B&V Pad Noise Modeling Report

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1. Introduction

The following report provides a noise modeling assessment of the current and ongoing fracing operations at the B&V pad operated by Ursa Resources in relation to the Colorado Oil and Gas Conservation Commission (COGCC) noise regulations. The noise modeling includes existing mitigation and additional mitigation scenarios. The B&V pad (39°27'0.88"N, 108°2'49.49"W) is located adjacent to the intersection of Cardinal Way and Callahan Avenue in Parachute, Colorado. The site is bordered by single family homes and commercial properties in close proximity to the north, west, and southeast. Figure 1-1 identifies the pad location.

To assess the predicted noise levels of the existing B&V pad fracing operations, historical noise level data previously measured and typical of Calfrac Well Services fracing equipment was used in conjunction with third-party noise level measurements provided by Ursa Resources. Noise sensitive receptor locations were chosen at the direction of Ursa Resources. The noise model was developed using SoundPLAN 7.4 software.

The following is provided in this report:

- A brief introduction of the fundamentals of noise.
- Introduction of applicable COGCC noise standards.
- Discussion of noise modeling methodology and results.

Figure 1-1 Ursa Resources Pad Location

2. Noise Fundamentals

Sound is most commonly experienced by people as pressure waves passing through air. These rapid fluctuations in air pressure are processed by the human auditory system to produce the sensation of sound. The rate at which sound pressure changes occur is called the frequency. Frequency is usually measured as the number of oscillations per second or Hertz (Hz). Frequencies that can be heard by a healthy human ear range from approximately 20 Hz to 20,000 Hz. Toward the lower end of this range are low-pitched sounds, including those that might be described as a “rumble” or “boom”. At the higher end of the range are high-pitched sounds that might be described as a “screech” or “hiss”.

Environmental noise generally derives, in part, from a combination of distant noise sources. Such sources may include common experiences such as distant traffic, wind in trees, and distant industrial or farming activities. These distant sources create a low-level "background noise" in which no individual source is identifiable. Background noise is often relatively constant from moment to moment, but varies slowly from hour to hour as natural forces change or as human activity follows its daily cycle.

Superimposed on this low-level, slowly varying background noise is a succession of identifiable noisy events of relatively brief duration. These events may include the passing of single-vehicles, aircraft flyovers, screeching of brakes, and other short-term events. The presence of these short-term events causes the noise level to fluctuate. Typical indoor and outdoor A-weighted sound levels are shown in Figure 2-1.

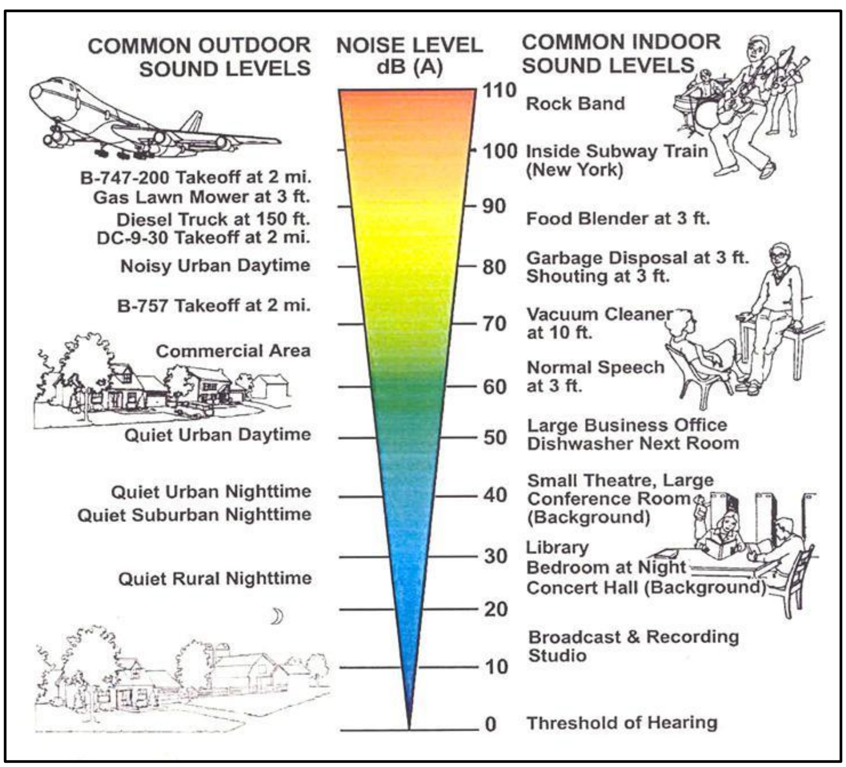

Figure 2-1 Typical Indoor and Outdoor A-Weighted Sound Levels

Detailed acoustical definitions have been provided in Appendix A -Nomenclature.

3. Noise Standards

The modeling analysis was developed to evaluate drilling and fracing noise levels at adjacent occupied structures and verify compliance of operations with the Colorado Oil and Gas Conservation Commission (COGCC) Section 802 "Noise Abatement" requirements. The COGCC Code lists exterior noise limits for stationary noise sources. The noise limits are provided in Table 3-1.

