

Clean Air Strategic Alliance

Non-Point Source Workshop

October 23, 2013

- Background Information -

Prepared by:

Government of Alberta

September 13, 2013

Note:

This submission was drafted by the following Government of Alberta Ministries (Environment and Sustainable Resource Development, Health, Human Services, and Transportation) to assist the Clean Air Strategic Alliance Board members' understanding of the state of information pertaining to Non-Point Source emissions in Alberta at this time. This document is not intended to be a comprehensive list of all Non-Point sources or provide a comprehensive understanding of the state of all knowledge of these emissions types. A separate submission by Agriculture and Rural Development describes the emissions, policy instruments, regulations, and tools that are or can be used in the Agriculture sector.

1. Air Emissions and their Significance on Air Quality:

Ambient air quality is a measure of the substances dispersed in the air (the concentration), and is used to indicate the state of the air. Air emissions are the quantity of a substance released into the air from a source or combination of sources. Air pollutants emitted directly from sources are called primary pollutants. There are also secondary pollutants which, under the right atmospheric conditions, can react with other substances in the atmosphere to transform into other air pollutants. Some air pollutants are emitted both directly and formed in the atmosphere.

The relationship between air emissions and ambient air quality is very complex, and will depend on a number of different factors. The impact of a pollutant released into the air will depend on: wind speed and direction; atmospheric stability; atmospheric temperature; precipitation; sunlight; other substances present in the atmosphere; topography of the landscape; height of the emitting source; exit velocity and temperature of the release; emission rate; size, weight and shape of the particulate; solubility of the pollutant; reactivity of the pollutant; etc.

Just because an air pollutant is released into the air, does not necessarily mean that there will be a corresponding decline in air quality at one particular location. A release of an air pollutant can be adequately dispersed so that the ambient concentrations remain below safe levels, and there are little to no negative effects on human or environmental health.

Another factor to consider is whether specific sources are impacting local, regional or global air quality. Pollutants can travel anywhere from a few metres to thousands of kilometers before falling to the ground as part of wet or dry deposition. Some sources of air emissions may emit large quantities of certain pollutants, but much of the substance released may fall to the ground near the emitting source, or travel only a short distance before falling to the ground.

Both Point and Non-Point Sources make up the emissions profile in Alberta. There are a variety of factors affecting Non-Point Source emissions and as such this is a complex topic. Therefore, it is difficult to determine exactly how much of the emissions come from Non-Point sources. Although the Government of Alberta does not perform emissions projections, estimations (and not direct measurements) of emissions are done yearly through Environment Canada. However, it should be noted that the accuracy of their estimations is determined upon resource limitations. Better estimations for the four major Non-Point Sources are needed, in addition to maintaining consistent methodologies.

Despite the limitations in the estimations received from Environment Canada, some general trends in emissions from Non-Point sources can be seen. Some are on the rise, while others are declining somewhat. However, many Non-Point source emissions will only be exacerbated with a growing population in Alberta. What should also be noted is that emissions may be different for each Land-use Region, based on the sources. Some emissions – like Road Dust - might be quite high, but if there is not a large population in the Region, it might not be the emission to be that concerned about; While Road Dust might be the issue to be concerned about in an urban area.

2. Description of Non-Point Sources:

Definition:

Point source pollution is a term used to describe emissions from a single discharge source that can be easily identified. Non-point source pollution is subtle and gradual, caused by the release of pollutants from many different and diffuse sources (aggregated sources of emissions). This aggregation is done because the emission sources are either too small and numerous, too geographically dispersed, or too geographically large to be estimated or represented by a single point.

There are four types of non-point sources:

Area: Area sources are spatially diffuse and/or numerous sources that can only be measured or estimated using the accumulation of numerous point sources or as estimation of an entire area (e.g. forest fires, tailings ponds).

Volume: A volume source is a three-dimensional source of air emissions. Essentially, it is an area source with a third dimension. Examples include: particulate emissions from the wind erosion of uncovered piles of materials, fugitive gaseous emissions from various sources within industrial facilities, etc.

Line: A line source is a source of air pollution that emanates from a linear (one-dimensional) geometric shape, usually a line. Examples include dust from roadways, emissions from aircraft along flight paths, etc. There can be several different segments in a line source (e.g. road network).

Mobile: Mobile sources are broad area sources that are the accumulation of non-stationary operations. These include transportation sources such as: cars, trucks, boats and non-stationary construction equipment. Mobile sources can include both on-road and non-road sources. On-road refers to pollutants emitted by on-road engines and on-road vehicles. For example: cars, trucks, motorcycles, etc. Non-road emissions refer to pollutants emitted by non-road engines and non-road vehicles. For example: mine fleets, farm and construction equipment, gasoline-powered lawn and garden equipment, etc.

3. Examples of Non-Point Sources in Alberta:

Activities associated with Non-Point Source emissions include industry, transportation, urbanization, and agriculture, to name a few. However, Non-Point Source emissions are also caused naturally as a result of forest (wild) fires and emissions from live and decaying vegetation, soil, etc. Cumulatively, these Non-Point Sources contribute substantially to certain types of emissions.

The following non-exhaustive list depicts the predominant Non-Point Sources as well as the major contributors to these emissions:

- Residential Fuel Combustion (e.g. home heating) – **Public**;
- Commercial Fuel Combustion (e.g. space and water heating) – **Commercial**;
- Residential Fuel Wood Combustion (e.g. fire places, wood burning stoves) – **Public**;
- Transportation (e.g. on-road and off-road vehicles, air, rail, etc) – **Public, Commercial, Industry (construction, road-building and use, mine fleet, mine faces), Airlines, Rail lines**;
- Incineration (e.g. cremation) – **Commercial, Industrial**;
- Cigarette Smoking – **Public**;
- Dry Cleaning – **Commercial**;
- General Solvent Use – **Commercial**;
- Meat Cooking (e.g., BBQ, etc.) – **Public, Commercial**;
- Refined Petroleum Products Retail (gas stations) – **Commercial**;
- Printing – **Commercial**;
- Structural Fires – **Commercial, Public**;
- Surface Coatings – **Commercial**;
- Agriculture (e.g. animals, tilling & wind erosion, fertilizer application) – **Public**;
- Construction Operations – **Commercial, Industrial**;
- Road Dust (paved and unpaved roads) – **Public, Commercial, Industrial**;
- Waste – **Public, Commercial, Industrial**;
- Mine Tailings – **Industrial**;
- Prescribed Burning – Forest Fire and Pest Management, **Industrial**;
- Biogenics (soils and plants) – Natural Processes;
- Forest Fires – Natural Processes, **Public-induced**;
- Etc.

4. Significance of Non-Point Sources:

The predominant emissions from Non-point sources include the following six Criteria Air Contaminants: Particulate Matter, Sulphur Dioxide, Oxides of Nitrogen, Volatile Organic Compounds, and Ammonia.

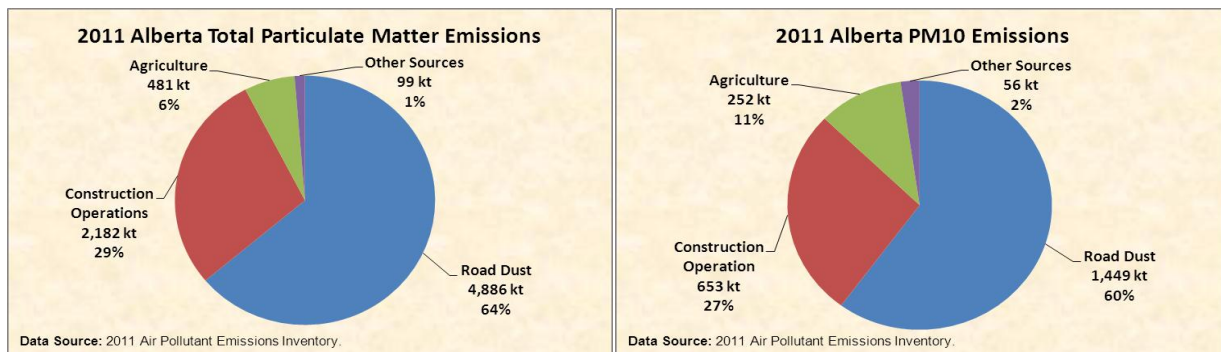
Several areas in the province (Capital Region, Calgary, Red Deer) are currently in either management plan action level or in exceedance of the Canada Wide Standards for Particulate Matter and Ozone, meaning that in some cases mandatory management actions involving Environment and Sustainable Development and a variety of stakeholders (e.g., industry, municipal, provincial, federal agencies, public), need to occur to reduce emissions. Additional exceedances may occur in other areas of the province once the more stringent Canadian Ambient Air Quality Standards come into effect in 2014. With the exception of Sulphur Dioxide, which is predominantly a point-source emission, much of the Particulate Matter and Ozone in Alberta are from Non-Point Sources or from non-regulated industrial point sources.

Particulate Matter

Particulate matter consists of particles in the air that are in solid or liquid form. Particulate matter may be released directly into the atmosphere or formed in the atmosphere as a result of physical or chemical transformations of precursors. Particulate matter in the atmosphere can reduce visibility and form smog. Particulate matter at ground level can be inhaled and cause respiratory problems.

Particulate matter is generally classified into three sizes. Total particulate matter (TPM) has a diameter of smaller than or equal to 100 micrometres. PM_{10} is any particulate matter that has a diameter less than or equal to 10 micrometres, while $PM_{2.5}$ is any particulate matter that has a diameter of less than or equal to 2.5 micrometres.

