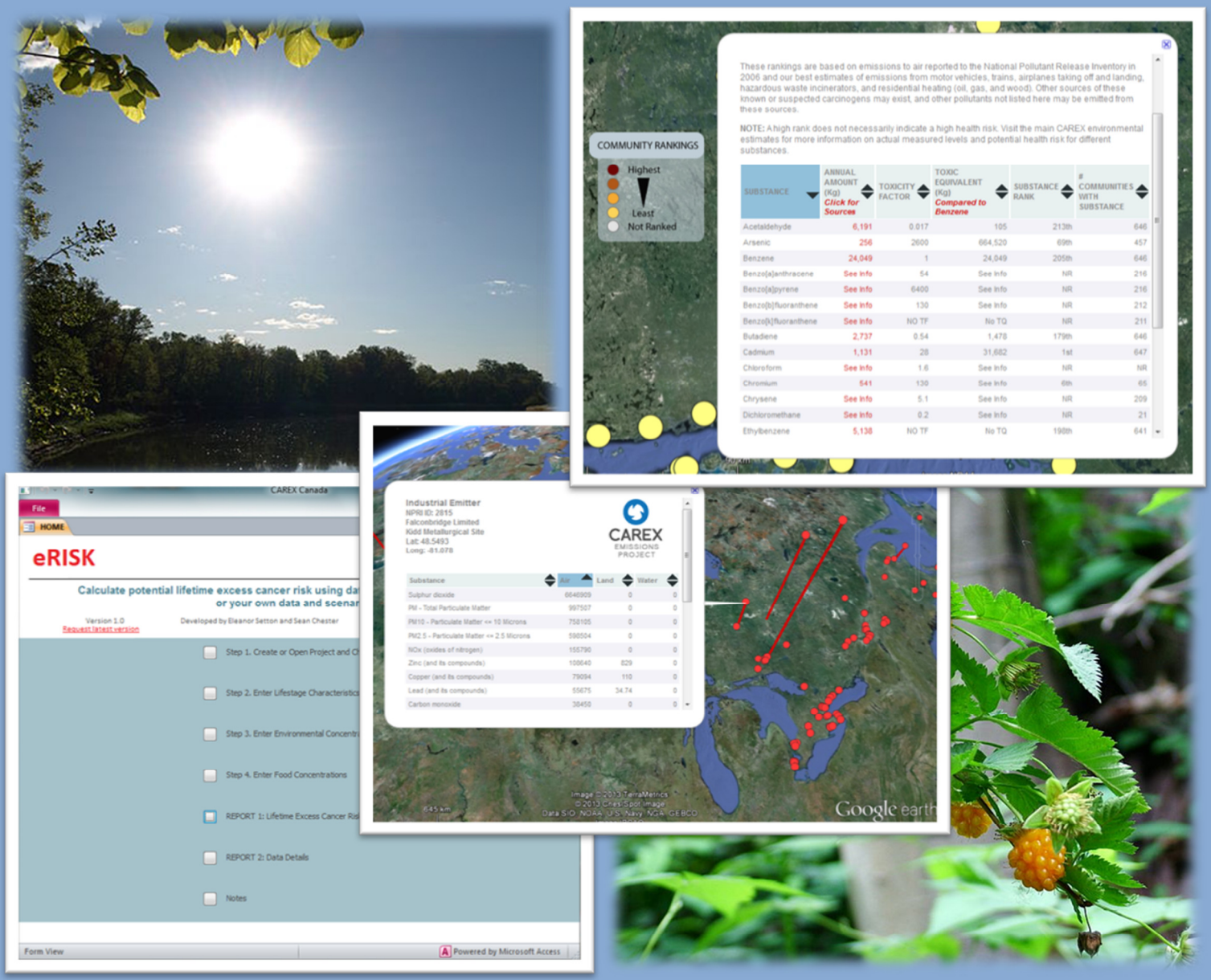


Cancer and the Environment

An Overview of Contaminant Sources and Measurements, Stakeholders, and Potential Future Emissions in Manitoba

CAREX CANADA

SSRL Spatial Sciences Research Lab

PROPEL CENTRE FOR POPULATION HEALTH IMPACT

FNEHIN FIRST NATIONS ENVIRONMENTAL HEALTH INNOVATION NETWORK
RÉSEAU D'INNOVATION EN SANTÉ ENVIRONNEMENTALE DES PREMIÈRES NATIONS

CIHR IRSC Canadian Institutes of Health Research / Instituts de recherche en santé du Canada

"…We have the paper mill, Abitibi-Price, Manitoba Hydro, we have TanCo, which mines tantalum, and we have Atomic Energy of Canada Ltd. As well as farmers who use fertilisers, which eventually leaches into the ground water and the various areas of the watershed that feed the Winnipeg River…Hydro developments in northern Manitoba affect us as well.

The highways department pollutes not only the water, they pollute the environment with their chemicals. You walk around the bush close to the road and you will see partridges laying dead. Hydro polluted with erosion, then they pollute through the spraying of their transmission lines to prevent growth. Abitibi pollutes by spraying chemicals too and then they pollute by burning coal, by sewage."

Sagkeeng Community Members, quoted in: A Study of the Social and Cultural Construction of Environmental Health Risks in Aboriginal Communities[1]