Table 3-1. COGCC Sec. 802(b) Noise Abatement Requirements "Exterior Noise Level Limits"

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

Section 802.b of the standard states:

> The type of land use of the surrounding area shall be determined by the Director in consultation with the Local Government Designee taking into consideration any applicable zoning or other local land use designation. In the hours between 7:00 a.m. and the next 7:00 p.m. the noise levels permitted above may be increased ten (10) dB(A) for a period not to exceed fifteen (15) minutes in any one (1) hour period. The allowable noise level for periodic, impulsive or shrill noises is reduced by five (5) dB (A) from the levels shown.
>
> (1) Except as required pursuant to Rule 604.c.(2)A., operations involving pipeline or gas facility installation or maintenance, the use of a drilling rig, completion rig, workover rig, or stimulation is subject to the maximum permissible noise levels for industrial zones.

Section 802C.(1) of the standard states:

> Sound levels shall be measured at a distance of three hundred and fifty (350) feet from noise source. At the request of the complainant, the sound level shall also be measured at a point beyond three hundred fifty (350) feet that the complainant believes is more representative of the noise impact. If an oil and gas well site, production facility, or gas facility is installed closer than three hundred and fifty (350) feet from an existing occupied structure, sound levels shall be measured at a point twenty-five (25) feet from the structure toward the noise source. Noise level from oil and gas facilities located on surface property owned, leased, or otherwise controlled by the operator shall be measured at the three hundred and fifty (350) feet or at the property line, whichever is greater.

Section 802(d) of the standard states:

> In situations where the complainant or Commission onsite inspection indicates that low frequency noise is a component of the problem, the Commission shall obtain a sound level measurement twenty-five (25) feet from the exterior wall of residence or occupied structure to the noise source, using a noise meter calibrated to the dB(C). If this reading exceeds 65 dB(C), the Commission shall require the operator to obtain a low frequency noise impact analysis by qualified sound expert, including identification of any reasonable control measures available to mitigate such low frequency noise impact.

Colorado Oil and Gas Conservation Commission Setback Rules

Section 604.c.(2)

A. Noise.
Operations involving pipeline or gas facility installation or maintenance, or the use of a drilling rig, are subject to the maximum permissible noise levels for Light Industrial Zones, as measured at the nearest Building Unit. Short-term increases shall be allowable as described in 802.c. Stimulation or re-stimulation operations and Production Facilities are governed by Rule 802.

4. B&V Pad Noise Modeling

4.1 Noise Modeling Methodology

The noise modeling was completed with use of three-dimensional computer noise modeling software. All models in this report were developed with SoundPLAN 7.4 software using the ISO 9613-2 standard. Noise levels are predicted based on the locations, noise levels and frequency spectra of the noise sources, and the geometry and reflective properties of the local terrain, buildings and barriers. SoundPLAN 7.4 software simulates light downwind conditions in all directions to ensure conservative assessments. The predicted noise levels represent only the contribution of the fracing operations and do not include ambient noise or noise from other facilities. Actual field sound level measurements may vary from the modeled noise levels due to other noise sources such as traffic, other facilities, other human activity, or environmental factors.

The sound level data for the fracing equipment were based on historical measurements from Calfrac Well Services per the request of Ursa Resources. Fracing equipment placement and orientation was coordinated with Ursa Resources and oriented to minimize noise impact when possible. The modeling results predicted are dependent upon equipment and mitigation orientation as indicated.

4.2 Noise Sensitive Receptors

The noise sensitive receptors have been chosen to be consistent with the requirements of the COGCC noise standards and the requests of Ursa Resources. The requirements indicate that dBA noise levels shall comply with the applicable noise limits as measured at 350 feet from the nearest noise source or at the property line, whichever is greater. The requirements indicate that dBC noise levels shall comply with the applicable noise limits as measured at 25 feet from the exterior wall of residence or occupied structure to the noise source. The dBC noise sensitive receptors were focused on the neighborhood to the southwest of the pad per the request of Ursa Resources. Figure 4-1 shows the dBA and dBC noise sensitive receptor locations.

