GEORGIA STRAIT AIR ZONE REPORT (2014-2016)

Introduction

This is the fourth annual air quality report for the Georgia Strait Air Zone. Annual air zone reporting is a commitment under the national Air Quality Management System (AQMS). This report describes achievement of the Canadian Ambient Air Quality Standards (CAAQS) for ground-level ozone (O_3) and fine particulates ($PM_{2.5}$), the associated management levels and recent actions to improve air quality. A province-wide summary can be found at: http://www.env.gov.bc.ca/soe/indicators/air/.

Background

The AQMS is the national approach to managing air quality in Canada. Under the AQMS, the CAAQS are developed to drive action to protect human health and the environment. Air zones are areas that exhibit similar air quality characteristics, issues and trends, and that form the basis for monitoring, reporting and taking action on air quality. The Georgia Strait Air Zone (see Figure 1) is one of seven broad air zones across the province. Under the AQMS, progressively more rigorous actions are expected as air quality approaches or exceeds the CAAQS. The level of action is guided by the Air Zone Management Framework outlined in Table 1.

Figure 1. Georgia Strait Air Zone.

Table 1. Air zone management framework for ground-level ozone and $PM_{2.5}$. The CAAQS define the upper threshold, separating the "red" and "orange" management levels.

Management Level	O_3 (ppb)		$PM_{2.5}$ – Annual ($\mu g/m^3$)		$PM_{2.5}$ - 24h ($\mu g/m^3$)	
	2015	**2020**	**2015**	**2020**	**2015**	**2020**
Red	Actions for Achieving Air Zone CAAQS					
Threshold (CAAQS)	63	62	10	8.8	28	27
Orange	Actions for Preventing CAAQS Exceedance					
Threshold	56		6.4		19	
Yellow	Actions for Preventing Air Quality Deterioration					
Threshold	50		4		10	
Green	Actions for Keeping Clean Areas Clean					

Ozone Levels

Ozone measurements in the Georgia Strait Air Zone are summarized in Figure 2. Concentrations ranged from 44 ppb in Nanaimo to 52 ppb in Whistler.[1] All sites achieved the national standard of 63 ppb.

Trends in annual ozone levels are shown in Figure 3.[2] Concentrations have remained below the national standard over the 10-year period.

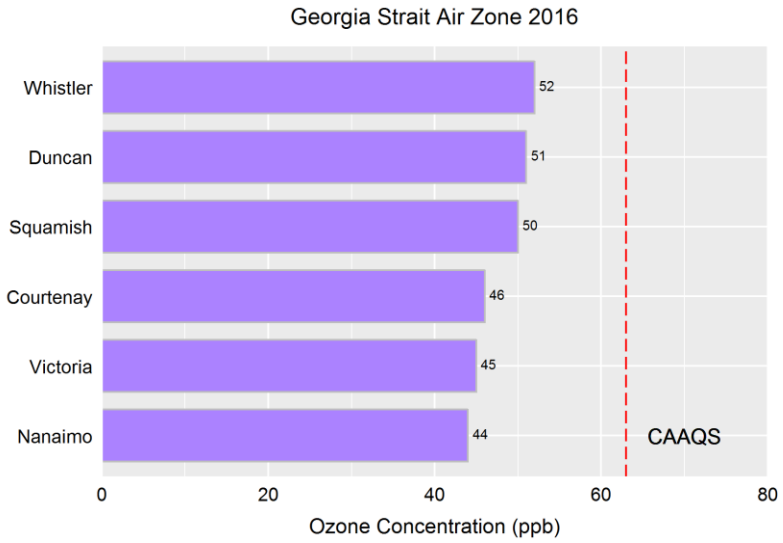

Figure 2. Ozone concentrations in the Georgia Strait Air Zone, based on annual 4th highest daily 8-hour maxima, averaged over 2014-2016. Red dashed line identifies the CAAQS of 63 ppb.