Total particulate matter is emitted in the largest quantities by three major source categories in Alberta. In 2011, road dust was the largest source of particulate matter in Alberta. Construction operations were the second largest source, while agricultural sources were the third largest source. Figure 1 provides the breakdown of the three sizes of particulate matter by major source category.



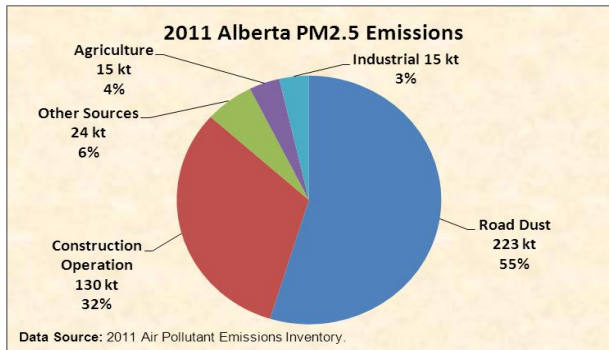


Figure 1: 2011 Alberta Particulate Matter Emissions.

Sulphur Dioxide

Sulphur dioxide (SO₂) is a colourless gas with a pungent odour and is formed when sulphur is oxidized and emitted to the atmosphere. SO₂ is emitted when fuels that contain sulphur (such as coal and oil) are burned. SO₂ is also emitted during various other industrial processes. SO₂ is a precursor to the formation of particulate matter and, subsequently, smog. SO₂ emissions can also be a contributor to acid rain.

SO₂ in Alberta is emitted mainly from industrial sources. In 2011, industrial sources accounted for 99% of SO₂ in Alberta. All other sources made up the remaining 1% of SO₂ emissions. Figure 2 shows the major source categories that emit SO₂ in Alberta.

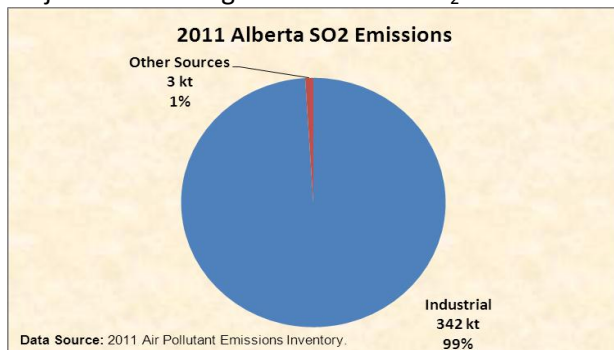


Figure 2: 2011 Alberta SO₂ Emissions.

Oxides of Nitrogen

Oxides of nitrogen (NO_x) are a group of highly reactive gases, which includes nitrogen dioxide and nitric oxide. NO_x is formed when nitrogen and oxygen combine at high temperatures. The combustion of fossil fuels and various industrial processes can produce NO_x. NO_x is linked with a number of adverse effects on the respiratory system. NO_x is also precursor to the formation of ozone and fine particulate matter, which can cause declines in air quality. NO_x emissions can also be a contributor to acid rain.

In Alberta, NO_x is emitting in largest quantities by two major source categories. In 2011, industrial operations were the largest source of NO_x, with about or about 64% of total NO_x emissions. Transportation was the second largest source of NO_x in Alberta with about 31% of emissions. All other sources make up the remaining 5% of NO_x emissions. Figure 3 shows the major source categories that emit NO_x in Alberta.

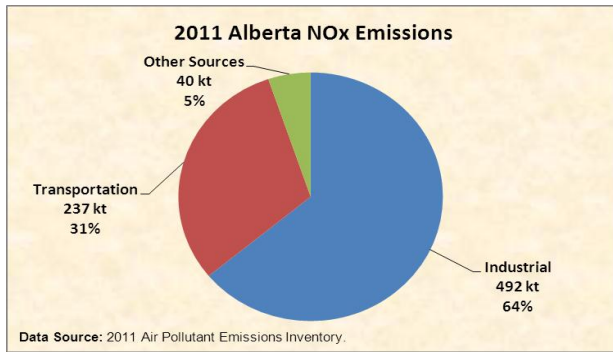


Figure 3: 2011 Alberta NOx Emissions.

Volatile Organic Compounds

Volatile organic compounds (VOCs) are an aggregate grouping of thousands of organic substances that readily dissipate. Some VOCs can undergo photochemical reactions in the atmosphere and contribute to the formation of particulate matter and ozone. VOCs can have a variety of health and environmental impacts, ranging from no known affect, to simple eye and respiratory tract irritation, to organ damage and cancer. The health and environmental effects can vary greatly depending on the specific species of VOC, and the level and length of exposure.

VOCs are emitted in large quantities by natural sources such as biogenic emissions from vegetation and soils. In 2011, biogenic sources accounting for about 85% of total VOC emissions in Alberta. In terms of emissions and air management in general, there are limited actions that can be taken to reduce air emissions from natural sources. It is therefore useful to examine the contribution of major sources to VOC emissions, excluding natural sources. Industrial sources were the second largest source of VOCs in Alberta with about 9% of emissions. Agricultural, transportation and other sources accounted for the remaining 6% of total VOC emissions. Figure 4 shows the major source categories that emit VOCs in Alberta.

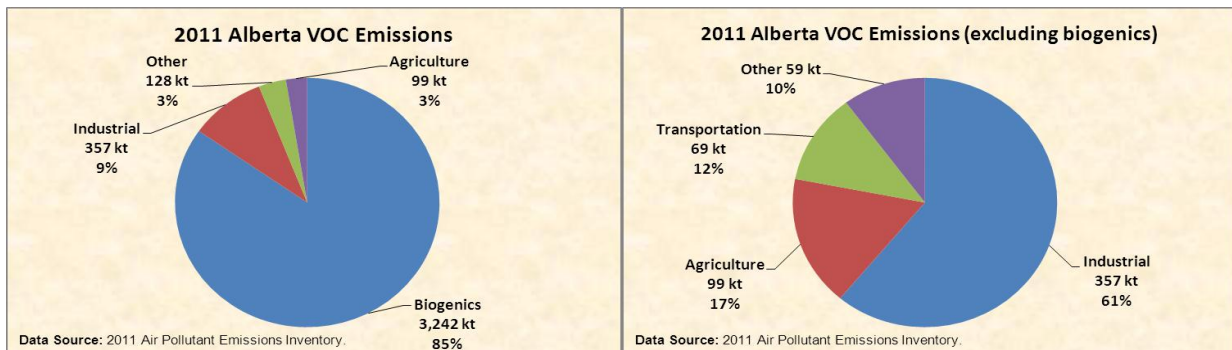


Figure 4: 2011 Alberta VOC Emissions.

Carbon Monoxide

Carbon monoxide (CO) is a colourless, odourless, poisonous gas that is formed during the incomplete combustion of fossil fuels. Other sources beside combustion of fossil fuels include various industrial processes. CO can cause harmful health effects by reducing oxygen delivery to the body's organs and tissues. At extremely high levels CO can even cause death.

CO is emitted in largest quantities by three major source categories in Alberta. In 2011, transportation was the largest source of CO in Alberta, with 62% of total CO emissions. Industry was the second largest source of CO with about 30% of emissions. Forest fires were the next source, with about 5% of CO emissions. All other sources make up the remaining 3% of CO emissions. Figure 5 shows the major source categories that emit CO in Alberta.

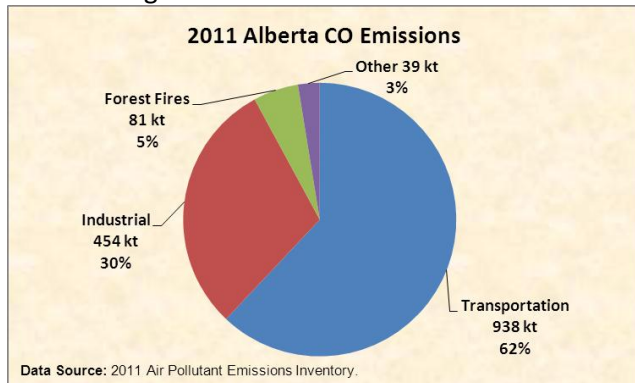


Figure 5: 2011 Alberta CO Emissions.

Ammonia

Ammonia (NH₃) is a colourless gas with a pungent odour, being noticeable by humans at relatively low concentrations. Ammonia is poisonous if inhaled in great quantities and is irritating to the eyes, nose, and throat in lesser amounts. Ammonia is also a contributing factor to smog. Major sources of ammonia emissions include commercial feedlots, fertilizer use and fertilizer manufacturing.

Ammonia is emitted in large quantities in Alberta by two major source categories. In 2011, agriculture was the largest source of NH₃ in Alberta, with about 90% of total NH₃ emissions. Industry was the second largest source of NH₃ in Alberta with about 6% of emissions. All other sources make up the remaining 4% of NH₃ emissions. Figure 6 shows the major source categories that emit NH₃ in Alberta.

