Air Pollution Concentrations in Iqaluit, Nunavut (June 14 - Sep 22, 2014)

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SUMMARY

Health Canada and Environment Canada are monitoring air pollution emissions from a land fill fire in Iqaluit, Nunavut in order to characterize potential risks to the environment as well as public health. Several hundred compounds are being monitored as part of this campaign including pollutants that may have short-term or long-term health effects. This report summarizes data collected between June 14 and September 22, 2014. Specifically, the following air pollutants were monitored: $PM_{2.5}$, O_3, NO_2, SO_2, CO, $PM_{2.5}$-associated metals, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), dioxins/furans, and PCBs. Data for benzene and benzo(a)pyrene (BaP) are presented below to represent VOCs and PAHs respectively, as the health risks of these compounds are well characterized. The Ontario Ambient Air Quality Criterion (24-hour average: 0.1pg TEQ/m^3) was used to interpret dioxin/furan concentrations and is based on the impact of maternal exposures during pregnancy on fertility in male offspring; this standard is also protective of potential cancer risks. The Ontario standard is being phased in for 2016 and is considered to be very conservative (i.e. protective of human health). Each dioxin/furan sample consists of 17 separate compounds that are weighted with Toxic Equivalent Factors from the World Health Organization to generate Toxic Equivalency Quotients (TEQ) to compare with the standard.

Criteria air pollution concentrations ($PM_{2.5}$, NO_2, SO_2, O_3, CO) in Iqaluit have been low since air monitoring began and do not require an emergency response or pose a threat to public health. All 24-hour average concentrations have been below available health standards; SO_2 was present at concentrations below the method detection limit and is not reported. $PM_{2.5}$-associated metals have also been low and thus are not presented.

Occasional peaks in hourly average $PM_{2.5}$ concentrations were observed when the wind was blowing from the land fill site and reached values as high as 85 µg/m^3. For comparison, between July 8-9 hourly average peaks in ambient $PM_{2.5}$ in areas impacted by forest fires in the North West Territories reached 170 µg/m^3 with 24-hour average values exceeding 100 µg/m^3. The median hourly-average $PM_{2.5}$ value in Iqaluit since monitoring began is 2.14 µg/m^3.[1] Spikes in hourly average $PM_{2.5}$ levels could have an impact on sensitive populations (e.g. asthmatics) even if 24-hour average values are below existing standards. These people should seek medical attention if they feel that poor air quality is having an adverse impact on their health.

Median 24-hour average concentrations of VOCs and PAHs in Iqaluit have also been low throughout the monitoring period and are below Health Canada Reference concentrations. The highest 24-hour average concentrations of benzene and benzo(a)pyrene tend to occur at the site closest to the land fill fire (PAB site) and on occasion concentrations at this site have exceeded typical values observed in Canada (i.e. greater than the 90th percentile). However, short-term elevations in benzene and benzo(a)pyrene pose a negligible health risk as long-term exposures (e.g. over many years) are most relevant to human health. Ambient VOC and PAH concentrations in Iqaluit do not pose an unacceptable risk to health. Similarly, ambient PCB concentrations are well below available guidelines and do not pose an unacceptable risk to health.

Twenty-seven 24-hour samples have been analysed for dioxins/furans to date and the mean sample concentration exceeds the Ontario Ambient Air Quality Standard of 0.1

