MAWC – IUP Service Contract
Air Quality Monitoring at Beaver Run Reservoir
Quarterly Report #4

Covering the Period from 5/1/2019 – 7/31/2019

Submitted by

Dr. John L. Bradshaw
Indiana University of Pennsylvania
Tel: (724) 357-7731
bradshaw@iup.edu

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OUTLINE OF REPORT

I. Scope of Contract

The third year of the contract between the Municipal Authority of Westmoreland County (MAWC) and the Indiana University of Pennsylvania (IUP) started on 1 August 2018 and ran until 31 July 2019. The scope of the contract calls for the contractor, IUP, to perform air quality measurement services at Beaver Run Reservoir (BRR) quarterly.

The air quality measurement services include field sampling, laboratory analyses and reporting as follows: (1) Field Sampling: air quality samples and hand-held sensor readings will be taken at the Mamont compressor station and at the Kuhns, DeArmitt, Hutchinson and Mamont (KDHM) pad sites. Background air quality samples will be taken near the Kuhns pad. (2) Laboratory Analyses: The air samples taken from the pad sites will be analyzed for methane concentration and compared to the hand-held sensor readings taken at the pads. The air samples taken from the Mamont compressor station will be monitored for the standard compressor gases of CO, NO_2, SO_2, Benzene, Ethylbenzene, Formaldehyde, n-Hexane, Toluene, Xlenes and 2,2,4 Trimethylpentane. (3) Reporting: A report on the results of the field sampling and analyses will be delivered to MAWC personnel after data analysis is completed. After review and approval of the report results by MAWC, the results will then be posted on an IUP web site for public access.

II. Scope of Report

This report covers the fourth quarter of the contract. Field samples and hand-held sensor readings were taken directly off the KDMH fracking pads on 7 June 2019. A background sample was taken about 200 meters from the Kuhns pad, as measured by Google Maps. Field samples and hand-held sensor readings were also taken at the Mamont Compressor site on 7 June. Carbon Monoxide (CO) data loggers were previously placed at the Mamont compressor site on 23 February. These data loggers were removed and replaced with new loggers on 7 June. The data loggers were again rotated out (replaced with software-reset sensors with new batteries) on 29 July. Field sampling notes are reported in section III. The results from the CO data loggers, laboratory analyses of the air samples and hand-held sensor readings are reported in section IV. Section V is a summary of the results for this quarter and section VI reviews the contract status and notes.

III. Field Report of Air Quality Sampling

Figure 1 shows the approximate locations where an air sample was taken or CO monitors were placed at the Mamont compressor station. One air sample was taken at position P7 and the CO data loggers were placed at the positions labeled P7, P1 and P3. Hand-held sensor readings for CO, SO_2, CH_4, NO_2 and CH_2O were taken at position P7. The hand-held sensor reading were taken for 10-minute durations for each gas.

All of the aerial views shown in this section of the report are taken from Google Maps and do not represent the vegetation or construction in the area on the date of the samples, but instead are intended to show the locations of the data loggers and the air and

Figure 1. Aerial image of the Mamont compressor station. An air sample was taken at position P7. Hand-held sensor readings for CO, SO_2, CH_4, NO_2 and CH_2O were recorded at P7. CO data loggers were placed at the positions P1, P2 and P7. The aerial image is from Google Maps.

Figure 2. Aerial image of the Kuhns pad and nearby vicinity. The red square marks the location of the air sample taken. The blue line shows the pathway for the walking survey of CH_4. The blue square labeled "bkg" at the upper right in the figure marks the location of the background air sample. The aerial image is from Google Maps. The distance from the location of the background sample to the Kuhns well head is about 200 meters.

Figure 3. Aerial image of the DeArmitt pad. The red square marks the location of the air sample taken. The blue line shows the pathway for the walking survey of CH_4. The aerial image is from Google Maps.

