Yukon Greenhouse Gas Emissions: The transportation sector

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Executive Summary

The purpose of this research project is to produce a clear and detailed picture of the sources of greenhouse gas (GHG) emissions from the transportation sector in the Yukon.

The approach taken was to build on the March 2013 version of this report titled *Yukon Greenhouse Gas Emissions: The transportation sector* along with updated data from Environment Canada, Statistics Canada, Yukon Bureau of Statistics and YG Finance.

This report has findings in two key areas:

1. **Data Accuracy:** Environment Canada's reporting of GHG emissions is accurate for the purposes of Canada's commitment to meet international United Nations' reporting requirements. However, the results both substantively under-report Yukon emissions (actual emissions are an average of 75% higher than reported from 2009 through 2012) and are subject to very large revisions in subsequent years. Under-reporting is prevalent across all Yukon sectors, not just transportation.
2. **Emissions Re-calculations: Transportation emissions**: According to re-calculations of the Yukon's 2012 emissions based on high-quality YG Finance data, known transportation uses accounted for 57% of total GHG emissions (This does not include off-road transportation that the data do not allow us to distinguish from other off-road uses). On-road gasoline use accounts for 25% of the Yukon's total emissions and 44% of known transportation emissions. On-road diesel use also accounts for 25% of total emissions.

Finding #1: Data Accuracy

For YG to be successful in meeting its reduction commitments, GHG emissions must be accurately reported. Environment Canada's National Inventory Report (NIR) relies on a national data set the Report on Energy Supply and Demand in Canada (RESD) that unfortunately accounts for neither the import of fuel by secondary distributors from Alberta nor the import of fuel from Alaska.

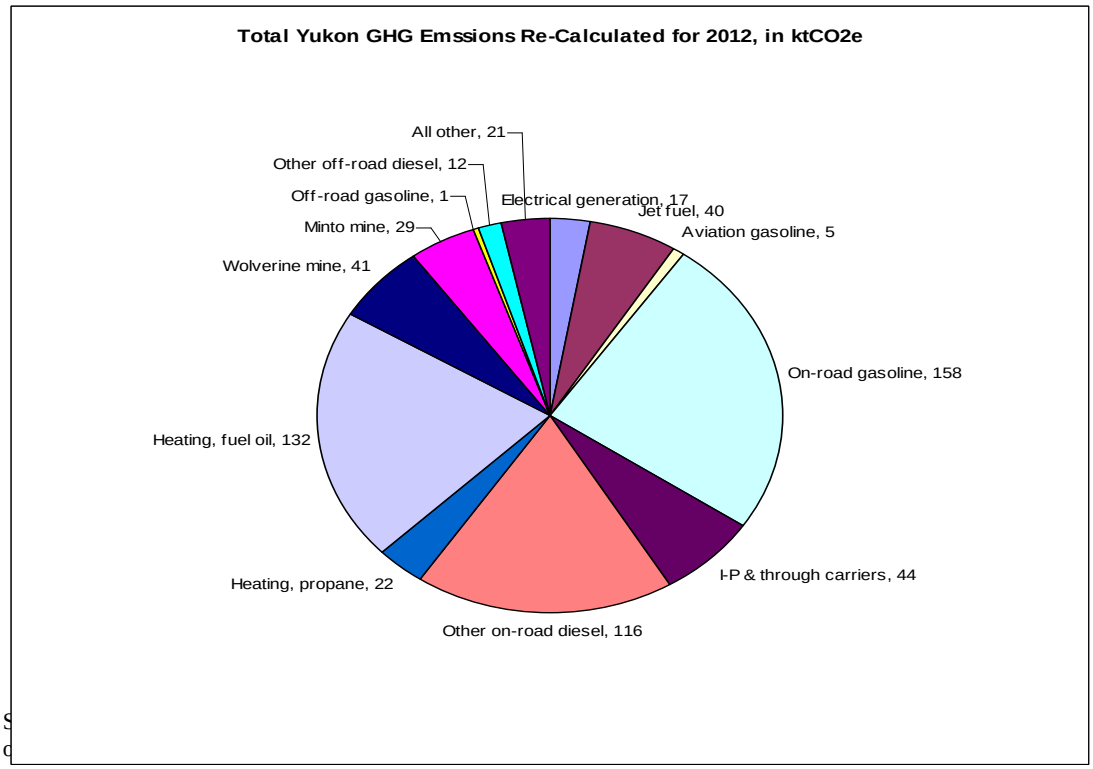
Environment Canada is aware of how reliance on the RESD data affects jurisdictions like the Yukon. While willing to work with YG and others to improve the accuracy and utility of the NIR data set, Environment Canada is also open to provinces and territories developing their own emission reporting that will better reflect the realities in each jurisdiction.

Recommendation #1*:*
While working to improve the NIR — likely a long process — YG would do well to support an annual made-in-Yukon emissions report that is based on the solid fuel consumption data provided by YG Finance. The emission re-calculations offered in this report provide a good base for such a report, which can be significantly improved by following the steps outlined in Recommendation #2 and Recommendation #4.

Recommendation #2*:*
YG Finance data is the key to understanding and managing GHG emissions in the Yukon. Departmental concerns arising from the *Access to Information and Protection of Privacy Act* have prevented the release of more disaggregated data on fuel usage to date. If those concerns can be allayed, the use of disaggregated data will significantly enhance emissions calculations — especially for heating fuel versus other diesel fuel exempt from the excise tax.

Finding #2: Emissions Re-calculation: Transportation emissions

The re-calculation of the Yukon's 2012 emissions largely based on high-quality YG Finance data is shown here.



Source: 2014 NIR; Yukon Department of Finance, special data request November 21, 2014' Statistics Canada; CANSIM 405-0002 and 128-0012; and Yukon Bureau of Statistics

Key points on emission re-calculation:

- On-road gasoline use is responsible for 25% of total Yukon GHG emissions.
- Fuel oil used for heating is estimated to produce 21% of the Yukon's emissions (see the discussion in Section 4.2.1 on page 18 for caveats).
- On-road diesel use is responsible for 25% of total Yukon GHG emissions (7% by inter-provincial and through carriers and 18% by other on-road diesel).
- In 2012 the Yukon's two operating hardrock mines were responsible for 11% of the Yukon's total emissions from their on-site fuel use.
- Aviation (both jet fuel and avgas) produced 7% of total Yukon emissions in 2012.
- In 2012 the diesel electrical generation by the Yukon's two utilities produced 3% of emissions.
- Propane for heating was also responsible for 3% of total emissions.
- The 'all other' category (that includes industrial processes, fugitive sources, agriculture, solvents and waste) also accounted for 3% of total emissions
- Off-road gasoline use was a negligible contributor to the Yukon's 2012 total emissions.

We have a very high level of confidence in the overall emissions calculated using YG Finance data, which accounts for 94% of all emissions in the Yukon. Because they are also based directly on YG Finance data, we have the same level of confidence in the re-calculations for on-road

gasoline, off-road gasoline, and inter-provincial and through carriers, and other on-road diesel. We have somewhat lower levels of confidence in the data for the remaining re-calculations as each required an additional calculation or reliance on more than one data set to arrive at them. The estimate for emissions due to heating fuel is presented with a low level of confidence as it is based on somewhat questionable assumptions. Similarly, only a low confidence level can be assigned to the other off-road diesel component as it is what remains after the mining and heating fuel emissions are calculated.

Recommendation #3:
Transportation emissions are not dominated by heavy-duty diesel use as shown by the NIR; YG Finance data shows that on-road gasoline and on-road diesel contribute to emissions equally. Therefore emission reduction efforts need not be confined to the heavy-duty diesel segment; both the on-road gasoline and diesel segments are attractive targets for reduction.

Recommendation #4:
YG needs to improve its understanding of off-road diesel transportation and of industrial use in general. Primary research should be undertaken with the Yukon's operating mines and other industrial operations to disaggregate their fuel use between transportation on-site, electrical generation, and other use.

Recommendation #5:
Imports of fuel from Alaska accounted for approximately 16% of the total diesel fuel consumed in the Yukon in 2013. For more accurate data on the quantity and types of fuel being imported, three possible research avenues for YG are recommended:

- Obtain fuel import quantities from Environment Canada's databases;
- Conduct primary research by surveying the limited number of companies hauling fuel from Alaska to the Yukon; and,
- Collect the 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.

Definitions and Acronyms

Accountable volume:	Term used by YG Finance to indicate the volume, in litres, of all consumption of a particular fuel in the Yukon on which the Yukon's excise tax has been paid. Includes jet fuel, aviation gasoline (or avgas), fuel used by trucks passing through the Yukon and all other fuel that is not specifically exempt.
CANSIM	Statistics Canada's key socio-economic database. Yukon fuel use is calculated using YG Finance data.
CO_2:	Carbon dioxide.
CO_2e:	Carbon dioxide equivalent. The standard unit of measure for greenhouse gas emissions of all kinds. The effect of other GHGs on the atmosphere is converted into the equivalent effect in CO_2.
CH_4:	Methane. A greenhouse gas and primary component of natural gas.
Emission factors:	Standard conversion factors provided by Environment Canada and updated at intervals, that allow the calculation of the CO_2e emission per litre of fuel used in different contexts, e.g., heating, on-road diesel, off-road diesel, electrical generation etc.
Exempt sales:	Term used by YG Finance to indicate the volume, in litres, of all consumption of a particular fuel in the Yukon on which the Yukon's excise tax has NOT been paid. 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.
GHGs:	Greenhouse gases. These are the gases when added to the atmosphere increase its ability to trap heat.
Inter-provincial carriers:	Commercial vehicles over 26,000 pounds used to transport freight or passengers that operate across the Yukon's borders and load or unload freight or passengers in the territory.
Kt CO_2e:	Kilo tonnes CO_2e. Standard measure of GHG emissions.
NIR:	National Inventory Report. Produced by Environment Canada each year to fulfill Canada's international obligations on GHG emissions reporting. National emissions are reported as are emissions for each province and territory broken out into a number of categories. Each NIR reports over a five year period and therefore each report has a new base year.
NO_2:	Nitrous dioxide. A greenhouse gas whose primary source is internal combustion engines.
RESD:	*Report on Energy Supply and Demand in Canada.* Annual report from Statistics Canada that forms the basis of emissions as reported in the NIR. Reflects the country's overall energy balance.
Through carriers:	Commercial vehicles over 26,000 pounds used to transport freight or passengers that operate across the Yukon's borders but do not load or unload freight or passengers in the territory.