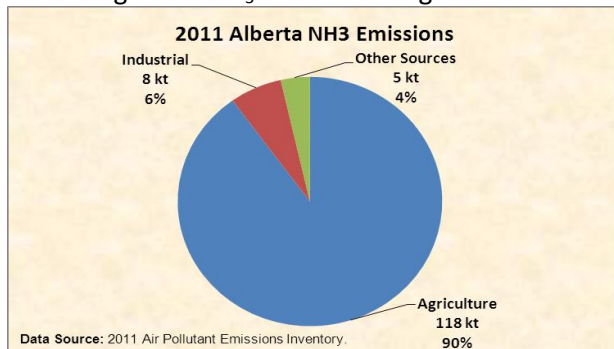


Figure 6: 2011 Alberta NH₃ Emissions.

5. Major Non-Point Sources in Alberta:

Note: Sector descriptions were adapted from Environment Canada’s “Criteria Air Contaminant Emissions Inventory 2006 Guidebook”.

The six major Non-Point Sources in Alberta are (in no order): Agriculture, Transportation, Construction, Biogenic, Road Dust, and Forest Fires. Some of these sources cannot be managed (i.e., Biogenic and naturally occurring wildfires). Other prominent sources of Non-Point emissions include (in no order): Prescribed Burning, Residential Fuel Combustion, Commercial Fuel Combustion, Residential Wood Combustion, Dry Cleaning, Solvent Use, Surface Coatings, and Refined Petroleum Products Retail (e.g., Gas Stations).

Agriculture

There are four components of the agricultural sector that are inventoried by Environment Canada as part of their Air Pollutant Emissions Inventory. These are: agricultural animals, tilling and wind erosion, fertilizer application and agricultural fuel combustion.

Agricultural animals primarily emit particulate matter, ammonia and VOC emissions. Particulate matter emissions from animals result from the movement of cattle, hogs, sheep, pigs and horses in man-made enclosures (such as pens and corrals), as well as in fields and pastures. VOC and ammonia emissions come mainly from the anaerobic degradation of animal excreta and livestock feed.

Agricultural tilling and wind erosion creates particulate emissions resulting from all operations involved in the preparation, sowing, tilling and harvesting of fields. This source has the potential to emit large quantities of particulates to the atmosphere as the soil is worked. In addition, it includes particulate emissions due to the entrainment of soil particles by the wind.

Fertilizers are chemicals that enhance the growth and development of crops, and are typically applied in a liquid or granular form. Particulate matter and ammonia emissions occur during the handling and application of fertilizer.

The combustion of fossil fuels by agricultural operations also emit small quantities of several air pollutants. Figure 7 shows the breakdown of the 2011 Alberta agricultural emissions by the major agricultural categories.

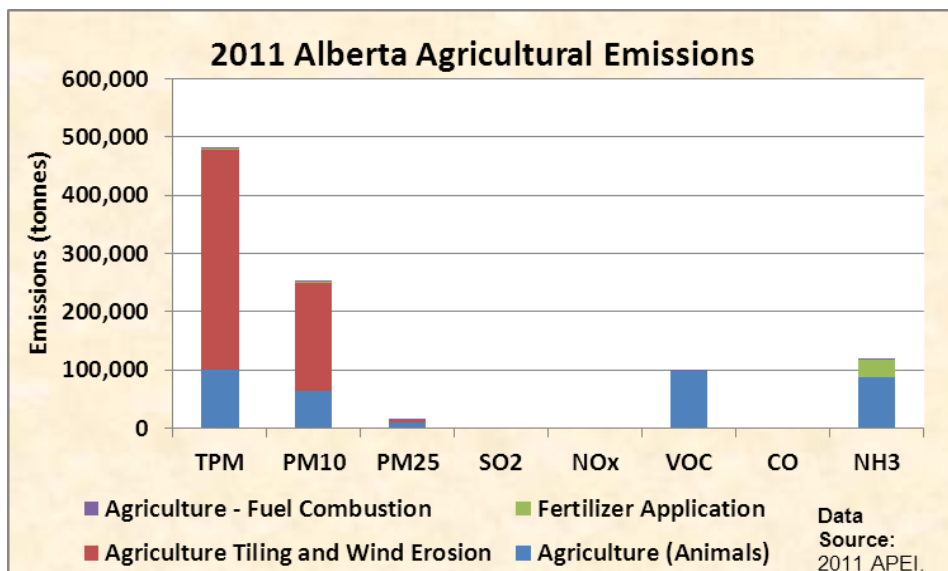


Figure 7: 2011 Alberta Agricultural Emissions.

Transportation

The transportation sector of Environment Canada’s Air Pollutant Emissions Inventory covers all the major transportation categories in Alberta. This includes on-road vehicles, off-road vehicles and equipment, air and rail transportation.

On-road vehicles include heavy duty vehicles, light duty vehicles and motorcycles that are licensed for use on roads (paved and unpaved) to transport people and/or goods. Air emissions from this sub-sector result from the combustion of fossil fuels in internal engines, the evaporation of the fuels through the fuel system and from tire and brake wear.

The off-road subsector covers emissions from engines, vehicles and machines not licensed for use on roads. Off-road sources include small spark-ignition engines such as lawnmowers and chainsaws; large spark-ignition engines such as those in forklifts; recreational vehicles and engines such as outboard engines, personal watercraft, snowmobiles and off-highway motorcycles; and off-road diesel engines such as those used in construction equipment.

The air transportation subsector covers emissions from aircraft. The air subsector includes jets, turbo-props, piston aircraft, helicopters and military aircraft. Only emissions from landings and take-off are inventoried. Emissions from airport activity that is not from aircraft (such as aircraft maintenance vehicles and equipment) are covered under the off-road categories.

The rail transportation subsector covers emissions from locomotives, but not rail support equipment. These are captured under the off-road categories. Figure 8 shows the breakdown of the 2011 Alberta transportation emissions by the major transportation categories.

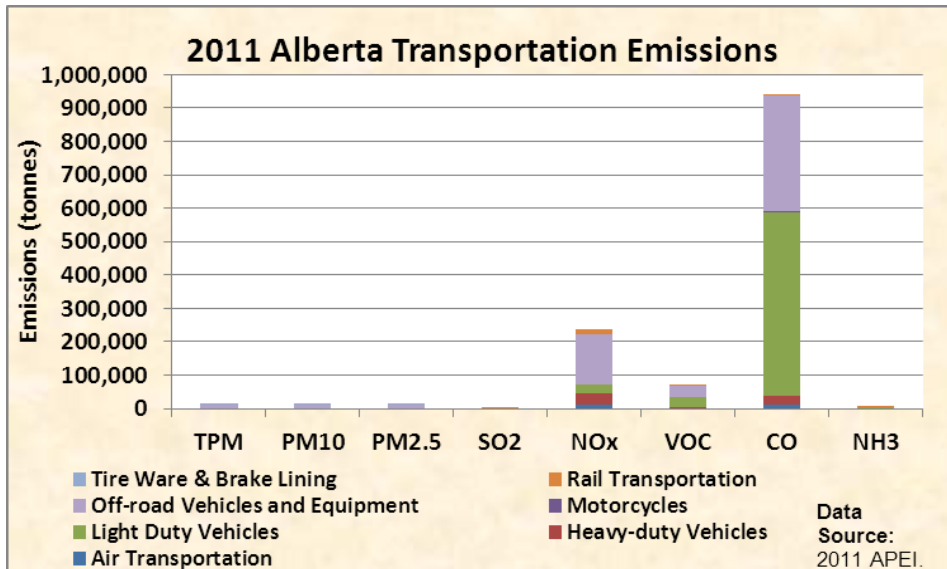


Figure 8: 2011 Alberta Transportation Emissions.

Construction

The construction operation sector accounts for particulate matter emissions that result from heavy machinery operations, including: excavation, levelling, loading, unloading and compaction, and all vehicular movement. Residential, commercial, institutional and engineering construction operations produce the majority of the fugitive particulate matter. Emissions from construction equipment fuel combustion by off-road vehicles and engines are inventoried as part of off-road use of diesel and gasoline. Figure 9 shows the total emissions from construction operations.

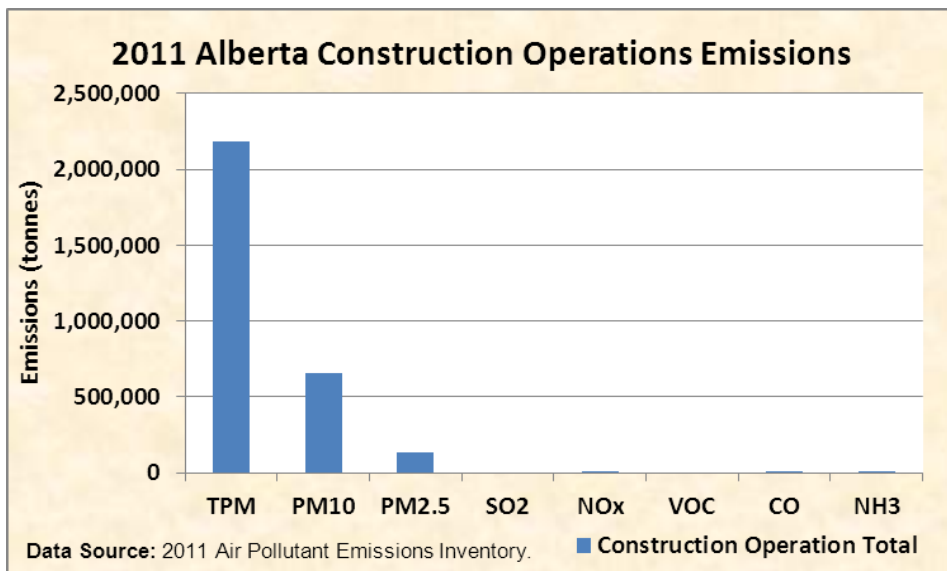


Figure 9: 2011 Alberta Construction Operations Emissions.

