

RESORT MUNICIPALITY OF WHISTLER

2021 SUMMARY OF AMBIENT AIR QUALITY MONITORING

CHEAKAMUS CROSSING AMBIENT AIR QUALITY MONITORING STATION





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RESORT MUNICIPALITY OF WHISTLER

PROJECT NO.: 171-03296-04

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RESORT MUNICIPALITY OF WHISTLER
4325 Blackcomb Way
Whistler, BC V0N 1B4

Attention: Chelsey Roberts

Dear Chelsey Roberts:

**Subject: Summary of 2021 Ambient Air Quality Monitoring, Cheakamus Crossing
Neighborhood**

WSP Canada Inc. (WSP) is pleased to provide the Annual Ambient Air Monitoring Report for the Resort Municipality of Whistler for 2021. The report outlines the monitoring program conducted during 2021 and compares the data to current ambient air quality objectives.

Yours sincerely,

A handwritten signature in black ink, appearing to read 'Braden Bartnik'.

Braden Bartnik, B.Sc., CPESC
Air Quality Specialist, Environment

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1 INTRODUCTION

WSP has operated and maintained the Cheakamus Crossing Ambient Air Monitoring Station on behalf of the Resort Municipality of Whistler (RMOW) since September, 2010. The station was installed to assist in addressing local citizen's concerns of potential ambient air quality issues associated with an asphalt plant located near the neighbourhood. The station originally monitored ambient particulate matter less than 2.5 microns ($PM_{2.5}$). As of January 8th 2016, the station was upgraded from a TEOM unit (Tapered Element Oscillating Microbalance) to a BAM unit (Beta Attenuation Mass Monitor) and switched to continuously monitor ambient particulate matter less than 10 microns (PM_{10}). WSP provides public access to the monitoring data via a dedicated website. This report summarizes the data from the monitoring station for the calendar year of 2021 (January 1st 2021, to December, 31st 2021).

2 STATION DETAILS

The Cheakamus Crossing Ambient Air Monitoring Station is located on the High Performance Centre (HPC) building (Figure 1). The HPC building was selected for the monitoring site because:

- ⇒ the HPC building is one of the closest structures to the property currently occupied by the asphalt plant;
- ⇒ the HPC building is located in the Cheakamus Crossing neighbourhood (Figure 2) and provides a suitable location to record representative measurements of particulate matter concentrations in the neighbourhood;
- ⇒ the location minimizes interference from surrounding buildings or vegetation;
- ⇒ the monitoring station's indoor sensors/controllers as well as the rooftop equipment are safely accessible for routine maintenance and cleaning; and,
- ⇒ the HPC building is a secure location to house the monitoring station, as it contains sensitive/expensive scientific equipment.



Figure 1 High Performance Centre (HPC) in Cheakamus Crossing Neighbourhood



Figure 2 Location of the Monitoring Station in the Cheakamus Crossing Neighbourhood (shown as a green dot)

The monitoring equipment at the station includes:

- ⇒ BAM-1020 Beta Attenuation Mass Monitor (BAM) (Figure 3)
- ⇒ R.M. Young 05305 Air Quality Wind Anemometer

The BAM-1020 Beta Attenuation Mass Monitor automatically measures and records airborne particulate concentration levels using the principle of beta ray attenuation. This method provides a simple determination of concentration in units of micrograms of particulate per cubic meter ($\mu\text{g}/\text{m}^3$) of air. The BAM has been recognized by the US EPA as an acceptable continuous monitor of particulate matter concentrations (August, 1998). This unit is outfitted with a PM_{10} inlet directly connected onto the inlet tube. Ambient air is pumped through the inlet, which only allows airborne particulate matter with an aerodynamic diameter of 10 micrometers ($10\ \mu\text{m} = 0.00001$ meters) or less into the BAM's sensor unit. The BAM collects the ambient dust on a filter tape from a measured amount of ambient air which causes an attenuation of the beta particle signal. The degree of attenuation of this beta particle signal is used to determine the mass concentration of particulate matter on the filter tape, and hence the volumetric concentration of particulate matter in ambient air ($\mu\text{g}/\text{m}^3$).

