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October 3, 2017

Noise Monitoring Adjacent to the Pratt Well Site August 1, 2017, to September 12, 2017

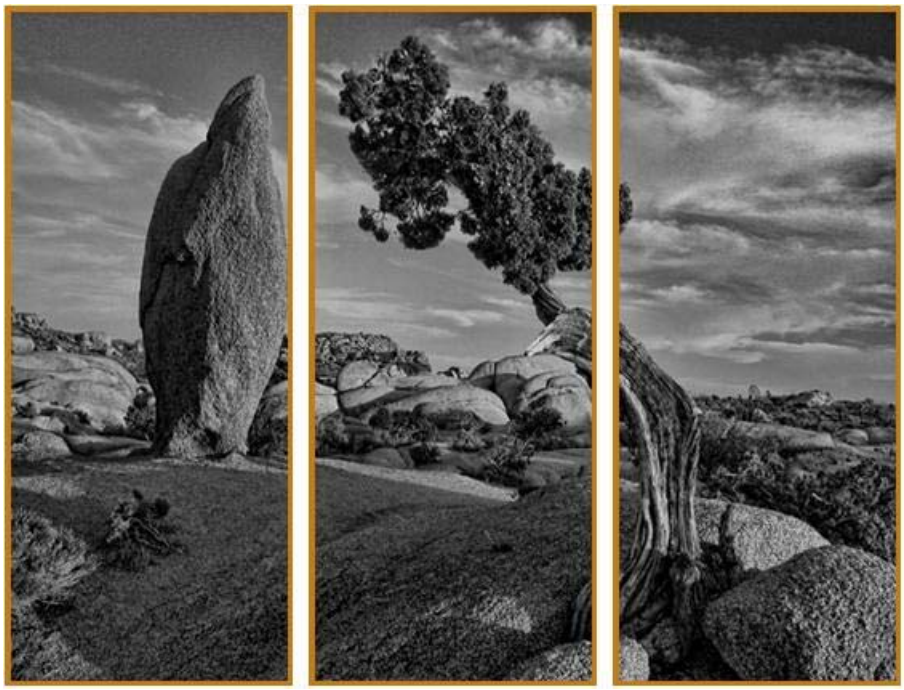
Noise Monitoring of Crestone Peak Resources Operations Erie, Colorado

Prepared For:

Town of Erie
645 Holbrook Street
Erie, Colorado 80516

Pinyon Project No.:

1/17-695-02.1200



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1. Introduction

The Town of Erie (Town) has contracted with Pinyon Environmental, Inc. (Pinyon), to perform noise monitoring near the Crestone Peak Resources (Crestone) Pratt well site. Pinyon collected continuous noise measurements at three locations adjacent to the well site (Figure 1). Pratt Site 1 is located approximately 350 feet to the south of the well site and was used to collect A-weighted noise measurements. Pratt Site 2 is located near a residential neighborhood approximately 830 feet to the southeast of the well site. Waste Connections Site 2 is located near a residential neighborhood approximately 5,100 feet to the southwest of the well site. Both A-weighted and C-weighted noise measurements were collected at Pratt Site 2 and Waste Connections Site 2. C-weighted noise was not collected at Sampling Site 1 as is not located near any occupied structures. Crestone began drilling operations at the Pratt well site on July 21, 2017, and continued activities at this location throughout the reporting period. Prior to the start of drilling, Pinyon also collected baseline noise data from July 18, 2017 to July 21, 2017, that is used to assess how ambient noise levels may change during Crestone's activities during this reporting period. This report details noise measurements collected during drilling activities, from August 1, 2017, at 7:00 AM through September 12, 2017, at 7:00 AM, and compares these levels to the baseline data. The noise monitoring data was analyzed to evaluate noise levels at the three locations during Crestone's drilling activities.

Figure 1-1 Noise Monitoring Locations

2. Methodology

2.1 Noise Monitoring Approach

In accordance with Colorado Oil and Gas Conservation Committee (COGCC) Rule 802, well production facilities may not exceed the maximum permissible noise levels established in accordance to Section 802.b of the rule (Table 2-1). In addition to the maximum permissible A-weighted noise levels, expressed in A-weighted decibels (dBA) (Table 2-1), COGCC Rule 802 specifies that operators may not exceed 65 C-weighted decibels (dBC) measured from the exterior wall of the residence or occupied structure nearest to the noise source, at a distance of 25 feet from the structure.

Table 2-1 COGCC Maximum Permissible Noise Levels

Zone	Maximum Permissible Noise Level	
	7:00am to 7:00pm	7:00pm to 7:00am
Residential/Agricultural/Rural	55 dBA	50 dBA
Commercial	60 dBA	55 dBA
Light Industrial	70 dBA	65 dBA
Industrial	80 dBA	75 dBA

dBA A-weighted decibel

Pinyon mobilized to the sampling locations and monitored for noise at these locations using 3M Quest SoundPro DL Type 1 datalogging sound level meters. The sound level meters collected continuous measurements of both A-weighted and C-weighted decibels, as applicable to the location. At Pratt Site 1, the sound level meter monitored continuously for A-weighted noise. At Pratt Site 2 and Waste Connections Site 2, continuous A-weighted and C-weighted noise measurements were collected. The monitoring period for this report lasted from August 1, 2017, at 7:00 AM through September 12, 2017, at 7:00 AM. Crestone began drilling operations at the well site at on July 21, 2017, and has continued well drilling activities throughout this reporting period.