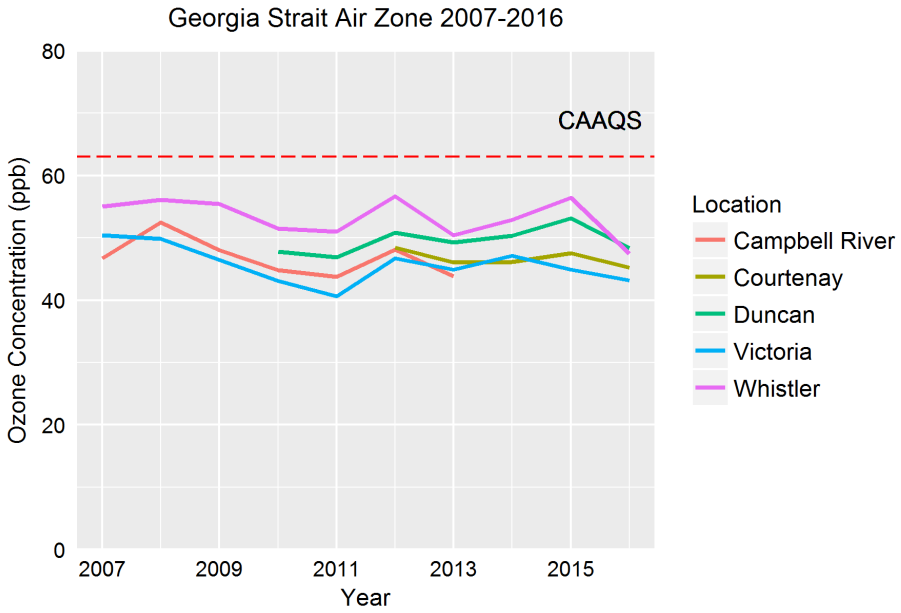

Figure 3. Annual trends in ozone concentrations (2007-2016), based on annual 4th highest daily 8-hour maxima for a single year. Red dashed line identifies CAAQS of 63 ppb.

[1] Concentrations based on 4th highest daily 8-hour maximum, averaged over three years (2014-2016).
[2] Concentrations based on 4th highest daily 8-hour maximum, averaged over a single year.

$PM_{2.5}$ Levels

$PM_{2.5}$ refers to inhalable particles up to 2.5 micrometres in diameter. $PM_{2.5}$ measurements are summarized in Figure 4. A distinction is made between data collected using the new Federal Equivalent Method (FEM) technology and the older TEOM instruments that are being phased out. The FEMs are the preferred instrument as they provide a more complete measure of $PM_{2.5}$ than the TEOMs.

Daily concentrations (upper plot) ranged from 7 to 33 µg/m^3.[3] The national standard of 28 µg/m^3 was exceeded at two sites: Courtenay and Port Alberni. Annual concentrations (lower plot) ranged from 2.6 to 8.5 µg/m^3.[4] All monitoring sites achieved the national standard of 10 µg/m^3.

