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Ministry of Environment

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2010-2011 Formaldehyde Summary Report for Prince George

In 2010-2011, the B.C. Ministry of Environment, in collaboration with PGAIR and Environment Canada, conducted two ambient air monitoring programs specifically measuring formaldehyde and related compounds in Prince George. These programs followed concerns regarding high formaldehyde levels reported on two days in 2008. This release contains a summary of daily samples taken during this 2010/11 monitoring period. This data shows formaldehyde and related compounds detected in Prince George were typically well within air quality standards for health and safety. The unusually high levels of formaldehyde reported in 2008 are now believed to be incorrect, either due to contaminated equipment or contamination from other sources.

The first study, began in 2010, involved 1-hour samples collected at various locations in Prince George during poor air quality events when formaldehyde levels were anticipated to be high. These results were released by PGAIR throughout the year as results were available. The second study, done in collaboration with Environment Canada, involved 24-hour samples collected at the Ministry of Environment's Plaza 400 monitoring station, every 6 days, and during special episodes like forest fires. More confidence is placed in the 24-hour samples than the 1-hour samples because a larger sample is taken, making analysis more reliable. This report covers the results of the 24-hour sampling program.

The 24-hour sampling program was conducted from April 14, 2010 to March 28, 2011, and in addition to formaldehyde, samples were also analyzed for other aldehydes and ketones. Aldehydes and ketones are simple compounds that contain hydrogen, carbon and oxygen atoms. Each compound has different properties and chemical make-up but is generally associated with odour and/or health effects.

Table 1 shows the average concentrations of each aldehyde and ketone for the monitoring period, as well as the maximum concentrations, and the percent of samples in the study where specific aldehydes or ketones were detected. When calculating the average concentration all values less than detectable were reported as zero. The maximum concentrations for most of these compounds were recorded on August 18, 2010, when the region was severely impacted by smoke from forest fires. Since this forest fire event was an unusual event for Prince George, a second maximum is provided in Table 1, based on all the data except for the August 18, 2010 sample.

B.C. has a specific air quality objective for formaldehyde (action level of 60 $\mu g/m^3$ for 1-hour average concentration). Where B.C. objectives do not exist, the Province may use guidelines or screening levels from other jurisdictions as guidance. In this case, priority is given to Canadian jurisdictions with existing objectives, followed by the Texas Effects Screening Levels (ESLs), which have been developed for a large number of organic compounds not commonly considered by other jurisdictions (Table 2). Alberta Environment provincial objectives are not included in this table because those objectives are the same as the Texas ESL. The short term ESL used in Texas is generally for 1-hour concentrations and may be based on health effects or odour, while the long term ESL is for annual averages and may be based on health effects. Ontario and Quebec guidelines have durations of less than 1-hour, and are based on odour. Most other guidelines are based on health effects.

Additional information for each aldehyde or ketone measured is provided in Appendix A. This includes other names used for each compound, potential source, the odour detected and the low odour threshold, as well as web pages where this information was obtained. The low odour threshold is the lowest concentrations reported at which sensitive individuals can detect an odour. This value can vary considerably for some of the reference sources used in this report, and it mainly depends on how that source defines the low odour threshold. Since no single referenced study yielded low odour thresholds for all the aldehydes and ketones measured in Prince George, the lowest odour threshold value found for each compound was included in the Appendix. This provides a more conservative approach than what is typically expected to be the low odour threshold.

With the exception of acrolein, the maximum concentrations recorded for all other compounds were below all 24-hour objectives listed as well as the Texas long term ESL. For health concerns, an annual guideline is expected to be lower than a 24-hour guideline. The concentrations for acrolein exceeded the Ontario provincial 24-hour objective of 0.04 µg/m^3 on two occasions. The first occasion was during the major forest fire event in August when acrolein was measured at 1.00 ug/m^3, and the second occasion was on Dec 22, 2010 when the concentration was measured at 0.042 µg/m^3. On both occasions, unrelated to the acrolein levels, the MOE issued an air quality advisory due to high particulate levels. The second highest maximum for formaldehyde (4.89 ug/m3) also was recorded on December 22, 2010. High readings on that day are attributable to meteorological conditions; no unusual events were recorded.