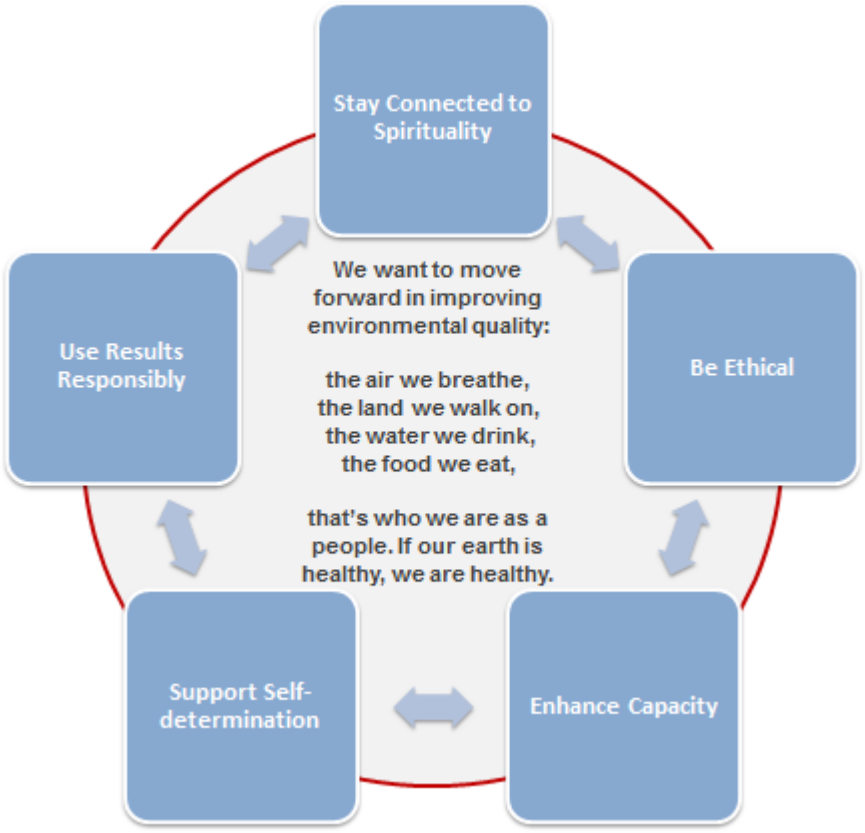
[1] O'Neil, J., et al. *A study of the social and cultural construction of environmental health risks in Aboriginal communities*. Northern Health Research Unit, Department of Community Health Services, University of Manitoba, 1997.

The information gathered in this set of reports focuses on substances in the air, water, soil, or food that are known or suspected to cause cancer. All of the data are from publicly available sources. In some cases, data have been summarized or combined with other information to produce new analyses.

This information has been prepared to support First Nations staff active in land and resource management or in the protection of human health, by increasing awareness of contaminants in the environment, their link to cancer, and potential hazards associated with measured levels when possible.

These reviews were completed as part of the "Cancer and the Environment" projects, funded by CIHR and CAREX Canada and prepared in collaboration with staff of the Assembly of Manitoba Chiefs.

We are guided by the following principles, developed by the First Nations Knowledge Transfer Advisory Committee:



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INCLUDED IN THIS OVERVIEW:

SUMMARY

- An overview of cancer risk factors and rates for First Nations in Manitoba, and how some environmental pollutants are linked to cancer.
- Summary tables by community and by substance, integrating information from other sections.

> **Look in this section to find out**: the number of large emitters and contaminated sites within 50 km of each First Nations community, priority for radon monitoring and our assessment of which contaminants may be of concern in the future.

ENVIRONMENTAL POLLUTANTS – SOURCES

- Data and summaries of emissions inventories, agriculture, forestry, large industrial and commercial emitters, contaminated sites, and mine tailings.

> **Look in this section to find out**: how close emitters and contaminated sites are to First Nations communities.

ENVIRONMENTAL POLLUTANTS – MEASUREMENTS

- Data and summaries of measured levels of contaminants in outdoor air, indoor air, drinking water and traditional foods.

> **Look in this section to find out:** if measured levels are of concern with respect to increasing cancer risk.

STAKEHOLDERS IN RESOURCE DEVELOPMENT OR PROTECTION OF HUMAN HEALTH

- Lists of organizations and contacts with an interest or role in regulating environmental quality or human health.

> **Look in this section to find out:** contact information for a wide range of organizations.

FUTURE RESOURCE DEVELOPMENT

- A brief assessment of potential increases in emissions from key economic sectors, including agriculture, forestry, mining, energy and manufacturing

> **Look in this section to find out**: which known and suspected carcinogens are emitted by different sectors, and information about pending and recently permitted projects with potential to increase emissions.

SUMMARY

In this section:

1. CANCER AND FIRST NATIONS HEALTH IN MANITOBA

We don't have a lot of information on how many First Nations people had cancer in the past, however, some patterns are clear:

- First Nations people used to have lower rates of most cancers[2], and fewer died from cancer compared to non-aboriginal Canadians in the 1960s to 1980s;
- In the 1980s, the age-adjusted cancer mortality rate was 40 percent lower for First Nations people than other Canadians, but by 2000, cancer was the third leading cause of death for First Nations men and the second leading cause of death for First Nations women;
- In Manitoba, First Nations cancer rates increased 7 percent between 1972 and 1991, while death from cancer increased by 50 percent – mostly related to colorectal, lung, cervical and gallbladder cancers[3].

Cancer is linked to a wide range of **risk factors** – things that increase your chance of getting cancer. Simply getting older increases the chance you will get cancer, but smoking, drinking alcohol, obesity, lack of exercise, and a poor diet make the chance even higher. Over time, these risk factors add up, and **cancer is most common in people over the age of 50**.

First Nations people living on reserve in Manitoba are younger than non-aboriginal people living in rural Manitoba: only 20 percent are over 50 now, compared to almost 45 percent of non-aboriginal people (Figure 1.1)[2]. **We expect cancer rates to increase as the First Nations population gets older**.

Many First Nations people living on reserve in Manitoba have a higher risk of getting cancer compared to non-aboriginal people because of poorer diets, lower physical activity levels (for women) and higher rates of smoking, drinking alcohol, and obesity (Figures 1.2, 1.3)[2].

[2] Aboriginal peoples historically have had higher rates of gallbladder, kidney and cervical cancer compared to non-aboriginal Canadians.

[3] Elias B, Kliewer EV, Hall M, Demers AA, Turner D, Martens P et al. The burden of cancer risk in Canada's indigenous population: a comparative study of known risks in a canadian region. International journal of general medicine 2011; 4:699

Figure 1.1. Comparison of age groups – First Nations people on reserve and non-aboriginal people living in rural Manitoba

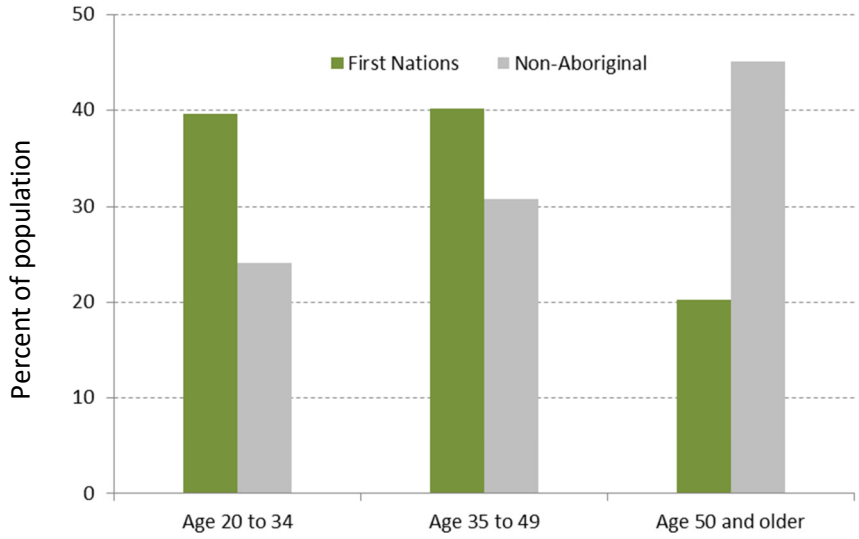


Figure 1.2. Risk Factors for Cancer - comparison of **First Nations men** living on reserve in Manitoba with non-aboriginal men living in rural Manitoba

