Resort Municipality of Whistler

2014 Summary of Ambient Air Quality Monitoring

Cheakamus Crossing Ambient Air Quality Monitoring Station

Submitted by:

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February 2, 2015

Andrew Tucker
Resort Municipality of Whistler
4325 Blackcomb Way
Whistler, BC
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Dear Mr. Tucker:

Regarding: **Summary of 2014 Ambient Air Quality Monitoring, Cheakamus Crossing Neighborhood**

Levelton is pleased to provide the Annual Ambient Air Monitoring Report for the Resort Municipality of Whistler for 2014. The report outlines the monitoring program conducted during 2014 and compares the data to current standards.

Sincerely,
Levelton Consultants Ltd.

Braden Bartnik, B.Sc., BC-CESCL

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1. Introduction

Levelton Consultants Ltd. (Levelton) 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 continuously monitors ambient particulate ($PM_{2.5}$). Levelton 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 2014 (January 1st 2014, to December, 31st 2014).

2. Station Details

The Cheakamus Crossing Ambient Air Monitoring Station is located on the High Performance Centre (HPC) building (Figure 1). The High Performance Centre (HPC) building (Figure 1) 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 red star)

The monitoring equipment at the station includes:

- TEOM Series 1400a Ambient Particulate Monitor (TEOM) (Figure 3)
- R.M. Young 05305 Air Quality Wind Anemometer

The TEOM Series 1400a Ambient Particulate Monitor incorporates the patented Tapered Element Oscillating Microbalance (TEOM) technology to measure particulate matter mass concentrations continuously. The TEOM has been recognized by the US EPA as an acceptable continuous monitor of particulate matter concentrations (Rupprecht, 2002). This unit is outfitted with a Sharp Cut Cyclone (SCC) $PM_{2.5}$ inlet. Ambient air is pumped through the SCC inlet, which only allows airborne particulate matter with an aerodynamic diameter of 2.5 micrometers (2.5 µm = 0.0000025 meters) or less into the TEOM's sensor unit. The TEOM then measures the mass of particulate matter per volume of air sampled and displays it in micrograms per cubic meter (µg/m^3).

$PM_{2.5}$, also known as fine particulate, is so small it can only be detected with an electron microscope. Sources of fine particles 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 TEOM inlet (Figure 4).

The datalogger records 1-hour averages for both the TEOM and anemometer data to an onsite computer system. Along with storing the data on the onsite computer system, data is also transferred to Levelton'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)

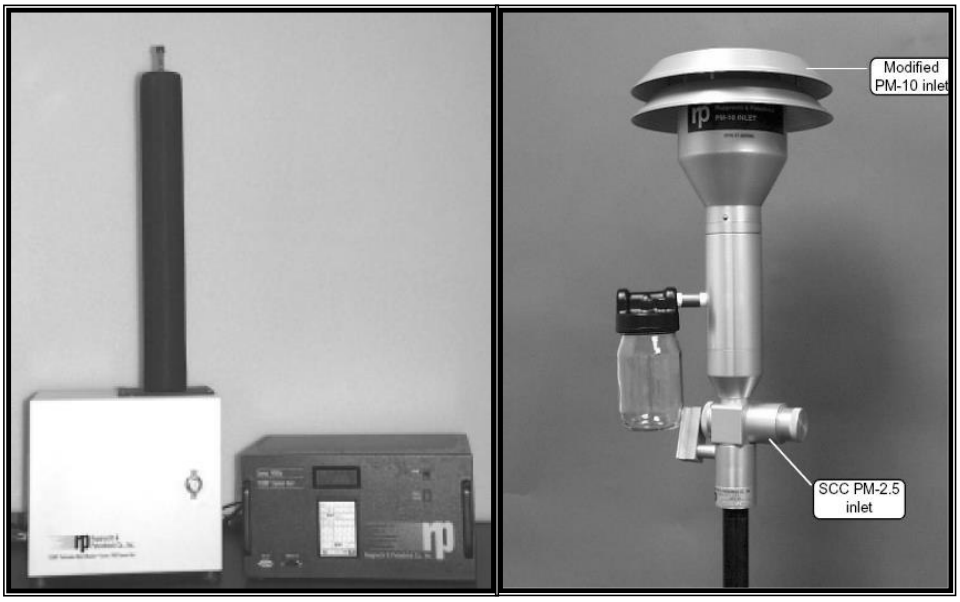

Figure 3 TEOM Sensor Unit (left), Control Unit (middle) and Inlet System (right)

