from 2006 through 2010 as reported in the NIR is shown in Table 1 below.

Table 1: Yukon Greenhouse Gas Emission as Reported by the NIR by Category: 2006 through 2010 in ktCO_2 equivalent

CATEGORY	2006	2007	2008	2009	2010	GROWTH OR DECLINE
Electrical Generation	18	18	18	17	19	3%
Mining, Oil & Gas Industries	103	113	74	19	27	-73%
Manufacturing & Construction	2	4	22	18	16	729%
Commercial, Institutional & Residential Heating	107	110	124	82	76	-29%
Agriculture and Forestry	6	0	0	0	0	-100%
Air Transport	**34**	**39**	**34**	**33**	**37**	**9%**
Ground Transport	**227**	**228**	**180**	**160**	**149**	**-34%**
Industrial Process	9	10	10	11	13	47%
Other (Solvents & Waste)	3	3	3	3	3	8%
TOTAL	508	524	466	343	340	-33%

Source: Environment Canada 2012 NIR. Table A14-22, Part 3, Page 71

Key observations from Table 1:

- Ground transport is the largest source of GHG's in the Yukon, ranging from 39% to 47% over the 2006 through 2010 period.
- Heating is the second largest source of GHG's, ranging from 21% to 27% of the totals over the period.
- The 73% decline in the mining, oil & gas industries category over the 2006 through 2010 period mirrors the 67% decline in the production of natural gas in the Yukon over the same years.
- The NIR data suggest that emissions from ground transportation and for heating are shown as declining substantially over the period, helping to drive an overall decrease in emissions. There is no obvious explanation for these sharp declines with an increasing population and growing GDP in the Yukon.

The 2010 emissions as reported by the NIR are shown in graph form in Figure 1 below. The NIR suggests that 43% of GHG emissions in the territory were attributable to ground transportation and a further 11% were from air transportation.

Figure 1: Yukon's 2010 Greenhouse Gas Emissions by Category, as Reported by the NIR

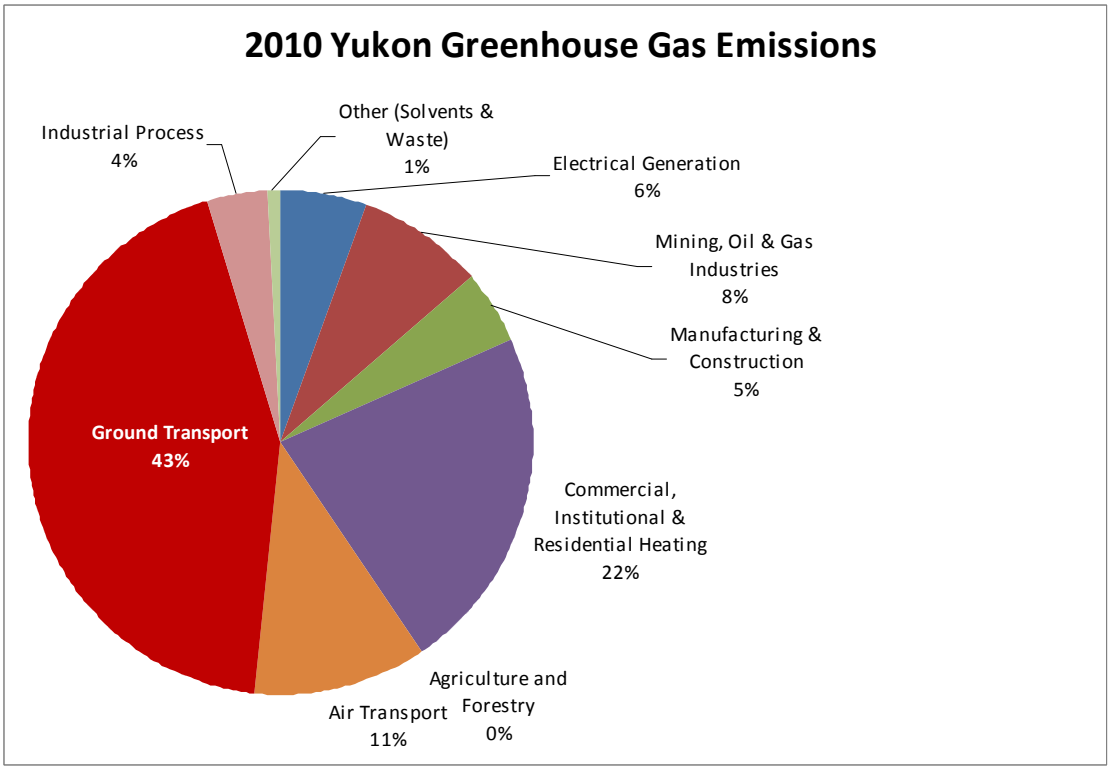


Table 2 below shows the breakdown of ground transportation GHG emissions by category for the years 2006 through 2010 as reported by the NIR.