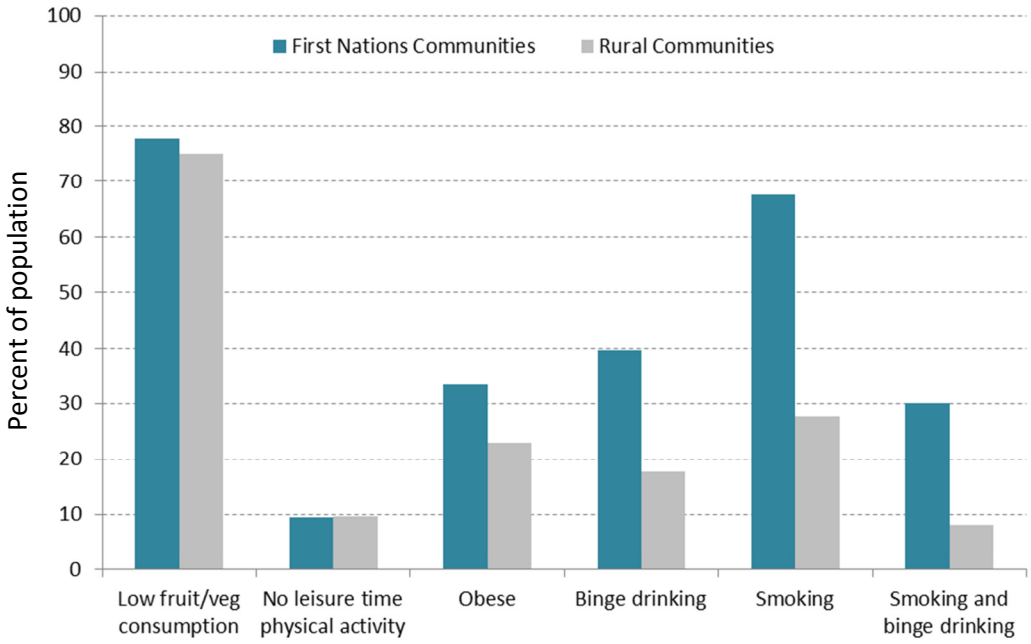
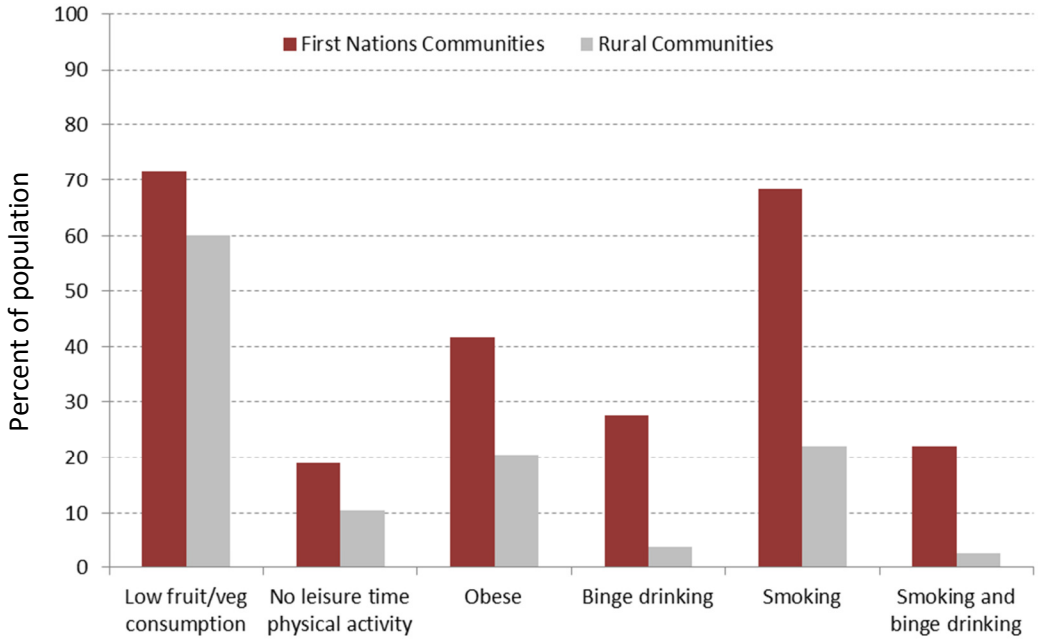


Figure 1.3. Risk Factors for Cancer - comparison of **First Nations women** living on reserve in Manitoba with non-aboriginal women living in rural Manitoba



Exposure to some **environmental pollutants** can also increase the risk if getting cancer. People might be exposed to these substances when outside or inside at home or work, or through contaminated food or water (Figure 1.4).[4]

