CANADA-WIDE STANDARDS FOR PM & OZONE

STATUS OF JURISDICTIONAL IMPLEMENTATION PLANNING ACTIVITIES - BRITISH COLUMBIA

I. INTRODUCTION

The following provides an overview of achievement of the Canada-wide Standards (CWS) for PM and Ozone in British Columbia, the status of British Columbia's implementation planning activities concerning CWS, and identifies geographical considerations based on separate analyses of provincial air quality data that are not included in the current update. For CWS reporting purposes, BC has four Census Metropolitan Areas (CMAs) with population > 100,000: Vancouver, Victoria, Abbotsford and Kelowna. Both Vancouver and Abbotsford are located in the Lower Fraser Valley (LFV), while Victoria is located on Vancouver Island. Kelowna is the only CMA located in the interior of the province.

Achievement of the CWS for $PM_{2.5}$

The numerical target for the CWS for $PM_{2.5}$ is 30 $\mu g/m^3$ (24-hr averaging time), based on the annual 98th percentile ambient measurement, averaged over three consecutive years. $PM_{2.5}$ concentrations in the form of the CWS metric for 2005 are shown in Figure 1 and Table 1 for specific BC sites.[1] An inset map is provided for the LFV, where multiple monitoring sites are located. No CMAs were in exceedance of the $PM_{2.5}$ metric. However, the CWS metric was exceeded in Prince George and Golden (both 34 $\mu g/m^3$). Prince George has consistently exceeded the CWS since 2000. However, 2005 was the first year since 1999 that the annual 98th percentile value did not exceed 30 $\mu g/m^3$. In the case of Golden, the concentrations in excess of the CWS have been attributed to forest fires occurring in the summer of 2003.

As few $PM_{2.5}$ monitoring sites were operating prior to 2000, a robust trends analysis is not possible. Preliminary analyses by Vingarzan and Farris (unpublished) for sites in Victoria, Vancouver Airport, Chilliwack, Kamloops, Kelowna and Prince George showed no significant increasing or decreasing trends in daily $PM_{2.5}$ concentrations. These analyses accounted for meteorological influences such as temperature and wind speed.

Achievement of the CWS for Ozone

The numerical target of the CWS for ozone is 65 ppb (8-hr averaging time), based on the 4th highest measurement annually, averaged over three consecutive years. Ozone concentrations in the form of the CWS metric for 2005 are shown for specific BC sites in Figure 2 and Table 2.[2] An inset map is provided for the LFV, where numerous ozone monitors are located. In 2005, the only exceedance of the CWS value was observed in Hope (68 ppb), at the eastern end of the LFV. Other sites in the eastern LFV and in Kamloops were within

[1] Only those sites collecting daily $PM_{2.5}$ data were included here, as per the reporting requirements of the CCME Guidance Document on Achievement Determination.

[2] Ozone concentrations measured at sites outside of the Lower Fraser Valley are currently under review, and may be subject to small changes in the future.

10% of the CWS. In the LFV, concentration gradients are observed from west to east, with the lowest values generally observed along the coast and in the vicinity of the City of Vancouver, and the highest values found in the eastern LFV.

Trends analysis was performed on ozone data collected between 1990 and 2004 at three sites in the Lower Fraser Valley (Vancouver, Port Moody and Chilliwack) and one site in Kelowna (Vingarzan and Farris, unpublished). Based on a multiple regression model that accounted for daily average temperature, daily average wind speed, and seasonal cycles, the following statistically significant increasing trends ± 95% confidence intervals were found:

- Daily average ozone: Chilliwack (slope=0.32±0.19 ppb/year) and Kelowna (0.95±0.31 ppb/year)
- Daily maximum ozone: Chilliwack (slope=0.41±0.33 ppb/year)

No significant decreasing trends were observed for the above parameters.

Additional trends analysis based on provincially averaged CWS metrics (i.e. three-year average of the annual 4th highest 8-hour maximum concentration) indicated no significant trends.[3] Meteorological factors were not included in this analysis.

Environmental Drivers/Concerns

Local sources are generally believed to be the major contributors to periods of poor air quality in B.C. A number of communities are located in valleys that are periodically subject to temperature inversions and/or calm winds that limit the dispersion of pollutants away from the airshed. Wildfires have the largest potential to affect background concentrations on an episodic basis (McKendry, 2006). As an example, forest fires in Kelowna in 2003 resulted in peak hourly $PM_{2.5}$ concentrations of 250 $\mu g/m^3$. Events involving trans-Pacific transport of $PM_{2.5}$ and ozone are infrequent, but have the potential to increase $PM_{2.5}$ and ozone concentrations by about 20 $\mu g/m^3$ and 5-15 ppb, respectively, in the short term (McKendry, 2006). Transboundary transport in the LFV, which spans the Canada-U.S. border, was evaluated as part of the Georgia Basin/Puget Sound airshed characterization study (EC/U.S. EPA, 2004). Studies indicated that wind flow patterns move pollutants across the border in both directions through all seasons of the year, and hence the need for a coordinated approach to addressing common air issues.