Table 2: Yukon Ground Transportation Greenhouse Gas Emission by Category, as reported by the NIR: 2006 through 2010 in $ktCO_2$ equivalent

GROUND TRASPORTATION CATEGORY	2006	2007	2008	2009	2010
Light-duty gasoline vehicles	62.1	50.4	40.6	41.2	40.3
Light-duty diesel vehicles	2.4	2.0	1.6	1.6	1.6
Heavy-duty gasoline vehicles	5.1	4.2	3.4	3.5	3.5
Heavy-duty diesel vehicles	73.5	75.2	80.1	71.3	67.1
Motorcycles & propane vehicles	1.8	2.0	2.0	1.1	1.5
Off-road gasoline	2.5	1.8	1.5	1.8	0.9
Off-road diesel	79.0	92.0	50.0	40.0	34.0
TOTAL	226.4	227.6	179.2	160.5	148.9

Source: Environment Canada 2012 NIR. Table A14-22, Part 3, Page 71

Key observations from Table 2:

- The NIR suggests there have been significant reductions in emissions from every transportation category, a red flag given that the Yukon's population and GDP were growing throughout the period.
- Heavy-duty diesel vehicles are consistently the single largest category — ranging from a 32% to 45% share of emissions.
- Heavy-duty diesel vehicles show the smallest relative decline in emissions over the 5 year period.
- The drop in off-road diesel emissions in 2008 correlates with the connection of the Minto Mine to the Yukon's electrical grid, thereby reducing fuel consumption for electrical generation at the mine site. Onsite diesel electric generation at the Minto Mine produced approximately 23 to 24 $ktCO_2$ equivalent/ year. This amount correlates well with the reported reduction on off-road diesel emissions in 2008.

1.3 Yukon fuel consumption data

One issue that arose almost immediately when we began reviewing the available data on consumption of fuels for transport in the Yukon was that there appeared to be two very different sets of numbers for the amount of transport fuel being used. One is based on the Report on Energy Supply and Demand in Canada (RESD). The source for the RESD is the monthly Refined Petroleum Products Survey carried out by Statistics Canada that covers all refining companies in Canada along with selected major wholesalers and distributors. The other is a Statistics Canada data series (CANSIM 405-0002). We initially decided that the CANSIM 405-0002 data could not be accurate (they were much higher than the RESD) because:

- The Yukon Bureau of Statistics used the RESD data to report annual fuel use in all of its annual statistical reports; and,
- A reverse check of Environment Canada's National Inventory Report GHG transportation emissions for the Yukon using available conversion factors indicated that the NIR was also using the RESD data.

However, we began to question our initial assumption that the CANSIM 405-0002 data were the less accurate when:

- Further research found that it is based on Yukon government tax data on fuel sales, and we judge that the government is likely to have an accurate assessment on the amount of fuel it collects a per-litre excise tax on (or allows to be sold without the excise tax); and,
- A careful review of the Yukon Bureau of Statistics' annual statistical reviews shows a pattern of steep decline in consumption (e.g. sale of motor gasoline declining by 58% between 2001 and 2010 even as the Yukon's population and GDP were rising significantly. This is highly unlikely to say the least.

We made enquiries with the Yukon Bureau of Statistics about the large differences in reported Yukon fuel consumption between the CANSIM 405-0002 table and the amounts being reported by the Bureau in their annual statistical reviews, along with the declines in consumption. The Bureau agreed that the large decline in consumption shown raised a large flag that the source data were potentially problematic.

The Yukon Bureau of Statistics followed up with Statistics Canada and received confirmation that the data from CANSIM 405-0002 was the most appropriate to use when looking at the consumption of gasoline and diesel in the Yukon. Reasons for the Yukon problems with the monthly Refined Petroleum Products Survey data include the significant amount of fuel shipped

in from Alberta by secondary distributors (which will show up in the Alberta data) and the imports of fuel from Alaska that is not captured in the data. The Yukon is a highly unusual jurisdiction in Canada in that all fuel is transported to the Yukon by truck (as opposed to refined in Yukon or transported by pipeline), and a substantive portion of this fuel is trucked in from Alaska. It is unlikely that any other jurisdiction in Canada obtains a substantive portion of its fuel by trucked imports from the United States. This trend has probably increased in recent years due to the increasingly favourable US-Canada exchange rate.

The Yukon Bureau of Statistics has now stopped using the RESD data and has moved to use the CANSIM 405-0002 table only for reporting fuel consumption. We understand that they are also in the process of correcting their annual statistical reviews for the past 10 years in order to ensure that the trends in consumption are clear.[2]

1.3.1 Yukon fuel consumption: comparison by data source

We requested the underlying data that are used to create CANSIM 405-0002 from the Yukon Department of Finance and the result is shown in Table 3 below.

Table 3: Yukon Consumption of Gasoline and Diesel in Litres: 2009 through 2011

CATEGORY	2009		2010		2011	
	Gasoline	**Diesel**	**Gasoline**	**Diesel**	**Gasoline**	**Diesel**
Exempt sales	2,766,907	73,767,413	1,445,189	86,545,265	688,299	96,634,816
Accountable volume	68,859,349	63,879,323	71,601,119	71,683,730	73,285,828	82,922,735
Total consumption	**71,626,256**	**137,646,736**	**73,046,308**	**158,228,995**	**73,974,127**	**179,557,551**

Source: Yukon Department of Finance, special data request

Key observations on Table 3:

- It is very important to note that the figures shown here are for all gasoline and diesel consumed in the Yukon.
- The diesel exempt sales include heating fuel, electrical generation and off-road transportation.
- The diesel accountable volume figures include jet fuel.
- Exempt sales are the fuel consumption on which no excise tax is paid. Exempt fuel includes heating fuel, fuel used in stationary generators and for off-road commercial purposes in a number of industries of which mining is by far the largest fuel consumer.

We requested a more detailed breakdown of the data but perceived concerns centered on the *Access to Information and Protection of Privacy Act* prevented the release of more detailed data by Finance at this time.