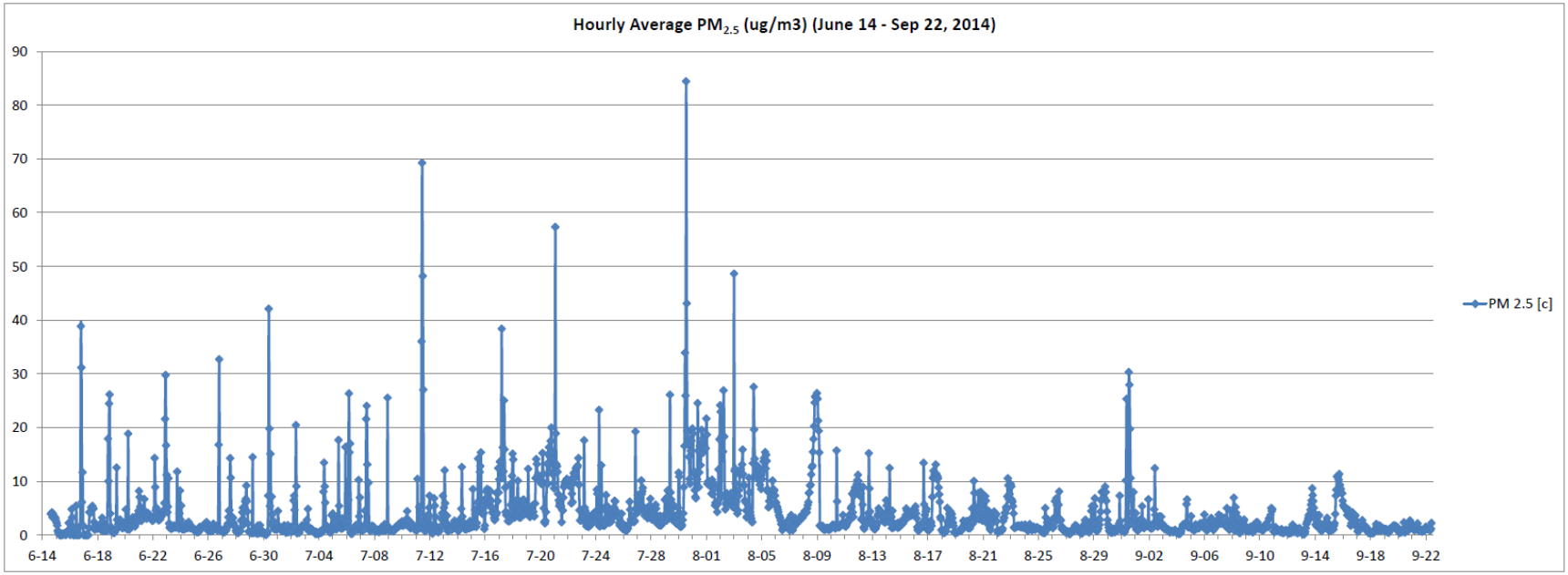
[1] On August 25, 2014, the $PM_{2.5}$ sampling equipment was re-zeroed to correct for equipment drift. A linearly interpolated correction value based on the offset measured in the re-zeroing process was applied to PM2.5 data measured prior to the re-zeroing. As a result, descriptive statistics found in the report pertaining to $PM_{2.5}$ are lower as compared to those found in previous revisions and should not be misinterpreted as to indicate a trend.

pg TEQ/m^3. This information is particularly important to pregnant women and women who may become pregnant, as exposure to dioxins/furans can decrease the fertility of male offspring. As previously communicated by the local health authorities, pregnant women and women who may become pregnant should take precautionary measures to minimize their exposures to smoke from the landfill fire. Such measures may include avoiding the area around the landfill fire, staying indoors with the doors and windows closed when air quality is being impacted by the fire (with air exchangers set to recirculate or turned off) and/or reducing or rescheduling outdoor physical activity during these time periods.

Although dioxin concentrations have sometimes exceeded the relevant health standard this does not mean that adverse health effects will be observed. In particular, the Ontario Standard is very conservative (i.e. protective of health) and the health risks associated with airborne concentrations of dioxins/furans in Iqaluit remain low. Long-term exposure to high levels of dioxins is known to increase cancer risk; however, the levels of dioxins observed in Iqaluit are far below the relevant health standard for cancer. Elevated levels of dioxins/furans are not unexpected as major fire events (e.g. forest fires and land fill fires) are known sources of these compounds.

Health Canada recognizes that offensive odours may be detected in Iqaluit as a result of the fire and that these odours may raise concerns with respect to the health impacts of the fire. Although unpleasant, odours alone do not necessarily indicate a health risk as odours are often detected at concentrations below values that are relevant to public health.

Figure 1. Time-Series Plot of $PM_{2.5}$ at Bi-Law site, Iqaluit, Nunavut.



* [c] A linearly interpolated correction value of 3.75 ug/m3 was applied to PM2.5 data measured before Aug 25 11:15 AM to offset monitoring drift measured upon re-zeroing of the device.

Table 1. Descriptive Statistics for hourly average $PM_{2.5}$ concentrations **(**µg/m^3) in Iqaluit, Nunavut between June 14 - Sep 22, 2014

Date	Median (10-90th)	Wind Condition[a]		Percentiles for Existing Canadian NAPS Data[1]			Canadian Standards[2]	
		Upwind Median	Downwind Median	10th	50th	90th	Short-Term (24-hour)	Long-Term (annual)
June 14 - Sep 22	2.08 (0.68-9.75)	2.14	1.58	3	6	13	28	10

[a]Samples were identified as downwind if the wind direction during the hour of sampling was from the West, North West, or North North West (between 270-330^{o}).

Figure 2. Time-Series Plot of CO at Bi-Law site, Iqaluit, Nunavut.

