Oil and Gas Permit Application

Section (11) Noise Management Plan

Aurora Phase 1 Development

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1.0 Executive Summary

As per Article II. H. (11) and Best Management Practices 25, of the Operator Agreement, Axis is providing a Noise Management Plan to the City. As part of this plan Axis has contracted TruHorizons, a third-party sound modeling consulting firm, to analyze existing sound impacts and what potential effect oil and gas operations will have at the location. The TruHorizons ambient sound study and sound impact assessments are below.

Approximately 460' of 24' tall soundwalls are recommended to be installed on the south and west sides of the pad to mitigate any potential noise impacts. Due to requests during the pre-application process additional soundwalls will be installed along the south and west sides of the pad. Approximately 600' of 32' tall soundwalls will be installed along the southern edge of the pad and 400' of 32' tall soundwalls will be installed on the western edge of the pad. Soundwall dimensions are more specifically described on the site plan. Noise mitigation, including soundwalls, berms and bales, has been designed using the attached reports to ensure compliance with COGCC Rule 802 and the Operator Agreement.

Pipe will not be unloaded between 8:00PM and 7:00AM.

2.0 ACM Highpoint Pad Sound Impact Assessment and Ambient Noise Study

Sound Impact Assessment

ACM High Point Pad

Adams County, Colorado

Prepared for:

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Prepared by:

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March 28, 2019

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Executive Summary

Principle Environmental, LLC (TruHorizon) prepared this report to investigate the anticipated sound impact of drilling and hydraulic fracturing operations on the surrounding environment at the ACM High Point pad which is to be located in Adams County, Colorado. Sound levels from the Patterson Traditional Rig #284, the Patterson Electric Drilling Rig #346, the Liberty Hybrid Fracturing Fleet and the Liberty Quiet Fracturing Fleet have been modeled for the ACM High Point location. **Table 1** shows the estimated sound levels at the closest structure.

Table 1: Sound Levels at Closest Structure

Mitigation	Traditional Drilling (dBA)	Traditional Drilling (dBC)	Electric Drilling (dBA)	Electric Drilling (dBC)
No Mitigation	46.6	62.5	43.3	63.5
24-Foot-Tall Mitigation	44.3	55.6	40.0	56.7

Mitigation	Hybrid Completions (dBA)	Hybrid Completions (dBC)	Quiet Completions (dBA)	Quiet Completions (dBC)
No Mitigation	48.2	67.1	44.9	66.9
24-Foot-Tall Mitigation	45.8	59.8	41.2	59.3

The sound levels generated by oil and gas operations are expected to exceed 65 dBC at nearby structures during completions operations. The mitigation option outlined in this report shows the impact of adding a 24-foot-tall barrier on the southwest portion of the pad. Please note sound levels will not decrease below ambient sound conditions. The overall sound averages for the ambient study conducted at the location from Friday October 19 to Monday October 22, 2018 were 56.0 dBA and 65.4 dBC, which exceeds the COGCC limit for C-weighted sounds.

Ordinance Summary

In December 2005 Ordinance No. 1R-99 was enacted for the State of Colorado by the Colorado Oil and Gas Commission which regulates the environmental performance standards. Section 802 sets regulations to establish a process for reasonable noise control.

Section 802 states that "Sound levels shall be measured at a distance of three hundred and fifty (350) feet from the noise source", or "sound levels shall be measured at a point twenty-five (25) feet from the structure towards the noise source."

In situations where measurement of noise levels at three hundred and fifty (350) feet is impractical or unrepresentative due to topography, the measurement may be taken at a lesser distance and extrapolated to a 350-foot equivalent using the following formula:

$$dB(A)_{DISTANCE\ 2} = dB(A)_{DISTANCE\ 1} - \left(20 \times \log_{10}\left(\frac{distance\ 2}{distance\ 1}\right)\right)$$

Noise levels not to exceed designated limits in **Table 2** during the stated time frames:

Table 2: COGCC Zones and Designated Limits for Oil and Gas Operations

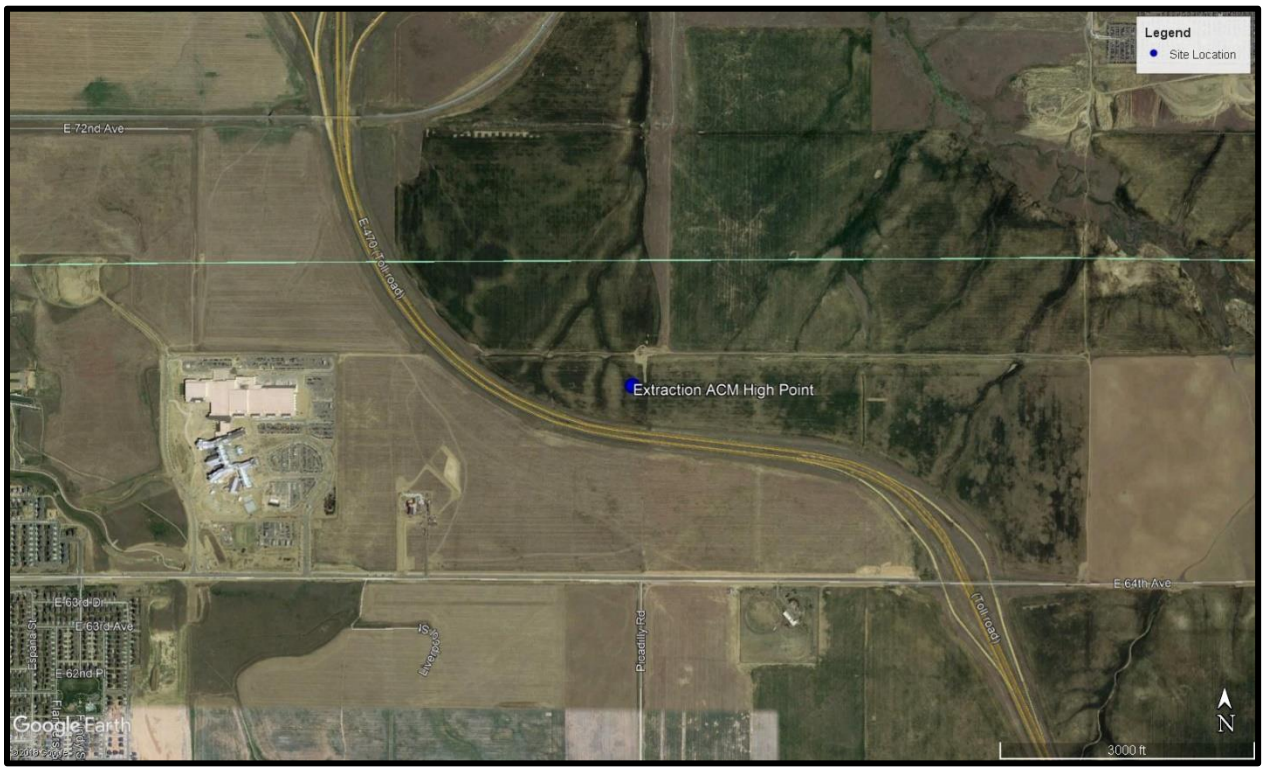
ZONE	7:00 a.m. – 7:00 p.m.	7:00 p.m. – 7:00 a.m.
Residential	55 dB(A)	50 dB(A)
Commercial	60 dB(A)	55 dB(A)
Light industrial	70 dB(A)	65 dB(A)
Industrial	80 dB(A)	75 dB(A)