II. AIR QUALITY OVERVIEW

Provincial emissions data for year 2000 are summarized in Figure 3 and Table 3[4]. Excluding road dust estimates, which have a high level of uncertainty, and wildfires, the major sources of direct anthropogenic $PM_{2.5}$ emissions in B.C. include prescribed burning (29%), the wood industry (18%), residential wood combustion (15%), transportation (13%) and the pulp and paper industry (13%). In the LFV, emissions are distributed among a number of different sectors, including marine transportation, other mobile sources and point sources. In the

[3] CCME (2006) *Canada-wide Standards (CWSs) for Particulate Matter (PM) and Ozone: Five Year Report.* Prepared for the Canadian Council of Ministers of the Environment.

[4] Emissions based on updated 2000 emission inventory prepared by Environment Canada in cooperation with the province and the GVRD, July 2006.

interior communities, wood smoke sources (including residential wood combustion and prescribed burning) and industrial point sources are the major contributors.

While the provincial inventory provides a snapshot of total emissions in the province, it does not reflect the wide variation in contributing sources across the province. In the Lower Fraser Valley, emissions are distributed among a number of different sectors, including marine transportation, other mobile sources and point sources. In the interior communities, wood smoke sources (including residential wood combustion and prescribed burning) and industrial point sources are the major contributors.

With respect to the sources of precursor gases to secondary $PM_{2.5}$ and ozone, the upstream oil and gas industry was the major source of SOx, accounting for 37% of emissions, followed by the pulp and paper industry (19%) and marine transportation (17%). NO_x emissions were largely from the transportation sector (71%), including 18% from marine sources. Other major sources include the upstream oil and gas industry (12%) and the pulp and paper industry (5%). Major sources of VOC include the transportation sector (42%), upstream oil and gas industry (12%), the wood industry (11%), residential wood combustion (7%), general solvent use (6%), and prescribed burning (5%). Ammonia emissions are dominated by the agriculture sector, including livestock (71%) and pesticide and fertilizer application (7%), followed by the transportation sector (6%).

$PM_{2.5}$ emission estimates from 1990, 1995 and 2000 and projected emissions in 2005 and 2010 are summarized in Table 4. Caution is warranted in comparing data from different years, as differences may be a result of different calculation methodologies as opposed to real changes in emissions. Projected emissions are based on the 2000 inventory, with adjustments made based on population and industry estimates.

III. STATUS OF ACTIVITIES RELATED TO PM & OZONE IMPLEMENTATION

With the exception of the Prince George and the easternmost parts of the LFV, most areas of the province are focussed on implementation of programs to support CI/KCAC. Airshed planning plays an integral role by providing the context for both voluntary and regulatory actions that can be taken at all levels of government, and by stakeholders and the public. This generally leads to a better understanding of the issues, better information on the impacts and costs of various actions, and ultimately to broader support for the actions that are chosen. Provincial initiatives that support CI/KCAC, as well as airshed-level initiatives, including those in Prince George and the LFV, are summarized as follows.

Regulatory Framework

- The *Environmental Management Act* (EMA) establishes for the province a permitting framework and fees, authority to set emission guidelines or standards, and enables development of Cabinet and Minister's regulations.
- Regulations in support of ozone management, primarily those involving fuel quality and motor vehicle emissions, have largely been superseded by federal regulations. Regulations developed in support of PM management include:

- **Open Burning Smoke Control Regulation** to limit where, when and how open burning of land-clearing fires can take place;
- **Solid Fuel Burning Domestic Appliance Regulation** to set PM emission limits and labelling and testing requirements for new woodstoves, fireplace inserts and factory-built fireplaces manufactured after November 1, 1994; and
- **Wood Residue Burner Incinerator Regulation** to set dates for the phase-out of beehive and silo burners in populated areas of the province.

- The Ministry is currently in the process of developing codes of practice and reviewing existing regulations under the *EMA* (http://www.env.gov.bc.ca/epdiv/ema_codes_of_practice).
- EMA also contains enabling legislation for the Minister to require area-based management plans (such as airshed plans) where the need arises. The Minister can designate the area for which a plan must be developed and establish the process that is to be followed.
- To-date, all airshed plans developed in B.C. have been voluntary in nature, driven by local concerns to protect and improve air quality. To guide future activities, the province is currently developing a provincial framework on airshed planning to promote greater consistency and more efficient use of resources. The province is also examining options for new air quality objectives for $PM_{2.5}$ to assist with day-to-day air management decisions, in consultation with stakeholders (SENES and Bates, 2006).

Improved Scientific Understanding

- PM speciation studies in Golden, Prince George and Kelowna (coarse PM only) to improve our understanding of the complex mix of local PM sources and to guide future actions.
- Findings from the Golden study will also be used to guide future speciation studies in B.C. (see: http://wlapwww.gov.bc.ca/kor/epd/pdf/spec_mon_source_golden.pdf).
- Research into the socio-economic impacts of PM and ozone have been carried out under the auspices of the BC Lung Air Quality & Health Steering Group that includes representatives from regional, provincial and federal health and environment agencies.
- Work to date includes the Phase 1 report on methodologies to estimate the health effects of air quality in B.C. and the Phase 2 report on estimating the health effects of PM and ozone in the LFV and the associated economic costs from changes in PM and ozone levels.