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1 Introduction

The purpose of this research project is to produce a clear and detailed picture of the sources of greenhouse gas emissions (GHGs) from the transportation sector in the Yukon.

The approach taken was to build on the March 2013 version of this report titled *Yukon Greenhouse Gas Emissions: The transportation sector* along with updated data from Environment Canada, Statistics Canada, Yukon Bureau of Statistics and YG Finance.

A clearer picture was and is necessary as YG moves towards its commitment to reduce GHG emissions in the transportation sector. 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 GHG emissions shows that the transportation sector is responsible for the majority of the Yukon's GHGs and the sector's share is substantially higher in the Yukon than for Canada as a whole.

The NIR data breaks down the transportation sector into three Yukon-relevant sub-sections: aviation, road transportation and off-road transportation. Under NIR's road transportation category 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.

In our efforts to further understand where transportation related emissions come from and to inform the management and development of strategies to reduce these emissions, we looked deeply not only at NIR data but also at the source data used by the NIR and other Yukon data sources.

1.1 Approach

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

- Look very closely at all of the data and approaches used to calculate GHG emissions 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 for the March 2013 report included the following:

- To complete a canvas of YG 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 NIR, 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.

For this update to the March 2013 report we were already well versed in the available data and have used it to update and improve the conclusions and recommendations.

2 Yukon GHG Emissions from all Sectors: the NIR

An overview of the Yukon's GHGs from 2008 through 2012 as reported in the latest available (2014) NIR is shown in Table 1.

Table 1: Yukon GHG Emission as Reported by the NIR by Category: 2008 through 2012 in ktCO_2e

CATEGORY	2008	2009	2010	2011	2012	GROWTH OR DECLINE
Electrical Generation	18	17	19	28	18	0%
Mining, Oil & Gas Industries	71	16	25	19	20	-72%
Manufacturing & Construction	22	18	16	16	16	-27%
Commercial, Institutional & Residential Heating	105	82	76	92	78	-26%
Agriculture and Forestry	0	0	0	0	0	0%
Air Transport	34	33	38	38	38	12%
Ground Transport	127	160	149	170	179	41%
Fugitive Sources (from natural gas production)	3	3	3	3	3	0%
Industrial Process	10	12	13	14	14	40%
Other (Solvents & Waste)	3	3	3	3	4	33%
TOTAL	394	344	342	383	370	-6%

Source: Environment Canada 2014 NIR. Table A11-22, Part 3, Page 35.

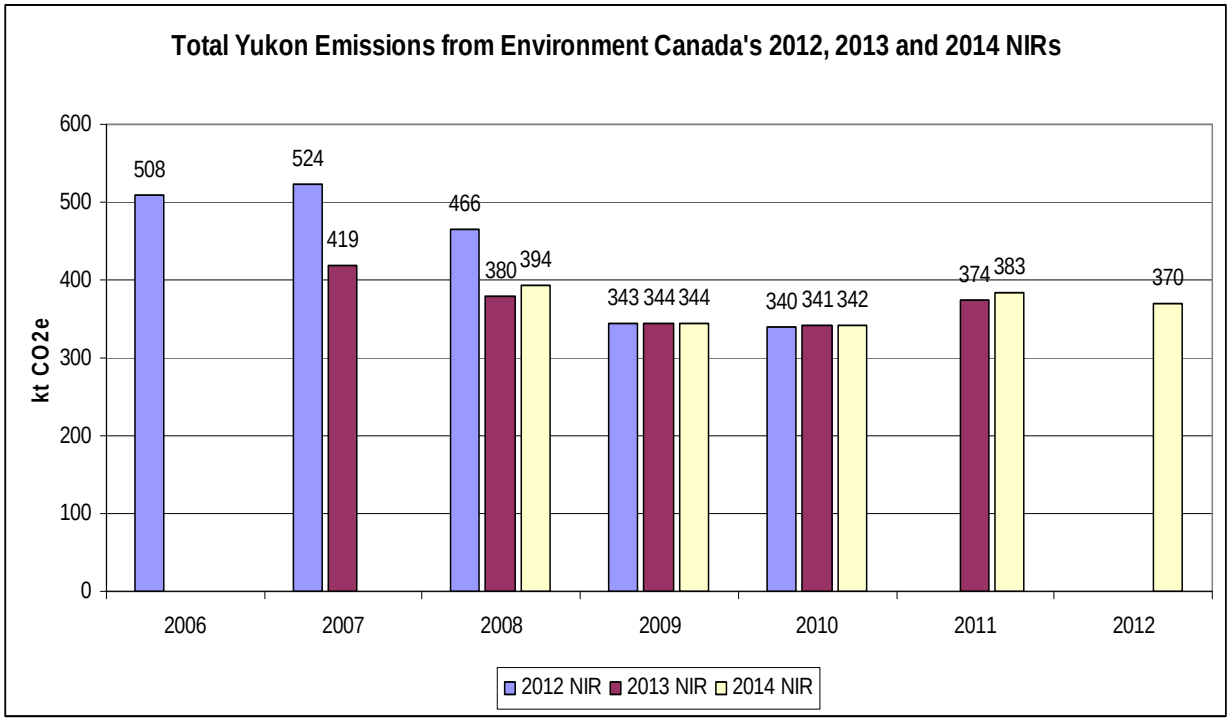
Key observations from Table 1:

- Each NIR includes some revisions of emissions reported in previous years. Some of these revisions can result in significant changes to reported emissions:
  - In the original March 2013 version of this report, the 2012 NIR was the latest available and it showed an overall 33% decline in emissions over the 2006 through 2010 period, driven in large part by a 34% decline in emissions from ground transportation and a 29% decline in emissions from commercial, institutional and residential heating. There was no obvious explanation for these sharp declines with an increasing population and growing GDP in the Yukon.
  - Significant revisions to some of the data (see Figure 1 and Figure 2 below) and especially to the new base year of 2008 in Table 1 has resulted in the NIR now reporting a 41% increase in emissions from ground transport and a much smaller overall decline of 6% in emissions from 2008 through 2012.
  - Note that each NIR reports over a five year period and therefore each report has a new base year. Prior to that new base year data is only reported from years ending in zero or five. For example, the current 2014 NIR reports for the 2008 through 2012 period and includes data for 2005, 2000, 1995 and 1990, but not 2006 and 2007.
- According to the NIR ground transport is the largest source of GHG emissions in the Yukon, ranging from 32% to 48% over the 2008 through 2012 period.

- According to the NIR heating is the second largest source of GHG emissions, ranging from 21% to 27% of the totals over the period.
- The significant decline in the mining, oil & gas industries category over the 2008 through 2012 period reflects the decline in the production of natural gas in the Yukon over the same years.

Some revisions to emissions as reported by the NIR are shown in graph form in Figure 1 and Figure 2.

Figure 1: Revisions to Yukon's Total GHG Emissions as Reported in the 2012, 2013 and 2014 NIRs

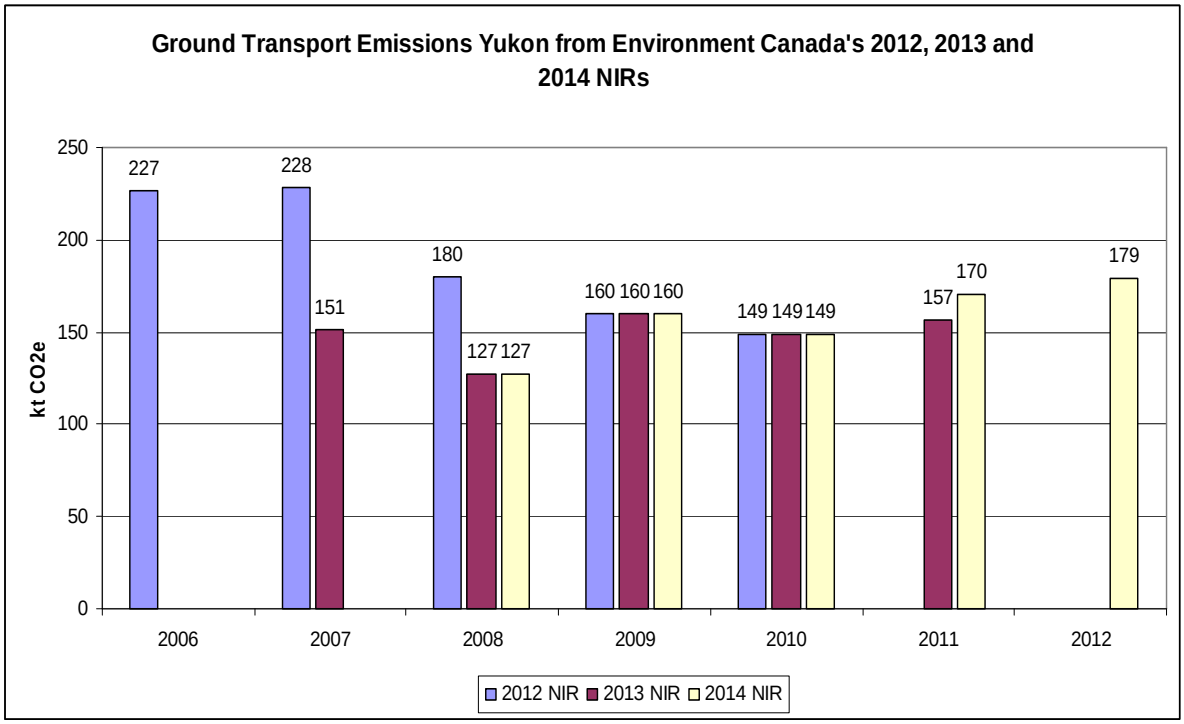


Sources: Environment Canada 2012 NIR. Table A14-22, Part 3, Page 71, Environment Canada 2013 NIR. Table A11-22, Part 3, Page 33, and Environment Canada 2014 NIR. Table A11-22, Part 3, Page 35.

