Air Quality Standards and Municipal Solid Waste Incineration in Metro Vancouver

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A review of current standards and best practices in Metro Vancouver, Provincial, National and International jurisdictions prepared for Zero Waste BC.

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This report has four sections: a review of ambient air quality standards, a review of air quality emission limits for waste incineration, information on ambient air quality in Metro Vancouver and air quality emissions limits for waste burned in cement kilns.

Ambient Air Quality Levels for Common Pollutants in Various Jurisdictions

Ambient air quality standards (sometimes called objectives) are established by regulatory agencies, and are based on epidemiological and other studies of the effects of air pollutants on humans, plants and ecosystems. These standards are established for so-called criteria pollutants: sulphur dioxide (SO_2), ozone (O_3), nitrous oxide (NO), nitrous dioxide (NO_2), carbon monoxide (CO), lead (Pb), particulate matter under 2.5 microns ($PM_{2.5}$) and particulate matter under 10 microns (PM_{10}). The levels of these pollutants are expressed as mixing ratio or mass concentrations - for example parts per billion (ppb) and microgrammes per cubic metre ($\mu g/m^3$) respectively. Compliance with ambient objectives is generally determined by either environmental monitoring or modelling, or both.

There are several sets of guidelines for ambient air quality that impact policy for the Metro Vancouver area. These are issued by the World Health Organization for a global standard, the Canadian Council of Ministers of Environment for a Canadian Standard, the Province of BC for the provincial standard and Metro Vancouver for the regional standard.

World Health Organization

The World Health Organization published recommended Air Quality Guidelines (AQG) in 2022.[1] These recommendations reflect the fact that air pollution is a key environmental risk to health, and can result in stroke, heart diseases, lung cancer and chronic and acute respiratory diseases including asthma.[2] In 2019, with over 99% of the global population living in areas where the air quality does not meet standards, poor outdoor air quality was estimated to have caused 4.2 million premature deaths globally.[3] The WHO suggests meeting these targets through cleaner transport, energy efficient homes, changes to power generation, changes to industry and better waste management.

These guidelines are periodically updated to reflect evolving research results.

Note that these guidelines are for ambient air quality rather than standards for emissions from a single facility. They show the growing need to limit all sources of air pollution. The tables below show the recommended levels and interim target. The interim targets are incremental steps designed as target levels to aid heavily polluted jurisdictions achieve the AQG, which is the level at which adverse health effects do not occur. These interim targets clearly do not apply in a relatively clean environment such as the Lower Fraser Valley, where the WHO AQG is intended to apply.

[1] World Health Organization (2022). Ambient (outdoor) air pollution. Accessed at https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health.

[2] ibid.

[3] ibid.

Pollutant	Averaging time	Interim target				AQG level
		1	2	3	4	
$PM_{2.5}$, µg/m³	Annual	35	25	15	10	5
	24-hour[a]	75	50	37.5	25	15
PM_{10}, µg/m³	Annual	70	50	30	20	15
	24-hour[a]	150	100	75	50	45
O_3, µg/m³	Peak season[b]	100	70	–	–	60
	8-hour[a]	160	120	–	–	100
NO_2, µg/m³	Annual	40	30	20	–	10
	24-hour[a]	120	50	–	–	25
SO_2, µg/m³	24-hour[a]	125	50	–	–	40
CO, mg/m³	24-hour[a]	7	–	–	–	4

[a] 99th percentile (i.e. 3–4 exceedance days per year).
[b] Average of daily maximum 8-hour mean O_3 concentration in the six consecutive months with the highest six-month running-average O_3 concentration.

Table 1a. WHO Recommended interim targets and AQG for 2022.

Pollutant	Averaging time	Air quality guideline that remain valid
NO_2, µg/m³	1-hour	200
SO_2, µg/m³	10-minute	500
CO, mg/m³	8-hour	10
	1-hour	35
	15-minute	100

Table 1b. WHO Recommended AQG levels for NO2, SO2 and CO for short averaging times.

In response to the most recent updated WHO guidelines (2022), some jurisdictions such as the European Union (EU) are updating their own standards to align. The EU has an overarching goal to have a zero-pollution environment in the EU by 2050. The proposed ambient air quality standards are intended to spur member states to develop air quality roadmaps, air quality plans and short term actions where exceedances may occur, to mitigate health risks.[4]

[4] Clearing the Air: The EU's Pollution Battle Plan - Medscape - February 22, 2024.

Canadian Council of Ministers of Environment

The Canadian Council of Ministers of the Environment (CCME) latest Canadian Ambient Air Quality Standards (CAAQS) are shown in the table below.[5] Note that the asterisked numbers* are converted from the CCME standard to units comparable to the WHO standard using conversion shown in Appendix B. For the pollutants and measures that are comparable ($PM_{2.5}$ annual and 24-hour), O_3 (8-hour), NO_2 (annual)) the CCME 2025 standards are less stringent than WHO AQG. The CCME standard for NO_2 (1-hour) is much more stringent than the WHO AQG. The WHO notes that in most practical circumstances the 24-hour AQG of 25 µg/m^3 is more stringent than 200 µg/m^3 1-hour standard. The CCME standards have evolved over time showing the continuing trend towards tighter standards as more is learned about how air quality impacts human health.

Pollutant	Averaging Time	2015	2020	2025	Statistical Form
$PM_{2.5}$	annual	10 µg/m3	8.8 µg/m3	-	3 year average of the annual average of the daily 24 hour average concentrations
$PM_{2.5}$	24 hour	28 µg/m3	27 µg/m3	-	3 year average of the annual 98th percentile the daily 24 hour average concentrations
O_3	8 hour	63 ppb	62 ppb	60 ppb (118.2 *µg/m3**)	3 year average of the annual 4th highest of the daily maximum 8 hour average concentration
NO_2	annual	-	17.0 ppb	12.0 ppb (22.56 µg/m3*)	The average over a single calendar year of all 1 hour average concentrations
NO_2	1 hour	-	60 ppb	42 ppb (78.96 µg/m3*)	3 year average of the annual 98th percentile the daily maximum 1 hour average concentrations
SO_2	1 hour	-	70 ppb	56 ppb (146.16 µg/m3*)	3 year average of the annual 99th percentile of the daily maximum 1 hour average concentration
SO_2	annual	-	5.0 ppb	4.0 ppb (10.44 µg/m3*)	The average over a single calendar year of all 1 hour average concentrations

Table 2 CCME Ambient Air Quality Standards

*calculated from ppb

[5] Canadian Council of Ministers of Environment. Accessed at https://ccme.ca/en/air-quality-report

Province of British Columbia

The Province of BC has its own ambient air quality objectives, some of which are based on the CCME CAAQS noted above. Last updated in December 2019, these can be seen in the table below which includes conversions between ppb and µg/m^3.[6] For the pollutants and measures that are comparable, the BC standards are broadly similar to, or slightly less stringent than the CCME 2025 CAAQS. In the case of SO_2 , the BC objectives are far less stringent than the CCME (CAAQS) standards for both 1-hour and annual averages.

