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June 26, 2017

Air Monitoring Adjacent to the Waste Connections Well Site

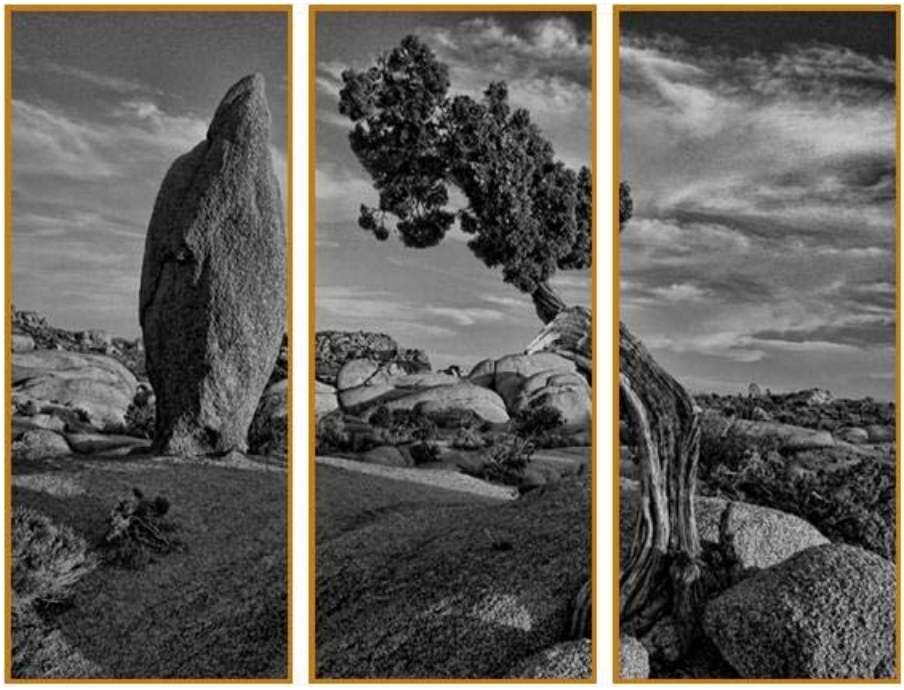
Erie Air Quality Monitoring
Erie, Colorado

Prepared For:

Town of Erie
645 Holbrook Street
Erie, CO 80516

Pinyon Project No.:

1/1769-502.1200



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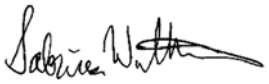

Sabrina M. Williams
Air Quality Specialist

Reviewed by:

Lauren E. Evans
President

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Tables

1. Introduction

The Town of Erie (Town) has contracted with Pinyon Environmental, Inc. (Pinyon), to perform air quality monitoring near the Crestone Peak Resources (Crestone) Waste Connections well site. Pinyon captured 24-hour air samples every five days at the residential sampling location (Sampling Site 2), located to the west of Vista Parkway from April 26 through May 31, 2017. Sampling Site 2 is located approximately 1,250 feet to the southwest of the Waste Connections well site. This location was selected by the Town to evaluate the level of potential exposure that may be experienced by the residents located in closest proximity to the well site. A health screening evaluation of the concentrations of compounds detected in these samples was conducted to identify baseline exposures for citizens in the area. Crestone began drilling operations on April 25, 2017, and has continued activities at the well site throughout this reporting period.

A summary of the data follows:

- Twenty-four of the 67 substances analyzed were detected.
- All substances detected were at concentrations well below levels at which health symptoms are expected to occur.
- Based on the sampling data, there is a very low potential for short- or long-term health effects due to these exposures.
- These conclusions are based on nine samples collected for a short period of time. The samples may not have captured all the substances or amounts of substances in the air during times when residents are experiencing exposures.

These conclusions are based on limited sampling, conducted during a limited investigation. Concentrations of constituents can be highly variable, and detections may be dependent on a variety of environmental conditions (e.g., date, operations, wind bearings, actual emissions from operations). This sampling may therefore not be representative of, or account for, all variables that could be present during all phases of oil and gas operations within the Town.

