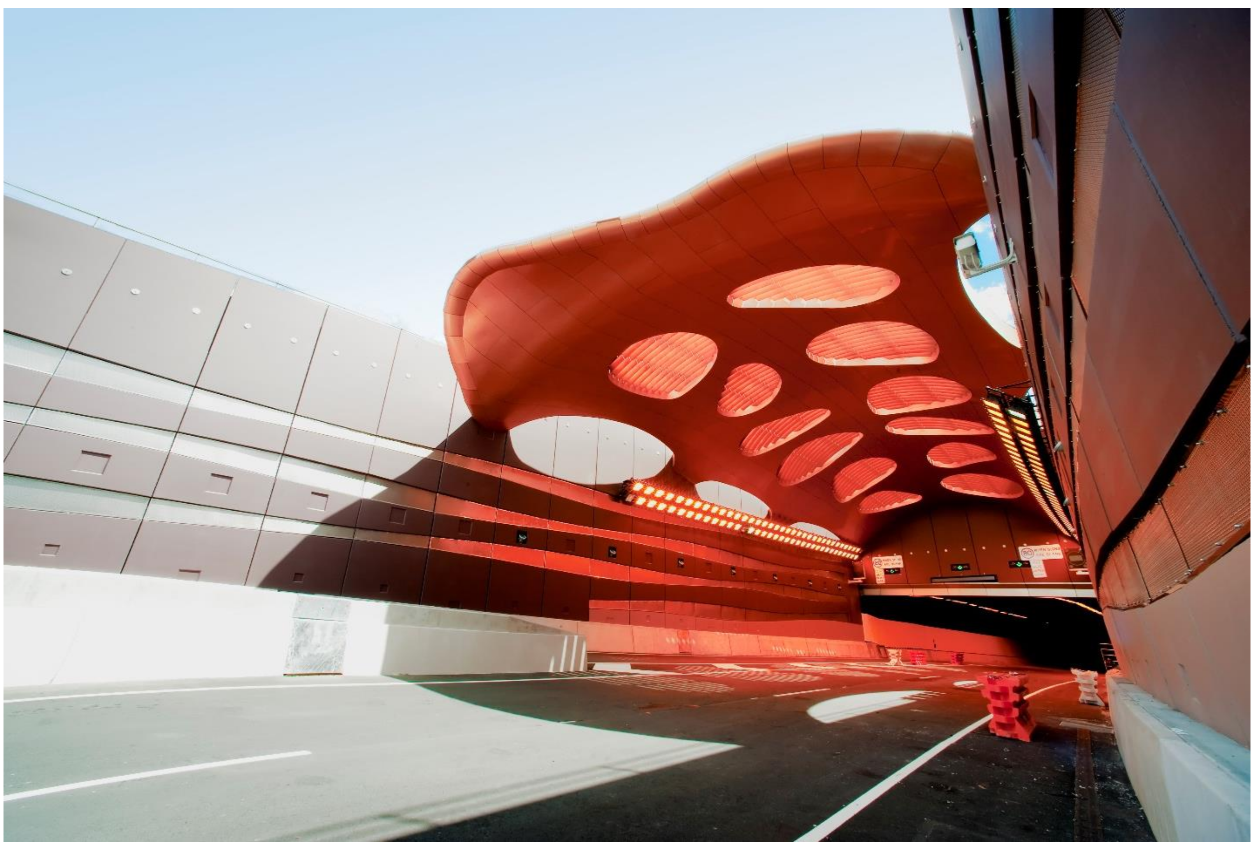
RESORT MUNICIPALITY OF WHISTLER

2016 - 2020 SUMMARY OF AMBIENT AIR QUALITY MONITORING

CHEAKAMUS CROSSING AMBIENT AIR QUALITY MONITORING STATION

MARCH 19, 2021



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RESORT MUNICIPALITY OF WHISTLER

PROJECT NO.: 171-03296-03
CLIENT REF:
DATE: MARCH 19, 2021

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March 19, 2021

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

Dear Madam/Sir:

Client ref.: 2016 – 2020 Summary of Ambient Air Quality Monitoring

WSP Canada Inc. (WSP) is pleased to provide a Summary report of the Ambient Air Monitoring Program for the Resort Municipality of Whistler for 2016 to 2020. The report compares the monitored levels of PM_{10} at the Cheakamus Crossing Air Monitoring Station with BC and Metro Vancouver Ambient Air Quality Objectives, data collected at the BC Ministry of Environment and Climate Change Strategy's Meadow Park Station and with activity data from the nearby asphalt plant. As requested, WSP has also provided its recommendations on the monitoring program in the Cheakamus Crossing Neighbourhood.

Yours sincerely,

Braden Bartnik, B.Sc., CPESC

SIGNATURES

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March 19, 2021
Date

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1 INTRODUCTION

WSP Canada Inc. (WSP) has operated and maintained the Cheakamus Crossing Ambient Air Quality 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 adjacent to the neighbourhood in the nearby provincial crown tenure property. The air quality monitoring station continuously monitors ambient particulate matter, wind direction, and wind speed. WSP provides public access to the air quality monitoring data via a dedicated website. Annual reports on the data collected from 2010 – 2020 have been provided to RMOW following each year of monitoring.

This report summarizes and compares the data from the monitoring station for 2016 through the end of 2020. The objective of the report is to:

- Provide comparison of the Particulate Matter (PM) concentrations monitored at the Cheakamus Crossing neighbourhood with the monitoring station located at Meadow Park Sports Center (Whistler) managed by the Ministry of Environment and Climate Change Strategy's (BC MOECCC);
- Analyze the monitored PM_{10} concentrations during the Alpine Paving Ltd. (owned) asphalt plant operations;
- Provide a review and summary of the current monitoring program;
- Provide recommendations for future air quality monitoring.

2 AMBIENT AIR MONITORING STATION DETAILS

The Cheakamus Crossing neighbourhood Ambient Air Monitoring Station is located on the High Performance Centre (HPC) building (Figure 2-1). The HPC building was selected for the monitoring site because:

- the HPC building was one of the closest structures to the crown tenure property occupied by the Alpine Paving Ltd. asphalt plant;
- the HPC building is located within a central location of the Cheakamus Crossing neighbourhood (Figure 2-2) and provides a suitable recording location to collect 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 monitoring equipment.

Figure 2-1 High Performance Centre (HPC) located in Cheakamus Crossing Neighbourhood

Figure 2-2 **Location of the Monitoring Station in the Cheakamus Crossing Neighbourhood (shown as a green dot labeled as BAM-HPC). The approximate perimeter of Alpine Paving Ltd. and Quarry provincial crown tenure is shown with a green line.**

The air quality monitoring equipment at the HPC station includes:

- A Beta Attenuation Mass (BAM) Monitor 1020 model (Figure 2-3)
- A R.M. Young 05305 Air Quality Wind Anemometer

The BAM 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 of air. The BAM unit has been recognized by the United States Environmental Protection Agency (US EPA) as an acceptable continuous monitor of particulate matter concentrations (August, 1998). This unit is outfitted with a *Particulate Matter of 10 micrometers* (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 µm = 0.00001 meters) or less into the BAM's sensor unit. The BAM unit 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 ($\mu g/m^3$).

The particulate matter referred to as, PM_{10}, is also known as inhalable particulate, is primarily comprised of larger dust or visible smoke particles from sources like motor vehicles, wood burning stoves and fireplaces, dust from construction and industrial sources and windblown dust from erosion. The smaller subset of Particulate Matter referred to as, $PM_{2.5}$, is the fraction of particulate that was previously monitored at the station, and it comprises a portion of particulate measured as PM_{10}. Although the $PM_{2.5}$ fraction is collected as part of the PM_{10} fraction, the monitoring equipment does not have the ability to separate the fractions from each other and the samples is just considered PM_{10}.