Contaminant	Avg. Period	Air Quality Objective		Source	Date Adopted by Source
		µg/m^3	ppb		
Formaldehyde (HCHO)	1 hour	**60[6]**	50	Provincial AQO	1995
Nitrogen Dioxide (NO_2)	1-hour	188	**100[7]**	Interim Provincial AQO	2014
		113	**60[8]**	2020 CAAQS	2017
	Annual	60	**32[9]**	Interim Provincial AQO*	2014
		32	**17[10]**	2020 CAAQS	2017
Ozone (O_3)	1-hour	**160**	82	NAAQO[11]	1989
	8-hour	123	**62[12]**	2020 CAAQS	2013
Particulate Matter <2.5 microns ($PM_{2.5}$)	24-hour	**25[13]**	-	Provincial AQO	2009
		27[14]	-	2020 CAAQS	2013
	Annual	**8[15]**	-	Provincial AQO	2009
		8.8[16]	-	2020 CAAQS	2013
Particulate Matter <10 microns (PM_{10})	24-hour	**50**	-	Provincial AQO	1995
Sulphur Dioxide (SO_2)	1-hour	196	**75[17]**	Interim Provincial AQO	2016
	1-hour	183	**70[18]**	2020 CAAQS	2017
	Annual	13	**5[19]**	2020 CAAQS	2017
Total Suspended Particulate (TSP)	24-hour	**120**	-	NAAQO	1974
	Annual	**60[20]**	-	NAAQO	1974

Table 3 BC Ambient Air Quality Standards

Metro Vancouver

Metro Vancouver is empowered by the Province of BC to establish its own air quality objectives for its region. Last updated in January 2020, the table below shows the current objectives.[7] Again for the pollutants and measures that are comparable ($PM_{2.5}$ (annual and 24-hour), O_3 (8-hour), NO_2 (annual)), the Metro Vancouver standards are less stringent than WHO AQG.

[6] Province of BC (Dec 17, 2019). British Columbia Ambient Air Quality Objectives. Accessed at https://www2.gov.bc.ca/assets/gov/environment/air-land-water/air/reports-pub/aqotable.pdf.

[7] Metro Vancouver (January 2020). Metro Vancouver Ambient Air Quality Objectives. Accessed at https://https://metrovancouver.org/services/air-quality-climate-action/Documents/ambient-air-quality-objectives.pdf.

Air Contaminant	Averaging Period	Ambient Air Quality Objective[a]	
		µg/m³	parts per billion
Carbon monoxide (CO)	1-hour	14,900	13,000
	8-hour[b]	5,700	5,000
Nitrogen dioxide (NO_2)	1-hour[c]	113	60
	Annual[d]	32	17
Sulphur dioxide (SO_2)	1-hour	183	70
	Annual[d]	13	5
Ozone (O_3)	1-hour	161	82
	8-hour[e]	122	62
Fine particulate matter ($PM_{2.5}$)	24-hour[b]	25	-
	Annual[d]	8 (6[f])	-
Inhalable particulate matter (PM_{10})	24-hour[b]	50	-
	Annual[d]	20	-
Total reduced sulphur (TRS)	1-hour (acceptable)	14	10
	1-hour (desirable)	7	5

Table 4 Metro Vancouver Ambient Air Quality Objectives

Comparison of Similar Pollutants and Measures

The table below shows the most recent ambient air quality objectives that have the same units and averaging time. This shows that the WHO targets are more stringent than the Canadian standards, in some cases by a significant amount.

Pollutant	Averaging Time	WHO	CCME	BC	Metro Vancouver
$PM_{2.5}$ µg/m3	annual	5	8.8	8/8.8 (voluntary 6)	8 (aspirational 6)
$PM_{2.5}$ µg/m3	24 hour	15	27	25/27	25
O_3 µg/m3	8 hour	100	118.2*	123	122
NO_2 µg/m3	annual	10	22.56*	60/32	32

Table 5 Comparable Limits (*calculated from ppb)

Air Quality Emission Limits for Waste Incineration

As facilities that thermally treat waste contribute to poor ambient air quality, there are separate standards for how much pollution can be released from a facility. **Emission Limits** are expressed as concentrations of the pollutants under question as measured in stack gases being emitted by the facility. Pollutants for which emissions limits are commonly set can include the primary criteria pollutants (SO_2, NO, NO_2, CO, Pb, $PM_{2.5}$ and PM_{10}) but can also include other pollutants of concern. It must be recognized that the concentrations set in emissions limits are not the same as ambient concentrations. Emissions limits are generally set for a specific point source. Compliance with emissions limits is tested by direct measurement of pollutants at the point of emission - often a “smoke” stack. There are some generally applied industry or source category emissions limits, and in some instances the emissions limits are specified in regulatory permitting processes.

Ideally emissions limits should be expressed as a pollutant emission rate (weight per time) rather than a concentration (weight per volume of gas). This is because there always exists the possibility that a facility could simply increase the rate of flow of gases from the smoke stack (presumably by pumping more air into the stack base) to decrease the stack gas concentration (and therefore comply with a concentration based limit) while increasing the total mass of pollutant that is entering the environment. This pollutant dilution approach could either be done at the design stage, or dynamically during operation. The usual way of preventing this is to specify the total flow volume exiting the stack in a permit. For example, the EU regulations state “The emission limit values for polluting substances shall apply at the point where the emissions leave the installation, and any dilution prior to that point shall be disregarded when determining those values.”[8] This explicitly removes the possibility of achieving a limit by dilution. In many instances, emissions permits specify the maximum emission flow rate to prevent an installation achieving an emission limit by dilution.

Air pollution dispersion (and chemical transformation) models are an important regulatory and assessment tool used to calculate ambient concentrations from emissions amounts. In such models, the pollutant emission rate is the primary input.