2. Methodology

2.1 24-hour Summa Canister Air Samples

Pinyon utilized 6-liter Summa canisters to collect the air quality samples. A Summa canister is a spherical stainless steel container that has had the internal surfaces specially passivated using a "Summa" process. The canister is prepared for sampling by evacuating the contents to a vacuum of approximately 29.9 inches of mercury (in Hg). Opening the stainless-steel bellows valve allows the air sample to enter the canister. A 24-hour flow controller was utilized to restrict the flow and allow for collection at the desired flow rate over a period of 24 hours. After a 24-hour sample collection period, the valves were closed and Pinyon returned the canisters to the laboratory for analysis. Summa canister analysis was conducted by ESC Lab Sciences in accordance with EPA method TO-15 (EPA, 1999). EPA method TO-15 (TO-15) is appropriate for use when sampling a subset of 67 Volatile Organic Compounds (VOCs) which constitute the target analyte list. Typical situations involve ambient air testing associated with the potential exposures from emission sources, including oil and gas operations. In this case sampling and analysis of VOCs was performed to evaluate the potential exposures of dispersing source emissions in the surrounding area. Pinyon collected a 24-hour sample on a one in every five-day sampling schedule. In addition to the five-day sampling schedule, Pinyon collected a sample on May 19, 2017, based on an odor complaint in the vicinity of the well site, for a total of nine samples. Table 2-1 shows the sample collection dates.

Table 2-1 April 26 through May 31, 2017, Sample Collection Dates

Sample Start Date	Sample Start Time	Sample End Date	Sample End Time
4/26/2017	6:20 PM	4/27/2017	6:15 PM
5/1/2017	3:20 PM	5/2/2017	3:20 PM
5/7/2017	4:00 PM	5/8/2017	4:00 PM
5/12/2017	4:20 PM	5/13/2017	4:15 PM
5/17/2017	3:15 PM	5/18/2017	3:15 PM
5/19/2017	4:10 PM	5/20/2017	4:05 PM
5/23/2017	3:30 PM	5/24/2017	3:20 PM
5/28/2017	4:35 PM	5/29/2017	4:30 PM
5/31/2017	2:15 PM	6/1/2017	2:15 PM

2.2 Meteorology

Meteorological data is collected by the National Weather Service (NWS) at the Erie Municipal Airport in 20-minute intervals. The NWS data coinciding with the sampling periods were used to evaluate prevailing wind speed and wind direction during collection. Using the NWS data, a wind rose plot for each sampling location corresponding to the sampling period was generated by Pinyon. A wind rose plot is a graphical display of the frequency of wind direction and intensity of wind speed, and can be used to identify whether the sample was collected downwind of the well site, and how wind conditions during the sample collection period may affect sample results. A wind rose plots demonstrates the fraction of the observation period where wind speeds are greater than zero and does not illustrate to what extent calm winds are observed during the sampling period. Wind rose plots were used to evaluate the frequency at which Sample Site 2 was downwind of the well site and to assess whether periods of high winds were observed. Calm winds and low wind speeds are ideal for the collection of ambient air samples, as under this condition substances will not rapidly disperse from the sampling location. During periods of recorded high wind speeds or periods when the sampling location is not downwind of the well, site the sample may underestimate ambient concentrations under other meteorological conditions.

2.3 Screening Level Health Evaluation

A screening level health evaluation was performed by comparing the concentrations of detectable substances in the air sample with short-term and long-term health limit levels established by federal and state agencies for each detected substance. The health limit levels represent the concentrations at or below which no appreciable health effects are likely to occur to individuals (including sensitive individuals) for a certain exposure period. Concentrations at or below this level can be considered a "safe" level of exposure. The sampling completed for this investigation represent a "snapshot" of the air concentrations in the area during the time of collection, and may not be representative of the potential exposures over a longer period. A generally accepted method for conducting this type of health evaluation is to conduct a two-step screening process:

1. Compare the results of the short-term sample with long-term health screening levels.
   - If the substance result is below the long-term health screening level, it is very unlikely that short-term exposure will result in short or long-term negative health consequences. A short-term exposure is considered exposure of 24 hours a day, for up to one year, to that pollutant.
   - If the sample result is above the long-term health screening level, then move on the step two. A long-term exposure is considered a minimum of one year of exposure.

2. Compare the results of the short-term sample (substance identified in step one) with short-term health screening levels.
   - If the sample result is below the short-term health screening level, it is unlikely that short-term exposure to this substance will result in negative health consequences.