Statistics Canada's CANSIM 405-0002 (titled *Road motor vehicles, fuel sales, annual (litres)*) for the Yukon is shown in Table 4 below.

[2] The discrepancy between the data sources in 2010 was approximately 53 million litres of gasoline and 87 million litres of diesel. This represents about $156 million in fuel imports to the Yukon in 2010 that may not be accounted for in the Yukon's economic account balances. The Yukon's GDP should be re-calculated downward accordingly.

Table 4: Yukon Fuel Sales for Road Motor Vehicles in Litres: 2009 through 2011

	2009	2010	2011
Net sales of gasoline	67,053,000	70,133,000	71,641,000
Gross sales of gasoline	69,738,000	71,502,000	72,336,000
Gross minus net gasoline (exempt sales)	2,685,000	1,369,000	695,000
Net sales of diesel oil	50,197,000	55,958,000	63,585,000

Source: Statistics Canada, CANSIM 405-0002 *Road motor vehicles, fuel sales, annual (litres)*

Key observations on Table 4:

- Although not a perfect match, the gasoline numbers track very closely with the data from Yukon Finance shown in Table 3 above. The difference appears to be the aviation gasoline (avgas) that is subject to the fuel excise tax but is not, obviously, used in road motor vehicles.
- However, the net sales of diesel oil in Table 4 do not track the accountable volume data in Table 3 because the jet fuel included under diesel in Table 3 is not included in Table 4. (Aviation fuel is subject to the fuel excise tax but is not, obviously, used in road motor vehicles).

1.4 Transportation emissions: discussion with Environment Canada

With confirmation that any use of the Yukon fuel consumption based on the Refined Petroleum Products Survey would substantially understate the consumption of fuel in the territory we turned back to the NIR and its estimates of GHG emission for the Yukon's transportation sector.

From Annex 2 of the NIR (A.2.4.2) we understand that the top down estimate for gasoline and diesel consumption is based on gross and taxed sales data (CANSIM 405-0002) with Yukon tax data as the source for that top down estimate. But Annex 2 also states that this estimate is then adjusted to equal the total gasoline or diesel available for transport as reported in the Report on Energy Supply and Demand in Canada (RESD). As noted previously, the data source for the RESD is the monthly Refined Petroleum Products Survey and is not the appropriate source for calculations of fuel consumption in the Yukon.

In summary, our concern was that if Environment Canada has been adjusting its top down estimate of fuel consumption to equal the amount reported in the RESD as they say they do in Annex 2 of the NIR, it appears that the Yukon transportation GHG emissions reported are likely to be significantly understated. For example, the CANSIM 405-0002 data for 2009 shows gross sales of gasoline in the Yukon at 69.7 million litres. But the 2009 RESD shows only 19.7 million litres available for transport (Table 3-14). Further, even overall gross trends in Yukon GHG emissions cannot be accurately discerned if this adjustment has been made over all of the years of reporting. Although the Refined Petroleum Products Survey data have been showing an overall steep downward trend in fuel consumption over the past decade in the Yukon, the decline is not consistent and has certainly been affected by changes in which secondary fuel distributors have been supplying the Yukon and how much has been imported from Alaska.

We summarized our concerns with the NIR calculation (including detailed references on the data that are the source of those concerns) and sent them to Scott McKibbon of Environment Canada who we understand is in charge of the transportation portion of the NIR. On October 3, 2012 we had a lengthy phone conversation with Mr. McKibbon:

- He recognizes that there is a problem with the Yukon transportation emissions as reported in the NIR and that they are likely being substantially under-reported;
- Issues with Environment Canada's adjustment of its initial top-down estimate for gasoline and diesel consumption using the RESD have been raised by other jurisdictions (e.g., Nova Scotia) in the past, but those jurisdictions have not previously been able to definitively identify the source of the data errors as has been done in this research.
- In the NIR Environment Canada is bound by agreement with the United Nations on GHG emissions reporting and is required to use the national energy balance (as represented by the RESD) in its reporting;
- On the national level, the Yukon's GHG emissions (and especially any difference between the actual and reported transportation emissions) are not significant;
- However, Mr. McKibbon recognizes that the Yukon government is responsible for managing Yukon emissions and the size of the likely discrepancy in emissions reporting is highly significant for the territory. Further, other jurisdictions are also seeing discrepancies in their emissions reporting;
- Therefore, Mr. McKibbon would like to work with the Yukon to get a better picture of actual transportation GHG emissions. Specifically he has asked if we can put together a definitive document on how the current NIR calculation is incorrect and how it can be corrected. With that document, he can apply to the UN for a reporting exception for the Yukon.

1.5 Alaska as source of fuel imports

As noted above, one factor that has created the significant under-reporting of the Yukon's transportation greenhouse gas emissions is that some of the fuel used in the territory is imported from Alaska and therefore does not show up in the RESD data. The Yukon Department of Finance has data on exactly how much fuel is imported to the Yukon from Alaska but chose not release it due to perceived concerns regarding the *Access to Information and Protection of Privacy Act*.

However, we can provide a rough estimate for the volume of fuel coming into the Yukon from Alaska through weigh station data provided by Yukon Highways. Transport trucks must stop at the weigh scales at Watson Lake and Whitehorse as they pass through either community. Data collected for each truck includes: type of load (e.g., petroleum products), point of origin and destination.