- Sound level measurements shall be taken four (4) feet above ground level.
- Sound levels shall be determined by averaging minute-by-minute measurements made over a minimum fifteen (15) minute sample duration.
- Sound levels that are C-weighted for low frequency shall not exceed 65 dB(C) when measured twenty-five (25) feet from the exterior wall of the residence or occupied structure nearest to the noise source, in the event of a complaint.

Site Information

The ACM High Point pad is to be located northeast of E-470 and south of Pena Blvd. The coordinates for the location are approximately 39°49'9.84"N, 104°44'9.65"W. **Figure 1** below shows the vicinity of the ACM High Point location, designated by the blue dot. There are no known structures within 1,000 feet of the pad. The closest structure is about 2,200 feet southwest of the pad. The closest residential structure is 5,600 feet southwest of the site. All of the closest structures are separated from the site by E-470, which is a high traffic highway.

Figure 1: Aerial View of ACM High Point Location



The ACM High Point site is to be located in an open area with minimal changes in topography. There are no major obstructions near the site. The closest road, E-47, is about 500 feet to the southwest. E-470 is a large contributor to noise levels for the area due to the speed limit of 75 mph and to the high levels of traffic.

Equipment Noise Signature Data

TruHorizon performed a noise signature on the Patterson traditional drilling rig 284 and the Patterson electric drilling rig 346 as well as the Liberty hybrid fracturing fleet and the Liberty Quiet fracturing fleet. Note that the levels for the hybrid fleet were obtained by performing a sound signature on a Pioneer Wireline truck. The sound levels of the wireline truck were then added to the model for the Liberty Quiet Fleet. The full layout and sound levels of operations can be found in **Attachment 1**. Please reference the Extraction Gardner Site Patterson Rig 346 Sound Signature 181026, the Extraction Johnson Trust Noise Signature 160829 and the Extraction Pioneer Wireline Sound Signature 190130 for additional information. The following sound levels in **Table 3** are utilized in the models:

Table 3: ACM High Point Site Sound Sources (dBA) at Selected Distances (ft.)

Sound (Point Source)	Quantity	Sound Level (dBA)	Distance (ft.)
Patterson Drill Rig 248 (Traditional Drill Rig)			
Rig Floor	1	73.33	20
Generators	3	88.86	20
Shakers	2	67.99	20
Patterson Drill Rig 346 (Electric Drill Rig)			
Rig Floor	1	77.10	25
Pump	3	78.21	25
Shaker	1	71.57	25
Generator	3	89.22	25
Liberty Hybrid Fracturing Fleet			
Liberty Quiet Frac Pump	21	80.60	25
Wireline Truck	1	87.05	25
Liberty Quiet Fracturing Fleet			
Liberty Quiet Frac Pump	21	80.60	25

Sound Model Limitations and References

By modeling the geographical properties of the location and utilizing equipment sound level data sound levels around the location can be predicted at specific locations. The predicted sound levels can then determine if mitigation is required. TruHorizon utilized DataKustik CadnaA version 2017 MR 1 software for the calculation and assessment of noise propagation to generate the models in the report.