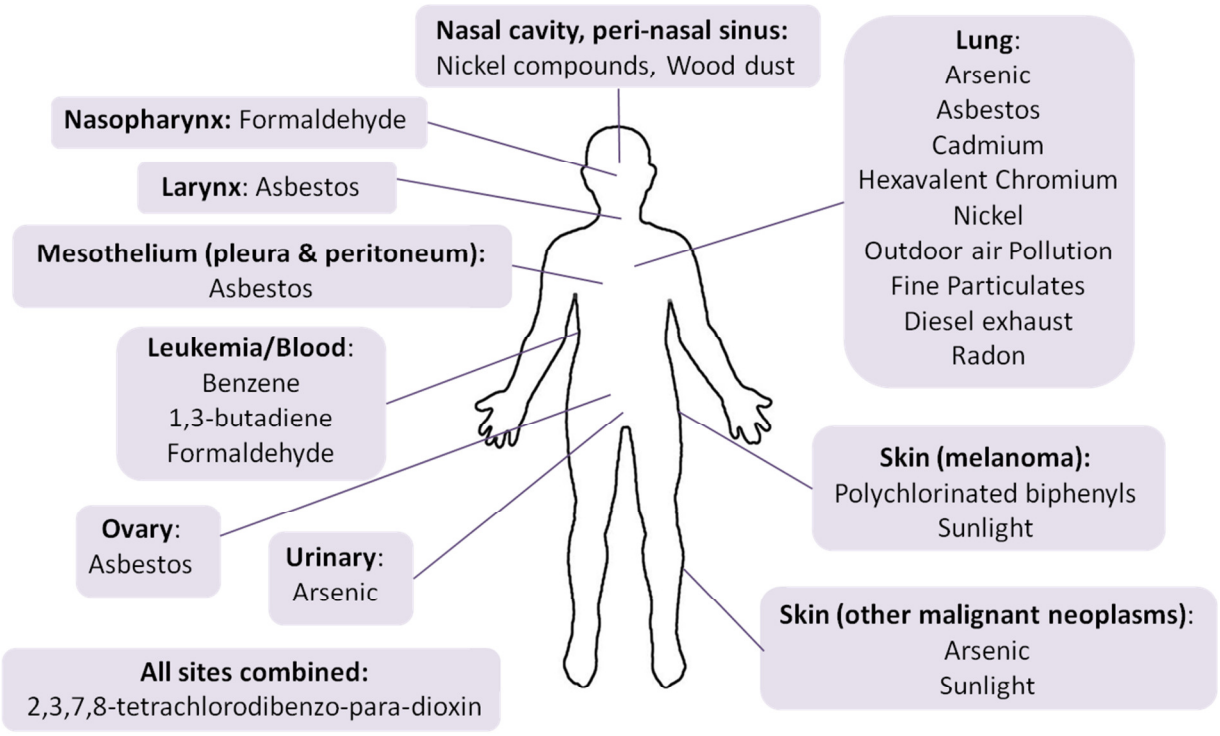
In general, exposure to environmental pollutants **directly** causes relatively few cancers, compared to smoking.

- Smoking is linked to about 85 percent of lung cancers[5] – in Canada, this works out to 22,600 new cases of lung cancers in 2015 alone[6]. Exposure to **asbestos** is responsible for about 500 new cases of mesothelioma every year in Canada.[7]
- **Radon** is known to cause lung cancer, and just over 460 non-smoking Canadians will die of radon-related lung cancer in 2015[8], compared to 18,000 who will die from smoking-related lung cancer.[9]

[4] Cogliano VJ, Baan R, Straif K, Grosse Y, Lauby-Secretan B+, El Ghissassi F et al. Preventable exposures associated with human cancers. Journal of the National Cancer Institute 2011; 103(24):1827-1839.
[5] http://www.cancer.ca/en/prevention-and-screening/live-well/smoking-and-tobacco/smoking-and-cancer/?region=on
[6] Based on lung cancers making up 13.5% of 196,900 new cases of cancer in 2015 (Canadian Cancer Society)
[7] Canadian Mesothelioma Foundation http://www.cmfonline.org/?q=node/4
[8] Based on 13.6% of lung cancer deaths attributed to radon exposure, of which 16% occur in never-smokers (Peterson E, Aker A, Kim J, Li Y, Brand K, Copes R. Lung cancer risk from radon in Ontario, Canada: how many lung cancers can we prevent? Cancer Causes & Control 2013; 24(11).)
[9] Based on lung cancer deaths making up 27% of 78,000 cancer deaths in 2015 (Canadian Cancer Society)

Environmental pollutants may also have **indirect** links to cancer. In some cases, we know that exposures act as a 'multiplier' – one out of seven heavy smokers will get lung cancer, but for those who smoke AND are exposed to high levels of radon, the risk is one in three.[10] Some researchers have suggested exposure to some types of environmental pollutants can increase obesity and diabetes rates, and these conditions in turn increase the risk of getting cancer.

Figure 1.4. Environmental substances known to cause cancer in different parts of the body.



There are also gaps in our scientific knowledge. Many studies of cancer and contaminants focus on one substance at a time. Most often, however, people are exposed to a wide range of pollutants, and how these complex exposures contribute to the overall risk of getting cancer is not well understood. There are also tens of thousands of new chemicals in the environment compared to even 100 years ago, and many have not been studied yet.

Reducing future cancer rates will depend on several key actions:

- **Reducing behavioural risk factors - lower smoking rates, increase activity, improve diets.**
- **Reducing exposure to cancer causing substances - increase awareness and limit or avoid exposure when possible.**
- **Increasing screening - early detection improves survival chances.**

[10] Canadian Cancer Society Website. Harmful substances and environmental risks: Radon. at <http://www.cancer.ca/en/prevention-and-screening/be-aware/harmful-substances-and-environmental-risks/radon/?region=on>

2. FIRST NATIONS COMMUNITIES SUMMARY

Table 2.1 provides a summary of information collected about most of the First Nations communities in Manitoba. The following describes what is in each column of the table and provides suggestions and cautions about using the information.

- The numbers of large industrial and commercial emitters active in 2011, 2012 and 2013 (the most recent year of data available), by substance emitted, within 50km of each community are listed. This information is based on data from the National Pollutant Release Inventory. The NPRI does not include small emitters and often the amounts emitted are estimates, not actual measurements. Having one or more emitters within 50km does not necessarily mean that community members are at risk, but it may indicate a need for further investigation to confirm contaminants are not reaching the community via air, water or food.

- The numbers of mine tailings, federal contaminated sites and provincial contaminated sites within 50 km of each community are listed. This information is based on tailings data from the NPRI, the Federal Contaminated Sites Inventory (FCSI) maintained by the Federal Treasury Board, and the Manitoba Contaminated/Impacted Sites Program. The mine tailing sites are not necessarily considered to be contaminated sites currently, but may have potential to release carcinogens accidentally in the future. **The federal contaminated sites are listed according to priority for action as established by the federal government, not by the authors of this report or by First Nations communities.** Priority is classified according to the National Classification System developed by the Canadian Council of Ministers of the Environment. **No priority is assigned to the provincial sites**. It is important to note that the number of sites in proximity to a community does not confirm that community members are at risk. A single site may have a large impact (For example, the community of Mathias Colomb, where there is a high priority federal contaminated site on reserve that has been a significant issue for some time), and in other areas, numerous sites may not be impacting a community. Where contaminated sites exist close to communities, additional investigation will be needed to confirm if contaminants are reaching the community.