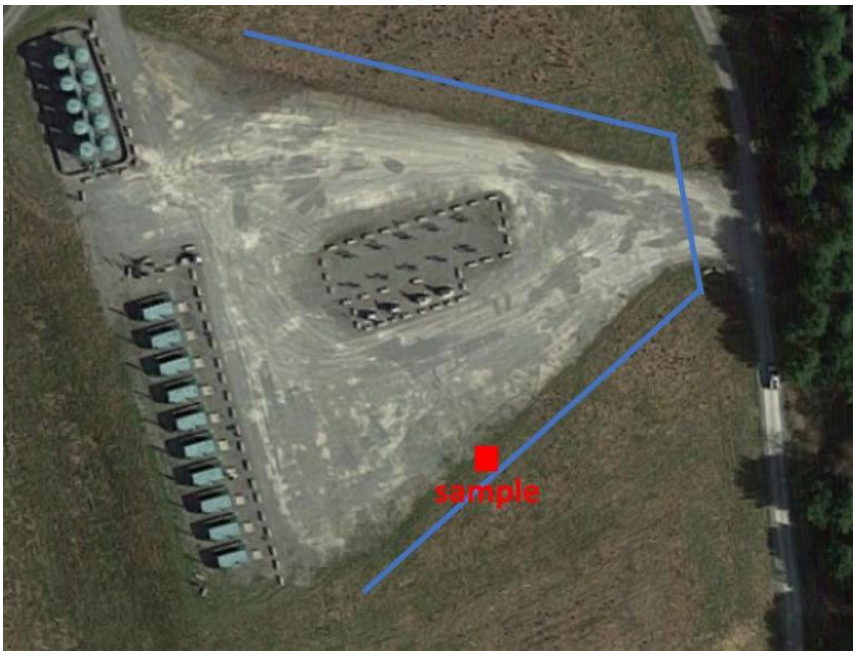

Figure 4. Aerial image of the Hutchinson pad. The red square marks the location of the air sample taken. The blue line shows the pathway for the walking survey of CH_4. The aerial image is from Google Maps.

Figure 5. Aerial image of the Mamont pad. The red square marks the location of the air sample taken. The blue line shows the pathway for the walking survey of CH_4. The aerial image is from Google Maps.

background samples relative to landmarks around the Mamont compressor and the Kuhns, DeArmitt, Hutchinson, and Mamont (KDHM) pad well sites.

In figure 2, the location of the air sample taken at the Kuhns pad is marked with a red square (■). The location of the background sample (in the upper right of that figure) is marked with a blue square (■) and the notation "bkg". The walked pathway for the handheld monitor (Aeroqual) survey of CH_4 is shown as a blue line.

In figure 3, the location of the air sample taken at the DeArmitt pad is marked with a red square (■). The walked pathway for the handheld monitor survey of CH_4 is shown as a blue line. In figure 4, the location of the air sample taken at the Hutchinson pad is marked with a red square (■). The walked pathway for the handheld monitor survey of CH_4 is shown as a blue line. In figure 5, the location of the air sample taken at the Hutchinson pad is marked with a red square (■). The walked pathway for the handheld monitor survey of CH_4 is shown as a blue line.

The CO data logger and field measurement results are presented in tabular and graphical forms and discussed in the next section.

IV. Results

A. Results of Methane content from air samples at Kuhns, DeArmitt, Hutchinson and Mamont-1 pads and background sampling

i. Air Sample Results

Table 1 below summarizes the results of the methane concentration measurements at the KDHM pads and the background sample from near the Kuhns pad. The sample locations at each pad are shown as the red squares in Figures 2 through 5 and as a blue square for the background sample near the Kuhns pad in figure 2. Each bag sample was analysed using Fourier-Transform Infrared Absorption Spectroscopy for methane content. When the results are indistinguishable from the atmospheric background (which is approximately 1.8 ppmv), the results are shown as 1.5 ± 1.5 ppmv.

The results summarized in table 1 indicate that methane content of the bag samples from the Kuhns, DeArmitt, and Hutchinson pad sites was indistinguishable from background.

The result of the bag sample analysis from the Mamont pad site on 7 June was approximately 4x background. Equivalently, this suggests that the additional methane concentration from the Mamont well head was 3x background. When the bag sample was taken at the Mamont site, there was a distinct "hissing" heard from the well head. The bag sample was taken off the pad itself, but directly in front of the well head, as shown by the red square in figure 5. Also, a slight breeze from the north-east directed any emissions from the well head directly towards the location of the air sample. We returned to this well head on 29 July and took another air sample at the same point shown in figure 5. We heard hissing from the well head similar to the 7 June sample record. On 29 July the breezes were variable in direction and we recorded no discernible concentration above background.