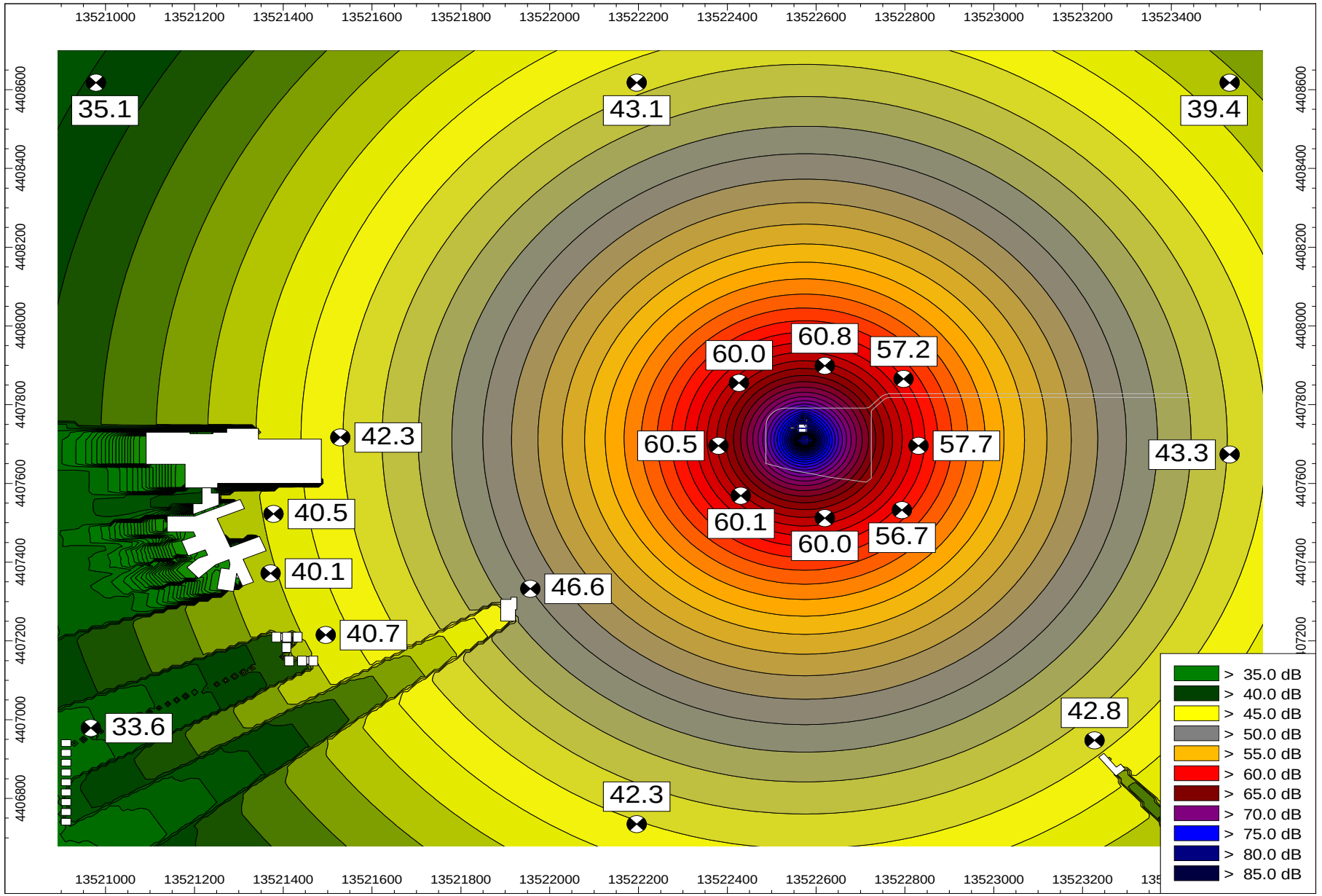
Pre-existing sound sources such as those from road traffic, weather, animals, air traffic and other ambient sounds are not included in the models. Weather conditions such as wind speed, wind direction, temperature and humidity can influence sound intensity and direction. Wind can affect the propagation of sound by several decibels depending on the wind speed, direction and cloud cover. A chart of attenuation of sound due to wind is provided in **Attachment 2**. For conservatism and the uncertainty of the season, TruHorizon omitted foliage in the models. The sound levels generated in the models are strictly from oil and gas operations; measured sound levels may differ from those in the model. **Attachment 3** details typical decibel levels for various types of sounds for reference and comparison.

Predictive modeling of C-weighted sound data is not included in the International Standard ISO 9613 (Acoustics—Attenuation of sound during propagation outdoors.)

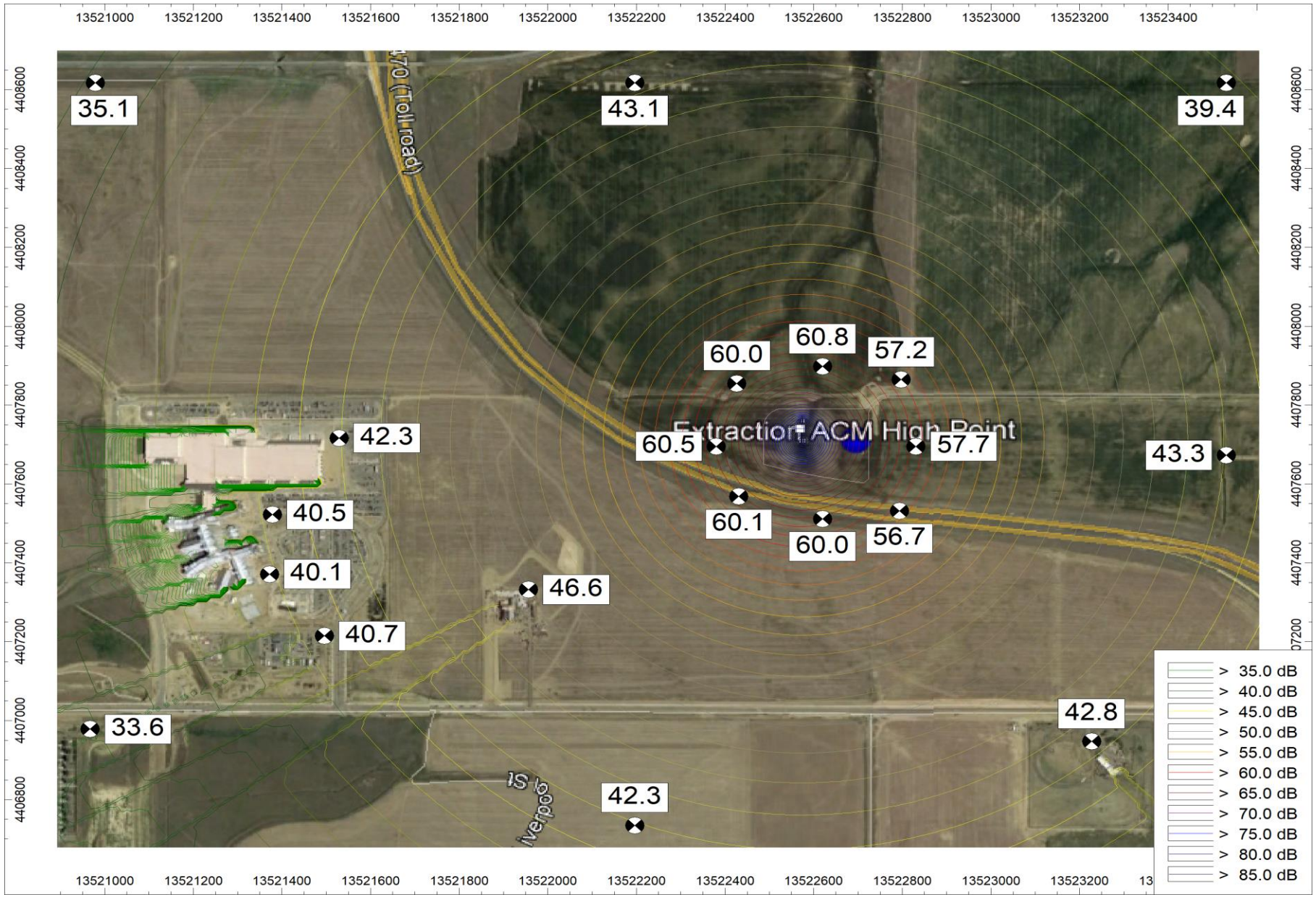
The services provided for the project was performed with the care and skill ordinarily exercised by reputable members of the profession practicing under similar conditions. No warranty, expressed or implied, is made or intended by rendition of these consulting services or by furnishing oral or written reports of the findings made. This report has been prepared by Principle Environmental, LLC for the exclusive use by Axis Exploration, LLC.