Pinyon utilized health screening levels established by the following agencies in the evaluation:

- Environmental Protection Administration Integrated Risk Information System (IRIS)
- ATSDR MRL (US Agency for Toxic Substances and Disease Registry Minimal Risk Level)
- TCEQ AMCV (Texas Commission on Environmental Quality Air Monitoring Comparison Values)

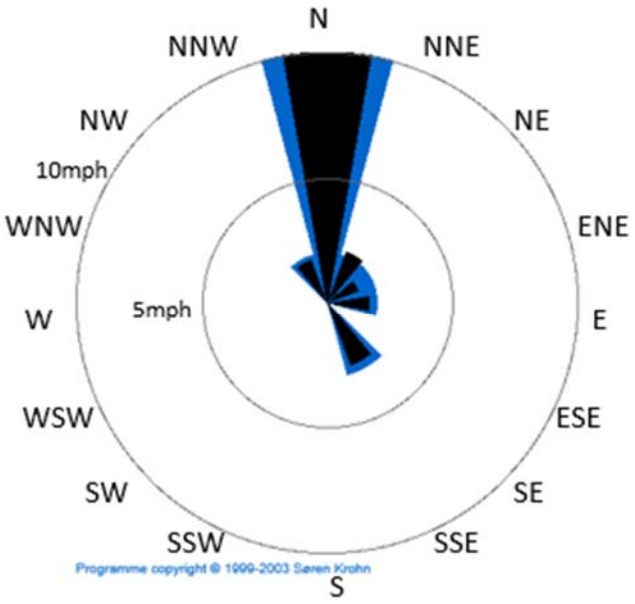
2.4 Trends in Detected Substances

If a substance was detected above the reporting detection limit (RDL) in one or more samples, Pinyon performed statistical analysis of the data to evaluate trends in concentrations over time. If the substance was not detected by the lab on a specific sampling date, for the statistical analysis Pinyon used a concentration of one-half of the RDL in the graphical display. This approach is supported by the Environmental Protection Agency (EPA) for risk assessments and recognizes that values between the RDL and zero could be present, and that the average value could be as high as half of the RDL (EPA, 1991). Pinyon calculated the Pearson correlation coefficient (R-value) for each detected substance and then determined the p-value to assess whether the trend was statistically significant. The R-value is a statistical variable that is commonly utilized to assess trends in concentrations over time (Davis, 2002). To assess the level of confidence in the calculated R-value, a p-value is calculated. The p-value is based on the magnitude of the R-value and the total number of samples collected in the sampling periods. A p-value of less than or equal to 0.05 means that there is a 95% confidence level that the trend is statistically significant.

3. Meteorology

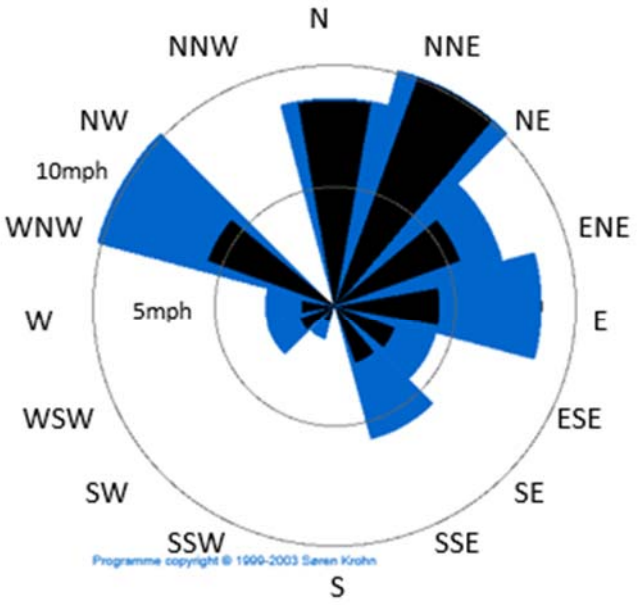
Figures 3-1 through 3-9 show the wind roses corresponding to the TO-15 sample collection periods as measured in 20-minute intervals from the Erie Municipal Airport.

Figure 3-1 Wind Rose for April 26, 2017, at 6:20 PM though April 27, 2017, at 6:15 PM



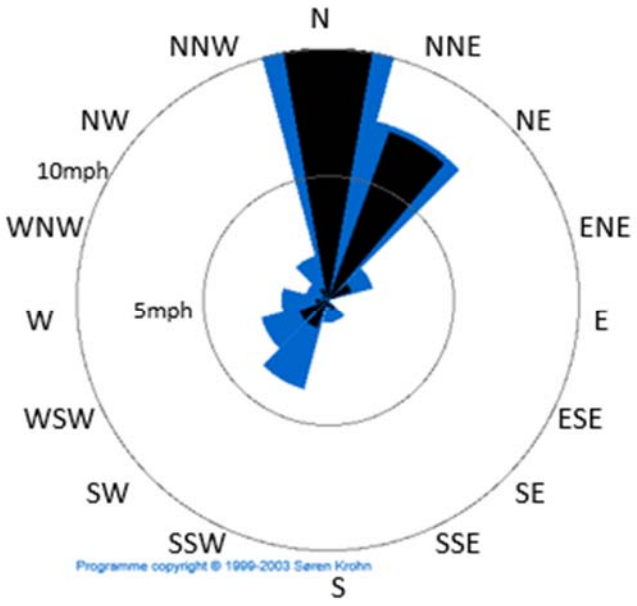
Weather conditions observed during the April 26 through April 27, 2017, sample collection period were often windy with wind speeds varying from 0 to 23 miles per hour (mph). The prevailing wind direction was to the north. During these periods the sampling location was not downwind of the well site; however, calm winds were recorded for 30.6% of the sampling period. Therefore, the sample collected from April 26 through April 27, 2017, is likely to be adequate in representing ambient conditions at Sample Site 2.

