MAWC – IUP Service Contract
Air Quality Monitoring at Beaver Run Reservoir
Quarterly Report #3

Covering the Period from 2/1/2019 – 4/30/2019

Submitted by

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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 third quarter of the contract. Field samples, a background sample and hand-held sensor readings were taken directly off the four BRR fracking pad sites on 7 February 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 and Carbon Monoxide (CO) data loggers were placed at this site on 7 February. These data loggers were removed from the Compressor site on 10 February and replaced with new CO data loggers on 23 February that were housed in new post-and-plastic-dome housings to protect the data loggers from direct exposure to the elements, but allow unimpeded access to the air flow in front of the detector sensor elements. Field sampling notes and the results of logged data and laboratory analyses of the field samples are reported in section III.

III. Field Report of Air Quality Sampling

Figure 1 (next page) 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, air and

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

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 for 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.

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 for CH_4. The aerial image is from Google Maps.

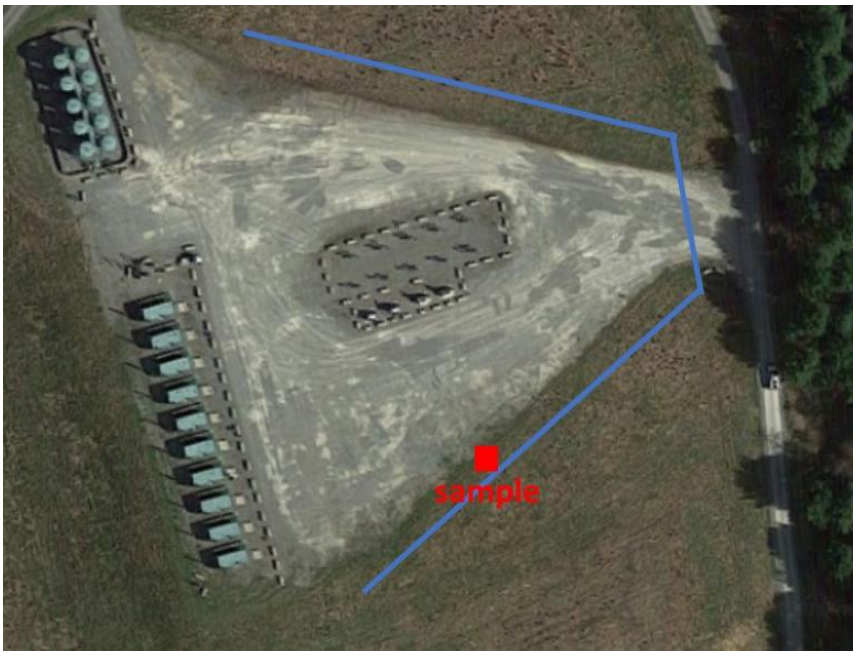

Figure 4. Aerial image of the Hutchinson pad. The red square marks the location of the air sample taken. The blue line shows the pathway for the walking survey for CH_4. The aerial image is from Google Maps.

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 for CH_4. The aerial image is from Google Maps.

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 for 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 for 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 for 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 for CH_4 is shown as a blue line.

The results of the field measurements are summarized in table 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 sampling near the Kuhns pad. The sample locations at each pad are shown as the red squares in Figures 2 through 5. Each bag sample was analysed using Fourier-Transform Infrared Spectroscopy for methane presence. 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 methane content of all samples was determined to be indistinguishable from 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)
2/7/2019	Kuhns-1	1.5 ± 1.5
2/7/2019	Dearmitt-1	1.5 ± 1.5
2/7/2019	Hutchinson-1	1.5 ± 1.5
2/7/2019	Mamont-1	1.5 ± 1.5
2/7/2019	bkg	1.5 ± 1.5

ii. Example walking survey results

The results for the walking survey for Methane at the DeArmitt pad is shown in Figure 6. The pathway walked at the DeArmitt pad is shown in Figure 3. 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 5ppm throughout the entire walked path. Very similar results, meaning readings between 5 and 7 ppm CH_4, below the minimum detectable methane concentration, were obtained for the walked paths at the Kuhns, Hutchinson and Mamont-South pads.