The weigh station data we have from 2010 and 2011 has a number of problems:

- It is incomplete, with 2010 missing January 1 to 11th and July 8th to August 2nd for the Watson Lake scale, and January 1 to February 2nd for the Whitehorse scale. 2011 data are missing January 1 to 11th, and all of July for the Watson Lake scale and all of July for the Whitehorse scale;
- Trucks that do not pass through either Whitehorse or Watson Lake do not have to report to the station. Therefore a truck from Alaska delivering fuel to Dawson City via the Top of the World Highway in summer for example would not be counted.
- We do not have accurate volumes for the amount of fuel carried per truck. Different configurations can haul varying amounts of fuel depending on load restrictions. However, based on the vehicle weight and the tare weight of the vehicle configuration, it is possible to estimate the quantity of fuel loaded on the truck.

Importers of fuel are required to report their imports to Environment Canada through the *Sulphur in Diesel Fuel Regulations* and the *Fuel Information Regulations.* The Sulphur in Diesel regulation requires imports to report quarterly on volumes imported for land transportation usage. Diesel for heating or aviation is not required reporting as part of the *Sulphur in Diesel Fuel Regulations.* The *Fuel Information Regulations* requires any importer bring more than 400 m^3 annually (400,000L, or about 8 B-train loads) to report volume to Environment Canada. These reports are filed with the Regional office in Vancouver. Based on our discussions with Environment Canada enforcement staff in Whitehorse, we understand that all the fuel being imported from Alaska is diesel, being primarily heating fuel and jet fuel, and it has been many years since any gasoline was imported from Alaska.

Given caveats as noted below the table, we provide the following as an estimate range for the amount of fuel imported from Alaska in 2010 and 2011.

Table 5: Estimated Volume of Diesel Imported from Alaska: 2010 and 2011

	VOLUME IN LITRES		PERCENT OF DIESEL FUEL CONSUMED	
	Low	**High**	**Low**	**High**
2010	4,050,000	4,400,000	2.6%	2.8%
2011	16,050,000	19,250,000	8.9%	10.7%

Notes:

- The low end estimates are based on the number of trucks carrying loads of petroleum products from Alaska to the Yukon that reported to the Whitehorse weigh station multiplied by an estimated 50,000 litre average load.
- The high end estimates extrapolate the data to cover the whole year (we have data for 11 of 12 months in 2010 and 10 of 12 months in 2011).
- The percentages are expressed against the base of total Yukon consumption of diesel as provided by Yukon Finance (see Table 3 above) because we do know from Environment Canada that all of the imports are diesel, not gasoline.

To better improve the understanding of the quantity of fuel being imported from Alaska, three research avenues are recommended:

- Obtain fuel import quantities from Environment Canada's databases;
- As there are a limited number of companies hauling fuel from Alaska to Yukon, primary research could be conducted by surveying these companies and their associated activities; and,
- There are data associated with the cross-border transit of these trucks. There are two sources – excise tax collection for import of fuel as well as Canada Border Services maintains records of fuel trucks entering Canada. Excise tax is typically handled electronically by a customs broker for the importing company. Canada Border Services maintains a database of all fuel trucks, including quantities that enter Canada. They generate reports from these data annually for use by other government agencies, such as Environment Canada to support EC's compliance and enforcement programs. These data are used to identify carriers not complying with EC's reporting requirements described previously.

2 Heavy Truck Transport

From Statistics Canada's 405-0002 data shown in Table 4 above, we know that diesel used by on-road vehicles in the Yukon increased from approximately 50.2 million litres in 2009 to 63.6 million litres in 2011. Almost all of that fuel use is for heavy trucks and busses. In the sections below, we attempt to break out some of that use.

2.1 Inter-provincial and through carriers

The Yukon's Department of Finance requires that all through carriers and inter-provincial carriers report the number of kilometres driven in the Yukon and the number of litres of fuel consumed in the Yukon. Both class of carrier are commercial vehicles over 26,000 pounds or having three or more axles used to transport freight or passengers. Through carriers are those who do not load or unload any freight or passengers in the Yukon. Inter-provincial carriers operate across the Yukon's borders but load or unload freight or passengers in the territory. (Carriers that operate entirely within the Yukon are not obliged to report as they will have paid the Yukon fuel tax by default). Table 6 below shows the volumes and share of on-road diesel use by inter-provincial and through carriers along with their kilometres driven.

Table 6: Inter-provincial and Through Carrier Share of Road Vehicle Diesel Use: 2009 through 2011

CATEGORY	2009		2010		2011	
	Litres	Percent	Litres	Percent	Litres	Percent
Total road vehicle diesel	50,197,000	—	55,958,000	—	63,585,000	—
Total used by Inter-provincial and through carriers	14,494,938	28.9%	14,681,513	26.2%	16,126,240	25.4%
Total Yukon km driven by Inter-provincial and through carriers	26,627,676		27,271,484		29,451,664	

Source: Statistics Canada, CANSIM 405-0002 *Road motor vehicles, fuel sales, annual (litres)* and Yukon Department of Finance, special data request

Notes:

- Total road vehicle diesel is taken from Statistics Canada's 405-0002 data.
- Inter-provincial and through carriers have increased their fuel use in the Yukon from 2009 through 2011 but their share of total on-road diesel use has fallen from 28.9% to 25.4%.
- Kilometres driven has risen by 10.6% from 2009 through 2011.
- Overall fuel efficiency has not changed significantly, remaining in the 54 L/100km range. Canadian average fuel efficiency for vehicles over 15 tonnes was 33 L/100km in 2010[3].