- Radon testing priority is listed as well, based on data collected in a national program in 2009 – 2011 by Health Canada. **Priority was assigned by the authors of this report, not by Health Canada. Priority for radon testing was assigned based on the percentage of homes in the region testing above the radon guideline**: more than 25 percent – high priority; 15 to 25 percent – moderate priority; 10 to 15 percent - low priority; and less than 10 percent – very low priority. It is important to note that radon levels can vary dramatically from one home to the next, depending on the condition of the foundations and the local geology, so testing each home is the only way to know the exact radon level indoors.

- The common use of several pesticides for forestry and agriculture may be of concern for some communities. The last two columns in Table 1 indicate which communities are located within Forest Licence Management Areas that may be treated occasionally with herbicides, and which communities are located in census areas where agricultural herbicides, insecticides and fungicides are used. **For the agricultural analysis, the authors identified which census area each First Nation community was located in and used data from the 2011 Statistics Canada Census of Agriculture to assign intensity of herbicide use** as high (more than 40 percent of the census area treated with herbicides), moderate (between 20 and 40 percent of the census area treated with herbicides) or low (less than 20 percent of the census area treated with herbicides). Living in an area with higher intensity herbicide use does not necessarily mean that community members are at increased risk of cancer. It may indicate where additional information or data might be useful to confirm the level of exposure to these chemicals and hence the level of cancer risk.

Table 2.1 First Nations Communities Summary

	NUMBER OF SITES WITHIN 50 KMS																						
	INDUSTRIAL and COMMERCIAL EMITTERS 2011-2013													CONTAMINATED SITES									
Community	Arsenic	Benzene	Cadmium	Formaldehyde	Hex. Chromium	Nickel	Fine particulates	Lead	Acetaldehyde	Cobalt	Hexachlorobenzene	Naphthtalene	Styrene	Mercury	Mine tailings	Federal High Priority	Federal Medium Priority	Federal Low Priority	Provincial Contaminated	Provincial Impacted	Radon Priority**	In Forest Management License Area	Herbicide Intensity***
Barren Lands							1									2	2			1	VL		
Berens River																1	4	4			M		L
Birdtail Sioux					1		6										3	2		4	H		M
Bloodvein																	9	3		1	M		L
Brokenhead Ojibway Nation							4	2			1			1		2	2	2		11	M		M
Buffalo Point First Nation																		2		1	VL		L
Bunibonibee Cree Nation																1	2				VL		
Canupawakpa Dakota First Nation							12										2	1		4	H		M
Chemawawin Cree Nation																	8	1			L	Y	L
Cross Lake First Nation																	2			1	VL	Y	
Dakota Plains							9			1						2	2			2	H		H
Dakota Tipi							7									2	2	1		2	H		H
Dauphin River																1	1	3			M		L
Ebb and Flow			1				1	1						1			3	1		1	H	Y	L
Fisher River																	5	5	1	1	M		L
Fort Alexander							2										3	1		3	M		
Fox Lake																	1			1	VL		
Gamblers							2										3	2		1	H		M
Garden Hill First Nations																5	9			1	VL		
God's Lake First Nation																2	1				VL		
Grand Rapids First Nation																	7	3			L	Y	L
Hollow Water	1		1			1	1	1		1					1		2	4		2	M		L
Keeseekoowenin	1	1					3									1	9	1			H		H
Kinonjeoshtegon First Nation																	9	3			M		L

	NUMBER OF SITES WITHIN 50 KMS																							
	INDUSTRIAL and COMMERCIAL EMITTERS 2011-2013														CONTAMINATED SITES									
Community	Arsenic	Benzene	Cadmium	Formaldehyde	Hex. Chromium	Nickel	Fine particulates	Lead	Acetaldehyde	Cobalt	Hexachlorobenzene	Naphthtalene	Styrene	Mercury	Mine tailings	Federal High Priority	Federal Medium Priority	Federal Low Priority	Provincial Contaminated	Provincial Impacted	Radon Priority**	In Forest Management License Area	Herbicide Intensity***
Lake Manitoba																	4	1		1	M			L
Lake St. Martin			1				1	1						1		1	1	4			M			L
Little Black River	1		1			1	1	1		1							4	4		3	M			L
Little Grand Rapids															1	2	6				M			L
Little Saskatchewan			1				1	1						1		1	2	4			M			L
Long Plain							6									2	2	1		1	H			H
Manto Sipi Cree Nation																	1				VL			
Marcel Colomb First Nation																				1	VL	Y		
Mathias Colomb																1	1	2		2	L	Y		
Mosakahiken Cree Nation																	3			1	L	Y		L
Nisichawayasihk Cree Nation																1	1				VL	Y		
Northlands																1	5	1			VL			
Norway House Cree Nation																	2			1	VL			
O-chi-Chak-Ko-Sipi First Nation			1				1	1						1			2	3			H	Y		L
Opaskwayak Cree Nation	1		1		1		1	1	1		1						4	3		1	L	Y		L
Pauingassi First Nation																2	6				M			L
Peguis							1										4	4	1	1	M			L
Pinaymootang First Nation			1				1	1						1		1	2	3			M			
Pine Creek																	3	7			H	Y		L
Poplar River First Nation																	3				M			L
Red Sucker Lake																2	1				VL			
Rolling River	1	1					3									1	9	1		3	H			M
Roseau River Anishinabe				1			7					1	1				2			11	H			H
Sandy Bay																	2	1		1	H			L
Sapotaweyak Cree Nation																	3			1	H	Y		L
Sayisis Dene First Nation							1									2	1				VL			

	NUMBER OF SITES WITHIN 50 KMS																							
	INDUSTRIAL and COMMERCIAL EMITTERS 2011-2013														CONTAMINATED SITES									
Community	Arsenic	Benzene	Cadmium	Formaldehyde	Hex. Chromium	Nickel	Fine particulates	Lead	Acetaldehyde	Cobalt	Hexachlorobenzene	Naphthtalene	Styrene	Mercury	Mine tailings	Federal High Priority	Federal Medium Priority	Federal Low Priority	Provincial Contaminated	Provincial Impacted	Radon Priority**	In Forest Management License Area	Herbicide Intensity***
Shamattawa First Nation							1										2				VL			
Sioux Valley Dakota Nation			1	1	2		14				1						2	1		11	H			M
Skownan First Nation																	3	8			H			L
St. Theresa Point																5	9			1	VL			
Swan Lake							1									1	3	4		2	H			H
Tataskweyak Cree Nation																	2	1			VL			
Tootinaowaziibeeng Treaty Reserve																	1	2		2	H	Y		M
War Lake First Nation																	3	1			VL			
Wasagamack First Nation																	9			1	VL			
Waywayseecappo First Nation							2										5	2		1	H			M
Wuskwi Sipihk First Nation			1	1			1										2			1	H	Y		L
York Factory First Nation																	2	1			VL			