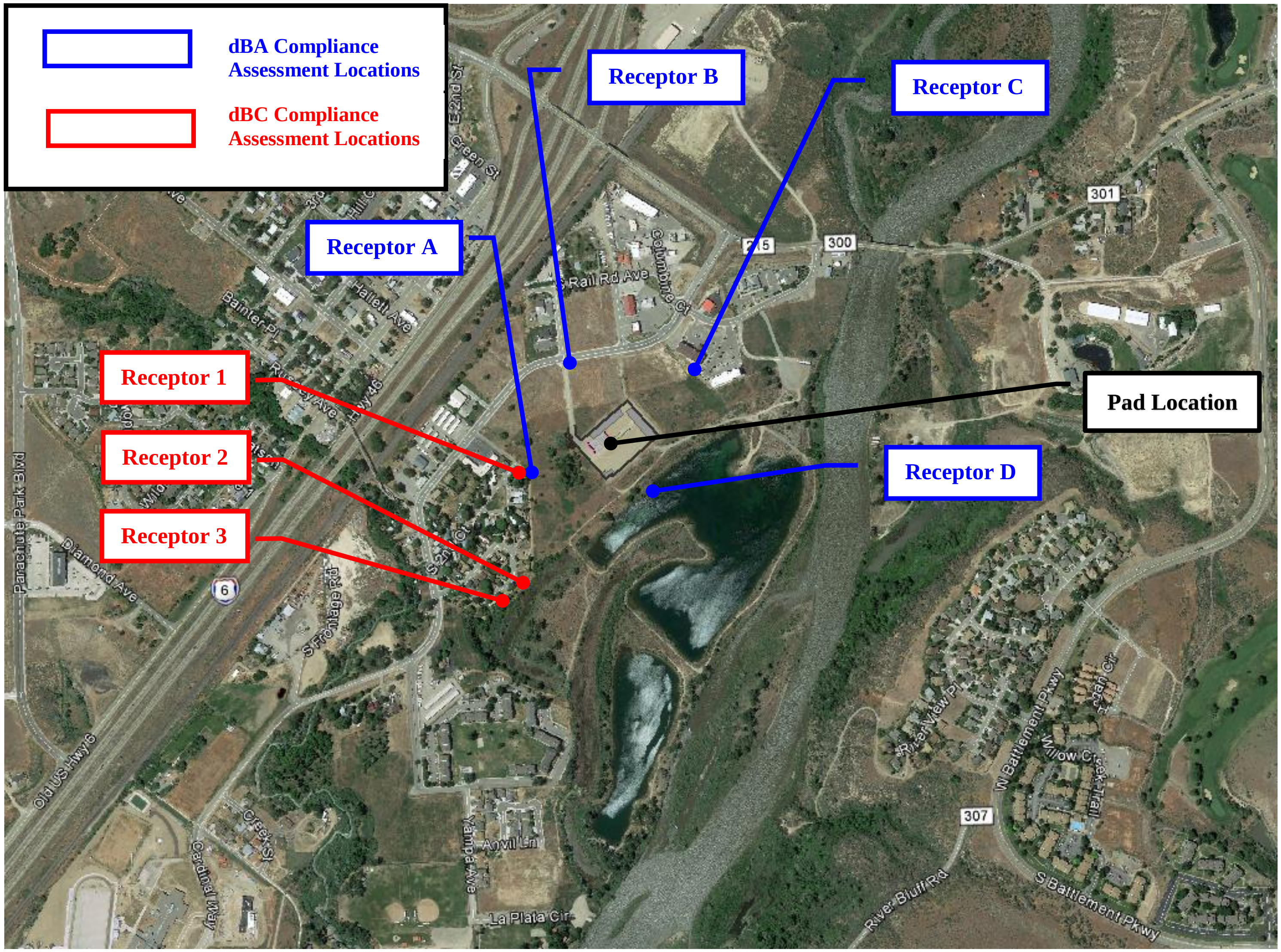

Figure 4-1 Noise Sensitive Receptor Locations

4.3 Existing Mitigation Noise Modeling Results

The Existing Mitigation scenario represents the existing mitigation, to date, installed at the B&V pad. This mitigation is comprised of approximately 1,480 linear feet of 32-foot-high acoustical perimeter wall with a Sound Transmission Class (STC) rating of 32 and is shown in Figure 4-2. The results of the Existing Mitigation noise modeling are presented in Tables 4-1 and 4-2. The locations in the tables correspond to the receptor locations identified in Figure 4-1. The results of the noise modeling are also shown as noise contour maps. Figure 4-3 shows the Existing Mitigation Fracing Noise Contour Map in dBA and Figure 4-4 shows the Existing Mitigation Fracing Noise Contour Map in dBC. The noise contours are provided in 5 dB increments with the color scale indicating the sound level of each contour.

Table 4-1 Existing Mitigation Noise Modeling Results (dBA)

Receptor	Location Description	Fracing dBA
Location A	West Property Line	61.3
Location B	North Property Line	61.8
Location C	East Property Line	62.0
Location D	South Property Line	62.4
Allowable Noise Level	**350 ft. from the noise source towards an existing, occupied structure or at the property line, whichever is greater**	**80.0 Day / 75.0 Night**

Table 4-2 Existing Mitigation Noise Modeling Results (dBC)

Receptor	Location Description	Fracing dBC
Location 1	25 Feet from West Residence	76.6
Location 2	25 Feet from Southwest Residence 1	71.9
Location 3	25 Feet from Southwest Residence 2	71.0
Allowable Noise Level	**25 ft. from the exterior wall of a residence or occupied structure towards the noise source**	**65.0**

Figure 4-2 Modeled Existing Mitigation Fracing Scenario Layout

Figure 4-3 Existing Mitigation Fracing Noise Contour Map (dBA)