Figure 3-2 Wind Rose for May 2, 2017, at 3:20 PM through May 3, 2017, at 3:20 PM



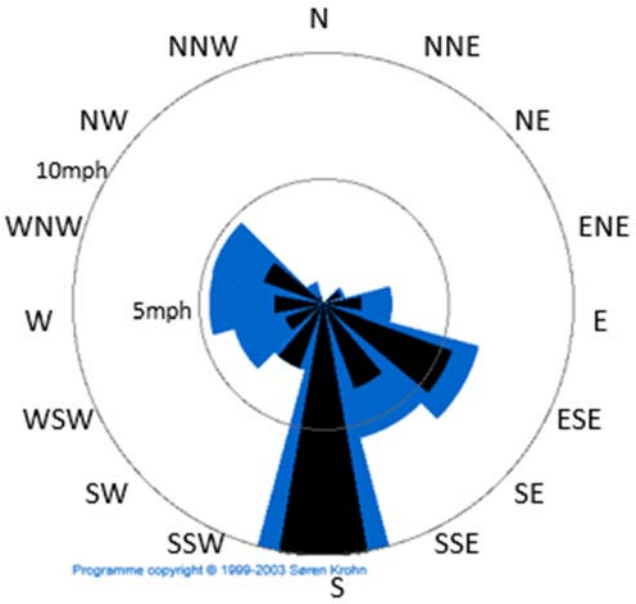
Weather conditions observed during the May 2 through May 3, 2017, sample collection period were often windy with wind speeds varying from 0 to 20.7 mph. The prevailing wind directions were to the north, north northeast and northeast , and placed the sampling location upwind of the well site. Calm winds were recorded for 17.0% of the sampling period. Due a prevailing wind direction upwind of the sampling location, the sample collected from May 2 through May 3, 2017, may underestimate ambient concentrations under other meteorological conditions.

Figure 3-3 Wind Rose for May 7, 2017, at 4:00 PM through May 8, 2017, at 4:00 PM



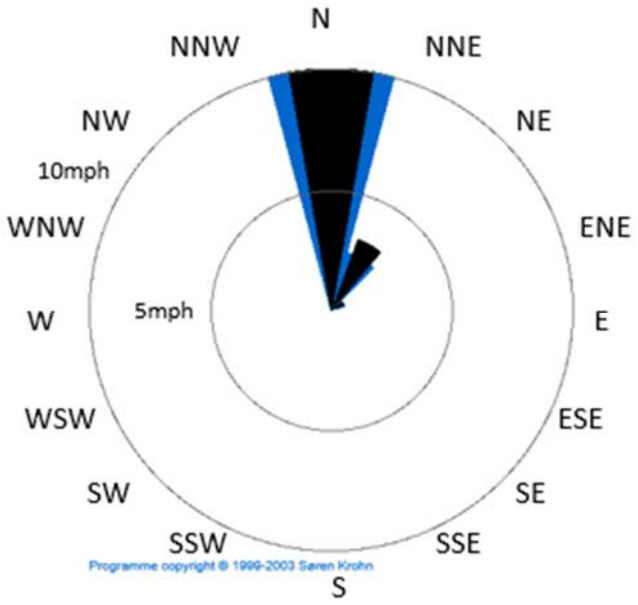
Weather conditions observed during the May 7 through May 8, 2017, sample collection period had a low average wind speed of 3.5 mph with occasional gusts up to 18 mph. The prevailing wind directions were to the north and northeast, which did not place the sampling location downwind of the well site. Calm winds were recorded for 14.0% of the sampling period. Although the sampling location was generally not downwind of the well site, during the majority of the sample collection period wind speeds were low, which is a favorable sampling condition. Therefore, the sample collected from May 7 through May 8, 2017, is likely to be adequate in representing of ambient conditions.