Technical Tools to Support Local Decision-making

- Provincial wood stove survey in support of improved emission inventory estimates (http://www.env.gov.bc.ca/air/airquality/pdfs/wood_emissions.pdf)
- GIS-based emission inventory
- Improved high-resolution mesoscale modelling capability for BC airsheds,
- Guidelines for dispersion modelling (http://www.env.gov.bc.ca/air/airquality/pdfs/airdispmodelguide_july%2005.pdf),
- Web-based guide to airshed planning in British Columbia (http://www.airqualityplanning.ca)
- Emissions reduction toolkit for local government (under development)

Best Management Practices

- For landuse near major thoroughfares (draft)
- For mitigating road dust due to winter road traction materials (http://www.env.gov.bc.ca/air/airquality/pdfs/roaddustbmp_june05.pdf).

Incentives to Support Lower-emission Alternatives:

- Fuel tax exemptions to encourage the use of cleaner-burning fuels and partial sales tax relief for purchase of alternative fuel vehicles (http://www.rev.gov.bc.ca/ctb/publications/bulletins/sst_085.pdf)
- Vehicle scrappage programs that provide financial incentives to take older polluting vehicles off the road (http://www.scrapit.ca).
- Woodstove change-out programs that provide financial incentives to replace older, inefficient woodstoves with EPA/CSA emission-approved appliances (e.g. http://stoveexchange.com).

Opportunities for Public Outreach and Local Capacity Building

- Fraser Basin Council Clean Air Forum (http://www.fraserbasin.bc.ca/programs/basin_wide.html#Climate)
- BC Lung Association Air Quality and Health Workshop (http://www.bc.lung.ca/beta/airquality.htm)
- Clean Air Teacher's Guide, developed by BC Transit in partnership with the province and Environment Canada (http://www.bctransit.com/clean_air/).

Airshed Planning

Community-based airshed plans have been developed for the following areas of B.C.:

- GVRD (http://www.gvrd.bc.ca/air/planning_plans.htm)
- FVRD (http://www.fvrd.bc.ca/FVRD/Services/Air+Quality/)
- Whistler (http://www.whistler.ca/Sustainability/Sustainability_Journey/Environment/)
- Regional District of Okanagan-Similkameen (http://www.rdos.bc.ca)
- North Okanagan Regional District (http://www.nord.ca/airquality.php)
- Williams Lake (www.williamslake.ca)
- Quesnel (www.cariboord.bc.ca/PublicInfo/PDF/Whats%20News/QAMP-executive-summery.pdf)
- Prince George (http://wlapwww.gov.bc.ca/nor/pollution/environmental/air_mgmtplan_final.html)
- and the Bulkley Valley-Lakes District (http://www.bvldamp.ca/cap.shtml).

Each plan contains a series of actions that have been identified to address local air quality issues, including PM. A new plan is under development in the Sea-to-Sky airshed that extends from West Vancouver to Pemberton. There are at least eight other areas expressing an interest in airshed planning. Further information on airshed planning in Prince George and the LFV is provided in the following.

Prince George

Prince George has been in exceedance of the CWS for $PM_{2.5}$ since 2001. There are a number of natural and cultural factors in the Prince George airshed that increase the

difficulty of improving $PM_{2.5}$ levels. Heavy industry and rail and road transportation corridors are located in the Fraser River valley, which funnels emissions into the City on the prevailing winds. The valley topography increases the frequency of inversions and calm winds, reducing the dispersion of both elevated plumes and ground level emissions from the valley. The primary sources of $PM_{2.5}$ are the pulp mills, residential wood smoke, crustal dust, and diesel emission sources, with overlapping source profiles that increase the difficulty of segregating sources. Source identification and prioritization is being done using ambient monitoring data, and receptor and dispersion modelling. Through the Prince George Air Quality Management Plan, which was completed in 1998, improvements have been made in road dust, sawmill and pulp mill emissions, and in the planning for new developments, but further actions are needed to significantly reduce $PM_{2.5}$ levels.

Lower Fraser Valley

Within the LFV airshed, the GVRD has delegated authority from the provincial government to manage air emissions within its boundaries. The FVRD has delegate authority for air quality planning purposes.

To support efforts to maintain and improve air quality in the LFV airshed, the GVRD adopted a new Air Quality Management Plan (AQMP) in October 2005 (GVRD, 2005). Although Greater Vancouver currently experiences good regional air quality relative to most other urban areas in North America, health impacts still occur at current levels and emissions of some air contaminants – such as particulate matter and greenhouse gases – are forecast to increase as a result of predicted growth in population, trade and transportation. Further, localized “hot spots” can also exist even though regional air quality may remain acceptable.

The new AQMP aims to meet its goals of minimizing the risk to human health from air pollution, improving visibility and reducing Greater Vancouver’s contribution to global climate change through the following strategies:

- reduce emissions from major regional sources (e.g., reduce primary particulate matter emissions, as well as ozone and particulate matter precursor emissions from major sources such as marine vessels and port operations; cars, trucks and buses; construction, rail and agricultural equipment; industrial, commercial and institutional sources; communities; and agriculture);
- develop and implement local air quality management programs; and
- enhance air quality information and public awareness.

As the CWS for $PM_{2.5}$ is being met throughout the LFV, and the CWS for ozone is exceeded in only the most eastern part, the AQMP supports the CI/KCAC provisions of the CWS. New health-based ambient air quality objectives for the region, established as part of the AQMP, are more stringent than the CWS for ozone and $PM_{2.5}$. In addition, CI defined as "taking remedial and preventative actions to reduce emissions from human activities towards the long-term goal of reducing overall ambient concentrations and health risks "is a fundamental principle of the AQMP. The AQMP's emission reduction actions will reduce direct emissions of particulate matter, and emissions of ozone and particulate matter precursors.