The sources of this smaller subset ($PM_{2.5}$) would include all types of combustion, including motor vehicles, power plants, residential wood burning, forest fires, agricultural burning, and some industrial processes.

In order to determine hourly wind direction and speed, the R.M. Young anemometer was installed, which provides useful data in combination with 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 2-4).

The datalogger records 1-hour averages for both the BAM and anemometer monitoring units and sends this 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 at www.whistler.ca.

Figure 2-3 BAM Monitoring unit with PM_{10} Inlet System

Figure 2-4 Tripod Mounted Anemometer and BAM Inlet located on the roof of the HPC Building

3 APPLICABLE REGULATORY GUIDELINES

In Canada, the Federal and Provincial Governments have implemented ambient air quality objectives (AAQO) to ensure long-term protection of public health and the environment. In this assessment, monitored PM_{10} data are compared against current British Columbia (BC) and Metro Vancouver (MV) AAQOs. The AAQOs are non-statutory limits (i.e. not legally binding).

The AAQOs are used to:

- Gauge current and historical air quality,
- Guide decisions on environmental impact assessments and authorizations,
- Guide airshed planning efforts,
- Inform regulatory development, and
- Develop and apply episode management strategies such as air quality advisories.

In this summary report, monitored PM_{10} concentrations are compared with the BC AAQO as a gauge of short term (24-hour) impacts, while the MV AAQO was considered for long term (annual) impacts (Table 3-1).

Table 3-1 Ambient Air Quality Objectives (AAQOs) Considered in Assessment

Air Contaminants	Averaging Periods	Statistical form of Objective	Objective	Jurisdiction of Criteria
Inhalable Particulate Matter (PM_{10})	24-hour	Maximum 24-hour block average predicted concentration	50 $\mu g/m^3$	BC MOECC
	Annual	Annual mean concentration	20 $\mu g/m^3$	Metro Vancouver

4 MONITORING PROGRAM DATA SUMMARY

Monitoring of particulate matter less than 2.5 microns ($PM_{2.5}$) started on *September 3rd, 2010* at the HPC Cheakamus Crossing Ambient Air Monitoring Station. On *January 8, 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}). Annual reports have been presented each year of data collection from 2010 - 2020. This report summarizes the PM_{10} data collected from 2016 to 2020 of the monitoring program.

4.1 CHEAKAMUS CROSSING AMBIENT AIR MONITORING STATION PM_{10} CONCENTRATIONS

The BAM unit measures 1-hour average PM_{10} concentrations at the HPC. From these hourly averages a rolling 24-hour average is calculated using the last 24 hourly measurements. The rolling 24-hour average displayed on the WSP and RMOW websites provide a 'real-time' representation of current conditions but is not directly compared to the provincial objectives. When comparing the results to the maximum threshold for the BC AAQO, a daily 24-hour average (midnight to midnight), also referred to as block average, is used.

In this report, the full annual hourly dataset is used to determine the maximum daily average PM_{10} concentration. The daily average is compared with the threshold level (BC AAQO) of 50 ug/m^3. The annual hourly dataset is also averaged to determine the annual average PM_{10} concentration. This is then compared the to the annual threshold level (Metro Vancouver AAQO) of 20 ug/m^3.

During the years that the local area (airshed) was affected by forest fire smoke the results are shown in tables below with a second value for the 24-hour maximum and annual averages. The second value with asterix are the results when the days affected by forest fire smoke are removed from the data set.

When comparing the periods unaffected by regional forest fire smoke in Table 4-1 and Figure 4-1 the results indicate:

- All years are in compliance with the BC AAQO. There is a year to year trend showing slightly lower maximum 24-hour PM_{10} concentration from 2016 to 2020;
- A consistent annual average of approximately 7 ug/m^3 (35% of the Metro Vancouver AAQO) with a much lower 2020 annual average concentration of 5.6 ug/m^3.

Table 4-1 Annual PM_{10} BAM Data (2016 – 2020)

Year	PM_{10} (µg/m³)			
	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*	

*Adjusted with data removed for days when forest fire smoke affected air quality. Specific days were listed as Air Quality Advisories by Metro Vancouver in 2017, 2018, and 2020.

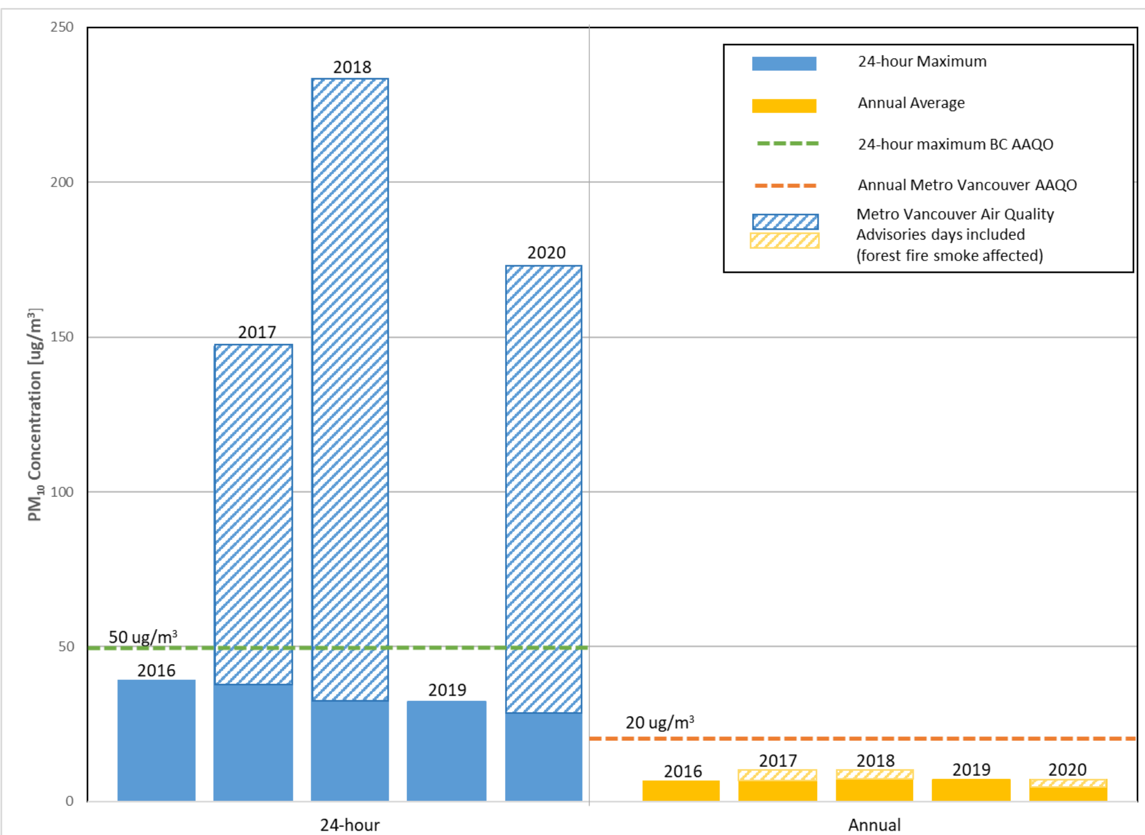

Figure 4-1 PM_{10} 24-hour Maximum Data Compared to BC AAQOs and Annual Average Data compared to Metro Vancouver AAQOs. The hashed portion of the bars in 2017, 2018, and 2020 were including the Metro Vancouver Air Quality Advisory Days (days affects of forest fire smoke)