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

2.1 2014 Station Maintenance and Audits

Levelton has consulted with the British Columbia Ministry of Environment (BC MOE) and follows the same maintenance and calibration standards by which the BC MOE operates their provincial system of ambient air monitoring stations. Levelton and the RMOW coordinated with the BC MOE to have the Cheakamus Crossing Ambient Air Monitoring Station audited by the BC MOE's provincial auditing team. This team conducts semi-annual audits on all of the BC MOE stations to validate the condition of the equipment, therefore validating the data. During 2014, MOE audits were conducted on March 7th 2014 and October 22nd 2014. Copies of the audit reports can be found in Appendix A. The maintenance/calibration and verification schedule for the monitoring station are more stringent than the manufacturer's recommended schedule.

3. Data Summary

Data collection began on September 3rd, 2010 for $PM_{2.5}$ data and on September 15th, 2010 for the wind data. The TEOM and anemometer continuously collect data. Required monthly maintenance results in the system being offline for short periods of time. 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. This report summarizes the data collected for the calendar year of 2014 (January 1st 2014, to December, 31st 2014) with comparisons to previous years.

3.1 Wind Direction and Wind Speed

A wind rose was created using the wind data collected onsite for 2014 (Figure 7). 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 previous annual monitoring data (Figure 5, Figure 6, and Figure 7). They 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 3.5% of the time over the 2014 monitoring period (slightly less than in 2013).

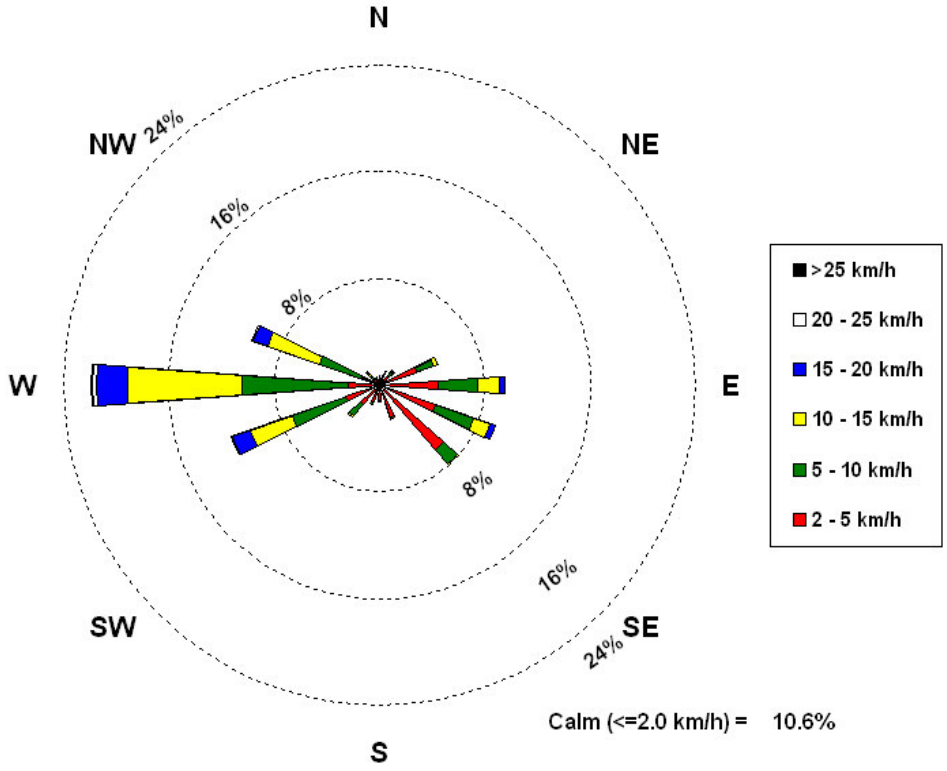

Figure 5 **Windrose of the Cheakamus Crossing Anemometer Data, January 1st, 2011 to December 31st, 2011**