3. KNOWN AND SUSPECTED CARCINOGENS SUMMARY

Tables 3.1 through 3.5 provide a summary of information collected about the known and suspected carcinogens emitted and measured in Manitoba. Table 3.1 has information about some general known carcinogens; Table 3.2 contains information on pesticides; Table 3.3 contains information on metals; Table 3.4 contains information on volatile organic compounds (VOCs) and Table 3.5 contains information on polycyclic aromatic hydrocarbons (PAHs). The following describes what is in each column of the table and provides suggestions and cautions about using the information.

- For each substance, the International Agency for Research on Cancer (IARC) classification is listed (1 = known carcinogen, 2a = probable carcinogen, 2b= possible carcinogen), along with an indication of the major sources: industrial emitters (to air, water and land), agriculture, forestry, transportation, and heating (with oil, gas or wood).
- The presence of each substance in drinking water and food is also indicated.
- A summary of currently measured levels and associated risks is provided.

An assessment of the level of future concern based on current levels, likely trends and proposed projects is also provided. This assessment is based solely on the opinion of the authors

Table 3.1. Known and Suspected Carcinogens Summary – General Substances

	IARC Category*	Industrial Emitters									Measured levels of concern	Future concern
		Air	Water	Land	Agriculture	Forestry	Transportation	Heating	Drinking water	Food		
Asbestos	1										No measured data were identified.	**LOW** - Asbestos use is already limited and will decrease in the future.
Radon	1										Some areas in Manitoba may have more than 25% of homes with radon levels above the current guideline.	**HIGH** - Radon occurs naturally, new homes should be built according to codes that prevent radon from entering buildings
Fine particulate air pollution ($PM_{2.5}$)	1	Y			Y		Y	Y			Few locations are monitored - Winnipeg, Flin Flon, Thompson, and Brandon. Levels there meet current and future guidelines.	**MODERATE** - There are numerous sources of $PM_{2.5}$ within 50km of many First Nations communities, but no available monitoring data for these locations. See Table 4.10 in ENVIRONMENTAL POLLUTANTS - SOURCES
Dioxin/Furans	1	Y						Y		Y	Levels measured in traditional foods are very low and do not present a health hazard	**LOW -** The main exposure pathway is via food. D/Fs are heavily regulated and expected to decline.
PCBs	1									Y	Levels measured in traditional foods are very low and do not present a health hazard.	**LOW** – The main exposure pathway is via food. PCBS are heavily regulated and expected to decline.
Trihalomethanes (THM - includes chloroform and bromodichloromethane)	2b								Y		60% of drinking water samples taken in 2012, 2013 and 2014 from public systems in Manitoba exceeded the guideline level for total THM.	**HIGH -** This will continue to be a concern when chlorination is used to disinfect drinking water supplies and should be tested for regularly.

* International Agency for Research on Cancer (IARC) category 1 = known carcinogen, 2a = probable carcinogen, 2b = possible carcinogen.

Table 3.2. Known and Suspected Carcinogens Summary – Pesticides

	IARC Category*	Industrial Emitters			Agriculture	Forestry	Transportation	Heating	Drinking water	Food	Measured levels of concern	Future concern
		Air	Water	Land								
DDE	2a									Y	Levels measured in traditional foods are very low and do not present a health hazard.	**LOW** - The main exposure pathway is via food. DDE is an indicator of DDT, which is no longer used in Canada.
Glyphosate	2a				Y	Y					There is not much data available, but outdoor studies suggest levels are low.	**LOW to MODERATE -** Agricultural use may increase if the area planted with crops genetically modified to resist glyphosate continues to increase; new rights-of-way proposed by Manitoba Hydro may be treated with herbicides containing glyphosate (RoundUp) to control weeds and other unwanted vegetation.
2,4-D	2b				Y	Y					Very little data are available in terms of 2,4-D residues on food	**LOW to MODERATE** - Agricultural use may increase if the area planted with crops genetically modified to resist 2,4-D increases; new rights-of-way proposed by Manitoba Hydro may increase the amount of land treated with 2,4-D to control weeds and other unwanted vegetation.
Chlordane	2b									Y	Levels measured in traditional foods are very low and do not present a health hazard.	**LOW** - The main exposure pathway is via food. Chlordane is no longer used in Canada.
Chlorothalonil	2b				Y					Y	Very little data are available in terms of chlorothalonil residues on food	**LOW** - Agricultural use levels may increase if there is an increase in crop types treated with chlorothalonil.

	IARC Category*	Industrial Emitters			Agriculture	Forestry	Transportation	Heating	Drinking water	Food	**Measured levels of concern**	**Future concern**
		Air	Water	Land								
Hexachlorobenzene	2b	Y								Y	Levels measured in traditional foods are very low and do not present a health hazard.	**LOW** - The main exposure pathway is via food. Hexachlorobenzene is no longer used as a pesticide in Canada, although small amounts are created unintentionally by some industrial processes.
Toxaphene	2b									Y	Levels measured in traditional foods are very low and do not present a health hazard.	**LOW** - The main exposure pathway is via food. Toxaphene is no longer used in Canada.

* International Agency for Research on Cancer (IARC) category 1 = known carcinogen, 2a = probable carcinogen, 2b = possible carcinogen.

Table 3.3. Known and Suspected Carcinogens Summary – Metals

	IARC Category*	Industrial Emitters			Agriculture	Forestry	Transportation	Heating	Drinking water	Food	Measured levels of concern	Future concern
		Air	Water	Land								
Arsenic	1	Y	Y	Y			Y	Y	Y	Y	Measured levels in air in Flin Flon are associated with a 6.3 per million lifetime excess cancer risk. 5% of public drinking water systems exceeded the guideline in 2014, which is associated with a 470 per million lifetime excess cancer risk. The maximum level measured in tap water on selected reserves was associated with a 100 per million lifetime excess cancer risk. Levels measured in traditional foods result in lifetime excess cancer risks of between 36 and 90 per million.	**HIGH** – There are multiple exposure routes and measured levels associated with lifetime excess cancer risks well above the 1 to 10 per million considered to be negligible by Health Canada. Any new emitters of arsenic may increase the risk even more and should be avoided.
Cadmium	1	Y	Y				Y	Y		Y	Measured levels in air in Flin Flon are currently associated with a lifetime excess cancer risk of 9.7 per million, just within the 1 to 10 per million considered to be negligible by Health Canada. Cadmium is not known to be carcinogenic via ingestion.	**LOW to MODERATE** – There is potential for emissions to increase at the Flin Flon smelter due to increased operations at Snow Lake.