Emissions limits for the European Union, Japan, US (current and proposed), the Durham York Energy Centre(DYEC) in Ontario, British Columbia and the Metro Vancouver Waste to Energy Facility (WTEF) in Burnaby, BC were reviewed. Details of the standards and their sources are outlined in Appendices C and D. As with ambient air quality objectives, having comparable measures and units remains a challenge. There are quite substantial variations across jurisdictions. This is in part because emissions limits can be quite contentious. There is generally a three-way tension between citizens, governments and industries (those operating incinerators, and those manufacturing and selling incinerators) on emissions limits for waste incineration. This tension is exemplified in the letter to the US Presidential Council on Environmental Quality from the White House Environmental Justice Advisory Council.[9]

The table below compares the standards in key global locations. Note that the US Environmental Protection Agency recently proposed revised limits for existing and new facilities. The provincial limits are not statutory requirements but a guideline for provincial staff reviewing the solid waste management plans or issuing operational certificates. The strictest standards are highlighted in yellow.

[8] European Union (2011). Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control). Article 15. Accessed at https://eur-lex.europa.eu/eli/dir/2010/75/oj.

[9] White House Environmental Justice Advisory Council (Aug 16, 2022). Air Pollution emissions limits for incinerators. Accessed at https://www.epa.gov/system/files/documents/2022-08/WHEJAC%20Incinerators%20Letter%208_4%20Final_0.pdf.

Contaminant	E.U [1]	US EPA current - existing [7]	US EPA proposed - existing [7]	US EPA current -new [7]	US EPA proposed - new [7]	JEGS	DYEC [5]	MV WTEF[1,8]
TPM (mg/m^3)	10/ 10	25	7.4	20	4.9	20	9	9 [4]
CO (mg/m^3)	50/ 100	57.5 -287.5*	115 -287.5 *	57.5 -172.5*	18.4 -115*	-	40	50/100
SO_2 (mg/m^3)	50/ 200	75.98*	52.40*	78.60*	36.68*	81*	35	50/90 [3]
NO_x (mg/m^3)	200/400	239.4 - 332.5*	146.30*	199.50*	66.50*	282.27*	121/ -	190/350
HCl (mg/m^3)	10 / 60	41.47*	18.59*	35.75*	11.15*	35.75 *	9/-	10 / 60 [3]
HF (mg/m^3)	1 / 4					-	-	1.0 [4]
THC (mg/m^3)	10 / 20					-	-	10 / 20
Cd (μg/m^3)		35	1.5	10	1.1	10	7	7 [4]
Hg (μg/m^3)		50	12	50	6.1	50	15	20 [4]
Pb+As+Cr (μg/m^3)						-	-	64 [4]
Pb (μg/m^3)		400	56	140	13	- [6]	50	-
Chlorophenols (μg/m^3)	-					-	-	1 [4]
Chlorobenzenes (μg/m^3)	-					-	-	1 [4]
Polycyclic Aromatic Hydrocarbons (μg/m^3)	-					-	-	5 [4]
Polycyclic Biphenyls (μg/m^3)	-					-	-	1 [4]
Dioxins & Furans (ng/m^3)	0.2 [2]	30/35	7.2	13	1.8	-	0.06	0.08/-

Table 6. Comparison of emissions standards for thermal waste treatment

* = calculated from original units

Notes
[1] The BC and EU limits are expressed as X/Y : daily average/half-hour average.
[2] This is the sum of separately limited dioxins and furans. Averaging time is between 6 -8 hours.
[3] These limits come into effect in 2025. Until then, less stringent interim limits hold.
[4] Determined by an "approved test method" established by director.
[5] DYEC limits are specified for the following averaging times.

(i) the daily minimum and maximum 4-hour average readings for carbon monoxide;
(ii) the daily minimum and maximum one hour average readings for oxygen;
(iii) the daily minimum and maximum 10-minute average readings for organic matter;
(iv) the daily minimum and maximum 24-hour average readings for sulphur dioxide;
(v) the daily minimum and maximum 24-hour average readings for nitrogen oxides;
(vi) the daily minimum and maximum 24-hour average readings for hydrogen chloride;
(vii) the daily minimum and maximum 6-minute average and 2-hour average opacity readings.

[6] Value not shown as possibly anomaly.
[7] The range of the US limits reflects that there are different limits for different types of technology used., with the higher proposed limits for refused derived fuel systems and lower ones for mass burn incineration.
[8] WTEF limits match the BC guidelines.
Sources are shown in Appendix C.

For some metrics it is difficult to compare as the units may be different or some jurisdictions have limits for combinations of molecules or metals while others have separate ones for each. In comparing permitted emissions limits for the Metro Vancouver WTEF to limits in the other jurisdictions noted, it would appear that the WTEF is required to operate under emissions limits are in some cases stronger and in some cases weaker than others. In some cases (CO, SO_2, NO_x, HCl, Hg and dioxins & furans), the DYEC appears to be required to meet slightly more stringent limits that specified by WTEF's Operating Certificate. These differences are difficult to reconcile because of different required averaging times.

Ambient Air Quality in Metro Vancouver

Through its Air Quality division, Metro Vancouver operates an extensive and well-maintained network of high-quality ambient air quality monitoring stations. The agency publishes an annual report of ambient air quality for every year, and uses that report to assess the quality of ambient air in the jurisdiction by comparison with AAQO listed in Table 4.

The most recent such report is for 2021, and is available at

https://metrovancouver.org/services/air-quality-climate-action/Documents/lower-fraser-valley-air-quality-monitoring-report-2021.pdf

These reports summarize the air quality monitoring data collected by the Lower Fraser Valley Air Quality Monitoring Network in the given year and describe the air quality monitoring activities and programs conducted during the year.

Metro Vancouver also publish summary reports. Summary Reports for 2022 and 2023 are available on the same web site.

The summary reports highlight notable air quality and weather events in the given year, describe air quality trends, and reports on the achievement of regional air quality objectives. As noted in the 2023 Summary Report:

- Eastern parts of the Lower Fraser Valley experienced exceedances of the Metro Vancouver 1-hour and 8-hour objective for ozone on 3 days in 2023.

- All of the Lower Fraser Valley experienced exceedances of the Metro Vancouver 24-hour objective for $PM_{2.5}$ on 6 days in 2023.

Future requirements

There are new provincial requirements coming into force for SO_2 in 2025. Metro Vancouver's Operational Certificate required a site specific Contaminant Dispersion Assessment. Metro Vancouver commissioned three reports to investigate this more closely. A review of the reports follows.