The sound level meters are configured with a data logging system that uploads one minute time resolved measurements to a secure online database at 10-minute intervals. The sound level meters are configured with an alert system that will send a message to Pinyon's noise specialist as soon as the data is uploaded, whenever established noise criteria levels have been exceeded, based on the monitored equivalent continuous noise level (Leq). Leq is the preferred method to describe noise levels that vary over time, resulting in a single decibel value that takes into account the total sound energy over the period of time of interest. The Town and Pinyon agreed to set the alert system at 75 Leq dBA for A-weighted noise at Pratt Site 1, 60 Leq dBA for A-weighted noise at Pratt Site 2 and 65 Leq dBC for C-weighted noise at Pratt Site 2. The alert system for Waste Connections Site 2 was set to 60 Leq dBA for A-weighted noise and 70 Leq for C-weighted noise. These noise criteria levels were established based on the COGCC's maximum permissible noise levels, as well as baseline noise monitoring data collected prior to Crestone mobilizing to the well site. The C-weighted noise alert criteria level at Waste Connections Site 2 is set higher than the COGCC's maximum permissible noise level because baseline noise measurements collected prior to Crestone beginning operations at the well site exceeded this level.

2.2 Noise Monitoring Data Analysis

Pinyon's noise specialist downloaded the noise monitoring data from the online database for this collection period. The data was then formatted into spreadsheets that allowed for analysis of the noise monitoring data.

Pinyon utilized statistical methods, as well as graphical representations of the data, to evaluate baseline noise levels at the two sampling locations during the monitoring period. COGCC's Rule 802 specifies different maximum permissible noise levels based on time of day (Table 2-1). Therefore, for the statistical analysis of the noise measurements, the monitor data was split into two discrete analytical groups based on time of day:

- Daytime: 7:00 AM—6:59 PM
- Nighttime: 7:00 PM—6:59 AM

The daytime and nighttime analytical groups ended at 6:59 PM and 6:59 AM, respectively, in order to not complete a duplicate analysis of the 7:00 AM and 7:00 PM noise measurements.

To evaluate how noise levels may change over time during Crestone's operations at the well site, the monitoring data was separated into the following discrete analysis periods with each monitoring period then subdivided by time of day:

- July 18, 2017, at 1:00 PM to July 21, 2017, at 6:59 AM (Baseline Monitoring Period)
- August 1, 2017, at 7:00 AM to August 8, 2017, at 6:59 AM
- August 8, 2017, at 7:00 AM to August 15, 2017, at 6:59 AM
- August 15, 2017, at 7:00 AM to August 22, 2017, at 6:59 AM
- August 22, 2017, at 7:00 AM to August 31, 2017, at 6:59 AM
- August 31, 2017, at 7:00 AM to September 7, 2017, at 6:59 AM
- September 7, 2017, at 7:00 AM to September 12, 2017, at 7:00 AM

Section 3-2 describes how differences in the statistical mean between these monitoring periods were analyzed to confirm the existence of statistically significant increases in average observed noise levels as compared to the baseline monitoring period. To evaluate the distribution of the noise monitoring data, the statistical mean, median and mode were calculated. The statistical mean, median and mode are used to evaluate the statistical distribution of the noise monitoring data. Large data sets, such as several days of continuous noise monitoring data, tend to follow the normal distribution, which is referred to as the central limit theorem (Shao, 2004). Assessing the distribution of the noise monitoring data is important because this distribution is used to evaluate the appropriate statistical methods for further analysis. The observed relationship between the statistical mean, median and mode for the monitored datasets was determined to follow the normal distribution. The standard deviation for each monitoring periods was also calculated to evaluate the amount of variation in the baseline noise monitoring data and allow for a test of significance in differences between mean noise levels as compared to the baseline monitoring period.