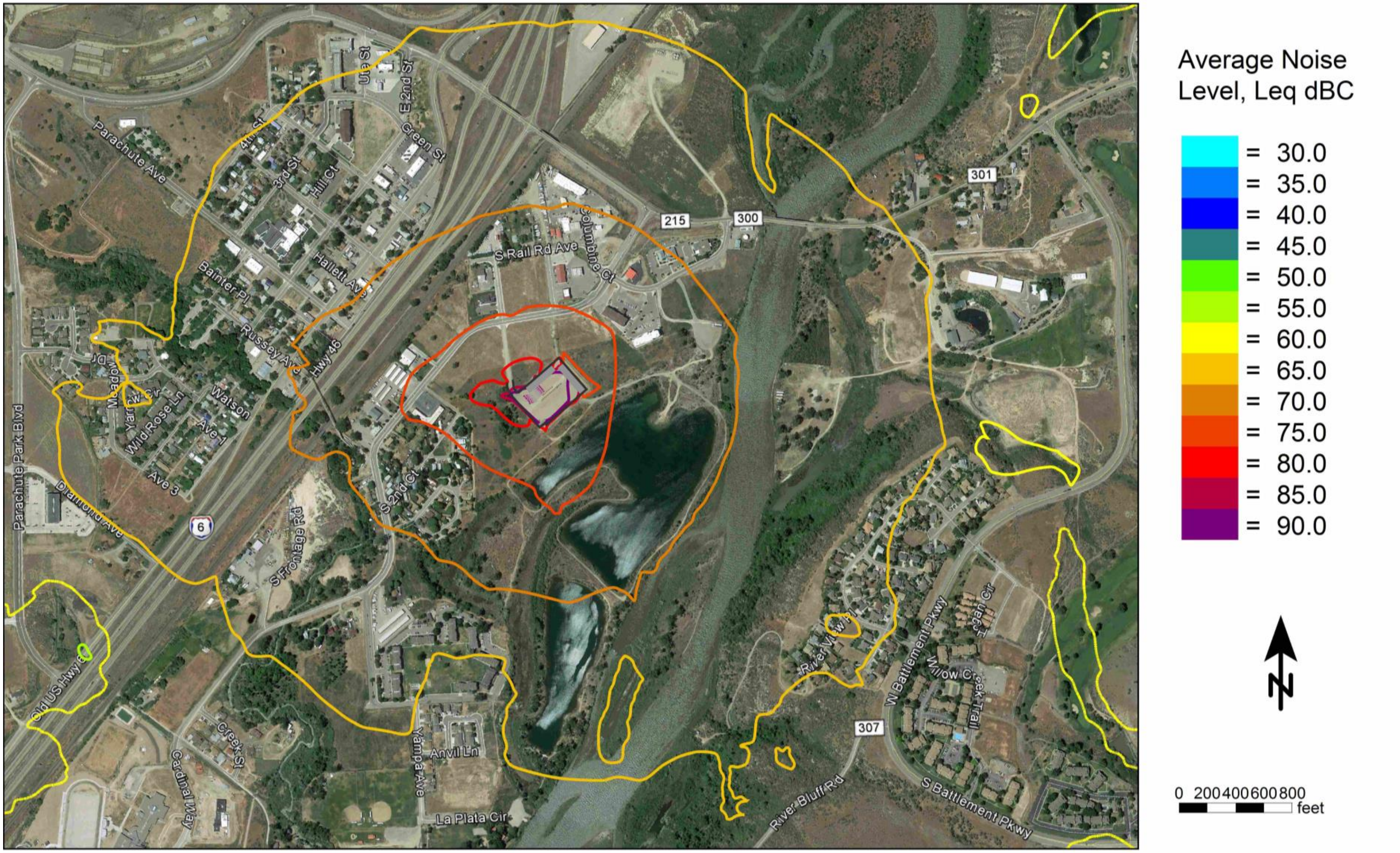

Figure 4-4 Existing Mitigation Fracing Noise Contour Map (dBC)

4.4 Mitigation Recommendations

The results of the Existing Mitigation modeling indicate that the current B&V pad activities and mitigation will exceed dBC COGCC noise limits at the modeled receptors. Additional noise mitigation was added to the Existing Mitigation models to further reduce noise levels associated with the pad activities at the residences adjacent to the site. Table 4-3 lists the individual components of the recommended mitigation layouts. Figure 4-5 shows the Additional Mitigation layout.

Table 4-3 Modeled Mitigation Scenarios

Modeled Scenario	Description
Additional Mitigation	• A total of 1,480 linear feet of 32-foot-high, Sound Transmission Class (STC) 32 acoustical wall installed around the perimeter of the site (currently installed). • A total of 40 linear feet of 20-foot-high and 240 linear feet of 24-foot-high, STC-43 portable acoustical panels installed on the western and southern side of the east fracing truck group, and along the western and southern perimeter of the existing perimeter wall.

Figure 4-5 Modeled Additional Mitigation Fracing Scenario Layout

4.5 Mitigated Noise Modeling Results

The results of the Additional Mitigation fracing noise modeling scenario are presented in Tables 4-4 and 4-5 and compared against the previous Existing Mitigation results. The locations of the receptors in the tables correspond to the locations identified in Figure 4-1. The results of the noise modeling are also shown as noise contour maps. Figures 4-6 and 4-7 show the Additional Mitigation fracing noise contour maps in dBA and dBC. The noise contours are provided in 5 dB increments with the color scale indicating the sound level of each contour.