Review of RWDI (2020) Study:
The RWDI Study in 2020 built on a similar study in 2018.[10,11] The dispersion modelling methodology used by RWDI was based on the air quality dispersion modelling guideline recommended by the British Columbia Ministry of Environment & Climate Change Strategy. The modelling used the CALMET-CALPUFF dispersion modelling suite to estimate ambient concentrations and deposition rates of criteria air contaminants ($PM_{2.5}$, carbon monoxide, sulphur dioxide, and nitrogen oxides) as well as hydrogen chloride, hydrogen fluoride, total dioxins and furans, cadmium, mercury, the sum of lead, arsenic and chromium, polycyclic aromatic hydrocarbons, and polychlorinated biphenyls.

Modelling was conducted under four emissions scenarios:

> **Permit Scenario**: representing maximum permitted operations, 24 hours a day, each day of the year.
> **Operational Scenario**: representing typical operations.
> **Start Up Scenario**: representing typical operations with a boiler starting up
> **Shut Down Scenario**: representing typical operations with a boiler shutting down

CALMET modelling was based on three years of hourly meteorological data and WRF prognostic model output fields (years 2013, 2014 and 2015). These years were chosen because they were the most recent complete data sets, not for meteorological representativeness, though the years may be representative. The CALMET grid was spaced at 250m on a 50 km x 50 km domain, with 10 vertical layers. The domain is appropriate for this region and source configuration. CALMET employed 19 fixed surface monitoring stations. Seventeen stations are part of the Metro Vancouver air quality monitoring network, while the remaining two are from Vancouver and Abbotsford airports.

CALMET-CALPUFF modelling was conducted on a three-level nested grid with a grid spacing varying between 20 m (at facility property line) to 500 m within 5 km of the facility and 1000m for the remaining domain. This is an appropriate grid resolution for the domain. NO_x and SO_2 were modelled as inert gases to obtain conservative results. The ambient ratio method (ARM) was used to estimate NO_x conversion to NO_2. Secondary particulate matter was explicitly modelled. Stack parameters and emission rates were taken from Metro Vancouver data. Representative background pollutant concentrations were added to modelled values.

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[10] RWDI (2020). Metro Vancouver Waste to Energy Facility Air Dispersion Modelling Study. Accessed at https://metrovancouver.org/services/solid-waste/Documents/wtef-air-dispersion-modelling-study.pdf.

[11] RWDI (2018). Metro Vancouver Waste to Energy Facility Air Dispersion Modelling Study. Accessed at https://metrovancouver.org/services/solid-waste/Documents/wtef-air-dispersion-modelling-study-2018.pdf.

In summary, the modelling exercise was built around an appropriate model platform, and executed using realistic parameters and input data. The four model scenarios were appropriately chosen and prepare the way for a successful modelling exercise that should realistically capture the ambient air pollution field resulting from the operation of the facility.

All modelling exercises must include a statistically rigorous comparison of modelled and measured values of the modelled quantity, in this case ambient pollution. This comparison is called "Model Evaluation".The RWDI modelling report fails to do this in a way that is needed if the model results are to be interpreted as a fair representation of reality, and therefore can be used as a basis for policy decisions..

The RWDI report does contain a very simple comparison between modelled and measured pollution. This is only done for one station (T18 - Burnaby South), for only two of the modelled pollutants (NO_2 and SO_2), for hourly and annual averages, and for MPOI (maximum point of impact, which is not measured, but rather is extracted from modelled pollution fields). The RWDI report makes no conclusions about the overall reliability of their model output as a reflection of actual ambient pollutant concentrations.

A robust model evaluation exercise should contain direct comparison (scatter plots and a suite of agreement statistics) of modelled and measured pollution (for relevant averaging times), over all pollutants for which measurements exist. These plots can be paired in space, and paired in time. Ideally the evaluation should also include Quantile-Quantile[12] (Q-Q) plots of hourly average pollution.

Without a robust (and successful) model evaluation exercise, it is extremely unwise to interpret model output as depicting reality. This is particularly important when using models to develop environment policy.

The main difference between the 2018 and 2020 studies are the inclusion of the BC Ministry of Environment and Climate Change Strategy method for calculating NO to NO_2 conversion, updated maps based on that methodology and further discussion of modelling results for NO_2 and SO_2 and the model to measurement comparison.

Discussion

The modelling scenarios should but do not include two **Permit Scenarios:** One with the present discharge limits, and another with the proposed reduction in discharge limits.

As explained above, the modelling work was well executed, but stopped short of a robust model evaluation assessment. Without proper model evaluation, the assumption that model output matches reality, even in a statistical way, cannot be justified. Without a robust model evaluation, any interpretation of model output will be associated with an unacceptable degree of uncertainty.

As noted, a pair of discharge limit scenarios should have been conducted to provide an estimate of the effect of the proposed reduction in discharge limits.

The absence of an overall conclusion (in the RWDI report) about model performance is a disturbing omission, but not unexpected, given the rudimentary model evaluation analysis. This absence puts in doubt the veracity of any decision based on the modelling results.

Review of the Ollson (2018) Study:

[12] for examples, see https://en.wikipedia.org/wiki/Q-Q_plot

The Ollson (2018) study[13] states:

" The Air Dispersion Modeling (sic) Study provided 1-hr, 24-hr and annual concentrations for contaminants of potential concern for the four scenarios. These concentrations of contaminants were used to assess the potential for public health risk from their exposure."

The Air Dispersion Modelling study referred to is that of RWDI (2018). As noted above, given the absence of proper model evaluation, it is premature to use model results in any application, including an assessment of potential public health risks from exposure to ambient air pollution.

Review of GVS&DD Meeting Minutes:

The minutes from the October 2, 2020 Greater Vancouver Sewerage and Drainage District Board meeting[14] state:

"… new ambient air quality monitoring equipment ….. will allow Metro Vancouver to compare ambient levels of sulphur dioxide and hydrogen chloride with dispersion modelling results and ambient air quality objectives over the next 2 years, ….."

which shows the intention to perform the model evaluation exercise identified as needed in the review of RWDI (2020) to establish the veracity of the modelling. However the minutes go on to state:

"Dispersion modelling and a health risk assessment showed that at current emission levels, hydrogen chloride and sulphur dioxide concentrations are projected to meet air quality objectives and not result in a public health risk."

This statement is premature, as the dispersion modelling results have not been evaluated, as explained in the review of RWDI (2020).