All models are oriented in the northern direction.

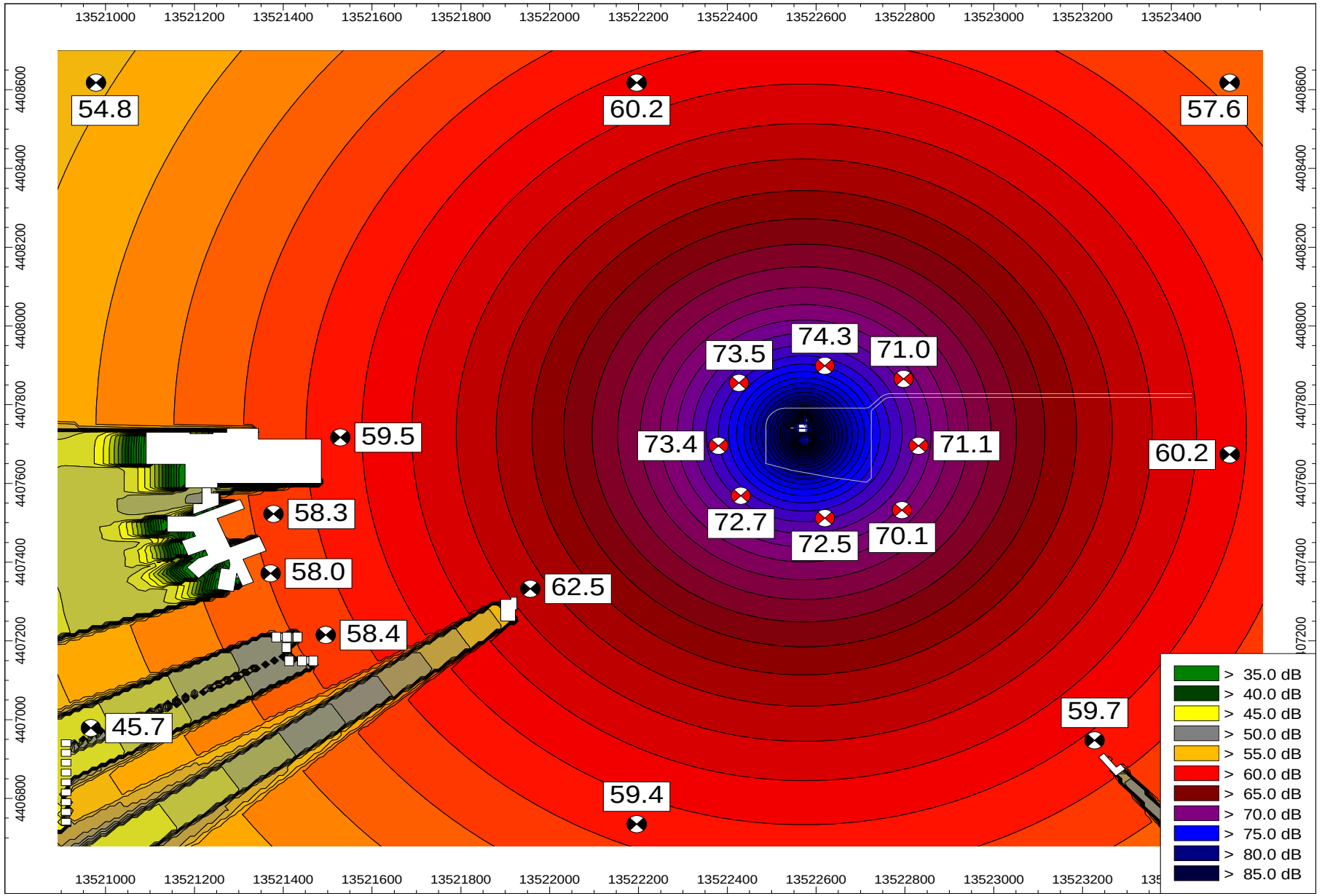
Model 1: Patterson 284 Traditional Drilling Operations (A-Weighted Levels)



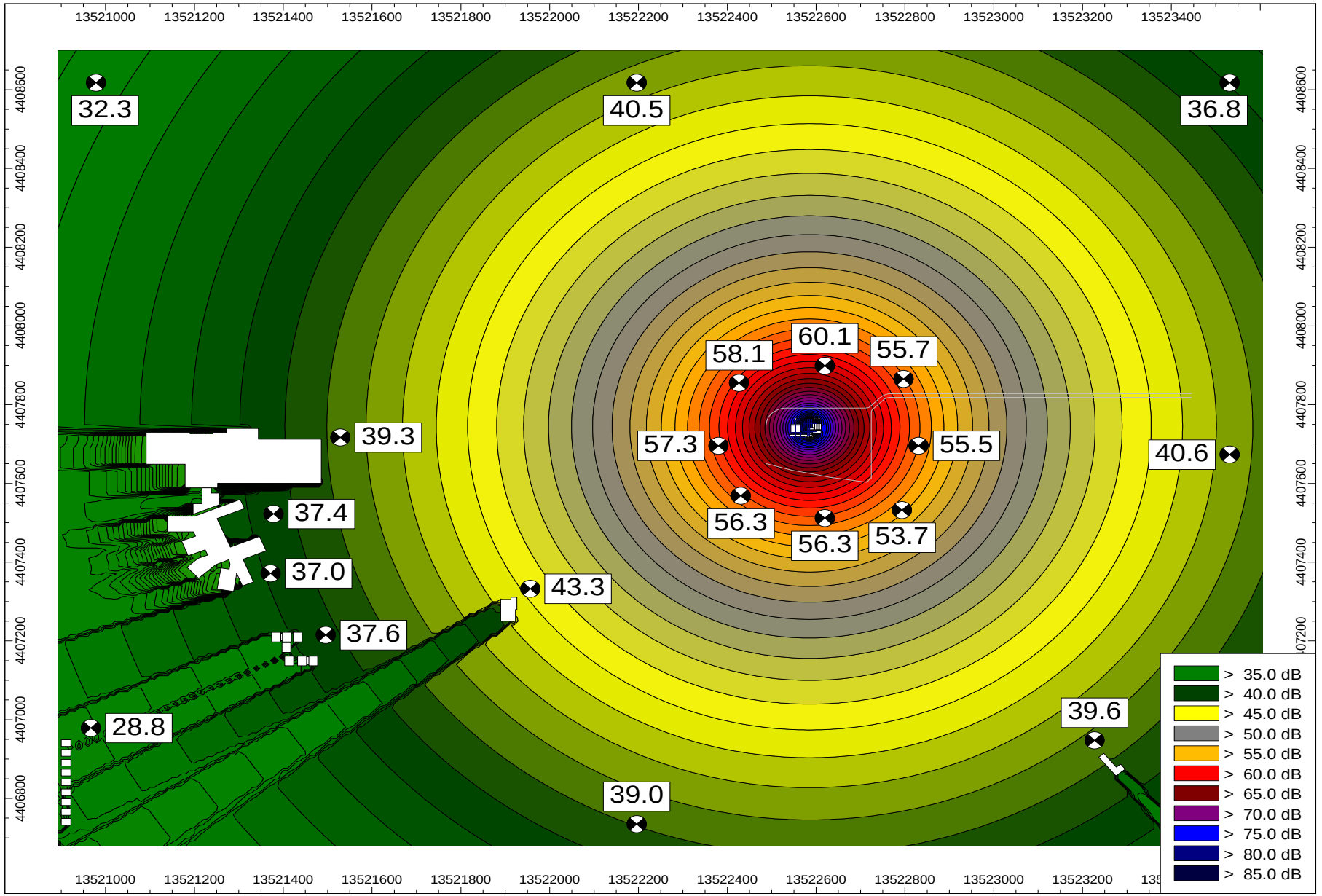
Model 2: Patterson 284 Traditional Drilling Operations (A-Weighted Levels)