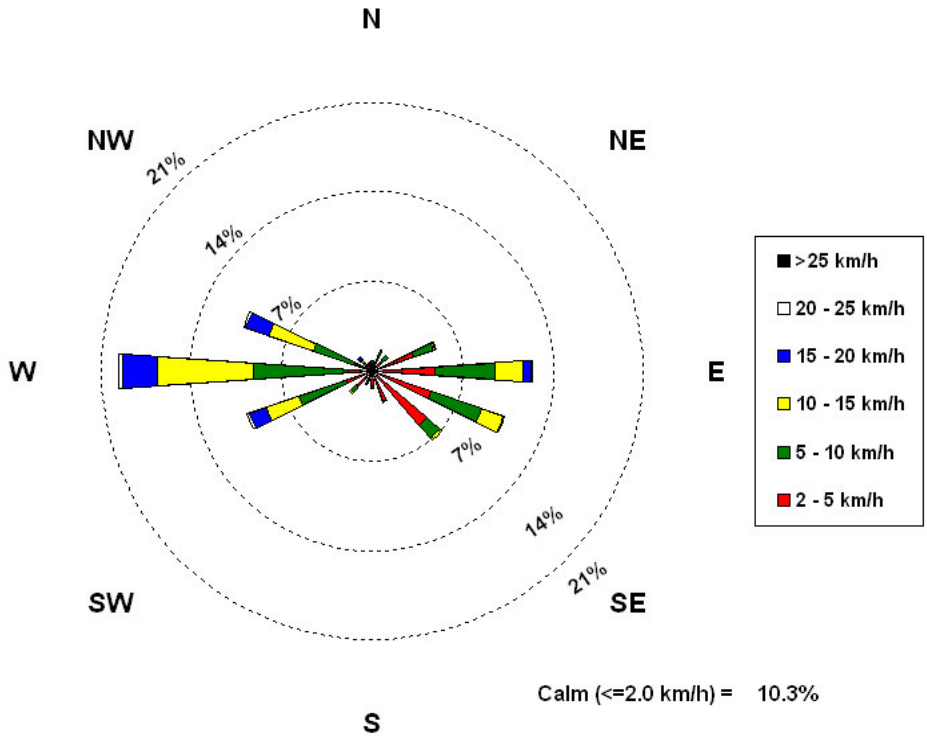

Figure 6 Windrose of the Cheakamus Crossing Anemometer Data, January 1st, 2012 to December 31st, 2012

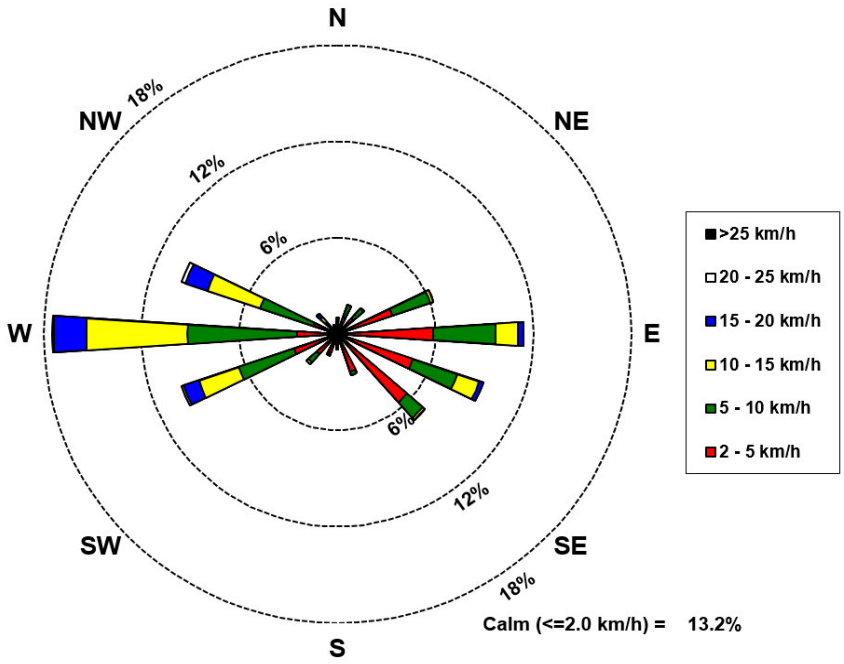

Figure 7 Windrose of the Cheakamus Crossing Anemometer Data, January 1st, 2013 to December 31st, 2013