Table 4-4 Fracing Noise Modeling Results (dBA)

Receptor	**Location Description**	**Existing Mitigation dBA**	**Additional Mitigation dBA**
Location A	West Property Line	61.3	60.7
Location B	North Property Line	61.8	61.1
Location C	East Property Line	62.0	61.1
Location D	South Property Line	62.4	60.2
Allowable Noise Level	**350 ft. from the noise source towards an existing, occupied structure or at the property line, whichever is greater**	**80.0 Day / 75.0 Night**	

Table 4-5 Fracing Noise Modeling Results (dBC)

Receptor	**Location Description**	**Existing Mitigation dBC**	**Additional Mitigation dBC**
Location 1	25 Feet from West Residence	76.6	74.8
Location 2	25 Feet from Southwest Residence 1	71.9	67.7
Location 3	25 Feet from Southwest Residence 2	71.0	67.3
Allowable Noise Level	**25 ft. from the exterior wall of a residence or occupied structure towards the noise source**	**65.0**	

The predicted results of the Additional Mitigation fracing noise modeling scenario indicate that the ongoing B&V pad fracing activities will comply with dBA COGCC noise limits at all modeled receptor locations but will still exceed dBC COGCC noise limits at Receptor Location 1 by 9.7 dBC, Receptor Location 2 by 1.9 dBC, and at Receptor 3 by 1.7 dBC with installation of the mitigation recommendations. **Please note that these results do not include the contribution of any ambient measurement data.** Third-party testing data commissioned by Ursa Resources suggests that existing ambient noise levels of the B&V pad and surrounding areas may be in excess of the COGCC noise limits and should be considered when interpreting these results.

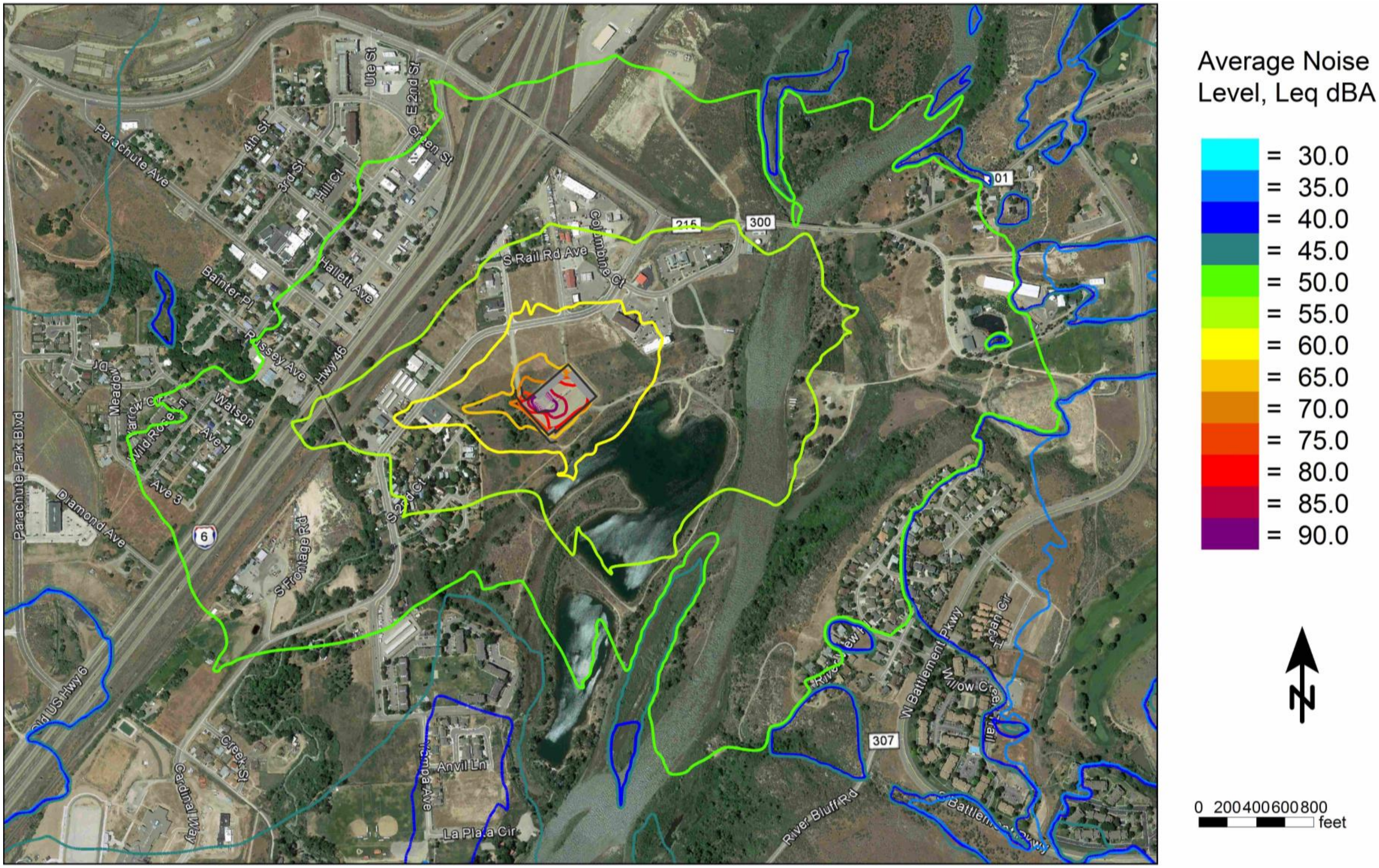

Figure 4-6 Additional Mitigation Fracing Noise Contour Map (dBA)