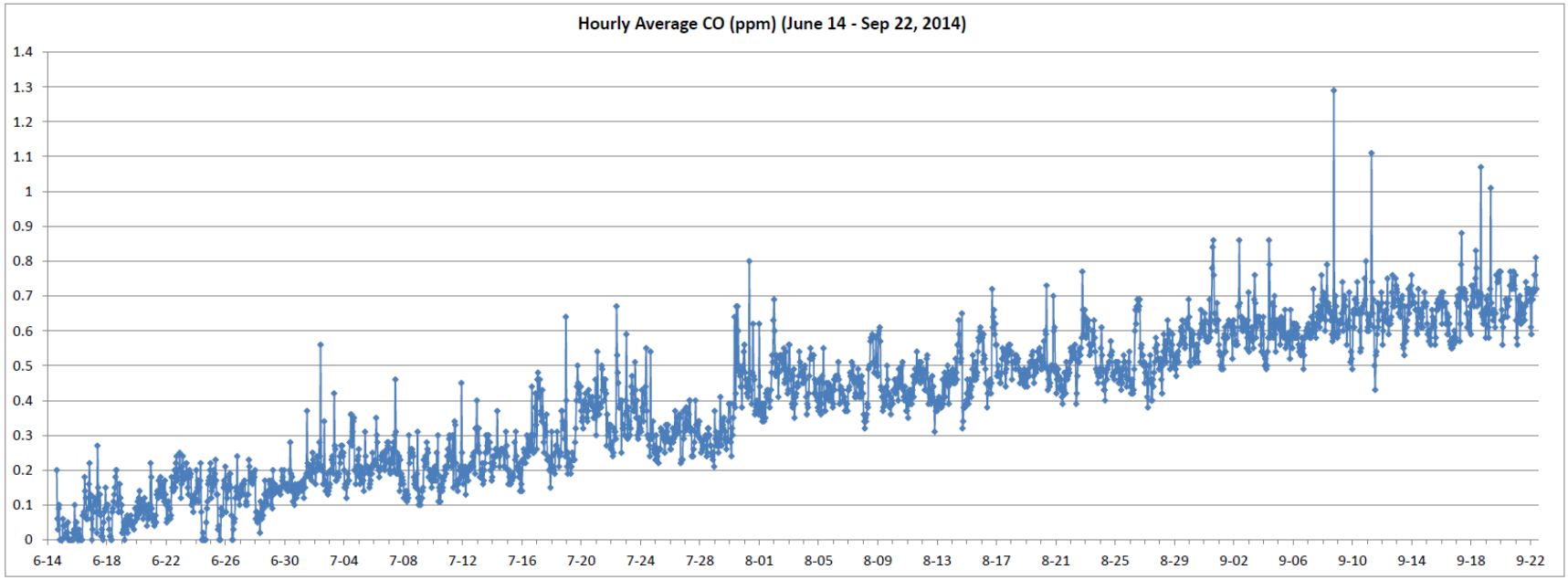


Table 2. Descriptive Statistics for hourly average CO concentrations **(**ppm) in Iqaluit, Nunavut between June 14 - Sep 22, 2014

Date	Median (10-90th)	Wind Condition[a]		Percentiles for Existing Canadian NAPS Data[1]			EPA Standards[3]	
		Upwind Median	Downwind Median	10th	50th	90th	Short-Term (1-hour)	Long-Term (8-hour)
June 14 - Sep 22	0.42 (0.13-0.65)	0.41	0.26	0.12	0.24	0.45	35	9

[a] Samples were identified as downwind if the wind direction during the hour of sampling was from the West, North West, or North North West (between 270-330^{o}).

Figure 3. Time-Series Plot of O_3 at Bi-Law site, Iqaluit, Nunavut.