PM_{10} , also known as inhalable particulate, is so small it can only be detected with an electron microscope. Sources of this fraction of particles include motor vehicles, wood burning stoves and fireplaces, dust from construction and industrial sources and windblown dust from erosion. $\text{PM}_{2.5}$, the fraction of particulate that was previously monitored at the station, is a smaller subset of PM_{10} , and is included in the particulate measured as PM_{10} . The sources of this smaller subset would include all types of combustion, including motor vehicles, power plants, residential wood burning, forest fires, agricultural burning, and some industrial processes.

The R.M. Young anemometer was installed to determine hourly wind direction and speed, which is useful in interpreting the particulate matter concentrations recorded at the monitoring station. The anemometer is mounted on a 10-foot tripod installed on the roof of the HPC building in the Cheakamus Crossing Neighbourhood adjacent to the BAM inlet (Figure 4).

The datalogger records 1-hour averages for both the BAM and anemometer data to an onsite computer system. Along with storing the data on the onsite computer system, data is also transferred to WSP's Air Quality website (www.airquality.ca/clients/Whistler) where it is displayed in 'real-time'. A link to this site is provided on the RMOW website (www.whistler.ca)



Figure 3 BAM Monitor with PM₁₀ Inlet System



Figure 4 Tripod Mounted Anemometer and BAM Inlet located on the Roof of the HPC building

2.1 2021 STATION MAINTENANCE AND AUDITS

WSP has consulted with the British Columbia Ministry of Environment and Climate Change Strategy (BC MOECCS) and follows the same maintenance and calibration standards by which the BC MOECCS operates their provincial system of ambient air monitoring stations. WSP and the RMOW coordinated with the BC MOECCS to have the Cheakamus Crossing Ambient Air Monitoring Station audited by the BC MOECCS's provincial auditing team. This team conducts semi-annual audits on all of the BC MOECCS stations to validate the proper operation of the equipment. During 2021, the BC MOECCS conducted an audit on September 16th, and December 6th. All the audited parameters passed, and a copy of the audit reports can be found in Appendix A.

WSP completed twelve (12) site visits (monthly) during 2021 to complete necessary audits, calibrations and maintenance on the monitoring equipment. The maintenance/calibration and verification schedule for the monitoring station are the recommended standards.

The data completeness for the 2021 calendar year was 92.2% as a result of a standard zero calibration audit and some equipment downtime in June/July due to pump issues.

3 DATA SUMMARY

Data collection began at the station on September 3rd, 2010 for PM_{2.5} data and on September 15th, 2010 for the wind data. As of January 2016, the TEOM was replaced by the BAM which now records PM₁₀. The BAM and anemometer continuously collect data. The monthly equipment maintenance results in the system being offline for short periods of time (1-3 hours). A report was presented in December 2010 summarizing the first 3 months of monitoring data (September 15th, 2010 to November 30th, 2010) and details on the station installation. Annual reports have been presented following each year of data collection. Five year summary reports were also published in 2015 and 2021 which consolidated the years of data collected until those points.

This report summarizes the data collected for the calendar year of 2021 (January 1st, 2021 to December 31st, 2021).

This is the sixth full year of collecting PM₁₀ data with the BAM unit so the annual data is compared to the 2016 - 2020 data. A summary of PM_{2.5} data collected from 2011-2015 is available in previous annual reports.

3.1 WIND DIRECTION AND WIND SPEED

A wind rose was created using the wind data collected onsite for 2021 (Figure 6). Wind roses are used to display the frequency of wind speed at wind direction. The annual windrose is similar in wind direction and speed when compared to the historical wind data (Figure 5). Winds typically show a dominant wind path dictated by the topography of the site. The dominant direction of wind at the station continues to be from the west. This was also the direction that recorded the highest wind speeds. Winds from the southwest and south-southwest have the greatest potential to transport emissions directly from the asphalt plant towards the monitoring station. These winds occurred approximately 3.9% of the time over the 2021 monitoring period (similar to 2020).