4.2 COMPARISON TO BRITISH COLUMBIA MINISTRY OF ENVIRONMENT AIR QUALITY STATION AT MEADOW PARK

The BC Ministry of Environment and Climate Change (MOECC) operates air quality monitoring stations throughout BC, including the primary air quality monitoring station in Whistler, located at Meadow Park Sports Center (MPSC). The following (Table 4-2) and (Figure 4-2) provide a comparative summary of the PM data collected at the MPSC air quality station with data collected at Cheakamus Crossing neighbourhood. Please note that a direct numerical comparison cannot be conducted as the MPSC station monitors $PM_{2.5}$, while the Cheakamus Crossing station monitors PM_{10}. Thus, results presented in Figure 4-2 were quantified as percentages of each applicable air quality objective to allow for comparison. Outside of forest fire periods, both the Cheakamus Crossing and MPSC stations show compliance with the applicable Ambient Air Quality Objectives (AAQOs) for BC and Metro Vancouver.

Table 4-2 Comparison of PM Data (2016 – 2020) Monitored at Cheakamus Crossing and Meadow Park Sports Center Air Qulaity Monitoring Stations

Station	Cheakamus Crossing PM_{10}		Whistler Meadow Park $PM_{2.5}$			BC 24-hour AAQO (µg/m³)		Annual AAQO (µg/m³)	
Year	**24-hour Maximum**	**Annual Average**	**24-hour Maximum**	**24-hour 98th Percentile**	**Annual Average**	**PM_{10}**	**$PM_{2.5}$**	**PM_{10} (MV)**	**$PM_{2.5}$ (BC)**
2016	39.3	6.8	25.4	17.0	6.3	**50**	**25**	**20**	**8**
2017	(147.1) 37.2*	(10.2) 6.8*	(140.0) 23.5*	(86.8) 19.0*	(10.9) 6.2*				
2018	(233.6) 32.8*	(9.9) 7.2*	(234.0) 27.9*	(50.5) 14.5*	(7.9) 5.3*				
2019	32.3	7.0	21.9	13.9	4.9				
2020	(173.3) 28.8*	(7.3) 5.6*	(166.6) 62.0*	(37.0) 16.2*	(7.0) 5.5*				

*Adjusted with data removed for days when forest fire affected air quality and these days were listed as Air Quality Advisories by Metro Vancouver in 2017, 2018, and 2020.

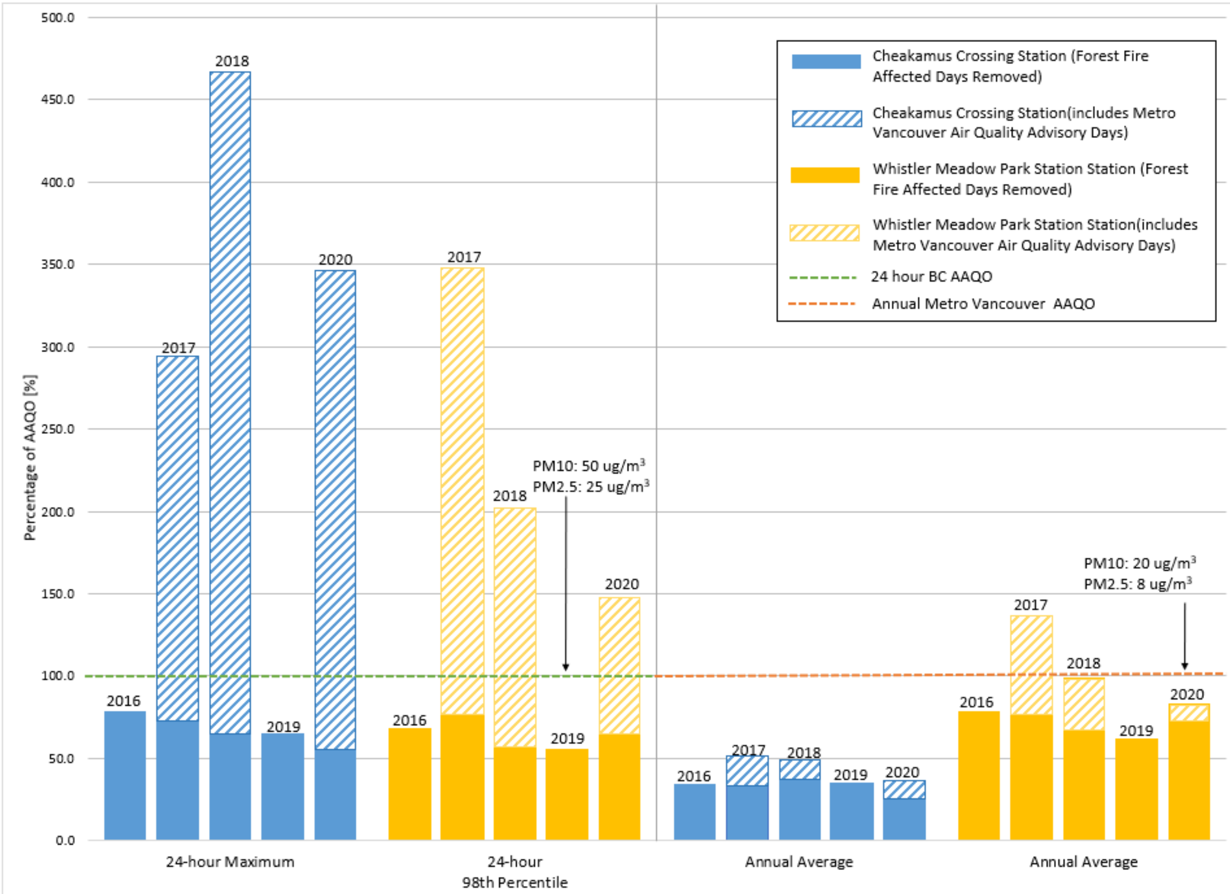

Figure 4-2 Comparison of PM Data (2016 – 2020) Monitored at Cheakamus Crossing and Meadow Park Air Monitoring Stations

5 ASPHALT PLANT OPERATIONS

The asphalt plant located to the southwest of the Cheakamus Crossing BAM monitoring station is owned by Alpine Paving Ltd. and has been in operation on the crown tenure property since 1989. This plant operates in a batch process and the primary source of emissions from an asphalt plant are the dryers, hot bins, and mixers which emit particulate matter and a variety of gaseous pollutants. Other potential sources of particulate matter (detectable at PM_{10} size or smaller) at the plant may include storage silos, truck load-out operations and fugitive dust emissions from the yard.

Data on operations of the asphalt plant was provided for 2016 – 2020 by Alpine Paving Ltd. for comparison with the monitored PM_{10} concentrations at Cheakamus Crossing air quality station. Asphalt plant operations are limited from spring to fall days, due to winter weather making it inoperable. During this time period the asphalt plant operated on a maximum of five consecutive days.

5.1 DATA ANALYSIS

Figure 5-1 through Figure 5-5 show the daily (24-hour average) PM_{10} concentrations measured at Cheakamus Crossing station for each year. Days with plant operations are marked as orange bars.

As the annual average wind conditions in the Cheakamus Crossing neighbourhood are quite consistent from year to year we have included a single windrose in Figure 5-6. The predominant wind directions are west and east as winds move up and down the valley.