[3] From Canadian Vehicle Survey: Annual 2009. Catalogue no. 53-223-X. http://www.statcan.gc.ca/pub/53-223-x/53-223-x2009000-eng.htm

B-trains have significantly lower fuel efficiency, which is typically reported at 58 L/100 km[4]. Therefore, these numbers compare well given the nature of the terrain, roads and prevalence of B-train units.

2.2 Mining

How much does the Yukon's mining sector contribute to the territory's heavy truck transport fuel use? We do not have sufficient data to estimate the entire sector's contribution, but the weigh station data do allow some rough estimates to be made for the operating mines at Minto, Wolverine and Tungsten (the Cantung mine is in the NWT but road access is through the Yukon). Alexco's mine at Keno is not listed as a separate origin or destination in the data.

Table 7: Wolverine and Cantung Mines' Share of Watson Lake Weigh Station Total Truck Count: 2011

Watson Lake Weigh Station Total Count	32,585
Trucks to Wolverine Mine	945
Trucks from Wolverine Mine	542
Total trucks Wolverine Mine	1,487
Percent of Watson Lake Weigh Station Total Count	**4.6%**
Trucks to Cantung Mine	485
Trucks from Cantung Mine	225
Total trucks Cantung Mine	710
Percent of Watson Lake Weigh Station Total Count	**2.2%**

Source: Yukon Highways and Public Works, special data request

Table 8: Minto Mine's Share of Whitehorse Weigh Station Total Truck Count: 2011

Whitehorse Weigh Station Total Count	41,945
Trucks to Minto Mine	923
Trucks from Minto Mine	695
Total trucks Minto Mine	1,618
Percent of Whitehorse Weigh Station Total Count	**3.8%**

Source: Yukon Highways and Public Works, special data request

[4] Fuel Efficiency Benchmarking in Canada's Trucking Industry. Results of an Industry Survey. March 2000. http://oee.nrcan.gc.ca/publications/transportation/10771

Note that the weigh station data were incomplete for 2011 and both the counts for each mine and the total counts are actually higher. However, it is unlikely that the each mine's percentage share of the total count will differ much from that shown in Table 7 and Table 8 above.

2.3 Tour buses

The weigh station data also allow us to make a rough estimate of the tour bus share of total weigh station counts. The short answer is that the share is small, with buses accounting for only 559 of 41,945 total count (1.3%) at the Whitehorse Weigh Station in 2011.

3 Off-Road Transportation

The use of fuel for off-road ground transportation includes commercial uses in a number of industries of which mining is by far the largest fuel consumer.

Annex 2 – A2.4.2 of the National Inventory Report describes off-road transportation emissions reported as the difference between total fuel available for transportation minus the on-road fuel consumption calculated. This indicates that off-road emissions are likely to be under-reported in the same way that overall emissions have been (see Section 1.3 above). In addition, our discussions with Environment Canada (see Section 1.4 above) indicate that the NIR faces ongoing challenges with distinguishing actual off-road transportation use (e.g., mine haul trucks) with industrial use (e.g., emissions from stationary generators at a mine site).

3.1 Off-Road Gasoline

The Yukon's Department of Finance provided us with separate data on total volumes of gasoline and diesel in two categories: exempt sales and accountable volume (see Table 3 above).

Accountable volume is fuel consumed on which the Yukon's excise tax has been paid. Exempt sales are the fuel consumption on which no excise tax is paid. Exempt fuel includes heating fuel, fuel used in stationary generators and for off-road commercial purposes in a number of industries of which mining is by far the largest fuel consumer.

Table 9 below shows off-road gasoline emissions calculations and sales data for exempt gasoline.

Table 9: Off-Road Gasoline Emissions and Exempt Gasoline Sales, 2006 through 2011

	2006	2007	2008	2009	2010	2011
NIR off-road gasoline emissions ($ktCO_2$ equivalent)	2.5	1.8	1.5	1.8	0.9	—
Yukon exempt gasoline sales (litres)				2,766,907	1,445,189	688,299
Re-calculated off-road gasoline emissions ($ktCO_2$ equivalent)	—	—	—	6.3	3.3	1.6

Source: NIR and Yukon Finance special data request

Key observations on Table 9:

- Close to 100% of exempt gasoline sales will be for off-road transportation purposes, as there is no significant use of gasoline for space heating or stationary power generation.
- The recalculation of off-road gasoline emissions based on exempt sales data indicates that these emissions are three to four times higher than NIR reporting.

- Yukon exempt gasoline sales have declined substantially between 2009 and 2011, perhaps reflecting a decline in the mineral exploration sector, or a shift to increased use of light duty diesel vehicles off-road.

3.2 Off-Road Diesel

The NIR calculates that off-road diesel has contributed between 34 and 92 $ktCO_2$ equivalent annually to the Yukon's GHG emissions between 2006 and 2010 (see Table 2 above). This calculation is, like all of the others in the NIR, likely significantly underreporting actual emissions.

Unfortunately, we are unable to provide a better estimate at this time as the data on exempt sales of diesel in the Yukon provided by Yukon Finance includes all of the heating fuel sold in the Yukon folded in with the diesel fuel used for off-road transportation and for stationary electrical generation. We requested a more detailed breakdown of the data but perceived concerns centered on the *Access to Information and Protection of Privacy Act* prevented the release of more detailed data by Finance at this time.

To better improve the understanding of off-road diesel transportation (and of industrial use in general) we recommend:

- That the Climate Change Secretariat work with Finance to find a means of separating the heating fuel data from other exempt sales;
- This will then allow a starting point for some primary research with the Yukon's operating mines to provide estimates on how much diesel fuel they use in stationary equipment compared with off-road transportation use.