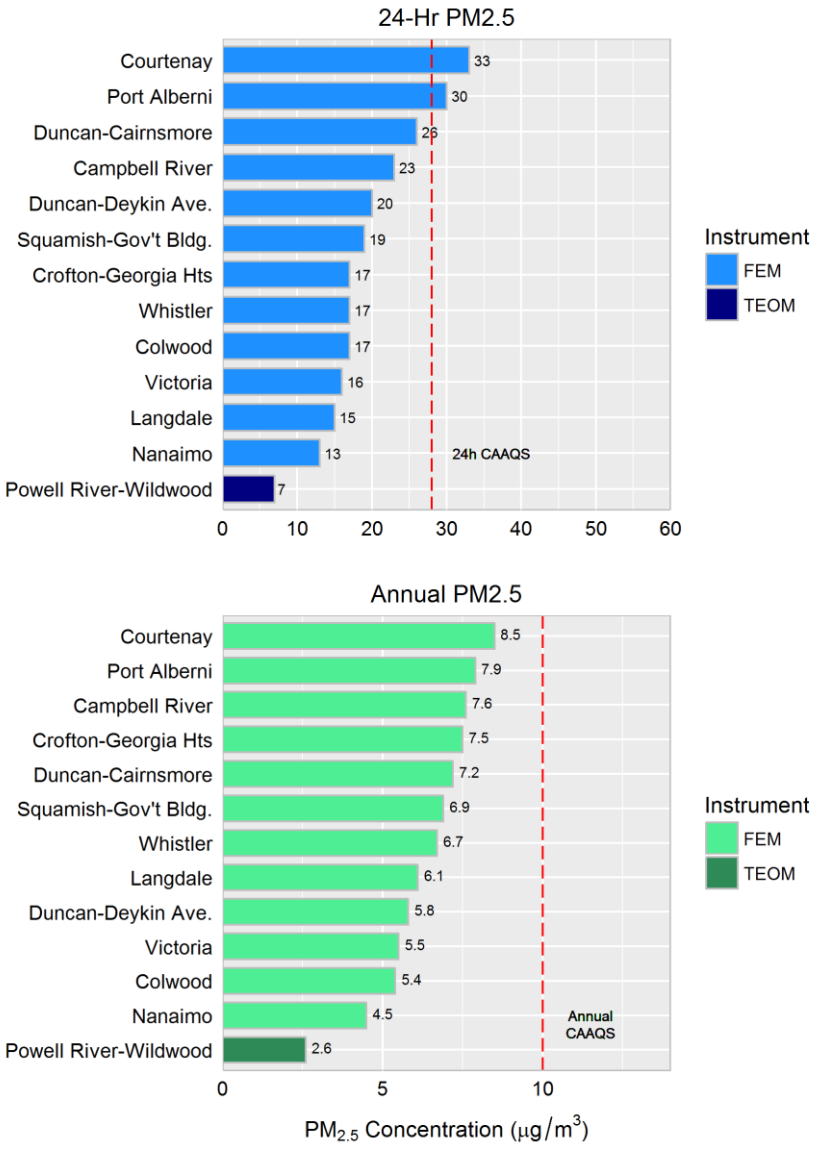

Figure 4. $PM_{2.5}$ concentrations in the Georgia Strait Air Zone. Upper plot based on 24-hour concentration (annual 98th percentile, averaged over 2014-2016). Lower plot based on annual mean concentration (averaged over 2014-2016). Red dashed lines identify CAAQS of 28 µg/m^3 (upper plot) and 10 µg/m^3 (lower plot).

Trends in annual mean concentrations between 2007 and 2016 are shown in Figure 5 for a subset of these sites.[5] A shift to higher reported concentrations is seen with the change from TEOM to FEM instruments from about 2010 onward. However, all monitoring sites have recorded annual mean concentrations below the CAAQS level since 2014.

[3] Concentrations based on annual 98th percentile of 24-hour values, averaged over three years (2014-2016).
[4] Concentrations based on annual average of 24-hour values, averaged over three years (2014-2016).
[5] Concentrations based on annual average of 24-hour values over single year.

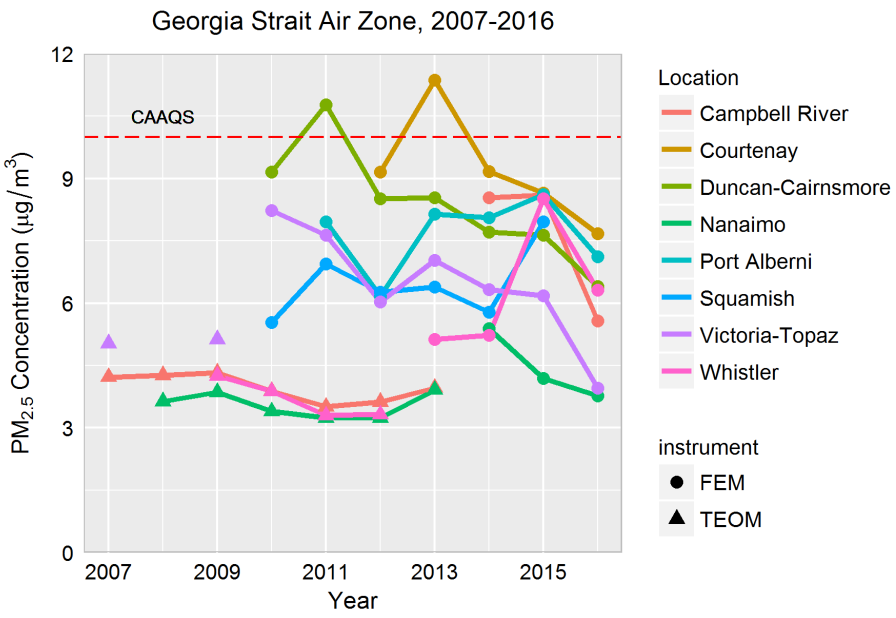

Figure 5. Trends in $PM_{2.5}$ concentrations (2007-2016), based on annual mean concentrations from a single year. The CAAQS value of 10 µg/m^3 is shown by the dashed line. $PM_{2.5}$ measurements prior to 2011 are reported at 25°C and 1 atm. From 2011 onward, measurements are reported at local conditions.

Air Zone Management Levels

Air zone management levels are assigned on the basis of the highest concentrations within an air zone, excluding contributions from transboundary flows (TF) and exceptional events (EE) such as wildfires. This is done so that long-term management strategies are not developed on the basis of events that are beyond local or provincial control.

In the Georgia Strait Air Zone, wildfires are the primary contributor to TF/EE. The methodology for identifying wildfire-influenced data is provided in Appendix I. Excluded data are identified in Appendix II. For the period of 2014-2016, wildfire influences were primarily restricted to the summer of 2015, when smoke from wildfires in the Pemberton area and on southern Vancouver Island contributed to periods of elevated $PM_{2.5}$.