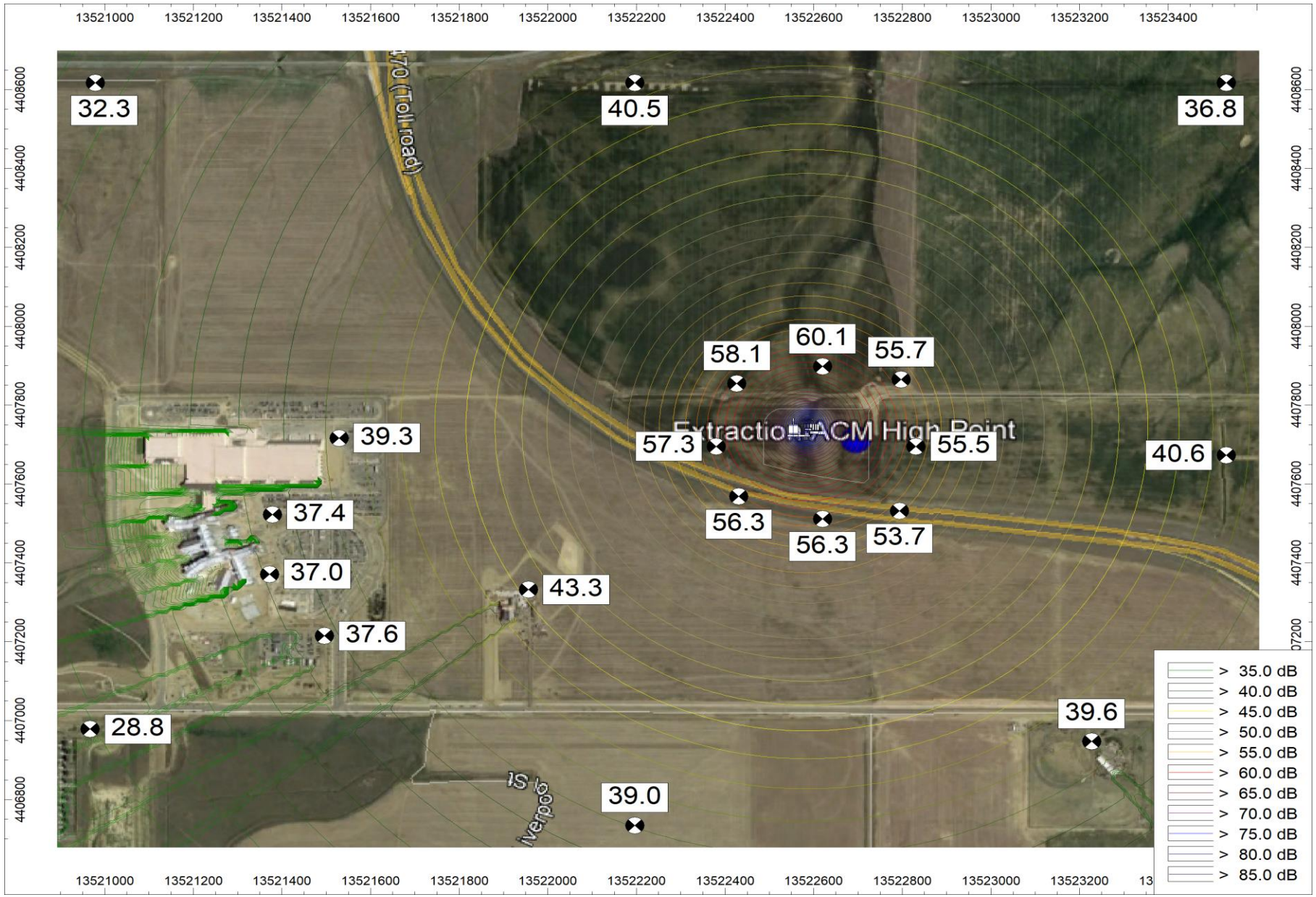
Model 3: Patterson 284 Traditional Drilling Operations (**C-Weighted Levels**)