For the majority of plant operation days the concentrations of PM_{10}, which include potential contributions from the asphalt plant and all other sources in the area, were below the BC AAQOs. The exceptions to this occurred during Air Quality Advisories in the summers of 2017, 2018, and 2020 when the local airshed was affected by forest fire smoke causing it to be above the BC AAQOs. The exceedances are not considered to be due to the plant operations as the elevated ambient air levels was recorded at the Meadow Park air monitoring station as well. The time series of daily averages shows that it is difficult to distinguish the plant operation days from typical variability in PM_{10} concentrations over the entire data record.

The maximum 24-hour average PM_{10} concentration (118.3 µg/m^3) recorded on a plant operations day occurred on August 3rd, 2017, *due to the influence of forest fire smoke in the region*. This was documented in the Air Quality Advisories issued by Metro Vancouver and elevated PM levels on the days before and after the 3rd. The predominant wind direction on August 3rd would not suggest any potential emissions from Alpine Paving would have influenced the PM_{10} concentrations.

The maximum 24-hour average PM_{10} concentration (39.4 µg/m^3) recorded on a plant operations day, *without the influence of regional forest fire smoke*, occurred on August 5th, 2016. The predominant wind direction during the 24-hour period had the potential to direct emissions from Alpine Paving towards the air monitor and affected the PM_{10} concentration. It is possible that PM_{10} concentrations are influenced by the plant operations, *but concentrations remain below BC Ambient Air Quality Objectives (AAQOs)*.

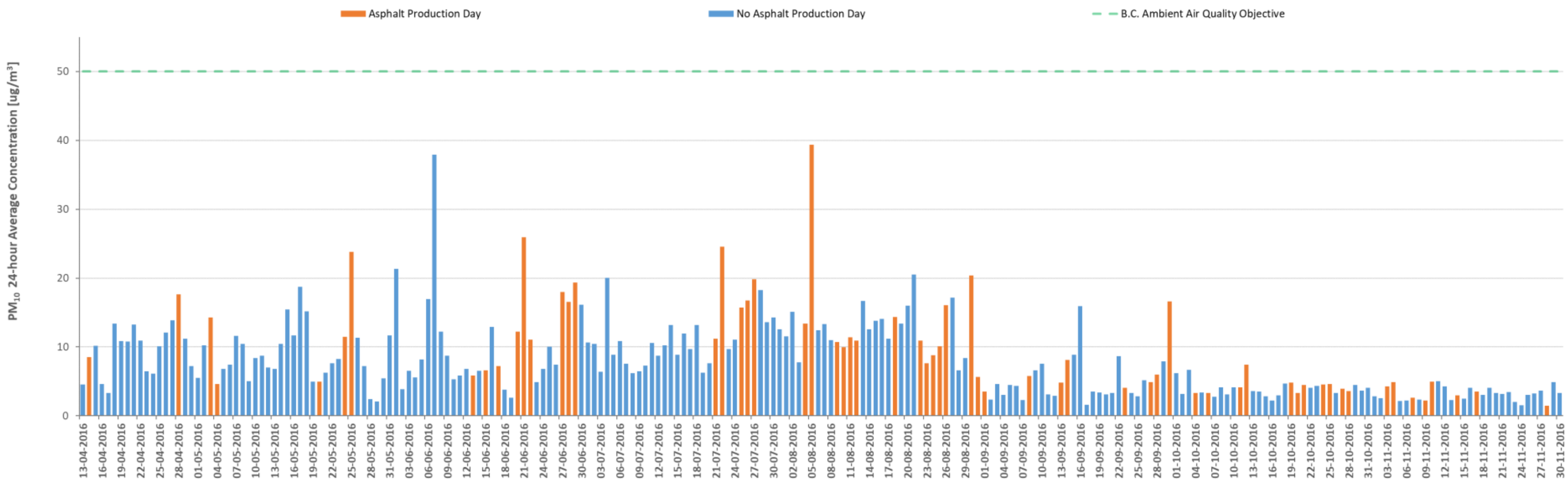

Figure 5-1 Timeseries of Daily Average PM_{10} Concentrations Monitored at Cheakamus Crossing, 2016

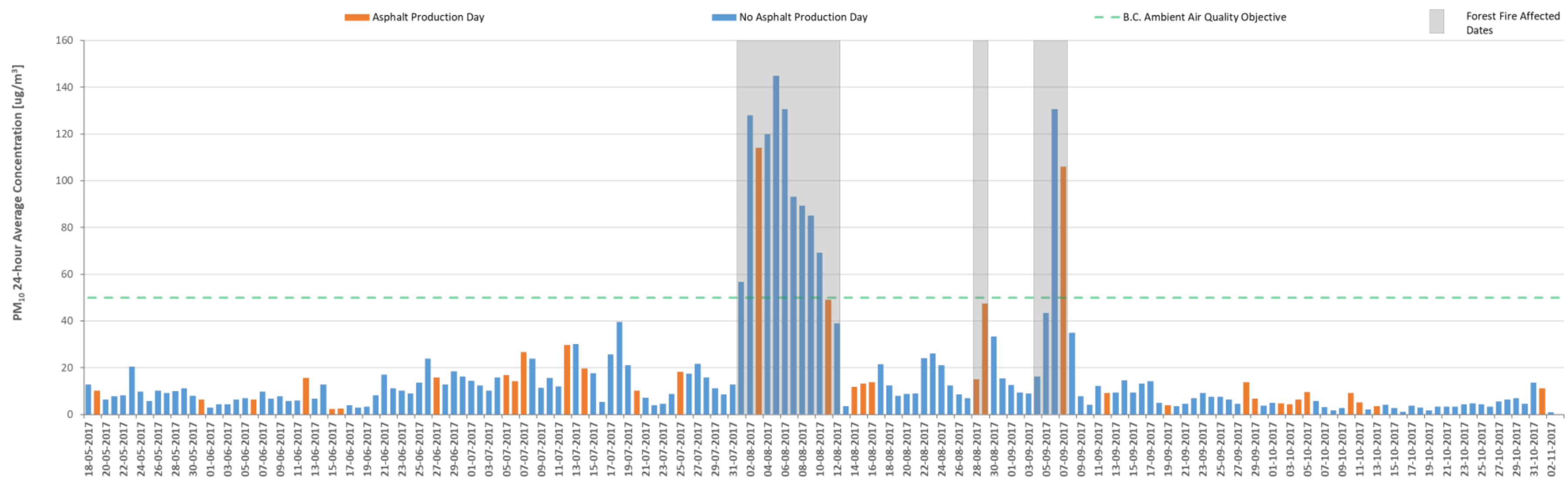

Figure 5-2 **Timeseries of Daily Average PM_{10} Concentrations Monitored at Cheakamus Crossing, 2017**