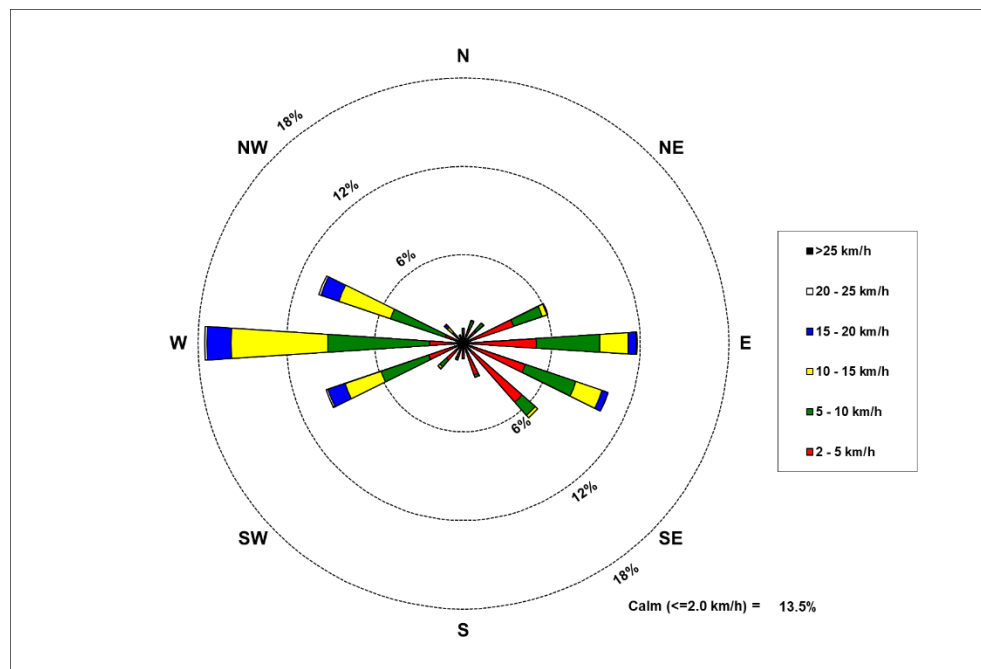


Figure 5 Historical Windrose of the Cheakamus Crossing Anemometer Data, January 1st, 2011 to December 31st, 2020