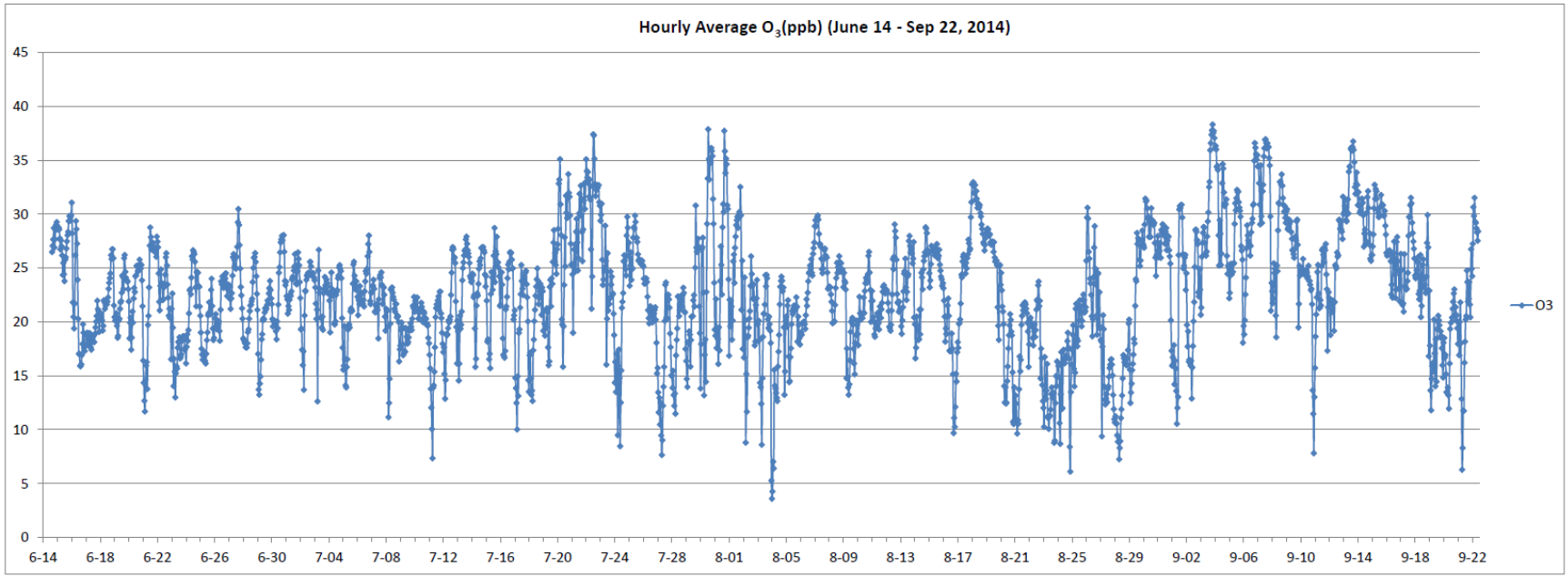


Table 3. Descriptive Statistics for hourly average O_3 concentrations **(**ppb) in Iqaluit, Nunavut between June 14 - Sep 22, 2014

Date	Median (10-90th)	Wind Condition[a]		Percentiles for Existing Canadian NAPS Data[1]			Canadian Standards[2]	
		Upwind Median	Downwind Median	10th	50th	90th	Short-Term (1-hour)	Long-Term (8-hour)
June 14 - Sep 22	22.74 (15.84-29.75)	22.62	21.99	8	24	41		63 ppb

[a] Samples were identified as downwind if the wind direction during the hour of sampling was from the West, North West, or North North West (between 270-330^{o}).

Figure 4. Time-Series Plot of NO_2 at Bi-Law site, Iqaluit, Nunavut.