However, in light of the limitations above, a few estimates, of varying certainty, can be made with respect to some of end uses off-road diesel consumption based on a variety of secondary data sources. These include a pro-rated estimate of heating fuel consumption, consumption of diesel for electrical generation and an estimate of fuel consumed at the Yukon's two hard rock mines—Minto and Wolverine mine in 2010 and 2011. These estimates are presented in Sections 3.2.1 through 3.2.3 below.

3.2.1 Estimate of emissions from heating fuel

As noted above, segregated heating fuel data have not been provided by Yukon Finance. Although the quantities total quantity heating fuel consumption for the Yukon in the Report on Energy Supply and Demand (RESD, and as re-reported by Yukon Bureau of Statistics in their Annual Statistical Reviews) are inaccurate, it is assumed that the percentage of heating fuel relative to total diesel consumption may be representative. Thereby, knowing the actual total diesel consumption from Yukon Finance, the amount consumed for space heating can be estimated by applying the relative percentage from the RESD.

Yukon Bureau of Statistics Annual Statistical Review reports that between 2006 and 2010 an average of 26 million litres of fuel were used for space heating. Total diesel consumption over this period averaged 88 million litres (as re-reported by YBS from Stats Canada's RESD). This suggests approximately 30% of the total diesel fuel consumption in the Yukon is for space heating.

The actual total diesel fuel consumption in the Yukon for 2010 and 2011 (from Yukon Finance) was 158 and 179 million litres respectively. Assuming 30% of this was used for space heating,

the actual diesel consumption for space heating for 2010 and 2011 is estimated at 47 and 54 million litres respectively. Emission from space heating therefore are 130 and 147kt of CO_2e for 2010 and 2011, using Environment Canada's emission factor of 2.73 g/L for light fuel oil.

3.2.2 Emissions from diesel fired electrical generation

A portion of the Yukon's diesel consumption is for electrical generation by the Yukon's two electrical utilities. Electric generation by hydro, wind and diesel are all reported in Yukon Bureau of Statistics Annual Statistical Review. These data are also reported in other sources such Yukon Energy's Annual Reports and various submissions to the Yukon Utilities Board. Diesel consumption for electrical generation is relatively consistent, and therefore it is possible to estimate annual diesel fuel consumption based on electricity production. Table 10 below presents diesel electrical generation and fuel consumption estimates for the two utilities, Yukon Electrical Company Ltd (YECL) and Yukon Energy Corporation (YEC):

Table 10: Electrical Generation Emissions 2009 through 2011

Year	Annual Diesel Electric Generation (GWh)		Estimated Annual Diesel Consumption (L) [3]		Total (L)
	YECL [1]	YEC [2]	YECL	YEC	
2009	20.5	1.9	5,516,000	518,000	6,034,000
2010	18.5	5.1	4,992,000	1,390,000	6,382,000
2011	24.5	13.7	6,611,000	3,733,000	10,344,000

Notes:
[1] Total diesel electric generation (Yukon Bureau of Statistics Annual Statistical Review) minus YEC Generation
[2] Yukon Energy Corporation annual reports http://yukonenergy.ca/about/business/reports/
[3] Average fuel consumption rates: YECL – 3.71 kWh/L (http://yukonutilitiesboard.yk.ca/pdf/480_2008-2009_YECL_Rate_Application.pdf); YEC – 3.67 kWh/L (http://yukonutilitiesboard.yk.ca/pdf/1338_YEC%202012_2013%20GRA%20FINAL_2012%2004%2027%20Tabs%201-11.pdf)

From Table 10, emissions from fuel-fired electrical generation are estimated at 17, 17 and 28kt of CO_2e for 2009 through 2011, using Environment Canada's emission factor of 2.74 g/L for electrical utility usage of light fuel oil.

3.2.3 Emissions from mine site fuel usage

A significant portion of off-road fuel usage is at the large hard rock mines in the Yukon. In 2010 and 2011 there were two major hard rock mines operating in the Yukon, the open-pit Minto Mine and the underground Wolverine Mine. The Minto Mine is significantly larger than Wolverine; however it is connected to the Yukon's electrical grid and therefore does not rely on onsite diesel generators for electricity. Therefore Wolverine's fuel consumption is relatively larger than Minto's.

An estimate of fuel consumption by these two mines can be generated from the Whitehorse and Watson Lake weigh station data. Notwithstanding the limitations of the weigh station data noted previously, the database does record the mine-bound trucks' weight, cargo and vehicle configuration. Knowing the tare weight of each truck type, it is thereby possible to calculate the fuel-load onboard each truck. These data are then summed to estimate the total minimum volume

of fuel delivered to the two mine sites. Tables 12 and 13 present the calculation of fuel delivered to the Minto and Wolverine mines respectively.

Table 12: Minto Mine's Minimum On-Site Fuel Consumption Estimate
Weight Station Total Truck Count - 2010 & 2011

Truck Type	Average Tare Weight (kg)	2010			2011		
		Average Loaded Weight	# of Trucks Recorded	Total Fuel Delivered (L)[1]	Average Loaded Weight	# of Trucks Recorded	Total Fuel Delivered (L)[1]
8 axle B train double (Type 21)	23,000	62,286	100	5,207,000	62,242	132	6,942,000
3 axle tractor with 2 axle semi (Type 12)	17,900	36,954	7	177,000	36,743	10	248,000
3 axle tractor with 3 axle semi (3S3) (Type 14)	19,000	42,850	1	32,000	49,670	3	121,000
Total	-	-	108	5,415,000	-	145	7,711,000

[1] pro-rated upward to account for missing records, see discussion in Section 1.5 above.