This 24-hour program indicated that the maximum level of formaldehyde detected was 10.19 µg/m^3 which coincided with the August 2010 forest fires. On that day, the $PM_{2.5}$ daily value of 104 µg/m^3 was four times the provincial objectives. Excluding the forest fire events, the range of formaldehyde measured during this program was from 0.3 – 4.9 µg/m^3. These concentrations are well below Ontario's 24-hour objective of 65 µg/m^3. BC's 1-hour objective of 60 µg/m^3 is, however, much more stringent. In Ontario, to convert from a 24-hour concentration to a maximum one-hour concentration, a factor of 2.5 is recommended. If there are high background levels of the contaminant of concern then a lower conversion factor may be used. A more conservative factor of 4 can also be used. Using a factor of 4 to convert the 24-hour concentration to a 1 hour concentration, the measured levels are still below the provincial 1-hour objective for BC. Based on the levels recorded in Table 2 and Appendix 1, measured levels of formaldehyde, aldehydes and ketones during this program would not be expected to produce major health effects. For the 2011/2012 fiscal year, the MOE launched another study during high odour days to identify and to quantify other volatile organic compounds in the air shed.

Following collection of the samples from April 2010 to March 2011, lengthy sample analysis was conducted at the contracted lab as well as quality assurance procedures. This report now concludes the formaldehyde studies undertaken in 2010-2011. Currently the MOE in Prince George working with city residents has ongoing program to measure VOCs during odorous days.

This summary is posted on the BC Air Quality webpage at:
http://www.bcairquality.ca/reports/region_Omineca.html.

This bulletin has been distributed through PGAIR and the MOE's air quality advisory distribution list to notify multiple stakeholders.

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Table 1: Summary table of all Aldehydes and Ketone concentrations (µg/m^3) measured from **April, 2010 to March 2011**

Aldehyde/Ketones	Average (µg/m^3)	24-hr Max. (µg/m^3)	24-hr 2nd Max. (µg/m^3)	Percent of Samples above detectable
Formaldehyde	1.84	10.19	4.89	98%
Acetaldehyde	1.17	7.81	4.13	100%
Acrolein	0.07	1.00	0.42	89%
Acetone	3.29	10.24	8.95	100%
Propionaldehyde	0.20	1.57	0.69	100%
Crotonaldehyde	0.01	0.15	0.11	32%
Methyl Ethyl Ketone	0.54	1.86	1.60	100%
Benzaldehyde	0.27	1.86	0.66	100%
2-Pentanone/Isovaleraldehyde	0.17	0.60	0.44	96%
Valeraldehyde	0.06	0.14	0.13	100%
o-Tolualdehyde	0.00	0.00	0.00	0%
m-Tolualdehyde	0.27	1.77	1.41	93%
p-Tolualdehyde	0.00	0.08	0.02	4%
Methyl Isobutyl Ketone	0.04	0.16	0.16	64%
Hexanal	0.16	0.54	0.54	100%
2,5-Dimethylbenzaldehyde	0.00	0.00	0.00	0%

Table 2: Air Quality Objectives at other Juridictions for Aldehydes and Ketone concentrations (µg/m^3)

Aldehyde/Ketones	Texas Short term ESL (µg/m^3)	Basis	Texas Long-term ESL (µg/m^3)	Ontario (µg/m^3)	Period	Quebec (µg/m^3)	Period
Formaldehyde	15	health	3.3	65	24-hr.	37	15 min.
Acetaldehyde	90	odour	45	500	24-hr.	2.0	Annual
Acrolein	3.2	health	0.15	0.4	24-hr.	0.15	Annual
Acetone	5900	health	590	11880	24-hr.	380	Annual
Propionaldehyde	20	odour	46	10	10 min	2.4	24-hr.
Crotonaldehyde	9	health	0.9			120	8-hr.
Methyl Ethyl Ketone	1300	odour	2600	1000	24-hr.	740	4 min.
Benzaldehyde	22	odour	9			100	Annual
2-Pentanone/Isovaleraldehyde	1800	odour	180				
Valeraldehyde	100	odour	180			1750	8-hr.
o-Tolualdehyde	90	health	9				
m-Tolualdehyde	90	health	9				
p-Tolualdehyde	90	health	9				
Methyl Isobutyl Ketone	820	health	82	1200	24-hr.	400	4 min.
Hexanal	80	odour	818				
2,5-Dimethylbenzaldehyde	90	health	9				