Biogenic

Plants and soils emit VOCs and NO during their natural processes. These are what are known as biogenic emissions. Emission rates have considerable variation depending on the vegetation and soil

type, as well as the climate region and season. Figure 10 shows the total emissions from biogenic sources.

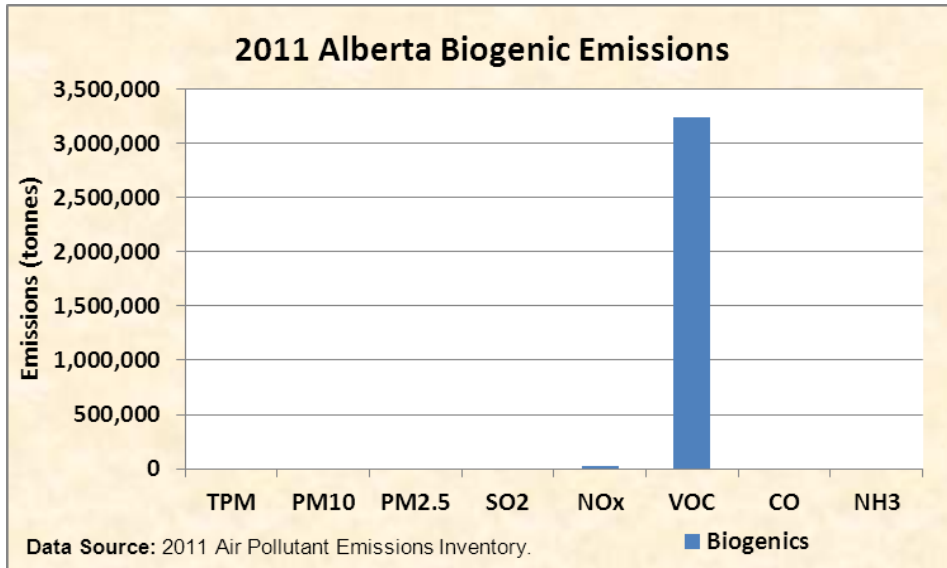


Figure 10: 2011 Alberta Biogenic Emissions.

Road Dust

This sector covers particulate matter emissions that result from vehicles travelling on paved and unpaved roads. Particulate matter emissions due to tire and brake lining wear are considered in a separate category in the transportation sector. When vehicles travel on paved or unpaved roads, the silt, dust and other particles that are present on the road surface are disturbed by mechanical actions and turbulence generated by the vehicle passage and can become airborne, thus leading to particulate emissions to the air. Figure 11 shows the breakdown of the 2011 Alberta road dust emissions for paved and unpaved roads.

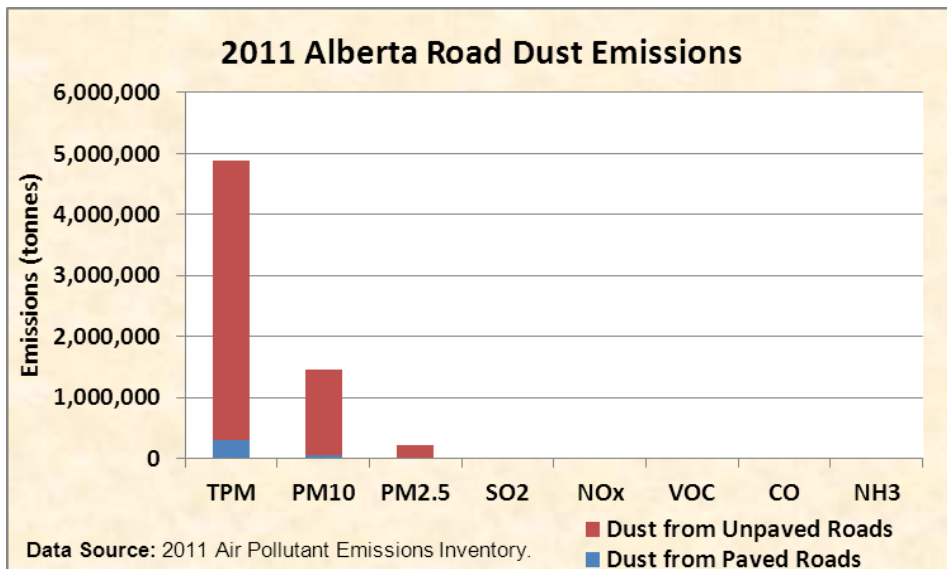


Figure 11: 2011 Alberta Road Dust Emissions.

Forest Fires

This sector covers the emissions of criteria air pollutants from the combustion of forest material. Forest fires (also called wildfires) release large quantities of particulate matter, CO and VOCs, moderate quantities of NOx and small amounts of SO₂ and NH₃. The size and intensity of a forest fire depend directly on such variables as: meteorological conditions, the type of vegetation involved (and moisture content) and the weight of consumable fuel. Figure 12 shows the total emissions of each of the criteria air contaminants from forest fires.

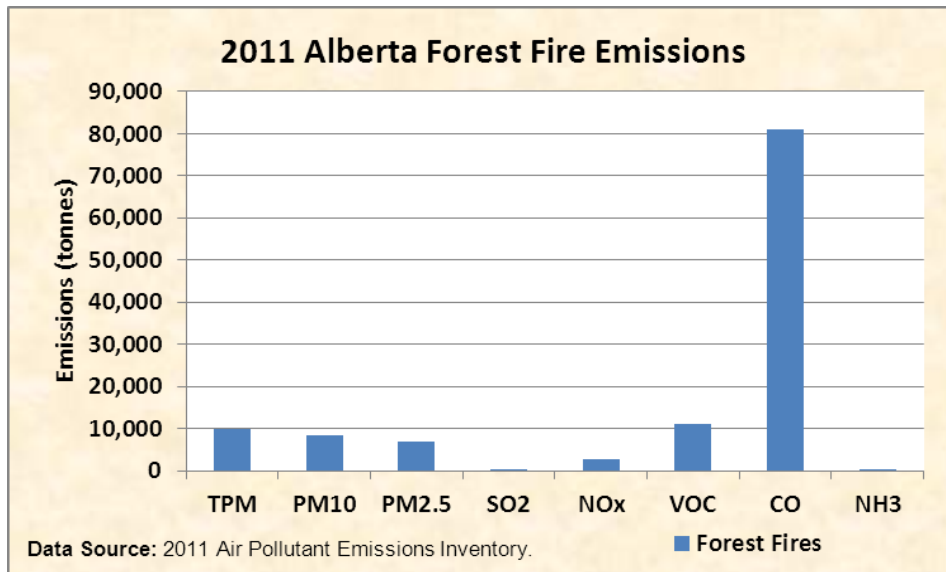


Figure 12: 2011 Alberta Forest Fire Emissions.

Prescribed Burning

Prescribed burning is a controlled land management treatment used to reduce logging residues, manage forest production, control insects and minimize potential for destructive wildfires. This sector covers emissions of criteria air contaminants from the intentional combustion of forest materials. Figure 13 shows the total emissions of each of the criteria air contaminants from prescribed burning.

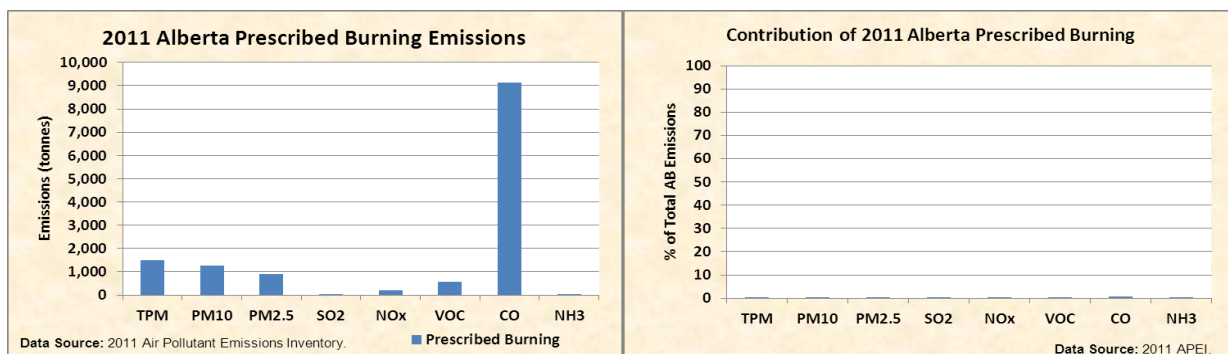


Figure 13: 2011 Alberta Prescribed Burning Emissions.

Residential Fuel Combustion

Residential fuel combustion encompasses the combustion of fuels by residential and agricultural users. There are 10 fuel types considered: natural gas, natural gas liquids, kerosene and stove oils, light fuel oil, heavy fuel oil, Canadian bituminous coal, sub-bituminous coal, lignite coal, anthracite coal and imported coal. Residential wood combustion is covered in the separate “residential wood combustion” sector. Residential and agricultural combustion of diesel and gasoline fuels are inventoried as off-road sources in the transportation sector. Figure 14 shows the total emissions of each of the criteria air contaminants from residential fuel combustion.