Table 1. Summary of results of methane content analysis from air samples at the Kuhns, DeArmitt, Hutchinson and Mamont pads, including the background measurement taken near the Kuhns pad.

Date	sample	Methane concentration (ppmv)
6/7/2019	Kuhns-1	1.5 ± 1.5
6/7/2019	Dearmitt-1	1.5 ± 1.5
6/7/2019	Hutchinson-1	1.5 ± 1.5
6/7/2019	Mamont-1	6.0 ± 1.5
7/29/2019	Mamont-1	1.5 ± 1.5
6/7/2019	bkg	1.5 ± 1.5

ii. Example walking survey results

The results for the walking survey for Methane at the Mamont pad using the Aeroqual hand-held sensor are shown in figure 6. The pathway walked at the Mamont pad is shown in figure 5. The Aeroqual detector has a minimum detectable level of 10 ppm, which is approximately 5x background. As shown in the figure, the sensor reading was about 5-to-6 ppm throughout the entire walked path. Very similar results, meaning readings between 5 and 7 ppm CH_4, below the minimum detectable methane concentration for the Aeroqual

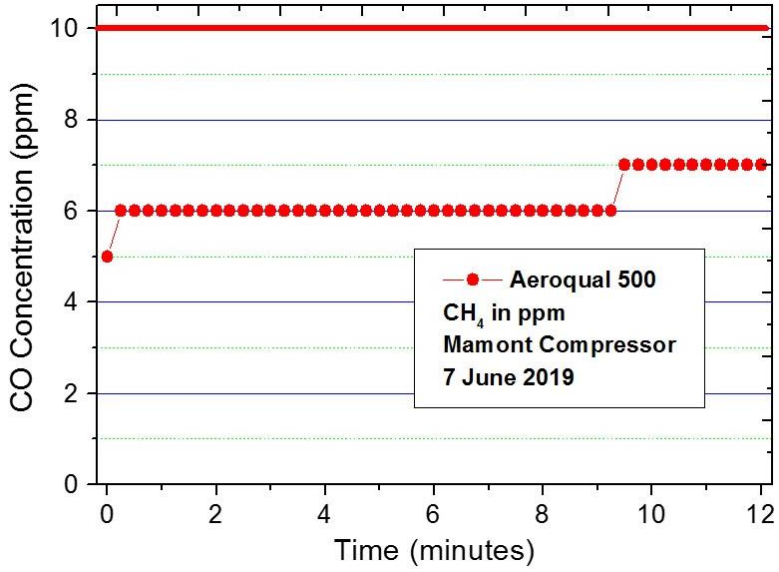

Figure 6. Aeroqual hand-held monitor readings for the walking survey about the DeArmitt pad on 7 February 2019. The readings show no detected methane concentration above the minimum detectable level of the sensor which is 10 ppm.

instrument, were obtained for the walked paths at the Kuhns, Hutchinson and Mamont pads.

Note that the 7 June results of the air sampling at the Mamont pad (shown in table 1) and the Aeroqual hand-held results (shown in Figure 6) both show a concentration near 6.0 ppm. This is purely coincidental. The 6.0 ± 1.5 ppm results in Table 1 are significantly above the minimum detectable concentration of the FTIR instrument. The readings shown in Figure 6 only indicate a CH_4 concentration below the minimum detectable concentration of 10 ppm for the Aeroqual instrument. The specific concentration as measured by the Aeroqual detector are not significant, or comparable to any other instrument, until the Aeroqual readings are above 10 ppm.

B. Results of Air Quality Measurements at the Mamont compressor

i. CO logger data results

Five CO data loggers were placed at the Mamont compressor site on 23 February and replaced with three software-reset data loggers with new batteries on 7 June. These data loggers in turn were replaced with three software-reset data loggers with new batteries on 29 July. Data downloaded from these loggers indicates that the compressor was in a "pass-through" mode. That is, the data loggers at positions P7 and P1 showed only occasional non-zero readings. An example is shown in figure 7 below.