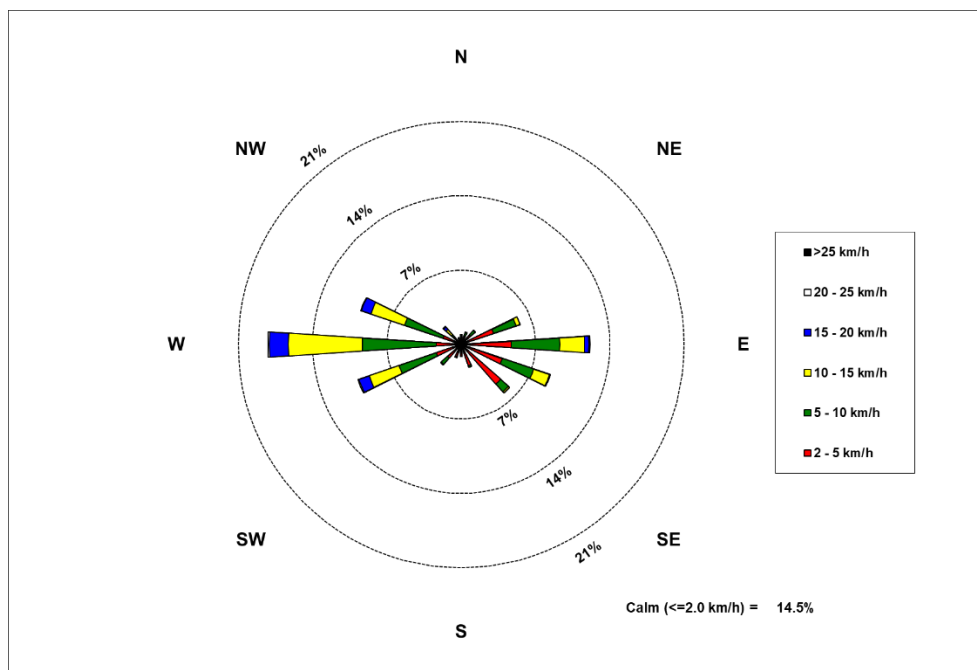


Figure 6 Windrose of the Cheakamus Crossing Anemometer Data, January 1st, 2021 to December 31st, 2021