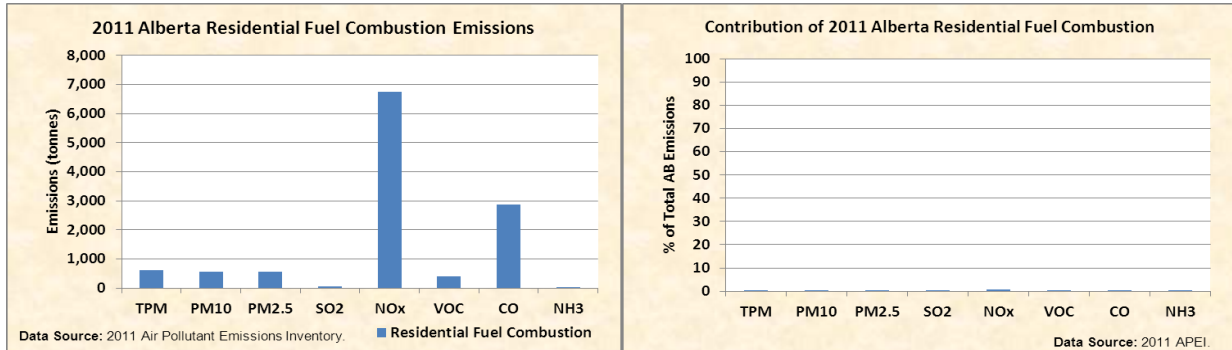


Figure 14: 2011 Alberta Residential Fuel Combustion Emissions.

Commercial Fuel Combustion

This sector covers the emissions of criteria air pollutants from the combustion sources used for space/water heating in commercial establishments, health and educational institutions and government/public administration facilities. Fuel types include coal, distillate oil, residual oil, kerosene and stove oil, liquid petroleum gases and natural gas. Natural gas is the dominant fuel in Alberta. Air pollution control equipment is usually not installed on commercial/institutional combustion units. Figure 15 shows the total emissions of each of the criteria air contaminants from commercial fuel combustion.

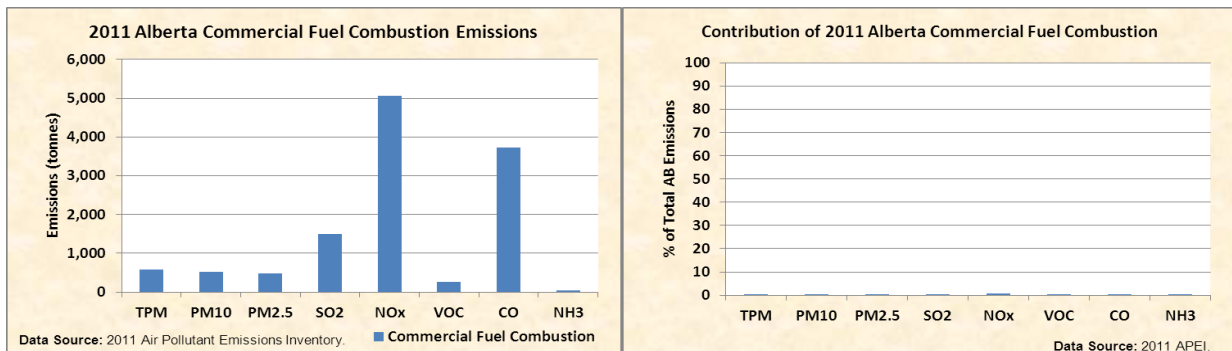


Figure 15: 2011 Alberta Commercial Fuel Combustion Emissions.

Residential Wood Combustion

This sector covers the emissions of criteria air pollutants from the combustion of wood by residential users. The main types of residential wood combustion devices that are considered in this sector are stoves, fireplaces, furnaces, cook stoves and pellet stoves. Figure 16 shows the total emissions of each of the criteria air contaminants from residential wood combustion.

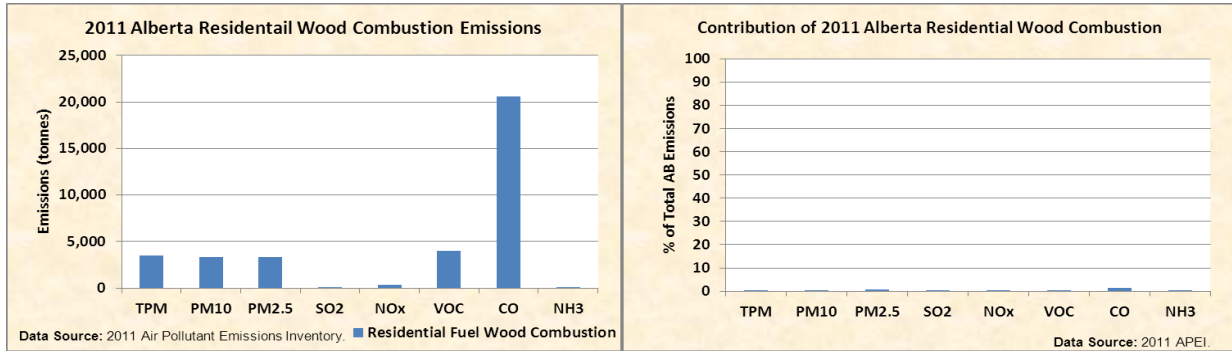


Figure 16: 2011 Alberta Residential Wood Combustion Emissions.

Dry Cleaning

This sector covers the emissions of criteria air pollutants from the handling of solvents by dry cleaning operations. Dry cleaning involves the cleaning of fabrics with non-aqueous organic solvents. Dry cleaning generally involves three principal steps, washing the fabric in solvent one or more times, extraction of the excess solvent, often by spinning, and drying the cleaned fabric in ovens or hot air streams. Solvent emissions are estimated based on the type and quantity of solvents used in dry cleaning operations. It is assumed that any solvent that is not recycled is emitted to the atmosphere. Figure 17 shows the total emissions of each of the criteria air contaminants from dry cleaning.

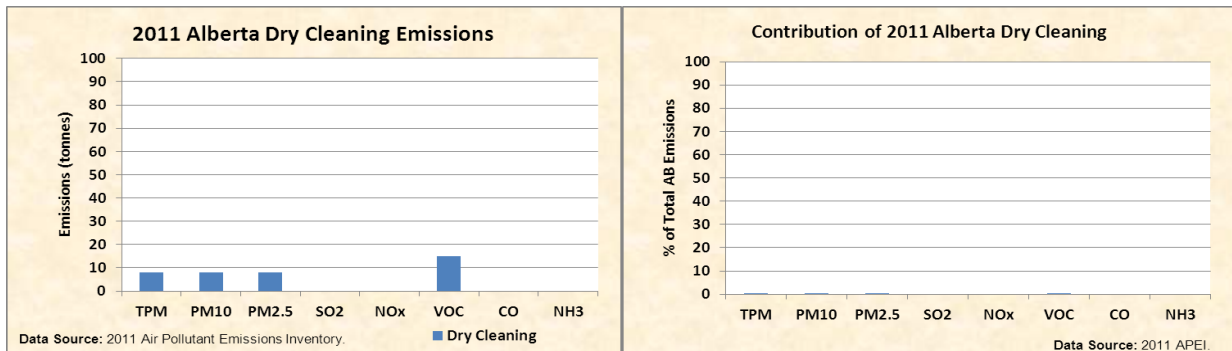


Figure 17: 2011 Alberta Dry Cleaning Emissions.

Solvent Use

This sector covers the emissions of criteria air pollutants from the general solvent use sector whereby fugitive VOC emissions can result from industrial, commercial and home uses of solvents. Consumer and commercial applications include many different uses of solvents in both household and commercial settings, as well as many consumer products that are applied outside of households. Examples include cleaning products, windshield washer fluid, personal care and other household products. Solvents used in industrial applications are used for general purpose cleaning and various specialized applications. Figure 18 shows the total emissions of each of the criteria air contaminants from solvent use.

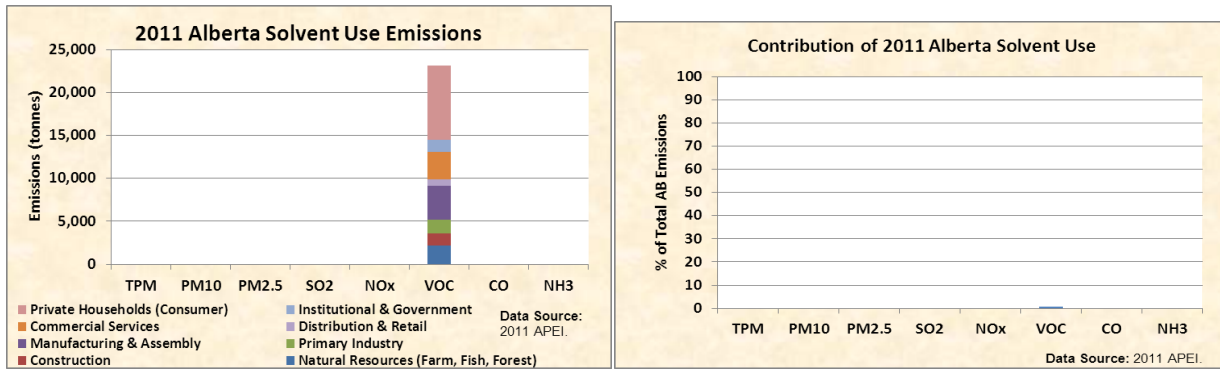


Figure 18: 2011 Alberta Solvent Use Emissions.

