Pulp and Paper

Pollution

The Toxic Story of Federal Regulatory Neglect

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Executive Summary

This report examines the status of the pulp and paper industry in Canada, including closures, barriers to information, and the range and quantities of pollutants released from pulp and paper mills with a focus on those pollutants found toxic under the *Canadian Environmental Protection Act (CEPA).* It reviews regulatory and voluntary government measures in place, and legacy sites resulting from mill closures. While B.C. mills are a major focus of this report, the overall national picture on pulp and paper mills is also considered.

The report demonstrates major inadequacies in government oversight of the pulp and paper industry. These inadequacies are the result of decades of failure by the federal government to adequately protect human health and the environment through federal programs concerned with regulation, jurisdictional matters, the management of toxic substances, the quality and accessibility of data and information, and legacy sites resulting from closures of mills. The federal government has failed to properly safeguard public health and workers' health and to fulfill its obligations under international environmental agreements.

For decades, communities have been exposed to a toxic brew of pollutants in air, water and their food from mills, and have then been left to contend with the contaminated sites, with no requirements that the polluters pay for cleanup and remediation of these sites. Governments have seriously resisted enforcing technological improvements to reduce pollution, and making these operations more efficient.

With the exception of some federal regulations on pulp and paper introduced in the early 1990s, such as the *Pulp and Paper Effluent Regulations* under the *Fisheries Act*, governments, (both federal and provincial) have been missing in action for decades. There has been a complete lack of government oversight for an industry that plays such a vital role in Canada.

Overall, the industry in Canada is in difficulty – financial and otherwise. They have made some poor choices in investments and have been slow to make investments. While government (provincial usually) has provided financial assistance to bail out failing operations, (e.g., Saskatchewan's Meadow Lake facility, B.C.'s Skeena mill at Prince Rupert) it is not evident that the overall performance of these mills has improved and their emissions reduced. In fact, Canada lags well behind Sweden and Finland, the leaders in this industry, and in some instances the U.S., in regulatory measures and technologies to control and reduce pollution from pulp and paper mills.

Strong federal regulations under *CEPA 99* are needed to deal with the suite of pollutants released from and disposed of by these facilities. Emission limits should be set based on Best Available Techniques (BAT) for preventing and minimizing pollution. Sufficient resources must be dedicated to ensure that emissions are directly monitored on a regular basis, and that regulations are fully enforced.

Compliance, enforcement and on-site inspection of these facilities are the ultimate responsibility of the federal government. While federal and provincial governments share authority over environmental issues, the application of such authority must be consistent and rigorous and ensure uniformity across the country. Provincial regulations must incorporate federal standards as a minimum, and should do better. Operating permits must be subject to renewal and upgrade on a regular basis.

Data must be derived through direct measurement and monitoring done on a routine and, where possible, continuous basis. Estimation methods (emissions factors) that are not verified by actual measurement are meaningless. Without credible, verifiable data, and independent monitoring, there is no means to validate

reductions, and Canada cannot claim that it is enforcing its regulations or meeting its international commitments.

Pollutant inventories need to be improved in terms of data quality, ease of use, and comprehensiveness in terms of reporting thresholds and substances covered.

Access to information on mill operations must be improved. An appropriate and consistent classification system must be used to incorporate all operating pulp and paper mills in Canada. Government departments should employ uniform means of tracking the industry.

All facilities must be required to have provisions built into their operating licenses or permits that take into account closures, and include liability on the part of the company for costs associated with the accumulation of pollutants on site, including any migration of these pollutants, and the clean-up, remediation and restoration of their sites. It is not the responsibility of the taxpayer, or the affected community, to clean up a site or to have to live with contaminants from derelict industries. In particular, governments must take responsibility to examine specific issues such as the impact on human health of dioxins and furans in the B.C coastal mills region, and to update dioxin-based fish advisories in accordance with revisions made by Health Canada to "safe" exposure levels.

Recommendations

In order to make the necessary changes to significantly alter decades of pollution caused by this industry, governments must take the following actions:

- Implement federal regulation that incorporates standards based upon Best Available Techniques (BAT), pollution prevention strategies and that require substantial directly measured reductions.
- Require operating permits to be updated on a regular basis. Permits must include provisions for closure, such as including costs, posting bonds and remediation plans.
- Establish consistent policies regarding standards, inspections, and monitoring of both provincial and federal regulations and permit requirements.
- Use an appropriate classification system to clearly define the pulp and paper mill industry in Canada.
- Require emissions data to be derived through direct measurement and direct monitoring on a routine basis.
- Improve pollutant inventories in terms of quality of data, ease of use, and comprehensiveness of coverage.
- Ensure that public information on government websites on regulations and monitoring is consistent, up-to-date, and clear.

Reliable data are essential for setting policies, developing and enforcing regulations, and projecting trends. Lack of credible, verifiable data compromises public well-being and calls into question whether or how Canada is meeting its domestic and international obligations.

Ineffective and/or non-existent regulations continue to allow companies to pollute with impunity and leave in their wake a legacy of toxic sites when they close. Regulatory action on the part of the federal government is necessary. But to be effective, as demonstrated by *PPER*, the department must have the resources to ensure compliance and enforcement. Piecemeal, inconsistent provincial measures do not

work. At all levels of government, what is mainly lacking is the political will to properly protect human health and the environment.

A. The Pulping Process

Pulping processes are generally classified as chemical, mechanical or semi-chemical mills.[1]

Chemical

The kraft process is the dominant type of chemical wood pulping. The sulphite process, which is much less common, is primarily used for newsprint manufacturing. Chemical pulping involves cooking the wood at elevated pressure with a solution of sulphur-based chemicals to extract the fibrous component (cellulose) from trees. The sulphur chemicals account for the rotten egg smell of many pulp mills. Less than 50% of the tree is used in the process. The remainder ends up as sludge, which is burned, spread on land or landfilled. An advantage to kraft pulping is that chemicals can be recycled and re-used in the mill. Another advantage is that kraft fibre is exceptionally strong and is used in products such as magazines, corrugated packaging, printing and graphics papers, grocery bags, etc.

Kraft pulp is usually dark and is often bleached with chlorine compounds. Northern bleached softwood kraft pulp (NBSK) is used by a number of mills for several papermaking applications.

Semi-chemical pulping uses a combination of chemical and mechanical methods. Wood chips are partially cooked with chemicals and the remainder of the pulping is done by mechanical means.

Mechanical

Mechanical (groundwood) pulping physically shreds trees into pulp with grindstones and/or heat. These processes use about 90% of the tree. Mechanical pulping, which is both water and energy intensive, produces an opaque product which is weak and tends to discolour easily over time. The pulp is commonly used for making newsprint and other poorer grades of paper newspapers. It is often bleached with hydrogen peroxide or other chlorine-free products. Mechanical pulping also includes refiner mechanical (RMP), thermomechanical (TMP) and chemithermomechanical (CMTP) processes.

De-inking

Pulp mills remove ink from recycled paper and produce pulp that is usually blended with virgin pulp to produce paper.

[1] Reach for Unbleached – The *Pulp Pollution Primer* http://www.rfu.org/cacw/PulpPrimer.htm. Also, http://www.epa.gov/waterscience/guide/pulppaper/jd/fs2.pdf

B. Health and Environmental Impacts – In Brief

Throughout the various steps in the pulp and paper process, from producing the raw pulp, treating it to remove impurities, and then bleaching it, to the manufacturing of paper, numerous hazardous contaminants are generated and released to air, water and land. These pollutants contribute to acid rain, smog, destruction of fish habitat, all of which affect the quality of air, water and food.

The pollutants are harmful to human health in a wide variety of ways. They include known or suspected carcinogens, neurotoxins, endocrine disruptors, and reproductive toxins. They contribute to and cause respiratory and cardiovascular disease, skin disorders, damage to organs, particularly the liver, and compromise the immune system.

C. Status of Pulp and Paper Mills in Canada

Industry Profile

The forestry industry is very important in the Canadian economy but is subject to large variations. In 2000, it was the largest exporter in the world of market pulp, newsprint and softwood lumber, accounting for 20% of the world trade in forest products. Pulp production was in the order of 26,000,000 tonnes, and paper and paperboard production about 20,700 000 tonnes. Direct employment (excluding logging) totaled about 65,000, while indirect employment was in the order of 264,000. The manufacturing of pulp and paper was being carried out in 154 sites, 45 of which were specifically Kraft mills.[2]

Since that year, the situation has drastically altered. While the industry remains significant, its relative importance has seriously declined. Growth projections that were made at its peak no longer have any validity.

Current Status of Pulp and Paper Mills

Sources used to determine what pulp and paper mills are actually operating include government (federal and provincial), industry consultants, company and industry association websites, and other sources (e.g., *Reach for Unbleached*).

Research on pulp and paper facilities in Canada encounters a number of obstacles to obtaining information from companies, industry consultants and industry association websites. Many of these sites have restricted access, except for "members." Information on pollutants, if provided, is given collectively from a common operator/owner. Some of these websites are outdated or don't work (For example, the website for Abitibi Bowater was not operational for over a year after the merger was completed. The websites for the two individual companies are still maintained but the information outdated.[3])

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[2] *Multi-Pollutant Emission Reduction Analysis Foundation Report (MERAF) on Pulp and Paper*, June 2002 (MERAF) is found at: http://www.ccme.ca/assets/pdf/pulp_paper_final_meraf_e.pdf. The report did not identify individual mills or the nature of their operation. It noted that in 2002, BC had 16 Kraft mills; Quebec had 10 and Ontario 9 such mills.

[3] http://www.abitibibowater.com/home. Also, refer to http://www.cbc.ca/canada/story/2007/11/29/abitibibowater.html.

The federal government (primarily Environment Canada) has been the main source of information on the status of mills and pollutants released. In addition, Natural Resources Canada (NRCAN) has been a source of valuable information on layoffs, closures and capacity reduction in the Canadian forest industry.[4] Data on pollutants released fro the pulp and paper industry have been obtained through the National Pollutant Release Inventory (NPRI), under the *Canadian Environmental Protection Act* (CEPA). The NPRI tracks industries using industrial codes.[5]

Industrial Classification System (Codes):

Searching for information on pulp mills using industrial classification systems should have been the simplest part of the research for this paper. However, this has not been found to be necessarily the case.

A number of different classification systems, such as the 4-digit (and 6-digit) North American Industry Classification Systems (NAICS) and the 4-digit (and 2-digit) Canadian Standard Industrial Classification (SIC) are used. In all these cases, facilities are free to specify the codes with which they want to be identified. Any one facility could use all these different codes.

The primary and most reliable code to identify the Pulp and Paper industry in Canada is the 4-digit North American Industry Classification System (NAICS) 3221 - Pulp, Paper & Paperboard Mills. Other classification systems used in combination with NAICS include:

- 4-Digit Canadian Standard Industrial Classification (SIC)
    - 2711 "Pulp Industries" (kraft, sulphite, semi-mechanical and mechanical)
    - 2712 "Newsprint Ind."
    - 2713 "Paperboard Ind." (Packaging paper mills, linerboard, and paperboard mills using recycled paper)
    - 2719 "Other Paper Ind."(Printing and writing paper mills and tissue mills)
- 2-Digit SIC 27 "Paper and Allied Products Industries While one would expect these codes to accurately identify an industry, this is not necessarily the case.

However, a number of anomalies have been noted under the 4-digit NAICS 3221. For example:

- For 2006, 52 facilities reported to the NPRI under SIC 2711. Pulp mills that reported under SIC 2712 include Crofton, Elk Falls, and Powell River.
- Zelstoff (a kraft pulp mill in B.C.) uses NAICS 1132 – "Forest Nurseries & Gathering Forest Products", even though its SIC is 2711.
- Dorset Industrial Chemicals (Quebec) reports under NAICS 4 Code 3221. It is a chemical industry plant that does not produce pulp, paper or paperboard.
- Under NAICS 3221, the number of facilities reporting emissions to the NPRI ranged from 119-125 for the years 2002-2006. 119 facilities reported in 2006. In 2000-105 facilities reported; in 2001, 108. The reason for the variation in facility numbers warrants explanation.

The Multi-Pollutant Emission Reduction Analysis (MERAF) Report of 2002 indicated that 154 mills were operating, but specific sites were not identified. The Pulp and Paper Air Quality Forum (held September

[4] Canadian Forest Services, Natural Resources Canada (NRCAN) 2008 tracks layoffs and closures on a quarterly basis from 2003 on. NRCAN uses RISI, a forest industry and economic analysis firm, as its source of information on pulp and paper mills. The information from RISI is not free. http://www.risiinfo.com/pages/product/pulp-paper/

[5] NPRI: http://www.ec.gc.ca/pdb/npri/npri_home_e.cfm

2006), under Environment Canada, indicated that approximately 150 mills were in operation, but again, no sites were identified.

Environment Canada has identified 114 Pulp and Paper Reporters (to the NPRI) for 2006 for the purposes of developing its Clean Air Industrial Regulations Agenda (CAIRA). It has also identified 11 mills that have temporarily shut down and 14 mills that are no longer in operation.[6] The list of 114 "active" mills includes facilities not identified under NAICS 3221, such as:

- New Forest Paper Mills, Scarborough - no NPRI ID, no information available – not found on the NPRI site
- IKO Industries (NPRI 10179): NAICS 4 Code: 3241 - Petroleum & Coal Products Mfg. Canadian SIC: 2721 - Asphalt Roofing Ind.
- Kimberly-Clark Inc. (NPRI 2917): NAICS 4 Code: 3222 - Converted Paper Product Mfg., Canadian SIC: 2719 - Other Paper Inds.
- CKF-Hantsport (NPRI 6006): NAICS 4 Code: 3222 - Converted Paper Product Mfg., Canadian SIC: 2793 Paper Consumer Prods. Ind.
- Zelstoff (NPRI 3374): NAICS 4 Code: 1132 – Forest Nurseries, Canadian SIC 2711: Pulp Ind.

However, facilities under NAICS Code 3221 are <u>not</u> included in the list of "114", such as:

- IKO Industries (NPRI 6799, Alberta); SIC 3999 - Other Manufacturing Prods.
- EMCO BP (NPRI 19546, Alberta); SIC 2721 - Asphalt Roofing Ind. and
- Cascades Moulded Pulp (NPRI 174, Ontario); SIC 2719.

A comprehensive spreadsheet has been compiled using these various sources and industrial codes (NAICS 3221, SIC 2711).[7] It includes 128 facilities along with the NPRI Identification Number, process type, web-sites of facilities (where available), and information on closures. Not all the facilities listed are pulp and paper, but may be asphalt plants and producers of specialized wood-related finished products.

Closures, Layoffs

The following tables summarize layoffs and closures from pulp and paper mills from 2005 to June 2008 for each affected province and specifically for B.C.

Table 1A: Provincial Closures, Layoffs 2005-08

Province	B.C.	Alberta	Sask.	Ontario	Quebec	N.B.	N.S.	N.F.	Canada
Layoffs	2,233	100	690	3,970	4,028	1,926	50	485	13,482

Table 1B: Closures, Layoffs, and Loss in Production in B.C. Mills: 2005 to June 2008

Company Mill/Machine	Location	Product	Closure Type/ Duration	Date Effective	Capacity Reduced (tonnes)	Layoffs
Abitibibowater Mackenzie Newsprint	Mackenzie	newsprint	Shift Reduction Indefinite	15/01/2008	189 000	250
Catalyst Paper Elk Falls	Campbell River	General pulp and paper	Partial (Machine) Indefinite	17/08/2007	750 000	145

[6] Refer to Appended file: <Pulp and Paper Reporters by Province for – 2006> by Environment Canada
[7] Refer to Appended file: <Status of Pulp and Paper Operations in Canada, 2005-6>

Catalyst Paper Crofton Mill	Crofton	Kraft pulp	Shift Reduction Permanent	01/05/2008	0	82
Catalyst Paper Crofton	Crofton and Elk Falls	General pulp and paper	Partial (Machine) Indefinite	?	n.a.	85
Catalyst Paper paper machine	Port Alberni	newsprint	Partial (Machine) Indefinite	01/09/2007	134 000	85
Catalyst Paper Groundwood pulp facility	Port Alberni	General pulp and paper	Partial (Machine) Indefinite	30/09/2006	122 500	60
Catalyst Paper Paper machine #4	Port Alberni	newsprint	Shift Reduction Permanent	12/03/2007	0	37
Catalyst Paper Powell River	Powell River	newsprint	Shift Reduction Permanent	16/02/2007	n.a.	100
Domtar Annacis Island Mill	New Westminster	General pulp and Paper	Full mill Permanent	16/06/2006	120 000	280
Pope & Talbot Mackenzie Pulp	Mackenzie	Kraft pulp	Full mill Permanent	06/05/2008	220	251
Pope & Talbot Harmac	Nanaimo	Kraft pulp	Full mill Indefinite	06/05/2008	390	535
Western Forest Products	Squamish	General pulp and paper	Full mill Permanent	09/03/2006	275 000	323
		Total			**940 000**	**2233**
Source: Canadian Forest Service, Natural Resources Canada (This list is updated quarterly but may not include all facilities affected.)						

The situation regarding closures and layoffs is further exacerbated when considering the wood-forest industry as a whole. It has suffered devastating losses in the work force to the tune of 7,000 in B.C. alone and over 18,000 in Canada in this three-year period.[8]

D. Pollutant Inventories

National Pollutant Release Inventory (NPRI)

The primary source of pollutant data is the NPRI, a publicly accessible inventory. The NPRI provides annual data on a specified set of substances that are released, disposed of and recycled by industrial, institutional and commercial facilities across the country.[9] Those facilities that meet specified requirements and thresholds are required to report this information to Environment Canada.[10]

[8] Refer to Appended file <Closures lay-off.xls> for a detailed list of closures and layoffs in Canada.
[9] NPRI: http://www.ec.gc.ca/pdb/npri/npri_home_e.cfm
[10] The reporting criteria for most NPRI substances are 10 tonnes manufactured, processed or otherwise (M,P,O), and 10 or more employees. (Refer to the Appendix C for more detail on reporting thresholds).