Further the minutes state:

"The proposed amendment to the Waste-to-Energy Facility Operational Certificate would defer the reduction in discharge limits for sulphur dioxide and hydrogen chloride…"(because) "Dispersion modelling and a health risk assessment showed that at current Operational Certificate emission levels, hydrogen chloride and sulphur dioxide concentrations are projected to meet air quality objectives and do not result in a public health risk …"

The proposed deferment is illogical for two reasons:

1) As explained in the review of RWDI (2020) above, the dispersion modelling results cannot be considered a reasonable reflection of reality until a robust model evaluation exercise has been conducted, AND that evaluation exercise shows the model results to a statistically acceptable match to measurements.

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[13] Ollson (2018): Metro Vancouver Waste-to-Energy Facility Public Health Risk Assessment. Accessed at https://metrovancouver.org/services/solid-waste/Documents/wtef-public-health-risk-assessment-2018.pdf.

[14] GVS&DD, (2020): GREATER VANCOUVER SEWERAGE AND DRAINAGE DISTRICT BOARD OF DIRECTORS REGULAR BOARD MEETING (dated Friday, October 2, 2020)

2) Aside from the veracity of the modelling, there is no logical link between the two statements. Even if the modelling were successfully evaluated, and did show pollution levels meet applicable air quality objectives, that would be no reason to defer relaxation of the discharged limits. Setting stringent discharge limits is simply good environmental protection policy. Setting MORE stringent emission limits seems to be a logical "abundance of caution" approach. The GVS&DD claim that the present limits are strict enough to ensure no public health risk. We have argued in our review of RWDI (2020) that this claim is overstated. In such circumstances an abundance of caution is logically called for.

Conclusion:

The deferment of reduction in discharge limits is statistically indefensible and illogical.

Air Quality Emission Limits for Waste Burned in a Cement Kiln

The two cement kilns in BC are located within Metro Vancouver. As Metro Vancouver has the authority to issue Air Quality permits, the limits that apply are those set by Metro Vancouver. This study took a closer look at how those limits compare.

International emissions limits and standards from cement kilns

In general, emission limits for the cement industry are related to the three main pollutants NO_x, SO_2 and dust. Some countries have additional limits for metals, HCl, HF, organic compounds and PCDD/Fs (dioxins and furans).

In order to develop an understanding of the range of emissions limits, data for four pollutants have been extracted from an industry publication.[15] Because of the number of countries represented in this publication, only the maximum and minimum emissions limits are presented.

Contaminant	**Min.**	**Country**	**Max.**	**Country**
TPM (*mg/m^3*)	10	Colombia & Egypt	400	India
Dust M (*mg/m^3*)	15	UAE	300	Bolivia
SO_2 (*mg/m^3*)	50	Germany & Australia	2000	Nigeria
NO_x (*mg/m^3*)	200	Germany & EU	2500	Lebanon
Hg (*mg/m^3*)	0.02	Germany & Colombia	10	Pakistan

Table 7 Emissions limits for cement kilns

In some countries (Colombia for example), emissions limits are specific to fuel type (Conventional Fuels; Non-Hazardous Alternative Fuels & Hazardous Alternative Fuels).

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[15] Global Cement (2014). Global cement emissions standards. Accessed at https://www.globalcement.com/magazine/articles/845-global-cement-emissions-standards.

Note that USA limits are given in intensity units of lb./ton of clinker, and are therefore not commensurate with absolute emissions limits for all other countries.

While the EU has emissions limits for cement kilns co-incinerating waste, there appears to be no such set of limits in Canada or BC. As will be evident from this table, the lowest emissions limits are generally seen in mature economies where environmental pressures have come to bear on industrial activities.

Metro Vancouver Cement Plant Limits

As noted above it is Metro Vancouver that provides the permits for the Lafarge Cement Plant located in Richmond (Permit GVA0154) and the Lehigh Cement Plan located in Delta (Permit GVA0175), rather than the Province of BC, who provides the permit for the Metro Vancouver WTEF. Comparison between emissions limits set for the cement plants and applicable limits in other jurisdictions are complicated by a number of factors:

1. Many components of a cement plant emit pollutants (mainly dust) and in BC, limits are placed on each component. These will depend on jurisdiction.
2. Different jurisdictions use different averaging periods for pollutant monitoring, and therefore standards.
3. Some jurisdictions differentiate between existing and new cement plants.
4. Some jurisdictions set standards based on the production capacity of the installation, commonly distinguishing between more than/less than 500 tonnes per day.
5. Pollutant emissions from cement kilns depend on standard atmospheric conditions (oxygen content, temperature and pressure). Different jurisdictions use slightly different standard conditions.

In addition, the limits set out in the Metro Vancouver permits include a very different set of metrics (for example, some measures like for hydrogen chloride are not listed as an EU limit) and units (for example, there may be a limit on the sum of allowed trace metals or individual limits for each metal, or the averaging period varies) so a full comparison between emissions limits between other jurisdictions and what is allowed by Metro Vancouver is not possible.

The Metro Vancouver cement plant limits are permit-specific sets of guidelines rather than to a common standard. They are based on multiple resources, including research on cement industry emission control techniques as well as emission standards and permit conditions for cement plants in other jurisdictions. US EPA Best Available Control Technologies (BACT) references were also reviewed. Subsequent amendments to the authorization continued to assess BACT, available air quality dispersion modelling and/or stack testing results, recent technology changes in the industry, and facility specific considerations. Facilities such as a cement kilns are required to have an authorization to discharge waste into the environment. A Statutory Decision Maker (SDM), in this case Metro Vancouver, decides what limits are written into an authorization. The emission limits may be higher or lower than what a guideline suggests, because the SDM has discretion in setting those limits, which are legally enforceable.

The permits for Lafarge and Lehigh do allow for burning of waste-based alternate fuels with specific requirements (works & procedures). Lafarge has utilized various waste-based alternate fuels in their facility, but there is no authorization to utilize hazardous wastes. The requirements include specific terms and conditions to have an alternate fuel authorized before use, including providing preliminary technical information and conducting trial stack testing at specific material usage levels. If the facility fully satisfies those requirements, including an acceptable stack test in compliance with the existing restrictions, the material is authorized for use (up to

the maximum usage level achieved during trial testing). The SDM may also require additional stack testing beyond that specified in the permit.
The table below compares the limits for the waste incinerator to the limits for the two cement plants. The permits for cement plants have separate limits for multiple sections of the plant but the ones shown below are for the kilns which is where the waste would be burned and for which tests are done at the stack.