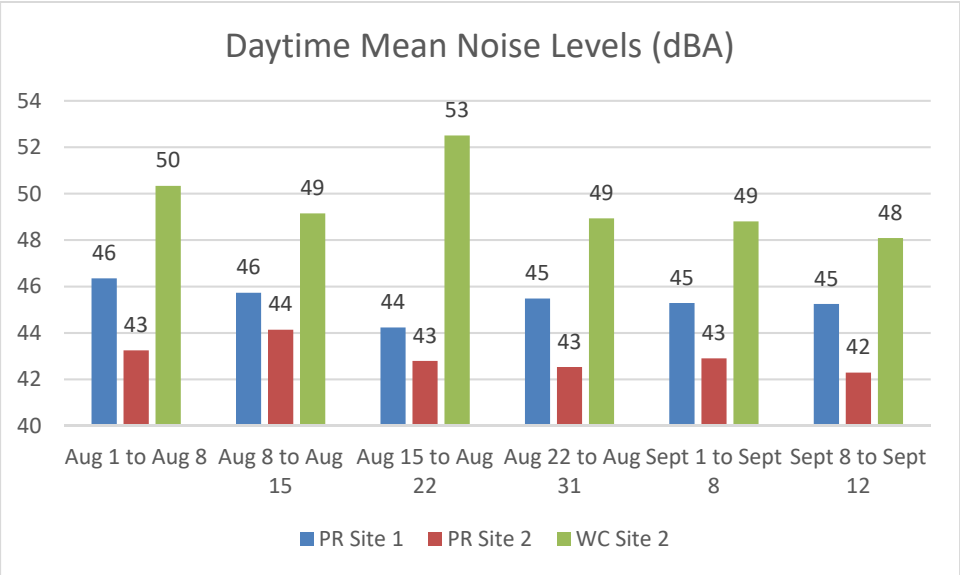
3. Data Analysis Results

3.1 Graphical Representations of Data

3.1.1 Average Daytime Conditions

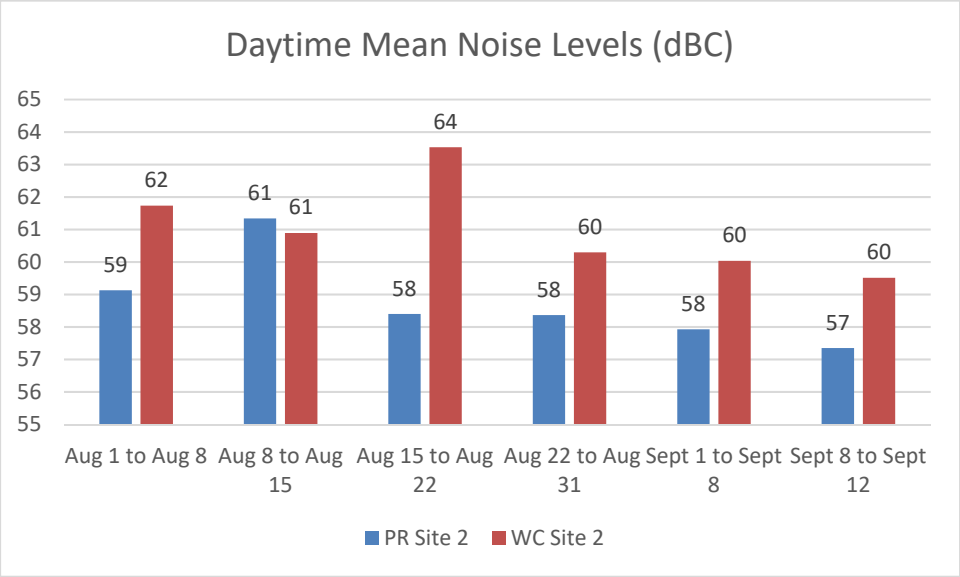
The statistical mean for each noise monitoring period was calculated for the daytime hours (7:00 AM to 6:59 PM) (Figure 3-1 and Figure 3-2). For A-weighted noise the highest mean levels were observed at Waste Connections Site 2, which corresponds with the noise levels observed during the baseline monitoring period. Measured A-weighted mean noise levels were higher at Pratt Site 1 than Pratt Site 2, which is likely attributable to the fact that Pratt Site 1is located closer to the Pratt well site than Pratt Site 1. For C-weighted noise, the highest mean levels were generally observed at Waste Connections Site 2, which also measured higher noise levels than Pratt Site 2 during the baseline monitoring period.