Key observations from Figure 1:

- The 2012 NIR showed a large and inexplicable decline in total emissions between 2007 and 2010.
- A very large downward revision to the 2007 estimate by Environment Canada changed the pattern of total emissions to a dip and rise between 2007 and 2011 according to the 2013 NIR.
- The 2014 NIR left the 2009 and 2010 estimates unchanged while upping the 2008 and 2011 estimate, changing the pattern of total emissions to effectively flat over the 2008 through 2012 period.

Figure 2: Revisions to Yukon's GHG Emissions from Ground Transport as Reported in the 2012, 2013 and 2014 NIRs



Sources: Environment Canada 2012 NIR. Table A14-22, Part 3, Page 71, Environment Canada 2013 NIR. Table A11-22, Part 3, Page 33, and Environment Canada 2014 NIR. Table A11-22, Part 3, Page 35.

Key observations from Figure 2:

- As ground transport is the single largest contributor to the Yukon's GHG emissions, any revisions to the estimates for past years has a disproportionately large effect on total reported emissions.
- The 2012 NIR shows a steep decline in ground transport emissions for 2006 through 2010.
- A massive downward revision of the 2007 and 2008 data in the 2013 NIR changed the pattern to effectively flat emissions for ground transport for 2007 through 2011.
- In the 2014 NIR there were no revisions to the 2008 through 2010 data and an upward revision to 2011, changing the overall pattern to one of rising emissions over the five year period of 2008 through 2012.

Table 2 shows the breakdown of ground transportation GHG emissions by category for the years 2008 through 2012 as reported by the NIR.

Table 2: Yukon Ground Transportation GHGs by Category, as Reported by the NIR: 2008 through 2012 in ktCO_2e

GROUND TRANSPORTATION CATEGORY	2008	2009	2010	2011	2012
Light-duty gasoline vehicles	31.7	41.2	40.3	37.3	39.6
Light-duty diesel vehicles	0.2	0.2	0.2	0.2	0.3
Heavy-duty gasoline vehicles	2.7	3.5	3.5	3.3	3.5
Heavy-duty diesel vehicles	60.7	71.3	67.1	78.8	82.6
Motorcycles	0.2	0.2	0.2	0.2	0.2
Off-road gasoline & diesel	29.0	41.0	35.0	47.0	50.0
TOTAL	**127**	**160**	**149**	**170**	**179**

Source: Environment Canada 2014 NIR. Table A11-22, Part 3, Page 35

Key observations from Table 2:

- In the March 2013 report we found that over the 2006 through 2010 period the 2012 NIR suggested that there had 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.
- The revisions made in the 2013 and 2014 NIRs — and especially the significant reduction of the estimate for emissions in the now-base year of 2008 — have completely reversed the pattern to one of significant growth of emissions, but at a much lower absolute level.
- Note that the NIR has begun to suppress certain sub-categories due to confidentiality concerns, resulting in off-road gasoline and diesel being aggregated in Table 2.
- It is important to note that the distribution of emissions by category is based on data from Ontario where the relative number of kilometres driven by light-duty diesel versus heavy-duty diesel vehicles, for example, may be quite different than in the Yukon.
- The original 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_2e annually. This amount correlates well with the reported reduction in off-road diesel emissions in 2008.

2.1 Yukon fuel consumption data

One issue that arose almost immediately when we originally began reviewing the available data on consumption of fuels for transport in the Yukon for the March 2013 report 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 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. The other is Statistics Canada data series CANSIM 405-0002 *Gasoline and Other Petroleum Fuels Sold*.

We initially decided that the CANSIM 405-0002 data could not be accurate (it was 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 NIR 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 was the less accurate of the two when:

- Further research found that it is based on YG 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 (YBS) about the large differences in reported Yukon fuel consumption between the CANSIM 405-0002 data and the amounts being reported by the YBS in their annual statistical reviews, along with the declines in consumption. YBS agreed that the large decline in consumption shown raised a large flag that the source data was potentially problematic.

YBS 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 are 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 the territory or transported by pipeline), and a significant 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.

YBS 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.[1] Note that the NIR continues to use the RESD data to calculate the Yukon's GHG emissions.

2.1.1 Yukon fuel consumption: comparison by data source

We requested the underlying data that is used to create CANSIM 405-0002 from the YG Finance and the result is shown in Table 3 and in graph form in Figure 3.

[1] 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 3: Yukon Consumption of Gasoline and Diesel in Litres: 2009 through 2013

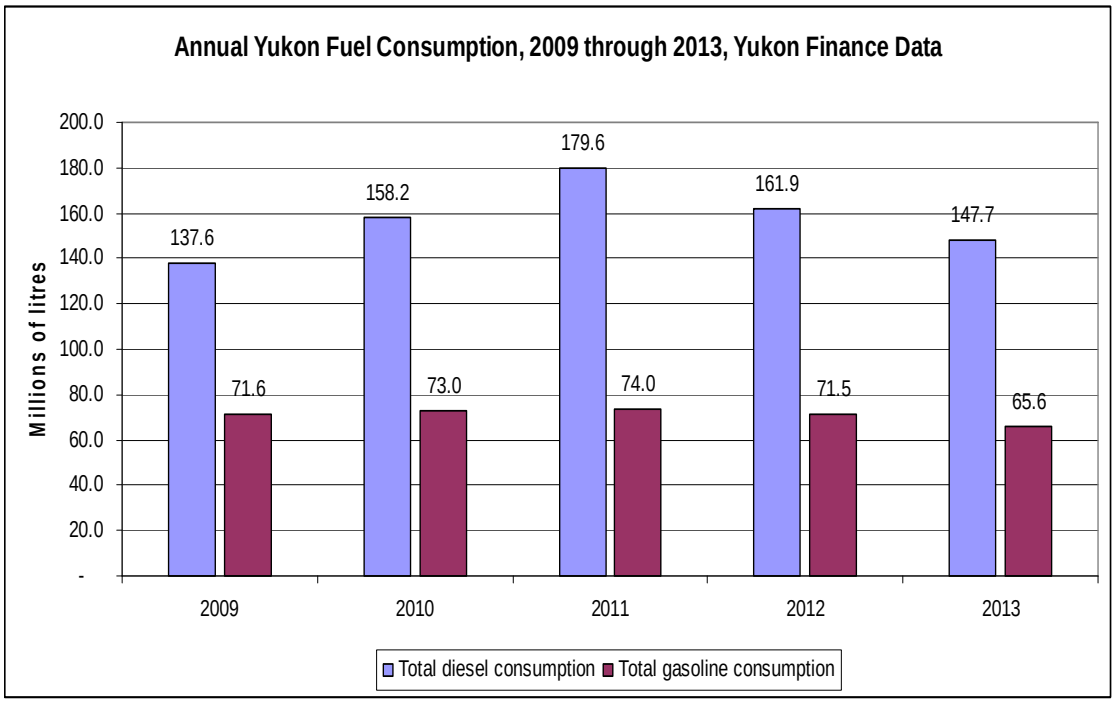
YEAR	CATEGORY	GASOLINE	DIESEL
2009	Exempt Sales	2,766,907	73,767,413
	Total Accountable Volumes	68,859,349	63,879,323
	Total Litres Consumed	71,626,256	137,646,736
2010	Exempt Sales	1,445,189	86,545,265
	Total Accountable Volumes	71,601,119	71,683,730
	Total Litres Consumed	73,046,308	158,228,995
2011	Exempt Sales	688,299	96,634,816
	Total Accountable Volumes	73,285,828	82,922,735
	Total Litres Consumed	73,974,127	179,557,551
2012	Exempt Sales	634,751	85,893,102
	Total Accountable Volumes	70,860,692	76,048,561
	Total Litres Consumed	71,495,442	161,941,663
2013	Exempt Sales	455,839	79,951,745
	Total Accountable Volumes	65,104,683	67,770,790
	Total Litres Consumed	65,560,522	147,722,535

Source: YG Finance, special data request November 21, 2014

Key observations on Table 3 and Figure 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.
- Yukon fuel consumption for both gasoline and diesel peaked in 2011 and has declined significantly through the end of 2013.
    - Total gasoline consumption declined by 11% from 2011 through 2013.
    - Total diesel consumption declined by 18% from 2011 through 2013.
    - These declines correlate with the decline in the Yukon's mining sector.
- Perceived concerns centered on the *Access to Information and Protection of Privacy Act* prevented the release of more detailed data by YG Finance both for the March 2013 report and for this updated report.

Figure 3: Yukon Consumption of Gasoline and Diesel in Litres: 2009 through 2013



Source: YG Finance, special data request November 21, 2014

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

Table 4: Yukon Fuel Sales for Road Motor Vehicles in Litres: 2009 through 2013

	2009	2010	2011	2012	2013
Net sales of gasoline	67,053,000	70,133,000	71,641,000	68,821,000	63,744,000
Gross sales of gasoline	69,738,000	71,502,000	72,336,000	69,513,000	64,190,000
Gross minus net gasoline (exempt sales)	2,685,000	1,369,000	695,000	692,000	446,000
Net sales of diesel oil	50,197,000	55,958,000	63,585,000	60,227,000	52,852,000

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 from CANSIM 405-0002 track very closely with the data from YG Finance shown in Table 3. The small discrepancy is due to the exclusion of avgas from Table 4 (avgas is obviously not used by road motor vehicles) but its inclusion in Table 3 as it is subject to the excise tax.
- 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. (Jet fuel, like avgas, is subject to the fuel excise tax but is not, obviously, used in road motor vehicles).

2.2 Yukon GHG emissions: discussion with Environment Canada

With confirmation that any use of the Yukon fuel consumption data 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 GHGs for the Yukon's transportation sector.

From Annex 2 of the NIR (A.2.4.2) we understand that the 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 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.

A Made-in-Yukon Emissions Report

Environment Canada is entirely open to the Yukon creating its own GHG emissions report and to working with provinces and territories to improve the NIR. The department states:

"While Canada is developing a national emissions inventory consistent with IPCC guidelines and international obligations, provincial governments may elect to develop an inventory structure in accordance with specific provincial needs. Environment Canada encourages collaboration with provinces for quality assurance and continuous improvement of this annual National Inventory Report."

In summary, our concern was that if Environment Canada has been adjusting its 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 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 has 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 is 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 recognized 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 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 current 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 recognized that YG 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 was open to working with the Yukon to get a better picture of actual transportation GHG emissions.