Surface Coatings

This sector covers the emissions of criteria air pollutants from the use of surface coatings by commercial, consumer and industrial users. Surface coating primarily involves the application of paint, lacquer, varnish, or paint primer for decorative or protective purposes. Figure 19 shows the total emissions of each of the criteria air contaminants from surface coatings.

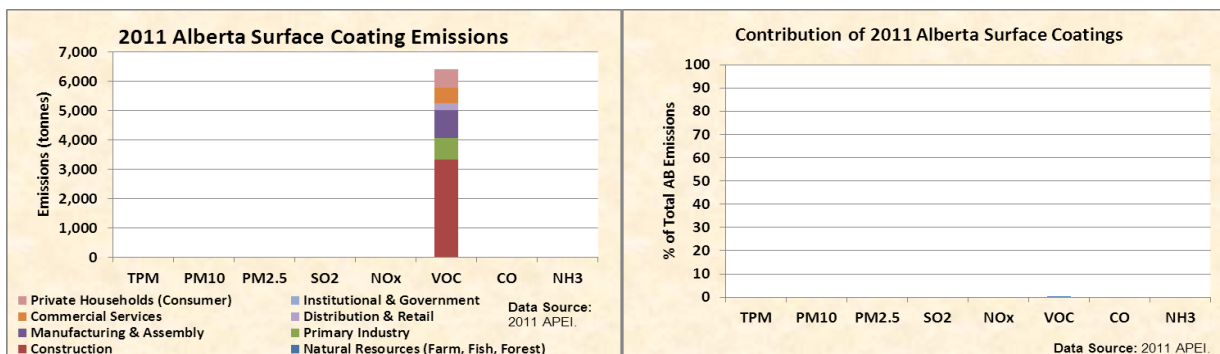


Figure 19: 2011 Alberta Surface Coating Emissions.

Refined Petroleum Products Retail (e.g. Gas Stations)

This sector covers fugitive VOC emissions from petroleum bulk distribution terminals, bulk plants and service stations. Volatile components of fuels are emitted as fuel moves from the refinery to the end user whenever tanks are filled or emptied or while tanks are open to the atmosphere, be they large above-ground tanks, tank trucks, railcars or underground tanks at service stations. In addition, emissions occur from evaporation of fuels spilled during transfer operations. Of the two fuels covered, gasoline and diesel, the vast majority of VOC emissions occur from gasoline as a result of its much higher vapour pressure. Figure 20 shows the total emissions of each of the criteria air contaminants from refined petroleum products retail.

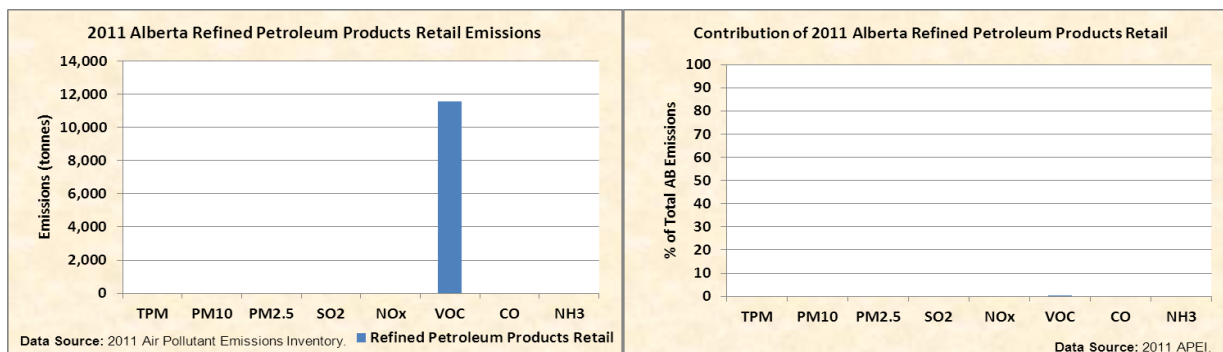


Figure 20: 2011 Alberta Refined Petroleum Products Retail Emissions.

6. Summary of the Six Major Non-Point Sources and their Emissions Contributions:

The following information summarizes the sources that contribute the majority of the six major Criteria Air Contaminants. Those with an asterisk contribute substantially more than any other source.

Significant Sources of Non-Point Source Emissions

PM (Total PM): 1) *Road Dust; 2) Construction; 3) Agriculture

PM10: 1) *Road Dust; 2) Construction; 3) Agriculture

PM2.5: 1) *Road Dust; 2) Construction

VOCs: 1) *Biogenic; 2) Agriculture; 3) Transportation

CO: 1) *Transportation; 2) Forest Fires

NH3: Agriculture

NOx: Transportation

Agriculture

Components of Agricultural emission sources are: i) Animals; ii) Tillage and Wind Erosion; iii) Fertilizer Application; and iv) Agriculture Fuel Combustion

Agriculture is a source of:

1. Particulate Matter
 - a. Total PM: 481 kilotonnes (6% of total TPM)
 - b. PM10: 252 kilotonnes (11% of total PM10)
 - c. PM2.5: 15 kilotonnes (4% of total PM2.5)
2. NH3: 118 kilotonnes (90% of total)
3. VOC: 99 kilotonnes (17% of total if excludes biogenics)

Transportation

Components of Transportation emission sources are: i) on-road; ii) off-road vehicles & equipment; iii) air and rail transportation

Transportation is a source of:

1. CO: 938 kilotonnes (62% of total)
2. NOx: 237 kilotonnes (31% of total)
3. VOC: 69 kilotonnes (~2% of total)
4. Particulate Matter:
 - a. Total PM: 122 kilotonnes (0.16% of total TPM)
 - b. PM10: 122 kilotonnes (0.51% of total PM10)
 - c. PM2.5: 110 kilotonnes (2.7% of total PM2.5)

5. SO₂: Included with 'other sources' as 3 kilotonnes (0.36% of total)

Construction

Components of Construction emission sources are: i) heavy machinery operations including excavation, levelling, loading, unloading and compaction, and all vehicular movement; ii) Residential; iii) commercial, iv) institutional, and v) engineering construction operations. Emissions from construction equipment fuel combustion by off-road vehicles and engines are inventoried as part of off-road use of diesel and gasoline.

Construction is a source of:

1. Particulate Matter:
 - a. Total PM: 2,182 kilotonnes (29% of total TPM)
 - b. PM₁₀: 653 kilotonnes (27% of total PM₁₀)
 - c. PM_{2.5}: 130 kilotonnes (32% of total PM_{2.5})
2. NO_x – fuel combustion
3. CO – fuel combustion
4. NH₃ – fuel combustion

Biogenic

Components of biogenic emission sources are: i) Plants; ii) Soil

Sources of biogenics are:

1. VOC: 3,242 kilotonnes (85% of total VOC)
2. NO_x: 24 kilotonnes (3.1% of total NO_x)

Road Dust

Components of Road Dust are the result of vehicles travelling on paved and unpaved roads (silt, dust, other particles). Particulate matter emissions due to tire and brake lining wear are considered in a separate category in the transportation sector.

Road Dust is a source of:

1. Particulate Matter
 - a. Total PM: 4,886 kilotonnes (64% of total TPM)
 - b. PM₁₀: 1,449 kilotonnes (60% of total PM₁₀)
 - c. PM_{2.5}: 223 kilotonnes (55% of total PM_{2.5})

Forest Fires

Components of forest (wild) fires covers the emissions of criteria air pollutants from the combustion of forest material (vegetation, soil)

Forest Fires are a source of:

1. Particulate Matter
 - a. Total PM: 10 kilotonnes (0.13% of total TPM)
 - b. PM₁₀: 9 kilotonnes (0.35% of total PM₁₀)
 - c. PM_{2.5}: 7 kilotonnes (1.69% of total PM_{2.5})
2. CO: 81 kilotonnes (5.35% of total)
3. VOC: 11 kilotonnes (1.90% of total)
4. NO_x: 3 kilotonnes (0.34% of total)
5. SO₂: 0.006 kilotonne (0.002% of total)
6. NH₃: 0.17 kilotonne (0.13% of total)

7. Non-Industrial Non-Point Source Emissions Data and Policies in Alberta:

Environment and Sustainable Resource Development's (ESRD) air policies and emission inventories have historically focussed mainly on the large regulated industrial facilities. Generally, the major non-industrial sources (such as transportation, agriculture, construction, etc) have fallen outside of the department's mandate. ESRD has however participated on CASA and national working groups that have looked at some non-industrial non-point sources, such as vehicles and confined feeding operations. The emission estimates for the non-industrial sources have primarily been developed by Environment Canada.

Given the significance of some of these non-industrial non-point sources and the growing focus on cumulative effects management, it will likely become increasingly important to account for and develop policies to address air issues related to these non-industrial sources.