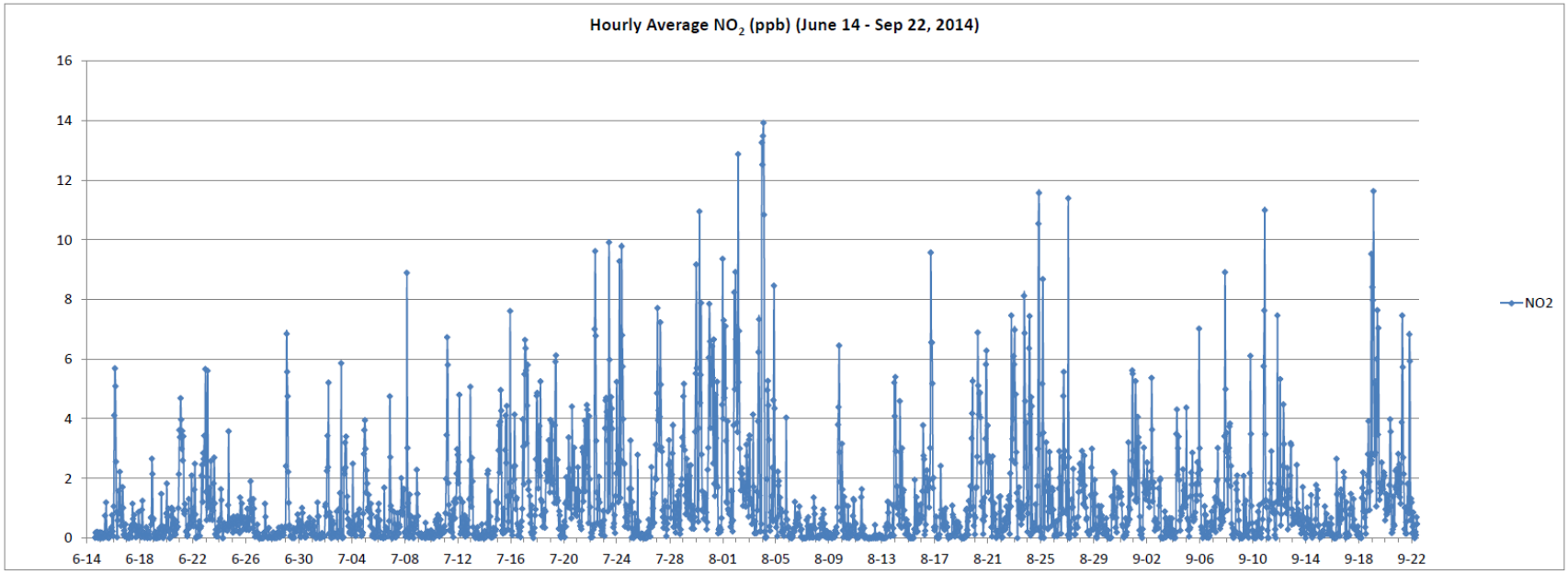
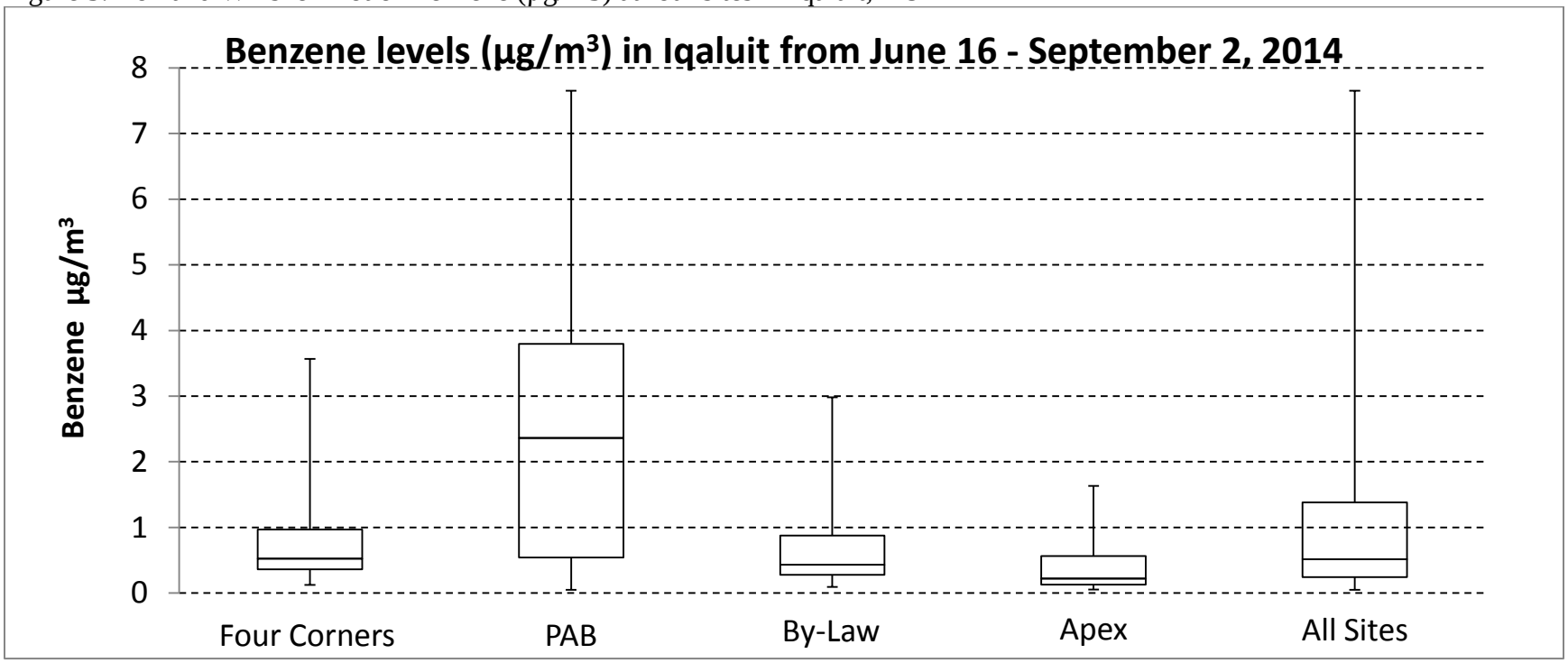


Table 4. Descriptive Statistics for hourly average NO_2 concentrations **(**ppb) in Iqaluit, Nunavut between June 14 - Sep 22, 2014

Date	Median (10-90th)	Wind Condition[a]		Percentiles for Existing Canadian NAPS Data[1]			EPA Standards[3]	
		Upwind Median	Downwind Median	10th	50th	90th	Short-Term (1-hour)	Long-Term (annual)
June 14 - Sep 22	0.58 (0.03-3.35)	0.72	0.48	3	8	20	100	53

[a]Samples were identified as downwind if the wind direction during the hour of sampling was from the West, North West, or North North West (between 270-330^{o}).

Figure 5. Box and Whisker Plot of Benzene (µg/m3) at four sites in Iqaluit, NU



[a]0th,25th,50th,75th,100th plotted; [b]Samples taken on dates listed in Table 5.