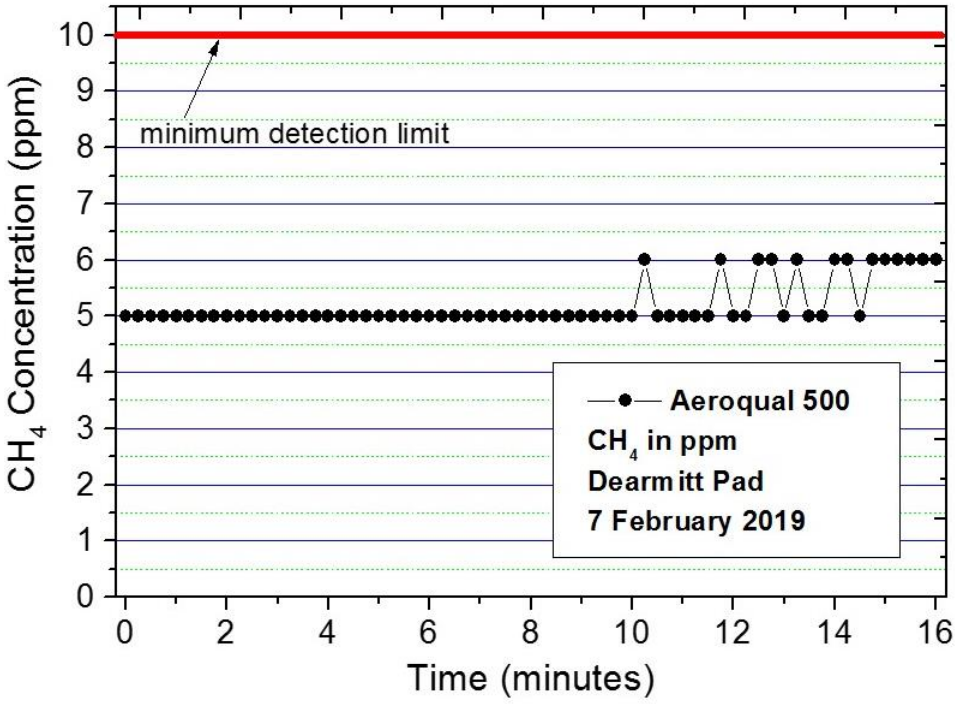

Figure 6. Aeroqual hand-held monitor readings for the walking survey about the DeArmitt pad on 7 February 2019. The readings show no detected methane concentration above the minimum detectable level of the sensor which is 10 ppm.

B. Results of Air Quality Measurements at the Mamont compressor

i. CO logger data results

Six CO data loggers were placed at the Mamont compressor site between on 7 February and removed on 10 February 2019. Data downloaded from these data loggers indicated that each logger did not work up to previous standards. A representative data plot from one of the loggers is shown in Figure 7. Only occasional single non-zero readings are recorded. In contrast, we monitored the CO concentration in a walking survey around the Mamont compressor using the Aeroqual handheld CO sensor on 10 February. The walking survey started at position P7 in Figure 1 and went to P1 and then P3. The data from this walking

survey is plotted in Figure 8. The data plotted in Figure 8 indicates variable but measurable CO concentration that are well within the operating range of the CO data loggers.