Since the 2012 conversation with Environment Canada and the March 2013 report YG's Climate Change Secretariat has been working with Environment Canada on the issues of reporting accurate GHGs for the territory.

2.3 Alaska as source of fuel imports

As noted above, one factor that has created the significant under-reporting of the Yukon's transportation GHG 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. YG Finance has data on exactly how much fuel is imported to the Yukon from Alaska but withheld its release for the 2013 report and continues to do so 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 YG 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 through 2013 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 is 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 (the net weight of the empty truck) of the vehicle configuration, it is possible to estimate the quantity of fuel loaded on the truck.
- The 2012 weigh station data for Whitehorse is missing only data for 5 days at the end of March while the 2013 data appears to be effectively complete (missing data only for October 3, 2013).
- The 2012 weigh station data for Watson Lake is missing 7 days of data in July while the 2013 data is missing 5 days of data from three different months.

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 Table 5, we can provide the following as an estimate range for the amount of fuel imported from Alaska from 2010 through 2013.

Table 5: Estimated Volume of Diesel Imported from Alaska: 2010 through 2013

	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%
2012	18,150,000	18,400,000	11.2%	11.4%
2013	23,500,000	23,500,000	15.9%	15.9%

Source: YG Highways special data request, November 21, 2014

Key observations on Table 5:

- 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 and are missing 5 days of data from 2012) as noted on page 11 above.
- The percentages are expressed against the base of total Yukon consumption of diesel as provided by YG Finance (see Table 3 above) because we do know from Environment Canada enforcement staff in Whitehorse that all of the imports are diesel, not gasoline.
- The estimated volume of diesel fuel imported from Alaska has increased almost 6-fold from 2010 through 2013.[2]
- As a percentage of diesel fuel consumed in the Yukon, imports from Alaska are now at a significant 16% share.
- As noted, these imports are not captured in the RESD data used by Environment Canada in its NIR and as imports increase the NIR figure becomes a greater under estimate of actual emissions.

[2] The closure and decommissioning of the refinery at North Pole Alaska in 2014 (see http://www.newsminer.com/news/local_news/flint-hills-quiet-transition-closed-refinery-prepares-for-next-phase/) may result in significant reductions in fuel imports from Alaska.

3 Heavy Truck Transport

From Statistics Canada's CANSIM 405-0002 data shown in Table 4 on page 9, we know that on-road diesel use in the Yukon increased from approximately 50.2 million litres in 2009 to 63.6 million litres in 2011 before falling back to approximately 52.8 million litres in 2013. 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.

3.1 Inter-provincial and through carriers

YG 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 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 in the Yukon: 2009 through 2013

YEAR		TOTAL ROAD VEHICLE DIESEL	TOTAL DIESEL USED BY INTER-PROVINCIAL AND THROUGH CARRIERS	TOTAL YUKON KM DRIVEN BY INTER-PROVINCIAL AND THROUGH CARRIERS
2009	Litres	50,197,000	14,494,938	26,627,676
	%	—	28.9%	
2010	Litres	55,958,000	14,681,513	27,271,484
	%	—	26.2%	
2011	Litres	63,585,000	16,126,240	29,451,664
	%	—	25.4%	
2012	Litres	60,227,000	16,606,862	29,892,862
	%		27.6%	
2013	Litres	52,852,000	16,338,756	29,238,314
	%	—	30.9%	

Source: Statistics Canada, CANSIM 405-0002 *Road motor vehicles, fuel sales, annual (litres)* and YG Finance, special data request November 21, 2014

Key observations on Table 6:

- Total road vehicle diesel is taken from Statistics Canada's 405-0002 data.
- Kilometres driven by inter-provincial and through carriers rose by 12.6% from 2009 to a peak in 2012 before declining slightly in 2013.
- Inter-provincial and through carriers increased their fuel use in the Yukon from 2009 through 2012 (followed by a small decline in 2013) but their share of total on-road diesel use rose to nearly 31% by 2013 as others reduced their road vehicle diesel use significantly.

- The total fuel use by carriers has remained high and relatively steady from 2011 through 2013 despite a 17% drop in total road vehicle diesel use from 2011 through 2013.
- 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]. 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.

3.2 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 does 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 through 2013

	2011	2012	2013
Watson Lake Weigh Station Total Count	32,585	34,992	33,304
Trucks to Wolverine Mine	945	1,869	2,329
Trucks from Wolverine Mine	542	1,214	1,791
Total trucks Wolverine Mine	1,487	3,083	4,120
Percent of Watson Lake Weigh Station Total Count	**4.6%**	**8.8%**	**12.4%**
Trucks to Cantung Mine	485	731	561
Trucks from Cantung Mine	225	349	329
Total trucks Cantung Mine	710	1,080	890
Percent of Watson Lake Weigh Station Total Count	**2.2%**	**3.1%**	**2.7%**

Source: YG Highways and Public Works, special data request November 21, 2014

Key observations on Table 7:

- Truck traffic to and from the Cantung mine increased somewhat from 2011 through 2013 but remains around 3% of total truck count.
- Truck traffic to and from the Wolverine mine rose significantly from 2011 through 2013 and now accounts for more than 12% of the total truck count.

[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

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

Table 8: Minto Mine's Share of Whitehorse Weigh Station Total Truck Count: 2011 through 2013

	2011	2012	2013
Whitehorse Weigh Station Total Count	41,945	41,457	40,101
Trucks to Minto Mine	923	750	1,016
Trucks from Minto Mine	695	455	513
Total trucks Minto Mine	1,618	1,205	1,529
Percent of Whitehorse Weigh Station Total Count	**3.8%**	**2.9%**	**3.8%**

Source: YG Highways and Public Works, special data request November 21, 2014

Key observations on Table 8:

- Truck traffic to and from the Minto mine remained fairly steady from 2011 through 2013 at a little under 4% of the total truck count for the Whitehorse weigh station.

Note that the weigh station data was incomplete for 2011 and both the counts for each mine and the total counts are actually higher for that year. 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.

It is also important to note that Table 7 and Table 8 are intended to estimate the mines' share of the on-road heavy truck transportation in the Yukon and not their fuel consumption.

3.3 Tour buses

The weigh station data also allows 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. The tour bus count rose somewhat to 624 in 2012 but this is still only 1.5% of the total count. And in 2013 tour bus numbers were largely unchanged at 607, again 1.5% of the total count.

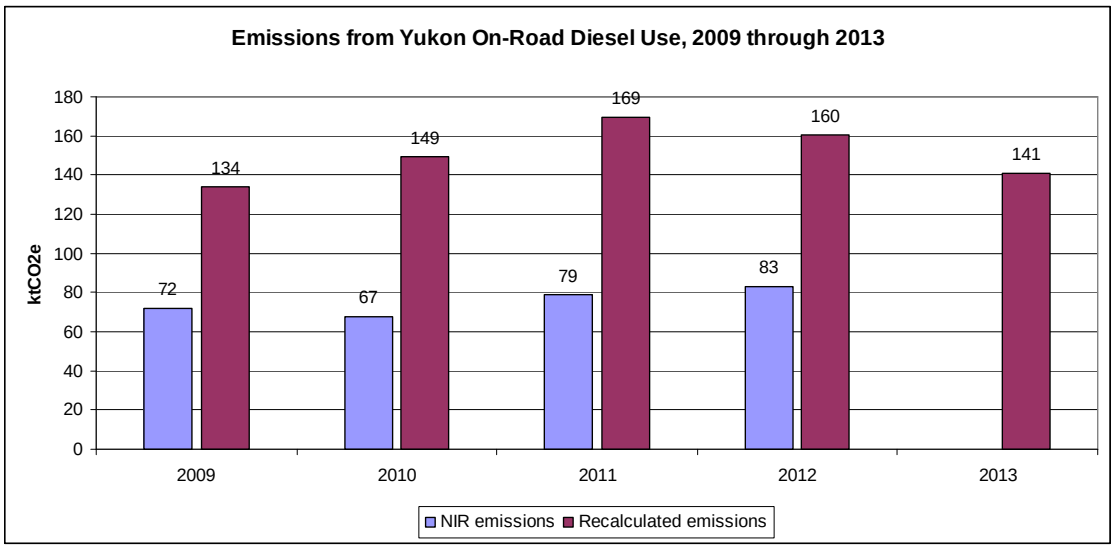
3.4 Emissions from on-road diesel, NIR versus recalculated totals

A comparison of the 2014 NIR's emissions estimate and a re-calculation of Yukon on-road diesel emissions for 2009 through 2013 is shown in Figure 4 on page 16.

Key observations on Figure 4:

- The NIR has been under-reporting Yukon on-road diesel emissions by approximately 50%.
- Yukon GHG emissions from on-road diesel use rose by 26% from 2009 through 2011 before falling by 17% from 2011 through 2013.
- From Table 6 on page 13 we know that inter-provincial and through carriers were responsible for between 25% and 31% of the Yukon's total on-road diesel use from 2009 through 2013.
- The re-calculated emissions are from Statistics Canada's CANSIM 405-0002.
- The emission factor used is 2.664 (for on-road diesel) from Environment Canada's 2014 NIR.

Figure 4: Yukon On-Road Diesel Emissions, 2009 through 2013



Source: Statistics Canada, CANSIM 405-0002 and 2014 NIR

4 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 NIR describes off-road transportation emissions reported as the difference between total fuels 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 2.1 on page 6). In addition, our discussions with Environment Canada (see Section 2.2 on page 10) 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).

4.1 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 on page 8).

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

Table 9: Off-Road Gasoline Emissions and Exempt Gasoline Sales, Yukon, 2009 through 2013

	2009	2010	2011	2012	2013
NIR off-road gasoline emissions ($ktCO_2e$)	1.8	0.9	0.4	X	—
Yukon exempt gasoline sales (litres)	2,766,907	1,445,189	688,299	634,751	455,839
Re-calculated off-road gasoline emissions ($ktCO_2e$)	6.3	3.3	1.6	1.5	1.0

Source: 2013 NIR and YG Finance special data request November 21, 2014

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.
- Recalculations are done using an emission factor of 2.29 $ktCO_2e$ for off-road gasoline from Environment Canada.

