Ambient Air Quality Study
In La Tuque (1994)

Executive Summary

André Germain
Nathalie Ferland
Bruno Lafortune

Environment Canada
Environmental Protection Branch, Quebec Region
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Introduction

Les Cartons Saint-Laurent Inc, located in La Tuque more than 100 kilometres north of Three-Rivers, is the major industrial employer in the Haut-Saint-Maurice Region and play a major role in economy of the town. Of all the pulp and paper (P&P) mill located in the Saint Lawrence watershed, this Kraft paper mill was one of the largest sources of conventional pollutants to the atmosphere in 1990. In 1994, Environment Canada's Environmental Protection Branch and the *Ministère de l'Environnement et de la Faune du Québec* (MEF) joined their efforts in order to measure the ambient air quality in La Tuque and look at potential relations with the mill.

Many compounds were measured in stack emissions from Recovery Furnace N° 5 of the mill. They included Volatile Organic Compounds (VOC), Polycyclic Aromatic Hydrocarbons (PAH), Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans (PCDD/PCDF), particulate matter (PM), metals, nitrogen oxide (NO_x) and total reduced sulphur (TRS). VOC emissions from the west vent of the dissolution tank were also measured. All of these have also been looked for inLa Tuque's ambient air (Figure 1). Results have also contributed to some of the initiatives of the NO_x/VOC Management Plan in identifying the major VOC emitted by a P&P mill and those found in the surrounding ambient air. These compounds are important because they can contribute to smog formation.

Stack Sampling

Less than a third (40) of the 144 VOC analyzed were detected in gas emitted by the Recovery Furnace N° 5 while the majority (approximately one hundred) were measured in the vent of the dissolution tank. Levels were 158[1] and 1039 $\mu g/m^3$ respectively, with toluene responsible for nearly 90 % of all the VOC measured (Table 1). Total VOC measured at the recovery furnace were higher than those found at the P&P mill located in Howe Sound in British Columbia (BC) but lower than at Elk Falls, also located in British Columbia. It is important to mention that more compounds were looked for in samples taken in La Tuque.

[1] All emission data are reported at 25 °C, 101,325 kPa and 11 % O_2

PAH were measured at a higher level in emissions of the recovery furnace of La Tuque mill (248 ng/m^3) than at Howe Sound (4 ng/m^3) but at a lower level than those measured in the stack of a power boiler burning salty hog fuel at Elk Falls' mill. PCDD and PCDF levels were similar at La Tuque (2.33 pg TEQ/m^3) and Howe Sound (3.17 pg TEQ/m^3) while Elk Falls' mill power boiler emitted more dioxins and furans (1195 pg TEQ/m). The burning of salt water laden wood in the power boiler promotes the formation of dioxins and furans. There was more total particulate matter emitted at La Tuque (126.5 mg/m^3) than at Howe Sound (24.3 mg/m^3) but less than at Elk Falls (171 mg/m^3). Sodium and potassium were the major elements measured on particles emitted by the recovery furnace N° 5. They were not looked for at the other two mills but black liquor taken in the recovery furnace of the Howe sound mill contained 20.8 % of sodium. In addition to the parameters shown in Table 1, emissions from the recovery furnace contained 54 ppm of NO_x but less than 1 ppm of TRS. However, TRS was measured in gas emitted by the other two furnaces present at the *Les Cartons Saint-Laurent Inc.* mill.