Contaminant	MV WTEF[1]	Lafarge Cement	Lehigh Cement
TPM (mg/m³)	9	25	125
CO (mg/m³)	50/100		
SO_2 (mg/m³)	50/90	450 [2]	500
NO_x (mg/m³)	190/350	1200 [2]	600 kg/hr[3]
HCl (mg/m³)	10 / 60	50	50
HF (mg/m³)	1.0		
THC (mg/m³)	10 / 20	70	50
Cd (µg/m³)	7		
Hg (µg/m³)	20		
Pb+As+Cr (µg/m³)	64		
Cd, Ti & Hg (µg/m³) (aka Trace metals Class III		150*	150*
Trace metals Class I Pb, Sb, Cu, Mn, V, Zn (ug/m³)		1500*	1500*
Trace metals Class II As, Cr, Co, Ni, Se, Te (ug/m³)		500*	500*
Chlorophenols (µg/m³)	1		
Chlorobenzenes (µg/m³)	1		
Polycyclic Aromatic Hydrocarbons (µg/m³)	5		
Polycyclic Biphenyls (µg/m³)	1		
Dioxins & Furans (ng/m³)	0.08/-	0.1	0.2
Opacity (%)	-/5	10	20

Table 8. Comparison of emissions standards for thermal waste treatment

* = calculated from original units
<u>Notes</u>
[1] Limits are as shown in Table 5

[2] Shown as hourly operating average
[3] This is a different metric than the others

The table above shows that the permissible limits for key pollutants are far higher than what is permitted when burning waste in the incinerator.

Appendix A: Author Biography

Douw Steyn, PhD, ACM, FCMOS is a Professor Emeritus of Atmospheric Science at The University of British Columbia, in the Department of Earth Ocean and Atmospheric Sciences, and is an emeritus member of the Institute for Applied Mathematics; the Institute for Resources, Environment and Sustainability; and the Liu Institute for Global Issues. He has served as Associate Dean (Research and Faculty Development) in the Faculty of Graduate Studies and Principal of the College for Interdisciplinary Studies. His professional, teaching and research activities are in the field of air pollution meteorology, boundary layer meteorology, mesoscale meteorology, environmental science and interdisciplinary science. His research involves measurement and modelling studies of regional air pollution, especially in regions with complex terrain. This work involves modelling of near-surface emissions of pollutants and their precursors, atmospheric flow and turbulence modelling, and modelling of chemical transformation of air pollutants. He has worked extensively on the statistics of air pollution, air pollution monitoring and monitoring network design. He is winner of a UBC Killam Teaching Prize, the Canadian Meteorological and Oceanographic Society Andrew Thompson Prize in Applied Meteorology, and the Canadian Federation for Earth Sciences Mentorship Medal. He has served as Chair of the scientific committee that leads the International Technical Meeting series on Air Pollution Modelling and its Application. He publishes regularly in the international peer reviewed literature, and served as managing editor of the journal *Atmosphere-Ocean*. He is an Accredited Consulting Meteorologist, and has international consultancy experience in his areas of expertise, and has provided expert testimony in numerous court cases and appeal board hearings and environment assessment panels in British Columbia and nationally.

Appendix B: Unit Conversions

Note that air quality levels are given either as concentrations (microgrammes per cubic metre: µg/m3), or mixing ratios (parts per billion: ppb)

Here are examples of conversion between ppm and µg/m3

O_3: $62ppb = 62 * 1.97\mu g/m^3 = 122\mu g/m^3$

NO_2: $42ppb = 42 * 1.88\mu g/m^3 = 79\mu g/m^3$

SO_2: $65ppb = 65 * 2.61\mu g/m^3 = 170\mu g/m^3$

Appendix C: Links to Source Documents for Emissions Limits

European Union: DIRECTIVE 2010/75/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 24 November 2010 on industrial emissions (integrated pollution prevention and control). Source: https://eur-lex.europa.eu/eli/dir/2010/75/oj

US EPA: Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Large Municipal Waste Combustors Voluntary Remand Response and 5-year Review. Tables 2 and 3. https://www.epa.gov/system/files/documents/2024-01/epa-oar_large-municipal-waste-combustors_nprm_2060-ao18_eo-12866-20231219-admin_0.pdf

Japan: Japanese Environmental Governing Standards https://www.usfj.mil/Portals/80/Documents/2022%20JEGS.pdf?ver=8IK9DQfnpthBttbIqAppEw%3D%3D

Durham York Energy Centre The Durham York Energy Centre incinerator in Ontario is operated by Covanta Energy under a Certificate of Approval # 7306-8FDKNX issued by the Ontario Ministry of Environment. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.durhamyorkwaste.ca/en/operations-documents/resources/2021/20220330_2021_DYEC_Annual_Report_ACC.pdf

BC Ministry of Environment Combustion of Municipal Solid Waste Fact Sheet https://www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/combustionmswfs.pdf

Metro Vancouver Operating Certificate 107051 https://metrovancouver.org/services/solid-waste/Documents/wtef-operationalcertificate-107051.pdf

Lafarge Cement Plant Permit GVA 0154 https://metrovancouver.org/services/environmental-regulation-enforcement/air-quality-regulatory-program/AirQualityPermits/0154%20-%20Lafarge%20Canada%20Inc.%20-%20%20Permit%20Amendment%20issued%202019-06-20.pdf

Lehigh Cement Plant Permit GVA 0175 (effective 2010). https://metrovancouver.org/services/environmental-regulation-enforcement/air-quality-regulatory-program/AirQualityPermits/0175_Lehigh_Hanson_Materials_-_Permit_Amendment_Issued_2010-01-01.pdf#search=lehigh%20permit

Appendix D: Emissions Limits from Source Documents

British Columbia

Emission Limits for Municipal Solid Waste Combustion Facilities in British Columbia (dated 2011)

Table 1. Emission Limits for Municipal Solid Waste Combustion Facilities in British Columbia