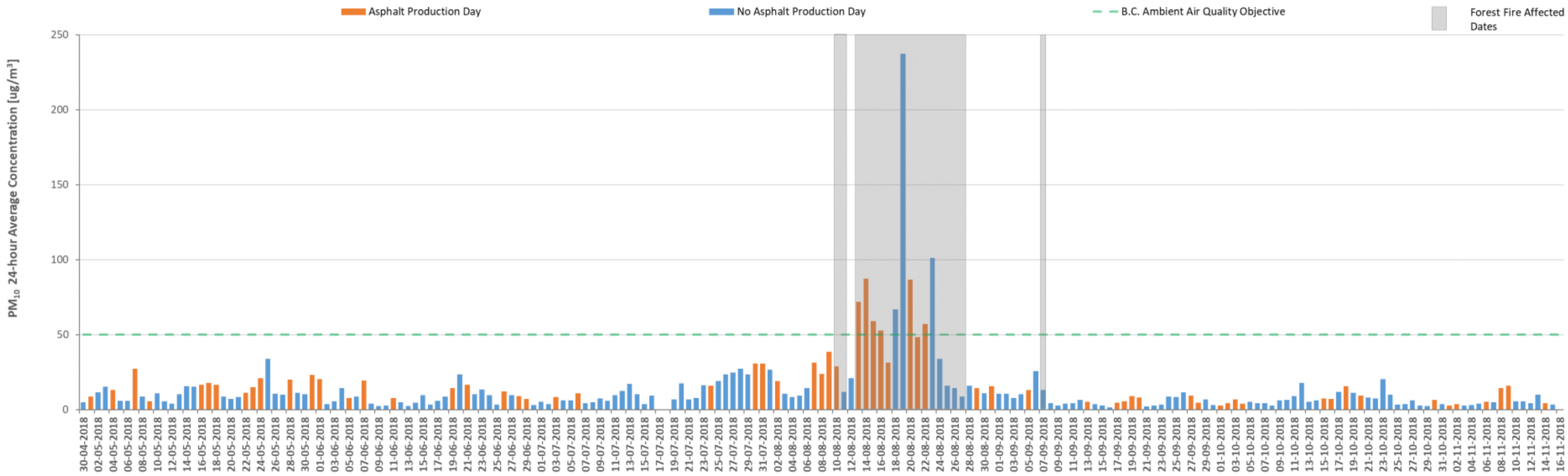

Figure 5-3 Timeseries of Daily Average PM_{10} Concentrations Monitored at Cheakamus Crossing, 2018

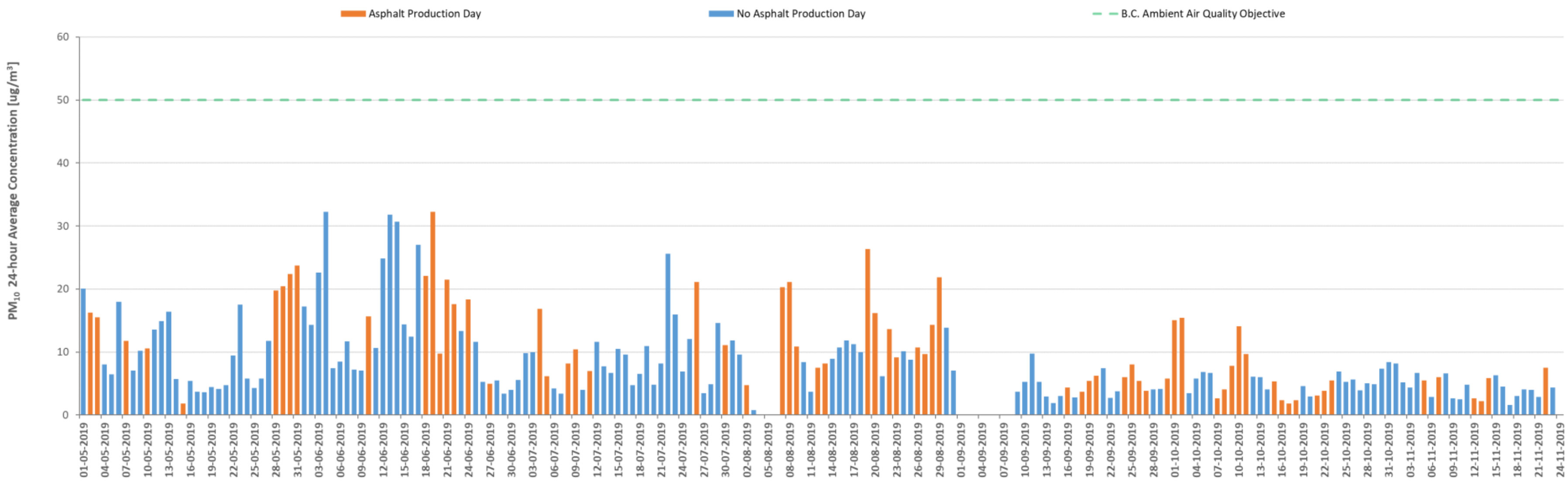

Figure 5-4 Timeseries of Daily Average PM_{10} Concentrations Monitored at Cheakamus Crossing, 2019

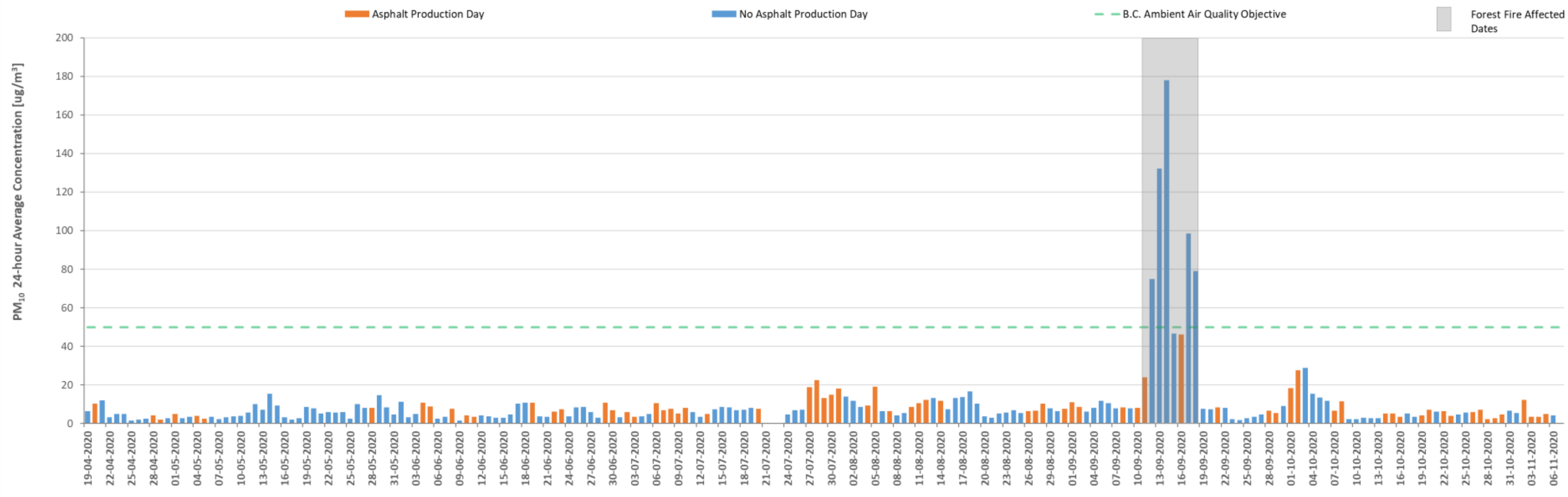

Figure 5-5 **Timeseries of Daily Average PM_{10} Concentrations Monitored at Cheakamus Crossing, 2020**