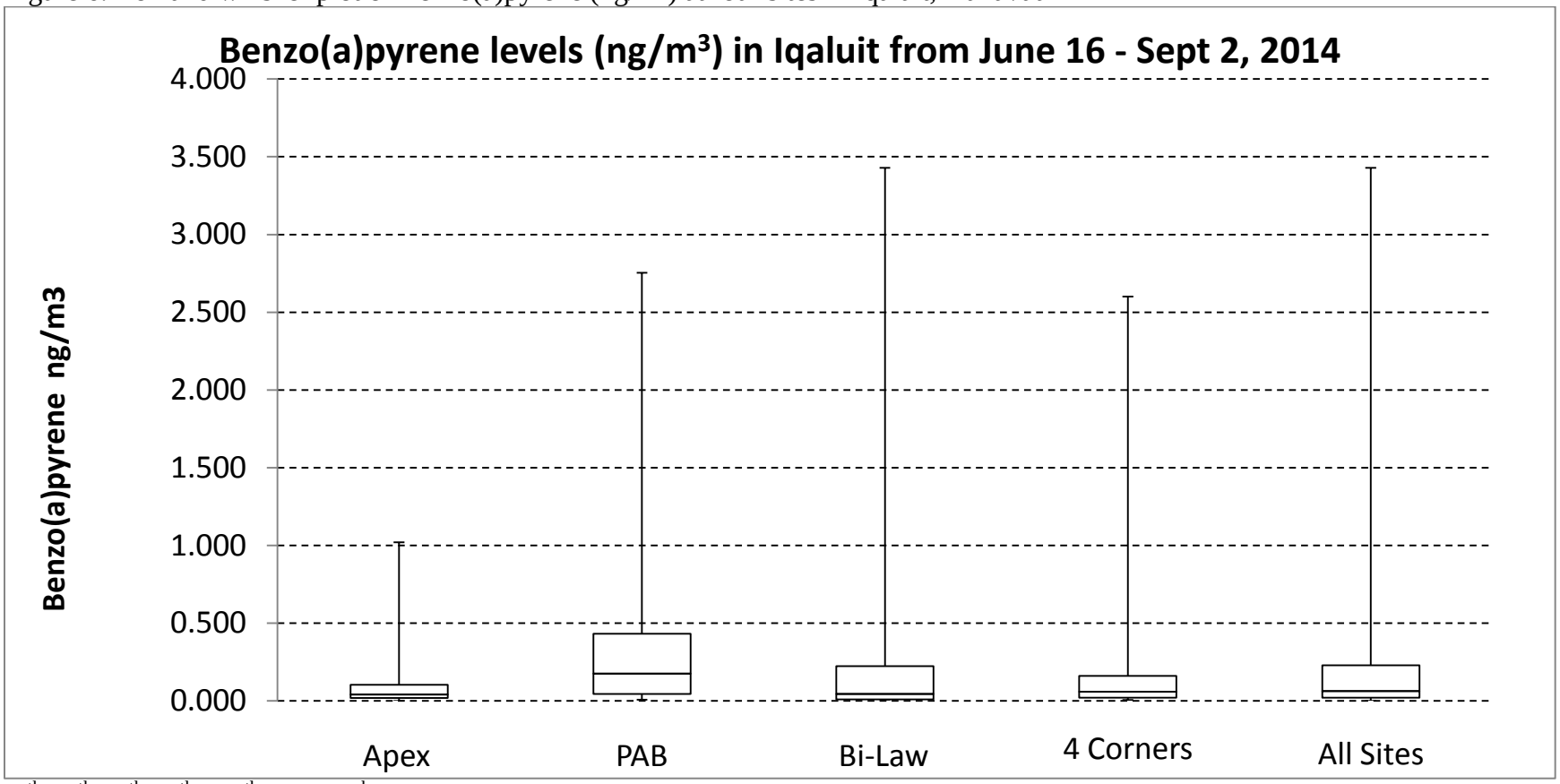
Table 5. Descriptive Statistics for 24-hour Benzene concentrations (µg/m^3) in Iqaluit, Nunavut

Date	Daily Median[a] (10-90th)	Percentiles for Existing Canadian NAPS Data[1]			Health Canada Reference Concentration[b]
		10th	50th	90th	
June 15	0.65 (0.24-1.77)	0.30	0.62	1.30	3
June 16	0.54 (0.19-1.11)				
June 18	0.91 (0.48-1.04)				
June 20	1.34 (0.30-6.05)				
June 22	1.34 (1.17-3.62)				
June 24	0.09 (0.06-0.18)				
June 26	0.51 (0.15-1.04)				
June 28	0.28 (0.11-0.44)				
June 30	0.51 (0.16-1.90)				
July 02	0.68 (0.24-1.81)				
July 04	0.31 (0.20-0.51)				
July 06	0.46 (0.36-1.69)				
July 08	0.58 (0.21-1.90)				
July 10	0.44 (0.26-1.43)				
July 12	1.66 (0.69-2.56)				
July 15	0.48 (0.37-0.59)				
July 16	3.27 (1.35-3.88)				
July 18	1.30 (0.54-4.71)				
July 20	1.45 (0.97-3.05)				
July 22	0.77 (0.44-4.48)				
July 24	0.60 (0.42-0.70)				
July 26	1.37[c]				
July 27	3.52[c]				