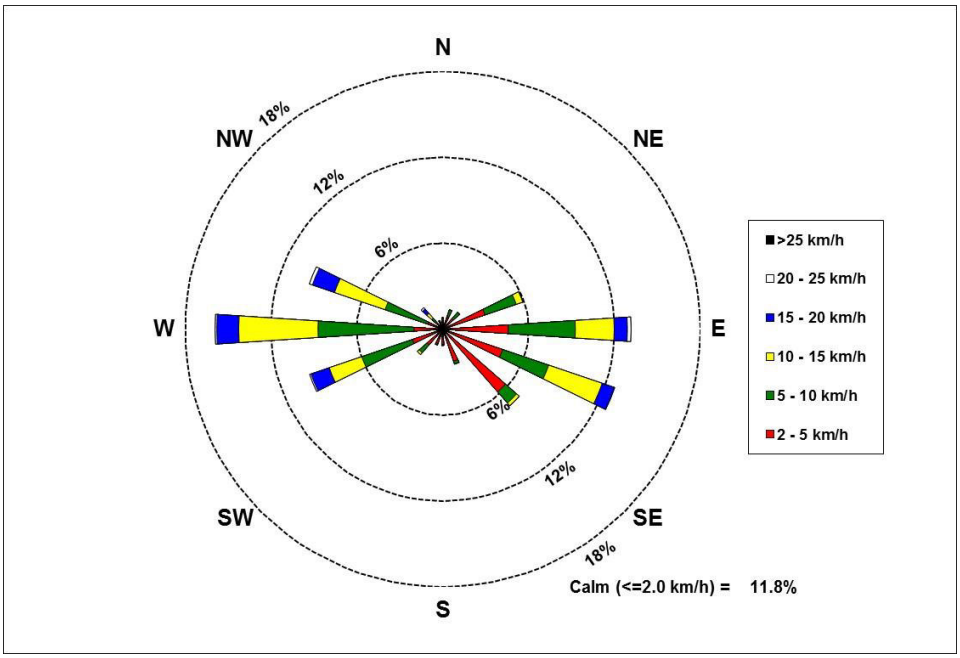

Figure 8 **Windrose of the Cheakamus Crossing Anemometer Data, January 1st, 2014 to December 31st, 2014**

3.2 $PM_{2.5}$ Concentrations

The continuous monitoring data from the TEOM unit was used to calculate 1-hour average $PM_{2.5}$ 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 Levelton and RMOW website provides a 'real-time' representation of current conditions but is not to compared to the provincial objectives. When comparing the results to the BC AAQO, a daily 24-hour average (midnight to midnight), also referred to as block average is used. Figure 8 displays a monthly breakdown of the 24-hour block averages and maximums, along with the hourly maximums.