	IARC Category*	Industrial Emitters			Agriculture	Forestry	Transportation	Heating	Drinking water	Food	Measured levels of concern	Future concern
		Air	Water	Land								
Hexavalent chromium	1	Y	Y	Y			Y	Y			No measured data were located for hexavalent chromium. The largest emitter near a FN community is Tolko's Kraft paper division, emitting a total of 3 kg over 2011-2013, within 6 km of Opaskwayak Cree Nation.	**UNKOWN but expected to be LOW** – It is unlikely that emissions of hexavalent chromium will increase in the future. Measured data would be required to assess any risk to members of Opaskwayak Cree Nation.
Nickel	1	Y	Y	Y			Y	Y			No measured data were found for levels in air. Nickel is not known to be carcinogenic via ingestion. There are very few emitters, none within 50 km of First Nations communities, but the Vale smelter in Thompson emitted 54 tonnes to air 2011-2013.	**LOW** – Only the area near the Vale smelter in Thompson may be at risk. It has been reported that the smelting operations at Vale will be phased out in 2015, so emissions may be substantially reduced.
Lead	2a	Y	Y	Y			Y	Y	Y	Y	Measured levels in air in Flin Flon are not currently of concern (lifetime excess cancer risk of 0.04 per million). The maximum lead level measured in tap water on selected reserves is associated with a lifetime excess cancer risk of 11 per million, and the lifetime excess cancer risk from lead in traditional foods was between 11.5 and 46 per million, thought to be due to the use of lead shot.	**MODERATE** - Lead in traditional foods is of concern if hunters continue to use lead shot.

	IARC Category*	Industrial Emitters			Agriculture	Forestry	Transportation	Heating	Drinking water	Food	Measured levels of concern	Future concern
		Air	Water	Land								
Cobalt	2b	Y	Y								No measured data were found for air. There are few industrial emitters and emission levels are low.	**UNKNOWN but expected to be LOW** – There are no indications that cobalt emissions will increase in the future.
Mercury	2b	Y	Y							Y	There are few emitters of mercury in Manitoba, The largest is Gerdau Ameristeel in Selkirk, emitting 59 kg to air in 2011-2013, within 31km of Brokenhead Ojibway Nation. Levels measured in traditional foods are generally low and safe, but measured levels in hair showed 7 people out of 236 had level above the guideline, all women in living in northern Manitoba.	**MODERATE** - While it is expected that mercury emissions to air will not increase in the future, mercury remains in the environment for a long time and can enter the food chain. Women in northern Manitoba should follow fish consumption guidelines carefully. The Keeyask hydroelectric project will increase mercury levels in fish behind the new dam above accepted thresholds for health protection, which will require people to reduce or avoid consuming fish from the new reservoir.

* International Agency for Research on Cancer (IARC) category 1 = known carcinogen, 2a = probable carcinogen, 2b = possible carcinogen.

Table 3.4. Known and Suspected Carcinogens Summary – Volatile Organic Compounds (VOCs)

	IARC Category*	Industrial Emitters			Agriculture	Forestry	Transportation	Heating	Drinking water	Food	Measured levels of concern	Future concern
		Air	Water	Land								
Benzene	1	Y					Y	Y			Measured levels in air in Winnipeg in 2013 are associated with a lifetime excess cancer risk of 1.4 per million. This is between the range of 1 to 10 per million considered negligible by Health Canada.	**LOW** - There are few industrial emitters. The most significant exposures will be in urban areas due to vehicle exhaust and emissions from home heating. In general, these emissions are not expected to increase quickly in the future.
Formaldehyde	1	Y					Y	Y			Measured levels in air in Winnipeg in 2014 are associated with a lifetime excess cancer risk of 1.6 per million. This is between the range of 1 to 10 per million considered negligible by Health Canada.	**LOW** - Few measured data exist, but the main sources of formaldehyde in Winnipeg are the transportation and home heating sectors. Emissions from these sources are unlikely to increase quickly in the future. There is one major industrial emitter – the Louisiana Pacific OSB plant - 49 km from Wuskwi Sipihk First Nation.
Trichloroethylene	1	Y									Measured levels in air in Winnipeg, in 2013 are associated with a lifetime excess cancer risk or 0.1 per million, therefore excess cancer risk is negligible.	**VERY LOW** – No major industrial emissions have been reported since 2000.
Dichloromethane	2a	Y									Measured levels in air in Winnipeg in 2013 are associated with a lifetime excess cancer risk of 0.04 per million, therefore cancer risk is negligible.	**VERY LOW** - No major industrial emissions have been reported since 2002. The transportation sector will continue to emit small but decreasing amounts in urban areas.

	IARC Category*	Industrial Emitters			Agriculture	Forestry	Transportation	Heating	Drinking water	Food	Measured levels of concern	Future concern
		Air	Water	Land								
Tetrachloroethylene	2a	Y					Y				Measured levels in air in Winnipeg in 2013 are associated with a lifetime excess cancer risk of 0.07 per million, therefore cancer risk is negligible.	**VERY LOW** - No major industrial emissions have been reported since 2000. The transportation sector will continue to emit small but decreasing amounts in urban areas.
Acetaldehyde	2b	Y	Y				Y	Y			Measured levels in air in Winnipeg in 2014 are associated with a lifetime excess cancer risk of 0.2 per million, therefore cancer risk is negligible.	**VERY LOW in general but MODERATE in proximity to the Tolko kraft paper mill** – The mill reported emitting 43.6 tonnes to air in 2011-2013, within 6 km of Opakwayak Cree Nation. Measured data in the community will be required to assess the level of risk, if any.
1, 3-Butadiene	2b						Y	Y			Measured levels in air in Winnipeg in 2013 are associated with a lifetime excess cancer risk of 0.8 per million, therefore cancer risk is negligible.	**VERY LOW** - No major industrial emissions have been reported between 1993-2013. The transportation and home heating sectors will continue to emit small amounts but are unlikely to increase quickly.
Diethanolamine	2b	Y									No measured data were found.	**UNKNOWN but expected to be VERY LOW** - No major industrial emissions have been reported since 2006.
Ethylbenzene	2b	Y		Y			Y				Measured levels in air in Winnipeg in 2013 are associated with a lifetime excess cancer risk of 0.03 per million, therefore cancer risk is negligible.	**VERY LOW** - Only one major industrial emitter currently exists (located in Winnipeg). The transportation and home heating sectors will continue to emit small amounts but are unlikely to increase quickly.