The FVRD also maintains an air quality management plan, which was adopted in 1998. A set of 43 recommendations were developed as part of the planning process, including the need for coordinated air management across the LFV. The FVRD is currently reviewing and revising this plan.

Cooperative Studies

The Georgia Basin-Puget Sound International Airshed Strategy is one of three pilot projects under Border Air Quality Strategy. It represents a multi-agency, international co-operative effort to address shared air quality management concerns. These include impacts to human and environmental health specific to this region. This strategy also aims to prevent future deterioration of air quality, and is particularly important due to the recent significant regional population growth, which is expected to continue for at least the next two decades.

The Georgia Basin-Puget Sound International Airshed Strategy aims to achieve the following through international and regional co-operation and collaboration:

- Reduce the impacts of air pollution to human health, ecosystems, and visibility in the GB-PS airshed;
- Prevent future deterioration and work towards continuous improvement of air quality in the GB-PS region; and
- Establish practical and effective instruments to address shared concerns regarding transboundary air pollution in the GB-PS region.

Work through the GB-PS International Airshed Strategy process also supports the "keeping clean areas clean" goal of the Canada-wide Standards implementation process.

IV. NEXT STEPS

The province is continuing to support community-based airshed planning through scientific expertise, technical support, direct funding and tools development. The province will be finalize its provincial airshed framework in 2006 to guide future airshed planning efforts, and continue consultations with stakeholders over the development of a new provincial air quality objective for $PM_{2.5}$ to support day-to-day management decisions. The province will be reviewing its Open Burning Smoke Control Regulation, which is an important contributor to $PM_{2.5}$ management in B.C. The province is further evaluating the effectiveness of wood stove-related programs with an eye to developing a province-wide wood stove change-out program. All of these initiatives are in support of government's response to government's Great Goal #4 to "lead the work in sustainable environmental management, with the best air and water quality, and the best fisheries management, bar none."

In terms of future challenges, the focus for most areas of the province is on implementing programs that support Continuous Improvement and Keeping Clean Areas Clean. Particular air quality challenges include:

- rapid population growth, with the B.C. population estimated to increase by almost 36% between 2001 and 2031 (http://www.bcstats.gov.bc.ca/data/pop/pop/Project/P29BCIntro.pdf), and
- management of forest fuel loadings through burning, including areas affected by the mountain pine beetle infestation.

References

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SENES and Bates (2005) *Development of Options for a New Provincial $PM_{2.5}$ Air Quality Objective. Summary Report.* Prepared by SENES Consultants Ltd. and Dr. David Bates for the B.C. Lung Association, December 2005. http://www.bc.lung.ca/PM2.5SummaryReport24Mar06.pdf

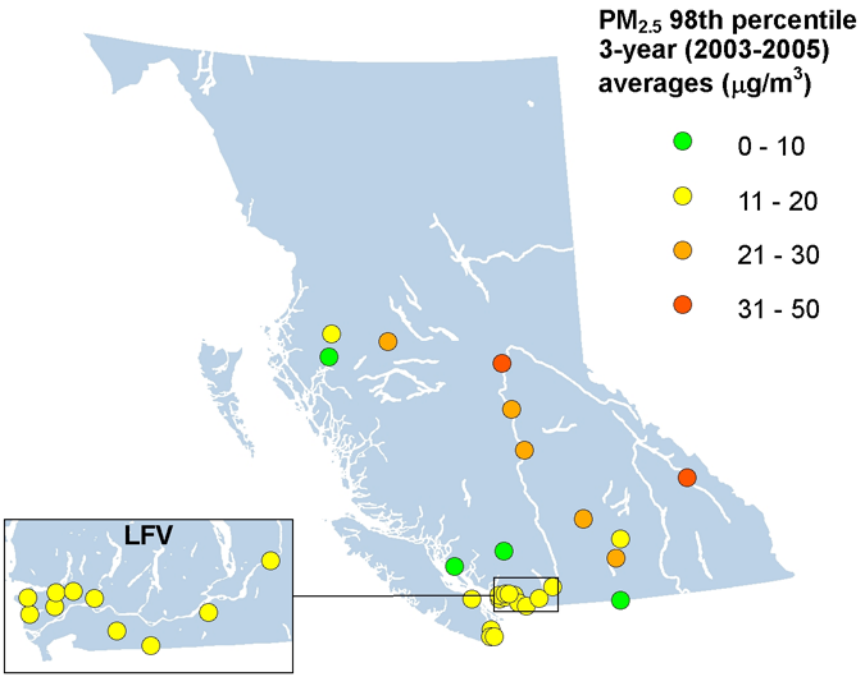

Figure 1. $PM_{2.5}$ 98th percentile concentrations, 3-year average (2003-2005).