Figure 3-1 Daytime Mean A-weighted Noise Levels



dBA A-weighted noise levels
PR Pratt
WC Waste Connections

Figure 3-2 Daytime Mean C-weighted Noise Levels

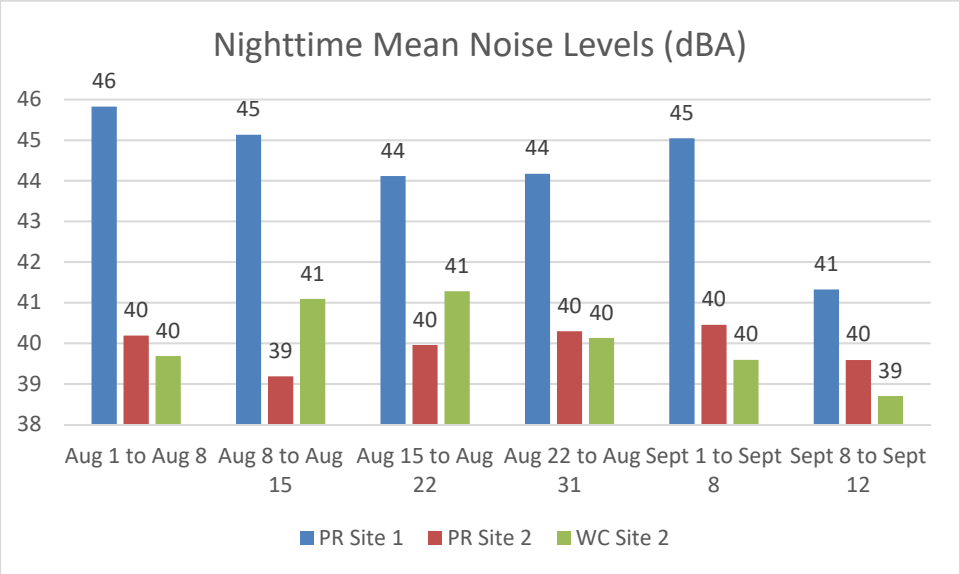


dBC C-weighted noise levels
PR Pratt
WC Waste Connections

3.1.2 Average Nighttime Conditions

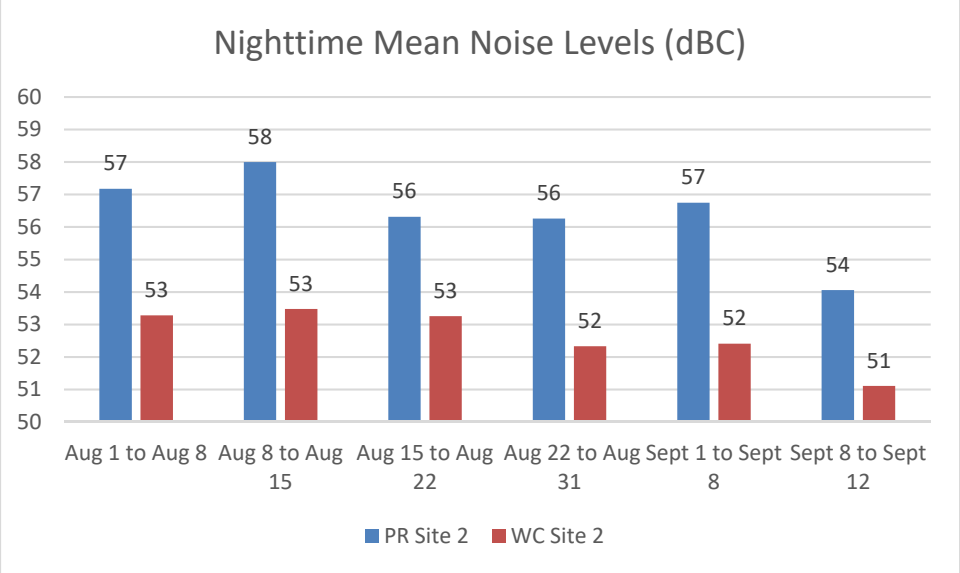
Figure 3-3 and Figure 3-4 show the statistical mean of noise monitoring data collected during the nighttime period (7:00 PM to 6:59 AM). For A-weighted noise the highest mean noise levels were measured at Pratt Site 1, which is located closest to the Pratt well site. Measured mean A-weighted noise levels were relatively consistent between Pratt Site 2 and Waste Connections Site 2. For C-weighted noise the highest mean noise levels were observed at Pratt Site 2, which is located closer to the Pratt well site than Waste Connections Site 2.