Figure 3-4 Wind Rose for May 12, 2017, at 4:20 PM through May 13, 2017, at 4:15 PM



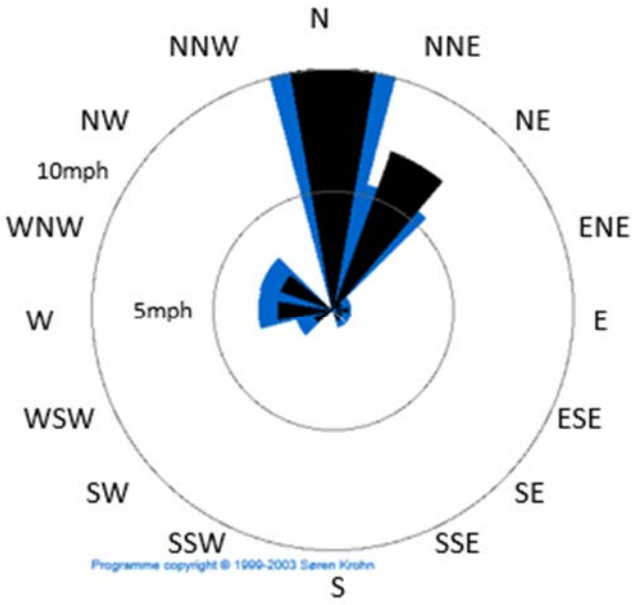
Weather conditions observed during the May 12 through May 13, 2017, sample collection period had a low average wind speed of 4.6 mph with occasional gusts up to 15 mph. The prevailing wind directions were to the south, south southeast and southeast, that did not place sampling location downwind of the well site. Calm winds were recorded for 29.6% of the sampling period. The sample collected on from May 12 through May 13, 2017, is likely to be representative of ambient conditions due to a high frequency of calm winds and low wind speeds.

Figure 3-5 Wind Rose for May 17, 2017, at 3:15 PM through May 18, 2017, at 3:15 PM



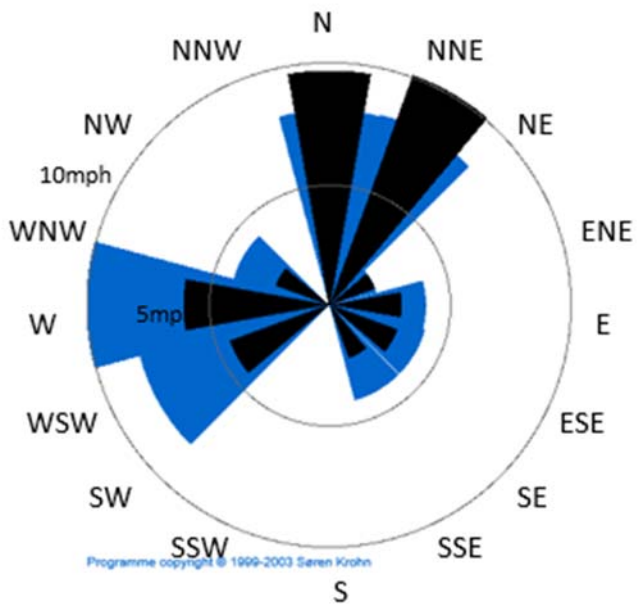
Weather conditions observed during the May 17 through May 18, 2017, sample collection period were windy with speeds varying from 4.6 to 24.2 mph and no periods of calm winds. The prevailing wind direction was to the north, which did not place the sampling location downwind of the well site. Prolonged periods of high winds with a can cause substances to rapidly disperse from the sampling location. Due to high winds and a prevailing wind direction upwind of the sampling location, the sample collected from May 17 through May 18, 2017, may underestimate ambient concentrations under other meteorological conditions.

Figure 3-6 Wind Rose for May 19, 2017, at 4:10 PM through May 20, 2017, at 4:05 PM



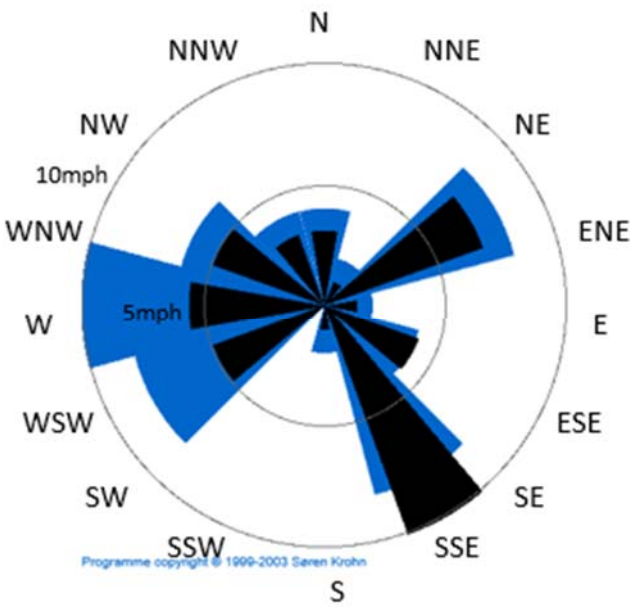
Weather conditions observed during the May 19 through May 20, 2017, sample collection period had a low average wind speed of 3.5 mph with occasional gusts up to 12.7 mph. The prevailing wind directions were to the north, and placed the sampling location upwind of the well site. Calm winds were recorded for 45.8% of the sampling period. Therefore, the sample collected from May 19 through May 20, 2017, is likely to be representative of ambient conditions.