As of 2006, 367 substances are listed on the inventory, thirty-one of which are CEPA-toxic. This list also includes emissions of seven Criteria Air Contaminants (CACs): sulphur dioxide (SO_2), nitrogen oxides (NO_X), Particulate Matter - total, coarse, and fine (PM, PM_{10}, PM $_{2.5}$), carbon monoxide (CO) and several Volatile Organic Compounds (VOCs).

However, there are notable limitations to the NPRI:

- Thresholds for reporting pollutants vary and a facility may not necessarily trigger reportable releases of a particular pollutant.
- It is not comprehensive, for example, area sources (e.g., transportation) are not included. Not all facilities are required to report. A limited number of pollutants are covered. (Not all pollutants of concern in the pulp and paper industry are listed in the NPRI.)
- Changes to the NPRI (such as additions of substances, thresholds and additional facilities required to report, etc.) affect the ability to analyze trends.
- Facilities are not required to measure or monitor their emissions for reporting purposes, although they may do so. They may use calculated emission factors instead. The accuracy of data is not indicated.
- The NPRI website can be awkward to navigate. Sector-specific sector information is obtained through industrial codes which are obscure for a public user.

The NPRI provides a general picture of releases of a number of pollutants on an annual basis. But upsets in operations, shutdowns, purging equipment, or any such incidences that could lead to highly significant variation in emissions are masked by an annual reporting system and these occurrences are the ones that would have the largest, immediate impact on local communities. Despite its limitations, the NPRI is the main and essential tool for public access to data and has been used extensively in this report.

Criteria Air Contaminants (CAC) Inventory

The CAC Inventory (maintained by Environment Canada) is a publicly accessible inventory that includes emissions from industrial sources (mainly obtained from the NPRI data) as well as mobile, natural and open sources.[11] This inventory plays an important role in international agreements on air pollutants, in particular, the U.N. Environmental Commission of Europe (ECE) Long-Range Transboundary Air Pollution (LRTAP).[12] The inventory consists of annual emissions summaries on CACs as well as ammonia, heavy metals (mercury, lead and cadmium), dioxins and furans, hexachlorobenzene, and 4 polycyclic aromatic hydrocarbons (PAHs). All of these substances are listed on the NPRI.

The data is collected mainly in collaboration with provinces and territories as well as some industrial sectors, using mechanisms such as provincial permits, surveys, GIS mapping, modeling and estimation methodologies. Unlike the NPRI, data is not limited by thresholds. As well, the CAC includes area sources for facilities that may not be in the NPRI. This means that sector-based data may not be the same between the two inventories. (The CAC website notes that the summaries may be different from those previously published by Environment Canada and other governmental agencies)

As with the NPRI, there are limitations to the CAC inventory:

[11] http://www.ec.gc.ca/pdb/cac/cac_home_e.cfm Other sources include transportation, residential fuel combustion, landfill sites, incineration, paved and unpaved roads, and forest fires.
[12] U.N. ECE – United Nations Environmental Commission of Europe http://www.unece.org/env/lrtap/hm_h1.htm

- Neither the comprehensive inventory nor the NPRI requires actual measurements of emissions. The source of data has typically been emission factors which have inherent uncertainties that impact their reliability.
- Data collection mechanisms by provinces are highly variable and not consistent.
- Emissions from individual facilities are not provided.

Summary Comments on Data

Changes in the industry in the last few years have added to the difficulty in tracking information and data. Some of the larger emitters of pollutants have closed (indefinitely and/or permanently) in 2005 and 2006. This means that data for a particular year, for example, 2006, may represent only about two thirds of total emissions of a particular mill if it had been operating the full year. Some of the mills report very low emissions for some pollutants, e.g., SO_2, which is not understandable, considering the nature of their operations.

Caution must be exercised in comparing different sectors emissions of a specific pollutant or group of pollutants. Comparisons are qualified by the limitations of the information sources, (e.g., the NPRI). Also, one sector may be dominated by a few facilities with large emissions of one type of pollutant. For example, emissions of polycyclic aromatic hydrocarbons (PAHs) from the aluminum smelter in Kitimat, sulphur dioxide (SO_2) from 3 base metal smelters and the Alberta oil sands, lead from the smelter in Trail, B.C., are so significant, that in proportion they would dominate emissions from other sectors. But that does not mean that emissions from other sectors should be ignored! Not only is pulp pollution significant itself, but the mills are typically located in or near several communities scattered across the land.

In considering the pulp and paper sector as a whole, it is important to keep in mind the sheer number of facilities across the country, the range of pollutants emitted, and the number of communities that are directly affected by the emissions. Growth in other industries doesn't lessen the amount from the pulp and paper industry. At the same time, it is evident that B.C. mills emit the greatest amounts of dioxins and furans of all mill facilities in Canada and the pulp and paper sector overall emits about 20% of fine particulate matter ($PM_{2.5}$) as compared to other reporting facilities to the NPRI.

E. Scope of Pollutants

All the substances surveyed in this report are listed on the NPRI. Data reported for the year 2006 is the most recent set of data that has been reviewed by Environment Canada. Where feasible, trend analyses on selected CEPA-toxic pollutants are given for the sector as a whole (using NAICS 3221) for the years 2002-6, a period in which the reporting criteria were relatively stable for the pollutants examined.

The categories of pollutants selected include CEPA-toxic substances, CACs, and other substances (Hazardous Air Pollutants – U.S. EPA) prevalent in the US pulp and paper industry.

British Columbia is the geographical focus for specific pollutants for 2006. The B.C. mills provide a good surrogate for mills in other provinces. They are also unique in that coastal mills are main emitters of dioxins and furans.

All the Criteria Air Contaminants (CACs) and selected CEPA-toxic substances have been examined nationwide wide.

CEPA-toxic substances:

Section 64 CEPA 99 defines a substance to be toxic if it is entering or may enter the environment in a quantity or concentration or under conditions that (a) have or may have an immediate or long-term harmful effect on the environment or its biological diversity; (b) constitute or may constitute a danger to the environment on which life depends; or (c) constitute or may constitute a danger in Canada to human life or health. Substance(s) meeting any one of the three criteria are declared toxic.[13]

These substances are of greatest concern, have undergone detailed risk assessments and are subject to federal risk management strategies to reduce and/or eliminate them over time.
All 31 CEPA-toxics listed on the NPRI were examined to determine the most relevant for the pulp and paper industry and for which sufficient data was available.[14] Those found to be relevant for this study and for which a 5-year trend (2002-6) was feasible include:

- Dioxins and Furans (B.C., Canada)
- Hexachlorobenzene (HCB) (B.C., Canada)
- Acetaldehyde (Canada)
- Formaldehyde (Canada)
- Polycyclic Aromatic Hydrocarbons (PAHs): with a focus on 3 of the most prevalent - Phenanthrene, Fluoranthene, Pyrene and total PAHs
- Metals: Arsenic, Hexavalent chromium compounds, Lead and Cadmium
- Ammonia (air and water) releases

While both Carbon Tetrachloride and Chloroform are CEPA-toxic and associated with the pulp and paper industry, no emissions of these substances from mills were reported on the NPRI.

Dioxins and furans are featured further in a separate section of this report because of their significance and attention they have received in Canada and worldwide under various programs.

Criteria Air Contaminants (CACs)

The inclusion of CACs is critical for a number of reasons.

- Firstly, CAC emissions are a strong indicator of activities of mills. It is unlikely that there would be no or few emissions of these pollutants from active mills.
- Secondly, SO_2, NOx, VOCs and PM_{10} are CEPA-toxic.
- Thirdly, the proposed federal regulations for the pulp and paper sector include two of the CACs, Total Particulate Matter (PM) and SO_2.

Other Substances (Hazardous Air Pollutants)

These air contaminants include Hazardous Air Pollutants as defined by the US Environmental Protection Agency that are derived from chemicals used by the industry or are by-products of the manufacturing process.[15] These contaminants are:

[13] The Act (1999) is obtained through http://www.ec.cg.ca/CEPARegistry
[14] Appendix A includes the 31 CEPA-toxics listed on the NPRI. A list of all CEPA-toxic substances is found at: ww.ec.gc.ca/CEPARegistry/subs_list/Toxicupdate.cfm.

- Methanol
- Manganese compounds
- Hydrogen Sulphide
- Hydrochloric Acid
- Chlorine
- Chlorine Dioxide
- Phenol
- Methyl ethyl ketone
- Catchecol
- Cumene
- o-cresol
- Styrene
- 1,2,4-trichlorobenzene
- o-xylene
- Beryllium (not listed on the NPRI)

HAPs that are CEPA-toxic have already been addressed and are not included in the above list. Emissions for the year 2006 are reviewed for methanol, manganese compounds, hydrogen sulphide, chlorine and chlorine dioxide, phenol and methyl ethyl ketone. (Emissions were found to be insignificant or none for the other substances on the list. This may be a consequence of the threshold required for reporting emissions to the NPRI.)

F. Results and Analysis of Data

Part 1: CEPA-toxics

Dioxins and Furans:

Dioxins and furans, byproducts of industrial processes, are among the most hazardous substances known – extremely tiny amounts have been shown to cause negative health effects. They are highly persistent in the environment, bioaccumulate up the food chain, and travel long distances from their point of origin. Some members of the dioxin and furan family are carcinogens, suspected endocrine disruptors, developmental and reproductive toxins as well as being associated with immune disruption, skin disorders, cardiovascular disease and diabetes.[16] The most common route of exposure is through dietary sources, particularly fatty foods which are higher on the food chain and have accumulated more dioxin.

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[15] Appendix B lists all these HAPs. A complete list of HAPs is available at http://www.epa.gov/ttn/atw/188polls.html. For details on the Sector notebook, refer to http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/pulppasn.pdf

[16] The International Agency for Research on Cancer (IARC) classified 2,3,7,8 tetrachlorodibenzo-para-dioxin (TCDD) carcinogenic to humans. http://www.ejnet.org/dioxin/ Other dioxin-like compounds may also be carcinogenic.

Under the Stockholm Convention on Persistent Organic Pollutants (POPs), Parties are required to take measures to reduce total releases of dioxins and furans from anthropogenic sources "with the goal of their continuing minimization and, where feasible, ultimate elimination."[17]

Various countries and agencies have developed risk-based exposure guidelines, referred to as Tolerable Daily Intake (TDI) levels, in attempts to determine a "tolerable" level of exposure to dioxins and furans.[18] Even so, these levels have become more stringent over time. In 2000, the U.S. EPA's dioxin assessment concluded that there is "no safe" level of exposure to dioxin.

In 1990, Health Canada set the TDI for dioxins and furans at 10 picograms per kilogram body weight per day (pg/kg-bw/day). This level was revised to 2.3 pg/kg-bw/day in 2005, in keeping with findings from international agencies such as the World Health Organization (WHO).[19]

The following table gives a national overview of the trend in dioxin and furan releases to air from pulp and paper mills for the years 2002-6. Dioxins and furans are reported in units of grams toxic equivalents (g TEQ).[20]

Table 2a: Releases of dioxins and furans to air (all mills Canada-wide)

Year	2002	2003	2004	2005	2006
g TEQ	3.7	5.4	6.5	4.8	3.7

The next table looks at releases of dioxins and furans to air and water and disposal from B.C. mills as compared to all mills and all reporting facilities in Canada for 2006.

Table 2b: Releases of Dioxins and Furans (grams TEQ) for 2006

Facility/Company	Air	Water	Disposal
Total for B.C. mills	3.52	0.797	105
Total - Canada mills	3.70	0.851	105
Total (B.C. all industries)	12.0	0.798	107
Total reported in Canada	49.0	0.858	163

As the table indicates, B.C. mills account for about 95% of air releases of dioxins and furans from all mills in Canada and virtually for all releases of dioxins and furans to water that are reported to the NPRI in Canada. Eight B.C mills, referred to as the "top 8", account for more than 95% of the disposal and air emissions of dioxins and furans from all B.C. mills.

Air releases and disposal levels are shown for these mills for 2002-6 and contrasted with levels from all B.C. and Canadian facilities in the table below.[21]

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[17] http://www.ec.gc.ca/cleanair-airpur/CAOL/POPS/Stockholm/p1_c5_e.html

[18] TDI is an estimate of the amount of a substance in air, food or drinking water that can be taken in daily over a lifetime without appreciable health risk.

[19] http://www.hc-sc.gc.ca/iyh-vsv/environ/dioxin_e.html Refer to Appendix D more information on different TDIs.

[20] Reporting dioxins and furans to the NPRI was initiated for the 2000 reporting year. 17 congeners are included. TEQs refer to the combined toxicity of a mixture of dioxins and furans. It is determined by comparing toxicity of the individual congener to that of its most toxic form, 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD). The final reported TEQ is the sum of all the individual TEQs of the 17 congeners. http://www.ec.gc.ca/pdb/npri/npri_dioxins_e.cfm

[21] Refer to the appended file <B.C. mill substances.xls> which shows release and disposal data for all B.C. mills.

Table 2c: Dioxins and Furans Air Releases and Disposal (grams TEQ): B.C.'s Top 8 mills

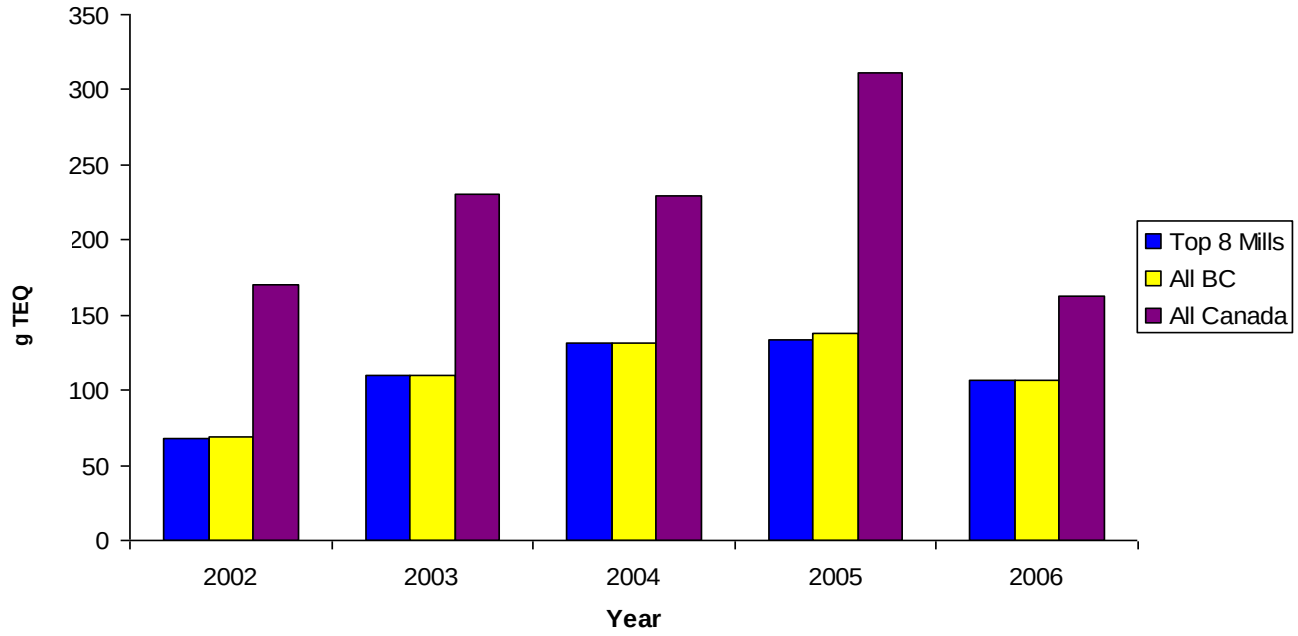
Year	2002		2003		2004		2005		2006		Totals 2002-6	
Facility/ Location	**Air**	**Dis-posal**	**Air**	**Dis-posal**	**Air**	**Dis-posal**	**Air**	**Dis-posal**	**Air**	**Dis-posal**	**Air**	**Dis-posal**
Howe Sound Mill Port Mellon	1.5	23	1.4	44	1.30	49	1.40	50	1.20	40	6.80	206
Catalyst Paper Port Alberni	0.35	19	0.29	34	0.29	28	0.294	29	0.965	22	2.18	132
Kruger Products New Westminster	0.1	0.9	0.87	1.0	1.90	7.8	1.00	19	0.544	9.9	4.42	38.5
Elk Falls (Catalyst) Campbell River	0.97	4.9	0.99	3.5	0.99	3.5	0.99	3.5	0.372	2.1	4.31	17.5
Pope & Talbot Harmac Nanaimo	0.07	5	0.07	6	0.17	6	0.203	6	0.144	5.2	0.66	28.2
Catalyst Paper Crofton	0.28	11	1	16	1	32	0.25	23	0.12	25	2.65	107
Catalyst Paper Powell River	0.06	1.8	0.14	2.4	0.09	2.36	0.048	3.1	0.073	2.5	0.41	12.16
Western Pulp - Squamish	0.12	2	0.28	2.6	0.35	2.6	0.389	0			1.14	7.2
Total -8 mills	3.5	68	5.0	109	6.1	131	4.57	133.6	3.42	106.7	22.6	549
All B.C.	4.1	69	5.7	110	15.0	131	11.0	138.0	12.0	107.0	47.8	555
All Canada	91	170	81	230	82	229	56	311	48	163	358	1103

Notes: Disposal data includes both on and off-site amounts.
The Squamish facility was closed in 2006.

In comparing releases from these mills to all facilities in B.C. and Canada, incinerators (mainly in Newfoundland) and one steel plant in particular, are major releases of dioxins and furans to air. In B.C., the Millstream Landfill, which first reported emissions for 2004, released between 5.7 to 8 g TEQ annually to air.

Clearly, these 8 mills consistently release and dispose of significant amounts compared to the provincial and national totals, as illustrated in the graph below.