Table 2 summarizes the as-measured concentrations for ground-level ozone and the management levels after any TF/EE influences have been removed. No TF/EE influences were identified for ozone. The ozone management level for the Georgia Strait Air Zone remains in the “yellow”, based on concentrations in Whistler and Duncan. This indicates that ozone-related actions should continue to focus on preventing further air quality deterioration.

Table 3 summarizes both as-measured $PM_{2.5}$ concentrations and management levels once estimated wildfire influences have been removed. The overall $PM_{2.5}$ management level remains in the “red”, based

on 24-hour $PM_{2.5}$ concentrations in Courtenay and Port Alberni. This means that $PM_{2.5}$-related actions should focus on meeting the standards in these communities. For more information on the estimated wildfire influences, see Appendix I.

Table 2. Summary of ozone concentrations as measured and air zone management levels for the Georgia Strait Air Zone (based on 2014-2016 data). All concentrations in ppb.

Location	No. Valid Years	4th Highest Daily 8-hour Maxima		Air Zone Management Level
		As Measured	TF/EE Influences Removed	
Colwood	3	49	49	Goal: Preventing Further Deterioration
Courtenay	3	46	46	
Duncan-Cairnsmore	3	51	51	
Nanaimo	3	44	44	
Squamish	2	50	50	
Victoria	3	45	45	
Whistler	3	52	52	

Table 3. Summary of $PM_{2.5}$ concentrations as measured and air zone management levels for the Georgia Strait Air Zone (based on 2014-2016 data). All concentrations in $\mu g/m^3$.

Location	Monitor Type	No. Valid Years	Daily Mean (98th Percentile)		Annual Mean		Air Zone Management Level
			As Measured	TF/EE Removed	As Measured	TF/EE Removed	
Campbell River	FEM	3	23	23	7.6	7.5	Goal: Achieving the CAAQS
Colwood	FEM	3	17	17	5.4	5.4	
Crofton-Georgia Hts.	FEM	2	17	17	7.5	7.4	
Courtenay	FEM	3	33	32	8.5	8.4	
Duncan-Cairnsmore	FEM	3	26	26	7.2	7.2	
Duncan-Deykin Ave.	FEM	3	20	20	5.8	5.8	
Langdale	TEOM	2	15	14	6.1	5.8	
Nanaimo	TEOM/ FEM	3	13	13	4.5	4.3	
Port Alberni	FEM	3	30	29	7.9	7.8	
Powell River	TEOM	2	7	7	2.6	2.6	
Squamish	FEM	2	19	15	6.9	6.5	
Victoria	FEM	3	16	16	5.5	5.5	
Whistler	FEM	3	17	17	6.7	6.1	

Actions to Protect Air Quality

The reduction of $PM_{2.5}$ emissions remains a focus in both the Cowichan and Comox Valleys. The Cowichan Valley is implementing an airshed protection strategy that identifies a number of actions to reduce emissions from open burning, residential wood combustion and other sources.[6] Emission inventory[7] and health studies[8] in the Comox Valley are helping to establish local priorities for action. Preliminary results from mobile monitoring studies in the province indicate that wood smoke levels in Cumberland may be comparable to those in the much larger community of Courtenay[9], and support ongoing efforts to replace older woodstoves with cleaner-burning models. Between 2014 and 2016, wood stove change-out programs were supported in the Sunshine Coast, the Regional Districts of Campbell River, Comox Valley, Nanaimo, the Alberni Valley and the Cowichan Valley to encourage residents to change out their older, smoky wood stoves for low-emission appliances. Funding support is also being provided to the Strathcona Regional District in 2017.

A description of other activities underway in B.C. air zones can be found in the "Air Zone Management Response for British Columbia" (see: www.gov.bc.ca/bcairquality).

[6] See: http://bc-cowichanvalley2.civicplus.com/DocumentCenter/View/70959.
[7] See: http://www.comoxvalleyrd.ca/assets/Community/Documents/170317_CV_PM_Emissions_Inventory_Final_Report.pdf
[8] Weichenthal, S., Kulka, R., Lavigne, E. et al. (2017) Biomass burning as a source of ambient fine particulate air pollution and acute myocardial infarction. *Epidemiology* 28 (3), pp. 329-337.
[9] BC Lung Association (2017) 2017 State of the Air Report. Available at: https://bc.lung.ca/sites/default/files/State%20of%20the%20Air%202017%20-%20merged.pdf.

Appendix I – Approach to Identify Wildfire-influenced Data

Summertime air quality in British Columbia is periodically influenced by wildfire smoke – from local fires as well as long-range transport from outside of the province. The wildfire season in B.C. typically occurs between May and September, when warm and dry conditions prevail.