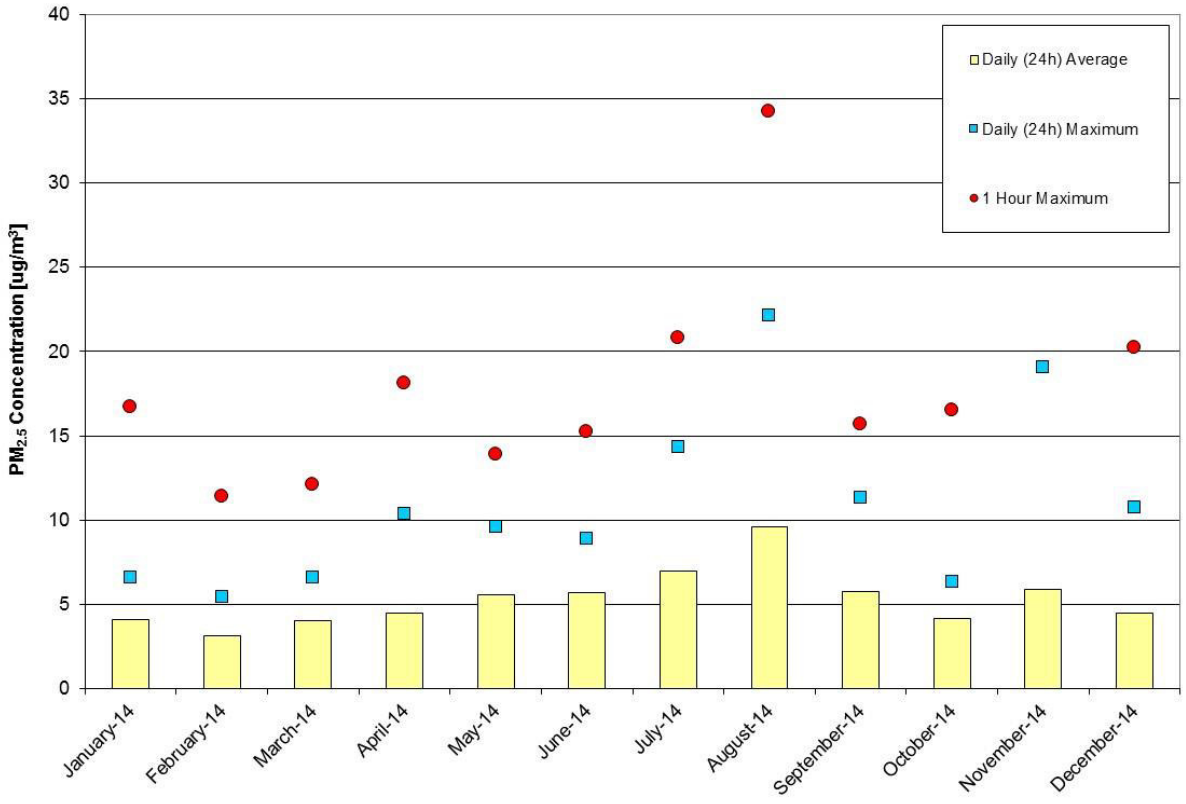

Figure 9 **$PM_{2.5}$ Monthly 24-hour Average, 24-hour Maximum, and 1-hour Maximum Concentrations**

Using the full annual data set, the 98th percentile value for a 24-hour block is determined and compared to the BC AAQO of 25 µg/m^3. In 2014, the 98th percentile value was 13.3 µg/m^3, which is below the provincial objective. The maximum 24-hour value recorded during 2014 was 22.1 µg/m^3. Although this value is not directly comparable to the BC AAQO, it is also below the objective.

The same data set is averaged to determine the annual average $PM_{2.5}$ concentration. This is compared to the Annual BC AAQO for $PM_{2.5}$ (8 µg/m^3). In 2014, the annual average $PM_{2.5}$ concentration recorded at Cheakamus Crossing was 5.3 µg/m^3, which is below the provincial objective and similar to previous years of monitoring. The 2011 - 2014 data is compared in Table 1 and Figure 10.

Table 1 Annual $PM_{2.5}$ TEOM Data (2011 – 2014)

Year	$PM_{2.5}$ (µg/m³)				
	Maximum (24-hour)	98th Percentile (24-hour)	BC AAQO (24-hour)*	Annual Average (24h)	BC AAQO (Annual)
2011	14.5	10.0	25	4.9	8.0
2012	19.8	12.9		5.3	
2013	14.0	10.3		5.0	
2014	22.1	13.3		5.3	

* The 24-hour $PM_{2.5}$ BC AAQO is compared to the annual 98th Percentile 24-hour block average concentration