Figure 1: Disposal Levels of Dioxins and Furans (g TEQ) 2002-06



No trend in releases and disposal of dioxins and furans is evident over the five-year period studied. These same facilities retain their position in the "top 8" throughout this period. Some notable observations of the trend data are:

- Howe Sound is consistently the largest air emitter of all mills in Canada – from 1.3 to 1.5 grams per year. It consistently disposes of substantial amounts (anywhere from 23 to 49 grams per year) "on-site", that is, landfill, over the 4-year period.
- Port Alberni reported larger air emissions in 2006 than for any of the other years. It also disposed of significant amounts (19-34 grams) "off-site".
- Releases reported from Kruger products (New Westminster, in Vancouver), which manufactures tissue, were relatively large and variable, with the highest level in 2005 (1.0 gram). The company also disposed of significant amounts in 2005-6 "off-site".
- The Crofton mill disposed of relatively significant amounts "off-site" (anywhere from 11-25 grams per year, the largest amount being in 2006), although its air emissions dropped over the 4-year period.
- Releases from the Pope and Talbot Nanaimo facility are mainly to water, but the facility also disposed of 6 g (on-site-landfill) annually.
- Squamish reported 4.0 grams "released to land" in 2005. Is this really disposal?

Hexachlorobenzene (HCB)

HCB is a probable human carcinogen, and toxic when inhaled. Short term acute exposures can result in kidney and liver damage, central nervous effects and potential fetal damage. The primary exposure path is through consumption of food. HCB, a fungicide, is also released as a byproduct during the manufacture of certain chemicals and from processes that emit dioxins and furans. HCB is one of the substances slated for elimination globally under the Stockholm Convention.[22]

[22] http://www.ec.gc.ca/international/multilat/stock_e.htm#com

HCB releases are primarily to air and disposal. Four B.C. mills account for more than 90% of the releases from all B.C. mills. These same mills also have relatively high levels of releases of dioxins and furans.

Table 3a: Releases of HCB (2006) – B.C. mills

Mill	Air Releases (grams)	Disposal (grams)
Catalyst - Crofton	30	296
Catalyst – Elk Falls	124	-
Catalyst – Port Alberni	114	178
Howe Sound	1.6	58
Total	**270**	**532**
Total – all B.C. mills	**302**	**588**

The following table shows the 5-year trend in HCB releases from mills Canada-wide.

Table 3b: HCB Releases (grams) from mills, Canada- 5 year trend

Year	Air	Disposal on, off site	No. of facilities	Top Emitters (all BC)
2002	213	170	48	Elk Falls, Pt. Alberni
2003	284	359	48	Elk Falls, Crofton, Pt. Alberni
2004	303	291	45	Elk Falls, Pt. Alberni, Kruger
2005	312	257	47	Elk Falls, Pt. Alberni. Squamish
2006	329	532	45	Elk Falls, Pt. Alberni, Crofton

While air emissions are variable, there is clearly no indication of any decrease. Disposals have increased dramatically in 2006. As is the case for dioxins and furans, of all mills in Canada, B.C. mills are the major emitters of HCB to air, emitting 302 grams in 2006 compared to a total for all mills of 329 g.

Acetaldehyde

Acetaldehyde, a VOC, reacts with other air pollutants to form ground-level ozone, which can cause damage to crops and materials as well as having potential effects on human health. Acetaldehyde appears to be toxic in air for some micro-organisms at relatively low concentrations. The upper respiratory tract is the principal target site for effects of inhaled acetaldehyde. Excessive exposure to acetaldehyde may also affect the brain, eye, lung, nose, skin and throat. It is classified as a possible human carcinogen.

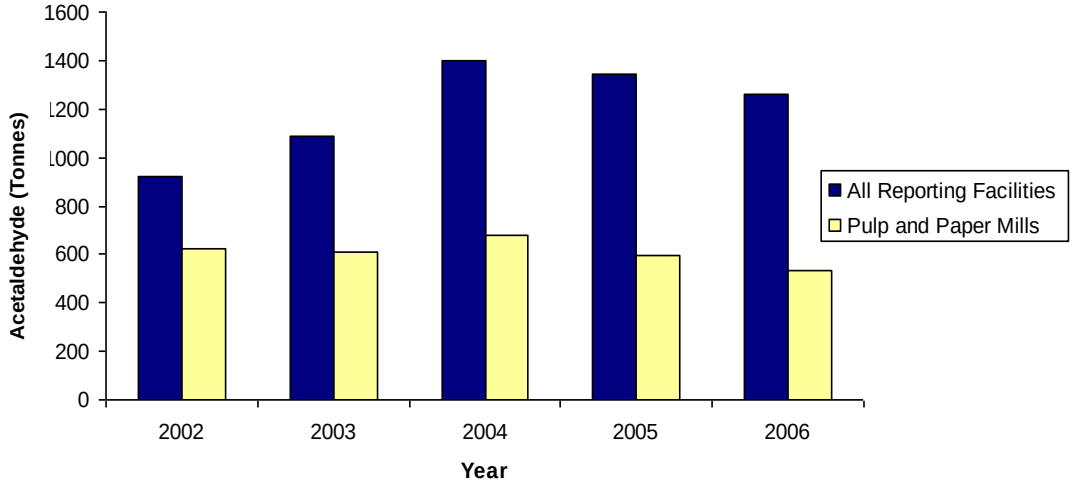
Table 4: Acetaldehyde Releases (tonnes) from mills – Canada- 5 year trend

Year	Air	Water	No. of facilities	Top 3 emitters (mills)*
2002	621	32	33	Kitimat, BC; Prince George (Canfor), BC; Red Rock, On
2003	607	33	36	Témiscaming, QC; Prince George (Canfor), BC; Prince George (Northwood), BC
2004	680	34	37	Red Rock, On; Kitimat, BC; Prince George (Canfor), BC
2005	596	22	36	Kitimat, BC; Red Rock, On; Prince George (Canfor), BC
2006	533	18	32	Témiscaming QC; Kitimat, BC; Prince George (Canfor), BC

* Note: Plywood manufacturers (2-3 facilities) are the largest emitters, followed by the mills noted in the table above.

No significant changes are noted in air emissions over 5 years and only a slight decrease in emissions to water. In comparison to all industrial reporting facilities (to the NPRI), the pulp and paper mill industry accounts for all the acetaldehyde emissions reported to water and for over 40% of air emissions in this 5-year period, as illustrated in the following graph.

Figure 2: Acetaldehyde Emissions to Air (2002-6) – Comparison of mills to all reporting facilities



Formaldehyde

Formaldehyde is used in the production of numerous products including paper, plywood, and urea-formaldehyde resins. Low levels of formaldehyde can cause irritation of the eyes, nose, throat, and skin. It is possible that people with asthma may be more sensitive to the effects of inhaled formaldehyde.

The U.S. Department of Health and Human Services (DHHS) has determined that formaldehyde may reasonably be anticipated to be a carcinogen. People exposed to formaldehyde in workplace air are at greater risk to develop cancer of the nose and throat than those not so exposed.

Table 5: Formaldehyde Releases (tonnes) from all mills – Canada-wide, 5 year trend

Year	Air	Water	No. of facilities	Top 3 Emitters
2002	54	43	9	Irving (St. John), NB; Prince George (Canfor), BC; Kamloops, BC
2003	208	55	19	Elk Falls, BC; Smooth Rock, On; Crofton, BC
2004	132	57	20	Smooth Rock, On; Irving (St. John's),NB; Mackenzie, BC
2005	113	59	19	Smooth Rock, On; Irving (St. John's) ,NB; Témiscaming, QC
2006	81	44	14	Irving (St. John), NB; Témiscaming, QC; Red Rock, On

Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs constitute a group of more than 100 compounds chemicals formed during incomplete combustion. PAHs are found throughout the environment in air (normally adhered to particulate matter), water, and soil. Several individual compounds have been identified as possible or known carcinogens. In humans, PAH exposure by inhalation or skin contact has been linked to cancer. PAHs can also cause birth defects, and are toxic to the skin, blood, reproductive and immune systems in animals.[23]

For 2002-5, the NPRI included 16 PAHs. 4 PAHs were added to the NPRI for 2006, namely, Acenaphthene, Acenaphthylene, Fluoranthene, and Fluorene. Also the method of reporting PAHs changed from total PAHs to specifying the individual ones. Some facilities still report total PAHs. These issues have made it challenging to work out the trends in emissions of total PAHs.

The following table shows the trends for total PAH releases for 2002-6. The 2006 figures are adjusted to include the same PAHs as the previous years.

Table 6a: PAH Releases (in kilograms) from all mills – Canada-wide, 5 year trend

Year	Air	Water	Disposal on, off site
2002	7682	170	531
2003	11292	251	491
2004	10926	323	492
2005	10408	230	467
2006	16825	156	370

In 2006, the total releases of PAHs (including the 4 additional PAHs) to air from all mills are 27, 528 kg. Air releases of the dominant PAHs for Pulp and Paper for the year 2006 are shown below:

Table 6b: PAH Releases (in kilograms) 2006 from all mills – Canada-wide

Substance	Air	No. of facilities	Top 3 Emitters
Acenaphthylene	8144	23	Neenah Paper, NS-2613 kg Prince George (Northwood), BC-2288 kg Nackawic, NB - 1809 kg
Phenanthrene	8650	31	Kruger (Trois-Rivières), QC-4380 kg; Prince George (Northwood), BC-628 kg Neenah Paper (New Glascow), NS-617 kg
Fluoranthene	1778	31	Kruger (Trois-Rivières), QC-774 kg: Prince George (Northwood), BC-107 kg Neenah Paper, NS-91kg

The pulp and paper industry contributes to over 30% of releases of Acenaphthylene to air (total 25,700 kg for all reporting facilities).

In addition to these PAHs, 4 specific PAHs are being tracked under the CAC inventory.[24] These PAHs are a sub-set of air pollutants that fall under the Convention on Long-Range Transboundary Air Pollution

[23] http://www.bodyburden.org/chemicals/chemical_classes.php?class=Polyaromatic+hydrocarbons+%28PAHs%29
[24] http://www.ec.gc.ca/pdb/cac/Emissions1990-2015/emissions_e.cfm

(LRTAP) under UNECE.[25] The table below indicates releases of these PAHs from all mills in Canada for the years 2002-6.

Table 6c: Air Emissions (kilograms) for Polycyclic Aromatic Hydrocarbons (under LRTAP)

PAH Substance	2002	2003	2004	2005	2006	Top 3 Emitters - 2006
Indeno(1,2,3-cd)pyrene	20	42	46	41	517	Kruger (Trois-Rivières), QC - 465 kg Norampac (Cabano), QC - 20kg; Irving (Saint John), NB - 4.5 kg
Benzo(a)pyrene	55	57	75	63	357	Kruger (Trois-Rivières), QC - 305 kg Canfor (Prince George), BC - 8.3 kg Domtar (Kamloops), BC - 8,2 kg
Benzo(b)fluoranthene	134	94	63	53	512	Kruger (Trois-Rivières), QC - 465 kg Norampac (Cabano), QC - 16 kg Canfor (Prince George), BC - 3.3 kg
Benzo(k)fluoranthene	21	45	50	43	501	Kruger (Trois-Rivières), QC - 465 kg Norampac (Cabano), QC - 16 kg Fraser (Thurso), QC - 2.8 kg

The large increase in emissions of these 4 PAHs for 2006, in particular from one facility, is perturbing. Are these numbers verified? If so, some explanation is warranted. Canada needs to explain this in light of being a partner to an international agreement that seeks reductions of these substances.

Metals – Arsenic, Hexavalent Chromium, Lead and Cadmium

Exposure to these metals can result in an array of adverse effects with no known threshold, from neurotoxicity, reproductive disorders, kidney and liver disease, to cancer. The most vulnerable populations are communities in which facilities that use and/or emit these metals are located, in particular, workers, children, and pregnant women.

Metals, by their very nature, do not break down. Decades of operations of mills result in an accumulation of these metals in landfills that present hazards to local communities and the environment.

The four CEPA-toxic metals featured are the most common of all the metals in pulp and paper mill operations. Serious issues with these metals have been noted and discussed for years. For example, a quote from a 1997 federal consultation report on CEPA metals states that "Arsenic and Cadmium compounds have been classified as substances for which the critical health effect (cancer) is believed not to have a threshold, that is, there is some probability of harm at any level of exposure. Therefore, effort should be directed toward reduction of exposure of the Canadian population to the extent practicable."[26]

Following is a brief description of the adverse effects of each of the four metals;

- **Arsenic:** Exposure by inhalation causes cancer of the respiratory tract. Ingestion of arsenic in drinking water has also been linked to skin cancer and cancers of various internal organs (bladder,

[25] Canada has signed on to and ratified a number of protocols under the convention on LRTAP under the UN ECE. These protocols include reductions of sulphur emissions, control of emissions of NOx, Heavy Metals, Persistent Organic Pollutants (POPs) and the Monitoring and Evaluating of long-range transmission of air pollutants in Europe.

[26] Strategic Options for the Management of Toxic Substances from the Base Metals Smelting Sector" Report of Stakeholder Consultations, June 23, 1997, p.82

kidney, prostate, lung and liver) and adult on-set diabetes. Concentrations of dissolved and soluble arsenic in environmental media in the vicinity of anthropogenic sources can cause adverse effects in a variety of aquatic and terrestrial organisms.

- **Cadmium:** Cadmium is a human carcinogen by the inhalation route, with the lungs as the primary target organ. In addition, cadmium is associated with the development of kidney disease in both occupational and non-occupational situations leading to increased excretion of proteins in urine. Kidney damage has also been noted in mammalian wildlife and birds.

- **Lead:** Exposure to lead occurs mainly through ingestion of food, water and dust and inhalation of dust as well as dermal contact. Once absorbed, lead is distributed to soft tissues and the skeleton, where it accumulates with a half-life of several decades. Lead is toxic to multiple organisms. Effects range from enzyme inhibition and anaemia, to disorders of the nervous, immune and reproductive systems, impaired kidney and cardiovascular functions, and death. It mobilizes from a woman's bones during pregnancy and may expose the fetus. Exposure to lead, especially *in utero* and in children, could result in impaired neurodevelopment, behavioural deficits and lower functional skills during childhood and later in life. There is no known threshold for the effect of lead. The US EPA has determined that lead is a probable human carcinogen, associated with lung and kidney cancer.[27] Lead has been shown to have similar adverse effects in animals.

- **Hexavalent Chromium (Chromium(VI)):** Chromium(VI) compounds are known to be human carcinogens. Exposure occurs from ingesting contaminated food or water or breathing contaminated workplace air. Breathing high levels of chromium(VI) can damage the nose and can cause cancer. Ingesting large amounts of chromium(VI) can also cause stomach upsets and ulcers, convulsions, kidney and liver damage, and even death. Workers in occupations involving chrome plating production, chromate pigment production, leather tanning, and wood preserving are at increased risk of developing lung cancer.

National Picture on CEPA-toxic Metals from Pulp and Paper Mills

The following tables give a national overview of releases and disposals of these metals from pulp and paper mills over a 5-year period. Landfill is the method of disposal used by all mills. The NPRI gives data for on-site and off-site disposal separately. Disposal, whether inside a fenced boundary, or nearby at a site owned by the same company, is still disposal. For this report, disposal totals these amounts.

Table 7a: Releases of CEPA-toxic metals (kilograms) from all mills – Canada-wide, 5 year trend

Year	Arsenic		Hexavalent Chromium		Lead		Cadmium	
	Air	Water	Air	Water	Air	Water	Air	Water
2002	179	2912	302	1215	954	2447	257	822
2003	495	3232	277	6456*	1691	2583	395	1012
2004	259	3745	257	1123	2714	2886	359	958
2005	264	3661	283	1121	2415	3341	321	932

[27]Refer to Interim reviews of Scientific information on lead and cadmium (October 2006) at the UNEP website: http://www.chem.unep.ch/Pb_andCD/WG/WG-meeting.htm

2006	274	3595	257	1090	2000	2366	317	1076

* One facility alone, AV Nackawic Inc. in New Brunswick, reported a release of 5405 kg to water in 2003.

Table 7b: Disposal of CEPA-toxic metals (kilograms) – Canada-wide, 5 year trend

Year	Arsenic	Hex. Chromium	Lead	Cadmium
2002	1775	4365	18115	3001
2003	2215	7347	17056	5251
2004	2584	3743	15956	4128
2005	2399	3576	15482	3677
2006	2407	3492	14864	3638
Total	**11380**	**22523**	**81473**	**19695**

The totals are for 5 years only. If the same levels of disposal are factored in for the lifetimes of the mills, which in many cases could be 50 years or more, then the levels in landfills could be at least 10 times these totals.

B.C. mills

The following table show release levels of the four CEPA-toxic metals to air and water for each B.C. mill for 2006.

Table 7c: Releases of CEPA-toxic metals to Air and Water (in kilograms) - BC mills 2006

Facility/Location	Arsenic		Hexavalent chromium		Lead		Cadmium	
	Air	Water	Air	Water	Air	Water	Air	Water
Mackenzie Pope & Talbot Ltd	4.9	109	11	16	117	31	7.3	6
Nanaimo Pope & Talbot Ltd	2.1	262	8.4	39	18	73	5.4	14
Skookumchuck Tembec Industries Inc.	0.03	64	10	9.6	12	9.6	2.8	3.5
Quesnel Cariboo Pulp and Paper	6.6	34	13	29	52	53	4.8	10
Kamloops Weyerhaeuser Company Ltd	20	203	28	32	17	63	7.6	42
Mackenzie Paper Division Abitibi			4.9	1.2	6	2	1.8	4.7
Prince George Northwood Pulp Mill			17	34	39	6.2	13	8.6
Prince George Canfor Forest Products Ltd.	2.1	286	17	43	55	80	11	16
Crofton Catalyst Paper Corp	0.5	74	8	44	11	32	4.7	8.5

Elk falls, Campbell River Catalyst Paper Corp	8.4	211	11	30	3.2	55	5.9	27
Powell River Catalyst	1.5	29	13	2.1	17	64	2.8	17
Port Alberni Catalyst	0.76	12	6	1.5	49	12	16	3.1
Kitimat Eurocan Pulp&Paper			5.1	25	17	0.22	5.3	0
Port Mellon Howe Sound	0.4	177	14	0	23	21	3.7	54
Quesnel West Fraser Mills Ltd							0.5	
Total - B.C. Mills	**47**	**1461**	**166**	**306**	**436**	**502**	**93**	**214**
National Total - mills	**274**	**3673**	**257**	**1090**	**1999**	**2366**	**317**	**1076**
Percent - B.C. mills to National Total	**17.3**	**39.8**	**64.7**	**28.1**	**21.8**	**21.2**	**29.2**	**19.9**

Releases of arsenic to water are notable and represent about 40% of the national total. Also, emissions of hexavalent chromium to air are proportionally large compared to the national amounts.