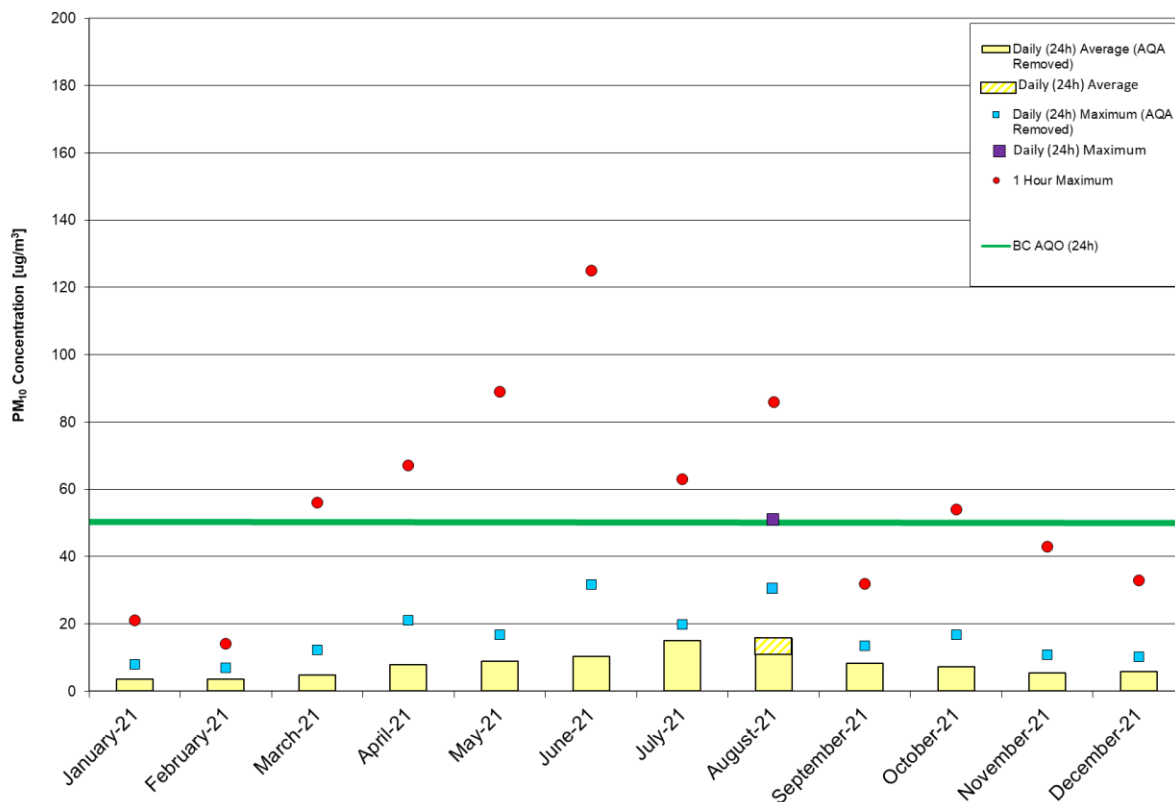
3.2 PM₁₀ CONCENTRATIONS

The BAM unit records 1-hour average PM₁₀ concentrations. From these hourly averages a rolling 24-hour average is calculated using the last 24 hourly averages at each hour of the data set. The rolling 24-hour average displayed on the WSP and RMOW website provides a ‘real-time’ representation of current conditions but is not compared to the provincial objectives. When comparing the results to the British Columbia Ambient Air Quality Objectives (BC AAQO, 50µg/m³), a daily 24-hour average (midnight to midnight), also referred to as block average is used.

Figure 7 displays the monthly breakdown of the 24-hour block averages and maximums, along with the hourly maximum. The BC AAQO is shown in Figure 7 by the green line. This is compared to the 24-hour maximum recorded during each month (blue squares). The other data displayed in the figure is the monthly average (yellow column) and the 1 hour maximum (red circles).

Although a direct comparison can only be made between the BC AAQO (green line) and the 24-hour maximum (blue square), the other data can also show trends. There is no objective for hourly data, but Figure 7 shows that during the drier months of the year there tends to be higher hourly particulate matter levels.

The yellow columns, which displays the monthly average, increase during the summer months (July and August) which would be expected as that is the driest time of the year. However during August 2021 regional ambient air quality was heavily impacted by forest fires. The effects of the smoke from the forest fires acutely affects the 24-hour maximum values (blue squares) and 1-hour maximums (red circles) reported in Figure 7, but also impacts the monthly average (yellow column).



* Note that the Green line denoting the BC AAQO for PM₁₀ is the objective for the 24-hour average data (blue boxes) presented and should not be compared to the 1-hour averages (red dots). There is no BC AAQO for the 1-hour averages.

Figure 7 PM₁₀ Monthly Average, 24-hour Maximum, and 1-hour Maximum Concentrations

During August there was 7 days with an Air Quality Advisory (AQA) issued by Metro Vancouver due to elevated ambient air quality levels as a results of regional forest fires in BC and Washington State (August 1st to 3rd and 12th to 15th). These elevated particulate matter levels are dissociated from local activities, such as impacts from the asphalt plant, and therefore an analysis where these periods are removed from the data set is also provided so that an evaluation of the data without the impacts of forest fires can also be provided. Of the 7 days removed from the data set due to the AQA from US forest fires, 1 of them was above the Air Quality Objective (AQO = 50µg/m³) at 50.9 µg/m³ for the 24-hour average. When the data from these periods is excluded the 24-hour maximum is reduced in August. Excluding the impacts of the forest fire periods, the 24-hour maximum recorded in 2021 is below the BC AAQO and comparable to previous years 24-hour maximum (Table 1).

There is no provincial or federal annual objective for PM₁₀, but the Metro Vancouver region does currently have an objective level of 20 µg/m³ for annual average PM₁₀. This objective was included in Table 1 to provide a comparison. The annual average of PM₁₀ at the Cheakamus Crossing monitoring location was 7.5 µg/m³ for 2021 which is well below the Metro Vancouver objective and similar to previous years. When the data collected during the air quality advisory period is removed from the dataset this annual average is slightly lower (7.2 µg/m³) and is similar to previous annual averages.

Figure 8 shows the 24-hour maximums as well as the annual average for 2016-2021. The hashed portion of the columns in 2017, 2018, 2020 and 2021 indicates the impact of the forest fire smoke on the annual statistics. The affects of regional forest fire smoke did affect the data in 2021 but as Figure 8 shows the effects were not as significant as there was only a single 24-hour period that was slightly above the objective.