Figure 3-7 Wind Rose for May 23, 2017, at 3:30 PM through May 24, 2017, at 3:20 PM



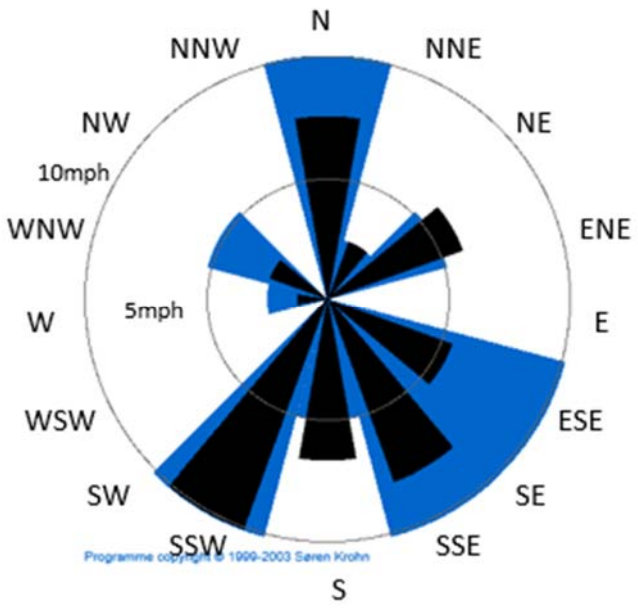
Weather conditions observed during the May 23 through May 24, 2017, sample collection period had a low average wind speed of 4.8 mph with occasional gusts up to 13.8 mph. The prevailing wind directions were to the west and southwest that placed the sampling location downwind of the well site. Calm winds were recorded for 47.2% of the sampling period. Therefore, the sample collected from May 23 through May 24, 2017, is likely to be representative of ambient conditions.

Figure 3-8 Wind Rose for May 28, 2017, at 4:35 PM through May 29, 2017, at 4:30 PM



Weather conditions observed during the May 28 through May 29, 2017, sample collection period had a low average wind speed of 4.6 mph with occasional gusts up to 11.5 mph. The prevailing wind directions were to the west and west southwest, and placed the sampling location downwind of the well site. Calm winds were recorded for 42.1% of the sampling period. Therefore, the sample collected from May 28 through May 29, 2017, is likely to be representative of ambient conditions.

Figure 3-9 Wind Rose for May 31, 2017, at 2:15 PM through June 1, 2017, at 2:15 PM



Weather conditions observed during the May 31 through June 1, 2017, sample collection period had a low average wind speed of 3.5 mph with occasional gusts up to 12.7 mph. The prevailing wind directions were to the southeast and south-southeast, which did not place the sampling location downwind of the well site. Calm winds were recorded for 50.8% of the sampling period. Therefore, the sample collected from May 31 through June 1, 2017, is likely to be representative of ambient conditions.

4. Air Sampling Results

Twenty-four of the 67 compounds analyzed by the lab were detected in the nine air samples collected by Pinyon at the Waste Connection pad. Ethanol, Propene and 2-Propanol were not evaluated in the health assessment since they are of very low health risk and, therefore, do not have health screening levels. The concentrations of all detected substances were below short and long-term health screening levels (Tables 4-1 and 4-2), with the exception of tetrachloroethylene, which was detected at a concentration of 11.9 parts per billion (ppb) on April 26, 2017. This concentration exceeded the long-term health screening level of 10 ppb. As described in Section 2.3, Pinyon then compared the detected value of 11.9 ppb to the short-term health screening level of 1,000 ppb, and concluded that it is unlikely that a short-term exposure to this substance will result in negative health consequences. Tetrachloroethylene was not detected during any of the sample collection periods after April 26, 2017, which indicated that this level of exposure was an isolated event, and that this compound does not pose a long-term health risk.