Appendix A: Characteristics of Aldehydes and Ketones

VOC	Odour Properties	Potential Sources	Other names
Formaldehyde	Has a distinct, pungent odour. The low odour threshold is 25 µg/m^3.	Residential sources include cooking cigarettes, fireplaces, gas furnaces and kerosene space heaters. It is also found in food preservatives, cleaning products, cosmetic products, building materials such as OSB, MDF, carpet and linoleum/vinyl flooring, pressed wood products, hardwood, and plywood paneling. Minor Sources include Upholstery fabrics, latex-backed fabrics, fiberglass, urea formaldehyde foam insulation, wallpaper, caulking compounds, varnishes, adhesives, lacquers and gypsum board. Newly constructed structures can release formaldehyde into the interior air for a long time after construction. Homes without enough ventilation can have higher levels of formaldehyde.Formaldehyde is used to keep clothing and draperies from wrinkling. It is also used as a preservative in some paints and coatings. Other sources include vehicle exhaust and forest fires. Industrial sources include: pulp mills, OSB, MDF, particle board and plywood plants, oil refineries and asphalt plants. Our bodies also produce formaldehyde in small amounts by normal processes.	methanal, methylene oxide oxymethylene methylaldehyde oxomethane
Acetaldehyde	Has a pungent suffocating odour, but at dilute concentrations it has a fruity and pleasant odour. The low odour threshold is 5 µg/m^3.	Residential sources include cooking cigarettes, fireplaces and wood stoves, oriented strand board (OSB) and medium density fibreboard (MDF) material, carpet and linoleum/vinyl flooring. Other sources include vehicle exhaust and forest fires. Industrial sources include: pulp mills, OSB, MDF, particle board and plywood plants, sawmills/wood preserving, oil refineries and asphalt plants. In addition, acetaldehyde is formed in the body from the breakdown of ethanol; this would be a source of acetaldehyde among those who consume alcoholic beverages.	Acetic aldehyde Acetic ethanol Acetylaldehyde Ethanal Ethyl aldehyde
Acrolein	Has a burned, sweet, pungent odour. The low odour threshold is 50 µg/m^3.	May be formed from the breakdown of certain pollutants found in outdoor air, Small amounts of acrolein may be found in some foods, such as fried foods, cooking oils, and roasted coffee. It is released into the environment as a product of fermentation and ripening	propylene aldehyde, 2-propenal 2-propen-1-one prop-2-en-1-al acrylaldehyde acrylic aldehyde

		processes and has been identified in oak trees. Other sources include cigarettes, furnaces, fireplaces, pesticides and vehicle exhaust. Industrial sources include: pulp mills, OSB, MDF, particle board and plywood plants, asphalt plants, refineries, waste incineration and coal-based electric power generation plants. It is also produced by photochemical oxidation of hydrocarbons in the atmosphere.	allyl aldehyde ethylene aldehyde aqualine
Acetone	Has a strong smell, which is commonly associated with nail polish remover. Low odour threshold is 8700 µg/m^3.	Acetone is often used as a solvent for painting, art supplies, adhesives and cleaners. It is found in nature in plants, trees, forest fires and gas from volcanoes. Residential sources include cooking cigarettes, fireplaces, plywood, solid wood, OSB, MDF, carpet, linoleum/vinyl flooring, and caulking. Other sources include vehicle exhaust and landfills. Industrial sources include: pulp mills, OSB, MDF, particle board and plywood plants. Also, when a body breaks down fat, it produces acetone. People on a low fat diet will have more acetone in their body.	2-Propanone Dimethyl ketone Dimethylformaldehyde Dimethylketal Ketone propane Ketone, dimethyl Methyl ketone Propanone Pyroacetic acid Pyroacetic ether beta-Ketopropane
Propionaldehyde	Has a overpowering fruity odour. The low odour threshold is 25 µg/m^3.	Used as a disinfectant and preservative; Sources include cooking, fireplaces, cigarettes and forest fires. Industrial sources include: pulp mills, particle board, OSB and plywood plants, oil refineries and asphalt plants.	Propanal Propionic aldehyde Methylacetaldehyde Propyl aldehyde Propaldehyde Propylic aldehyde Proprionaldehyde
Crotonaldehyde	Has a suffocating odour. The low odour threshold is 175 µg/m^3.	Sources include vehicle exhaust, cooking, fireplaces, cigarettes and forest fires. Industrial sources include: pulp mills, OSB and medium density fibreboard plants, and asphalt plants.	1-Formylpropene 2-Butenal 2-Butenaldehyde Crotonal Crotonic aldehyde Crotylaldehyde Methylpropenal Propylene aldehyde
Methyl Ethyl Ketone (MEK)	Has a sharp, sweet odour. The low odour threshold is 2600 µg/m^3.	Nearly half of Methyl Ethyl Ketone is used in paints and other coatings. In nature, it is emitted by some trees and is also found in small amounts in some fruits and vegetables. Residential sources include cigarettes, fireplaces, carpets, caulking, plywood, furniture, OSB, glues and cleaning agents. Other sources include vehicles exhaust, landfills, and forest fires. Industrial sources include: pulp mills, plywood, particle board and medium density fibreboard plants, asphalt plants and oil refineries.	2-Butanone Butanone Ethyl methyl ketone MEK
Benzaldehyde	Has an odour of almond oil. The low odour threshold is 840	Residential sources include cigarettes, fireplaces, OSB, MDF and solid wood, carpet, linoleum/vinyl flooring and caulking, perfumes and moisturizing and shaving creams. Other	Benzaldehyde Benzenecarboxaldehyde Benzenemethylal Benzoic aldehyde