8. What is the 'State' of the following (Gaps and Opportunities):

1. What has been done

a. **Agriculture**

Refer to the primer titled '*Non-Point Source Air Quality Management in Alberta: Agriculture*' that was prepared by Alberta Agriculture and Rural Development, for details on what has been done with respect to managing emissions from agricultural operations.

b. **Transportation**

Past CASA projects

The (former) CASA Vehicles Emissions Team, Report to the CASA Board (Final Report) dated August 31, 2010, contains a description of previous projects and recommendations.

http://www.casahome.org/DesktopModules/Bring2mind/DMX/Download.aspx?Command=Core_Download&EntryId=798&PortalId=0&TabId=78

Initiatives within Alberta

Related to vehicle emissions, the province has mainly been involved with awareness initiatives. For example:

- One Simple Act <http://onesimpleactalberta.com/get-involved/Air-Quality-and-OSA.asp>
- Idle Free School Resource Manual <http://onesimpleactalberta.com/docs/OSA-Be-Idle-Free-School-Resource-Manual.pdf>
- Idle Free School Bus Information <http://www.onesimpleact.alberta.ca/docs/OSA-Idle-free-School-Bus-Info-Sheet.pdf>
- One Simple Act School Toolkit <http://onesimpleactalberta.com/docs/One%20Simple%20Act%20School%20Toolkit.pdf>
- Alberta Transportation, Driver's Guide for AB <http://www.transportation.alberta.ca/2041.htm>

There are other initiatives by various stakeholders in Alberta, such as transit, staff training, and anti-idling legislation in several municipalities; occasional vehicle emission testing clinics in airsheds; car-sharing programs through non-profit organizations; etc.

2. What is planned

a. Agriculture

Refer to the primer titled '*Non-Point Source Air Quality Management in Alberta: Agriculture*' that was prepared by Alberta Agriculture and Rural Development, for details on what is planned with respect to assessing or managing emissions from agricultural operations.

b. Transportation

Mobile Sources Working Group - ongoing work

As part of the national Air Quality Management System (http://www.ccme.ca/ourwork/air.html?category_id=146), a federal/provincial/territorial working group has been established to address emissions from mobile sources. The focus of the group is on vehicles, including on-road and off-road. A draft 3-year action plan has been developed, for presentation to Council of Ministers for approval in August/September of 2013. The proposed action plan, including background on the Mobile Sources Working Group and a description of the proposed action plan components, is included below.

Draft Mobile Sources Working Group (MSWG) 2013/14 – 2016/17 Action Plan

The Canadian Council of Ministers of the Environment (CCME) established the Mobile Sources Working Group (MSWG) in 2011. This cross-Canada working group recognizes the necessity of coordinated and collaborative approaches to reduce smog-forming air pollutant and greenhouse gas emissions.

The federal, provincial, and territorial orders of government all have responsibility and jurisdiction over transportation emissions. MSWG will build on the existing range of policy and regulatory initiatives aimed at reducing air pollutants and greenhouse gas emissions from the mobile sources sector. These include federal emission standards for newly manufactured and imported vehicles and engines, and initiatives by provincial, territorial and municipal governments on issues such as vehicle inspection programs, transportation demand management and transit investment.

MSWG is one of the mechanisms under the Air Quality Management System (the System). The inclusion of mobile source emissions reflects the all-source approach of the System. MSWG includes membership from across the country including individuals from environment, transportation, infrastructure, energy and health agencies, ministries and departments.

The mandate of MSWG is to reduce emissions from mobile sources through information sharing and to identify areas of joint interest among jurisdictions in order to improve collaboration on initiatives to reduce air pollutant and greenhouse gas emissions from mobile sources.

MSWG will work with other pan-Canadian organizations such as the Transportation Working Group on Energy Efficiency under the Energy and Mines Ministers Conference to ensure alignment and to avoid duplication of efforts.

In response to direction from the Council of Ministers in October 2012 to look for opportunities for collaboration and to develop a plan of action to reduce emissions from the transportation sector MSWG, in consultation with stakeholders, has identified the following priority areas as the basis for an action plan to complement the work already underway:

1. REDUCING EMISSIONS WITH ADVANCED TRANSPORTATION TECHNOLOGIES

- Low emission and fuel efficient advanced technologies including hybrid vehicles, electric vehicle (EVs) and natural gas powered vehicles provide an opportunity to reduce the environmental impact of the transportation sector.

Action 1: MSWG will evaluate alternative mechanisms and identify preferred approaches for collaborative and/or cross-Canada implementation of EV and other infrastructure.

Action 2: MSWG will work to support the existing efforts regarding the need for common signage for plug-in electric vehicles and, if deemed beneficial, will support the development of such signage.

2. REDUCING EMISSIONS WITH PROPER VEHICLE MAINTENANCE

- Inspection and maintenance programs can be leveraged to reduce emissions from the in-use, on-road fleet and enhance efforts to reduce tampering of emission control equipment.

Action 1: MSWG will explore partnership opportunities with key stakeholders to leverage education, training, and materials pertaining to proper vehicle maintenance to heavy duty vehicle owners/operators, dealers, and service providers.

Action 2: Efforts to deter the tampering of emission control equipment on heavy-duty vehicles will be explored including an assessment on the need to update the *CCME Environmental Code of Practice for On-Road Heavy-Duty Vehicle Emission Inspection and Maintenance Programs*.

3. REDUCING EMISSIONS FROM IN-USE DIESEL VEHICLES AND ENGINES

- Programs aimed at retrofitting and replacing older higher-emitting vehicles and engines can greatly help reduce emissions from the in-use diesel fleet.

Action: MSWG will identify existing programs aimed at retrofitting and replacing older higher-emitting vehicles and engines and will evaluate partnership and opportunities to encourage retirement and retrofit of diesel engines across the country.

4. REDUCING EMISSIONS BY GREENING FLEETS

- The greening of fleets resulting in improved environmental performance in the freight sector needs to be promoted.

Action: The SmartWay Transport Partnership, a program delivered in Canada by Natural Resources Canada under agreement with the United States Environmental Protection Agency, is a collaboration among freight shippers, carriers, and logistics companies to voluntarily achieve improved fuel

efficiency and reduced emissions from freight transport. MSWG will support the efforts of the Transportation Working Group on Energy Efficiency to advocate for jurisdictions to become affiliates of the SmartWay program and promote SmartWay to industry partners and municipal colleagues. MSWG will also look for opportunities to leverage other green fleet programs such as E3 which help public and private organizations to improve fleet performance and recognize best practices.

c. Capital Region

In 2011, Alberta Environment and Sustainable Resource Development, along with stakeholders, developed the Capital Region Air Quality Management Framework. The Capital Region is defined by the boundary of Edmonton Capital Region Board including Elk Island National Park (this includes 25 municipalities). The Capital Region Air Quality Management Framework (embedded below) describes a shared vision of ambient air quality management in the Capital Region, which uses a triple-bottom line approach to support social and economic development and the environment. The management approach of the framework is that of: a) Identifying contaminants of concern and setting triggers, limits, and action levels; b) Ongoing monitoring to assess air quality; and c) Identifying and using mitigative management actions in response to any of the four levels of triggers and limits being reached.

Planned work on Non-Point Sources has been organized under relevant sections of the Clean Air Strategy (CAS) Action Plan.

1.3 Develop options to understand and prioritize non-regulated and non-point source

1.3.1 Assess non-point emission sources (agricultural, residential/commercial heating, transportation, and municipal sectors) and identify possible key sources for management.

- Identify the best mechanisms, including modeling, to quantify and determine the fate of emissions from specific non-point source sectors.

Capital Region: Environment and Sustainable Resource Development is currently drafting the Request for Proposal for particulate matter modeling. The exercise will include a model evaluation of a baseline scenario that will be representative of the fine particulate matter in the Capital Region during the wintertime. After the model evaluation is deemed appropriate, ~ 4 different scenarios will be tested to evaluate sector (industry, traffic) contribution to fine particulate matter.

1.4 Develop and implement policies and management tools for non-regulated and non-point sources.

1.4.1 Develop policies and corresponding management actions, including but not limited to education, Best Management Practices, regulatory or economic instruments, to address non-point source emissions in the agricultural, residential/commercial heating, transportation and municipal sectors.

Capital Region: The Capital Region Air Quality Management Framework incorporates a list of management actions and tools. This list comprises of least to most restrictive tools; however,

they're not prescriptive to any specific action level identified in the Framework (i.e., Level 1, Level 2, Level 3, or Level 4).

1.4.2 Engage stakeholders involved in air quality management to implement community education programs and community relations.

Capital Region: Capital Region participated in Environment Week to promote an understanding of the different sources of air pollution in the city and the new Air Quality Health Index (AQHI) App from Alberta Health.

Capital Region works closely with the local airshed organizations to lend support for their educational initiatives (e.g., Fort Air Partnership developed a curriculum for students/teachers - <http://www.fortair.org/resources/curriculum-resources/>).

Capital Region implementation process is a multi-stakeholder process which includes an Oversight Advisory Committee consisting of representatives from industry, municipalities, and Environmental Non-Government Organizations (ENGO).

Holding a Particulate Matter Information Session #2 to update the broader Capital Region stakeholders on what has been done. This is expected to happen either in the Fall of 2013 or after the PM Model Evaluation is completed in Spring of 2014.

3. What are the tools in the toolbox

a. Air Quality Management Policy Tools Leading Practice Research

In 2006, the Ministry of the Environment notified stakeholders that the ozone "Planning Trigger" of the Clean Air Strategic Alliance (CASA) PM and Ozone Management Framework had been exceeded at several airsheds in Alberta. In response to this notification, Environment and Sustainable Resource Development (formerly Alberta Environment) commissioned a study in 2007 called '*Air Quality Management Policy Tools Leading Practice Research*' (embedded below) to review available policy options and tools (regulatory and non-regulatory) aimed at managing particulate matter and ozone. The study identified policy tools that are applicable to the following three levels:

- Provincial
- Municipal
- Airshed organizations

The report documented over 100 policy tools that were used in air quality management by various jurisdictions around the world. Among the tools reviewed, twenty of them were profiled in detail. References were also provided for further information on all the tools reviewed. These policy tools could be very useful for both governments and stakeholders in developing air quality management plans.