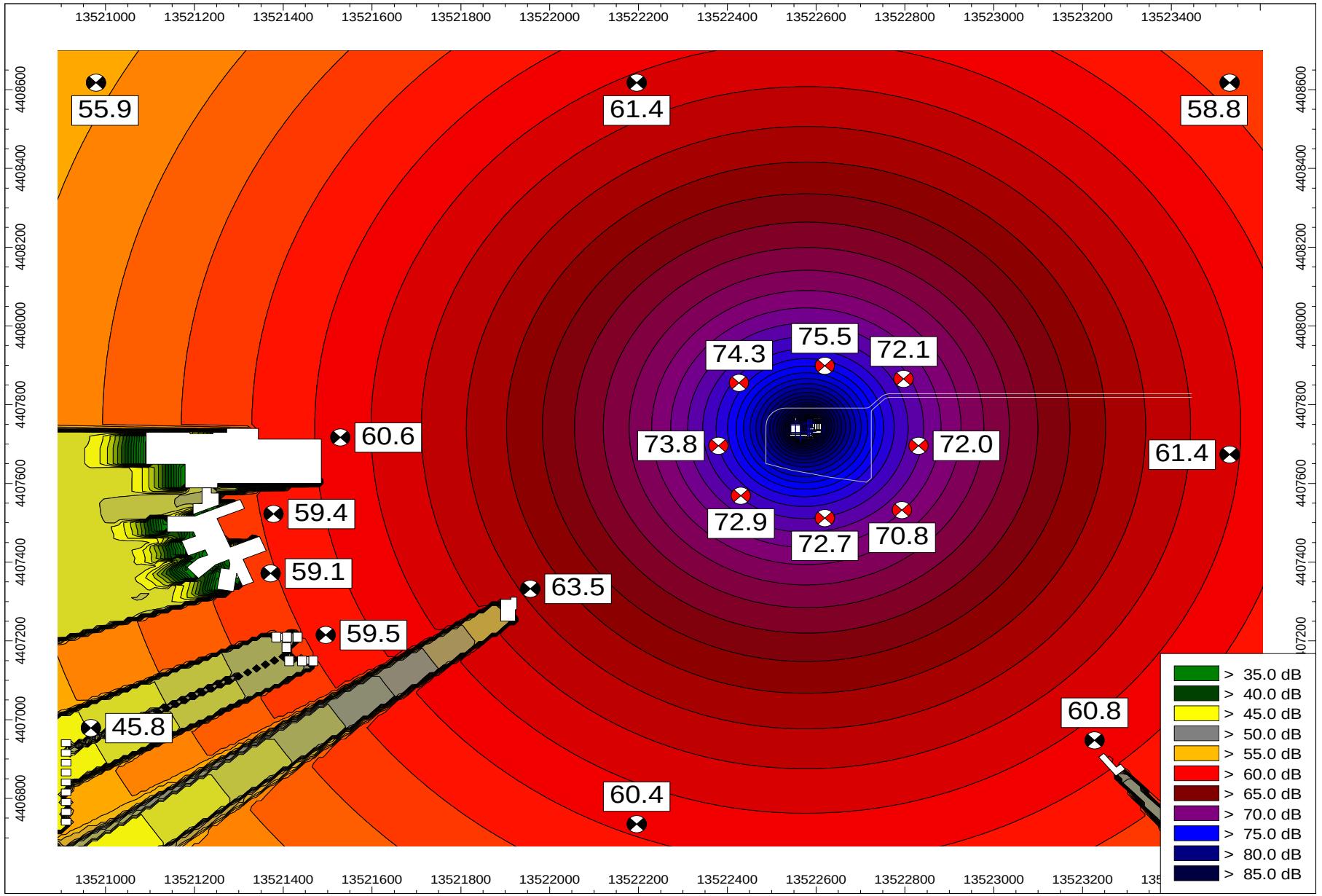
Model 4: Patterson 346 Electric Drilling Operations (A-Weighted Levels)



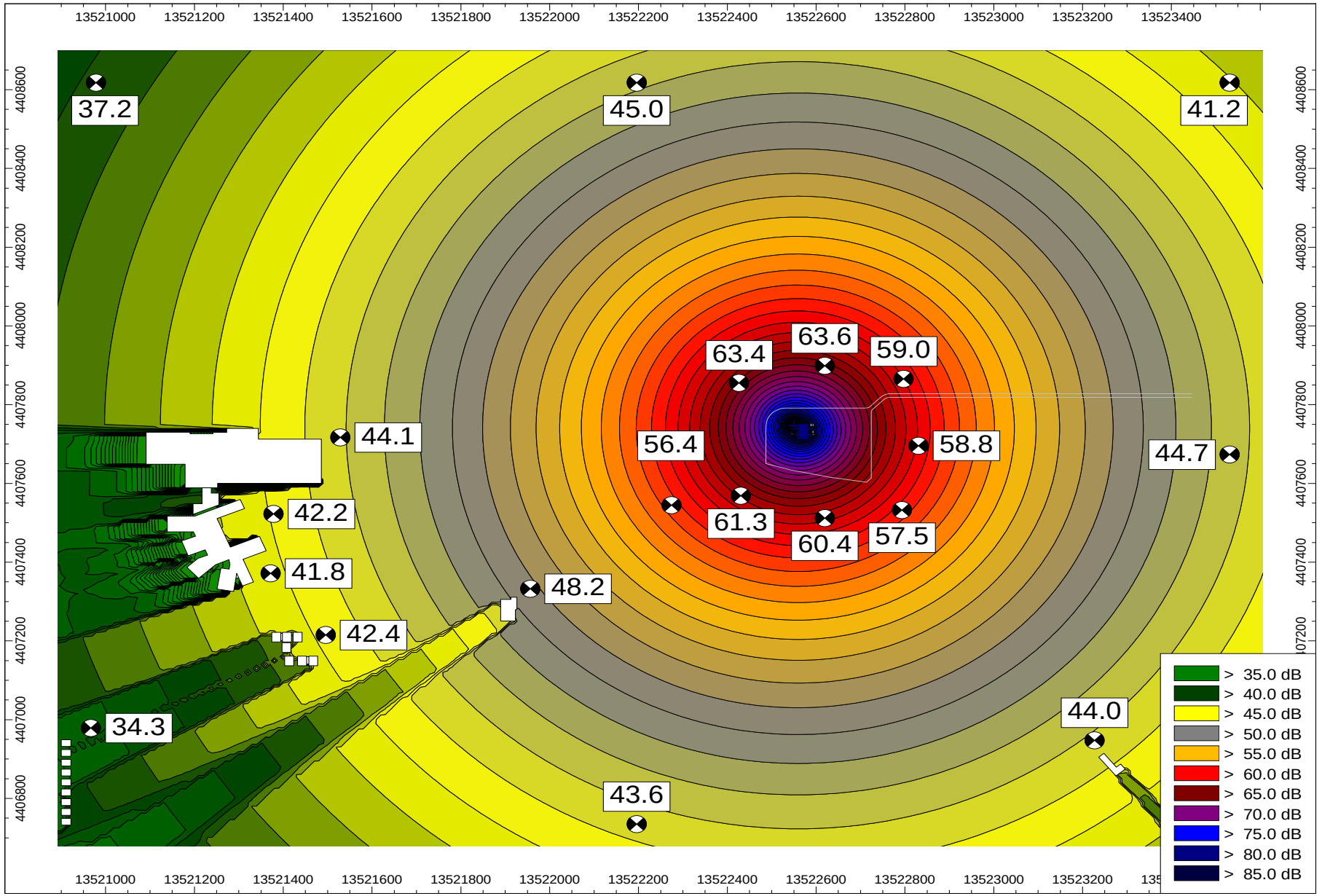
Model 5: Patterson 346 Electric Drilling Operations (A-Weighted Levels)