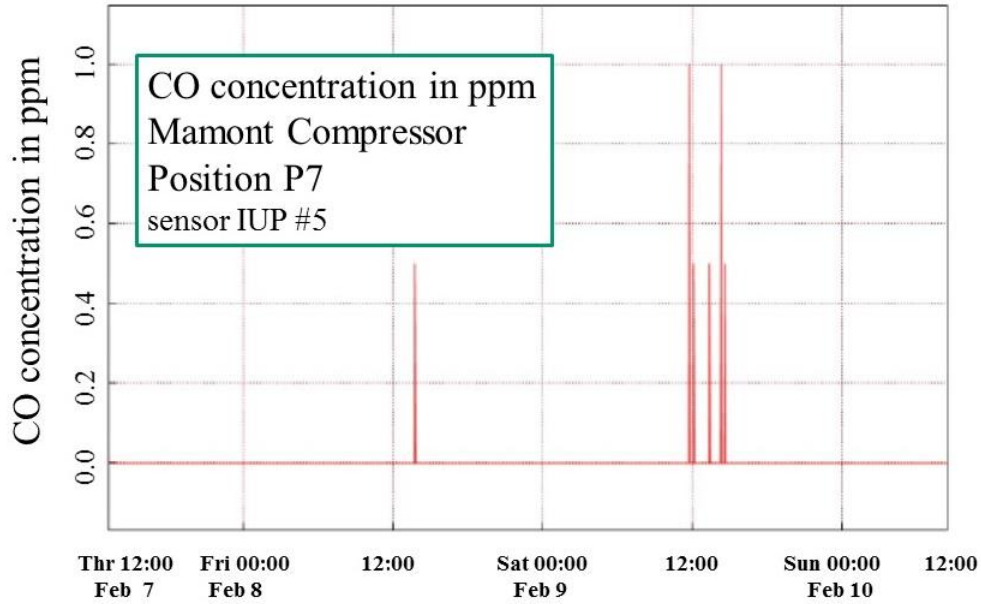

Figure 7. Carbon Monoxide concentration from data logger IUP #5 recorded at position P7 at the Mamont Compressor between 7 and 10 February.

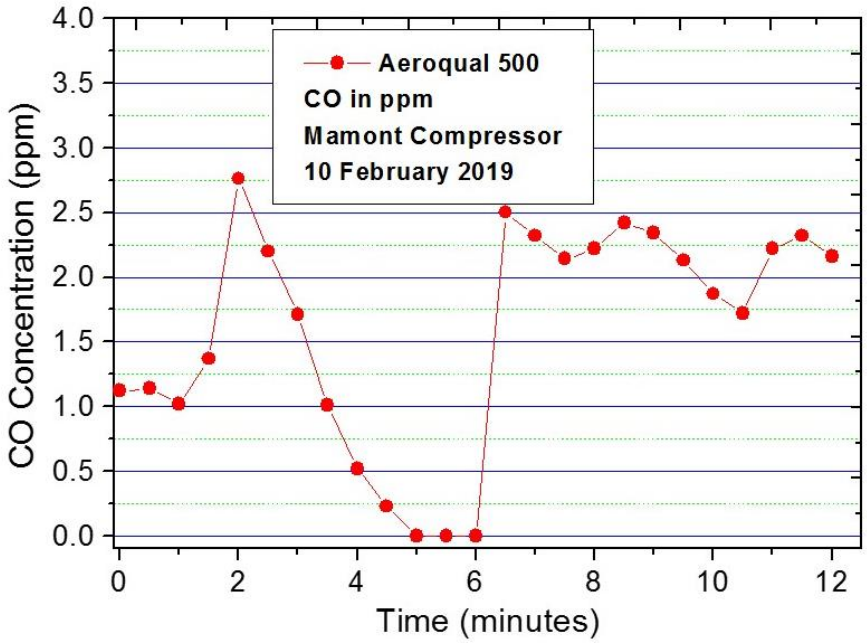

Figure 8. Carbon Monoxide concentration from recorded with the Aeroqual handheld sensor at the Mamont compressor on 10 February following the walking path from position P7 to P1 to P3 shown in Figure 1.