Table 4-1 Air Sampling Results from April 15 through May 17, 2017

Analyte	Sample Concentration (ppb)							Health Screening Level (ppb)	
	4/15/2017	4/21/2017	4/26/2017	5/1/2017	5/7/2017	5/12/2017	5/17/2017	Short Term	Long Term
Acetone	6.01	1.44	2.07	2.31	4.25	8.90	3.19	26,000[A]	13,000[A]
Benzene	ND	ND	ND	ND	ND	ND	ND	9,000[I]	9[I]
Carbon disulfide	ND	ND	ND	ND	ND	9.11	ND	220[I]	300[A]
Chloromethane	0.589	0.490	0.554	0.630	0.687	0.464	0.547	200[A]	50[A]
Cyclohexane	ND	ND	ND	ND	ND	ND	ND	1,000[I]	1,743[I]
cis-1,2-Dichloroethane	ND	ND	0.236	ND	ND	ND	ND	40[T]	1[T]
1,4-Dioxane	ND	ND	ND	ND	ND	0.440	ND	2000[A]	20[A]
Ethanol	2.60	1.04	1.97	3.84	7.60	6.35	4.1	NA	NA
Ethylbenzene	ND	ND	ND	ND	ND	ND	ND	33,000[I]	2301[I]
4-Ethyltoluene	ND	ND	ND	ND	ND	ND	0.513	250[T]	25[T]
Trichlorofluoromethane	0.270	0.227	0.272	0.260	0.254	2.38	0.226	10,000[T]	1,000[T]
Dichlorodifluoromethane	0.387	0.283	0.404	0.418	0.324	0.403	0.334	10,000[T]	1,000[T]
n-Hexane	0.351	ND	0.515	0.289	0.540	0.266	0.228	1,800[I]	198[I]
Methylene Chloride	ND	ND	ND	ND	ND	ND	ND	600[A]	100[T]
2-Butanone (MEK)	ND	ND	ND	ND	ND	1.68	ND	200,000[A]	200,000[A]
2-Propanol	ND	ND	ND	ND	ND	1.44	ND	NA	NA
Propene	ND	ND	ND	1.38	ND	ND	ND	NA	NA
Tetrachloroethylene	0.406	ND	11.9	ND	ND	ND	ND	1,000[T]	10[T]
Tetrahydrofuran	ND	ND	0.265	ND	ND	0.396	ND	680[I]	680[I]
Toluene	1.55	ND	0.237	0.511	ND	0.335	0.532	2,000[A]	1,327[I]
Trichloroethylene	ND	ND	0.412	ND	ND	ND	ND	1,000[T]	10[T]
1,2,4-Trimethylbenzene	ND	ND	ND	ND	ND	ND	0.530	250[T]	25[T]
m&p-Xylene	ND	ND	ND	ND	ND	ND	0.969	2,000[A]	23[I]
o-Xylene	ND	ND	ND	ND	ND	ND	0.440	2,000[A]	23[I]

I IRIS (Environmental Protection Agency Integrated Risk Information System), A ATDSR MRL (US Agency for Toxic Substances and Disease Registry Minimal Risk Level)
T TCEQ AMCV (Texas Commission on Environmental Quality Air Monitoring Comparison Value)
NA no health value available
ND substance not detected
ppb parts per billion

Table 4-2 Air Sampling Results May 19 through May 31, 2017

Analyte	Sample Concentration (ppb)				Health Screening Level (ppb)	
	5/19/2017	5/23/2017	5/28/2017	5/31/2017	Short Term	Long Term
Acetone	2.20	3.62	2.45	3.74	26,000[A]	13,000[A]
Benzene	ND	ND	ND	0.231	9,000[I]	9[I]
Chloromethane	0.427	0.485	0.437	0.623	200[A]	50[A]
Cyclohexane	ND	0.599	ND	0.330	1,000[I]	1,743[I]
cis-1,2-Dichloroethane	ND	ND	0.207	ND	40[T]	1[T]
Ethanol	1.25	8.18	4.29	4.41	NA	NA
Trichlorofluoromethane	0.206	0.256	0.204	0.258	10,000[T]	1,000[T]
Dichlorodifluoromethane	0.259	0.300	0.369	0.341	10,000[T]	1,000[T]
Heptane	ND	ND	ND	0.424	850[I]	85[I]
n-Hexane	0.351	0.206	0.233	1.05	1,800[I]	198[I]
Methylene Chloride	ND	0.244	ND	0.209	600[A]	100[T]
2-Propanol	ND	2.38	ND	ND	NA	NA
Propene	0.893	ND	ND	ND	NA	NA
Tetrahydrofuran	ND	1.05	ND	ND	680[I]	680[I]
Toluene	0.361	0.929	ND	0.430	2,000[A]	1,327[I]