Table 1 24-hour Maximum and Annual PM₁₀ Data Summary

Year	PM ₁₀ (µg/m ³)			
	Maximum Value (24-hour)	BC AAQO (24-hour)	Annual Average Value	MV AAQO (Annual)
2016	39.3	50	6.8	20
2017	(147.1) 37.2*		(10.2) 6.8*	
2018	(233.6) 32.8*		(9.9) 7.2*	
2019	32.3		7.0	
2020	(173.3) 28.8*		(7.4) 5.6*	
2021	(50.9) 31.7*		(7.5) 7.2*	

*Dates listed as Air Quality Advisories by Metro Vancouver were removed from the data sets as an indicator of periods when forest fires would have impacted the monitor in 2017, 2018, 2020, and 2021.

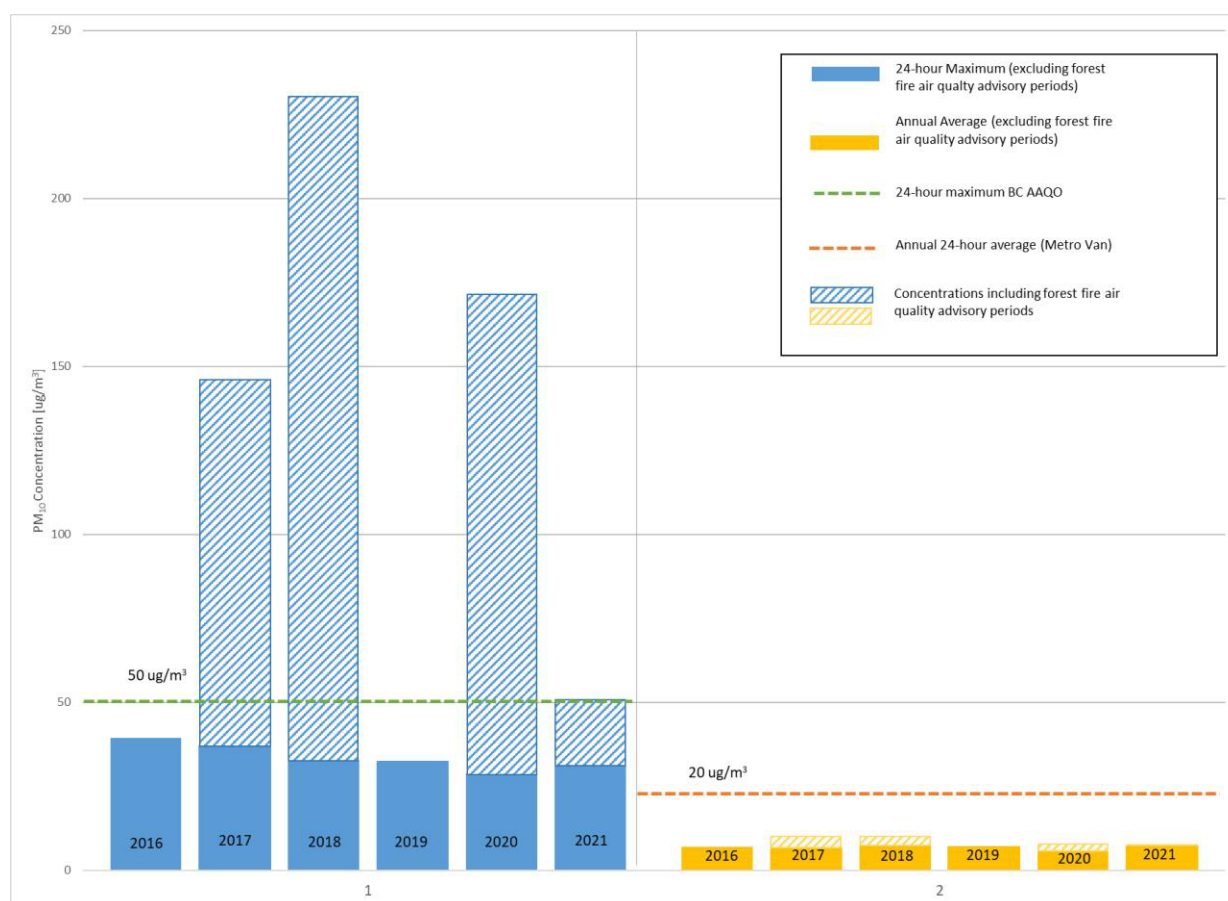


Figure 8 PM₁₀ 24-hour Maximum Data Compared to BC AAQOs and Annual Average Data compared to Metro Vancouver Objectives