- Yukon exempt gasoline sales have declined substantially between 2009 and 2013, perhaps reflecting a decline in the mineral exploration sector, or a shift to increased use of light duty diesel vehicles off-road.
- The 2014 NIR suppresses separate off-road gasoline emission estimates and therefore the numbers shown in Table 9 are from the 2013 NIR and no estimate is available for off-road gasoline for 2013.

4.2 Off-road diesel

The NIR calculates that off-road diesel has contributed between 28 and 40 $ktCO_2e$ annually to the Yukon's GHG emissions between 2006 and 2011 (see Environment Canada 2013 NIR. Table A11-22, Part 3, Page 33). This calculation is, like all of the others in the NIR, likely significantly underreporting actual emissions although it includes substantial downward revisions from the 2012 NIR.

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 YG 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 YG 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, even in light of these limitations 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 for 2010 through 2013. These estimates are presented in Sections 4.2.1 through 4.2.3.

4.2.1 Estimate of emissions from heating fuel

As noted previously, segregated heating fuel data has not been provided by YG Finance. Although the total quantity of heating fuel consumption for the Yukon in the 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. Therefore, knowing the actual total diesel consumption from YG Finance, the amount consumed for space heating can be estimated by applying the relative percentage from the RESD.

YBS 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 the 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 from 2009 through 2013 is shown in Table 3 on page 8. Using that data, the assumption that 30% of total diesel fuel use is for space heating and Environment Canada's (2014 NIR) emission factor of 2.725 g/L for light fuel oil gives us the estimate for emissions shown in Table 10.

Table 10: Estimate of Yukon GHG Emissions from Heating Fuel, 2009 through 2013

YEAR	TOTAL YUKON DIESEL CONSUMPTION IN LITRES	ESTIMATED DIESEL USED FOR HEATING (30% OF TOTAL) IN LITRES	ETIMATED EMISSIONS
2009	137,646,736	41,294,021	113 $ktCO_2e$
2010	158,228,995	47,468,699	129 $ktCO_2e$
2011	179,557,551	53,867,265	147 $ktCO_2e$
2012	161,941,663	48,582,499	132 $ktCO_2e$
2013	147,722,535	44,316,761	121 $ktCO_2e$

Source: 2014 NIR and YG Finance special data request November 21, 2014

Notes on Table 10:

- This estimate is weak for two reasons:
  - The 30% ratio of heating fuel to total diesel consumption may be incorrect;
  - And even if the ratio was correct for the 2006 through 2010 period, the overall drop in diesel consumption from 2011 through 2013 is unlikely to have occurred in the same proportion across all uses, i.e. most of the drop is likely to do with the decline of the mining industry and not a decline in the use of heating fuel.
- However, until and unless YG Finance releases disaggregated heating fuel data this approach appears to be the only way of estimating emissions from heating fuel.
- The estimate of emissions shown does not include emissions from propane used in space heating; for propane emissions see Section 7 on page 26.

4.2.2 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 YBS's 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 11 presents diesel electrical generation and fuel consumption estimates for the two utilities, Yukon Electrical Company Ltd (YECL) and Yukon Energy Corporation (YEC).

Table 11: Yukon Electrical Generation Emissions 2009 through 2013

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
2012	20.7	3.0	5,570,000	817,000	6,387,000
2013	21.6	2.0	5,812,000	545,000	6,357,000

Notes:
1 Total diesel electric generation (YBS 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 11, emissions from fuel-fired electrical generation (using Environment Canada's emission factor of 2.725 g/L for electrical utility usage of light fuel oil) are estimated at:

- 2009: 16 ktCO_2e
- 2010: 17 ktCO_2e
- 2011: 28 ktCO_2e
- 2012: 17 ktCO_2e
- 2013: 17 ktCO_2e

4.2.3 Emissions from mine site fuel usage

A significant portion of off-road fuel usage is at the large hard rock mines. In 2010 through 2013 there were two major hard rock mines operating in the Yukon, the open-pit Minto mine and the underground Wolverine mine. Minto is significantly larger than Wolverine, mining ore at approximately twice Wolverine's daily production level; 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 can be expected to larger than Minto's.

We generated an estimate of fuel consumption by these two mines from the Whitehorse and Watson Lake weigh station data provided by Yukon Highways. Notwithstanding the limitations of the weigh station data for these years noted previously in Section 2.3 on page 11, the database does record the mine-bound trucks' weight, cargo and vehicle configuration. Knowing the tare weight (i.e. the empty weight) of each truck type, it is possible to estimate 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.

As a cross check, the Climate Change Secretariat requested the same data from both of the mines directly. Capstone, the owner of Minto, supplied the amount of fuel delivered to their site for the years 2010 through 2013. However, the 2010 data supplied by Capstone (831,341 litres) can not possibly be correct. From the weigh station data we know that 108 loaded fuel trucks, 100 of them B-trains, went to Minto in 2010. Each of these is capable of hauling over 45,000 litres of fuel. To have delivered a total of only 831,000 litres each truck would be carrying less than one fifth of a load. The other Capstone data, for 2011 through 2013, is much closer to our estimates derived from the weigh station data with the actual reported litres being 6% higher on average than the estimates based on weigh station data.

Table 12 presents the estimate of fuel delivered to the Minto and Wolverine mines respectively from the weigh station data. The amounts reported by Capstone for 2010 through 2013 are also shown. Based on the average of 6% over estimate found in comparing the 2011 through 2013 Capstone numbers with the weigh station based estimates an adjusted estimate of the Minto mine's 2010 fuel use and Wolverine's use from 2010 through 2013 is also shown. Note that the Minto adjusted numbers for 2011 through 2013 are Capstone's numbers). The emission calculation is based on the adjusted fuel delivery estimates.

Table 12: On-Site Fuel Consumption Estimate, Minto and Wolverine Mines, 2010 through 2013

	2010	2011	2012	2013
Millions of litres delivered, Minto, weigh station estimate	5.2	7.0	8.6	10.0
Millions of litres delivered, Minto, Capstone data	0.8	5.6	11.0	12.9
Millions of litres, Minto, adjusted	5.5	5.6	11.0	12.9
Emission calculation Minto ($ktCO_2e$)	15	15	29	34
Millions of litres delivered, Wolverine, weigh station estimate	5.5	8.2	14.5	14.2
Millions of litres delivered, Wolverine, adjusted	5.8	8.7	15.4	15.1
Emission calculation Wolverine ($ktCO_2e$)	16	23	41	40
Total adjusted fuel (millions of litres)	11.3	14.3	26.4	28.0
Total emission calculation ($ktCO_2e$)	30	38	70	75

Sources: YG Highways and Public Works, special data request November 21, 2014 and Capstone Mining special data request from YG Climate Change, February 26, 2015

Notes on Table 12:

- 2010 and 2011 data include pro-rating of fuel delivered in the weigh station estimate to account for the approximate one month of missing weigh station data for each of those years.
- The 2010 number of litres for the Minto mine is the weigh station estimate adjusted upward by 6% as is done for all of the Wolverine data.
- Density of diesel fuel assumed to be 0.85 kg per litre.
- Emission factor used was 2.664 g/L $ktCO_2e$ for off-road diesel from Environment Canada.

5 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 as shown in Table 13 and in Figure 5 on page 23.

Table 13: Yukon On-Road Gasoline Emissions, 2009 through 2013

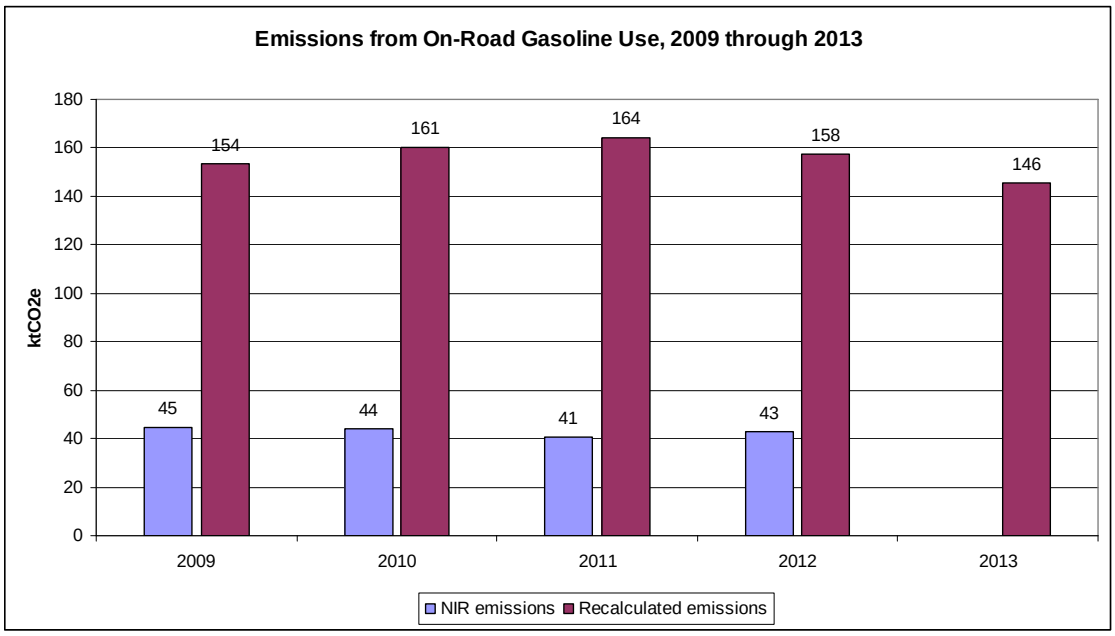
	2009	2010	2011	2012	2013
NIR calculation for on-road gasoline emissions ($ktCO_2e$)	45	44	41	43	—
Year-over-year change, %	—	-2%	-7%	+6%	—
Yukon consumption of on-road gasoline (net sales volume in millions litres)	67.1	70.1	71.6	68.8	63.7
Year-over-year change, %	—	4%	2%	-4%	-7%
Re-calculated on-road gasoline emissions ($ktCO_2e$)	154	161	164	158	146

Source: Statistics Canada, CANSIM 405-0002 and 2014 NIR

Key observations on Table 13 and Figure 5:

- Consumption of gasoline rose between 2009 and 2011 before falling in 2012 and 2013 with significant year-over-year declines of 4% and 7% respectively.
- Emissions from that gasoline use obviously follow the same rising and then falling pattern.
- The NIR under-reports emissions by a factor of four.