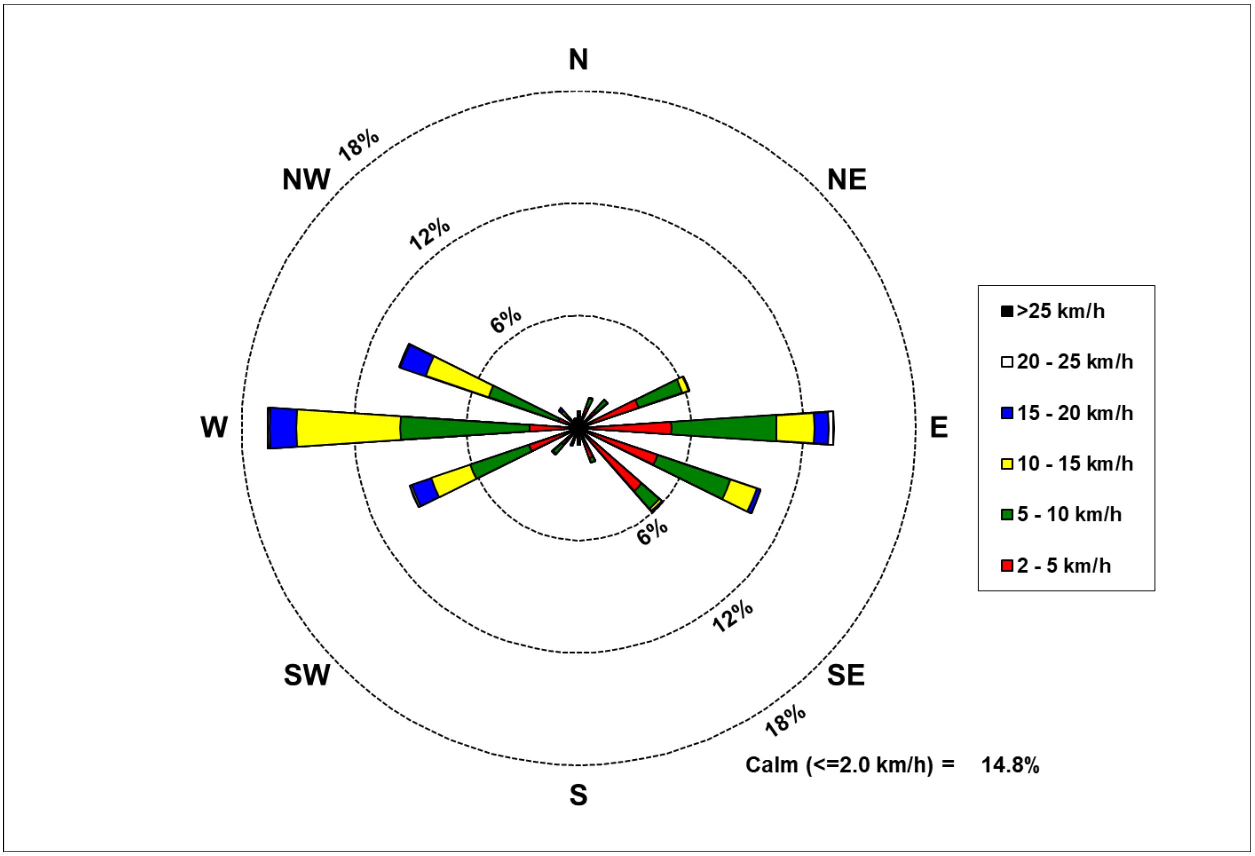

Figure 5-6 Windrose for data set 2016 to 2020

5.2 SUMMARY

As shown in Figures 5-1 to 5-5, the 24-hour block averages for the years from 2016 to 2020 never exceeded the Ambient Air Quality Objective (AAQO) of 50 µg/m^3 except when affected by smoke from forest fires (noted with a grey background in the figures).

6 RECOMMENDATIONS AND CONCLUSIONS

RMOW requested, as part of the summary report, for WSP to re-evaluate and provide recommendations for the Air Monitoring Program in the Cheakamus Crossing neighbourhood. This re-evaluation of the Air Monitoring Program is intended to:

- review the location(s) where the ambient air is monitored;
- review the feedback from RMOW with regards to community concerns and future air quality monitoring, and;
- review the air contaminants monitored by the Program.

6.1 AIR MONITORING LOCATIONS

When first sited in 2010, there were multiple reasons for the selection of the HPC building as the location for the monitoring equipment:

- the HPC building was one of the closest structures to the property currently occupied by the asphalt plant owned by Alpine Paving Ltd.;
- the HPC building was located in the Cheakamus Crossing neighbourhood and provides a suitable location to record representative measurements of particulate matter concentrations in the neighbourhood;
- the location minimizes air flow 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.

Although the HPC building remains an appropriate air monitoring location, since the initial site selection and installation of the Air Monitoring equipment in 2010 there has been significant development in the Cheakamus Crossing neighborhood. In the last 10 years additional residential structures have been built to the south and east of the HPC building as the neighborhood has grown.

In order to address the spatial variability of air quality impacts in the neighbourhood, WSP met with RMOW and completed a review of the neighborhood to identify potential locations for new monitoring sites that might provide more information on air quality impacts at the residential locations now nearer to the plant than the existing monitoring location at the HPC building. In the three options presented below to modify the air monitoring program WSP outlines different locations options along with their benefits and drawbacks.

6.2 COMMUNITY AIR QUALITY CONCERNS

From RMOW feedback recieved, WSP understands that the primary community concern with regards to air quality remains the emissions from the asphalt plant (Alpine Paving Ltd.) located in the adjacent property in the southwest corner of the Cheakamus Crossing neighbourhood. Alpine Paving is also the owner of the gravel quarry property to the south of the asphalt plant.

RMOW requested a review of the Air Monitoring Program to understand the potential air quality impacts at locations nearer to the asphalt plant as well as throughout the neighbourhood. Previous community concerns with regards to air quality were focused on the particulate matter (PM) emissions from the Alpine Paving asphalt plant. Originally the Air Monitoring Program focused on monitoring of the fine particulate fraction, $PM_{2.5}$. Emissions of

$PM_{2.5}$ are associated with combustion emissions and were monitored to determine if combustion-related emissions from Alpine Paving's plant were adversely affecting neighbourhood air quality. A WSP summary report in 2014 found that air quality monitoring in Cheakamus Crossing neighbourhood of $PM_{2.5}$ did not record an exceedance of the BC AAQOs for $PM_{2.5}$ and the data showed no statistical significance of Alpine Paving plant operations and the daily (24-hour) average $PM_{2.5}$ concentrations.

In 2016, the air quality monitor in Cheakamus Crossing located at HPC was switched to measure PM_{10}, the coarse particulate fraction. Emissions detected from monitoring of PM_{10} are typically associated with fugitive dust emissions and in the Cheakamus neighbourhood sources would potentially include fugitive dust from the material handling at Alpine Paving's tenure area, construction and / or road dust.

This report covers PM_{10} data collected from 2016 to 2020. In section 4.2 of this report, the PM_{10} concentrations in the neighbourhood were shown to be below the BC 24-hour AAQO (50 µg/m³) and the Metro Vancouver Annual AAQO (20 µg/m³) with the exception of the effects of forest fires in the summer of 2017, 2018, and 2020.

Continued monitoring of PM can provide an indication of the potential impact of sources from the Alpine Paving asphalt plant. As the particulate matter fractions (PM_{10} or $PM_{2.5}$) differ in the potential sources of the particulate they measure there are certain benefits in selecting one or the other. If the community concerns are specifically around combustion emissions in the neighbourhood (including those from Alpine Paving plant) then monitoring of $PM_{2.5}$ instead of PM_{10} would be recommended. If the concerns are fugitive dust and combustion emissions then PM_{10} would be recommended.

However, RMOW should also seek community input if there are other air quality issues related to the asphalt plant. Often times, air quality issues related to asphalt plants include a concern about the odours from the plant. Specifically, citizens may be concerned whether the odours from the plant operations signal any type of related health issue. As part of option 3 presented below, WSP recommends some initial volatile organic compound (VOC) monitoring to address this potential community concern.