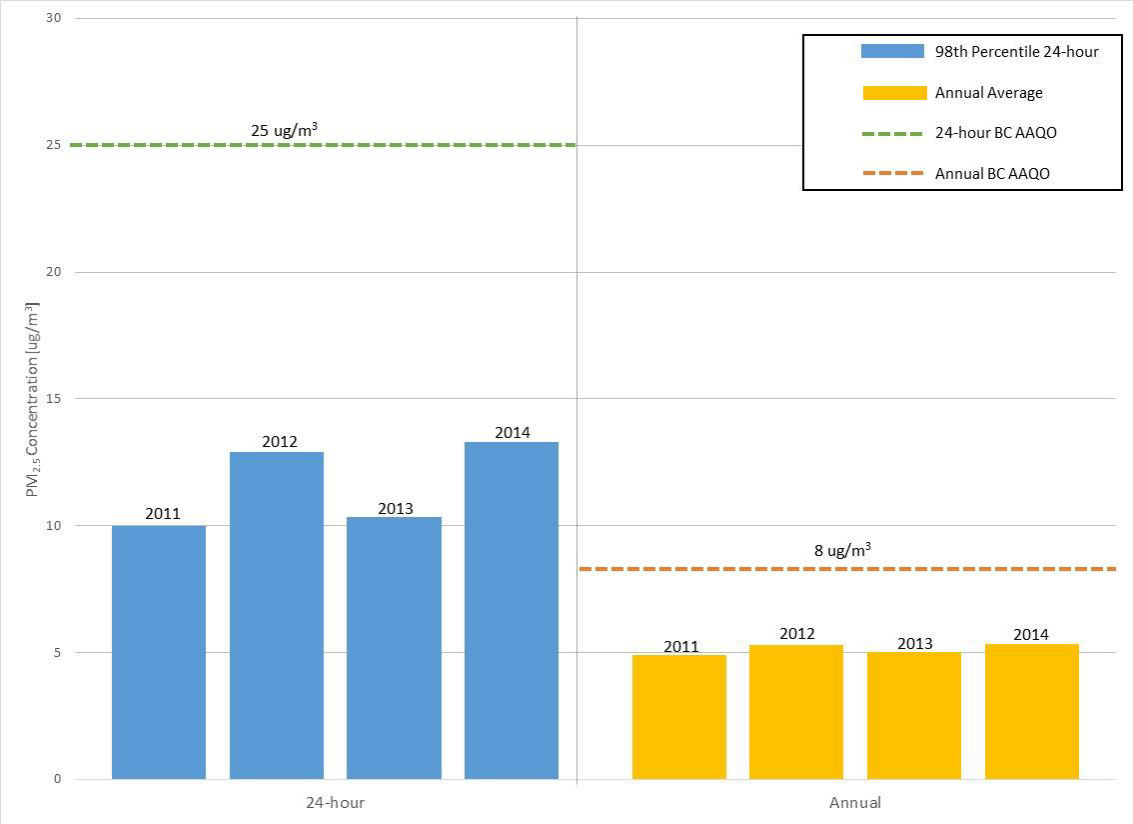

Figure 10 $PM_{2.5}$ 24-hour 98th Percentile and Annual Average Data for 2011 - 2014 Compared to BC AAQOs for $PM_{2.5}$

4. Conclusion

Levelton Consultants Ltd. (Levelton) 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 is equipped with a Series 1400a TEOM unit to measure $PM_{2.5}$ and a R.M. Young anemometer to measure wind speed and direction. The station was installed to address the concerns of potential ambient air quality issues associated with an asphalt plant located near the neighbourhood. The data from the monitoring station for the calendar year of 2014 was summarized in this report.

The dominant wind direction recorded at the monitoring station continues to be from the west. Winds from the southwest and south-southwest have the greatest potential to transport emissions from the asphalt plant towards the monitoring station. In 2014, the 24-hour average $PM_{2.5}$ concentration for comparison to air quality objectives (based on the annual 98^{th} percentile value) was 13.3 µg/m³ and the annual average $PM_{2.5}$ concentration was 5.3 µg/m³. For both averaging periods these concentrations fall below the BC AAQO of 25 µg/m³ and 8 µg/m³, respectively.

Given the proximity of the monitoring station to the Cheakamus Crossing neighbourhood, it is likely that these values are representative of the $PM_{2.5}$ concentrations in the neighbourhood.

5. References

Campbell Scientific, Inc., 2000, Operator's Manual: CR510 Basic Datalogger.

Rupprecht & Patashnick Co., Inc., 2002, Operating Manual: TEOM® Series 1400a Ambient Particulate (PM-10) Monitor (AB Serial Numbers), Revision B, March.