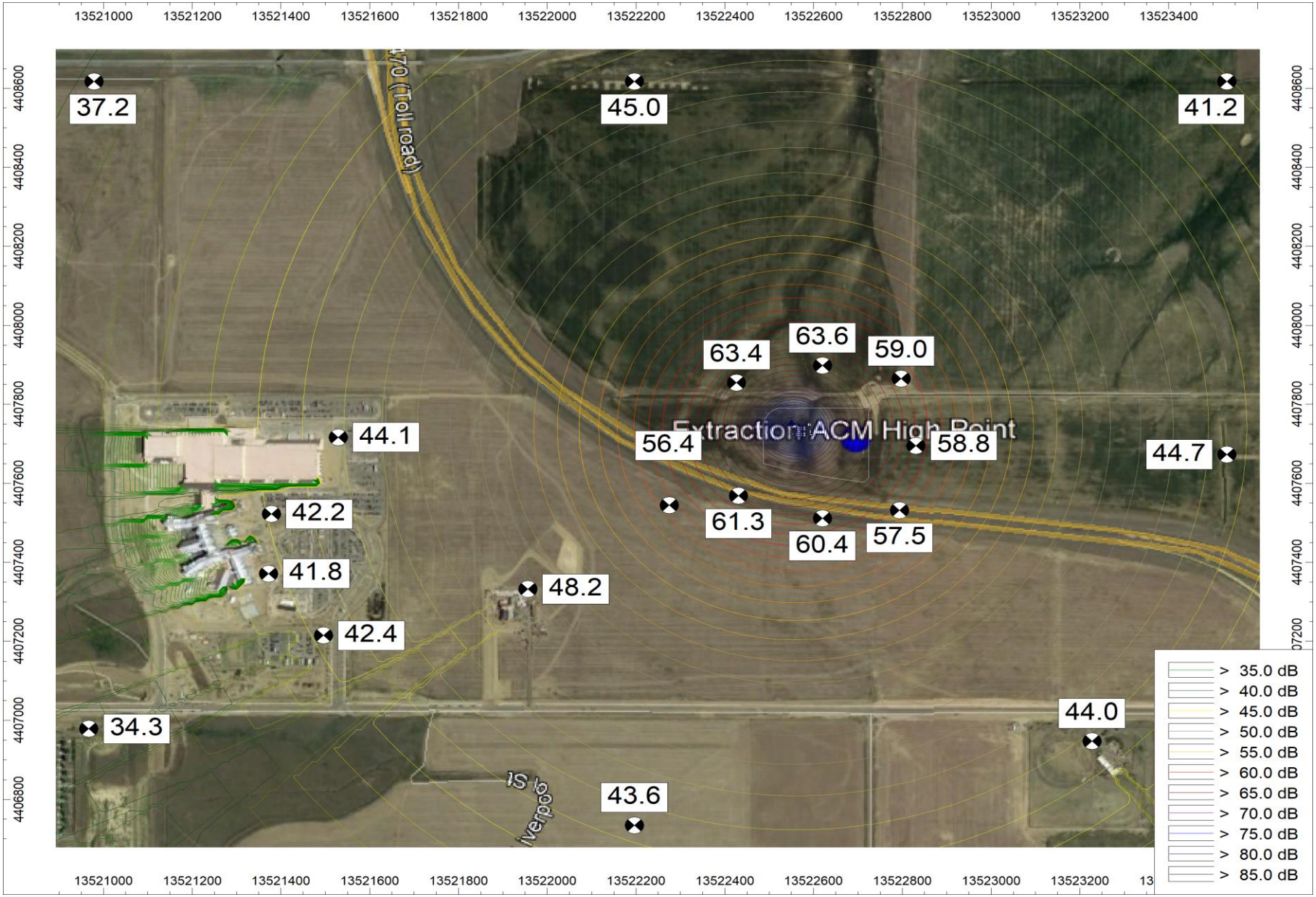
Model 6: Patterson 346 Electric Drilling Operations (**C-Weighted Levels**)