6.3 UPGRADES TO THE AIR MONITORING PROGRAM

Three options are presented by outlining the actions, general equipment, and potential locations to modify and/or expand the current Air Quality Monitoring Program.

6.3.1 OPTION 1: RELOCATION OF THE EXISTING BAM MONITORING EQUIPMENT

Option 1 would be to decommission the current air monitoring equipment from the HPC building and move it to one of the residential buildings along Cloudburst Drive (as shown in Figure 6.1 moving from the **green** indicator to the **blue** indicator at the nearest residential location to the asphalt plant). As the existing equipment would be re-deployed at the new site there would be minimal equipment costs beyond the consumables for the install. The main cost of this plan would be WSP labor to find a viable space to install the equipment and the labour associated with the decommissioning and re-installation of the monitoring equipment. The BAM monitor is a high end regulatory monitoring piece of equipment which requires professional installation. The specific requirements for a location to install a BAM monitor are outlined below.

There would be no change to the budget for the ongoing maintenance and operations of the equipment. There is the possibility of changing the particle size fraction that is monitored from PM_{10} to $PM_{2.5}$ if RMOW wants to focus more on potential combustion emissions from Alpine Paving asphalt plant operations.

This option of moving the existing monitoring location closer to Alpine Paving would provide monitoring data that is representative of the nearest residential location to the asphalt plant. However, it would have to be determined if it was feasible to be installed at this location.

OPTION 1 LOCATION REQUIREMENTS

In determining a location at the nearest residential building to Alpine Paving, there are specific requirements for the MetOne (BAM) Particulate Monitor that need to be considered. Along with a standard 120V power supply the control unit must be installed in a temperature and humidity-controlled environment. The inside of an occupied building is the most cost effective (similar the current installation at the HPC building). There also needs to be adequate space for the equipment to be installed (it can be wall mounted) and to be accessed on a monthly basis for maintenance and calibration. To sample ambient air, the equipment need to have its inlet mounted outside without obstruction from buildings, other equipment, or trees. At the HPC the inlet extends through the sloped metal roof and there are no other roof mounted pieces of equipment nearby or any stands of tall trees. The BAM also uses a pump which produces noise and could be disruptive if installed in a residential building without sufficient noise insulation.

If there is not a suitable location inside one of the residential buildings along Cloudburst Drive, the BAM can be installed in a custom enclosure that houses the equipment, provides power, and regulates the internal environment for the monitoring equipment. The benefits of this self-sufficient housing structure are that it avoids the need to puncture a buildings membrane to install the inlet through the roof and it does not take up space inside residential buildings. The free-standing enclosure can be installed on a flat roof or on the ground. The downside of the custom enclosure is the associated purchase cost.

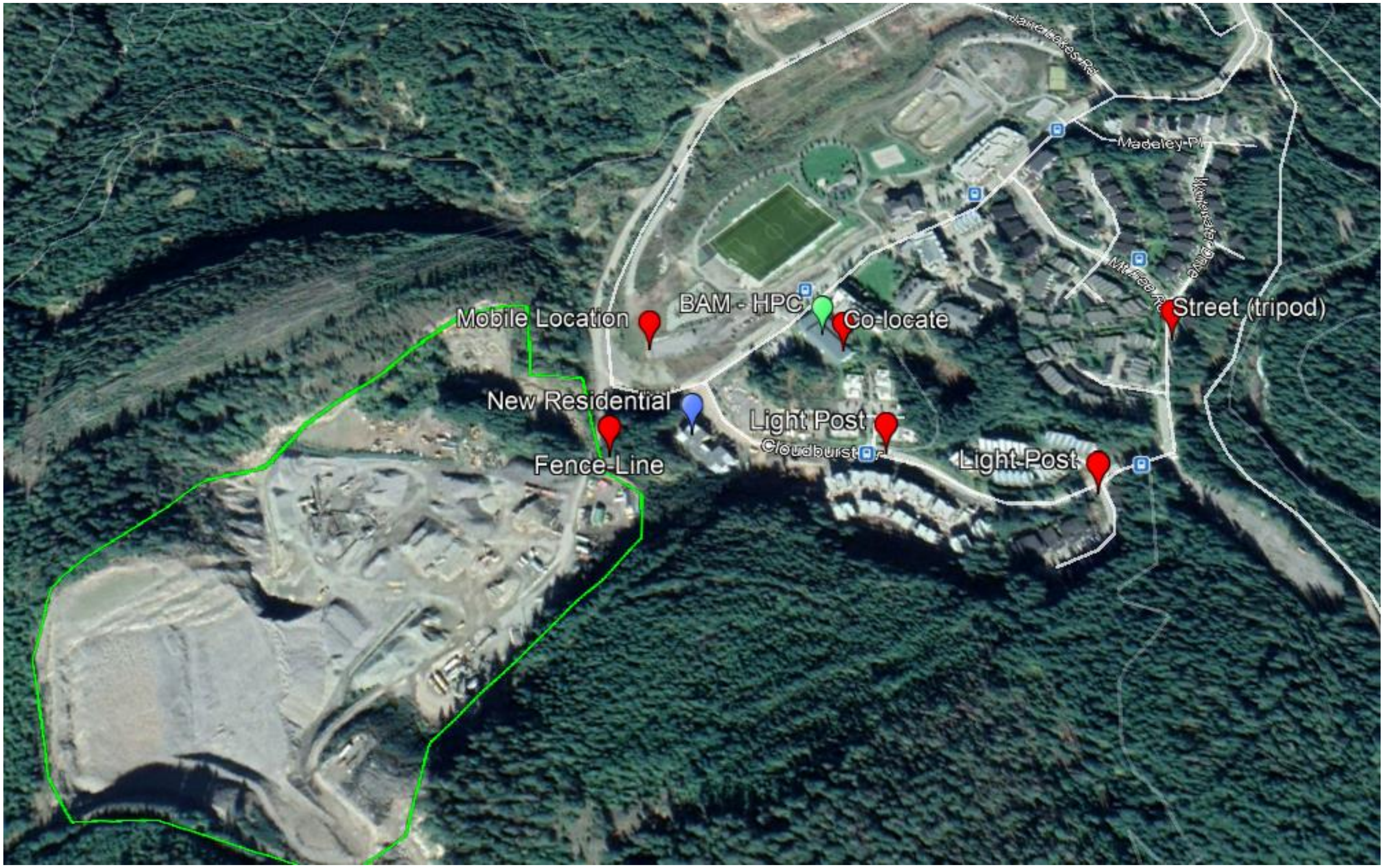

Figure 6-1: Proposed Air Monitoring Locations Map

Option 1 – would see the existing BAM moved from the green indicator (BAM-HPC) to the blue indicator (New Residential)

Option 2 – would keep the existing BAM at the green indicator (BAM-HPC) and see a new BAM installed at the blue indicator (New Residential) expanding the monitoring network.

Option 3 – would keep the existing BAM at the green indicator (BAM-HPC) with a new co-located sampling plus multiple new "near reference" quality monitors installed as some of the red indicator locations around the neighborhood.