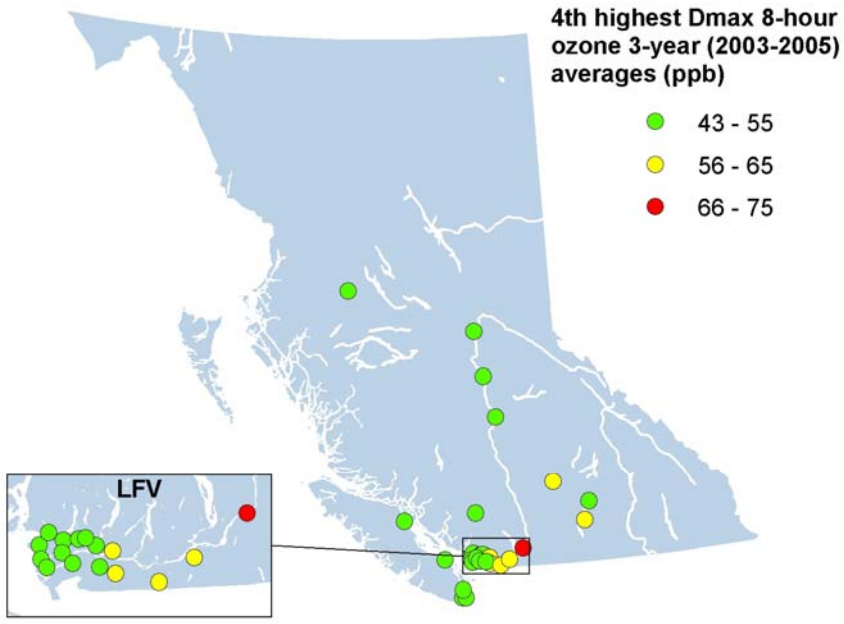

Figure 2. Ozone 4th highest daily 8-hour maximum concentrations, 3-year average (2003-2005).

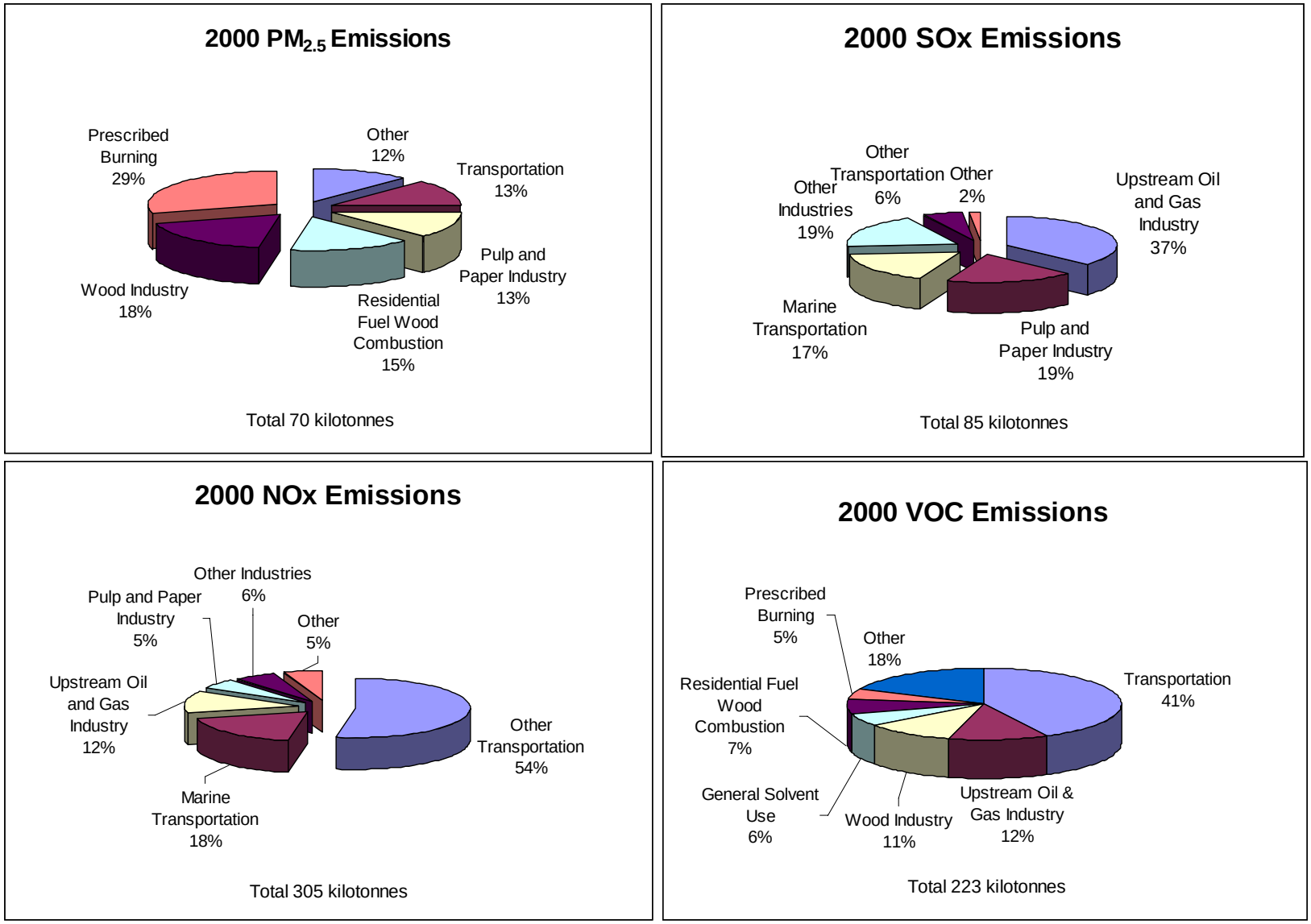

Figure 3. Summary of annual 2000 emissions of $PM_{2.5}$, SO_x, NO_x and VOC emissions for British Columbia (excluding natural sources and road dust).