Figure 3-3 Nighttime Mean A-weighted Noise Levels



dBA A-weighted noise levels
PR Pratt
WC Waste Connections

Figure 3-4 Nighttime Mean C-weighted Noise Levels

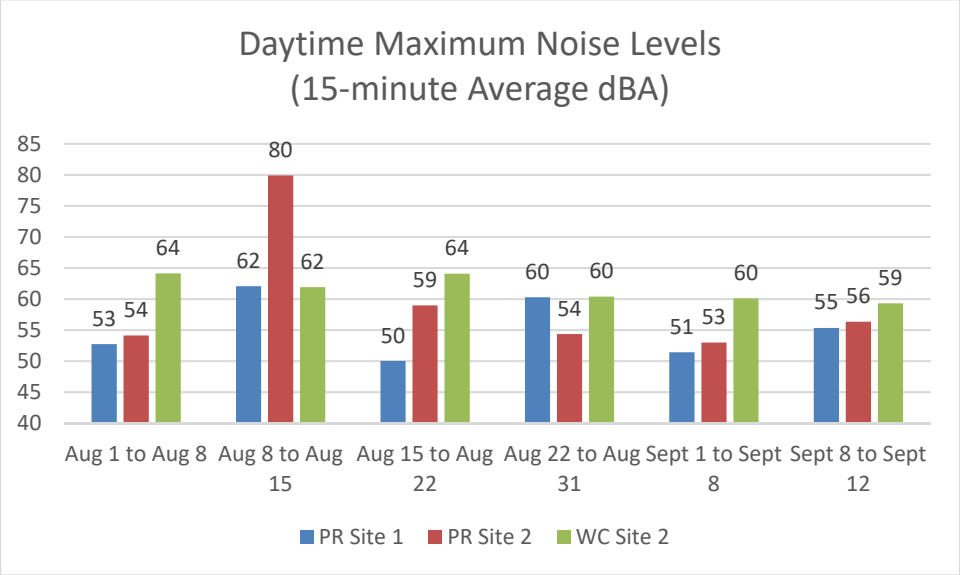


dBC C-weighted noise levels
PR Pratt
WC Waste Connections

3.1.3 Maximum Observed Daytime Noise Levels

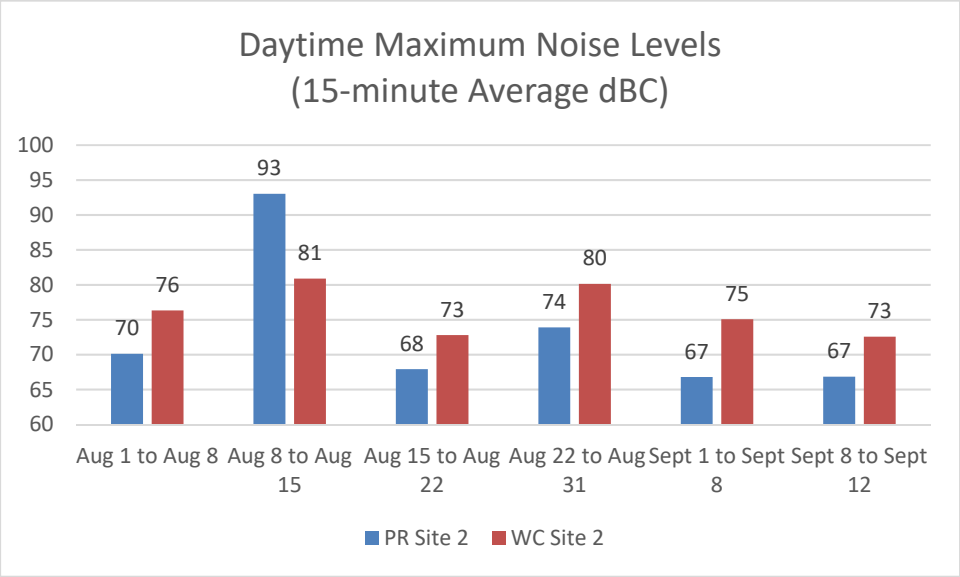
Figure 3-5 and Figure 3-6 shows the maximum 15-minute average noise measurements collected during the daytime condition for the monitoring periods. Except for the August 8, 2017 to August 15, 2017 monitoring period, the highest maximum measured 15-minute average A-weighted noise levels occurred at Waste Connections Site 2. The elevated noise at Pratt Site 2 during the August 8, 2017 to August 15, 2017 monitoring period, occurred on August 10, 2017. The maximum 15-minute average C-weighted noise was also higher at Waste Connections Site 2 than Pratt Site 2 during all monitoring periods except for August 10, 2017, when elevated noise at Pratt Site 2 was measured. The COGCC investigated the source of the elevated noise on August 10, 2017, and determined that it was originating from the landfill directly to the north of the Pratt well site and was not attributable to Crestone's operations at the well site.