Date	Daily Median[a] (10-90th)	Percentiles for Existing Canadian NAPS Data[1]			Health Canada Reference Concentration[b]
		10th	50th	90th	
July 28	1.02 (0.65-1.64)	0.30	0.62	1.30	3
July 30	2.21 (1.79-2.28)				
August 1	1.88 (1.06-2.79)				
August 3	0.25 (0.23-0.33)				
August 5	0.33 (0.22-3.91)				
August 7	0.22 (0.16-4.36)				
August 9	0.26 (0.17-0.32)				
August 11	0.36 (0.22-1.98)				
August 13	0.57 (0.45-1.92)				
August 15	0.24 (0.23-2.34)				
August 17	0.14 (0.09-3.23)				
August 19	0.47 (0.23-1.18)				
August 21	3.02 (0.67-5.36)				
August 23	0.22 (0.15-0.29)				
August 25	0.41 (0.19-0.55)				
August 27	0.36 (0.19-0.52)				
August 28	0.14 (0.13-0.18)				
August 31	0.55 (0.24-0.98)				
September 2	0.26 (0.26-0.43)				
June 15 – Sept 2	0.52 (0.14-2.75)	0.30	0.62	1.30	3

[a]Median value collected from 4 sites in Iqualuit; [b]Reference concentration for lifetime exposure and a 1 in 100,000 increase in cancer risk; [c]Single sample, taken on "event" day

Figure 6. Box and whisker plot of Benzo(a)pyrene (ng/m^3) at four sites in Iqaluit, Nunavut



[a]0th,25th,50th,75th,100th plotted; [b]Samples taken on dates listed in Table 6.

Table 6. Descriptive Statistics for Benzo(a)pyrene concentrations (ng/m^3) in Iqaluit, Nunavut

Date	Daily Median (10-90th)	Percentiles for Existing Canadian NAPS Data[1]			Health Canada Reference Concentration[d]
		10th	50th	90th	
June 15	0.23 (0.09 - 0.49) [b]	0.02	0.07	0.26	300
June 16	0.54 (0.10 - 1.70) [b]				
June 18	0.06 (0.05 - 0.60)				
June 19	0.07[c]				
June 20	0.19 (0.11 - 0.28)				
June 22	0.04 (0.01 - 0.07)				
June 23	0.23[c]				
June 24	0.29 (0.18 - 0.39)				
June 25	0.01[c]				
June 26	0.53 (0.30 - 0.68)				
June 28	2.03 (1.00 - 3.18)				
June 29	1.25[c]				
June 30	0.74 (0.22 - 1.62)				
July 02	0.90 (0.43 - 2.21)				
July 03	0.26[c]				
July 04	0.11 (0.02 - 0.27)				
July 06	0.01 (0.01 - 0.01)				
July 08	0.01 (0.01 - 0.01)				
July 10	0.08 (0.03 - 0.26)				
July 12	0.03 (0.01 - 0.09)				
July 14	0.05 (0.03 - 0.13)				
July 16	0.03 (0.02 - 0.08)				
July 17	0.01[c]				
July 18	0.06 (0.03 - 0.26)				
July 20	0.06 (0.03 - 0.09)				

Date	Daily Median (10-90th)	Percentiles for Existing Canadian NAPS Data[1]			Health Canada Reference Concentration[d]
		10th	50th	90th	
July 22	0.00 (0.00 - 0.11)	0.02	0.07	0.26	
July 24	0.01 (0.01 - 0.03)				
July 26	0.03 (0.02 - 0.05)				
July 28	0.03 (0.02 - 0.25)				
July 30	0.19 (0.05 - 0.23)				
July 31	0.02 [c]				
Aug 1	0.03 (0.02 - 0.09)				
Aug 3	0.01 (0.00 - 0.05)				
Aug 5	0.10 (0.04 - 0.53)				
Aug 6	0.00 [c]				
Aug 9	0.00 [c]				
Aug 11	0.02 (0.01 - 0.19)				
Aug 12	0.00 [c]				
Aug 6	0.00 [c]				
Aug 9	0.00 [c]				
Aug 12	0.00 (0.00 - 0.01)				
Aug 13	0.07 (0.01 - 0.37)				
Aug 15	0.03 (0.01 - 0.04)				
Aug 17	0.02 (0.02 - 0.41)				
Aug 18	0.15 (0.03 - 0.27)				
Aug 19	0.02 (0.02 - 0.05)				
Aug 21	0.17 (0.08 - 0.54)				
Aug 23	0.07 (0.05 - 0.08)				
Aug 25	0.14 (0.08 - 0.38)				
Aug 27	0.15 (0.05 - 0.23)				

Date	Daily Median (10-90th)	Percentiles for Existing Canadian NAPS Data[1]			Health Canada Reference Concentration[d]
		10th	50th	90th	
Aug 29	0.13 (0.08 - 0.27)	0.02	0.07	0.26	
Aug 31	0.30 (0.11 - 0.42)				
Sept 02	0.11 (0.08 - 0.20)				
June 15 – Sept 02	0.06 (0.01 - 0.60)	0.02	0.07	0.26	300

[a] Median value collected from 4 sites in Iqualuit;[b]Values less than the detection limit were replaced with the detection limit when calculating median; [c]single site value; [d]Reference concentration for lifetime exposure and a 1 in 100,000 increase in cancer risk.