	µg/m^3.	sources include vehicle exhaust and forest fires. Industrial sources include: pulp mills, particle board, OSB and medium density fibreboard plants, and asphalt plants.	Artificial almond oil
Isovaleraldehyde	Has a strong and disagreeable odour of apples. The low odour threshold is 0.7 µg/m^3.	It occurs naturally in various foods and flavourings (e.g., coffee, cheese, corn tortilla chips, and orange, lemon and eucalyptus oils). It is used in perfumes and pharmaceuticals. Sources include vehicle exhaust and forest fires. Industrial sources include: pulp mills, particle board and medium density fibreboard plants, and asphalt plants.	2-Pentanone isopentaldehyde 3-methylbutanal 3-methylbutyraldehyde isoamylaldehyde methyl butyraldehyde 3-methyl-1-butanal Isopentanal
Valeraldehyde	Has a strong, acrid, pungent odour. The low odour threshold is 45 µg/m^3.	It occurs naturally in a wide variety of foods (e.g., alcoholic beverages, dairy products, cocoa, popcorn, potato chips). Sources include vehicle exhaust, Forest fires and fireplaces. Industrial sources include: pulp mills and particle board plants.	Amyl aldehyde Amylaldehyde Butyl formal Pentanal Valeral Valerianic aldehyde Valeric acid aldehyde Valeric aldehyde Valerylaldehyde
Tolualdehyde	Sweet, cherry floral odour.	Sources include forest fires and vehicle exhaust. Industrial sources include: pulp mills, particle board and medium density fibreboard plants.	4-Methylbenzaldehyde Formyltoluene Tolylaldehyde Paratolualdehyde Methoxybenzaldehyde
Methyl Isobutyl Ketone (MIBK)	Has an odour similar to mothballs; The low odour threshold is 420 µg/m^3.	Occurs naturally in oranges, graphs and vinegar. It is used as a solvent in factories that produce paints, rubber products, chemicals and machinery. Consumer products include aerosol paints, coatings and primers. MIBK is used in home products like hard surface cleaners, dyes and tints, laundry starches, paints and varnish products. It is also used in pesticides and insecticides, greases and oil used as lubricants, pet flea and tick products, shoe polish, wood office furniture and carpets. Industrial sources include: pulp mills, plywood, particle board and medium density fibreboard plants, and oil refineries. Other sources: landfills and diesel combustion.	4-methyl-2-pentanone hexone isopropylacetone MIBK
Hexaldehyde	Has a fruity, green grass, or sharp aldehyde odour. The odour threshold is 20 µg/m^3.	Occurs naturally in many fruits, vegetables, meats, and shellfish and can be emitting through cooking. It is also in vapor given off by many plants such as red oak, redwood, and poplar trees. Residential sources include cooking, cigarettes, fireplaces, OSB, plywood, MDF and solid wood, polyurethane wood finish, and linoleum/vinyl flooring. Other	1-Hexanal Aldehyde C-6 C6 aldehyde Caproaldehyde Caproic aldehyde Capronaldehyde Hexanal Hexanaldehyde

		sources include vehicle exhaust, insecticides, perfumes and forest fires. Industrial sources include: pulp mills, particle board, plywood plants, and asphalt plants.	Hexoic aldehyde Hexylaldehyde
2,5-Dimethylbenzaldehyde	a mild, sweet, bitter-almond odour	Sources include fireplaces and vehicle exhaust. Industrial sources include: pulp mills, particle board and medium density fibreboard plants	Isoxylaldehyde

http://cfpub.epa.gov/si/speciate/index.cfm

http://www.epa.gov/ttn/atw/index.html

http://www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=B85A1846-1

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http://www.atsdr.cdc.gov/toxprofiles/index.asp

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http://environment.gov.ab.ca/info/library/6686.pdf

http://www.ecy.wa.gov/programs/air/pdfs/pulpmil3.pdf

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http://hazmap.nlm.nih.gov/cgi-bin/hazmap_list?tbl=TblAgents&alpha=A

http://ecb.jrc.ec.europa.eu/esis/

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http://msds.chem.ox.ac.uk/adir.html