	IARC Category*	Industrial Emitters			Agriculture	Forestry	Transportation	Heating	Drinking water	Food	Measured levels of concern	Future concern
		Air	Water	Land								
Methyl Isobutyl Ketone	2b	Y									No measured data were found.	**UNKNOWN but expected to be LOW** - No major industrial emitters are located within 50 km of First Nations communities.
Styrene	2b	Y									Levels of styrene have been measured in air in Winnipeg as recently as 2013, but there is no cancer potency factor available to calculate lifetime excess cancer risk.	**UNKNOWN but expected to be LOW** - One major industrial emitter, Triple E RV, a manufacturer of transportation equipment, emitted 7.6 tonnes to air 2011-2013 , 48 km from Roseau River Anishinabe First Nation.

* International Agency for Research on Cancer (IARC) category 1 = known carcinogen, 2a = probable carcinogen, 2b = possible carcinogen.

Table 3.5. Known and Suspected Carcinogens Summary – Polycyclic Aromatic Hydrocarbons (PAHs)

	IARC Category*	Industrial Emitters			Agriculture	Forestry	Transportation	Heating	Drinking water	Food	Measured levels of concern	Future concern
		Air	Water	Land								
Benzo[a]pyrene	1	Y						Y		Y	Total PAHs, measured as equivalents to benzo[a]pyrene in traditional foods are associated with a lifetime excess cancer risk of 0.5 to 2.8 per million, within the 1 to 10 per million considered negligible by Health Canada. Levels of benzo[a]pyrene measured in air in Winnipeg in 2011 were associated with a lifetime excess cancer risk of 0.009 per million, therefore cancer risk via this pathway is negligible.	**VERY LOW - No major industrial emissions** have been reported since 2008. Small amounts will continue to be emitted by home heating (oil, gas, wood), but are not expected to increase quickly.
Dibenz[a,j]acridine	2a	Y									No measured data were found.	**UNKNOWN but expected to be VERY LOW** - No major industrial emissions have been reported since 2008. Small amounts will continue to be emitted by home heating (oil, gas, wood), but are not expected to increase quickly.
Dibenz[a,h]anthracene	2a	Y									Levels of dibenz[a,h]anthracene have been measured in air in Winnipeg as recently as 2011, but there is no cancer potency factor available to calculate lifetime excess cancer risk.	**VERY LOW** - No major industrial emissions have been reported since 2008. Small amounts will continue to be emitted by home heating (oil, gas, wood), but are not expected to increase quickly.

	IARC Category*	Industrial Emitters			Agriculture	Forestry	Transportation	Heating	Drinking water	Food	Measured levels of concern	Future concern
		Air	Water	Land								
Benzo[a]anthracene	2b	Y						Y			Levels measured in air in Winnipeg in 2011 are associated with a lifetime excess cancer risk of 0.001 per million, therefore cancer risk via this pathway is negligible.	**VERY LOW** - Insignificant emissions (3 grams) from a single industrial emitter in Winnipeg were reported in 2011-2013. Small amounts will continue to be emitted by home heating (oil, gas, wood), but are not expected to increase quickly.
Benzo[b]fluoranthene	2b	Y						Y			Levels measured in air in Winnipeg in 2011 are associated with a lifetime excess cancer risk of 0.001 per million, therefore cancer risk via this pathway is negligible.	**VERY LOW** - No major industrial emissions have been reported since 2008. Small amounts will continue to be emitted by home heating (oil, gas, wood), but are not expected to increase quickly.
Benzo[j]fluoranthene	2b	Y										**UNKNOWN but expected to be VERY LOW** - No major industrial emissions have been reported since 2006. Small amounts will continue to be emitted by home heating (oil, gas, wood), but are not expected to increase quickly.
Benzo[k]fluoranthene	2b	Y						Y			Levels measured in air in Winnipeg in 2011 are associated with a lifetime excess cancer risk of 0.0005 per million, therefore cancer risk via this pathway is negligible.	**VERY LOW** - No major industrial emissions have been reported since 2008. Small amounts will continue to be emitted by home heating (oil, gas, wood), but are not expected to increase quickly.

	IARC Category*	Industrial Emitters			Agriculture	Forestry	Transportation	Heating	Drinking water	Food	Measured levels of concern	Future concern
		Air	Water	Land								
Benzo[a]phenathrene (Chrysene)	2b	Y						Y			Levels measured in air in Winnipeg in 2011 are associated with a lifetime excess cancer risk of 0.0001 per million, therefore cancer risk via this pathway is negligible.	**VERY LOW** - Insignificant emissions (6 grams) from a single industrial emitter in Winnipeg were reported in 2011-2013. Small amounts will continue to be emitted by home heating (oil, gas, wood), but are not expected to increase quickly.
Dibenzo[a,i]pyrene	2b	Y										**UNKNOWN but expected to be VERY LOW** - No major industrial emissions have been reported since 2008. Small amounts will continue to be emitted by home heating (oil, gas, wood), but are not expected to increase quickly.
Indeno[1,2,3-cd]pyrene	2b	Y						Y			Levels measured in air in Winnipeg in 2011 are associated with a lifetime excess cancer risk of 0.0008 per million, therefore cancer risk via this pathway is negligible.	**VERY LOW** - Insignificant emissions (2 grams) from a single industrial emitter in Winnipeg were reported in 2011-2013. Small amounts will continue to be emitted by home heating (oil, gas, wood), but are not expected to increase quickly.
Naphthalene	2b	Y									Levels measured in air in Winnipeg in 2011 are associated with a lifetime excess cancer risk of 0.2 per million, therefore cancer risk via this pathway is negligible.	**VERY LOW** - No major industrial emissions have been reported since 2011. Small amounts will continue to be emitted by home heating (oil, gas, wood), but are not expected to increase quickly.

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