4 CONCLUSION

WSP has operated and maintained the Cheakamus Crossing Ambient Air Monitoring Station on behalf of the Resort Municipality of Whistler (RMOW) since September, 2010. The station was installed to address the concerns of potential ambient air quality issues associated with an asphalt plant located near the neighbourhood. After over five years of monitoring $PM_{2.5}$, in 2016 the RMOW decided to investigate another particulate matter fraction (PM_{10}) typically associated with fugitive dust emissions by installing a new particulate matter monitor. Data from the historic $PM_{2.5}$ monitoring at the Station can be found in previous annual reports. The PM_{10} data from the monitoring station for the calendar year of 2021 was summarized in this report.

The dominant wind direction recorded at the monitoring station follow the east - west valley alignment with predominantly from the west. Winds from the southwest and south-southwest have the greatest potential to transport emissions from the asphalt plant directly towards the monitoring station.

In 2021, the 24-hour maximum PM_{10} concentration was $50.9 \mu\text{g}/\text{m}^3$ which just exceeded the BC air quality objective of $50 \mu\text{g}/\text{m}^3$. However, this maximum was recorded in August during an air quality advisory issued due to forest fire smoke in the area. When the elevated particulate matter data during air quality advisories related to forest fires is excluded from the annual data the 24-hour maximum PM_{10} concentration was $31.7 \mu\text{g}/\text{m}^3$ which is below the BC air quality objective and comparable to previous years. The annual average PM_{10} concentration was $7.5 \mu\text{g}/\text{m}^3$ which is below the Metro Vancouver regional annual air quality objective of $20 \mu\text{g}/\text{m}^3$. When the elevated particulate matter data during air quality advisories related to the forest fires is excluded from the data the annual average PM_{10} concentrations drops to $7.2 \mu\text{g}/\text{m}^3$. Outside the periods affected by forest fire smoke, the 2021 data is comparable to the data collected from the previous five years.

BIBLIOGRAPHY

- ⇒ British Columbia Ministry of Environment, 2016, British Columbia Ambient Air Quality Objectives, updated December 16, 2016, <https://www2.gov.bc.ca/assets/gov/environment/air-land-water/air/reports-pub/aqotable.pdf>
- ⇒ Campbell Scientific, Inc., 2000, Operator's Manual: CR510 Basic Datalogger.
- ⇒ Met One Instruments, Inc., 2008, BAM-1020 Continuous Particulate Monitor Operation Manual, Rev K
- ⇒ Metro Vancouver, 2016, Ambient Air Quality Objectives, updated June 30, 2016, <http://www.metrovancouver.org/services/air-quality/AirQualityPublications/CurrentAmbientAirQualityObjectives.pdf>,