APPENDIX A:
MOE Audit Reports

Ambient Monitor Audit Certificate

Date:	March 07/14	Barometric Pressure:	714 mmHg
Location:	Whistler Cheakamus Crossing	Ambient Temperature:	4.2 °C
		Relative Humidity:	N/A %
Site Code:	MA491-2		
Auditors:	Jung/Nicklason		
Method:	Mass Transducer	Flow Adjust Main:	1.020
Make:	T.E.O.M	Flow Adjust Aux:	1.022
Model:	1400AB		
Serial Number:	140AB259370511	Flowmeter:	**Streamline**
Sensor Unit	140AB239860202		
Parameter:	PM2.5	Calibration Verification Kit	
		CVK: BB-2	0.09748 grams
Range:	-25 to 475		
		Streamline Data	**Total** **Main**
Start:	10:45	m:	0.4083 0.0791
Finish:	11:30	b:	-0.5816 -0.3241

	Target L/Min.	**(1)** In. H2O	**(2)** In. H2O	**(3)** In. H2O	**(Avg)** In. H2O		**Actual** L/Min.	**%Error**
Sample Flow:	16.67	6.01	6.02	6.06	6.03		16.62	-0.3%
	3.00	5.99	6.05	6.06	6.03		3.01	0.3%

~~Temperature:~~	**°C**	**~~Pressure:~~**	**atm**
Ambient Temperature (Audit)	4.2	Ambient Pressure (Audit)	0.940
Ambient Temperature (TEOM)	4.5	Ambient Pressure (TEOM)	0.942

~~Ko Verification~~

Element K number:	13074
Audit K0 number:	13074

~~Audit Criteria:~~

Sample Flow Error:		**PASS**
Temperature Error:	0.3	**PASS**
Pressure Error:	0.0	**PASS**
Ko Ver. Error	0.0%	**PASS**
Leak Test		
Main:	**0.00**	**PASS**
Aux:	**0.04**	**PASS**
Head Condition:	clean	**PASS**

Comments:

~~Leak Check:~~ (L/min)

Aux. Read:	0.17
Aux. Offset:	0.13
Aux Final:	0.16
Main Read:	0.04
Main Offset:	0.04
Main Final:	0.05

Audit Results: PASS

Air Audit Programme

~~Environmental Quality Branch~~

Continuous Ambient Monitor Audit Certificate

Date:	October 22/14	Barometric Pressure:	700 mmHg
Station Name:	Whstler Cheakamus Crossi	AmbientTemperature:	6.8 °C
Permit #:	N/A		
M-Code:	MA491		
Auditors:	Nicklason/Kubotani		
Method:	Mass Transducer	Flow Adjust Main:	1.020
		Flow Adjust Aux:	1.022
Make/Model:	TEOM 1400AB		
Serial #:	140AB239860202	Flowmeter:	**Streamline**
Parameter:	PM2.5	Calibration Verification Kit	
Range:	-25 to 475 ug	CVK: BB-2	0.09748 grams
Start Time:	08:10	**Streamline Data**	**Total** **Main**
Finish Time:	09:00	m:	0.4083 0.0791
		b:	-0.5816 -0.3241

	Target L/Min.	**(1)** In. H2O	**(2)** In. H2O	**(3)** In. H2O	**(Avg)** In. H2O		**Actual** L/Min.	**%Error**
Sample Flow:	16.67	5.81	5.81	5.82	5.81		16.55	-0.7%
	3.00	5.68	5.67	5.69	5.68		2.96	-1.4%

Temperature:	°C	**Pressure:**	atm
Ambient Temperature (Audit)	6.8	Ambient Pressure (Audit)	0.921
Ambient Temperature (TEOM)	6.7	Ambient Pressure (TEOM)	0.925

Ko Verification

Element K number: 13160
Audit K0 number: 13074

Audit Criteria:

Sample Flow Error:		**PASS**
Temperature Error:	0.1	**PASS**
Pressure Error:	0.0	**PASS**
Ko Ver. Error:	-0.7%	**PASS**
Leak Test		
Main:	**-0.03**	**PASS**
Aux:	**0.06**	**PASS**
Head Condition:	Clean	**PASS**

Leak Check: (L/min)

Aux Read:	0.16
Aux Offset:	0.10
Aux Final:	0.16
Main Read:	0.04
Main Offset:	0.07
Main Final:	0.04

Report:

Audit Results: PASS

Air Audit Programme
Knowledge Management Branch