Figure 3-5 Daytime Maximum A-weighted Noise Levels



dBA A-weighted noise levels
PR Pratt
WC Waste Connections

Figure 3-6 Daytime Maximum C-weighted Noise Levels

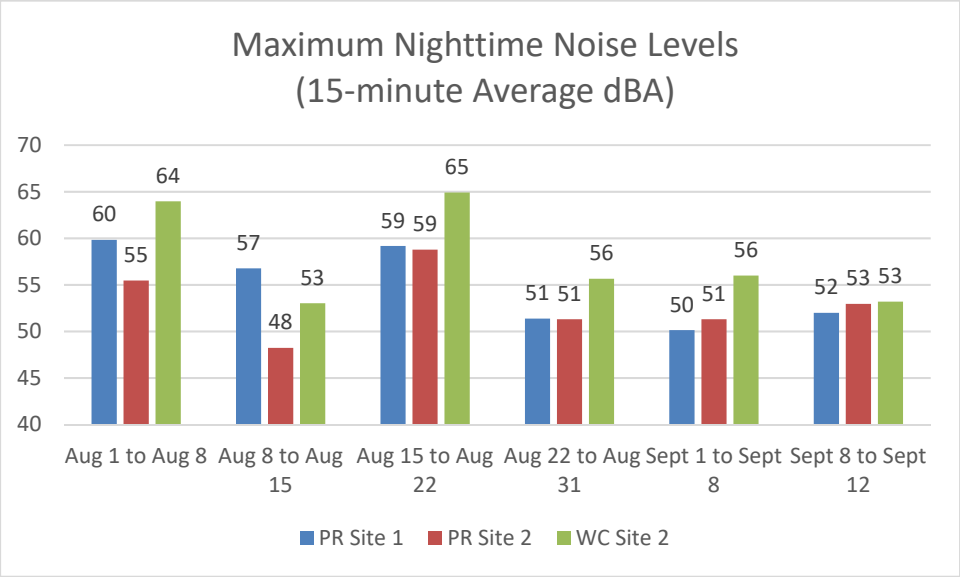


dBC C-weighted noise levels
PR Pratt
WC Waste Connections

3.1.4 Maximum Observed Nighttime Noise Levels

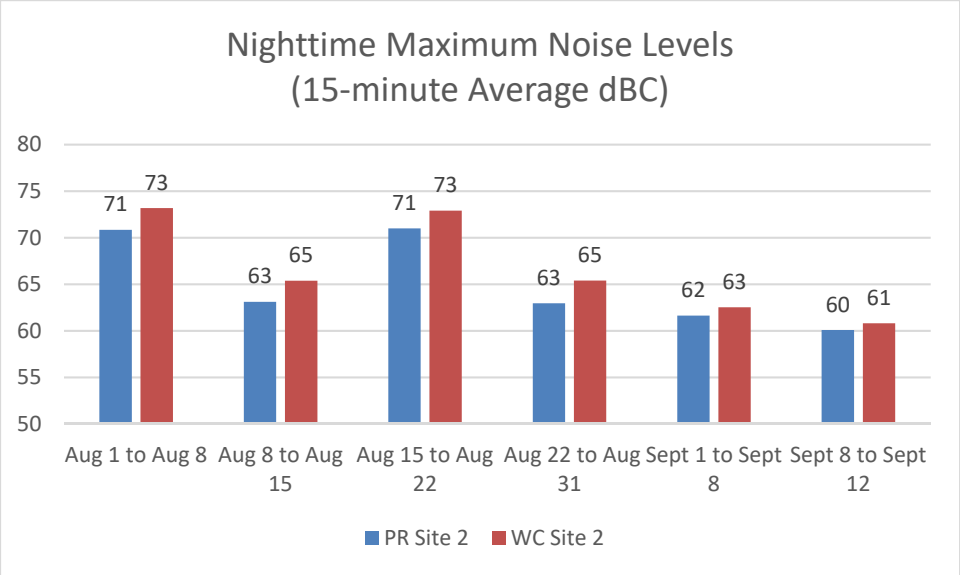
Figure 3-7 and Figure 3-8 show the maximum 15-minute average noise measurements collected during the nighttime monitoring periods. During this reporting period, the maximum observed A-weighted noise levels were highest at Waste Connections Site 2 except for August 10, 2017. As described in Section 3.1.3, it was assumed that the source of the elevated noise on this date was not attributable to Crestone's operations at the Pratt well site. The highest 15-minute average measured C-weighted noise levels were observed at Waste Connections Site 2.

Figure 3-7 Nighttime Maximum A-weighted Noise Levels



dBA A-weighted noise levels
PR Pratt
WC Waste Connections

Figure 3-8 Nighttime Maximum Noise Levels



dBC C-weighted noise levels
PR Pratt
WC Waste Connections

3.2 Statistical Analysis of Noise Monitor Data

Pinyon observed a statistically significant change in in the mean measured noise values from the baseline monitoring period while analyzing the monitoring data. Furthermore, this difference was also observed when generating graphical representations of the measured noise values at the three noise monitors for this reporting period, which was separated into 14 analysis periods for each monitor. A t-test was performed to evaluate whether the difference in calculated mean values were statistically significant. A t-test is a statistical method for evaluating the difference in means between two sample groups (Davis, 2003). The higher the t-value the greater the difference between the two means. To assess the level of confidence in the calculated t-value, a p-value is calculated. The p-value is based on the magnitude of the t-value and the total number of samples collected between the two monitoring periods. A p-value of less than or equal to 0.001 means that there is a 99.9% confidence level that the difference between means is statistically significant. The variation in statistical mean, the t-value and the p-value was calculated for the three noise monitors for each analysis period. The calculated p-values were less than 0.001 for all comparisons meaning that the means are statistically significantly different at the 99.9% confidence interval. A 99.9% confidence interval indicates that there is less than a 0.01% likelihood that the calculated differences in statistical means are insignificant.

At Pratt Site 1 there was a statistically significant increase in A-weighted noise relative to the baseline noise measurements for both the daytime and nighttime monitoring periods (Table 3-1, Table 3-2). This increase is expected at Pratt Site 1, as it is located in close proximity to Crestone's activities, and prior to the start of Crestone's operations there were few other noise sources (e.g., roadways) located within a short distance of the monitor.

Table 3-1 Variation in Daytime Statistical Mean for A-weighted Noise at Pratt Site 1

Period	Mean (dBA)	Change (dBA)	t-value	p-value
Baseline	43.6	NA	NA	NA
Aug 1 to Aug 8	46.3	2.8	23.8	<0.0001
Aug 8 to Aug 15	45.7	2.2	18.0	<0.0001
Aug 15 to Aug 22	44.2	0.7	5.60	<0.0001
Aug 22 to Aug 31	45.5	1.9	16.3	<0.0001
Sept 1 to Sept 8	45.3	4.0	36.6	<0.0001
Sept 8 to Sept 12	45.2	1.7	13.4	<0.0001

dBA A-weighted decibels

Table 3-2 Variation in Nighttime Statistical Mean for A-weighted Noise at Pratt Site 1