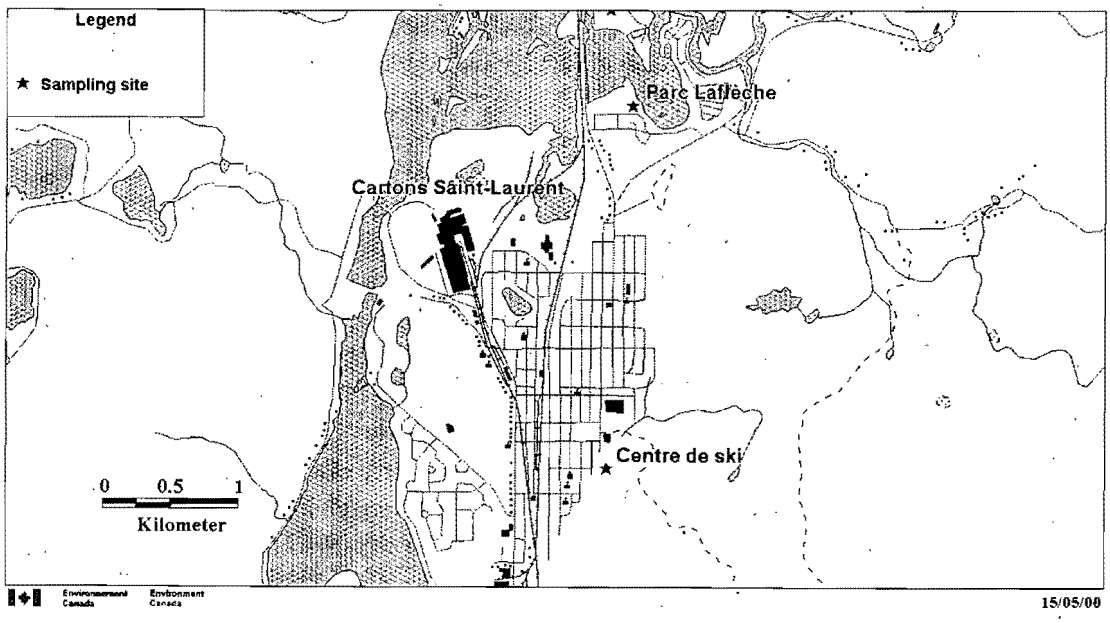


Figure 1 Sampling sites location

Table 1 Mean levels of the major families of compounds (or compounds) measured in recovery furnace N° 5 and at the vent of the dissolution tank of the *Les Cartons Saint-Laurent Inc.* mill and comparison with other P&P mills

Compound	Stack of recovery furnace N° 5	Dissolution tank vent	Howe Sound (BC) recovery furnace	Elk Falls (BC) hog fuel power boiler
VOC				
Total ($\mu g/m^3$)	158.3	1039	94[a]	901[b]
Toluene ($\mu g/m^3$)	125.4	901.6	< 1	> 100
PAH				
Total (ng/m^3)	248	n.a.[c]	4	3300-35 900
Total Dioxins and furans				
pg/m^3	635.7	n.a.	n.d.[d]	n.d.
[e]pg TEQ/m^3	2.33	n.a.	3.17	1195
Total Particles				
mg/m^3	126.5	n.a.	24.3	171

[a]: 34 VOC measured [b]: 37 VOC measured [c]: n.a. not analysed
[d]: non available [e]: TEQ; Toxic equivalent factor

Ambient air

In La Tuque, we have measured many compounds in ambient air sampled at two sites located East-Northeast and East-Southeast respectively of the mill. Levels varied slightly between sites but these differences were generally not significant (Table 2). VOC, PAH, particulate matter less than 10 µm in diameter (PM_{10}) and NO_x were typical of levels found in rural site elsewhere in Quebec or in Canada. Total suspended matter (TSP) levels compared well with those measured at the other sites operated by the MEF in La Tuque and elsewhere in Quebec. TRS was at the same level as the one measured near the refineries of the east-end of Montreal but greater than what has been measured at Cap-de-la-Madeleine. Five of the 44 metals analyzed at the two sites accounted for more than 75 % of all the metals; these five are sulphur, sodium, silicium, calcium and potassium at the Ski centre and sulphur, silicium, potassium and iron at Parc Lafleche. Interestingly, the ten VOC most present in ambient air represented 60 % of all the 144 VOC looked for (Figure 2).

Table 2 Statistical values for the different families of compounds measured at La Tuque in 1994

Compound	n[a]	Mean	Median	Minimum	Maximum
VOC (ppb)					
Ski centre	12	9.8	9.3	6.2	16.3
Parc Lafleche	9	13.2	12.6	5.5	28.6
PAH (ng/m^3)					
Ski centre	13	19.6	20.6	6.1	35.6
Parc Lafleche	15	20.8	15.3	1.8	64.3
Total Dioxins and furans (pg TEQ/m^3)					
Ski centre	13	2.96	2.64	1.04	5.67
Parc Lafleche	3	1.18	0.52	0.19	2.83
Total Particles (µg/m^3)					
Ski centre	13	44.4[b]	n.d.	24.8	77.0
Parc Lafleche	13	25.6[b]	n.d.	8.1	88.5
PM_{10} (µg/m^3)					
Ski centre	13	13.9	n.d.	6.5	30.5
Parc Lafleche	13	19.5	n.d.	1.7	80.8
$PM_{2.5}$ (µg/m^3)					
Ski centre	13	7.5	n.d.	2.3	21.8
Parc Lafleche	13	10.1	n.d.	0.2	50.9
Total Metals (µg/m^3)					
Ski centre	16	2.888	2.422	<l.d.	7.523
Parc Lafleche	16	2.540	1.525	<l.d.	11.477
Other parameters measured only at the Ski centre					
NO_x	[c]	0.68	0.28	< l.d.[d]	44.8[e]
FURNACE	[c]	0.8	< l.d.	< l.d.	37.3[e]