Table 1. Summary of $PM_{2.5}$ 98th percentile concentrations, 3-year average (2003-2005).

		PM reporting station		98th Percentile			
Community Name	**Reporting sub-area**	**Name**	**NAPS ID**	**2003**	**2004**	**2005**	**3-year average**
Vancouver	**Vancouver-Burnaby-North Shore**	Vancouver Kitsilano	100118		14.5	16.0	15
		Burnaby Kensington	100110		13.7	13.6	14
		Burnaby South	100119		14.4	13.2	14
		For Vancouver-Burnaby-North Shore			13.5	12.8	13
	NE Sector	Port Moody Rocky Point Park	100111		14.7	15.0	15
		Pitt Meadows Meadowlands Elementary School	101202	16.3	14.3	15.7	15
		For NE Sector		16.9	14.3	14.2	15
	Richmond-Delta	Vancouver International Airport	100134	15.9	15.6	17.5	16
	Surrey-Langley	Langley Central	101301	19.3	.	15.2	17
Abbotsford	.	Abbotsford Central	101003	15.0	14.6	14.3	15
Victoria	.	Saanich Stelly's Cross Road			14.3		
	.	Victoria Royal Roads University	100307	10.8	11.2	11.1	11
	.	Victoria Topaz	100304	14.9	15.5	13.7	15
		For Victoria		12.9	12.5	11.4	12
Kelowna		Kelowna Okanagan College	100701	40.9	17.2	12.3	23
OTHER SITES							
Chilliwack		Chilliwack Airport	101101	16.1	14.2	11.9	14
Hope		Hope Airport	101401	.	.	12.0	12
Nanaimo		Nanaimo Labieux Road	102102	9.5	11.5	11.0	11
Powell River		Powell River Cranberry Lake	102301	10.3	10.3	8.1	10
Golden		Golden Hospital		48.2	.	18.8	34
Osoyoos		Osoyoos Canada Customs		.	.	10.7	.
Whistler		Whistler Meadow Park		.	.	11.3	.
Kamloops		Kamloops Brocklehurst	100402	41.4	17.5	13.2	24
Vernon		Vernon Science Centre		27.4	18.7	14.5	20
Williams Lake		Williams Lake Columneetza School		25.9	21.8	19.2	22
Quesnel		Quesnel Senior Secondary		.	28.0	21.5	25
Prince George		Prince George Plaza 400	100202	41.4	34.3	26.6	34
Houston		Houston Firehall		23.4	19.5	21.7	22
Terrace		Terrace BC Access Centre		.	11.9	12.5	12
Kitimat		Kitimat Riverlodge		9.4	11.8	7.8	10

Table 2. Summary of ozone 4th highest daily 8-hour maximum concentrations, 3-year average (2003-2005). All concentrations are expressed in ppb. [5]

		Ozone reporting station		4th Highest Daily 8h Max			
Community Name	**Reporting sub-area**	**Name**	**NAPS ID**	**2003**	**2004**	**2005**	**3-year average**
Vancouver	**Vancouver-Burnaby-North Shore**	Vancouver Kitsilano	100118	48	50	46	48
		Burnaby Kensington	100110	44	51	43	46
		Burnaby South	100119	42	45	43	43
		North Vancouver Mahon Park	100132	48	57	44	50
		For Vancouver-Burnaby-North Shore		**48**	**57**	**46**	**50**
	NE Sector	Port Moody Rocky Point Park	100111	47	53	45	48
		Pitt Meadows Meadowlands Elementary School	101202	49	60	51	53
		Coquitlam Douglas College	100135		57	52	55
		Maple Ridge Golden Ears Elementary School	101501	58	64	55	59
		For NE Sector		**58**	**64**	**55**	**59**
	Richmond-Delta	Vancouver International Airport	100134	49	54	44	49
		Richmond South	100128	54	53	51	53
		North Delta	100125	46	53	46	48
		For Richmond-Delta		**54**	**54**	**51**	**53**
	Surrey-Langley	Langley Central	101301	58	62	53	58
		Surrey East	100127	51	59	51	54
		For Surrey-Langley		**58**	**62**	**53**	**58**
Abbotsford		Abbotsford Central	101003	58	60	52	57
Victoria		Victoria Royal Roads University	100307	53	50	52	52
		Victoria Topaz	100304	46	45	45	45
		Saanich Stellys Cross Road			53	51	52
		For Victoria		**53**	**53**	**52**	**53**
Kelowna		Kelowna Okanagan College	100701	59	59	54	57
OTHER SITES							
Chilliwack		Chilliwack Airport	101101	62	68	60	63
Hope		Hope Airport	101401	70	72	62	68
Squamish		Squamish	101601		62		
Prince George		Prince George Plaza 400	100202	55	54	50	53
Williams Lake		Williams Lake Columneetza			48	50	49
Smithers		Smithers St. Josephs		50	53	52	52
Kamloops		Kamloops Brocklehurst	100402	62	62	54	59
Quesnel		Quesnel Sr. Secondary School		56	52	50	53
Elk Falls		Elk Falls Dogwood		42	57	44	48

[5] Note: concentrations measured outside of the Lower Fraser Valley are currently under review and may be subject to small changes in the future.