Period	Mean (dBA)	Change (dBA)	t-value	p-value
Baseline	41.3	NA	NA	NA
Aug 1 to Aug 8	45.8	4.5	38.7	<0.0001
Aug 8 to Aug 15	45.1	3.8	35.4	<0.0001
Aug 15 to Aug 22	44.1	2.8	25.4	<0.0001
Aug 22 to Aug 31	44.2	2.9	26.3	<0.0001
Sept 1 to Sept 8	45.0	3.7	34.8	<0.0001
Sept 8 to Sept 12	41.3	0.0	0.182	0.8556

dBA A-weighted decibels

At Pratt Site 2 there was a decrease in A-weighted noise relative to the baseline noise measurements for all of the monitoring periods (Table 3-3, Table 3-4). Although Crestone had not begun drilling at the Pratt well site

during the baseline monitoring period, Pinyon staff did observe staging activities occurring during this time. It is possible that the noise associated with these activities resulted in measured A-weighted noise being higher during the baseline than the drilling activities monitored during this reporting period.

Table 3-3 Variation in Daytime Statistical Mean for A-weighted Noise at Pratt Site 2

Period	Mean (dBA)	Change (dBA)	t-value	p-value
Baseline	46.0	NA	NA	NA
Aug 1 to Aug 8	43.2	-2.7	-33.8	<0.0001
Aug 8 to Aug 15	44.1	-1.9	-15.9	<0.0001
Aug 15 to Aug 22	42.8	-3.2	-38.1	<0.0001
Aug 22 to Aug 31	42.5	-3.5	-42.2	<0.0001
Sept 1 to Sept 8	42.9	-3.1	-36.5	<0.0001
Sept 8 to Sept 12	42.2	-3.7	-41.7	<0.0001

dBA A-weighted decibels

Table 3-4 Variation in Nighttime Statistical Mean for A-weighted Noise at Pratt Site 2

Period	Mean (dBA)	Change (dBA)	t-value	p-value
Baseline	47.0	NA	NA	NA
Aug 1 to Aug 8	40.2	-6.8	-77.5	<0.0001
Aug 8 to Aug 15	39.2	-7.8	-93.6	<0.0001
Aug 15 to Aug 22	40.0	-7.0	-80.0	<0.0001
Aug 22 to Aug 31	40.2	-6.7	-83.2	<0.0001
Sept 1 to Sept 8	40.5	-6.5	-79.5	<0.0001
Sept 8 to Sept 12	39.6	-7.4	-75.6	<0.0001

dBA A-weighted decibels

At Pratt Site 2 there was a decrease in daytime C-weighted noise relative to the baseline noise measurements for all of the monitoring periods except for the daytime monitoring period from August 8, 2017 to August 15, 2017 (Table 3-5 and Table 3-6). The daytime statistical mean for the August 8, 2017 to August 15, 2017, was heavily influenced by the elevated noise levels measured on August 10, 2017. As discussed in Section 3.1.3 the COGCC determined that the measured elevated noise levels on this date were not attributable to Crestone's operations at the Pratt well site. Although Crestone had not begun drilling at the Pratt well site during the baseline monitoring period, Pinyon staff did observe staging activities occurring during this time. It is possible that the noise associated with these activities resulted in measured C-weighted noise being higher during the baseline than the drilling activities monitored during this reporting period.

Table 3-5 Variation in Daytime Statistical Mean for C-weighted Noise at Pratt Site 2

Period	Mean (dBC)	Change (dBC)	t-value	p-value
Baseline	60.0	NA	NA	NA
Aug 1 to Aug 8	59.1	-0.9	-14.5	<0.0001
Aug 8 to Aug 15	61.3	1.4	14.0	<0.0001
Aug 15 to Aug 22	58.4	-1.6	-27.0	<0.0001
Aug 22 to Aug 31	58.4	-1.6	-26.5	<0.0001
Sept 1 to Sept 8	57.9	-2.1	-33.8	<0.0001
Sept 8 to Sept 12	57.3	-2.6	-40.8	<0.0001

dBC C-weighted decibels

Table 3-6 Variation in Nighttime Statistical Mean for C-weighted Noise at Pratt Site 2

Period	Mean (dBC)	Change (dBC)	t-value	p-value
Baseline	59.2	NA	NA	NA
Aug 1 to Aug 8	57.2	-2.1	-52.0	<0.0001
Aug 8 to Aug 15	58.0	-1.2	-30.4	<0.0001
Aug 15 to Aug 22	56.3	-2.9	-67.1	<0.0001
Aug 22 to Aug 31	56.3	-3.0	-75.3	<0.0001
Sept 1 to Sept 8	56.7	-2.5	-68.9	<0.0001
Sept 8 to Sept 12	54.1	-5.2	-95.9	<0.0001

dBC C-weighted decibels

At Waste Connections Site 2 there were significant decreases in the statistical mean for A-weighted noise for all monitoring periods (Table 3-7 and Table 3-8). As Waste Connections Site 2 is the farthest noise measurement location from the Pratt well site it is likely that noise attributable to Crestone's activities is not being recorded at Waste Connections Site 2, and that measured A-weighted noise levels at this location are attributable to other sources in the area.