Figure 5: Yukon On-Road Gasoline Emissions, 2009 through 2013



Source: Statistics Canada, CANSIM 405-0002 and 2014 NIR

5.1 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 in detail here.

However, for those not familiar with the report, some of the key findings include:

- Comparisons of Whitehorse, Yukon communities and Canada as a whole show that a significant percentage of respondents in communities outside of Whitehorse walk to work resulting in significantly lower single occupancy vehicle numbers than either Whitehorse or Canada;
- Whitehorse respondents show a higher use of single occupancy vehicles as a means of getting to work than the Canadian average and significantly higher than the communities outside of Whitehorse.
- On average Canadian respondents showed an 11% public transit use for getting to work while Whitehorse respondents showed only 3.1%.
- Yukon residents on average have a significantly shorter commuting distance than the average Canadian. Median commuting distances for Yukon residents is 3.9 km while the median Canadian commute is nearly twice as far at 7.6 km.
- In the 10 years between 1996 and 2006 a slight increase has been seen in single occupancy transportation and a decrease in walking to work and carpooling in the Yukon. Respondents' use of bicycles has increased slightly over this time from 2% to 3%.

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

6 Aviation

From Table 1 on page 3, the NIR shows that Yukon emissions from air transport have remained relatively stable, fluctuating between 33 and 38 $ktCO_2e$ from 2008 through 2012 with no apparent strong trends. According to the NIR, air transport represents approximately 10% of the Yukon's GHG emissions in most years.

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 14 and Figure 6 on page 25 present calculations on air transport emissions in the Yukon.

Table 14: Aircraft Movements, Jet Fuel and Avgas Consumption and Emissions, 2006 through 2011

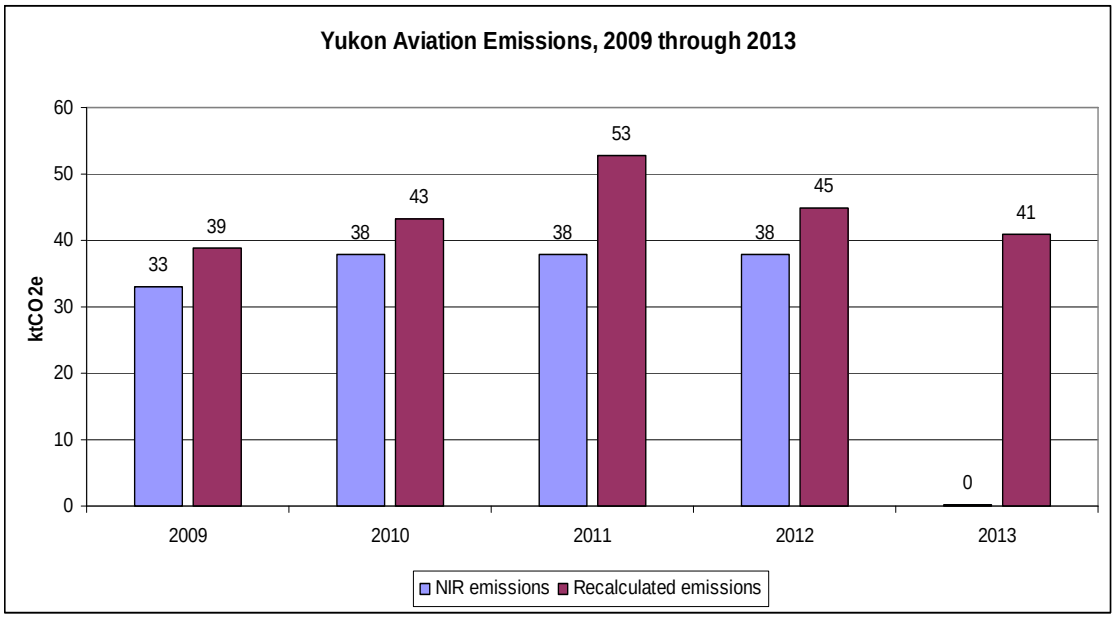
	2009	2010	2011	2012	2013
NIR air transport emissions ($ktCO_2e$)	33	38	38	38	—
Year-over-year change, %	—	12%	0%	0%	—
Total aircraft movements, Whitehorse	24,505	30,635	31,444	28,993	29,071
Year-over-year change, %	—	25%	3%	-8%	0%
Yukon consumption of jet fuel (estimate in litres)	13,682,323	15,725,730	19,337,735	15,821,561	14,918,790
Year-over-year change, %		15%	23%	-18%	-6%
Re-calculated jet fuel emissions ($ktCO_2e$)	35	40	50	41	38
Yukon consumption of avgas (estimate in litres)	1,806,349	1,468,119	1,644,828	2,039,692	1,360,683
Year-over-year change, %		-19%	12%	24%	-33%
Re-calculated avgas emissions ($ktCO_2e$)	4	3	4	5	3
Re-calculated total aviation emissions ($ktCO_2e$)	39	43	53	45	41

Source: Aircraft movement data from Yukon Bureau of Statistics 2011 Annual Statistical Review. Jet fuel and avgas consumption estimate derived from YG Finance special data request November 21, 2014 and CANSIM 405-0002. NIR emissions from 2014 NIR.

Key observations on Table 14 and Figure 6:

- 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 YG Finance, see Table 3 on page 8) and the net sales of diesel for motor vehicles (from Statistics Canada, see Table 4 on page 9).
- The same approach was used to estimate avgas consumption. 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.
- Total aircraft movements at the Whitehorse airport should be a reasonable proxy for fuel used in air transport but, because a small plane movement counts the same as a large jet movement, the correlation is not ideal.
    - Looking at jet fuel only, trends in fuel consumed and aircraft movements are not especially well correlated but more or less move in the same direction.
- We requested separate data on jet fuel and avgas from YG Finance but perceived concerns centered on the *Access to Information and Protection of Privacy Act* prevented the release of more detailed data by Finance both for the March 2013 report and this update.
- The re-calculated air transport emissions use the emission factors of 2.534 kg of CO_2e per litre jet fuel and 2.344 kg of CO_2e per litre avgas as published by Environment Canada.
- The recalculation shows that the NIR under-estimates Yukon aviation emissions by between 13 and 39%.

Figure 6: Yukon Aviation Emissions, 2009 through 2013



Source: 2014 NIR, YG Finance special data request November 21, 2014 and CANSIM 405-0002.

7 Propane

Although not looked at separately in the original March 2013 version of this report, we are providing data on the Yukon's total consumption of propane and the emissions it creates to help ensure our re-calculation of overall emissions is as accurate as possible.

Table 15: Total Yukon Propane Use, 2009 through 2013

	2009	2010	2011	2012	2013
Propane, final demand (millions of litres)	9.5	14.0	17.1	14.4	13.2
Emission calculation ($ktCO_2e$)	14	21	26	22	20

Source: Statistics Canada CANSIM Table 128-0012

Key observations on Table 15:

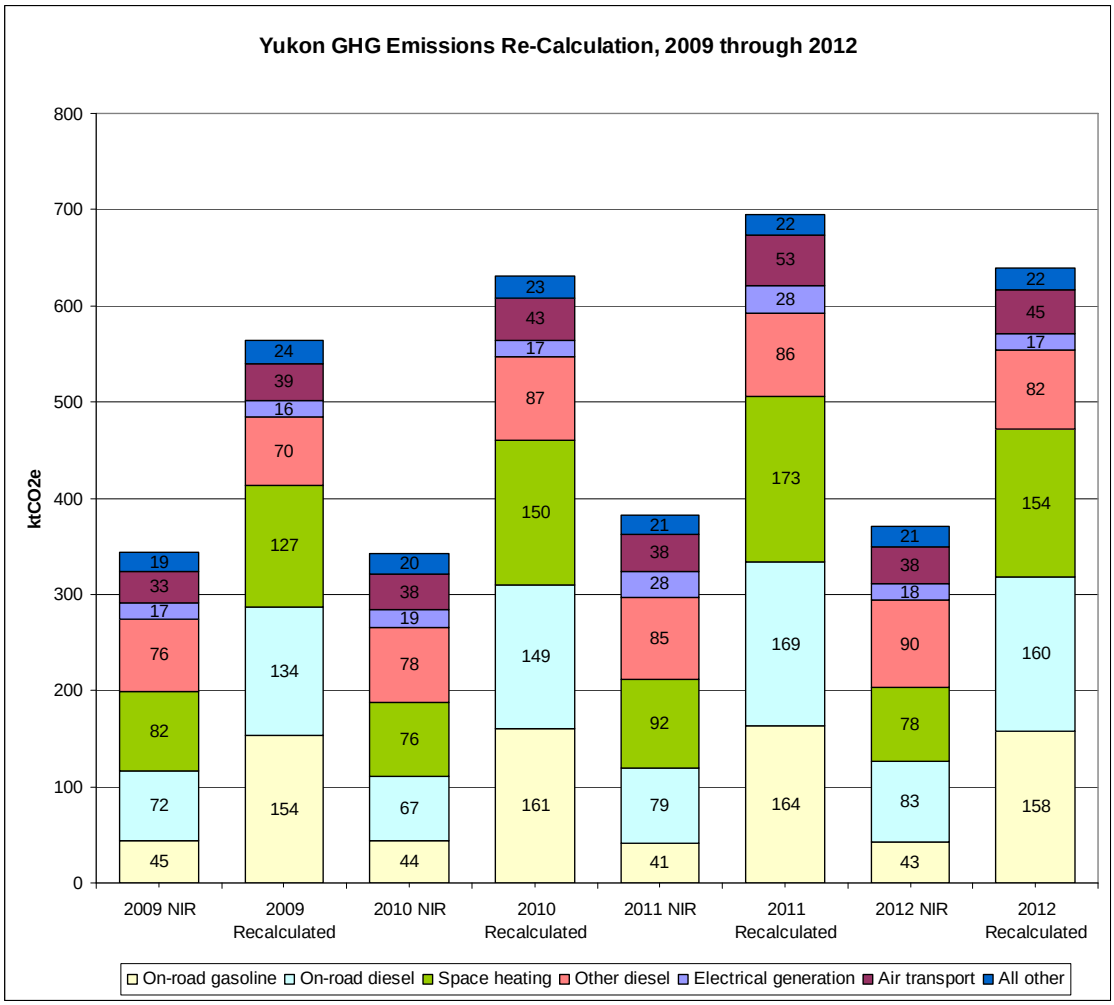
- Demand for propane in the Yukon rose by 80% between 2009 and 2011 before declining by 23% between 2001 and 2013.
- Almost all propane in the Yukon is used for heating.
- The emission calculation uses an emission factor of 1.508 kg of CO_2 equivalent per litre propane as published in the 2014 NIR.