1 IRIS (Environmental Protection Agency Integrated Risk Information System)
A ATDSR MRL (US Agency for Toxic Substances and Disease Registry Minimal Risk Level)
T TCEQ AMCV (Texas Commission on Environmental Quality Air Monitoring Comparison Value)
NA no health value available
ND substance not detected
ppb parts per billion

5. Trends in Detected Substances

Pinyon calculated the R-value and p-value for all substances detected during the reporting period (Table 5-1). The p-value was greater than 0.05 for all substances, which indicates that any trends are not statistically significant during this reporting period. This reporting period constituted a relatively small sample size (n=11), and it is possible that as additional samples are collected adjacent to the Waste Connections well site statistically significant trends in detected substances over time could be affirmed.

Table 5-1 Pearson Correlation Coefficient and p-value of Detected Substances

Substance	R-value	p-value
Acetone	0.03	0.93
Benzene	0.46	0.54
Carbon disulfide	0.04	0.91
Chloromethane	0.28	0.40
Cyclohexane	0.46	0.52
cis-1,2,-Dichloroethane	0.00	0.99
1,4-Dioxane	0.04	0.91
Ethanol	0.43	0.19
4-Ethyltoluene	0.15	0.95
Trichlorofluoromethane	0.44	0.66
Dichlorodifluoromethane	0.28	0.40
Heptane	0.46	0.15
n-Hexane	0.24	0.48
Methylene Chloride	0.53	0.09
2-Butanone (MEK)	0.04	0.91
2-Propanol	0.28	0.40
Propene	0.07	0.84
Tetrachloroethylene	0.32	0.34
Tetrahydrofuran	0.24	0.48
Toluene	0.28	0.40
Trichloroethylene	0.30	0.37
1,2,4-Trimethylbenzene	0.15	0.66
m&p-Xylene	0.15	0.66
o-Xylene	0.15	0.66

6. Conclusions

Pinyon collected 24-hour air samples for five days adjacent to Crestone's Waste Connections well site from April 26, 2017, to May 31, 2017. In addition to the every five-day sampling schedule, Pinyon collected an additional sample on May 19, 2017, in response to an odor complaint. The air sample measurements collected reflect well drilling and completion activities at a unique well site in Erie, Colorado. The following limitations must be considered before definitive conclusions can be made:

- Samples collected for a short amount of time may not accurately represent continuous exposure or the ranges of potential exposures.
- These samples reflect exposures in that area for a period of time, and are not intended to identify the source of exposures. The substances identified in the sample could come from multiple sources.
- Samples collected during other phases of operations and different weather conditions may have very different results.
- The samples were only analyzed for a limited set of substances that could be present in the air.

Based on the results from the air sampling data collected at both well pads, it is unlikely that short-term exposures would result in negative health effects. Tetrachloroethylene was detected at a concentration of 11.9 ppb in the air sample collected on April 26, 2017, at the well site. This concentration exceeded the long-term health screening level of 10 ppb, but was below the short-term screening level of 1,000 ppb. This exceedance of the long-term health screening level occurred during a single air sample and was not replicated in the other samples collected at the respective well site. Therefore, it is unlikely that tetrachloroethylene is resulting in a negative health effect.

The air monitoring data provided in this report provides a general understanding of ambient concentrations of select pollutants adjacent to the well site during various phases of Crestone's activities. Based on meteorology data collected at the Erie Municipal Airport, the air sampling location is generally representative of ambient conditions. However, on select sampling days the sampling location was upwind of the well site or periods of high winds were recorded. Thus, the air samples collected during these periods may not represent concentrations that citizens would be exposed to at locations downwind of the well site, or may underrepresent maximum exposure levels.

These conclusions are based on limited sampling, conducted during a limited investigation. Concentrations of constituents can be highly variable, and detections may be dependent on a variety of environmental conditions (e.g., date, operations, wind bearings, actual emissions from operations). This sampling may, therefore, not be representative of, or account for all variables that could be present during oil and gas operations within Erie and should not be considered conclusive of future operations.

7. References

Davis, J., 2002. "Statistics and Data Analysis in Geology." Wiley. ISBN: 978-0-471-17275-8

Environmental Protection Agency (EPA), 1991. "Chemical Concentration Data Near the Detection Limit."; EPA/903/8-91/001.

Environmental Protection Agency (EPA), 1999. "Compendium Method TO-15: Determination of Volatile Organic Compounds (VOCs) In Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)."