Table 13: Wolverine Mine's Minimum On-Site Fuel Consumption Estimate
Weight Station Total Truck Count - 2010 & 2011

Truck Type	Average Tare Weight (kg)	2010			2011		
		Average Loaded Weight	# of Trucks Recorded	Total Fuel Delivered (L)[1]	Average Loaded Weight	# of Trucks Recorded	Total Fuel Delivered (L)[1]
8 axle B train double (Type 21)	23,000	60,477	112	5,609,000	58,495	184	8,897,000
3 axle tractor with 2 axle semi (Type 12)	17,200	38,277	17	479,000	33,326	10	210,000
3 axle tractor with 3 axle semi (3S3) (Type 14)	19,200	38,630	5	130,000	42,160	14	442,000
Total	-	-	134	6,218,000	-	208	9,548,000

[1] pro-rated upward to account for missing records, see discussion in Section 1.5 above.

Total greenhouse gas emissions for fuel consumption at the two hard rock mines were at least 36 and 50kt of CO_2e for 2010 and 2011, using Environment Canada's emission factor of 2.99 g/L for off-road diesel consumption.

4 Gasoline Vehicles On-Road

The under-calculation of Yukon transportation emissions in the NIR is greatest in the use of gasoline for on-road use.

Table 11: On-Road Gasoline Emissions, 2006 through 2011

	2006	2007	2008	2009	2010	2011
NIR calculation for on-road gasoline emissions ($ktCO_2$ equivalent)	34	39	34	33	37	—
Year-over-year change, %	—	-18%	-19%	0%	-1%	—
Yukon consumption of on-road gasoline (net sales volume in litres)				67,053,000	70,133,000	71,641,000
Year-over-year change, %					4.6%	2.2%
Re-calculated on-road gasoline emissions ($ktCO_2$ equivalent)	—	—	—	163	171	174

Source: Statistics Canada, CANSIM 405-0002 and NIR

Key observations on Table 11:

- Consumption of gasoline rose between 2009 and 2011.
- The NIR under-reports emissions by a factor of five.

4.1 Background Data on Vehicles and Commuting

The June 2012 report by the Energy Solutions Centre, *An Energy Strategy for Yukon Priority Action: Yukon Transportation Sector Information Paper*[5], clearly presents all of the relevant background data and information on vehicles and commuting in the Yukon and we will not attempt to duplicate it here.

[5] Available at: http://www.energy.gov.yk.ca/publications.html

5 Aviation

From Table 1 above, the NIR shows that Yukon emissions from air transport have remained relatively stable, fluctuating between 33 and 39 $ktCO_2$ equivalent from 2006 through 2010 with no apparent strong trends. According to the NIR, air transport represented 11% of the Yukon's GHG emissions in 2010 (see Figure 1 above).

The fuel used in air transport is either aviation gasoline (a high-octane gasoline usually known as avgas) for piston engine aircraft or jet fuel (kerosene based) used in turbine engines. Because it is kerosene based, jet fuel is classed as diesel rather than as gasoline.

Table 12 below summarizes some data and calculations on air transport emissions in the Yukon.

Table 12: Aircraft movements, Jet Fuel Consumption and Emissions, 2006 through 2011

	2006	2007	2008	2009	2010	2011
NIR air transport emissions ($ktCO_2$ equivalent)	34	39	34	33	37	—
Year-over-year change, %	—	14.7%	-12.8%	-2.9%	12.1%	—
Total aircraft movements, Whitehorse	27,525	27,692	25,920	24,505	30,635	31,444
Year-over-year change, %	—	0.6%	-6.4%	-5.5%	25.0%	2.6%
Yukon consumption of jet fuel (estimate in litres)				13,682,323	15,725,730	19,337,735
Year-over-year change, %					14.9%	23.0%
Re-calculated jet fuel emissions ($ktCO_2$ equivalent)	—	—	—	35	40	49

Source: Aircraft movement data from Yukon Bureau of Statistics 2011 Annual Statistical Review. Jet fuel consumption estimate derived from Yukon Finance special data request.

Key observations on Table 12:

- Total aircraft movements at the Whitehorse airport are the proxy for fuel used in air transport.
- The correlation between changes in the NIR's calculation of air transportation emissions and total aircraft movements is not perfect but overall the changes move in the same direction.
- Between 2006 and 2010 the NIR shows an 8.8% increase in emissions while aircraft movements rose 11.3% over the same period.
- We requested separate data on jet fuel and avgas from Yukon Finance but perceived concerns centered on the *Access to Information and Protection of Privacy Act* prevented the release of more detailed data by Finance at this time.

- The estimate of Yukon jet fuel consumption shown is the difference between the total volume of diesel fuel on which excise taxes were paid (from Yukon Finance, see Table 3 above) and the net sales of diesel for motor vehicles (from Statistics Canada, see Table 4 above). Note that avgas is only used by piston engine aircraft and its use is dwarfed by the use of jet fuel by the major carriers and by helicopters.
- The re-calculated air transport emissions are based on the estimate of jet fuel consumption multiplied by an emission factor of 2.56 kg of CO_2 equivalent per litre as published by Environment Canada.[6]
- The recalculation shows emissions higher by approximately 6% to 8% for jet fuel alone.