8 Re-Calculation of Yukon Emissions

With the confirmation from Environment Canada that they are indeed using the data source that significantly understates emissions and is subject to periodic large revisions, we can offer the re-calculation of total Yukon emissions using the fuel use statistics based on the CANSIM 405-0002 and the underlying YG Finance data as discussed in detail in this report. (And many of the comparisons of the NIR and re-calculated emissions for various subsets of fuel use are in the figures throughout this report).

In our re-calculations, we replace all of Environment Canada's emissions estimates that are based on the consumption of fuel for whatever purpose. However, we retain three categories (fugitive sources, industrial processes, and solvents & waste) that are not dependent on the flawed RESD data source.

Figure 7: Comparison of Overall NIR Yukon Emissions and Re-Calculated Yukon Overall Emissions, 2009 through 2012

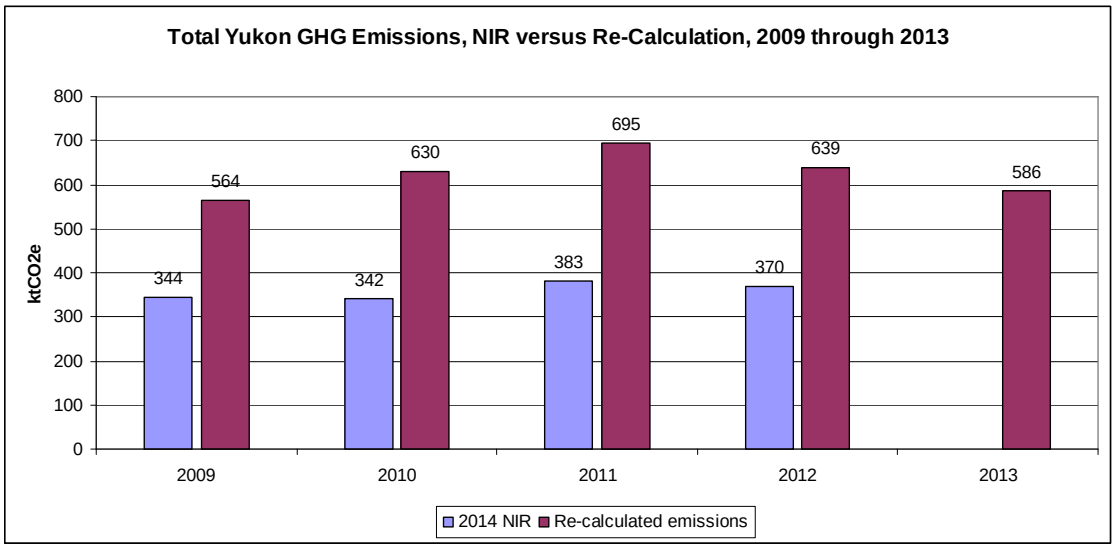


Sources: 2014 NIR, Yukon Department of Finance, special data request November 21, 2014, Statistics Canada, CANSIM 405-0002 and 128-0012, and Yukon Bureau of Statistics

Key points on Figure 7 and Figure 8:

- Compares each year's NIR emissions (from the 2014 NIR) with the re-calculated totals using solid data sources.
- Actual Yukon GHG emissions are an average of 75% higher than those reported by the NIR over the four years 2009 through 2012.
- Space heating includes both propane and fuel oil.
- Other diesel includes all off-road diesel use, including that in mining.
- The "All other" category is non-energy use related emissions including fugitive, industrial processes, solvents, agriculture and waste.

Figure 8: Total Yukon GHG Emissions, NIR versus Re-Calculation, 2009 through 2013

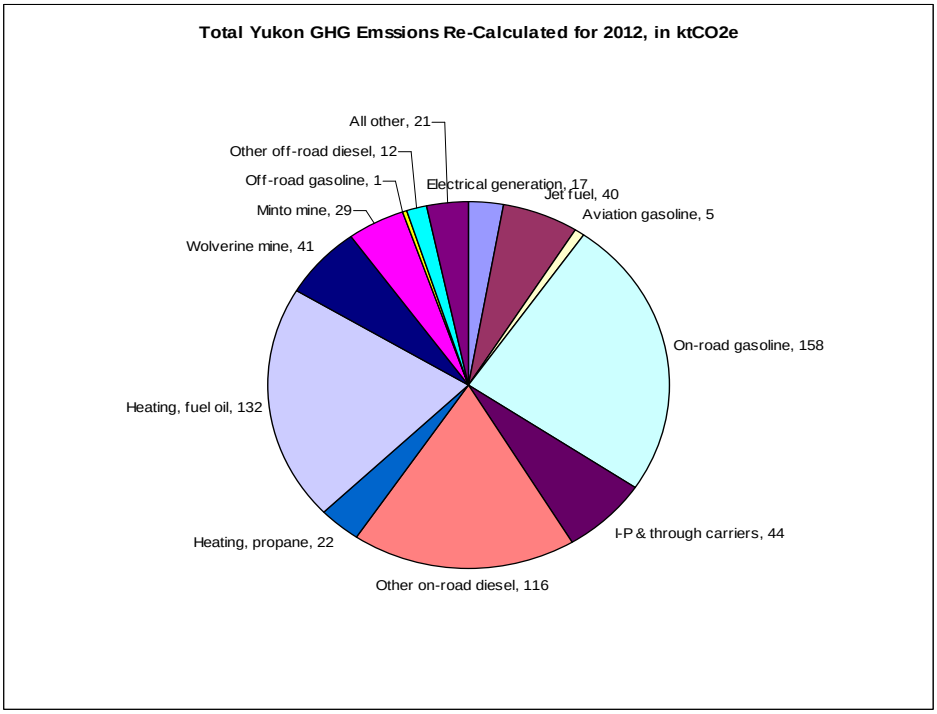


Sources: 2014 NIR, Yukon Department of Finance, special data request November 21, 2014, Statistics Canada, CANSIM 405-0002 and 128-0012, and Yukon Bureau of Statistics

We have a very high level of confidence in the accuracy of the re-calculation of total Yukon GHG emissions summarized in Figure 8. Approximately 97% of the Yukon's emissions are from the burning of fossil fuels — gasoline, diesel and propane — and gasoline and diesel together account for 94% of emissions. YG 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 and the data on total gasoline and diesel supplied by the department is deemed to be highly accurate.

Figure 9 on page 29 shows the 2012 re-calculation of emissions broken out in more detail.

Figure 9: Total Yukon GHG Emissions Re-Calculated for 2012, in $ktCO_2e$



Sources: 2014 NIR; YG Finance special data request November 21, 2014; Statistics Canada CANSIM 405-0002 and 128-0012, and Yukon Bureau of Statistics

Key points on Figure 9:

- On-road gasoline use is responsible for 25% of total Yukon GHG emissions.
- Fuel oil used for heating is estimated to produce 21% of the Yukon's emissions (see the discussion in Section 4.2.1 on page 18 for caveats).
- On-road diesel use is responsible for 25% of total Yukon GHG emissions (7% by inter-provincial and through carriers and 18% by other on-road diesel).
- In 2012 the Yukon's two operating hardrock mines were responsible for 11% of the Yukon's total emissions from their on-site fuel use.
- Aviation (both jet fuel and avgas) produced 7% of total Yukon emissions in 2012.
- In 2012 the diesel electrical generation by the Yukon's two utilities produced 3% of emissions.
- Propane for heating was also responsible for 3% of total emissions.
- The all other category (that includes industrial processes, fugitive sources, agriculture, solvents and waste) also accounted for 3% of total emissions
- Off-road gasoline use was a negligible contributor to the Yukon's 2012 total emissions.

As noted we are very confident that the overall emissions re-calculation is accurate but we have differing levels of confidence in the accuracy of different portions of the re-calculation of overall Yukon emissions as shown in Figure 9 on page 29 depending on the data source and the calculations or estimates required to arrive at each.

As they are based directly on YG Finance data we have a very high level of confidence in:

- On-road gasoline;
- Inter-provincial and through carriers;
- Other on-road diesel; and,
- Off-road gasoline.

Because each required an additional calculation or reliance on more than one data set to arrive at them we have a high (but not very high) level of confidence in:

- Propane;
- Jet fuel;
- Aviation gasoline; and,
- Electrical generation.

We are only moderately confident in the emissions assigned to the Minto and Wolverine mines due to the estimates and data adjustments required to arrive at them. Similarly, we are only moderately confident in the "All other" category as it comes directly from the NIR (though it obviously does not rely on the flawed RESD data as none of these sources of GHG emissions involve the burning of fuel).

The estimate for emissions due to heating fuel is presented with a low level of confidence as it is based on somewhat questionable assumptions. Similarly, only a low confidence level can be assigned to the other off-road diesel component as it is what remains after the mining and heating fuel emissions are calculated.