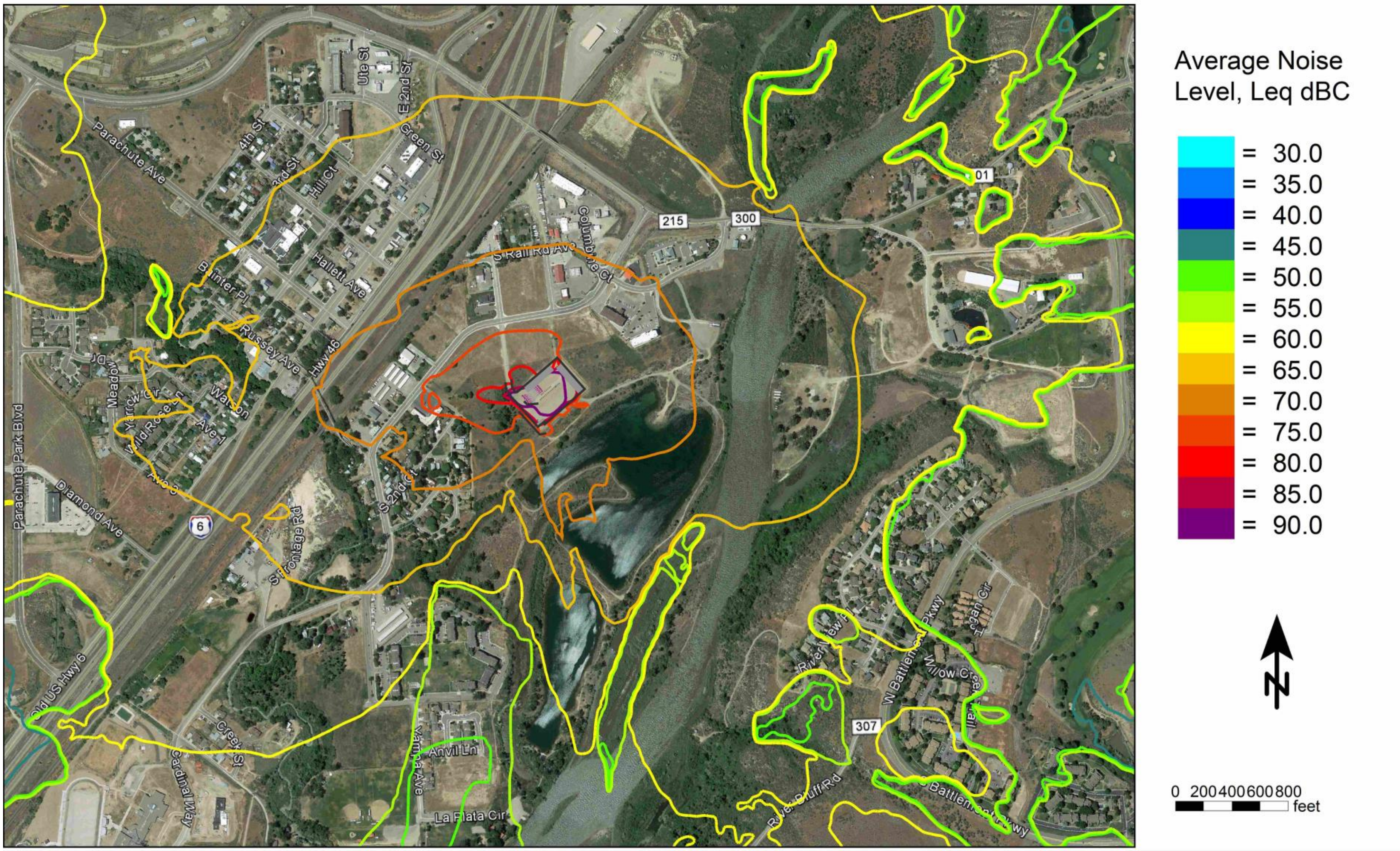

Figure 4-7 Additional Mitigation Fracing Noise Contour Map (dBC)

5. Conclusion

Mitigated noise models were created to represent the current and ongoing fracing operations at the Ursa Resources B&V pad. Our analysis indicates that fracing operations with the Existing Mitigation scenario layout will exceed allowable dBC noise limits per COGCC at various receptor locations.

A scenario showing additional mitigation was created for ongoing fracing activities and was modeled. With implementation of the recommended Additional Mitigation measures, the fracing activities will comply with the COGCC allowable dBA noise limits at all modeled receptor locations but will still exceed the COGCC allowable dBC noise limits at the modeled dBC receptors without consideration of the ambient noise levels. **Any third-party ambient testing data commissioned by Ursa Resources should be considered while reviewing this report and may impact the results herein.**

Appendix A - Nomenclature

Ambient Noise
The all-encompassing noise associated with a given environment at a specified time, usually a composite of sound from many sources both near and far.