The next table displays disposal levels of the 4 metals for each B.C. mill.

Table 7d: Disposal of CEPA-toxic metals (in kilograms) 2006 (BC mills)

Facility/Location	Arsenic	Hex. Chrom.	Lead	Cadmium
Mackenzie Pope & Talbot Ltd	8.4	30	165	28
Nanaimo Pope & Talbot Ltd	19	108	401	174
New Westminster Kruger Products	53		96	
Skookumchuck Tembec Industries Inc.	74	63	91	56
Quesnel Cariboo Pulp and Paper	38	47	285	19
Kamloops Weyerhaeuser Company Ltd	247	242	556	78
Mackenzie Paper Division Abitibi		68	227	20
Prince George (Northwood) Canadian Forest Products Ltd		21	109	29
Prince George Canfor Forest Products Ltd.	100	263	400	69
Crofton Catalyst Paper Corp	407	22	1009	36
Elk falls, Campbell River Catalyst Paper Corp	130	271	361	105
Powell River Catalyst Paper Corp	95	61	579	14.8
Port Alberni Catalyst Paper Corp	75	31	749	26
Kitimat Eurocan Pulp & Paper		34	208	21

Port Mellon Howe Sound	28	164	189	21
Norampac - Burnaby			30	5.4
Catalyst - Coquitlam	5.1			
Total	**1280**	**1425**	**5455**	**702**
National Total - mills	**2407**	**3492**	**15054**	**3638**
Percent B.C. mills to National Total	**53.2**	**40.8**	**36.2**	**19.3**

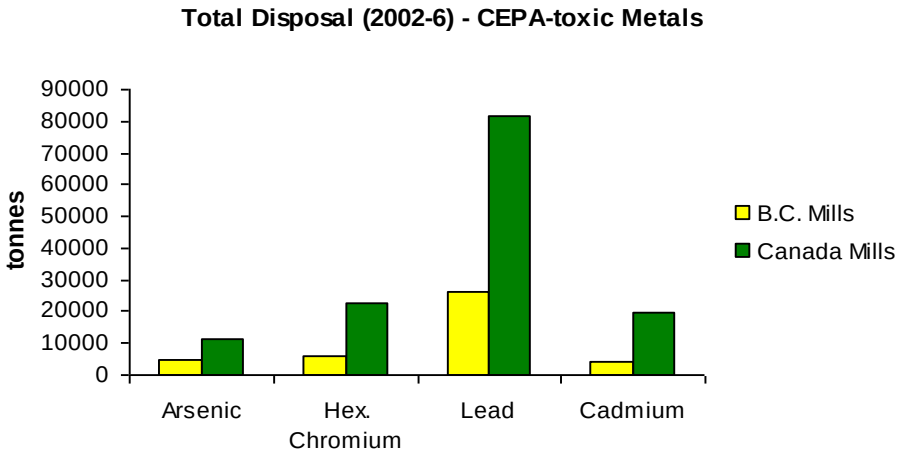
The disposal of these metals from B.C. mills is shown for 2002-6 below, along with the total disposal for that period and compared to the total disposal from all mills in Canada over that period.

Table 7e: Disposal of CEPA-toxic metals (in kg) - BC mills, 5 year trend

Year	Arsenic	Hex. Chromium	Lead	Cadmium
2002	498	1186	5129	719
2003	713	971	4241	704
2004	1293	1184	5720	989
2005	1134	1262	5414	756
2006	1277	1425	5456	715
Total	**4915**	**6028**	**25960**	**3883**
5-year Total - All mills in Canada	**11380**	**22523**	**81473**	**19695**
Per-cent B.C.	**43.2**	**26.8**	**31.9**	**19.7**

The following graph compares the 5-year total disposal levels of these 4 metals from B.C. mills to all mills in Canada.

Figure 3: Total Disposal (2002-06) CEPA-Toxic Metals



B.C. mills currently represent about 18% of all active mills in Canada. Yet disposal levels in landfills of arsenic, lead and hexavalent chromium from B.C. facilities are disproportionately and consistently high compared to the total for all mills in Canada.

Ammonia

The principal releases of ammonia to the environment from human activity come from a number of industries, municipal wastewater effluents and agricultural activities. Municipal wastewater treatment plants are the major sources of ammonia released to the aquatic environment (approximately 62 000 tonnes/year). Ammonia is also released in large quantities, mainly to air, by many industries such as pulp and paper mills, mines, food processing and fertilizer production.
Ammonia can become highly toxic to fish and other animals living in the water. Freshwater organisms are most at risk from releases of ammonia. Some of the observed effects include reduced reproductive capacity and reduced growth of young.[28]

The following table shows the four sectors that account for over 85% of air releases nationally (21,600 tonnes) in 2006.

Table 8a: Major Industrial Emitters of Ammonia (to Air) 2006– National

Facility	Releases (tonnes)
Pesticide, Fertilizer & Other agricultural and chemical manufacturing.	10042
Water, Sewage & Other systems	4866
Mining & Oil & Gas Extraction	2123
Pulp, Paper & Boardmills	1985

Gaseous ammonia is one of four primary precursor gases that contribute to secondary particle formation. The following table demonstrates releases of ammonia to air and water for all mills as well as for B.C. mills over the five-year period (2002-6).

Table 8b: Ammonia Releases (tonnes) - 5 year trend

	All Mills in Canada		B.C. mills	
Year	Air	Water	Air	Water
2002	2078	2194	719	833
2003	2077	2028	737	750
2004	2142	2106	771	848
2005	2088	1805	745	644
2006	1985	1748	706	653

As is evident from the above table, releases of ammonia to air and water are consistent over the 5-year period. B.C. mills consistently contribute to about 35 % of all releases to air and about 35-40% of releases to water.

Part 2: Criteria Air Contaminants

[28] http://canadagazette.gc.ca/partII/2003/20030702/html/sor229-e.html

Criteria Air Contaminants (CACs) are the subject of numerous international and bi-national agreements to which Canada is a party. These substances have well-known adverse efffects on human health and the environment. Sulphur dioxide and nitrogen oxides in their various forms affect respiratory systems of humans and animals, and cause damage to vegetation, buildings and materials. When combined with other substances, such as ammonia, they contribute to the formation of respirable (fine) particulate matter ($PM_{2.5}$).

Many individual **Volatile Organic Compounds (VOCs)** are known or suspected of having direct toxic effects on humans, ranging from carcinogenesis to neurotoxicity. The more reactive VOCs combine with nitrogen oxides (NOx) to form ground-level ozone, a major component of smog. VOCs are also a precursor pollutant to the secondary formation of $PM_{2.5}$.

Fine particulate matter ($PM_{2.5}$) penetrates deeply into the regions pf the lungs where there is no mechanism to remove them. Exposure to $PM_{2.5}$ is associated with several serious health effects, both chronic and short term, such as cardiovascular diseases, chronic bronchitis and asthma. It is also associated with increases in hospital admissions and premature death. There is no known threshold to exposure to $PM_{2.5}$. The most sensitive populations include people with asthma, cardiovascular or lung disease, as well as children and elderly people. $PM_{2.5}$ also contributes to environmental effects such as corrosion, soiling, vegetation damage, visibility deterioration and regional haze.[29]

Carbon Monoxide (CO) can have a significant impact on human health. It enters the bloodstream through the lungs and forms carboxyhemoglobin, a compound that inhibits the blood's capacity to carry oxygen to organs and tissues. Persons with heart disease are especially sensitive to CO poisoning, as are infants, elderly persons, and individuals with respiratory diseases. CO can affect healthy individuals, impairing exercise capacity, visual perception, manual dexterity, and learning functions.

The table below gives a provincial summary of emissions of CACs from mills across Canada for 2006.[30]

Table 9a: Provincial Summary of CAC Emissions from mills (in tonnes) for 2006

Province	No. of sites	SO_2	CO	NOx	VOCs	PM	PM_{10}	$PM_{2.5}$
British Columbia	21	14250	18263	10208	4762	9453	6724	4574
Prairies	11	5178	20164	6206	2232	5041	3326	2284
Ontario	19	4040	10771	5250	2333	4093	2931	2122
Quebec	36	22195	17124	11710	5512	4110	2742	1997
New Brunswick	9	9927	5860	4546	1651	1443	1116	944
Nova Scotia	2	386	3796	613	392	551	445	339
Newfoundland	2	1043	462	511	432	1137	442	183
Total[31]	**100**	**57019**	**76440**	**39044**	**17314**	**25828**	**17726**	**12443**
Total - all facilities		**1,777,545**	**1,048,669**	**826,843**	**271,182**	**198,835**	**110,646**	**62,672**
Percent of mills to total		**3.2**	**7.3**	**4.7**	**6.4**	**13.0**	**16.0**	**19.9**

[29] http://www.airqualityontario.com/science/pollutants/particulates.cfm
[30] The Appended file <CAC Emissions from Mills-Canada> features emissions of CACs from each facility for 2006.
[31] A number of facilities in Ontario (6) and Quebec (8) reported very little or no emissions and are not included in this table.

Pulp and paper mills contribute about 20% of the national total of emissions of $PM_{2.5}$ from all industrial sources reporting to the NPRI. B.C. alone contributes about 37% of that share.

Figure 4: Emissions of SO_2 and NOx (in tonnes) from Mills by Province/Region - 2006

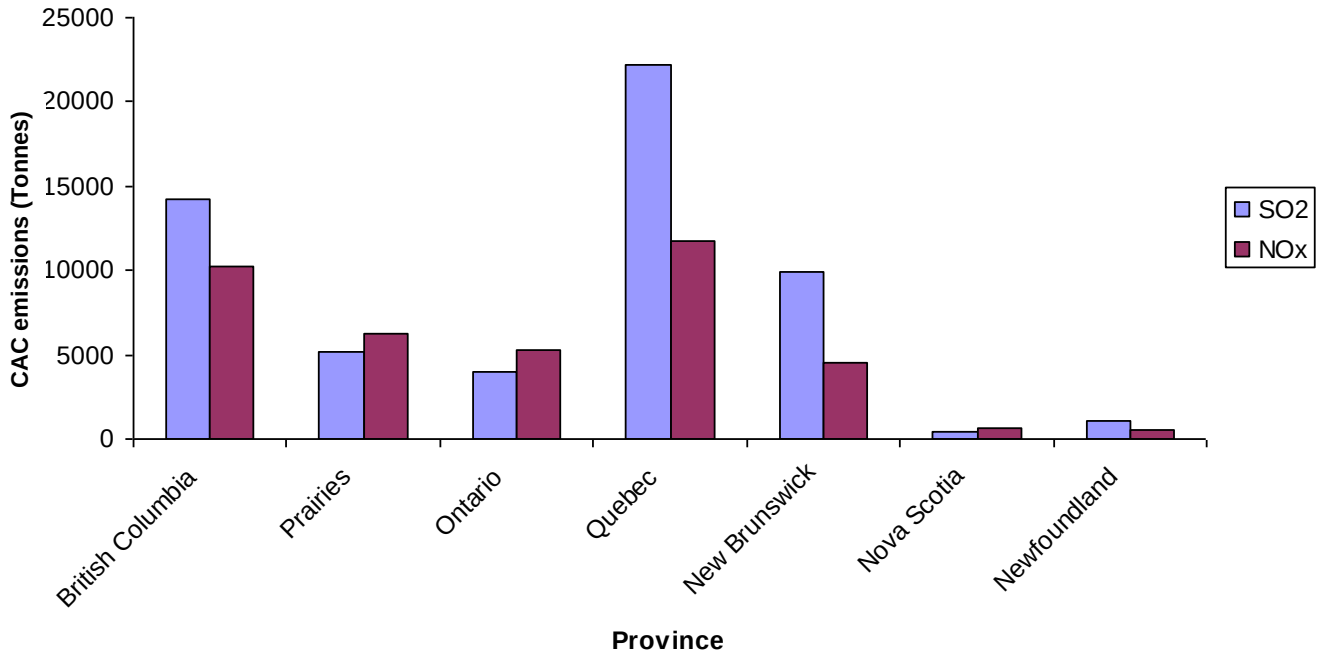
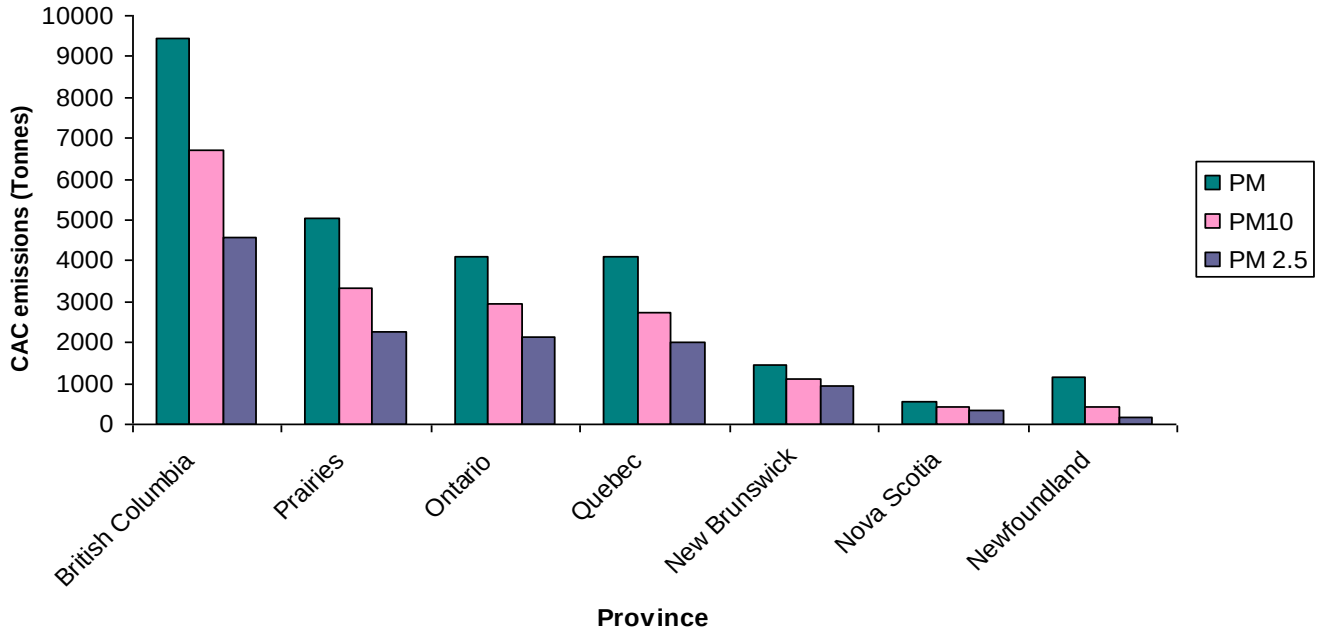


Figure 5: Emissions of Particulate Matter (in tonnes) by Province/Region - 2006



In examining individual mills in B.C., a number stand out as significant in terms of their contribution to NOx, SO_2 and PM $_{2.5}$ emissions as seen in the chart below.

Table 9b: Top 3 emitters in B.C.

NOx - tonnes		SO_2 - tonnes		PM $_{2.5}$ - tonnes	
Kamloops Domtar/Weyerhaeuser	1511	Crofton Catalyst Paper Corp	4133	Kamloops Domtar/Weyerhaeuser	897
Port Mellon Howe Sound	1262	Nanaimo -Harmac Pope & Talbot Ltd	2715	Prince George Northwood Pulp Mill	597
Crofton Catalyst Paper Corp	1018	Prince George (P.G.) P.G. Pulp and Paper	2610	Quesnel Cariboo Pulp and Paper	506
Total 3	**3791**		**9458**		**2000**
Total B.C. mills	10208		14250		4574
Per cent of B.C. mills	**37.1**		**66.4**		**43.7**

Trend Analysis of CACs

The first year for reporting CACs to the NPRI was 2002. There are likely some inconsistencies in reported emissions in the initial stages that would affect analysis of trends. In this case, the CAC inventory is used to indicate trends for the industry as a whole. (This inventory also includes some air emissions from area sources in facilities that may not be required to report to the NPRI. It also includes ammonia).[32]

Table 9c: CAC Inventory Emission Trends - Pulp and Paper Industry Canada (tonnes)

Pollutant	2002	2003	2004	2005	2006
SOx	72,858	76,872	74,992	65,464	59,567
TPM	34,312	40,429	34,412	29,589	25,667
PM_{10}	23,671	29,458	25,379	21,242	17,920
$PM_{2.5}$	17,325	21,243	17,555	15,031	12,650
NOx	51,809	50,326	52,095	44,147	37,931
CO	118,858	117,376	102,074	92,117	75,081
VOC	25,403	25,604	20,087	19,592	17,515
NH_3	3,975	2,272	1,875	1,872	1,991

Since it is not known what facilities have been included in the inventory, it is not possible to reconcile differences between the NPRI numbers in Table 9a (for 2006) and that of the CAC inventory for that same year. The numbers are reasonably close, with some slight difference for SOx (which is treated as SO_2). [33] While there is a downward trend in these emissions, to what degree closures (temporary and permanent) have played in this trend is not clear.

Part 3: Hazardous Air Pollutants (HAP)

[32] http://www.ec.gc.ca/pdb/cac/Emissions1990-2015/emissions_e.cfm
[33] SOx includes SO, SO_2, etc. expressed in terms of SO_2 equivalents.

The following table gives a snapshot view of air emissions of seven of these substances for 2006 for both all of Canada and BC specifically.