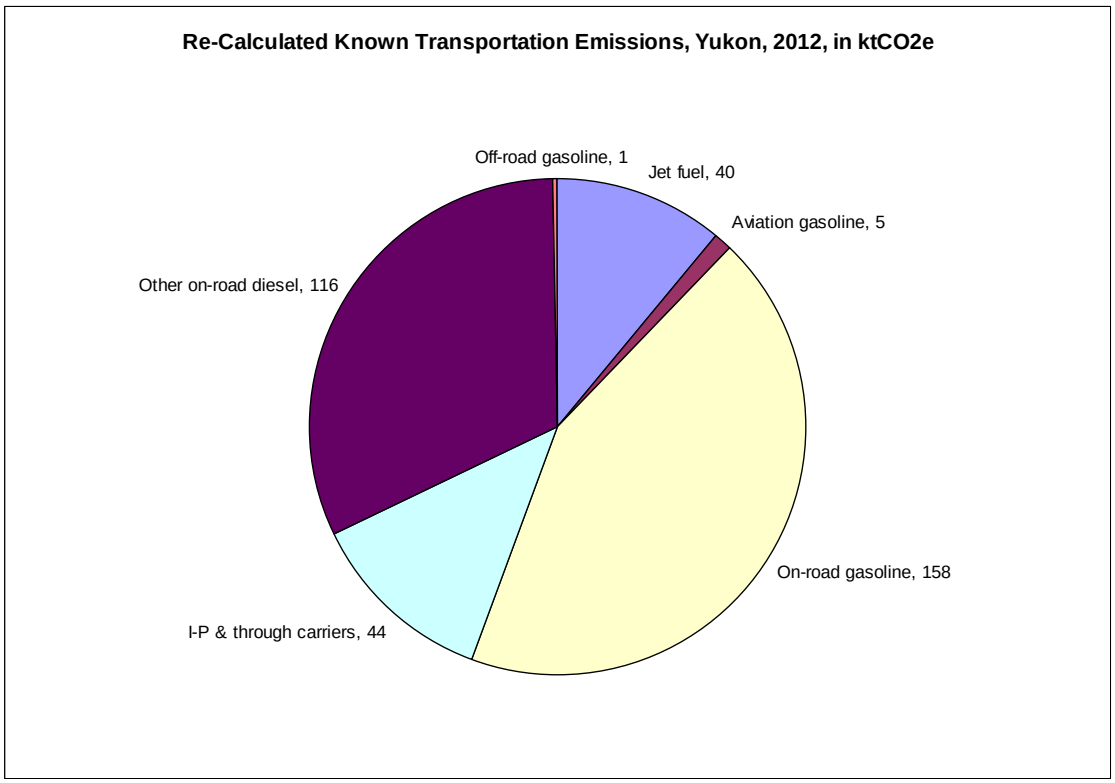
8.1 Re-calculation of known transportation emissions

Figure 10 breaks out the *known* transportation emissions from Figure 9 on page 29. There are no off-road transportation emissions shown in Figure 10 because we have no means to accurately estimate what proportion of off-road diesel is used for off-road transportation versus other uses. (See Section 4.2 on page 18 for details).

Key points on Figure 10:

- From the re-calculation of emissions, known transportation uses are responsible for 57% of the Yukon's total GHG emissions in 2012.
- The NIR found that 46% of all ground transportation emissions were from on-road heavy-duty diesel vehicles while only 24% came from all gasoline vehicles (see Table 2 on page 6). This dominance by heavy-duty diesel does not hold up when we look at the high quality YG Finance data for gasoline and on-road diesel use.
- On-road diesel and on-road gasoline each contribute approximately 25% of the Yukon's overall emissions but obviously dominate the known transportation segment at approximately 44% each.
- Again, given the data available, it is not possible to accurately estimate how much diesel is being used for off-road transportation versus other uses.
- Off-road gasoline use is not a significant contributor to transportation emissions in the Yukon.

Figure 10: Re-Calculated Known Transportation Emissions, Yukon, 2012, in $ktCO_2e$



Sources: Yukon Department of Finance, special data request November 21, 2014, Statistics Canada, CANSIM 405-0002 and 128-0012, and Yukon Bureau of Statistics

9 Conclusions and Recommendations

As noted in the introduction, the purpose of this research project is to produce a clear and detailed picture of the sources of GHG emissions from the transportation sector in the Yukon. A clearer picture was and is necessary as YG moves towards its commitment to reduce GHG emissions in the transportation sector.

Environment Canada's NIR is the go-to resource for information and estimates on Canada's GHG emissions both at the national and at the provincial and territorial levels. The annual NIR is used by governments at all levels to assist them in managing their GHG emissions and meeting reduction goals.

Environment Canada's work in reporting emissions, while accurate for the purposes of Canada's overall emissions to meet international United Nations requirements produces results that both substantively under-report Yukon emissions (actual emissions are an average of 75% higher than reported from 2009 through 2012) and are subject to very large revisions in subsequent years. This data inaccuracy is prevalent across all Yukon sectors and not just transportation.

The reasons for the problems with the NIR at the Yukon level are:

- Environment Canada relies on the *Report on Energy Supply and Demand in Canada* (RESD), as its source data for all fuel consumption in the Yukon. 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.
    - 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 and rising level of fuel imported from Alaska that is not captured in the data.
    - Further, the RESD data is subject to substantive revisions in subsequent years which in turn results in revisions to the NIR. This creates a particular problem for emission trends as each annual NIR reports on the latest five year period and so each has a new base year. The revision of emissions for the new base year can radically alter the overall trends shown in each NIR.

Environment Canada is well aware of the issues and problems that its reliance on the RESD data brings to some jurisdictions like the Yukon and it encourages these jurisdictions to work in collaboration with the department to develop their own emission reporting that will better reflect the realities in each jurisdiction.

The Yukon Bureau of Statistics has also recently been informed by Statistics Canada that the RESD is now in the process of redesign in order to make it less inaccurate on the provincial and territorial level.

Recommendation #1

While working to improve the NIR — likely a long process — YG would do well to support an annual made-in-Yukon emissions report that is based on the solid fuel consumption data provided by YG Finance. The emission re-calculations offered in this report provide a good base for such a

report, which can be significantly improved by following the steps outlined in Recommendation #2 and Recommendation #4.

9.1 Distribution of Yukon emissions

The re-calculations of emissions in this report using high quality YG Finance data show that the Yukon's actual total GHG emissions rose by 23% from 2009 through 2011 and then fell by 16% through 2013 rather than the much lower level ups and downs shown in the NIR. This rise and decline closely mirrors the rise and decline of the amount of gasoline and diesel consumed in the Yukon from 2009 through 2011; not surprising given that approximately 97% of the Yukon's emissions are the result of fossil fuel consumption.

The re-calculated distribution of the Yukon's actual 2012 emissions to the level of detail that the data allows indicates that:

- On-road gasoline use is responsible for 25% of total Yukon GHG emissions.
- Fuel oil used for heating is estimated to produce 21% of the Yukon's emissions (see the discussion in Section 4.2.1 on page 18 for caveats).
- On-road diesel use is responsible for 25% of total Yukon GHG emissions (7% by inter-provincial and through carriers and 18% by other on-road diesel).
- In 2012 the Yukon's two operating hardrock mines were responsible for 11% of the Yukon's total emissions from their on-site fuel use.
- Aviation (both jet fuel and avgas) produced 7% of total Yukon emissions in 2012.
- In 2012 the diesel electrical generation by the Yukon's two utilities produced 3% of emissions.
- Propane for heating was also responsible for 3% of total emissions.
- The all other category (that includes industrial processes, fugitive sources, agriculture, solvents and waste) also accounted for 3% of total emissions
- Off-road gasoline use was a negligible contributor to the Yukon's 2012 total emissions.

9.1.1 Level of confidence in the distribution re-calculation

We are very confident that the overall emissions re-calculation for 2012 is accurate as it is based directly on high quality YG Finance data that accounts for 94% of all Yukon emissions but we have differing levels of confidence in the accuracy of different portions of the re-calculation of depending on the data source and the calculations or estimates required to arrive at each.

As they are based directly on YG Finance data we have a very high level of confidence in:

- On-road gasoline;
- Inter-provincial and through carriers;
- Other on-road diesel; and,
- Off-road gasoline.

Because each required an additional calculation or reliance on more than one data set to arrive at them we have a high (but not very high) level of confidence in:

- Propane;
- Jet fuel;
- Aviation gasoline; and,
- Electrical generation.

We are only moderately confident in the emissions assigned to the Minto and Wolverine mines due to the estimates and data adjustments required to arrive at them. Similarly, we are only

moderately confident in the "All other" category as it comes directly from the NIR (though it obviously does not rely on the flawed RESD data).

The estimate for emissions due to heating fuel is presented with a low level of confidence as it is based on somewhat questionable assumptions. Similarly, only a low confidence level can be assigned to the other off-road diesel component as it is what remains after the mining and heating fuel emissions are calculated.

Recommendation #2

YG Finance data is the key to understanding and managing GHG emissions in the Yukon. Departmental concerns arising from the *Access to Information and Protection of Privacy Act* have prevented the release of more disaggregated data on fuel usage to date. If those concerns can be allayed, the use of disaggregated data will significantly enhance emissions calculations — especially for heating fuel versus other diesel fuel exempt from the excise tax.

9.2 Transportation emissions

Known transportation uses are responsible for 57% of the Yukon's re-calculated total GHG emissions in 2012. It is important to note that no off-road transportation emissions are included in this total because the data does not allow us to distinguish between types of off –road use. The NIR found that 46% of all ground transportation emissions were from on-road heavy-duty diesel vehicles while only 24% came from all gasoline vehicles (see Table 2 on page 6). This dominance by heavy-duty diesel does not hold up when we look at the high quality YG Finance data for gasoline and on-road diesel use. On-road diesel and on-road gasoline each contribute approximately 25% of the Yukon's overall emissions (and 44% of transportation emissions).

Recommendation #3

Transportation emissions are not dominated by heavy-duty diesel use as shown by the NIR; YG Finance data shows that on-road gasoline and on-road diesel contribute to emissions equally. Therefore emission reduction efforts need not be confined to the heavy-duty diesel segment; both the on-road gasoline and diesel segments are attractive targets for reduction.

Recommendation #4

YG needs to improve its understanding of off-road diesel transportation and of industrial use in general. Primary research should be undertaken with the Yukon's operating mines and other industrial operations to disaggregate their fuel use between transportation on-site, electrical generation, and other use.

9.3 Alaska fuel imports

As noted in Section 2.3 on page 11, imports of fuel from Alaska have risen to approximately 16% of the total diesel fuel consumed in the Yukon in 2013. But we currently do not have accurate data on the exact amount and type being imported.

Recommendation #5

Imports of fuel from Alaska accounted for approximately 16% of the total diesel fuel consumed in the Yukon in 2013. For more accurate data on the quantity and types of fuel being imported, three possible research avenues for YG are recommended:

- Obtain fuel import quantities from Environment Canada's databases;
- Conduct primary research by surveying the limited number of companies hauling fuel from Alaska to the Yukon; and,

- Collect the 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.