6.3.2 OPTION 2: ADDITION OF A SECOND BAM MONITORING LOCATION

Option 2 would be to continue to operate the current air monitoring equipment at the HPC building and select a supplemental location to install another BAM unit at the nearest residential location to Alpine Paving. The options for a new location would be in one of the residential buildings along Cloudburst Drive or in a custom enclosure (as described in Section 6.3.1 above and shown in Figure 6.1 in **red**). The main cost of this option would be the equipment costs associated with a BAM and possibly a custom enclosure. The labor cost to install a second BAM unit would be higher than relocating the existing unit as the new BAM would need to be set-up and calibrated during install. This option would have the same requirements for selecting a suitable location for the new equipment as described above when moving the existing BAM.

There would be an increase to the maintenance and operations budget for the air monitoring program as the amount of monitoring equipment would double. There would also be an increase to the cost of the annual report as the volume of data would increase. There is the possibility of changing the particle size fraction that is monitored from PM_{10} to $PM_{2.5}$ but that should be done to both monitors so they can be directly compared.

This option of retaining the existing monitoring location and adding a new one would provide three benefits to the community. First it would maintain a record of the general community exposure from the HPC location. Secondly it would provide monitoring data that is representative of the nearest residential location (the same as option 1). Thirdly it would allow for a comparison of the two locations to show if there is a measurable difference between the locations that could be used to determine potential source contributions.

6.3.3 OPTION 3: ADDITION OF ALTERNATIVE AIR MONITORING EQUIPMENT AT MULTIPLE LOCATIONS

Option 3 would be to retain the existing BAM monitoring location at the HPC building and install additional, lower-cost monitors at locations around the community (approximate locations shown in **red** in Figure 6.1). To manage the cost of equipment and labour, the proposed equipment would be lower-cost, "near-reference" quality monitors (see below for details on a potential option for this equipment) that are designed to generally match with the BAM monitor, but do not have regulatory US EPA designations for particulate monitoring. However, by co-locating one of these new monitors at the existing BAM location we would have a direct comparison which can be used to improve the reliability and interpretation of the data from the lower cost, "near-reference" monitoring equipment. This option would see the largest expansion of the monitoring network and provide multiple locations of air monitoring data (eg Alpine Paving property line, Cloudburst Drive, and other community locations). As the equipment has minimal installation requirements it can also be re-located without significant cost. Along with expanding the particulate matter monitoring network WSP suggest the investigative sampling of Volatile Organic Compounds (VOC's) as a part of this option. See Section 6.4.4. below for more details on VOC monitoring.

One option of "Near Reference" equipment to expand the monitoring program are E-Samplers (https://metone.com/wp-content/uploads/2019/10/ESAMPLER.pdf). They are manufactured by the same company that makes the BAM units (MetOne). E-Samplers provide real-time data but use a different method for measuring particulate (light-scattering aerosol monitor). There are many benefits to "near-reference" monitors including:

- Significantly cheaper then a BAM;
- Along with real-time data collection some can collect a physical sample which can be further analysed;
- They require a lower level of maintenance to operate;
- They have a very small footprint (pole or tripod mounted) and can be installed almost anywhere as they have their own weather proof enclosure. This also allows them to be easily moved/relocated providing the option to have a dynamic monitoring network;
- They have a lower power requirement which allow for alternative power options;
- Some provide an option to add VOC monitoring into the equipment;
- The potential to rent these monitors to allow for shorter term expansion of the monitoring network without large capital investments.

There would be an increase to the budget for the ongoing maintenance and operations of the equipment as the amount of monitoring equipment would quadruple. The increase in the annual maintenance and operations budget would be similar to Option 2 because although there are more monitors, there is less maintenance time with each monitor. There would be additional cost for the VOC sampling which would bring the total annual cost for the first year above option 2. There would also be an increase to the cost of the annual report as the volume of data would increase.

The option of retaining the existing monitoring location and adding multiple new one would provide the following benefits to the community:

- It would maintain a record of the general community exposure as represented by HPC location (same as option 1).
- It would provide monitoring data that is representative of the nearest residential location (the same as option 1 and 2).
- It would allow for a comparison of multiple locations (nearest residential, fence-line, etc) to quantify if there is an observable difference between the locations.
- By adding select VOC monitoring modules to the PM monitors it would address the potential perception of other contaminants or odour impacts in the community emissions from the Asphalt plant.

6.3.4 VOC MONITORING

Concerns have been reported from the community regarding the odour from the Alpine Paving asphalt plant. As mentioned above, if there is a community concern related to odours, it may be advisable to monitor Volatile Organic Compounds (VOC's) that are associated with asphalt plant emissions / odours. Operating a high end continuous VOC sampling unit would not be considered a worthwhile investment of funds. However "Near Reference" monitoring units can provide valuable data at a fraction of the price. Alternatively, spot sampling could be conducted on specific dates when the asphalt plant is operating at locations around Cheakamus Crossing. There are two options for spot sampling to collect VOC data, using a handheld sensor or collecting a sample for laboratory analysis.

As part of Option 3, WSP proposes that in year 1 moving forward that VOC grab or handheld samples are collected during periods when the asphalt plant is operating. These can be compared to relevant health and odour criteria. Odours are often detected at a nuisance-level concentration that is much below concentrations that would cause health concerns.

6.3.5 CONCLUSION

The table below shows the three options and ranks them relative to each other in three main categories:

- Price – A capital cost which includes the new equipment and labour to modify the monitoring program plus the annual operation cost for the air monitoring program. Option 1 would have the lowest equipment cost as the existing equipment would be re-deployed. The capital costs would come from the labour costs associated with the moving of the existing equipment and the potential need for a free-standing equipment enclosure. Option 2 would have the highest capital costs as new monitoring equipment would be purchased and installed. It would also have the highest operating costs as there is twice as much equipment to maintain. Option 3 would have a moderate capital costs as the new equipment is at a lower price point. Option 3 would also have the highest operating cost as it includes monitoring for VOC as well. After the two years of VOC sampling, the operating costs would lower back to a similar annual cost as Option 2.
- Data Quantity (Number of Monitoring Locations) – Is defined by the amount of data collected in the monitoring program as an indicator of the spatial information the option would provide. Option 1 would only change the location of the monitoring so the quantity would not change. Option 2 would double the quantity by adding another high-quality monitor. Option 3 would increase the quantity of data the most by adding multiple locations of data collection using more affordable equipment. Option 3 also has the option to adjust the monitoring locations by using temporary installations like tripods or a trailer. Option 3 includes the collection of VOC samples (6 sampling events a year for 2 years) which has not been done before in the monitoring program.
- Data Quality – Related to the type of equipment that is suggested. The BAM unit is a regulatory quality instrument that provides the most reliable data. In option 1 the quality of data would potentially improve by moving it closer to a suspected source. In option 2 there would be two BAM units operating which would add reliability of the data but not necessarily increase the quality. In option 3 the objective would be to use multiple lower quality instruments to collect a larger "network" of data. To counteract the lower reliability of the "Near Reference" monitors the plan would be to co-locate a unit with the existing BAM to validate data trends. Additional VOC screening data would be used to determine if continuous monitoring of VOCs would be valuable in future years of the monitoring program.

Table 6-1 Option Comparison Table

PLAN	CAPITAL COST	OPERATION COST	DATA QUANTITY	DATA QUALITY
Option 1: Move existing BAM monitor	1st (lowest) $24,500	$33,500/year	3rd (no change)	3rd (one high quality monitor, limited to one location)
Option 2: Install an additional BAM monitor	3rd (highest) $72,500	$42,000/year	2nd (doubled)	1st (two high quality monitors)
Option 3 Install multiple lower cost monitors across neighbourhood plus VOC sampling	2nd (middle) $49,000	$61,000/year	1st (tripled)	2nd (one high quality monitor, with supplemental “near-reference” monitors)