Table 10: Hazardous Air Pollutants Releases to Air (tonnes) – 2006

Substance	All mills (NAICS 3221)	BC mills
Methanol	10,931	4354
Manganese compounds	63	30
Hydrogen Sulphide	929	368
Hydrochloric Acid	2001	1702
Chlorine	75	0
Chlorine Dioxide	397	119
Phenol	289	34
Methyl ethyl ketone	39	0

Emissions from BC mills account for a fairly large portion of national emissions for five of these substances, in particular, hydrochloric acid, manganese and methanol. While the principle issue of concern with these substances is air releases, manganese compounds are being released in significant levels to water. Total water releases in 2006 were 1209 tonnes (B.C., 315 tonnes), while disposal levels were 2744 tonnes (B.C., 937 tonnes).

Two of these substances (manganese and hydrogen sulphide) are featured below because of a number of issues deemed significant.

Manganese compounds

Manganese is an essential trace element. While ingesting small amounts from food or water is critical to being healthy, high levels of exposure to manganese (from air, water and food), mainly through inhalation, can cause damage to the brain, liver, kidneys, and the developing fetus.[34] Long-term occupational exposure can result in irreversible damage to areas of the brain that control balance, movement, and fine motor coordination characteristic of Parkinson's Disease (PD) and place workers at much greater risk of developing PD itself.[35]

In areas where groundwater levels of the toxic metal are relatively high, children who received the highest doses of manganese in their drinking water have been observed to have significantly lower scores on tests of intellectual function.

Emissions of manganese on the NPRI are given in tonnes, whereas, emissions of most CEPA-toxic metals are in kilograms. While manganese has not been profiled as a concern similar to CEPA-toxic metals, recent discussions held by Health Canada indicate that concerns, especially regarding Parkinsonian –like symptoms, from exposure to manganese deserve attention.

Hydrogen Sulphide (H_2S)

[34] http://www.hc-sc.gc.ca/ewh-semt/air/out-ext/effe/manganese/discussion_1-eng.php
[35] http://www.niehs.nih.gov/health/impacts/manganese.cfm

Hydrogen Sulphide (H_2S) is one of a number of compounds referred to as Total Reduced Sulphur (TRS) and is particularly relevant to pulp and paper operations. These sulphur compounds are often associated with the unpleasant odour of rotten eggs or cooked cabbage.[36] Once released into the atmosphere, the oxidation products of TRS compounds, such as sulphuric acid, contribute to the acidity of the environment. The most commonly reported health concerns related to TRS substances are nausea and headaches, although each TRS compound has its own characteristics and effects.

Emissions of TRS compounds are often a signature of Particulate Matter and VOC emissions. The pulp and paper industry and upstream oil and gas facilities are the largest industrial sources of TRS in Canada. In addition to H_2S, other TRS substances pertinent to pulp and paper facilities include methyl mercaptan (CH_3S-H), dimethyl sulphide (CH_3-S-CH_3) and dimethyl disulphide (CH_3-S-S-CH_3).

H_2S has been the only one of these four substances reported to the NPRI. Up until and including the 2006 Reporting Year, Ontario has been the only province to report emissions of TRS.[37] However, for 2007, reporting of TRS emissions requirements to the NPRI apply nationally.[38]

While it is currently impossible to compare TRS emissions across the country, the 2006 Ontario data and the preliminary (unreviewed) 2007 NPRI data give an indication of the level of air emissions of these substances from pulp and paper mills.

Table 11: TRS and H2S releases

	TRS (tonnes)	H_2S (tonnes)
B.C.(2007)	1300	290
Ontario (2007)	881	238
Canada (2007)	3001	704
Ontario (2006)	1740	232

Notes:

- BC (2007 data): The major emitters of TRS are; Canfor (Prince George) – 542 tonnes, Crofton – 220 tonnes, Kitimat – 167 tonnes.
- Ontario: The decrease in TRS releases in 2007 is due to the closure of two mills in the fall of 2006, which emitted over 1000 tonnes of TRS in that year.

Given that the 2007 data is preliminary and has yet to be reviewed by Environment Canada, the data indicates the importance of including TRS. Exclusion of a substance or substances from the NPRI cannot be taken as meaning that emissions of these substances are insignificant.

[36] TRS refers to a group of compounds – hydrogen sulphide, carbon disulphide, carbonyl sulphyde, mercaptans, dimethyl disulphide, diethyl disulphide, thioesters and alkyl sulphides.
[37] Hydrogen sulphide, carbon disulphide, and carbonyl sulphide are reportable substances to the NPRI.
[38] Ontario has been reporting TRS provincially and as of 2006, to the NPRI. For the 2007 Reporting Year, TRS will be reported (in H_2S equivalents) and will include the above 4 compounds as well as carbon disulphide (CS_2) and carbonyl sulphide (COS).

G. Spotlight on Three Specific Mills

The Crofton Mill: Active, Large Emitter – A Pollutant Profile

The Crofton mill was built in 1957. It is a Kraft and thermo-mechanical mill producing specialty paper, newsprint and market pulp. In its 2005 annual report, it indicated production levels of 339,000 Megatonnes (Mt) directory paper, 103,000 Mt Newsprint and 319,000 Mt NBSK pulp. The types of fuel uses are salty hog, oil, gas and sludge.[39]

A number of studies have been carried out on the Crofton mill, in particular, "Baseline Air Quality Modelling and Human Health Risk Assessment of Current Day Emissions from NorskeCanada Crofton Division" by Jacques Whitford October, 2004 and a peer review of this study in 2005.[40]

The peer review report by RWDI AIR Inc. (RWDI) and PIONEER Technologies Corporation (PIONEER) noted significant deficiencies in the Whitford study which relate to emission inventory, dispersion modelling of the contaminants, and the health risk assessment. In particular,

- Emissions and associated risk may have been significantly underestimated.
- Deficiencies exist specifically in regards to the absence of site specific meteorology to generate wind fields. The air dispersion modelling may not provide the most realistic assessment of maximum concentrations and their location.
- The Baseline Health Risk Assessment does not evaluate indirect exposure pathways and sensitive sub-populations. Furthermore, cumulative risks and hazards were not calculated.

The following table indicates trends in releases of CACs for 2002-6 (NPRI data). (Note: The 2007 data has not yet been reviewed by Environment Canada.)

Table 12a: CAC emissions (in tonnes) - Crofton 2002-7

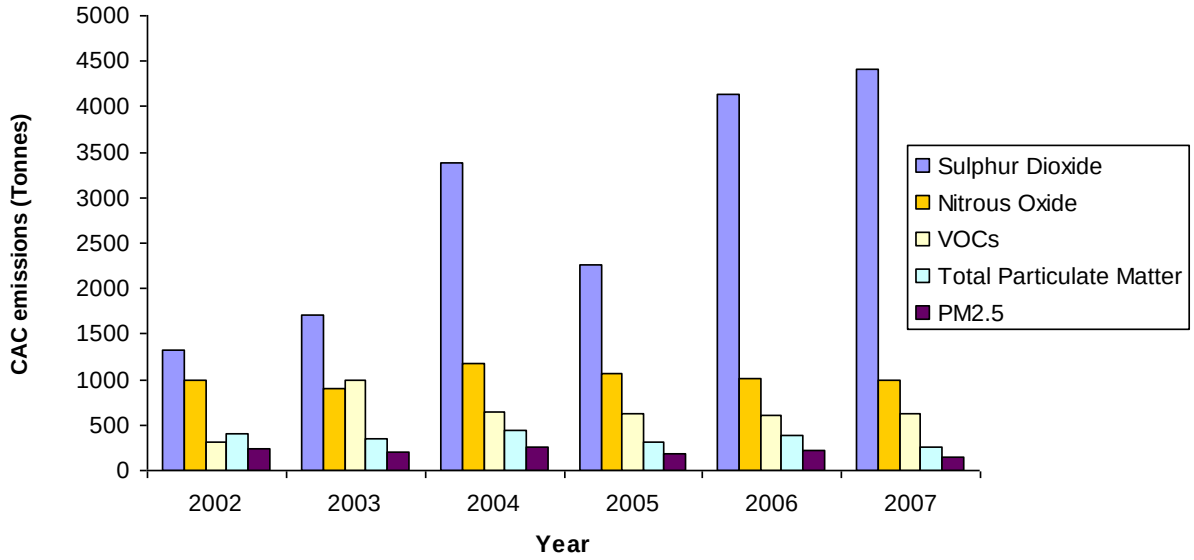
Substance	2002	2003	2004	2005	2006	2007
Sulphur Dioxide (SO_2)	1327	1711	3388	2266	4133	4414
Carbon Monoxide (CO)	965	925	1089	1333	1302	1267
Nitrous Oxides (NOx)	986	904	1176	1058	1018	986
Volatile Organic Compounds (VOCs)	304	997	642	620	609	633
Total Particulate Matter (TPM)	405	352	442	308	383	256
PM_{10}	349	304	371	261	324	217
$PM_{2.5}$	235	209	258	187	224	155

The following graph highlights emissions of SO_2, NOx, TPM, VOCs and $PM_{2.5}$ for 2002-7.

[39] http://www.rfu.org/cacw/BC%20Mill%20Tour.htm and http://www.rfu.org/cacw/Mill%20Tour/Crofton.htm

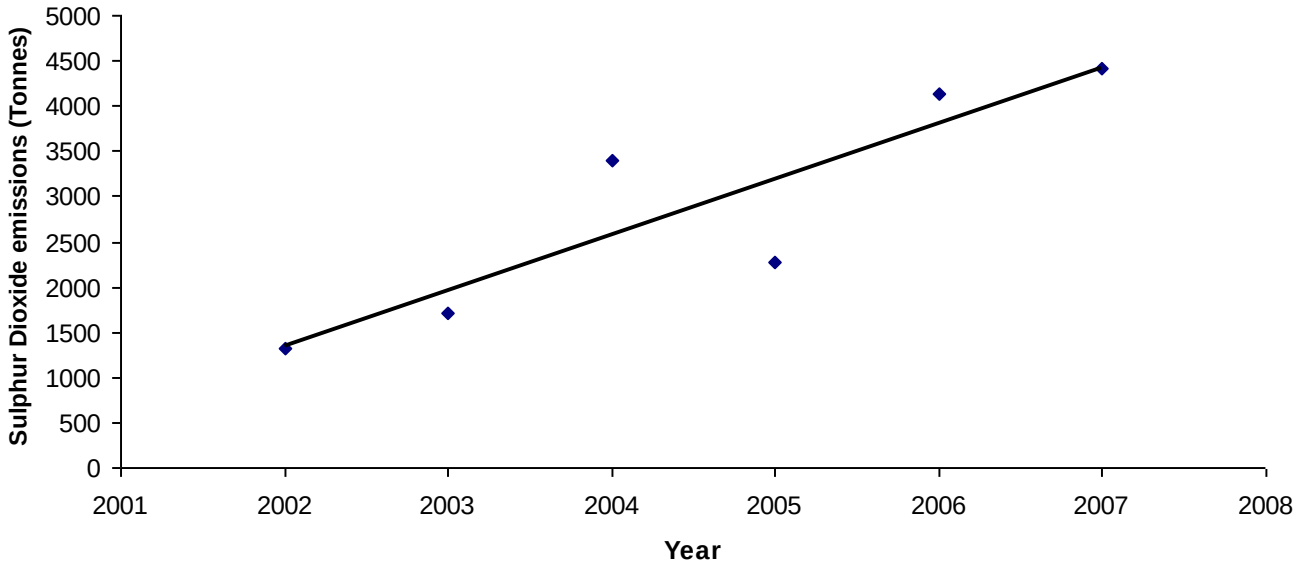
[40] The RWDI study was retained by the Crofton Airshed Citizens Group and Reach for Unbleached. Refer to the reports on Reach for Unbleached website for details. http://www.rfu.org/navigation/Librarydocs/RWDI050425Final.pdf

Figure 6: SO_2, NOx, TPM, VOCs and $PM_{2.5}$ for 2002-07



SO_2 emissions are increasing at a rate of approximately 600 tonnes per year during 2002-7, as shown in the next graph.

Figure 7: Emissions of SO_2, 2002-07



While emissions of some CACs have increased over 5 years, particularly for Sulphur Dioxide and VOCs, the reliability of 2002 data may be questioned as it was the first year of reporting CACs. However, the 2006 emission levels are indicative of a status quo for most CACs, with the exception of Sulphur Dioxide.

The next table shows releases of NPRI-reported substances to air and water for 2002-6.

Table 12b: Crofton (Catalyst Paper) - Releases of NPRI Substances – 2002-06

Year		2002		2003		2004		2005		2006	
Substance	**Units**	**Air**	**Water**	**Air**	**Water**	**Air**	**Water**	**Air**	**Water**	**Air**	**Water**
Acetaldehyde	tonnes	18	1.4	12	0.42	17	0.41	17	0.4	17	0.39
Ammonia (Total)	tonnes	64	36	64	28	50	29	53	10	54	9.3
Carbonyl sulphide	tonnes					10		11	-	11	
Chlorine dioxide	tonnes	4.9		5.6	5.6	6.4		4.5	-	3.3	
Dichloromethane	tonnes			29	0.51						
Formaldehyde	tonnes			21	0.98	10	0.96				
Hydrochloric acid	tonnes	698		424		410		465	-	495	
Hydrogen sulphide	tonnes	72		82		70		63	-	60	
Manganese (and its compounds)	tonnes	0.16	22	0.15	22	0.12	36	0.09	35	0.05	28
Methanol	tonnes	555		882		380		313		314	13
Methyl ethyl ketone	tonnes			11	0.04						
Nitrate ion in solution at pH >= 6.0	tonnes		131		102		106	-	38		34
Phenol (and its salts)	tonnes					14		14		14	
Phosphorus (total)	tonnes				39	0.12	30	0.12	28	0.12	24
Sulphuric acid	tonnes		11			9.9		9.9		10	
Zinc	tonnes			11		0.64	1.7	0.48	1	0.39	0.85
Arsenic (and its compounds)	kg	2.4	55	2.1	56	1.2	77	1.2	75	0.54	74
Cadmium (and its compounds)	kg	6.3	5.5	5.6	5.6	5.4	8.8	5.2	8.6	4.7	8.5
Hexavalent chromium compounds	kg	16		15	47	8.3	46	8.3	45	8.0	44
Lead (and its compounds)	kg	20	28	19	28	19	33	16	32	11	32
Mercury (and its compounds)	kg	2.3	0.55	2.2	0.56	1.9	0	1.6	0	1.2	
PAH (total)	kg	0	0	10.6	0	176	0	185.2	0	191.3	0
Hexachlorobenzene	grams					16	72	26	-	30	
Dioxins and furans	g TEQ			1		1		0.25		0.12	

The next table displays disposal of NPRI substances over 5 years along with totals. Individual Polycyclic Aromatic Hydrocarbons (PAHs) are shown in italics. The total PAHs are given at the bottom of the table.

Table 12c: Disposal - On/Off-site - Crofton (Catalyst paper)

Substance	Units	2002	2003	2004	2005	2006	Total
Manganese (and its compounds)	tonnes	12.8	16.8	133	118	55	336
Zinc (and its compounds)	tonnes			20.3	18.5	7.7	47
Phosphorus (total)	tonnes		79	120	105	122	426
Pyrene	kg		14	0.07	0.025	0.15	14.2
Benzo(g,h,i)perylene	kg		1.1				1.1
Benzo(e)pyrene	kg		1.2				1.2
Indeno(1,2,3-c,d)pyrene	kg		0.71				0.7
Perylene	kg		0.19				0.2
Benzo(b)fluoranthene	kg		1.2				1.2
Fluoranthene	kg		15	0.17	0.12	0.16	15.5
Benzo(k)fluoranthene	kg		0.71				0.7
Benzo(a)phenanthrene	kg		1.5				1.5
Benzo(a)pyrene	kg		0.94				0.9
Dibenzo(a,h)anthracene	kg		0.01	0.037	0.04	0.04	0.1
Phenanthrene	kg		27	1.5	0.22	0.28	29.0
Fluorene	kg						0.0
Arsenic (and its compounds)	kg	194	241	336.4	370.5	407	1549
Cadmium (and its compounds)	kg	26	31	74	69	36	236
Lead (and its compounds)	kg	288	380	1018	1030	1009	3725
Mercury (and its compounds)	kg	1.4	1.9	1.26	1.2	1.3	7.1
Hexavalent chromium compounds	kg	100	29	31	28	21.8	210
Hexachlorobenzene	grams	37	159	106	35	296	633
Dioxins and furans - total	g TEQ	11	16	32	23	25	107
PAHs (total)	kg	0	63.56	1.777	0.405	0.63	66.4

The Crofton mill exemplifies the issue of toxic legacy of outdated facilities that are still operating. Given the amount and range of pollutants released and disposed of, and the years that this facility has operated, and the present circumstances of this industry, the potential for closure must be considered. This mill would leave one huge toxic legacy.

Squamish: Closed Legacy Site

The kraft pulp mill at Squamish (owned by Western Forest Products), built in 1918, closed in 2005. Data on disposal of NPRI substances is shown for 3 years only, 2002-4 as this represents the most consistent period for reporting requirements. It also gives some idea of the scale of emissions released over the 85-year lifespan of the mill. (As in the case for the Crofton mill, individual Polycyclic Aromatic Hydrocarbons (PAHs) are shown in italics. The total PAHs are given at the bottom of the table.)