[a]: n: number of samples [b]: geometric mean [c]: measured continuously
[d]: less than limit of detection [e]: hourly maximum

In 1994, the P&P mill seemed to have an impact on the levels of some of the compounds present in ambient air. As such, VOC and TSP levels measured at Parc Lafleche were higher when the site was downwind from the mill. However, NO_x and TRS, measured only at the Ski centre, showed higher values when the sampling site was downwind from the plant. Among metals, potassium levels increased when winds were blowing in the direction of the sampling sites; sodium reacted the same but only at the ski centre, whereas sulphur levels did not

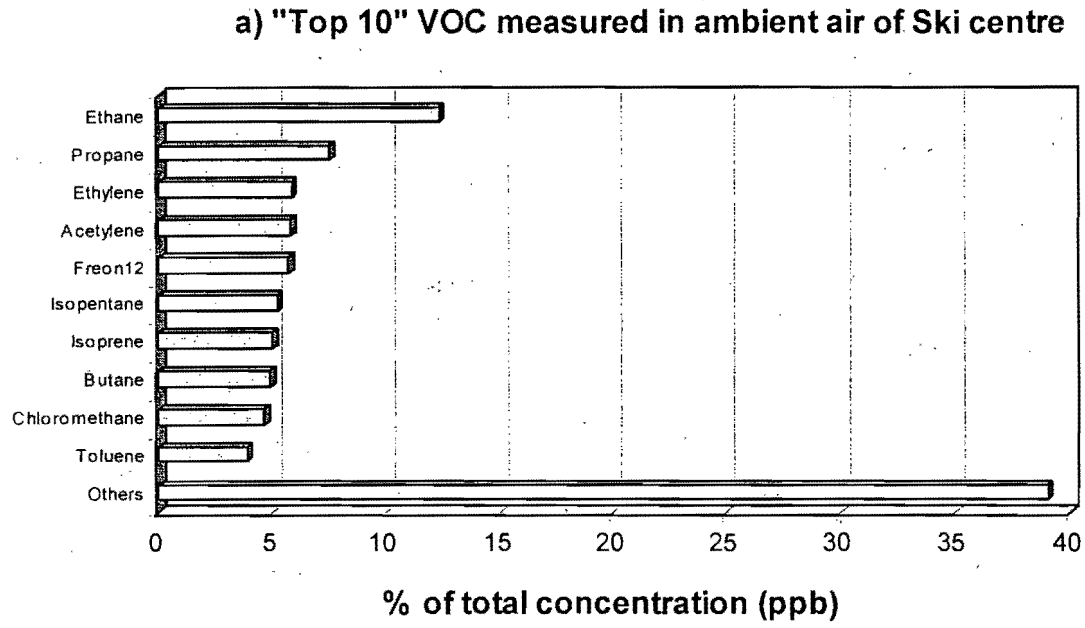
seemed influenced. PM_{10} (at both sites) and dioxins and furans (ski centre) did not seemed to be influenced by the mill. However, the plant was not the only source of atmospheric pollutants in La Tuque; road traffic and residential wood combustion are also known sources of VOC, dioxins and furans, PAH, particles and NO_x in the atmosphere.

The potential photochemical oxidant formation at both sampling sites in La Tuque was similar to that obtained in rural area elsewhere in Quebec. Among the VOC involved, there was toluene, major VOC component emitted by the recovery furnace N° 5 and isoprene, of natural origin. However, we noted differences between the two sampling sites. Isoprene, which represented a quarter of the potential oxidant formation calculated for the site located at the Ski centre, accounted for only 8 % of the potential calculated at Parc Lafleche. Xylenes and toluene were the major contributors to the potential calculated at this site.

Standards Conformity

Emissions of dioxins and furans by recovery furnace N° 5 respected the 500 pg TEQ/m^3 limit established by the Canadian Council of Ministers of the Environment (CCME) and the 92 pg TEQ/m^3 European regulation, the most restrictive regulation found.