Average Sound Level
See Equivalent-Continuous Sound Level

A-Weighted Decibel Scale
The human ear is more sensitive to some sound frequencies than others. It is therefore common practice to apply a filter to measured sound levels to approximate the frequency sensitivity of the human ear. One such filter is called the A-weighted decibel scale which emphasizes sounds between 1,000 and 5,000 Hertz by discounting the frequencies outside of this range. As the human ear is less sensitive to low frequency noise, the A-weighted decibel scale begins to increasingly discount noise below 500 Hertz.

Measurements conducted utilizing the A-weighted decibel scale are denoted with an "(A)" or "A" after the decibel abbreviation (dB(A) or dBA). The A-weighted scale is nearly universally used when assessing noise impact on humans.

C-Weighted Decibel Scale
High level low frequency noise can propagate large distances from its source. Although not always audible, high levels of low frequency noise can induce vibrations in objects or structures which could become evident in ways that might be annoying to humans (e.g., rattling of windows). The C-weighted decibel scale, which was developed to estimate human ear sensitivity to high noise levels, is a flatter filter that does not discount low frequency noise as much as the A-weighted decibel scale. As a result, a C-weighted decibel measurement could be significantly higher than an A-weighted decibel measurement if the noise being measured contains a heavy low frequency content.

Measurements conducted utilizing the C-weighted decibel scale are denoted with an "(C)" or "C" after the decibel abbreviation (dB(C) or dBC). C-weighted noise level limits are sometimes included in noise regulations as a way to address low frequency environmental noise issues.

Community Noise Equivalent Level (CNEL)
A 24-hour A-weighted average sound level which takes into account the fact that a given level of noise may be more or less tolerable depending on when it occurs. The CNEL measure of noise exposure weights average hourly noise levels by 5 dB for the evening hours (between 7:00 pm and 10:00 pm), and 10 dB between 10:00 pm and 7:00 am, then combines the results with the daytime levels to produce the final CNEL value. It is measured in decibels, dB.

Day-Night Average Sound Level (Ldn)
A measure of noise exposure level that is similar to CNEL except that there is no weighting applied to the evening hours of 7:00 pm to 10:00 pm. It is measured in decibels, dB.

Daytime Average Sound Level
The time-averaged A-weighted sound level measured between the hours of 7:00 am to 7:00 pm. It is measured in decibels, dB.

Decay Rate
The time taken for the sound pressure level at a given frequency to decrease in a room. It is measured in decibels per second, dB/s.

Decibel (dB)
The basic unit of measurement for sound level.

Direct Sound
Sound that reaches a given location in a direct line from the source without any reflections.

Divergence
The spreading of sound waves from a source in a free field, resulting in a reduction in sound pressure level with increasing distance from the source.

Energy Basis
This refers to the procedure of summing or averaging sound pressure levels on the basis of their squared pressures. This method involves the conversion of decibels to pressures, then performing the necessary arithmetic calculations, and finally changing the pressure back to decibels.

Equivalent-Continuous Sound Level (Leq)
The average sound level measured over a specified time period. It is a single-number measure of time-varying noise over a specified time period. It is the level of a steady sound that, in a stated time period and at a stated location, has the same A-Weighted sound energy as the time-varying sound. For example, a person who experiences an Leq of 60 dB(A) for a period of 10 minutes standing next to a busy street is exposed to the same amount of sound energy as if he had experienced a constant noise level of 60 dB(A) for 10 minutes rather than the time-varying traffic noise level. It is measured in decibels, dB.

Fast Response
A setting on the sound level meter that determines how sound levels are averaged over time. A fast sound level is always more strongly influenced by recent sounds, and less influenced by sounds occurring in the distant past, than the corresponding slow sound level. For the same non-steady sound, the maximum fast sound level is generally greater than the corresponding maximum slow sound level. Fast response is typically used to measure impact sound levels.

Field Impact Insulation Class (FIIC)
A single number rating similar to the impact insulation class except that the impact sound pressure levels are measured in the field.

Field Sound Transmission Class (FSTC)
A single number rating similar to sound transmission class except that the transmission loss values used to derive this class are measured in the field.

Flanking Sound Transmission
The transmission of sound from a room in which a source is located to an adjacent receiving room by paths other than through the common partition. Also, the diffraction of noise around the ends of a barrier.

Frequency
The number of oscillations per second of a sound wave

Hourly Average Sound Level (HNL)
The equivalent-continuous sound level, Leq, over a 1-hour time period.

Impact Insulation Class (IIC)
A single number rating used to compare the effectiveness of floor/ceiling assemblies in providing reduction of impact-generated sound such as the sound of a person's walking across the upstairs floor.

Impact Noise
The noise that results when two objects collide.

Impulse Noise
Noise of a transient nature due to the sudden impulse of pressure like that created by a gunshot or balloon bursting.

Insertion Loss
The decrease in sound power level measured at the location of the receiver when an element (e.g., a noise barrier) is inserted in the transmission path between the sound source and the receiver.