Table 13: Disposal - On/Off-site – Squamish

Substance	Units	2002	2003	2004	Total
Manganese (and its compounds)	tonnes	4.2	5.1	6.9	16

Phosphorus (total)	tonnes			12	12
Pyrene	kg	6	8.3	9.1	23.4
Dibenzo(a,i)pyrene	kg	0.03	1.2	0	1.23
Benzo(g,h,i)perylene	kg	4.2	2.9	2.8	9.9
Benzo(e)pyrene	kg	3.9	4.7	3.3	11.9
Indeno(1,2,3-c,d)pyrene	kg	3.7	2.3	2.3	8.3
Perylene	kg	0.78	0.48	0.54	1.8
Benzo(j)fluoranthene	kg	2.6	3.7	0	6.3
Benzo(b)fluoranthene	kg	2.6	3.7	3.3	9.6
Fluoranthene	kg	5.1	12	12	29.1
Benzo(k)fluoranthene	kg	5.4	2.9	3.1	11.4
Benzo(a)phenanthrene	kg	4.2	0.01	0	4.21
Dibenz(a,j)acridine	kg	0	0.01	0	0.01
Benzo(a)pyrene	kg	4.7	2.6	2.5	9.8
Dibenzo(a,h)anthracene	kg	0.24	0.14	0.23	0.61
Benzo(a)anthracene	kg	4.5	2.9	3	10.4
Phenanthrene	kg	8.1	18	23	49.1
Arsenic (and its compounds)	kg	6.5	8	13	28
Cadmium (and its compounds)	kg	3.6	4.4	6.1	14
Lead (and its compounds)	kg	103	115	138	356
Mercury (and its compounds)	kg	0.014			0.014
Hexavalent chromium compounds	kg		25	31	56
Hexachlorobenzene	grams	0	0.005	0.014	0.019
Dioxins and furans - total	g TEQ	2	2.6	2.6	7.2
PAHs (total)	kg	56.05	65.84	65.17	187.06

The mill has been closed for over two years. It is under new owners, China International Tourism & Trade Ltd, and has been disassembled, sitting at the docks in Nanaimo, waiting to be shipped to China to be reassembled as a Kraft mill. Meanwhile, what is the status of the site? Who is responsible for cleaning up the site? Has any remediation been done to the site?

Harmac – Nanaimo: Medium Emitter Future Unknown

In May 2008, the Harmac pulp mill in Nanaimo, built in 1950, was closed, its owners, Pope and Talbot, facing bankruptcy. After five months of being idle, the mill has re-opened under new ownership.

The following table shows the level of releases of pollutants to air and water for 2002-06.

Table 14a: Harmac (Pope and Talbot) - Releases of NPRI Substances - 2002-06

Year		2002		2003		2004		2005		2006	
Substance	**Units**	**Air**	**Water**	**Air**	**Water**	**Air**	**Water**	**Air**	**Water**	**Air**	**Water**

Acetaldehyde	tonnes	14	1.2	15	1.3	15	1.3	15	1.3	12	0.59
Ammonia (Total)	tonnes	72	40	70	53	70	53	72	39	55	53
Chlorine dioxide	tonnes	3.7		3.7		2.1		0.28		0.266	
Formaldehyde	tonnes					8.5	1.5	8.6	1.5	6.3	1.4
Cresol (mixed isomers and their salts)	tonnes	7.7	0.002								
Hydrochloric acid	tonnes	197		87		44	0	34		138	
Hydrogen sulphide	tonnes	38	9.8	52	11	57	11	55	10	55	9.5
Manganese (and its compounds)	tonnes	0.102	34	0.098	38	0.109	37	0.102	36	0.103	33
Methanol	tonnes	287	5.7	300	6.3	304	6.1	316	5.9	399	7.9
Nitrate ion in solution at pH >= 6.0	tonnes		41		45		7.3		28		7.1
Phosphorus (total)	tonnes			9.1	18	5.3	15	5.8	17	11	15
Sulphuric acid	tonnes	9.5	0	9.5		9.4	0	9.8	0	9	
Zinc	tonnes	0.164	2.3	0.158	2.6	0.173	2.5	0.163	2.4	0.167	2.3
Arsenic (and its compounds)	kg	1.8	270	1.9	297	2.3	290	1.9	279	2.1	262
Cadmium (and its compounds)	kg	5.5	15	5.3	16	5.4	16	5.4	15	5.4	14
Lead (and its compounds)	kg	18	76	17	83	19	81	18	78	18	73
Hexavalent chromium compounds	kg	8.6	41	8.4	45	8.5	44	8.6	42	8.4	39
Fluorene*	kg									0.605	
PAH total	kg	83.66	18.08	44.8	19.58	37.73	19.16	40.91	17.22	37.71	9.5
Hexachlorobenzene	grams	9.7		7.8		26		5.8		3.3	
Dioxins and furans	g TEQ	0.073		0.071		0.165		0.203	0.634	0.144	0.705

*Fluorene was first added to the NPRI for 2006

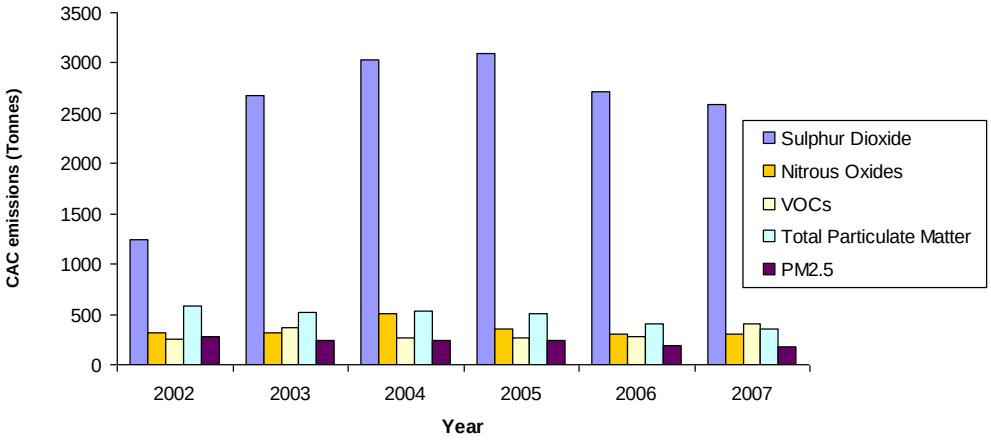
The next table and graph show releases of CACs from 2002-7 from the Harmac mill [41] (Note: The 2007 data is preliminary).

Table 14b: CAC emissions (in tonnes) - Harmac 2002-07

Substance	2002	2003	2004	2005	2006	2007
Sulphur Dioxide	1243	2671	3027	3098	2715	2591
Carbon Monoxide	3788	1428	1533	1483	1305	1140
Nitrous Oxides	311	311	512	357	302	305
VOCs	258	369	265	267	273	410
Total Particulate Matter (TPM)	581	516	528	511	407	358
PM_{10}	395	347	355	352	277	247
$PM_{2.5}$	273	239	247	245	191	177

[41] As in the case of Crofton, the 2002 data may not be as representative as the data for other years.

Figure 8: Emissions of SO_2, NOx, VOCs, TPM and $PM_{2.5}$ – Harmac 2002-07



There is no discernible trend in these emissions.

The following table displays disposal data for 5 years along with totals. Individual PAHs are shown in italics. The total PAHs are given at the bottom of the table.

Table 14c: Disposal - On/Off-site - Harmac (Pope and Talbot)

Substance	Units	2002	2003	2004	2005	2006	Total
Manganese (and its compounds)	tonnes	89	93	98	87.0	194	561
Zinc (and its compounds)	tonnes	22	23	24	23.0	20	112
Phosphorus (total)	tonnes		0.013	7.1	4.0	3.6	15
Pyrene	kg	1.2	1.3	1.3	1.00	0.945	5.75
Benzo(g,h,i)perylene	kg	0.291	0.259	0.451	0.31	0.293	1.61
Benzo(e)pyrene	kg	0	0	0	0.00	0	0.00
Indeno(1,2,3-c,d)pyrene	kg	0.098	0.107	0.093	0.08	0.072	0.45
Perylene	kg	0	0	0	0	0	0.00
Benzo(j)fluoranthene	kg	0	0	0	0.00		0.00
Benzo(b)fluoranthene	kg	0.974	1.0	1.1	0.86	0.79	4.72
Fluoranthene	kg	1	1.1	1.1	0.85	0.781	4.84
Benzo(k)fluoranthene	kg	0.166	0.122	0.332	0.21	0.202	1.03
Benzo(a)phenanthrene	kg	0.174	0.191	0.165	0.140	0.127	0.80
Benzo(a)pyrene	kg	0.263	0.229	0.425	0.289	0.273	1.48
Dibenzo(a,h)anthracene	kg	0.284	0.251	0.445	0.305	0.288	1.57
Benzo(a)anthracene	kg	0.34	0.312	0.498	0.350	0.329	1.83
Phenanthrene	kg	3.9	4	4.4	3.4	3.1	18.80
Fluorene	kg					0	0.00
Arsenic (and its compounds)	kg	24	24	25	22	19	114
Cadmium (and its compounds)	kg	193	204	205	196	174	972
Lead (and its compounds)	kg	472	478	514	445	401	2310
Hexavalent chromium compounds	kg	121	125	133	120.0	108	607
Dioxins and furans - total	g TEQ	6.0	6.0	6.0	6.0	5.2	29.2
PAHs (total)	kg	8.69	8.87	10.31	7.80	7.20	42.9

The Harmac mill has been a major employer and economic contributor to the town's industrial tax revenue. But after nearly 60 years of heavy operation, it has left a legacy of pollutants.

H. Spotlight on Dioxins and Furans

This section gives a brief description of federal programs and international agreements pertaining to dioxins and furans, with a particular focus on B.C. coastal mills related to effluent.

Canada – Overview of Programs

- Dioxins and furans were declared toxic under the *Canadian Environmental Protection Act (CEPA 1988*) following their assessment in 1990.[42]

- Dioxins and furans meet the criteria for virtual elimination under CEPA 1999, i.e., toxic, persistent, bioaccumulative, and result predominantly from human activity.[43] Furthermore, dioxins and furans have been slated for virtual elimination (VE) under the federal *Toxic Substances Management Policy (TSMP),* 1995 *and* the Canadian Council of Ministers of the Environment (CCME) *Policy for the Management of Toxic Substances*.[44] Dioxins and furans have not, however, been added to the Virtual Elimination List.

- Federal regulations on pulp and paper effluent: In 1992, the federal government enacted regulations to improve effluent quality, and to prevent the formation of and to control the release of chlorinated dioxins and furans. These regulations include the *Pulp and Paper Effluent Regulations* (PPER) under the *Fisheries Act, and* two regulations under CEPA, the *Pulp and Paper Mill Defoamer and Wood Chip Regulations,* and the *Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations.* [45]

- Canada-wide Standards (CWS) under the CCME were established for air emissions of dioxins and furans in 2001 for "Pulp and Paper Boilers Burning Salt Laden Wood" as well as other sectors.[46]

Pulp and Paper Mills – Effluent Regulations

The *Pulp and Paper Effluent Regulations* (PPER), under the *Fisheries Act,* 1992, limit the release of deleterious substances, namely, biochemical oxygen demand matter (BOD) and total suspended solids (TSS) in mill effluent. As well, the PPER prohibit the discharge of effluents that are acutely lethal to rainbow trout at 100% effluent concentration.

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[42] Refer to http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/contaminants/psl1-lsp1/dioxins_furans_dioxines_furannes/dioxins_furans-eng.pdf

[43] Refer to http://www.ec.gc.ca/CEPARegistry/the_act/ Section 77, CEPA 1999

[44] http://www.ene.gov.on.ca/envision/gp/A7appendix.pdf

[45] http://www.ec.gc.ca/eem/English/Publications/web_publication/smart_reg/c2_e.cfm

[46] http://www.ccme.ca/assets/pdf/d_and_f_standard_e.pdf

Mills were required to make changes in manufacturing processes and effluent treatment equipment and perform Environmental Effects Monitoring (EEM) on a 3-year cycle to assess the effects of their effluent on fish and fish habitat.[47]

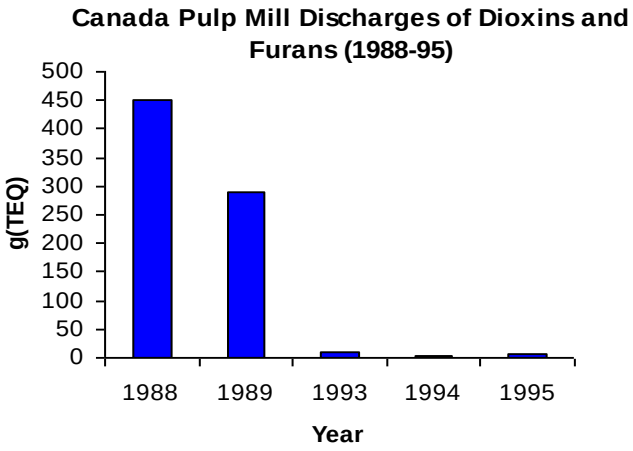
The *Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations* set maximum discharge limits for 2,3,7,8-tetrachlorodibenzo-para-dioxin (TCDD) and 2,3,7,8-tetrachlorodibenzofuran (TCDF), the most potent forms of dioxins and furans, for all mills using a chlorine bleaching process. Mills were required to achieve the discharge limit in the final effluent of 15 parts per quadrillion (ppq) for TCDD and 50 ppq for TCDF by January 1, 1994.[48]

The Pulp and Paper Mill Defoamer and Wood Chip Regulations are to prevent the formation of dioxins and furans and to limit the discharge of these substances from pulp and paper mills using a chlorine bleaching process. The defoamers used by these mills are limited to a maximum concentration of 10 parts per billion (ppb) of dibenzodioxin (DBD) and 40 ppb dibenzofurans (DBF).[49] In addition, these regulations ban pulp mills from using wood chips treated with pentachlorphenols (PCPs).[50]

These regulations have been instrumental in achieving major reductions in chlorinated dioxin and furans, BOD and TSS in effluent and in removing PCP completely from the feedstock.

The following graph illustrates the decrease in the annual discharge of dioxins and furans from forty-three pulp mills in Canada .The data was collected 1988 and 1989, and annually from 1993 to 1995.[51]

Figure 9: Dioxins and Furans to Water 1988-95



As seen from the graph, levels of dioxins and furans in effluent dropped from about 450 g (TEQ) in 1988 to 5 g (TEQ) in 1995. Since mills are in compliance, there are no further public reports on monitoring.

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[47] http://www.ec.gc.ca/eem/English/Publications/web_publication/smart_reg/c2_e.cfm
[48] http://www.ec.gc.ca/ele-ale/default.asp?lang=En&n=09ECE703&offset=2&toc=show#chap3
[49] http://laws.justice.gc.ca/en/showdoc/cr/SOR-92-268///en?page=1
[50] Pentachlorophenol (PCP) is a probable human carcinogen). It can cause damage to the liver, the immune system and possibly the thyroid and reproductive system. http://www.atsdr.cdc.gov/tfacts51.html#bookmark02
[51] http://www.ec.gc.ca/soer-ree/English/Indicators/Issues/Toxic/Tech_Sup/txsup6_e.cfm Note: The number of mills vary from 42 in 1996 to 43 in 1994.

Data and information available from government websites on regulations and the monitoring of effluent is sparse, outdated, difficult to locate and confusing, making it taxing for a public user to interpret. This could be easily avoided by providing a publicly accessible data base containing all environmental monitoring data from all mills in Canada and related regulations since 1992 to present.

B.C. Coastal Mills - Update

For years, nine pulp and paper mills have discharged secondary-treated effluent to the marine waters of B.C.[52] As a result of elevated dioxin and furan levels in edible fish and shellfish collected near these mill sites in 1987-9, the Department of Fisheries and Oceans (DFO) implemented the first dioxin-mediated shellfish closure in the vicinity of these mills. By 1995, additional areas were subject to harvesting restrictions, affecting nearly 1200 km^2 of B.C. coastal waters. Two years later, harvest restrictions were lifted from almost half of the closed areas.

Decisions as to fish harvest restrictions and closures are made by the DFO based on advice from Health Canada. However, in 2005, Health Canada lowered the Tolerable Daily Intake (TDI) level by a factor of almost 5 from a level that was set in 1990 (i.e., from 10 pg/kg-bw/day to 2.3 pg/kg-bw/day). This change should have an impact on any lifting of restrictions, and on fish consumption advisories. It is essential that fishing restrictions, closures and advisories be revised in accordance with the new TDI.

Even though some mill sites have shut down permanently[53] and mills are no longer dumping detectable levels of dioxin in effluent, in some marine areas, dioxin levels caused by historic dumping may not be dissipating and stay at or near the surface, thereby exposing organisms that live at or near the surface.

The south coastal region of B.C. has been subject to the cumulative impact of years of discharges of dioxins and furans into the waterways and loadings of dioxins and furans into landfills. No testing has been done on the impact of the exposure to dioxins and furans, mainly through food, on human health.

Dioxins and Furans Released to Air - Canada-wide Standard (CWS)

The CWS for dioxins and furans for the coastal pulp and paper boilers (2001) set targets (emission rates) for new and existing boilers and set out a process to examine pollution prevention opportunities to prevent the creation of dioxins and furans.[54] Airborne emissions of However, the CWS is an ineffective tool for a number of reasons.

- The CWS is a guideline and as such, is unenforceable. Industry is required only to make a "determined effort" and needs only to "explore" ways to prevent releases. While its ultimate objective is virtual elimination of dioxins and furans, there is no actual requirement for industries to work toward this goal.
- Its sole concern is the release of dioxins and furans to the atmosphere. It does not address the disposal of dioxins and furans nor their creation, except for the mention of pollution prevention.
- The CWS targets are based on stack exit concentration levels. But only emissions are reported to the NPRI. The relationship between stack exit concentration and emissions is unclear. Exit

[52] Reference: http://www.ecoinfo.ec.gc.ca/env_ind/region/dioxinfuran/dioxin_e.cfm .
[53] Three mills have shut down - Gold River (1998), Prince Rupert (2001), and Squamish (2006). The Harmac mill (Nanaimo) closed in May 2008 but is likely to reopen.
[54] http://www.ccme.ca/assets/pdf/d_and_f_standard_e.pdf . The targets for dioxin and furan emissions are: existing boilers -500 pg/m^3 by 2006; new boilers constructed after 2001-100 pg/m^3.

concentrations are based on annual one time stack tests lasting for a few hours while dioxins variability is high – clearly unrepresentative.
- There is no obvious way to determine a relationship between the CWS and the risk-based Tolerable Daily Intake level (TDI).
- The CWS makes no reference to the impact of releases on the surrounding community or environment.
- The 2003 review of the CWS Dioxins and Furans for Coastal Pulp and Paper stated that "there was no new significant information to warrant a review of the current standard at this time" and recommended no changes in the CWS. There was no indication of actions to prevent the creation of dioxins and furans, other than "studying alternative log movements to avoid contact with salt water".
- There have been no updates or reports since 2004 on the CCME website.[55]

International Agreements

Canada has signed and ratified two international agreements related to dioxins and furans.[56]

- Chlorinated dioxins and furans are listed on the United Nations Economic Commission for Europe's (UN ECE) Protocol on Persistent Organic Pollutants under the Convention on Long-Range Transboundary Air Pollution (LRTAP) as toxics with the potential for long-range transport through the atmosphere. Canada ratified the Convention in 1998.
- Under the Stockholm Convention on Persistent Organic Pollutants (the POPs Convention), chlorinated dioxins and furans and Hexachlorobenzene are listed as Unintentionally-Produced POPs , that is, they are produced and released unintentionally as the result of human activity, generated as by-products of incomplete combustion.