APPENDIX

A

MOE AUDIT REPORTS

Continuous Ambient Monitor Audit Certificate

Date: September 16, 2021 Station Name: Whistler Cheakamus Crossing Permit #: N/A Auditors: Chudak/Williams/Pedlar Method: Beta-Attenuation Parameter: BAM PM ₁₀ Make/Model: Met One 1020 Serial #: T21162					Barometric Pressure: 714 mmHg Ambient Temperature: 15.4 °C K-Factor: 0.971 Flowmeter: Streamline										
Parameter: PM ₁₀ Start Time: 1230 PST Finish Time: 1300 PST					<table style="width: 100%;"> <tr> <td style="text-align: right;">Streamline Data</td> <td style="text-align: right;">Total</td> </tr> <tr> <td style="text-align: right;">m:</td> <td style="text-align: right;">0.4269</td> </tr> <tr> <td style="text-align: right;">b:</td> <td style="text-align: right;">-0.5031</td> </tr> </table>					Streamline Data	Total	m:	0.4269	b:	-0.5031
Streamline Data	Total														
m:	0.4269														
b:	-0.5031														
Sample Flow:	Target	(1)	(2)	(3)	(Avg)	Actual		Error							
	L/Min	In. H2O	In. H2O	In. H2O	In. H2O	L/Min		%							
	16.700	5.05	5.03	5.05	5.04	16.27		-2.6%							
Target flow is read from calibration screen															
Temperature: °C Ambient Temperature (Audit): 15.4 Ambient Temperature (BAM): 15.0					Pressure: mmHg Ambient Pressure (Audit): 714 Ambient Pressure (BAM): 709										
Audit Criteria: Sample Flow Error: -2.6% Pass Temperature Error: 0.4 Pass Pressure Error: 5 Pass Leak Test: 0.5 Pass Self-test: Pass Pass PM Inlet Condition: Satisfactory Pass					Leak Check L/Min Leak Flow: 0.5										
					Operational Parameters: C _v : 0.966 Q _o : 0 ABS: 0.796 μ _{sw} : 0.312 K: 0.986 BKGD: -0.0003										
					Flow Mode: Actual										
					RH Control ON: Yes										
					RH Set Point: 35%										

Report: Flow on BAM reading 16.2 in open flow.

Audit Results: Pass

Continuous Ambient Monitor Audit Certificate

Date: December 6, 2021 Station Name: Whistler Cheakamus Crossing Permit #: N/A Auditors: Chudak/Pedlar Method: Beta-Attenuation Parameter: BAM PM ₁₀ Make/Model: Met One 1020 Serial #: T21162				Barometric Pressure: 709 mmHg Ambient Temperature: -2.0 °C K-Factor: 1.026 Flowmeter: Streamline									
Parameter: PM ₁₀ Start Time: 1235 PST Finish Time: 1255 PST				Streamline Data <table style="width: 100%; border: none;"> <tr> <td style="text-align: right;">Total</td> <td></td> </tr> <tr> <td style="text-align: right;">m:</td> <td>0.4064</td> </tr> <tr> <td style="text-align: right;">b:</td> <td>-0.5601</td> </tr> </table>				Total		m:	0.4064	b:	-0.5601
Total													
m:	0.4064												
b:	-0.5601												
Sample Flow:	Target L/Min	(1) In. H2O	(2) In. H2O	(3) In. H2O	(Avg) In. H2O	Actual L/Min	Error %						
	16.700	5.89	5.93	5.94	5.92	16.27	-2.6%						
Target flow is read from calibration screen													
Temperature: °C Ambient Temperature (Audit): -2.0 Ambient Temperature (BAM): -3.2				Pressure: mmHg Ambient Pressure (Audit): 709 Ambient Pressure (BAM): 705									
Audit Criteria: Sample Flow Error: -2.6% Pass Temperature Error: 1.2 Pass Pressure Error: 4 Pass Leak Test: 0.5 Pass Self-test: Pass Pass PM Inlet Condition: Satisfactory Pass				Leak Check L/Min Leak Flow: 0.5 Operational Parameters: <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">C_v: 0.966</td> <td style="width: 50%;">Q_o: 0</td> </tr> <tr> <td>ABS: 0.796</td> <td>μ_{sw}: 0.312</td> </tr> <tr> <td>K: 0.986</td> <td>BKGD: -0.0003</td> </tr> </table> Flow Mode: Actual RH Control ON: Yes RH Set Point: 35%				C _v : 0.966	Q _o : 0	ABS: 0.796	μ _{sw} : 0.312	K: 0.986	BKGD: -0.0003
C _v : 0.966	Q _o : 0												
ABS: 0.796	μ _{sw} : 0.312												
K: 0.986	BKGD: -0.0003												

Report:

Audit Results: Pass

Air Audit Programme
Regional Operations Branch