Inverse Square Law
A rule by which the sound intensity varies inversely with the square of the distance from the source. This results in a 6dB decrease in sound pressure level for each doubling of distance from the source.

Ln Percentile Sound Level
The noise level exceeded for n% of the measurement period where n is between 0.01% and 99.99%. Usually includes a descriptor i.e. A-weighting. Common Ln values include LA10, LA50, and LA90 levels. LA10 would represent the A-weighted sound level that is exceeded for 10% of the measurement period.

Masking
The process by which the threshold of hearing for one sound is raised by the presence of another sound.

Maximum Sound Level (Lmax)
The greatest sound level measured on a sound level meter during a designated time interval or event.

NC Curves (Noise Criterion Curves)
A system for rating the noisiness of an occupied indoor space. An actual octave-band spectrum is compared with a set of standard NC curves to determine the NC level of the space.

Noise Isolation Class (NIC)
A single number rating derived from the measured values of noise reduction between two enclosed spaces that are connected by one or more partitions. Unlike STC or NNIC, this rating is not adjusted or normalized to a measured or standard reverberation time.

Noise Reduction
The difference in sound pressure level between any two points.

Noise Reduction Coefficient (NRC)
A single number rating of the sound absorption properties of a material. It is the average of the sound absorption coefficients at 250, 500, 1000, and 2000 Hz, rounded to the nearest multiple of 0.05.

Normalized Noise Isolation Class (NNIC)
A single number rating similar to the noise isolation class except that the measured noise reduction values are normalized to a reverberation time of 0.5 seconds.

Octave
The frequency interval between two sounds whose frequency ratio is 2. For example, the frequency interval between 500 Hz and 1,000 Hz is one octave.

Octave-Band Sound Level
For an octave frequency band, the sound pressure level of the sound contained within that band.

One-Third Octave
The frequency interval between two sounds whose frequency ratio is 2^(1/3). For example, the frequency interval between 200 Hz and 250 Hz is one-third octave.

One-Third-Octave-Band Sound Level
For a one-third-octave frequency band, the sound pressure level of the sound contained within that band.

Outdoor-Indoor Transmission Class (OITC)
A single number rating used to compare the sound insulation properties of building façade elements. This rating is designed to correlate with subjective impressions of the ability of façade elements to reduce the overall loudness of ground and air transportation noise.

Peak Sound Level (Lpk)
The maximum instantaneous sound level during a stated time period or event.

Pink Noise
Noise that has approximately equal intensities at each octave or one-third-octave band.

Point Source
A source that radiates sound as if from a single point.

RC Curves (Room Criterion Curves)
A system for rating the noisiness of an occupied indoor space. An actual octave-band spectrum is compared with a set of standard RC curves to determine the RC level of the space.

Real-Time Analyzer (RTA)
An instrument for the determination of a sound spectrum.

Receiver
A person (or persons) or equipment which is affected by noise.

Reflected Sound
Sound that persists in an enclosed space as a result of repeated reflections or scattering. It does not include sound that travels directly from the source without reflections.

Reverberation
The persistence of a sound in an enclosed or partially enclosed space after the source of the sound has stopped, due to the repeated reflection of the sound waves.

Room Absorption
The total absorption within a room due to all objects, surfaces and air absorption within the room. It is measured in Sabins or metric Sabins.

Slow Response
A setting on the sound level meter that determines how measured sound levels are averaged over time. A slow sound level is more influenced by sounds occurring in the distant past that the corresponding fast sound level.

Sound
A physical disturbance in a medium (e.g., air) that is capable of being detected by the human ear.

Sound Absorption Coefficient
A measure of the sound-absorptive property of a material.

Sound Insulation
The capacity of a structure or element to prevent sound from reaching a receiver room either by absorption or reflection.

Sound Level Meter (SLM)
An instrument used for the measurement of sound level, with a standard frequency-weighting and standard exponentially weighted time averaging.

Sound Power Level
A physical measure of the amount of power a sound source radiates into the surrounding air. It is measured in decibels.

Sound Pressure Level
A physical measure of the magnitude of a sound. It is related to the sound's energy. The terms sound pressure level and sound level are often used interchangeably.

Sound Transmission Class (STC)
A single number rating used to compare the sound insulation properties of walls, floors, ceilings, windows, or doors. This rating is designed to correlate with subjective impressions of the ability of building elements to reduce the overall loudness of speech, radio, television, and similar noise sources in offices and buildings.

Source Room
A room that contains a noise source or sources

Spectrum
The spectrum of a sound wave is a description of its resolution into components, each of different frequency and usually different amplitude.

Tapping Machine
A device used in rating different floor constructions against impacts. It produces a series of impacts on the floor under test, 10 times per second.

Tone
A sound with a distinct pitch

Transmission Loss (TL)
A property of a material or structure describing its ability to reduce the transmission of sound at a particular frequency from one space to another. The higher the TL value the more effective the material or structure is in reducing sound between two spaces. It is measured in decibels.

White Noise
Noise that has approximately equal intensities at all frequencies.

Windscreen
A porous covering for a microphone, designed to reduce the noise generated by the passage of wind over the microphone.