The air quality management policy tools were divided into six sectors of the economy: transportation, industrial, residential, commercial/institutional, energy and agriculture. The

definitions provided below for each sector identify the emission sources that are included or excluded.

Industrial – The industrial sector includes all activities related to the production, processing and assembling of goods. Typically the industrial sector encompasses manufacturing, forestry, mining and construction. All industry activities related to primary energy production and electricity generation are covered in the energy sector.

Transportation - The transportation sector includes all activities that relate to on-road and off-road vehicles, irrespective of whether the transportation activity could be associated with the other economic sectors (e.g., commercial, residential, agriculture or industrial). Certain transportation types including aircraft and marine vessels have not been considered as these transportation modes are unlikely to be managed at an airshed level in Alberta. In addition to including policy tools that directly impact the level of emissions from vehicles, the transportation sector also includes policy tools that impact transportation demand and infrastructure. As a result, policy tools that impact land-use and have a significant impact on the transportation system have been included in this sector.

Residential – The residential sector includes all activities and equipment related to residential buildings including: space heating, water heating, air conditioning, lighting, refrigeration, cooking, and running a variety of other appliances. In addition, public product use and the use of small engines such as for lawn and garden maintenance have also been included. Electricity generation is considered under the energy sector.

Commercial/Institutional – The commercial/institutional sector includes non-manufacturing business establishments, government, schools, hospitals and public organizations. In addition commercial product use and the use of stationary engines related to commercial operations have been included.

Energy – The energy sector includes electricity generation and primary energy production. As a result, all industrial activities related to the production and upstream distribution of crude oil, bitumen and natural gas are covered in this sector.

Agriculture – The agriculture sector includes ozone precursor or particulate emission sources such as wind-blown soil erosion, manure waste management systems, burning of agricultural residues and fuel combustion for water pumping and space heating. Fuel combustion related to off-road vehicles such as tractors is included in the transportation sector.

Categorization of Air Quality Management Tools

For each sector, the air quality management tools were disaggregated by the management categories identified and used by Environment and Sustainable Resource Development in their policy development (i.e., ESRD Management Categories) and by a number of policy tool sub-categories that cover the spectrum of tools that could be applied.

AENV Management Category	Policy Tool Sub-Categories
Market Based Instruments and Fiscal Mechanisms	Emissions Trading
	Financial Incentives
	Charges and Taxes
	Other Market Mechanisms
Regulatory Approaches	Prescriptive Standards
	Performance-based Standards
	Bans or Restrictions
	Regulatory Approvals and Permits
	Other Regulations
Negotiated Agreements	(no subcategories)
Voluntary Stewardship and Corporate Responsibility	House-in-Order
	Voluntary Agreements
Supportive Programming	Information Disclosure
	Promotion and Awareness
	Development of Codes of Practice and Tools
	Capacity Building

Over 120 individual policy tools were generated in the long-list. The table below identifies the number of policy tools that were identified in each of the Economic Sectors. The long-list, divided into six separate tables for each economic sector, is presented in Appendix A of the embedded report.

Breakdown of AQM Policy Tools in the Long-list by Economic Sector

Economic Sector	Number of Policy Tools Profiled
Industrial	20
Transportation	31
Residential	27
Commercial / Institutional	23

Energy	15
Agriculture	12
TOTAL	128

The following list identifies the policy tools that were selected to be profiled in the report.

Short List of Policy Tools

Economic Sector	AENV Management Category	Potential Air Quality Management Policy Tool and Relevant Examples
Industry Sector	Market Based Instruments and Fiscal Mechanisms	Market mechanisms for emission trading
	Regulatory Approaches	Prescriptive standards to reduce emissions from industrial equipment and processes
	Negotiated Agreements	Negotiated agreements between governments and industry sectors to reduce emissions
	Voluntary Stewardship and Corporate Responsibility	House-In-Order agreements to reduce emissions from industrial facilities
	Supportive Programming	Provide training on methods to reduce emissions
Transportation Sector	Market Based Instruments and Fiscal Mechanisms	Financial incentives to increase the manufacturing and purchase of low emission vehicles
		Financial incentives to reduce emissions from existing vehicles
		Charges and taxes to encourage modal shift and Transportation Demand Management (TDM) that reduces emissions
	Regulatory Approaches	Mandatory inspection and maintenance programs to reduce emissions from existing vehicles
		Other regulations to encourage modal shift and Transportation Demand Management (TDM) that reduces emissions
Voluntary Stewardship and Corporate Responsibility	House-In-Order programs to reduce emissions through procurement and use of vehicles	
Residential Sector	Market Based Instruments and Fiscal Mechanisms	Financial incentives to encourage lower emission residential equipment
	Regulatory Approaches	Prescriptive standards to increase energy / resource use efficiency in residential buildings

Economic Sector	AENV Management Category	Potential Air Quality Management Policy Tool and Relevant Examples
		Performance standards for consumer products
	Supportive Programming	Promotion and awareness of integrated home retrofit services
Commercial / Institutional Sector	Market Based Instruments and Fiscal Mechanisms	Financial incentives to increase energy / resource use efficiency in commercial buildings
	Voluntary Stewardship and Corporate Responsibility	House-In-Order building performance standards
Energy Sector	Market Based Instruments and Fiscal Mechanisms	Financial incentives to encourage lower emission electricity generation
	Supportive Programming	Public information disclosure on emissions
Agriculture Sector	Regulatory Approaches	Ban or restriction to reduce agricultural sector emissions
	Voluntary Stewardship and Corporate Responsibility	Voluntary agreement to implement best management practices to reduce agricultural sector emissions

b. Capital Region Air Quality Management Framework

Mitigative Management Actions and Tools

Under the Capital Region Air Quality Management Framework, influences on ambient air quality levels at each monitoring station will be assessed annually. This information will be used to identify the appropriate management actions and which stakeholders would be most appropriate to engage. When mitigative management actions are required, Alberta Environment and Sustainable Resource Development will collaborate with stakeholders to identify and implement the appropriate management action. This will include identifying the public, stakeholders and different levels of government to be involved in the plan as well as the timelines required to achieve the reductions necessary to move below air quality levels, triggers, or limits. Management actions may require amendments to existing approvals and these amendments would be made in accordance with existing authority under the *Environmental Protection and Enhancement Act* including Director-initiated amendments to monitoring or reporting requirements, or amendments arising from unforeseeable effects. Assurance of the plans, and communication of progress with public, stakeholders and different levels of government (e.g., status of response and forecasts), will be required for all levels. Actions become more stringent as the ambient air quality level increases.

Management actions include a range of tools with varying degrees of rigour and are meant to be flexible to consider either more or less stringent action depending on the concentration trends and the magnitude above an ambient air quality trigger or action trigger. If trends are downward, or the concentration level is just above an ambient air quality trigger or action trigger, actions taken may not need to be extensive; whereas if there are upward trends or the level is approaching the next ambient air quality trigger or action trigger, actions taken may be more significant.

Table 7 lists the potential measures and tools from the least to most restrictive tools that would typically be used at the lower and highest air quality levels, respectively. Depending on the specific situation, Alberta Environment and Sustainable Resource Development and the parties involved may choose the tools that are deemed most effective, and some tools may be more appropriate in certain levels. It is understood that any regulatory agency (municipal, provincial or federal) can move forward management tools from any level in Table 7 since it is within their jurisdiction to do so. The list of management actions in Table 7 is not exhaustive and it is recognized that there are other management actions available to other agencies, such as the federal government (e.g., proposed Base Level Industrial Emission Requirements (BLIERs), transportation, emission fuel standards) that will be considered when selecting appropriate management tools for the region. Management tools in Table 7 could be applied to manage regional and local issues. An appropriate timeframe to design, plan and implement measures and tools will be recognized, considered and adopted so that the proactive intention of the triggers and levels is maintained.

Table 7. Potential Management Actions and Tools

- Education and awareness
- Additional regional monitoring is optional (assessed collaboratively by the environmental and community associations and Alberta Environment and Sustainable Resource Development)
- Approval conditions to participate in local airshed organizations, regional initiatives
- Air quality modeling
- Ambient air quality management plan

- Monitoring networks (continuous, passive)
- First Nations bylaws
- Municipal programs, planning, and policies
- Vehicle emission programs for in-use vehicles
- Memorandum of understanding
- Facility continuous improvement plans
- Economic instruments, including tools to incent
- Municipal bylaws
- Codes of practice
- Revise policies, plans and performance standards for new or existing sources
- Environmental Protection Order
- Enforcement Orders and fines
- Approval conditions or restrictions
- Regional planning: mechanisms for managing non-regulated sources
- Emission reduction plans
- Regional growth plans
- Regional emissions or concentration limits for specified substances
- More stringent performance standards or regulations
- Director-initiated approval amendments (in accordance with authority under *EPEA*)
- Emission reduction requirements
- Restrictions on further industrial emission sources

4. What tools are being used

- Air Quality Health Index
- Many regulatory and non-regulatory tools (see the different types in the tables in preceding sections)
- Refer to the primer titled '*Non-Point Source Air Quality Management in Alberta: Agriculture*' that was prepared by Alberta Agriculture and Rural Development, for details on tools for the agriculture sector.