  Pulp production involving chlorine is named as one of four categories with the potential for high formation and release of these POPs into the environment. The goal of the Convention is continuing minimization of total releases and, where feasible, the ultimate elimination of releases. The Convention promotes the use of Best Available Techniques (BAT) for new sources.[57] Canada was the first country to sign and ratify the POPs Convention (May 2001).

The CAC inventory tracks air releases of dioxins and furans for reporting purposes for international agreements. For 2002-6, it reports the following releases from the pulp and paper industry:

Table 15: Dioxin and Furan Releases to Air, 2002-06 (CAC Inventory)

Year	2002	2003	2004	2005	2006
g TEQ	3.8	30.5	6.7	3.5	3.8

The 2003 value of 30.5 g TEQ is particularly out of line with the NPRI data for that year (5.4 g TEQ) and with data from other years. The variance of the figure for 2003 warrants investigation.

[55] http://www.ccme.ca/assets/pdf/df_p_p_2003_review_e.pdf
[56] http://canadagazette.gc.ca/partI/2004/20040124/html/notice-e.html
[57] Best Available Techniques (BAT) are defined by the European Commission (EC) Directive 96/61 as 'the most effective and advanced stage in the development of activities and their methods of operation which indicates the practicable suitability of particular techniques for providing the basis for emission limit values designed to prevent, and where that is not practicable, generally to reduce the emissions and the impact on the environment as a whole'.

While significant progress has been made in reducing dioxins and furans in effluent, the same cannot be said for releases into the atmosphere and for the disposal of dioxins and furans from 2002-6, due mainly to the continued use of salt-laden wood as fuel in B.C.

I. Proposed Federal Air Regulations for Pulp and Paper

The proposed federal industrial air regulations under the Clean Air Industrial Regulatory Agenda (CAIRA) were introduced in 2007. They include eighteen industrial sectors, including pulp and paper sector. These regulations are to be in force in 2010. The base year by which targets are being established is 2006. Facilities are being asked (Section 71 Notice under CEPA 1999) for information on emissions and process-level information for 2006. The proposed targets for pulp and paper are indicated below[58]:

Table 16a: Proposed Targets for Pulp and Paper

	2006 Estimated Emissions (tonnes)	2015 Projected Emissions (tonnes)	2015 Emissions Target (tonnes)	% Change in 2015 from 2006
SO_2	61,500	59,853	41,700	-32%
PM	28,900	31,572	23,000	-20%

The estimated emissions are purportedly based on emission projections from the CAC inventory, which in turn, are based primarily on the NPRI for facility-specific emissions data. However, the estimated emissions in the table above do not correspond with either the CAC inventory or the NPRI.

The following table shows a comparison of data from the CAC inventory and the NPRI. The NPRI data were obtained from three sources: the list of 114 mills identified as Pulp and Paper Reporters by Environment Canada; the status of pulp and paper mills (126 mills) prepared for this report; and searching by the industrial code NAICS 3221.

Table 16b: 2006 Emissions (tonnes)

Source	SO_2	PM	Comment
CAC Inventory	59,567	25,667	120 facilities - not known which ones
NPRI:			
114 mills	53,780	24,539	facilities indicated by Environment Canada
126 mills	56,329	25,788	facilities included in this report on status of sector
NAICS 3221	55,781	25,185	Searching by code

This clearly shows the lack of reliability of the information required to establish and enforce a regulation. Furthermore, given all the plant closures that have occurred in this industry, the projected emissions reductions might easily be achieved without any restrictions on the emissions of individual facilities.

[58] Clean Air Regulatory Agenda - Regulatory Framework for Industrial Air Emissions http://www.ec.gc.ca/doc/media/m_124/ppt/tech_eng.htm

Further comments on the proposed regulation:

- The only pollutants covered are SO_2 and PM. Other highly toxic air pollutants, in particular, fine particulate matter ($PM_{2.5}$) and CEPA-toxic substances are not being regulated.
- The accuracy of the data, especially for PM, is highly questionable, as has been acknowledged by EC's NPRI staff. Facilities are not required to measure or monitor emissions directly. They are not required to go beyond the indirect determinations they are currently using, whose accuracy is completely unknown. Since we have no way of knowing the accuracy of the data on base year levels, it is impossible to determine whether any reductions have even been achieved, let alone what their magnitude might be.
- It is not clear which mills are covered under the proposed regulations. The list of mills from EC contains some facilities that were shut down over 2 years ago, and other facilities that make finished products, etc. EC does not have an up-to-date list of operating mills, temporary shutdowns or closures.
- Based on closure/lay-off information from NRCAN, a number of facilities have shut down permanently, or operated on a part-time basis in 2006-8. This information is not given in a form (i.e., codes) that is easily comparable with that being used by Environment Canada. Government departments need to provide information in a consistent, compatible format.
- The impact of closures on regulations and emission reduction is critical. For example, a reduction in emissions of 10-20% nationally could be a result of shut-downs, to say nothing of poor-quality data.
- It is not clear how the implementation of a national reduction target would be applied to individual mills, how they would be monitored, or who would enforce the regulation and how this would be done.
- The role (if any) of the provinces is not clear.
- A national emissions trading scheme is being proposed for SO_2. This will not effectively reduce emissions in local communities if mills can buy their way out through trading.

Regulation-permits: (Provincial/Federal Issues)

The regulatory and provincial permit requirements are inconsistent and inadequate across the nine provinces for pulp and paper mills.

- Emission limits for CACs, TRS (H_2S) from stacks, recovery boilers etc. vary from province to province and for individual mills.
- Facilities have no time limits imposed on their permits as to how many years they can operate.
- Operating permits do not include any contingency plans for shut downs or for remediation and associated costs.
- Measuring and testing requirements are not indicated for some provinces. There are next to no requirements for installing Continuous Emissions Monitoring (CEMs) with the exception of CEMs for SO_2 in B.C. Alberta, and New Brunswick.
- Ambient air limits range considerably, with Quebec being the most lax.
- Feedstock: Mills use a variety of feeds for the operations – some of which should be banned outright, such as salty hog fuel.

There are instances where pulp and paper mills have not been in compliance with existing federal regulations and concerns as to whether the federal government has failed to effectively enforce these

regulations, for example, by not conducting on-site inspections of these facilities.[59] By making different agreements with different provinces regarding enforcement, the federal government has abdicated its responsibility to enforce its own regulations.

J. Federal Failure

While federal regulations, in particular, effluent regulations, have been effective in the early 1990s, the failure of the federal government to take effective measures to reduce pollution from pulp and paper mills across Canada is demonstrated in several ways. For example,

- A mishmash of programs on the Pulp and Paper Sector have been started, but either aborted or ineffective e.g., Canada-wide Standards, Multi-Pollutant Reduction Analysis Work MERAF-2002, Pulp and Paper Air Quality Forum; Forest Sector Sustainability Sector Table, etc.

- The industry is not being properly tracked and monitored, as indicated by using industry codes that are inconsistent and incomplete, to not knowing what mills are actually operating, or what is being monitored, whether reductions in emissions are real or due to shut downs etc.

- Rather than developing effective federal regulations on air pollutants, the federal government has proposed Regulations (Air) whose premises are flawed, and are based on data whose accuracy cannot be verified. What's more, they address only two pollutants.

- *CEPA 1999* has not been well utilized or improved upon where needed. For example,
    - **CEPA-toxic substances:** Risk assessments on these substances are deficient in a number of ways. They do not incorporate cumulative health effects, concurrent exposure to other substances or exposure via other pathways of in the criteria for toxicity. They do not consider people at higher risk of exposure due to their occupation or those who are more sensitive to these substances. The assessment reports are not updated to take into account new information on toxicity.
        - The risk management strategies only consider a limited range of human activities that lead to releases of toxic substances.
        - There is no evidence that releases of CEPA-toxics are being monitored to determine whether reductions are really occurring. There is no report or mechanism to review the effectiveness of these pollutant abatement strategies, or to alter them if they are not effective.
- **NPRI:** Several issues related to data quality, reporting thresholds, ease of public use, coverage of pollutants etc. need to be addressed, Above all, the lack of directly measured data or for that matter, any requirement that data be directly measured, is a very serious hindrance to developing and enforcing any policy or regulation that can only be based on accurate data. Only 31 of the 83 CEPA-toxic substances are even listed on the NPRI.

[59] Refer to Factual Record http://www.cec.org/files/pdf/sem/SEM-02-003-FR_en.pdf regarding the submission filed by Sierra Legal Defence Fund to the Commission for Environmental Cooperation (CEC) on 8 May 2002 as to enforcement under the *Fisheries Act* and of the 1992 *Pulp and Paper Effluent Regulations* (*PPER*) in the case of some pulp and paper mills in Ontario, Quebec, New Brunswick, Nova Scotia, and Newfoundland.

- **Pollution Prevention (P2)**: P2 is the cornerstone of CEPA 1999. There is no evidence that P2 is being required or carried out for pulp an paper mills, except for cases of emergency planning (e.g., regarding Chlorine Dioxide).
- **Chemical Management Plan (CMP)**:[60] The Challenge Program which deals with high priority substances (i.e., substances that are persistent, bioaccumulative and inherently toxic) has evolved into an exercise of requiring further new information from industry as to what action the government should take, in particular, whether they should be declared toxic under CEPA 1999.

    - Several of these substances are used in pulp and paper operations, many of which are carcinogenic and genotoxic. Undetermined amounts of these chemicals end up in pulp mill sludge, which, in turn, is used in recycled products and by-products and in land applications. However, to date, the screening assessments and the risk management scopes for these substances are limited. They have not incorporated life cycle analysis, and hence, do not address the fate of these substances. They do not account for the full range of routes and magnitude of exposure, in particular, occupational exposure and vulnerable populations. Nor are safer alternatives considered. Little if any data on releases of these substances is on NPRI, likely due to an inappropriately high threshold for reporting.

    - So far, the government has declined to declare some of these substances toxic despite years of work that has shown them to be persistent, bioaccumulative and inherently toxic.

- **International Commitments:** Inefficient attention is paid to emission data for pollutants that are the subject of international agreements. These include the Stockholm Convention on Persistent Organic Pollutants (dioxins and furans and HCB in particular) and the Convention on Long-Range Transboundary Air Pollution (LRTAP) which includes several protocols related to Criteria Air Contaminants, Heavy Metals, Polycyclic Aromatic Hydrocarbons and Volatile Organic Compounds (VOCs). Not only is the data quality in question, but the data that is presented has anomalies that are not explained and have possibly been overlooked.

Summary

Federal Regulations – Issues

There are a host of issues that need to be addressed, related to the effective federal regulations, improving data and information, managing toxic substances, and dealing with legacy resulting from closures.

Federal regulations can and do work, when appropriately designed and enforced.

- Effluent regulations introduced in 1992 under the *Fisheries Act* and the *Canadian Environmental Protection Act (CEPA)* were very effective in drastically reducing the levels of dioxins and furans

[60] http://www.chemicalsubstanceschimiques.gc.ca/plan/index_e.html

in pulp and paper mill effluent by 1995. Mills were required to make major investments to achieve these reductions. However, since 1995, no further action has followed and little investment has been made.

- A mishmash of non-regulatory federal and federal/provincial initiatives in the Pulp and Paper Sector have been developed, such as Canada-wide Standards, Codes of Practice, Multi-Pollutant Reduction Strategy and Foundation Reports (MERAF-2002), Pulp and Paper Air Quality Forum, Forest Sector Sustainability Sector Table, etc. These programs have been ineffective because they are not enforceable and not driven by a regulatory agenda.
- The new industrial air regulations proposed by the federal government in 2007 for pulp and paper mills deal only with two air pollutants, Sulphur Dioxide and Total Particulate Matter. They completely ignore other highly hazardous air pollutants, in particular, fine particulate matter ($PM_{2.5}$), but also many other CEPA-toxic substances. Furthermore, the accuracy of baseline data is so poor that the proposed reductions, small as they are, cannot be verified.
- Federal and provincial regulatory requirements and provincial operating permit requirements for pollution (water, air and waste) are inconsistent and/or incomplete. For example, monitoring and enforcement of *Pulp and Paper Effluent Regulations (PPER)* through separate agreements with different provinces has resulted in inconsistencies in compliance and enforcement and has sometimes allowed the federal government to avoid having to carry out on-site inspections.

Data and Information - Issues

There is no uniform system amongst governments to identify, track and monitor pulp and paper facilities.

- The industrial classification systems currently used are confusing and inconsistent. It is even left up to each facility to choose its own classification.
- Emissions data obtained through the National Pollutant Inventories are based primarily on estimations by industries, not on data that has been directly measured or obtained through on-site monitoring. There is no way of knowing how accurate this data is. This makes it difficult, if not impossible, to ascertain changes and trends.
- Little public information is provided on individual mill sites, and it is difficult to obtain. The government websites in general are cumbersome to navigate and not necessarily up-to-date. The National Pollutant Release Inventory (NPRI) is complicated in many ways, including the various reporting requirements for facilities and pollutants, and the data as presented is difficult to manipulate.
- There is no way to determine the proportion of emission reduction that is due to closures.

CEPA-Toxic Substances – Issues

The regime to assess and manage toxic substances under CEPA (1999) falls far short of what is needed.

- Many of the CEPA-toxic substances were declared toxic several years ago. Trend analyses for the pulp and paper industry, however, do not show any demonstrable change or reduction in their release levels.

- Risk assessment reports on these substances are cumbersome and deficient in many ways. They are outdated, and do not incorporate cumulative health effects, concurrent exposure to other substances, or exposure via other pathways in the criteria for toxicity. Nor do they take into account occupational exposure or sensitive populations.
- The risk management strategies adopted for these substances are limited in scope. There is no report or mechanism to review the effectiveness of these strategies or to alter them if they are not effective.
- Virtual Elimination (VE) – To date, only one substance, Hexachlorobutadiene (HCBD), is on the Virtual Elimination List. Dioxins and Furans and Hexachlorobenzene meet all the criteria yet have not been slated for VE.
- Chemical Management Plan (CMP): Many of the high priority substances (i.e., substances that are persistent, bioaccumulative and inherently toxic) are used in pulp and paper operations and disposed of in sludge, which, in turn, may be used in land applications. However, the risk assessment and management scope for these substances do not address the fate of these substances or their re-use in products or by-products, nor do they consider exposure to these chemicals by workers and vulnerable populations. So far, the government has backed away from declaring 9 out of 15 of these substances toxic under CEPA 1999.
- Several substances of concern (Hazardous Air Pollutants, US EPA) associated with pulp and paper mills in the U.S. are not under consideration in Canada.

Legacy – Issues

The closures of mills leave a legacy of contaminated sites that need attention.

- The level of pollutants released and disposed of in landfill (in particular metals and dioxins) is of great concern, particularly when considering the accumulation of these substances over decades of operation and their impact after the closure of these facilities.
- There is no clear liability, or responsibility for clean-up, remediation, etc., of mill sites that have been closed.

Each and every of these issues must be addressed. In doing so. the following actions are recommended:

- Implement federal regulation that incorporates standards based upon Best Available Techniques (BAT), pollution prevention strategies and that require substantial directly measured reductions.
- Require operating permits to be updated on a regular basis. Permits must include provisions for closure, such as including costs, posting bonds and remediation plans.
- Establish consistent policies regarding standards, inspections, and monitoring of both provincial and federal regulations and permit requirements.
- Use an appropriate classification system to clearly define the pulp and paper mill industry in Canada.
- Require emissions data to be derived through direct measurement and direct monitoring on a routine basis.

- Improve pollutant inventories in terms of quality of data, ease of use, and comprehensiveness of coverage.
- Ensure that public information on government websites on regulations and monitoring is consistent, up-to-date, and clear.

Author's Epilogue

There are coal towns, mill towns, mining towns, oil towns, etc., – many one-industry towns all over Canada. The dominance of one industry in a community forges interdependence, and at times, a strained relationship between community and industry. This touches on almost every aspect of life, from social concerns, health and well-being, to economic and environmental issues. As long as these facilities operate, both the benefits and the detriments to the neighbouring communities continue. When these facilities close down, the economic impact of losing the main source of employment that drives the local economy is the most immediate and often the most devastating. But in the long run, the environmental and human health costs are far more devastating and often overlooked. What remains is a legacy of sites contaminated by pollutants that have accumulated over years of operations. They present hazards to the communities nearby and well beyond for a long time after the facility that produced them is gone.

Researching information and data on pulp and paper mills in Canada has made me keenly aware of the significant role this industry has played in so many communities across the country. But recently, there has been great instability in this industry, in particular, from the impact of NAFTA on the softwood lumber trade and then, the dramatic downturn in the U.S. housing market. Effects such as mergers, changes in ownership, reduced production, closures, and bankruptcies are all too commonplace.

It has been a daunting challenge to determine what mills are operating and who is responsible for them. Moreover, the closures and temporary shutdowns of pulp and paper mills have made it all the more difficult to project future trends in emissions. To cite one example, two companies, Abitibi and Bowater, with major operations in Ontario and Quebec, have posted large losses in recent years. These companies merged in 2007 to form AbitibiBowater Inc. The newly formed company announced that it would launch "cost-cutting" measures – which have translated into mill closures, job losses and devastation to affected communities, despite the "not necessarily so" statements issued by the new company.