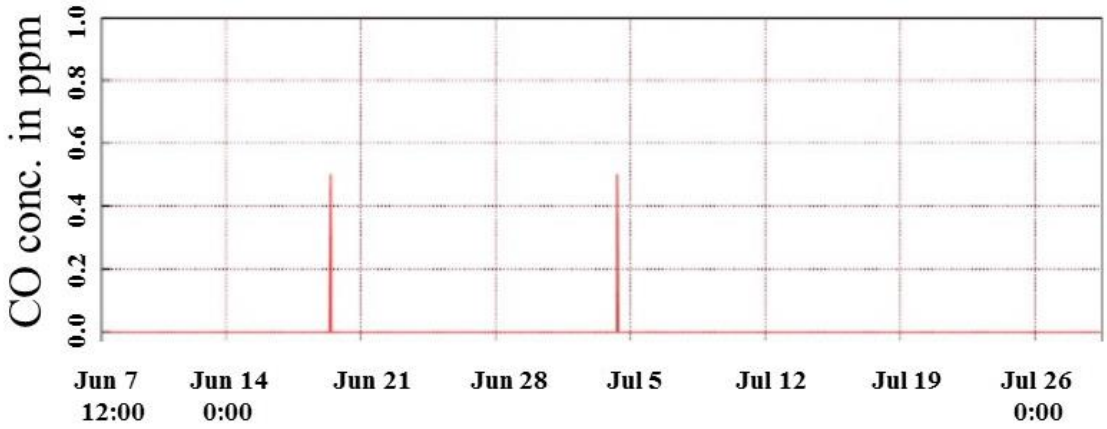

Figure 7. Carbon Monoxide concentration from data logger IUP #12 recorded at position P7 at the Mamont Compressor between noon on 7 June and 29 July.

Between 7 June and 29 July, only two non-zero readings of 0.5 ppm were recorded for this logger. 0.5 ppm is the smallest possible signal output from the CO data loggers. A similar result for logger IUP # 13 at position P1 was recorded. Both the IUP #12 and IUP #13 CO loggers were tested after extraction from the compressor site using a "smoke test" to verify that they were functioning properly (and they are). In contrast, the data logger at the P3 position is in front of the separator. The separator removes liquids, particles and other impurities from the natural gas before it is compressed for insertion into the distribution pipeline. Data from logger IUP #15 is shown in figure 8.