Table 3-7 Variation in Daytime Statistical Mean for A-weighted Noise at Waste Connections Site 2

Period	Mean (dBA)	Change (dBA)	t-value	p-value
Baseline	54.0	NA	NA	NA
Aug 1 to Aug 8	50.3	-3.7	-50.5	<0.0001
Aug 8 to Aug 15	49.1	-4.9	-85.0	<0.0001
Aug 15 to Aug 22	52.5	-1.5	-20.1	<0.0001
Aug 22 to Aug 31	48.9	-5.1	-97.0	<0.0001
Sept 1 to Sept 8	48.8	-5.2	-87.6	<0.0001
Sept 8 to Sept 12	48.1	-5.9	-85.1	<0.0001

dBA A-weighted decibels

Table 3-8 Variation in Nighttime Statistical Mean for A-weighted Noise at Waste Connections Site 2

Period	Mean (dBA)	Change (dBA)	t-value	p-value
Baseline	54.0	NA	NA	NA
Aug 1 to Aug 8	39.7	-14.3	-164.3	<0.0001
Aug 8 to Aug 15	41.1	-12.9	-173	<0.0001
Aug 15 to Aug 22	41.3	-12.7	-157	<0.0001
Aug 22 to Aug 31	40.1	-13.8	-199	<0.0001
Sept 1 to Sept 8	39.6	-14.4	-160	<0.0001
Sept 8 to Sept 12	38.7	-15.3	-163	<0.0001

dBA A-weighted decibels

At Waste Connections Site 2 there were significant decreases in the statistical mean for C-weighted noise for all monitoring periods (Table 3-9 and Table 3-10). As Waste Connections Site 2 is the farthest noise measurement location from the Pratt well site, it is likely that noise attributable to Crestone's activities is not being recorded at Waste Connections Site 2, and that measured C-weighted noise levels at this location are attributable to other sources in the area.

Table 3-9 Variation in Daytime Statistical Mean for C-weighted Noise at Waste Connections Site 2

Period	Mean (dBC)	Change (dBC)	t-value	p-value
Baseline	64.0	NA	NA	NA
Aug 1 to Aug 8	61.7	-2.3	-29.7	<0.0001
Aug 8 to Aug 15	60.9	-3.1	-54.0	<0.0001
Aug 15 to Aug 22	63.5	-0.5	-7.47	<0.0001
Aug 22 to Aug 31	60.3	-3.7	-86.3	<0.0001
Sept 1 to Sept 8	60.0	-4.0	-70.0	<0.0001
Sept 8 to Sept 12	59.5	-4.5	-71.2	<0.0001

dBC C-weighted decibels

Table 3-10 Variation in Nighttime Statistical Mean for C-weighted Noise at Waste Connections Site 2

Period	Mean (dBC)	Change (dBC)	t-value	p-value
Baseline	63.9	NA	NA	NA
Aug 1 to Aug 8	53.3	-10.6	-162	<0.0001
Aug 8 to Aug 15	53.5	-10.4	-179	<0.0001
Aug 15 to Aug 22	53.3	-10.6	-165	<0.0001
Aug 22 to Aug 31	52.3	-11.6	-228	<0.0001
Sept 1 to Sept 8	52.4	-11.5	-201	<0.0001
Sept 8 to Sept 12	51.1	-12.8	-192	<0.0001

dBC C-weighted decibels

4. Conclusions

Pinyon collected continuous noise measurements at three monitoring locations adjacent to Crestone's Pratt well site from August 1, 2017, at 7:00 AM to September 12, 2017, at 7:00 AM. On July 21, 2017 Crestone commenced drilling operations at the well site and has continued activities throughout this reporting period. Prior to the start of Crestone's operations, Pinyon collected baseline data at both locations from July 18, 2017, at 1:00 PM to July 21, 2017, at 7:00 AM.

An evaluation of the noise measurements collected showed an increase in ambient A-weighted noise levels that are likely attributable to Crestone's activities during this reporting period at Pratt Site 1. During this reporting period, measured mean A-weighted and noise levels were lower at Pratt Site 2 and Waste Connections Site 2 than the baseline measurements collected prior to Crestone beginning activities at the Pratt well site. During the baseline reporting period it was observed that Crestone was conducting staging operations at the Pratt well site and these activities could have contributed to increased noise levels at these located prior to Crestone commencing drilling operations at this location; however, a definitive assumption cannot be made as to whether elevated noise during the baseline monitoring period is attributable to Crestone's activities at the well site. Elevated levels of A-weighted and C-weighted noise were observed on August 10, 2017; however, the COGCC determined that the source of elevated noise was not attributable to Crestone's activities at the Pratt well site.

Pinyon will continue to monitor continuously for noise at locations determined by the Town throughout Crestone's operations at the well site and will compare measured levels of A-weighted and C-weighted noise to baseline levels, in order to assess potential changes in ambient noise levels during various phases of activity and evaluate whether potential exceedances of the COGCC's maximum permissible noise levels are observed.

5. References

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Shao, J. 2004. "Mathematical Statistics." Second Edition. Springer Texts in Statistics. ISBN-13: 978-0387953823