In 2002, 154 locations in Canada manufactured pulp and/or paper, 80% of which were located in B.C., Quebec and Ontario. Six years later, a dramatically different story emerges. The number of pulp and paper mills still operating has decreased to about 120 mills, production levels have dropped significantly, and tens of thousands of workers in this sector and forest-based industries have been laid off, in many cases, permanently.

Yet neither the federal government departments nor some provincial governments (e.g., Ontario) seem to have a clear picture of what mills are running, have shut down indefinitely or have permanently closed. Given the importance of this industry in Canada, government information on it should be far better than it currently is and access to such information should be publicly available. As it is, information on the status of mills in Canada that is publicly accessible is limited, unwieldy, and at times, inaccurate.

Many facilities have operated for several decades, with little, if any, changes to their provincial operating permits. In other words, they have been granted a license to pollute. But once a mill is "closed", not only is there a large contaminated area to deal with but there is also the potential for the migration of these substances into the water, food and the air well beyond the actual site itself. In the case of bankruptcy, the responsibility for the site and the clean up is typically borne by the government (i.e., the taxpayer), not the industry and to what degree a clean-up is done. Where that doesn't happen, the mill site becomes a forgotten legacy.

A Picture of two mills

An Active mill ….

Figure 13

Howe Sound Pulp and Paper Ltd.

Source: “The low-down on a High-Tech Industry” March 2006, http://www.paptac.ca/english/spotlight.pdf

A closed mill …..

Figure 14

Red Rock, Ontario (closed October 2006)

Photo courtesy of John Jackson, Great Lakes United (May 2008)

Appendix A. CEPA Toxics on NPRI

The following table lists the CEPA-toxics that are found on the NPRI as of 2007.

	Toxic Substances List - Schedule 1, CEPA 1999, December 27, 2006	
	Substances (Compounds)	**CAS Number**
1	Acetaldehyde	75-07-0
2	Acrolein	107-02-8
3	Ammonia dissolved in water	7664-41-7
4	Asbestos	1332-21-4
5	Benzene	71-43-2
6	1,3-Butadiene	106-99-0
7	1,2-Dichloroethane	107-06-2
8	Dibenzofuran	132649
9	Dibenzo-para-dioxin	*
10	Dichloromethane	75-09-2
11	Ethylene oxide	75-21-8
12	Formaldehyde	50-00-0
13	Gaseous Ammonia	*
14	Hexachlorobenzene	118-74-1
15	Hexavalent chromium compounds	*
16	Inorganic arsenic compounds	*
17	Inorganic cadmium compounds	*
18	Lead	*
19	Mercury	*
20	Nonylphenol and its ethoxylates	*
21	Nickel (Oxidic, sulphidic and soluble inorganic compounds)	*
22	Polychlorinated dibenzofurans	*
23	Polychlorinated dibenzo-para-dioxins	*
24	Polycyclic aromatic hydrocarbons (PAHs)	*
25	Respirable particulate matter less than or equal to 10 microns (PM_{10})	*
26	Sulphur dioxide	7446-09-5
27	Sulphur hexafluoride	2551-62-4
28	Tetrachloroethylene	127-18-4
29	Tetrachloromethane (carbon tetrachloride)	56-23-5
30	Trichloroethylene	79-01-6
31	Vinyl Chloride	75-01-4

Note: * indicates no unique CAS No.

Reference:
www.ec.gc.ca/CEPARegistry/subs_list/Toxicupdate.cfm

Appendix B. HAPs and CEPA-toxics

The US Cluster rules from the Federal Register, April 15, 1998, list the most prevalent compounds in the US industry. These compounds, identified by the US EPA as Hazardous Air Pollutants (HAPs)) are likely typical of the Canadian industry as well, and include the following substances.

Compound	**CEPA-toxic**
Acrolein	*
Acetaldehyde	*
Carbon tetrachloride (tetrachloromethane)	*
Benzene	*
o-cresol	
Chloroform	*
Cumene	
Formaldehyde	*
Manganese compounds	
Methanol	
methylene chloride (dichloromethane)	*
methyl ethyl ketone*	
methyl isobutyl ketone	
Phenol	
Styrene	
1,2,4-trichlorobenzene	
o-xylene	
mercury	*
cadmium	*
lead	*
Beryllium	
Dioxins and furans	*
PAHs	*

These substances, with the exception of beryllium, are listed on the NPRI.

Appendix C: National Pollutant Release Inventory

i) Limits to Information

The NPRI lists 367 pollutants as of the 2006 Reporting Year. This limiting feature leaves out several pollutants of concern in the pulp and paper industry and other reporting industries. Not all facilities are required to report their emissions. Area sources (e.g., transportation) are not included. Thresholds for reporting pollutants vary and a facility may not necessarily trigger reporting releases of a particular pollutant. Changes (such as additions of substances, thresholds and additional facilities required to report, etc.) are routinely made to the NPRI on an annual basis. These circumstances can affect the ability to report on trends with any degree or accuracy.

Many facilities that report do not give appropriate information about their operations, such as pollution prevention activities, even though it is required.

ii) Data Quality –Accuracy

Facilities are not required to measure or monitor their emissions for reporting purposes, although they may do so. They rely mainly on emission factors, which can vary as to their ability to predict actual emissions. The accuracy of data is not indicated.

iii) Ease of Use: Industrial Codes - Pulp and Paper Sector

The site can be awkward to navigate in a number of ways and not "user-friendly" by any means. It is extremely difficult and challenging to get specific sector information, which is based on industrial codes of various types, unless one is very familiar with the code system. For example, there is no way to access, "kraft mills" directly and get a list of just these facilities. While one can get a comprehensive list of substances emitted from a designated facility, to get a *comprehensive* list of facilities and emissions from the NPRI *directly* involves piecemeal assembly by the "user" – which is unwieldy and extraordinarily time-consuming. This begs the question of how the "public" can make use of the NPRI efficiently and effectively.

iv) Disposal data – NPRI: on-site versus off-site:

On-site disposal has been landfill. However, "offsite" is not clear. What is considered off-site for reporting purposes is not clear. The problem is that there is no requirement as to reporting the "receiver" of the off-site disposal material.

v) NPRI Reporting Thresholds

The reporting criteria for 232 core substances listed in the NPRI are:

- Employees worked a total of 20,000 hours or more (equivalent generally to 10 employee threshold) or the facility was used for an activity to which the employee threshold does not apply; **and**
- The amount of the substance manufactured, processed or otherwise used (M,P,O) at a concentration ≥ 1% by weight, plus the amount of the substance incidentally manufactured as a by-product at any concentration was ≥ 10 tonnes.[61]

This is referred to as the 10 tonne or conventional MPO threshold[62]. Alternate thresholds have been developed for a number of substances as follows:

NPRI Substance	Mass Threshold	Reporting Units
Arsenic (and its compounds)	50 kg (M,P,O)	kg
Lead (and its compounds)	50 kg (M,P,O)	kg
Hexavalent Chromium Compounds	50 kg (M,P,O)	kg
Mercury (and its compounds)	5 kg (M,P,O)	kg
Cadmium (and its compounds)	5 kg (M,P,O)	kg
Dioxins/Furans	Activity-based No threshold	g TEQ
Hexachlorobenzene (in grams)	Activity-based No threshold	g
Polycyclic Hydrocarbons (PAHs)	50 kg total, 29 individual species reported	kg
Carbon Monoxide	20 tonnes air release-based	tonnes
Oxides of Nitrogen	20 tonnes air release-based	tonnes
Sulphur Dioxide	20 tonnes air release-based	tonnes
Volatile Organic Compounds (VOCs)	10 tonnes air release-based	tonnes
75 Speciated VOCs	1 tonne air released, if 10 tonnes total VOC is met	tonnes
Total Particulate Matter	20 tonnes air release-based	tonnes
PM_{10}	0.5 tonnes air release-based	tonnes
$PM_{2.5}$	0.3 tonnes air release-based	tonnes

Dioxins and furans were added to the NPRI in 2000. Reporting is in grams (TEQ) and includes 17 congeners out of a total of 217 congeners. HCB was also added to the NPRI at that time with the same reporting criteria as dioxins and furans. Facilities using specifically identified activities had to report any releases and disposal of these substances in grams provided they met the 20,000 hour employee threshold.[63]

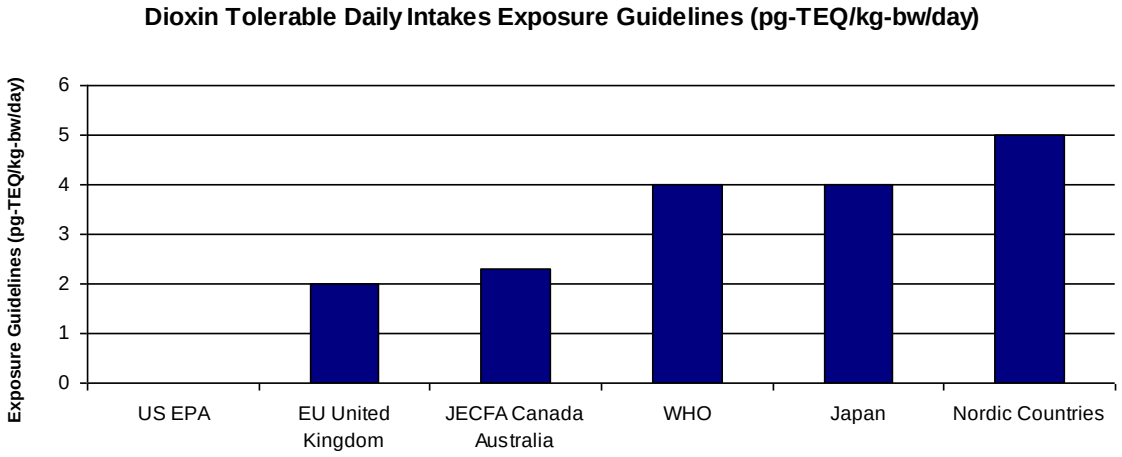
[61]. Refer to the NPRI Reporting Guide: http://www.ec.gc.ca/pdb/npri/2007Guidance/Guide2007/guide2007_e.pdf

[62] The manufacture, process or otherwise use values *are not necessarily the values to be reported*. These values only determine whether or not a substance needs to be reported.

[63] Combustion of hog fuel originating from logs transported or stored in salt water in the pulp and paper sector and combustion of fuel in kraft liquor boilers used in the pulp and paper sector were two designated activities.

Appendix D. Dioxins and Furans - Tolerable Daily Intakes (TDIs)

The following graph illustrates the range in TDIs adopted by various countries and agencies.[64]



JECFA: Joint FAO (Food and Agriculture Organisation) / WHO (World Health Organisation) Expert Committee on Food Additives

The USEPA has not established a reference dose for dioxin, but predicts that it would be 100-1,000 times lower than current background exposure levels. That theoretical reference dose is represented here as 0.001 pg-TEQ/kg-bw/day.

The following chart provides detail on the Reference Guidelines, Toxic Equivalents and their derivation from various governments and agencies.[65]

COUNTRY / AGENCY	YEAR	GUIDELINE (pg-TEQ/kg-bw/day)	DERIVATION	SOURCE
USEPA	2003	*RfD = 0.001	Range of effects from biochemical to adverse	USEPA
European Commission	2001	TDI = 2 (day)	Extrapolated from a 14 pg-TEQ/kg-bw/week. The TWI was derived using the LOAEL from a study showing developmental effects in male rat offspring following repeated subcutaneous administration of TCDD; applied uncertainty factor of 9.6	European Commission
WHO	1998	TDI = 1-4	Human daily intakes corresponding with body burdens similar to those associated with reproductive and developmental toxicity in animals estimated in the range of 14-37 pg/kg-bw/day. A composite uncertainty factor of 10 was	van Leeuwen et al, 2000

[64] Source: Chlorine Chemistry Council: http://www.chlorallies.org/exposure_othercos.html
[65] ibid

			recommended to achieve the TDI.	
JECFA	2001	TDI = 2.3	Based on developmental and reproductive effects in rodents and monkeys (4 studies), and endometriosis in monkeys; applied uncertainty factor of 9.6	JECFA
Health Canada	2005	TDI = 2.3	Based on JECFA TDI	Health Canada
Japan	1999	TDI = 4	Based on WHO TDI	Japan Environmental Health Committee of the Central Environmental Council
United Kingdom	2000	TDI = 2	Based on European Commission TDI	UK Committee on Toxicity
Australia	2002	TDI = 2.3	Based on JECFA TDI	Australian NHMRC
Nordic countries	2000	TDI = 5		Johansson and Hanberg, 2000; IARC, 1997; IOM, 2003
Netherlands		TDI = 1		IARC, 1997; IOM, 2003
Sweden		TDI = 5		IARC, 1997; IOM, 2003
AEA Technology	1999	TDI = 1-4		IOM, 2003
Fiedler et al.	2000	TDI = 1-4		IOM, 2003

*USEPA (U.S. Environmental Protection Agency). 2003. Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) and Related Compounds. Part III: Integrated Summary and Risk Characterization, Office of Research and Development, December (DRAFT).

Appendix E. PAHs on the NPRI for 2002-05

7H-Dibenzo(c,g)carbazole
Benzo(a)anthracene
Benzo(a)phenanthrene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(e)pyrene
Benzo(g,h,i)perylene
Benzo(j)fluoranthene
Benzo(k)fluoranthene
Dibenz(a,j)acridine
Dibenzo(a,h)anthracene
Dibenzo(a,i)pyrene
Indeno(1,2,3-c,d)pyrene
Perylene
Phenanthrene
Pyrene

Appendix F. Virtual Elimination

Where a substance is determined to be toxic (under section 64 of CEPA 1999), and is persistent and bioaccumulative, and entering the environment primarily as a result of human activity, and not a naturally occurring radionuclide or a naturally occurring inorganic substance, it shall be proposed for virtual elimination under subsection 65(3) of CEPA 1999 and added to the Virtual Elimination List (section 77(4) of CEPA 1999).

Virtual Elimination (Section 65, CEPA 1999) means the ultimate reduction of the quantity or concentration of the substance in the releases below the Level of Quantification (LOQ). LOQ is defined as "the lowest concentration that can be accurately measured using sensitive but routine sampling and analytical methods". The LOQ is specified for each substance on the Virtual Elimination List.

Estimated LOQ Values for Concentrations of Dioxins and Furans and HCB

	Dioxins and furans	HCB
Gaseous	32 pg TEQ/m³	6 ng/m³
Liquid	20 pg TEQ/L	70 ng/L
Solid	9 pg TEQ/g	2 ng/g

Hexachlorobutadiene (HCBD) is the first and only substance on the Virtual Elimination List under CEPA 1999. This action took place December 2006. HCBD has never been manufactured in Canada and has not been used or released in Canada for several years.

Appendix G. Acronyms, Abbreviations and Units

Acronyms

BAT	Best Available Techniques
BOD	Biochemical Oxygen Demand
CACs	Criteria Air Contaminants
CAIRA	Clean Air Industrial Regulations Agenda
CAS	Chemical Abstract System
CCME	Canadian Council of Ministers of the Environment
CEC	Commission for Environmental Cooperation (North America)
CEM	Continuous Emission Monitoring
CEPA	Canadian Environmental Protection Act
CMP	Chemical Management Plan
CMTP	Chemithermomechanical Pulp
CO	Carbon Monoxide
CWS	Canada-wide Standard
DBD	Dibenzodioxins
DBF	Dibenzofurans
DFO	Department of Fisheries and Oceans
DHHS	Department of Health and Human Services (US)
EC	Environment Canada
EEM	Environmental Effects Monitoring
FAO	Food and Agriculture Organization
GIS	Geographical Information Systems
H_2S	Hydrogen Sulphide
HAP	Hazardous Air Pollutants (US EPA)
HCB	Hexachlorobenzene
IARC	International Agency for Research on Cancer
JEFCA	Joint FAO / WHO Expert Committee on Food Additives
LOQ	Level of Quantification
LRTAP	Long-Range Transboundary Air Pollution Convention
MERAF	Multi-Pollutant Emission Reduction Analysis Foundation (Reports)
NAFTA	North American Free Trade Agreement
NAICS	North American Industry Classification System
NH_3	Ammonia
NBSK	Northern Bleached Softwood Kraft Pulp
NOx	Nitrogen Oxides
NPRI	National Pollutant Release Inventory
NRCAN	Natural Resources Canada
PAHs	Polycyclic Aromatic Hydrocarbons
PCPs	Pentachlorphenols
PD	Parkinson's Disease
PM or TPM	(Total) Particulate Matter
$PM_{2.5}$	Particulate Matter less than 2.5 microns (fine particulate matter)
PM_{10}	Particulate Matter less than 10 microns
POPs	Persistent Organic Pollutants

PPER	Pulp and Paper Effluent Regulations (Fisheries Act)
RFU	Reach for Unbleached
RMP	Refiner Mechanical Pulp
SIC (Can.)	Standard Industrial Classification (Canadian)
SO_2	Sulphur Dioxide
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD)
TCDF	2,3,7,8-tetrachlorodibenzofuran (TCDF)
TDI	Tolerable Daily Intake
TEQ	Toxic Equivalents
TMP	Thermomechanical Pulp
TRS	Total Reduced Sulphur
TSMP	Toxic Substances Management Policy
TSS	total suspended solids
UN ECE	United Nations Environmental Commission of Europe
US EPA	United Stated Environmental Protection Agency
VE	Virtual Elimination
VOCs	Volatile Organic Compounds
WHO	World Health Organization

Units

ppb	parts per billion, one thousand million (10^9)
ppq	parts per quadrillion, one thousand million million (10^{15})
pg/kg-bw/day	picograms per kilogram body weight per day, picograms is one-trillionth (10^{-12}) of a gram
g (TEQ)	grams Toxic Equivalents
Mt	megatonnes (one million tonnes)
mg/d	milligrams (one-thousandth of a gram)per day