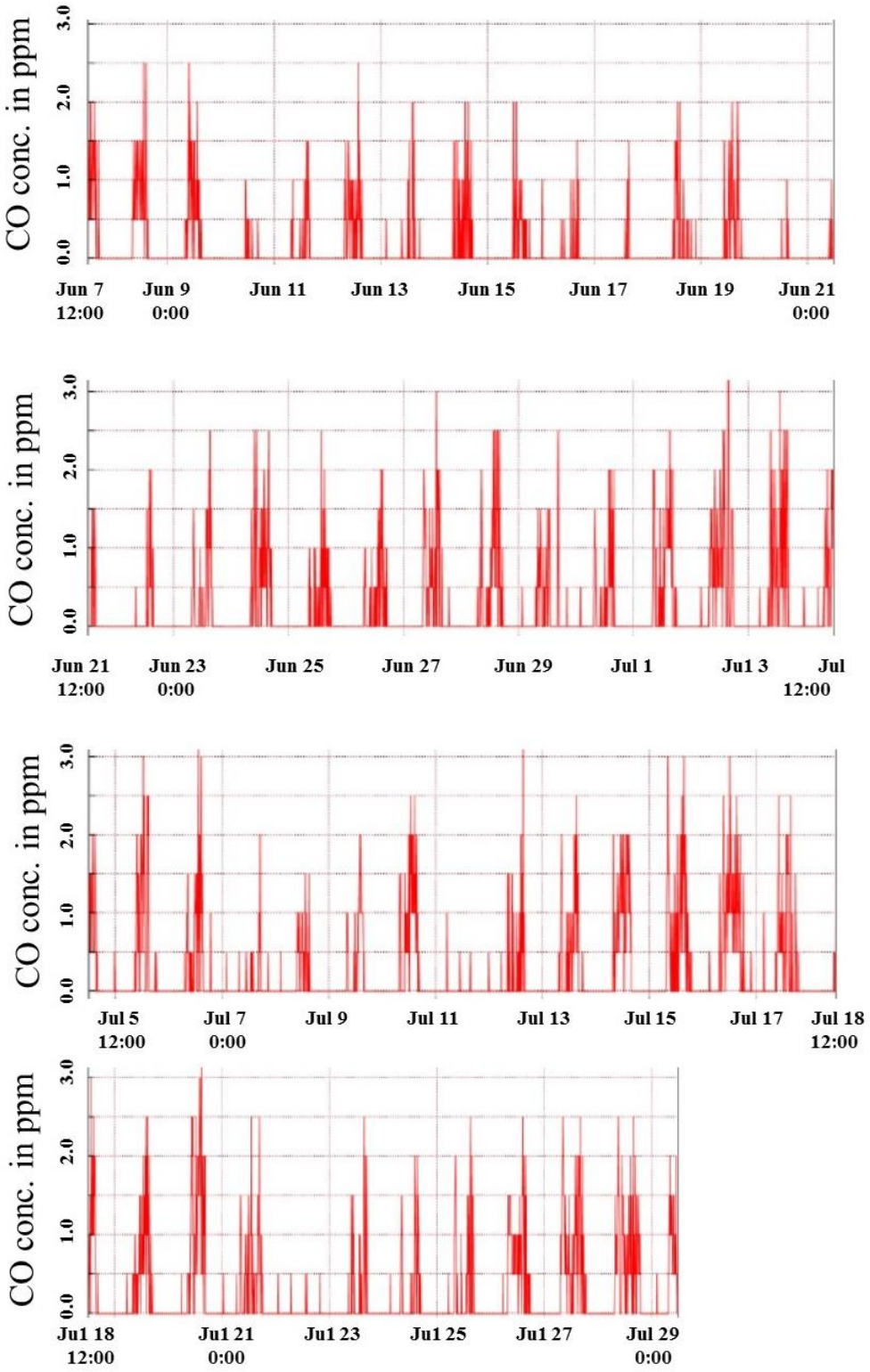

Figure 8. Carbon Monoxide concentration from data logger IUP #15 recorded at position P3 at the Mamont Compressor between 7 June and 19 July.

The data in figure 8 clearly shows an on-off combustion engine cycle. This suggests that the separator was utilized to separate liquids, particles and impurities from the natural gas, but gas compression (which would have been observed by the CO data loggers at positions P7 and P1) before insertion into the distribution pipeline was not performed.

Since the Q3 quarter of this contract, a temperature, relative humidity and dew point (T-RH) sensor is placed a the Mamont compressor site at the P7 position. The purpose of this sensor is to keep track of the temperature and humidity record and correlate that record, if possible, to any data logger failures. Additionally, the temperature data serves to help determine when the data loggers should be removed from the site in the fall (the Q2 quarter of the 2019-2020 contract). In figure 9, the T-RH data from IUP T-RH #2 is plotted between 15 July and 29 July. The data shows typical July temperatures and humidity. The lowest overnight temperature recorded over this period was 11.5°C (53°F) on 24 July.

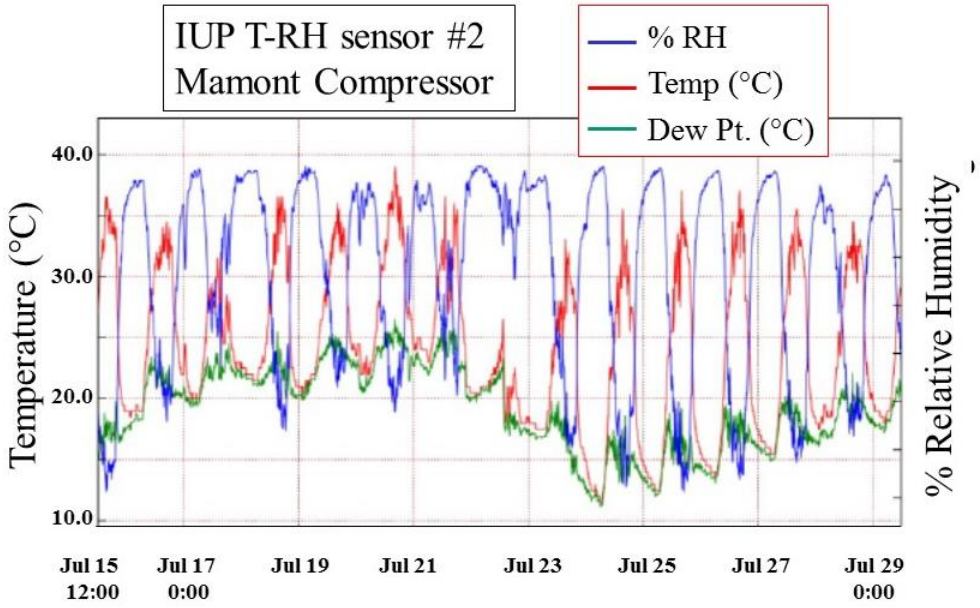

Figure 9. Temperature, Relative Humidity and Dew Point data logger results from the P7 position at the Mamont compressor station between 15 and 29 July.