Table 7. Dioxins and Furans Toxic Equivalency Quotient (TEQ), (pg/m^3) at Four Corners / By-Law / PAB in Iqaluit, Nunavut

Date	Sampling Location	Median ($10–90^{th}$)	Percentiles for Existing Canadian NAPS Data[1]			Ontario Ambient Air Quality Criteria (24-hour)[a]
		WHO_{2005}-TEQ	10^{th}	50^{th}	90^{th}	
June 15	Four Corners	0.1	0.0101	0.0163	0.0494	0.1
June 16	Four Corners	0.05				
June 18	Four Corners	0.2				
June 22	Four Corners	0.2				
June 23	Four Corners	0.5				
June 25	Four Corners	0.1				
June 28	Four Corners	0.1				
June 29	Four Corners	0.4				
July 3	Four Corners	0.2				
July 4	Four Corners	0.1				
July 6	Four Corners	0.5				
July 10	By-Law[b]	0.2				
July 16	By-Law	1.1				
July 17	By-Law	0.3				
July 22	By-Law	0.2				
July 26	By-Law	0.4				
July 28	By-Law	0.3				
July 31	By-Law	0.3				
August 3	By-Law	0.03				
August 6	By-Law	0.005				
August 9	By-Law	0.03				
August 12	By-Law	0.2				
August 12	PAB	0.102				

Date	Sampling Location	Median (10–90th) WHO_{2005}-TEQ	Percentiles for Existing Canadian NAPS Data[1] 10th	50th	90th	Ontario Ambient Air Quality Criteria (24-hour)[a]
August 15	By-Law	0.002				
August 15	PAB	0.6				
August 18	By-Law	0.004				
August 18	PAB	0.97				
June 15 – Aug 18	All Three	0.2 (0.02 - 0.54)	0.0101	0.0163	0.0494	0.1

[a]Based on male reproductive effects resulting from maternal exposure during pregnancy. [b].June 15 – July 6 monitored at Four Corners site, July 10 – Aug 9 at By-Law, and Aug 12 – 18 at both PAB and By-Law.

Table 8. Total PCBS (ng/m^3) at Four Corners / By-Law / PAB site in Iqaluit, Nunavut

Date	Sampling Location	Median (10–90th)	Percentiles for Existing Canadian NAPS Data[1]			Ontario Ambient Air Quality Criteria[a]	
			10th	50th	90th	Short-Term (24-hour)	Long-Term (annual)
June 15	Four Corners	0.015				1500	350
June 16	Four Corners	0.013					
June 18	Four Corners	0.047					
June 22	Four Corners	0.034					
June 23	Four Corners	0.023					
June 25	Four Corners	0.029					
June 28	Four Corners	0.009					
June 29	Four Corners	0.032					
July 03	Four Corners	0.018					
July 04	Four Corners	0.015					
July 06	Four Corners	0.025					
July 10	By-Law[b]	0.000					
July 16	By-Law	0.056					
July 17	By-Law	0.024					
July 22	By-Law	0.007					
July 26	By-Law	0.010					
July 28	By-Law	0.033					
July 30	By-Law	0.015					
August 3	By-Law	0.006					
August 6	By-Law	0.000					
August 9	By-Law	0.001					
August 12	By-Law	0.007					
August 12	PAB	0.086					
August 15	By-Law	0.001					
August 15	PAB	0.121					

Date	Sampling Location	Median (10–90th)	Percentiles for Existing Canadian NAPS Data[1]			Ontario Ambient Air Quality Criteria[a]	
			10th	50th	90th	Short-Term (24-hour)	Long-Term (annual)
August 18	By-Law	0.027					
August 18	PAB	0.432					
June 15 – Aug 18	All Three	0.018(0.001 - 0.068)				1500	350

[a]Reference concentration for a 1 in 100,000 increase in cancer risk; [b].June 15 – July 6 monitored at Four Corners site, July 10 – Aug 9 at By-Law, and Aug 12 – 18 at both PAB and By-Law.

References

1. Environment Canada 2013. 10Years of Data from the National Air Pollution Surveillance (NAPS) Network. Data Summary from 1999-2008. Available: http://www.ec.gc.ca/rnspa-naps/77FECF05-E241-4BED-8375-5A2A1DF3688C/NAPS_Annual_Report_August2013_E.pdf

2. Canadian Ambient Air Quality Standards. Available : http://www.ec.gc.ca/default.asp?lang=En&n=56D4043B-1&news=A4B2C28A-2DFB-4BF4-8777-ADF29B4360BD

3. U.S. Environmental Protection Agency National Ambient Air Quality Standards. Available : http://www.epa.gov/air/criteria.html

4. Ontario Air Standards for Dioxins, Furans, and Dioxin-like PCBs. 2011. http://www.downloads.ene.gov.on.ca/envision/env_reg/er/documents/2011/010-7193.pdf