[6] http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=AC2B7641-1#section5

6 Re-calculation of Emissions

With the confirmation from Environment Canada that they are indeed using data that significantly understates emissions, we can offer the re-calculation of total Yukon emissions using the fuel use statistics based on the CANSIM 405-0002 and the underlying Yukon Finance data as shown in Table 13 and Figure 2 below.

Table 13: Re-Calculation of 2009 and 2010 Yukon Greenhouse Gas Emissions in ktCO_2e [7]

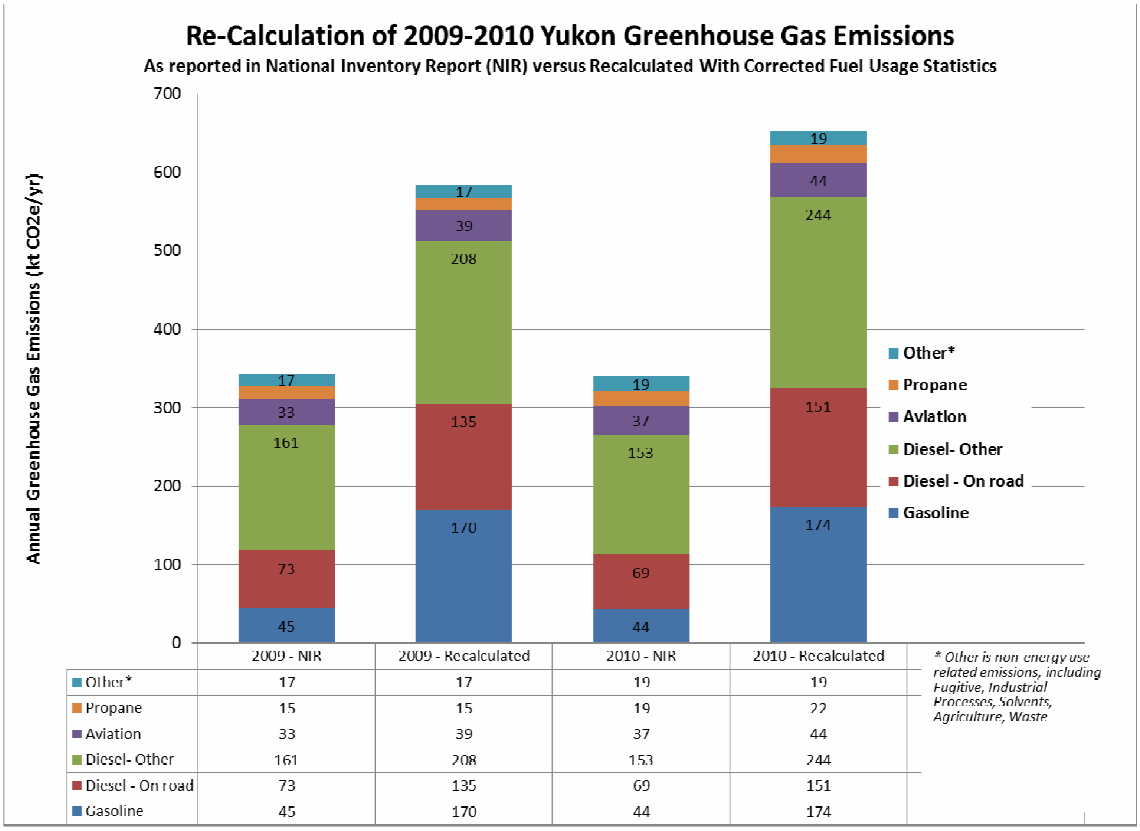
CATEGORY	2009		2010	
	NIR	New	NIR	New
Other	17	17	19	19
Aviation	33	39	37	44
Diesel — other	161	208	153	244
Diesel — on road	73	135	69	151
Gasoline	45	170	44	174
Propane	15	15	19	22
TOTAL	**344**	**584**	**340**	**653**

Notes:

- Actual 2009 emissions are 70% higher than stated by the NIR.
- Actual 2010 emissions are 92% higher than stated by the NIR.
- The "Other" category is non-energy use related emissions including fugitive, industrial processes, solvents, agriculture and waste.
- The recalculation in the aviation category in Table 13 is 4 ktCO_2e higher in each year than the re-calculation shown in Table 12 above because this re-calculation includes avgas along with jet fuel.

[7] Emission factors from Environment Canada's Greenhouse Gas Emissions Quantification Guidance http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=AC2B7641-1#section5

Figure 2: Re-Calculation of 2009 and 2010 Yukon Greenhouse Gas Emissions in $ktCO_2e$



Key points on the re-calculation:

- Actual 2009 emissions are 70% higher than stated by the NIR.
- Actual 2010 emissions are 92% higher than stated by the NIR.
- The "Other" category is non-energy use related emissions including fugitive, industrial processes, solvents, agriculture and waste.

Figure 3 below presents the estimated sources of the re-calculated emissions shown in Table 13 above. Figure 3 shows transportation representing 71% of the total emissions while 50% of the total emissions are on-road transportation.

Of the surface transportation, on-road gasoline is the single largest source of emissions (41% of the surface transportation emissions). Freight hauling to and through the Yukon constitutes 9% of the transportation emissions. 14% of the emissions are off-road usage that is not yet accounted for.

Figure 3: Re-Calculation of Greenhouse Gas Emissions for Yukon, 2010, including Distribution of Ground Transportation Emissions