Levels measured in ambient air respected the different standards, criterias, limits or objectives cited in the literature. As such, maximum levels of dioxins and furans reached only 1 % of the Federal-Provincial Advisory Committee recommendation and 10 % of Quebec working criteria. TSP respected the Quebec annual and daily means and the Canadian air quality objectives. PM_{10} are not regulated in Canada but the values of PM_{10} and $PM_{2.5}$ objectives proposed for Canada were exceeded in some occasions. The United States (USA) have annual and daily PM_{10} et $PM_{2,5}$ standards; no measured value exceeded them. NO and NO_2 levels measured at the site located at the Ski centre were also lower than the relevant Quebec standards or Canadian objectives. As for PAH, levels of Benzo(a)Pyrene [or B(a)P] respected the Quebec annual criteria.



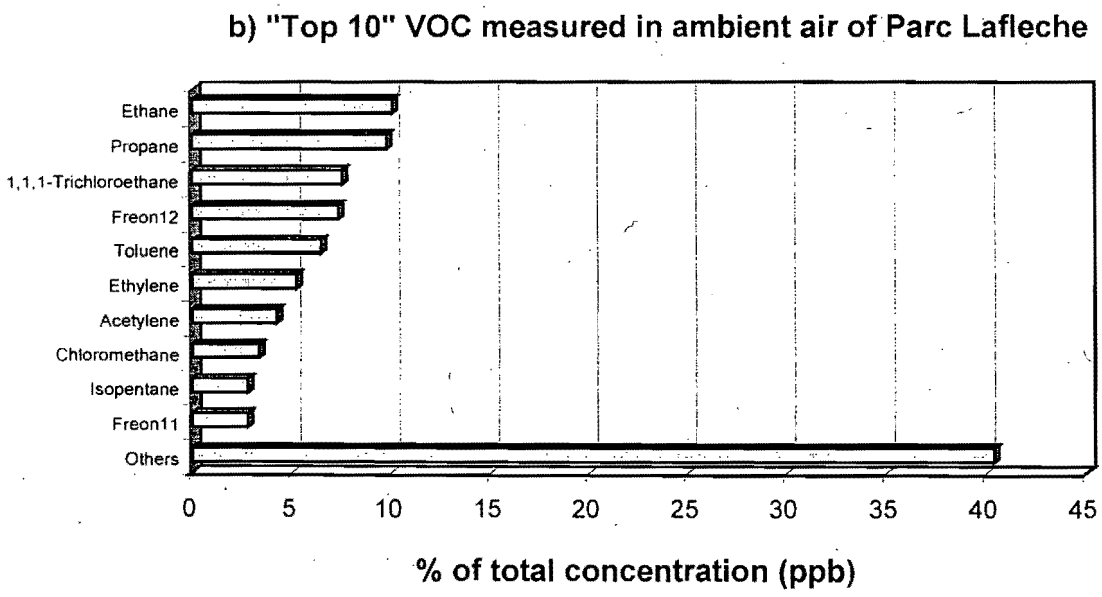


Figure 2 VOC measured at highest levels in La Tuque's air sampled at a) the ski centre and b) the Parc Lafleche

Conclusion

With this project, we wanted to measure the emissions of the recovery furnace N° 5, a major equipment in the *Les Cartons Saint-Laurent Inc.* P&P mill, verify if there was a significant impact on ambient air and contribute to some NO_x/VOC management plan initiatives.

In 1994, VOC, PAH and particle emissions from the furnace N° 5 were higher than those from a modern furnace of a P&P mill located at Howe Sound in British Colombia. As for dioxins and furans and NO_x, furnace emissions from the mill in La Tuque were lower than those from the mill at Howe Sound. In ambient air, we observed some small differences in the levels of different parameters measured at the two sampling sites but these differences were generally not significant. VOC, PAH, PM_{10} and NO_x were typical of level found in rural areas elsewhere in Quebec and Canada.

The examination of meteorological data helped to show that the P&P mill had an impact on ambient air. As such, VOC and TSP levels measured at Parc Lafleche and NO_x and TRS measured at the Ski centre were higher when the sites were downwind from the mill.

Globally, standards or criteria considered were mostly respected in La Tuque. Since 1994, *Les Cartons Saint-Laurent Inc.* has invested approximately $25 millions to modify their systems and to treat emissions from many types of equipment, including the recovery furnace N° 5. These improvements have helped the mill reduce its emissions. Consequently, report conclusions are valid for 1994 and the prevailing situation since these improvements should have had a benificial impact on air quality in La Tuque.