Contaminant	Units	EMISSION LIMITS	
		Daily Average	CEMS ½ Hour Average
Total Particulate Matter (TPM)	mg/m^3 @ 11% O_2	9	9[(1)], 28
Carbon Monoxide (CO)	mg/m^3 @ 11% O_2	50	100
Sulphur Dioxide (SO_2)	mg/m^3 @ 11% O_2	50	190
Nitrogen Oxides (NO_x as NO_2)	mg/m^3 @ 11% O_2	190	350
Hydrogen Chloride (HCl)	mg/m^3 @ 11% O_2	10	60
Hydrogen Fluoride (HF)	mg/m^3 @ 11% O_2	1	4[(2)]
Total Organic Carbon	mg/m^3 @ 11% O_2	10	20
Cadmium (Cd)	$\mu g/m^3$ @ 11% O_2	7	N.D.
Mercury (Hg)	$\mu g/m^3$ @ 11% O_2	20	N.D.
Sum of Lead (Pb), Arsenic (As), Chromium (Cr)	$\mu g/m^3$ @ 11% O_2	64	N.D.
Chlorophenols [(3)]	$\mu g/m^3$ @ 11% O_2	1	N.D.
Chlorobenzenes [(3)]	$\mu g/m^3$ @ 11% O_2	1	N.D.
Polycyclic Aromatic Hydrocarbons [(3)]	$\mu g/m^3$ @ 11% O_2	5	N.D.
Polychlorinated Biphenyls [(3)]	$\mu g/m^3$ @ 11% O_2	1	N.D.
Total Dioxins and Furans (as PCDD/F TEQ)	ng/m^3 @ 11% O_2	0.08	N.D.
Opacity[(4)]	%	N.D.	5

NOTES:
Concentration units: Mass per reference cubic metre corrected to 11% oxygen. Reference conditions: 20o C, 101.3 kPa, dry gas N.D. = Not Defined

(1) 97% of the ½ hour average values over an annual operating rolling average will not exceed 9 mg/ Rm^3 . The 28 mg/Rm^3 ½ hour average value is never to be exceeded.
(2) This requirement may be omitted at the discretion of the director should treatment stages for HCl demonstrate that the emission limit for HCl is not exceeded.
(3) Proponents may be able to demonstrate that monitoring both Total Organic Carbon and Total Dioxins and Furans could negate the need to monitor Chlorophenols, Chlorobenzenes, Polycyclic Aromatic Hydrocarbons and Polychlorinated Biphenyls.

(4) Opacity will not be required for compliance purposes for facilities utilizing continuous particulate monitoring systems. Opacity monitoring is recommended for operational monitoring purposes. However, opacity monitoring can be used as a temporary surrogate for total particulate monitoring in the event of a particulate monitoring system failure. Under these circumstances, the emission limit of 5% opacity over a ½ hour averaging period should apply.

Source: https://www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/combustionmswfs.pdf

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European Union

Daily average emission limit values for waste incinerators ($mgNm^{-3}$).

Total dust	10
Gaseous and vaporous organic substances, expressed as total organic carbon (TOC)	10
Hydrogen chloride (HCl)	10
Hydrogen fluoride (HF)	1
Sulphur dioxide (SO_2)	50
Nitrogen monoxide (NO) and nitrogen dioxide (NO_2), expressed as NO_2 for existing waste incineration plants with a nominal capacity exceeding 6 tonnes per hour or new waste incineration plants	200
Nitrogen monoxide (NO) and nitrogen dioxide (NO_2), expressed as NO_2 for existing waste incineration plants with a nominal capacity of 6 tonnes per hour or less	400

Half-hourly average emission limit values ($mgNm^{-3}$).

	(100 %) A	(97 %) B
Total dust	30	10
Gaseous and vaporous organic substances, expressed as total organic carbon (TOC)	20	10
Hydrogen chloride (HCl)	60	10
Hydrogen fluoride (HF)	4	2
Sulphur dioxide (SO_2)	200	50
Nitrogen monoxide (NO) and nitrogen dioxide (NO_2), expressed as NO_2 for existing waste incineration plants with a nominal capacity exceeding 6 tonnes per hour or new waste incineration plants	400	200

Average emission limit values ($mgNm^{-3}$) for the following heavy metals over a sampling period of a minimum of 30 minutes and a maximum of 8 hours .
These limits are for the metals, and their compounds.

Metal	emissions limit
Cd, Tl & Hg	0.05
Sb, As, Pb, Cr, Co, Cu, Mn, Ni & V	0.5

Average emission limit value ($ngNm^{-3}$) for dioxins and furans over a sampling period of a minimum of 6 hours and a maximum of 8 hours.

Substance	emissions limit
Dioxins	0.1
Furans	0.1

Emission limit values ($mgNm^{-3}$) for carbon monoxide (CO) :
(a) 50 as daily average value;
(b) 100 as half-hourly average value;
(c) 150 as 10-minute average value

The EU has special provisions for cement kilns co-incinerating waste. For such installations, emissions limits ($mgNm^{-3}$) are as follows:

Polluting substance	C
Total dust	30
HCl	10
HF	1
NO_x	500 (1)
Cd + Tl	0,05
Hg	0,05
Sb + As + Pb + Cr + Co + Cu + Mn + Ni + V	0,5
Dioxins and furans (ng/Nm^3)	0,1

Pollutant	C
SO_2	50
TOC	10

All EU emissions limits extracted from:
DIRECTIVE 2010/75/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 24 November 2010 on industrial emissions (integrated pollution prevention and control).
Source: https://eur-lex.europa.eu/eli/dir/2010/75/oj

Japan

Japan Environmental Governing Standards.

UNIT TYPE	LARGE MWC		
	Constructed/ Modified/ Reconstructed between December 20, 1989 and September 20, 1994	Constructed/ Modified/ Reconstructed between September 20, 1994 and December 19 2005	Constructed/ Modified/ Reconstructed after December 19, 2005
RATED CAPACITY	Greater than 227 Mtons/day [(250 tons/day]		
PM	34 mg/dscm[2,4,6]	24 mg/dscm[2,4,6]	20 mg/dscm[2,4,6]
Opacity	10 percent[2,4,7]	10 percent[2,4,7]	
Dioxins/Furans	30 ng/dscm[2,8]	30 ng/dscm or 13 ng/dscm[2,8,9]	
SO_2	30 ppmv or 80% reduction[4,5,11]	30 ppmv or 80% reduction[4,5,11]	
Hydrogen Chloride	25 ppmv or 95% reduction[2,6,11]	25 ppmv or 95% reduction[2,6,11]	
NO_X	180 ppmv[4,5]	150 ppmv or 180 ppmv[4,5,12]	
Cadmium		20 µg/dscm[2]	10 µg/dscm[2]
Lead		200 mg/dscm[2]	140 mg/dscm[2]
Mercury		80 µg/dscm or 85% reduction[2,17]	50 µg/dscm or 85% Reduction[2,17]