ii. Aeroqual handheld data

The Aeroqual handheld, when switching sensor heads, can detect gaseous concentrations of CO, SO_2, NO_2, CH_4, NH_3 and CH_20 at 0.005 to 1.0 ppm sensitivities. The handheld sensor has the additional advantage of real-time and mobile measurements. It is useful for gauging the concentration of the other compressor gases in proportion to the CO concentration. Ten-minute surveys for each of the compressor gases were taken on 7 June 2019. As shown in the data of section IV.B.i, the compressor was not in operation at the time of the surveys. The results are summarized in Table 2 below. No results above the minimum detectable levels for CO, SO_2, NO_2, CH_4, NH_3, and CH_2O were observed.

Table 2. Summary of results of compressor gas surveys at the Mamont compressor taken on 7 June using the Aeroqual handheld detector and different sensor heads.

Gas	Measured concentration (ppm)	minimum detectable level (ppm)
CO	2.80	0.05
SO_2	0.18	0.04
NO_2	0.000	0.005
CH_4	5	10
NH_3	0.0	0.2
CH_2O	0.00	0.01

V. Summary of Results

The methane content measurements summarized in Table 1 for sample taken on 7 June indicate methane levels that vary from 0.0 to 3.0 ppmv at the Kuhns, DeArmitt and Hutchinson pads. These levels are totally consistent with the background atmospheric methane concentration of approximately 1.8-1.9 ppmv. The estimated uncertainty of the concentrations of ±1.5 ppmv in table 1 are due to normal fluctuations in background and the accuracy of the FTIR method used.

The methane content measurement at the Mamont pad on 7 June indicated a methane concentration of 6.0 ± 1.5 ppm. Equivalently, this suggests that the additional methane concentration from the Mamont well head was 3x background. When the bag sample was taken at the Mamont site, there was a distinct “hissing” heard from the well head. Also, a slight breeze from the north-east directed any emissions from the well heads directly towards the location of the air sample. We returned to this well head on 29 July and took another air sample at the same point shown in figure 5. We heard hissing from the well head similar to the 7 June sample record. On 29 July the breezes were variable in direction and we recorded no discernible concentration above background.

The Q4 Kuhns methane result indicates the first measurement distinguishable above background in 48 measurements at the KDHM pads over three years.

At this time the CO logger data from section IV.B. of the report indicates that the compressor is in a pass-through mode; no CO gases were detected from the sensors at the P7 and P1 positions. The sensor at the P3 position, in front of the separator detected turn-on turn-off CO emissions typical of a combustion engine exhaust.

VI. Contract Status and Notes

Previous results from the Temperature-Relative Humidity sensors indicate that the overnight temperature needs to be watched starting in the early autumn. The CO data loggers should be removed from their positions around the Mamont Compressor when the overnight temperatures dip below -10°C. It is not clear at this time if CO data logging will be possible during the 2nd quarter of the 2019 2010 contract (1 November 2019 through 31 January 2020). However, it does look like CO data logging can occur through the majority of the first, third and fourth quarters of the contract.

Two new sensing heads are being purchased for the Aeroqual hand-held sensor. A volatile-organic-compound (VOC) sensor and a 2.5/10 micron particulate matter sensor are being purchased. The VOC sensor will allow measurement of total volatile organics, such as Benzene, Ethylbenzene, n-Hexane, Toluene, Xlenes and 2,2,4 Trimethylpentane, although not with chemical specificity. The intended procedure is to always bring the gas sampler when monitoring the exhaust of the compressor station with the Aeroqual hand-held held sensor. If the VOC indicates concentrations above the minimum detectable concentration, an air sample will be taken and analyzed with FTIR absorption in the laboratory.