Whistler		Whistler Meadow Park		57	55	50	54
Nanaimo		Nanaimo Labieux Road	102102	46	53	45	48
Vernon		Vernon Science Centre		47	42	42	44
Osoyoos		Osoyoos Canada Customs				53	

Table 3. 2000 total annual emissions of $PM_{2.5}$ and $PM_{2.5}$/ozone precursor gases for British Columbia (in tonnes)

CATEGORY/SECTOR	PM2.5	NOx	SOx	VOCs	NH3
INDUSTRIAL SOURCES					
Abrasives Manufacture	0	0	0	0	0
Aluminum Industry	546	12	5,450	1	2
Asbestos Industry	0	7	0	0	0
Asphalt Paving Industry	12	82	25	793	1
Bakeries	0	0	0	86	0
Cement and Concrete Industry	331	4,016	271	63	10
Chemicals Industry	53	3,154	298	42	13
Clay Products Industry	10	13	0	1	0
Coal Mining Industry	1,151	1,319	1,884	806	0
Ferrous Foundries	66	57	1	26	0
Grain Industries	25	0	0	0	0
Iron and Steel Industries	13	32	1	212	17
Iron Ore Mining Industry	0	0	0	0	0
Mining and Rock Quarrying	366	1,093	683	80	7
Non-Ferrous Mining and Smelting Industry	125	1	3,088	0	0
Oil Sands	0	0	0	0	0
Other Petroleum and Coal Products Industry	0	0	0	0	0
Paint & Varnish Manufacturing	1	0	0	203	0
Petrochemical Industry	0	0	0	0	0
Petroleum Refining	80	395	3,695	572	144
Plastics & Synthetic Resins Fabrication	1	18	4	4	0
Pulp and Paper Industry	8,928	16,756	15,943	4,559	1,229
Upstream Oil and Gas Industry	977	37,704	31,318	26,191	0
Wood Industry	12,668	6,234	451	23,836	2,514
Other Industries	971	1,418	366	2,216	230
TOTAL INDUSTRIAL SOURCES	**26,323**	**72,312**	**63,480**	**59,693**	**4,167**
NON INDUSTRIAL FUEL COMBUSTION					
Commercial Fuel Combustion	217	2,917	639	152	15
Electric Power Generation (Utilities)	336	2,704	135	613	51
Residential Fuel Combustion	275	3,696	160	207	39
Residential Fuel Wood Combustion	10,623	1,120	161	14,860	71
TOTAL NON INDUSTRIAL FUEL COMBUSTION	**11,451**	**10,437**	**1,095**	**15,833**	**176**
TRANSPORTATION					
Air Transportation	183	13,740	823	1,882	8
Heavy-duty diesel vehicles	1,026	34,848	501	1,449	63
Heavy-duty gasoline trucks	109	8,753	195	2,935	67
Light-duty diesel trucks	30	235	11	107	1
Light-duty diesel vehicles	23	206	8	73	1
Light-duty gasoline trucks	158	17,719	613	23,421	791
Light-duty gasoline vehicles	94	23,347	623	27,101	1,093
Marine Transportation	2,394	56,380	14,627	1,301	248

Table 3. 2000 total annual emissions of $PM_{2.5}$ and $PM_{2.5}$/ozone precursor gases (continued)

CATEGORY/SECTOR	PM2.5	NOx	SOx	VOCs	NH3
Motor cycles	1	124	2	489	1
Off-road use of diesel	3,156	31,942	1,012	3,753	19
Off-road use of gasoline	891	6,301	92	30,889	10
Rail Transportation	493	24,493	1,130	1,237	2
Tire wear & Brake lining	192	0	0	0	0
TOTAL TRANSPORTATION	**8,751**	**218,088**	**19,637**	**94,637**	**2,302**
INCINERATION					
Crematorium	0	0	0	0	0
Industrial & Commercial Incineration	0	0	0	0	0
Municipal Incineration	235	497	97	145	0
Wood Waste Incineration	0	0	0	0	
Other Incineration & Utilities	56	134	65	36	29
TOTAL INCINERATION	**291**	**631**	**161**	**181**	**30**
MISCELLANEOUS					
Cigarette Smoking	255	6	0	1	1
Dry Cleaning	0	0	0	241	0
Fuel Marketing	0	0	2	8,006	0
General Solvent Use	0	0	0	12,545	0
Marine Cargo Handling Industry	423	0	0	1	0
Meat Cooking	464	0	0	0	0
Pesticides and Fertilizer Application	68	0	0	0	2,714
Printing	2	11	0	1,900	0
Structural Fires	17	2	0	15	1
Surface Coatings	0	0	0	8,926	0
TOTAL MISCELLANEOUS	**1,229**	**18**	**2**	**31,633**	**2,716**
OPEN SOURCES					
Agriculture (Animals)	765	0	0	8,151	25,837
Agriculture Tilling and Wind Erosion	532	0	0	0	0
Construction Operations	12	0	0	0	0
Dust from Paved Roads	20,740	0	0	0	0
Dust from Unpaved Roads	12,977	0	0	0	0
Forest Fires	12,658	1,875	47	4,005	1,125
Landfills Sites	50	0	0	2,538	0
Mine Tailings	0	0	0	0	0
Prescribed Burning	20,353	3,838	144	10,575	209
TOTAL OPEN SOURCES	**68,088**	**5,714**	**191**	**25,269**	**27,171**
TOTAL WITH OPEN SOURCES	**116,132**	**307,200**	**84,566**	**227,246**	**36,561**
TOTAL WITHOUT OPEN SOURCES	**48,044**	**301,486**	**84,375**	**201,977**	**9,390**

Table 4. $PM_{2.5}$ emissions outlook for British Columbia (in tonnes). Earlier estimates (light grey shading) may reflect different estimation methodologies than base year 2000. Projected data (blue shading) based on year 2000 estimates.