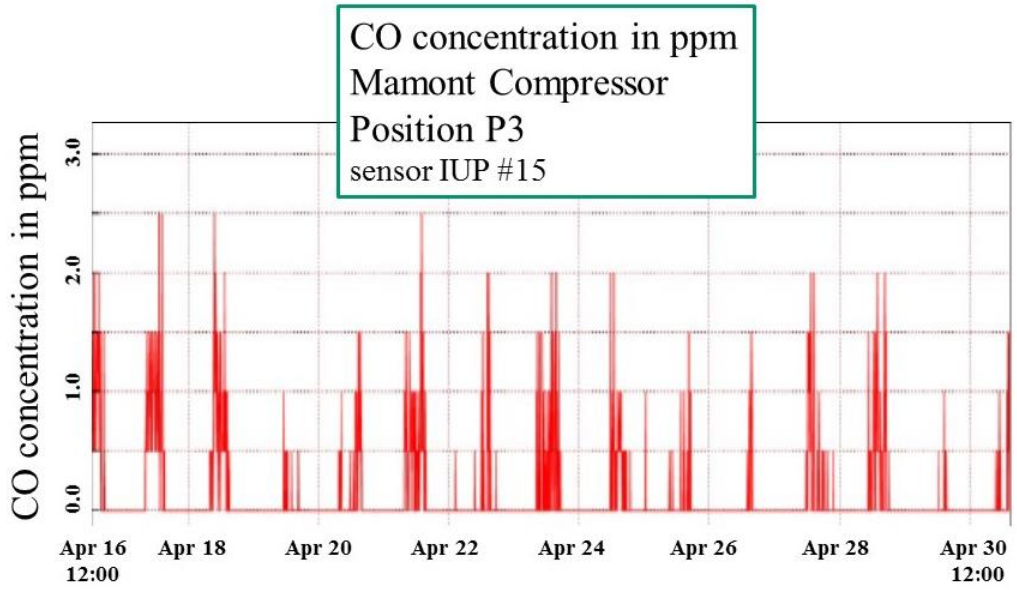

Figure 9. Carbon Monoxide concentration from recorded with the Aeroqual handheld sensor at the Mamont compressor on 10 February following the walking path from position P7 to P1 to P3 shown in Figure 1.

On 23 February three new CO data loggers were placed at positions P7, P1 and P2. Additionally, the data loggers were housed differently. The loggers were mounted on PVC tubing with a plastic dome on the top. The purpose of the dome is a protect the loggers from the elements, but still allow direct access to the air in front of the loggers' sensor. Additionally, a temperature and relative humidity (T-RH) data logger was placed within the dome with the CO data logger at the P7 position in Figure 1. If CO data loggers are failing due to some combination of temperature and moisture, then the T-RH loggers could help determine under what conditions that is happening.

So far, the results are encouraging. In figure 9, the data from the new CO data logger placed at position P3 is plotted. The data show the turn-on and turn-off combustion exhaust cycle from the compressor. However, this signature could also be from the separator in front of the P3 position in Figure 1. In Figure 10, the temperature and relative humidity data from the T-RH sensor is plotted. Note that in the top plot in Figure 9, the temperature low was -13.5°C in the early morning of 5 March. This temperature is 3.5 Celsius below the minimum rated temperature of the CO data loggers.

This offers a tentative explanation for why the data loggers failed in the first quarter. It seems quite possible that extraction of the loggers on 13 January waited too long, the temperature got too low, and the loggers failed because they were operated outside their stated operating range. The bottom plot in Figure 10 shows the R-RH data over the same date range as CO logger data of Figure 9.