Source: https://www.usfj.mil/Portals/80/Documents/2022%20JEGS.pdf?ver=8IK9DQfnpthBttbIqAppEw%3D%3D

Durham York Energy Centre

Approved emissions limits for Durham York Energy Centre (DYEC, 2011)

The Durham York Energy Centre incinerator in Ontario is operated by Covanta Energy under a Certificate of Approval # 7306-8FDKNX issued by the Ontario Ministry of Environment. The permitted in-stack emissions limits are:

Parameter	In-Stack Emission Limit	Verification of Compliance
Total Suspended Particulate Matter (filterable particulate measured in accordance with the Ontario Source Testing Code)	9 mg/Rm3	Results from compliance Source Testing
cadmium	7 µg/Rm3	Results from compliance Source Testing
lead	50 µg/Rm3	Results from compliance Source Testing
mercury	15 µg/Rm3	Results from compliance Source Testing
dioxins and furans	60 pg/Rm3	Results from compliance Source Testing; results expressed as I-TEQ
hydrochloric acid (HCl)	9 mg/Rm3	Calculated as the rolling arithmetic average of 24 hours of data measured by a CEM System that provides data at least once every 15 minutes
sulphur dioxide (SO2)	35 mg/Rm3	Calculated as the rolling arithmetic average of 24 hours of data measured by a CEM System that provides data at least once every 15 minutes
nitrogen oxides (NOx)	121 mg/ Rm3	Calculated as the rolling arithmetic average of 24 hours of data measured by a CEM System that provides data at least once every 15 minutes
organic matter (undiluted, expressed as equivalent methane)	50 ppmdv (33 mg/ Rm3)	Results from compliance source testing
carbon monoxide	35 ppmdv (40 mg/Rm3)	Calculated as the rolling arithmetic average of four (4) hours of data measured by a CEM System that provides data at least once every fifteen minutes, in accordance with condition 6 (2) (c)
opacity	10 percent	Calculated as the rolling arithmetic average of six (6) minutes of data measured by a CEM System that provides data at least once every minute
	5 percent	Calculated as the rolling arithmetic average of two (2) hours of data measured by a CEM System that provides data at least once every

Metro Vancouver Waste to Energy Facility

The Burnaby incinerator operates under Operational Certificate 107051, Issued by the Director of the British Columbia *Environmental Management Act.* The incinerator is operated by Covanta Energy. This certificate specifies operational conditions and discharge limits.

The certificate specifies a maximum discharge rate, and maximum allowable annual feed by weight. These mean that emissions limits may not be evaded by dilution. The emissions limits are given below.

		Interim Discharge Limits(2)(3)			Discharge Limits(3)		Response Limits(4)
Parameter	Units(1)	24-hr average(5)	4-hr average(6)	1-hr average	24-hr average(5)	Approved Test Method(7)	1/2-hr average(8)
Total Particulate Matter(9)	mg/dscm	-	-	-	-	9	-
Opacity	%	-	-	5	-	-	5
Carbon Monoxide (CO)	mg/dscm	-	55	-	50	-	100
Hydrogen Chloride (HCl)	mg/dscm	-	-	55(10)	10	-	60
Hydrogen Fluoride (HF)	mg/dscm	-	-	-	-	1.0	-
Sulphur Dioxide (SO_2)	mg/dscm	200	-	-	50	-	190
Nitrogen Oxides (NO_x)	mg/dscm	350	-	-	190	-	350
Total Hydrocarbons (THC)	mg/dscm	-	-	Manual Stack Test limit of 40(11)	10	-	20
Total Dioxins and Furans (as PCDD/F TEQ)(12)	ng/dscm	-	-	-	-	0.08	-
Cadmium (Cd)	µg/dscm	-	-	-	-	7	-
Mercury (Hg)(13)	µg/dscm	-	-	-	-	20	-
Sum of Lead (Pb), Arsenic (As), Chromium (Cr)	µg/dscm	-	-	-	-	64	-
Chlorophenols	µg/dscm	-	-	-	-	1	-
Chlorobenzenes	µg/dscm	-	-	-	-	1	-
Polycyclic Aromatic Hydrocarbons (PAHs)	µg/dscm	-	-	-	-	5	-
Polychlorinated Biphenyls (PCBs)	µg/dscm	-	-	-	-	1	-

1. dscm =dry standard cubic metre, corrected to 11% oxygen
2. Interim Discharge Limits will apply until and including the following dates, at which point the Discharge Limits and Response Limits will apply:
a. Opacity- December 31, 2017
b. CO - December 31, 2016 (Discharge Limit) and December 31, 2018 (Response Limit)
c. HCI - March 3, 2025 (Discharge and Response Limits)
d. 502 - March 3, 2025 (Discharge and Response Limits)
e. NOx - December 31, 2017 (Response Limit)
f. THC- December 31, 2018 (Discharge and Response Limits)
3. Discharge Limits are the criteria for compliance determination of each discharge parameter listed in the column, subject to Note 2 above.
4. Response limits are the threshold requiring the Operational Certificate Holder to take immediate action to bring down the discharge levels to the applicable discharge limits specified in this section. The response limits are expressed as Y. hour (block) average values measured by approved continuous emission monitors. The Operational Certificate Holder is required to demonstrate the response action(s) implemented by record keeping.
5. Interim Discharge Limits are daily average values, calculated as the arithmetic average of valid continuous emissions monitoring system (CEM5) data. Discharge Limits are 24-hour (daily block) averages.
6. Calculated as the arithmetic average of 4 hours of data from a CEM5.
7. Determined by a test method approved by the Director. A single manual stack test result is the average of a minimum of three test runs.
8. Calculated as the arithmetic average of Y. hour block of data from a CEM5.
9. Total particulate matter (filterable portion only) is determined by EPA Test Method 5 or an alternative method approved by the Director.
10. Continuous monitoring of 502 will be used as a surrogate for emission monitoring of acid gases, such as HCI and HF.
11. Monitored as total hydrocarbons (measured as methane).
12. PCDD (polychlorinated dibenzo-p-dioxins) & PCDF (polychlorinated dibenzofurans) will be expressed in dioxin toxicity equivalent value (dioxin TEQ) as defined in the Hazardous Waste Regulation.
13. Mercury determined by EPA Test Method 29 or an alternative method approved by the Director.

Source:
https://metrovancouver.org/services/solid-waste/Documents/wtef-operationalcertificate-107051.pdf