CATEGORY / SECTOR	1990	1995	2000	2005	2010
INDUSTRIAL SOURCES					
Abrasives Manufacture	0	0	0	0	0
Aluminum Industry	358	519	546	642	754
Asbestos Industry	184	3	0	0	1
Asphalt Paving Industry	12	12	12	14	15
Bakeries	0	0	0	0	0
Cement and Concrete Industry	258	344	331	346	377
Chemicals Industry	31	50	53	58	66
Clay Products Industry	139	54	10	10	11
Coal Mining Industry	1,874	810	1,151	1,470	1,607
Ferrous Foundries	287	9	66	49	49
Grain Industries	26	39	25	22	24
Iron and Steel Industries	201	146	13	15	15
Iron Ore Mining Industry	0	0	0	0	0
Mining and Rock Quarrying	387	386	366	392	414
Non-Ferrous Mining and Smelting Industry	131	144	125	148	174
Oil Sands	0	0	0	0	0
Other Petroleum and Coal Products Industry	0	0	0	0	0
Paint & Varnish Manufacturing	8	2	1	1	1
Petrochemical Industry	0	0	0	0	0
Petroleum Refining	117	149	80	80	81
Plastics & Synthetic Resins Fabrication	5	1	1	1	1
Pulp and Paper Industry	7,379	7,495	8,928	7,830	8,602
Upstream Oil and Gas Industry	112	692	977	1,024	1,104
Wood Industry	36,183	33,069	12,668	14,164	15,132
Other Industries	1,145	1,912	971	1,116	1,272
TOTAL INDUSTRIAL SOURCES	**48,835**	**45,838**	**26,323**	**27,381**	**29,700**
NON INDUSTRIAL FUEL COMBUSTION					
Commercial Fuel Combustion	310	319	217	232	245
Electric Power Generation (Utilities)	232	560	336	494	547
Residential Fuel Combustion	359	383	275	272	274
Residential Fuel Wood Combustion	8,569	9,841	10,623	10,791	11,280
TOTAL NON INDUSTRIAL FUEL COMBUSTION	**9,470**	**11,104**	**11,451**	**11,788**	**12,346**
TRANSPORTATION					
Air Transportation	152	148	183	179	199
Heavy-duty diesel vehicles	1,928	1,594	1,026	741	484
Heavy-duty gasoline trucks	281	161	109	92	66
Light-duty diesel trucks	34	41	30	18	14
Light-duty diesel vehicles	32	24	23	19	12
Light-duty gasoline trucks	218	210	158	78	79

Table 4. $PM_{2.5}$ emissions outlook for British Columbia (cont'd)

Light-duty gasoline vehicles	147	128	94	52	53
Marine Transportation	2,487	2,508	2,394	2,583	2,848
Motor cycles	2	1	1	2	2
Off-road use of diesel	4,034	3,755	3,156	2,516	1,990
Off-road use of gasoline	765	822	891	968	1,012
Rail Transportation	603	601	493	468	472
Tire wear & Brake lining	153	170	192	206	250
TOTAL TRANSPORTATION	**10,837**	**10,160**	**8,751**	**7,924**	**7,480**
INCINERATION					
Crematorium	0	0	0	0	0
Industrial & Commercial Incineration	0	0	0	0	0
Municipal Incineration	15	338	235	254	274
Wood Waste Incineration	0	0	0	0	0
Other Incineration & Utilities	0	0	56	60	64
TOTAL INCINERATION	**15**	**338**	**291**	**313**	**338**
MISCELLANEOUS					
Cigarette Smoking	78	100	255	273	292
Dry Cleaning	0	0	0	0	0
Fuel Marketing	0	0	0	0	0
General Solvent Use	0	0	0	0	0
Marine Cargo Handling Industry	406	390	423	461	493
Meat Cooking	358	415	464	496	529
Pesticides and Fertilizer Application	45	53	68	74	79
Printing	1	0	2	0	0
Structural Fires	604	601	17	15	16
Surface Coatings	0	0	0	0	0
			0		
TOTAL MISCELLANEOUS	**1,492**	**1,559**	**1,229**	**1,319**	**1,408**
OPEN SOURCES					
Agriculture (Animals)	935	935	765	851	919
Agriculture Tilling and Wind Erosion	261	261	532	576	612
Construction Operations	11	12	12	12	14
Dust from Paved Roads	16,416	16,416	20,740	22,183	23,931
Dust from Unpaved Roads	9,203	9,203	12,977	13,867	14,960
Forest Fires	106,654	33,002	12,658	12,658	12,658
Landfills Sites	7	7	50	19	20
Mine Tailings	377	377	0	0	0
Prescribed Burning	154,960	13,914	20,353	23,075	25,468
TOTAL OPEN SOURCES	**288,825**	**74,128**	**68,088**	**73,244**	**78,582**
TOTAL WITH OPEN SOURCES	**359,474**	**143,126**	**116,132**	**121,970**	**129,854**
TOTAL WITHOUT OPEN SOURCES	**70,649**	**68,998**	**48,044**	**48,726**	**51,272**