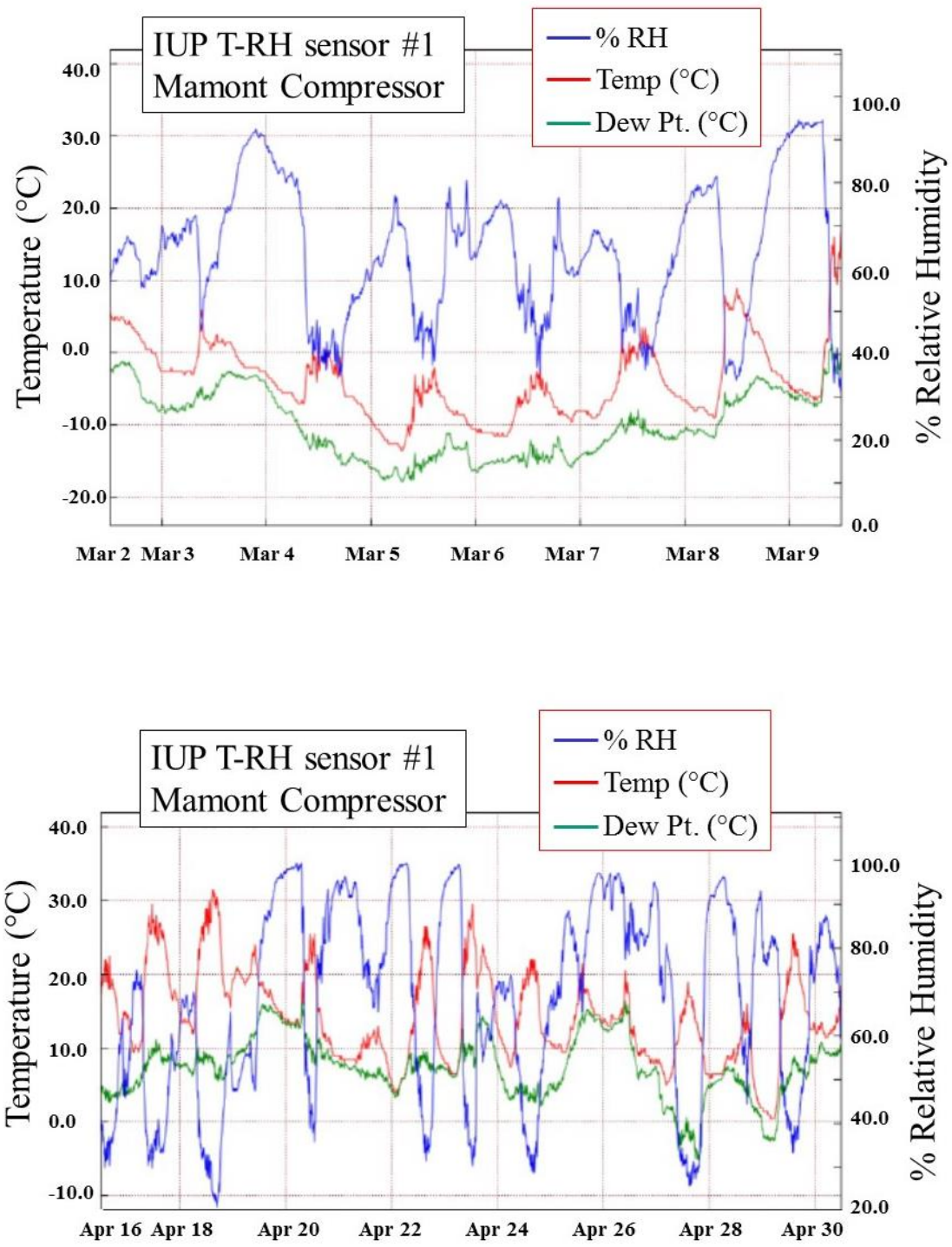

Figure10. Temperature, Relative Humidity and Dew Point data at the Mamont Compressor Station from March 2nd through 9th (top) and April 16th through April 30th (bottom).

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 23 February 2019. The compressor was not in operation at the time of the surveys. The results were undoubtably influenced by several nearby flares that were burning off excess natural gas pressure in the vicinity of the Shaw fracking pad. The results are summarized in Table 2 below.

Table 2. Summary of results of compressor gas surveys at the Mamont compressor taken on 23 February 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 indicate methane levels that vary from 0.0 to 3.0 ppmv at the KDHM pads. These levels are totally consistent with the background atmospheric methane level 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 Aeroqual handheld sensor data shown in Figure 6 also indicates no methane was detected above the minimum detectable concentration for that sensor along the walked pathway at the DeArmitt pad shown in Figure 3.

The compressor gas concentration results summarized in Table 2 show that carbon monoxide and sulfur dioxide were detected. Both of these gases are products of combustion of natural gas and were present due to the nearly flares buring off excess natural gas near the Shaw pad. The date of the survey, February 23rd, was the last day that the flares were operated; the flares were being extinguished and dismantled while the data was being taken. The compressor itself was not operating in a compression-exhaust cycle at the time of the measurements.

The Temperature-Relative Humidity sensor at the Mamont Compressor indicates that overnight temperatures can routinely drop below the minimum operating temperature of the CO data loggers which is -10°C.

VI. Contract Status and Notes

The 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 contract (1 November through 31 January). However, it does look like CO data logging can occur through the majority of the first, third and fourth quarters of the contract.