A myriad of different pollutants are emitted from wildfires, including $PM_{2.5}$ and gaseous pollutants such as nitrogen oxides and volatile organic compounds (VOCs) that can react in the atmosphere to form ground-level ozone and additional $PM_{2.5}$.

Given that smoke-affected areas may be extensive, and that smoke may linger for days before being fully dispersed from an airshed, the current analysis has focussed on those periods when wildfire smoke may have contributed to an exceedance of the CAAQS levels for $PM_{2.5}$ levels. Criteria used to flag and evaluate wildfire-influenced data included the following:

- 24-hour $PM_{2.5}$ concentrations exceeded the CAAQS level of 28 $\mu g/m^3$ or 8-hour daily maximum ozone levels exceeded the CAAQS level of 63 ppb between May and September,
- Wildfires of interest were identified based on data from B.C. Wildfire Management Branch,
- Wildfire smoke advisories had been issued by the Ministry of Environment & Climate Change Strategy during the period of interest,
- MODIS satellite images indicated smoke impacts over the region,
- Multiple monitoring sites in the area of concern exhibited similar air quality characteristics, suggesting a common source or contributing source, and
- Modelling studies identify enhanced pollutant concentrations due to wildfire smoke.

Wildfire-influenced data were then excluded from the calculation of air zone management levels. Excluded data are as summarized in Appendix II. This resulted in only minor adjustments to site-specific management levels and no changes to the overall air zone management level.

Appendix II – Wildfire-influenced Data in the Georgia Strait Air Zone (2014-2016)

Table II-1 Wildfire-influenced $PM_{2.5}$ data.

Location	Date	24-hr $PM_{2.5}$ ($\mu g/m^3$)	Wildfire Smoke-Related Air Quality Advisory?
Squamish Gov't Bldg	2015-06-15	28.9	
Langdale Elementary	2015-07-05	58.7	Y
Nanaimo Labieux Road	2015-07-05	49.4	Y
Port Alberni Elementary	2015-07-05	28.3	Y
Powell River James Thomson School	2015-07-05	96.3	Y
Powell River Wildwood	2015-07-05	85	Y
Courtenay Elementary School	2015-07-06	50.3	Y
Crofton Georgia Hts	2015-07-06	46.5	Y
Duncan Cairnsmore	2015-07-06	33.8	Y
Duncan Deykin Avenue	2015-07-06	41.8	Y
Elk Falls Dogwood	2015-07-06	47.2	Y
Langdale Elementary	2015-07-06	75	Y
Nanaimo Labieux Road	2015-07-06	81.1	Y
Port Alberni Elementary	2015-07-06	37.2	Y
Powell River James Thomson School	2015-07-06	54	Y
Powell River Wildwood	2015-07-06	66.6	Y
Squamish Gov't Bldg	2015-07-06	88.2	Y
Whistler Meadow Park	2015-07-06	133.5	Y
Whistler Meadow Park	2015-07-06	127.9	Y
Courtenay Elementary School	2015-07-07	39.1	Y
Elk Falls Dogwood	2015-07-07	31	Y
Langdale Elementary	2015-07-07	28.5	Y
Port Alberni Elementary	2015-07-07	53.6	Y
Powell River James Thomson School	2015-07-07	32.1	Y
Powell River Wildwood	2015-07-07	32.8	Y
Squamish Gov't Bldg	2015-07-07	42.3	Y
Whistler Meadow Park	2015-07-07	260.4	Y
Whistler Meadow Park	2015-07-07	280.1	Y
Langdale Elementary	2015-07-08	37.3	Y
Port Alberni Elementary	2015-07-08	40.9	Y
Squamish Gov't Bldg	2015-07-08	59.9	Y
Whistler Meadow Park	2015-07-08	136.1	Y
Whistler Meadow Park	2015-07-08	121.8	Y

Table II-1 (continued)

Location	Date	24-hr $PM_{2.5}$ ($\mu g/m^3$)	Wildfire Smoke-related Air Quality Advisory?
Langdale Elementary	2015-07-09	43.4	Y
Port Alberni Elementary	2015-07-09	28.6	Y
Squamish Gov't Bldg	2015-07-09	50.5	Y
Whistler Meadow Park	2015-07-09	78.3	Y
Whistler Meadow Park	2015-07-09	67.4	Y
Courtenay Elementary School	2015-07-10	31.8	Y
Whistler Meadow Park	2015-07-10	30.3	Y
Crofton Georgia Hts	2015-08-20	36.7	Y
Duncan Cairnsmore	2015-08-20	46.8	Y