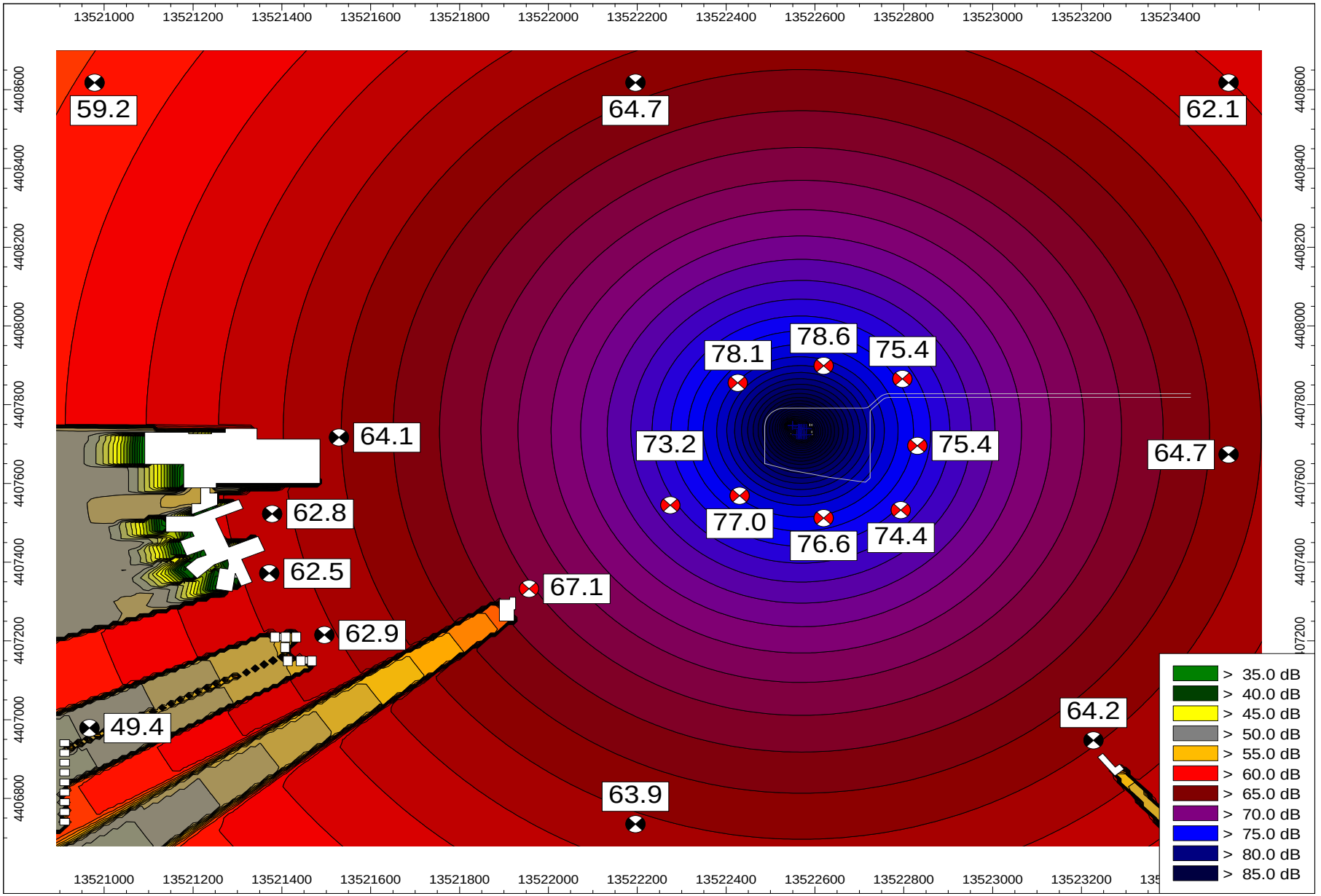
Model 7: Liberty Hybrid Completion Operations (A-Weighted Levels)



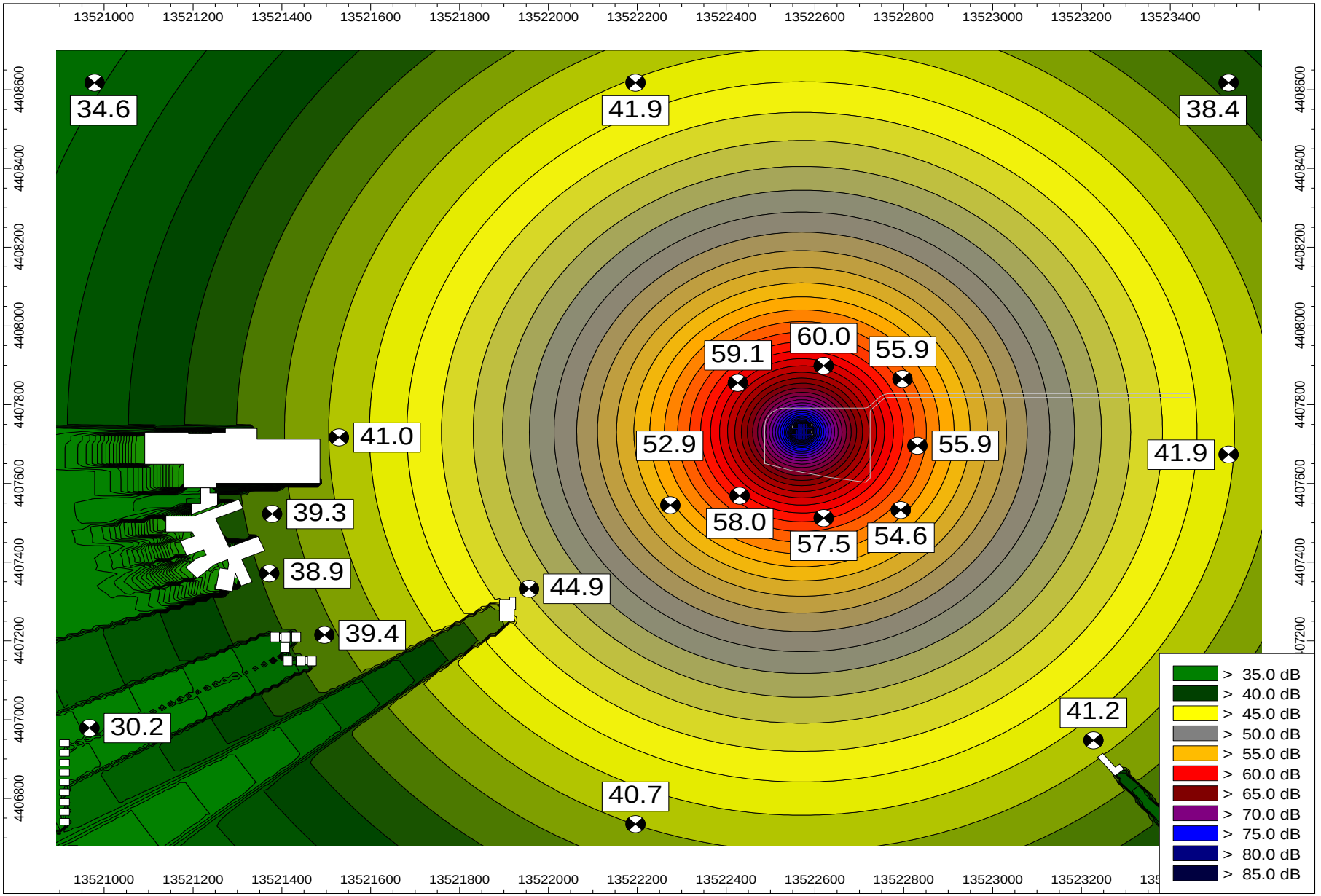
Model 8: Liberty Hybrid Completion Operations (A-Weighted Levels)



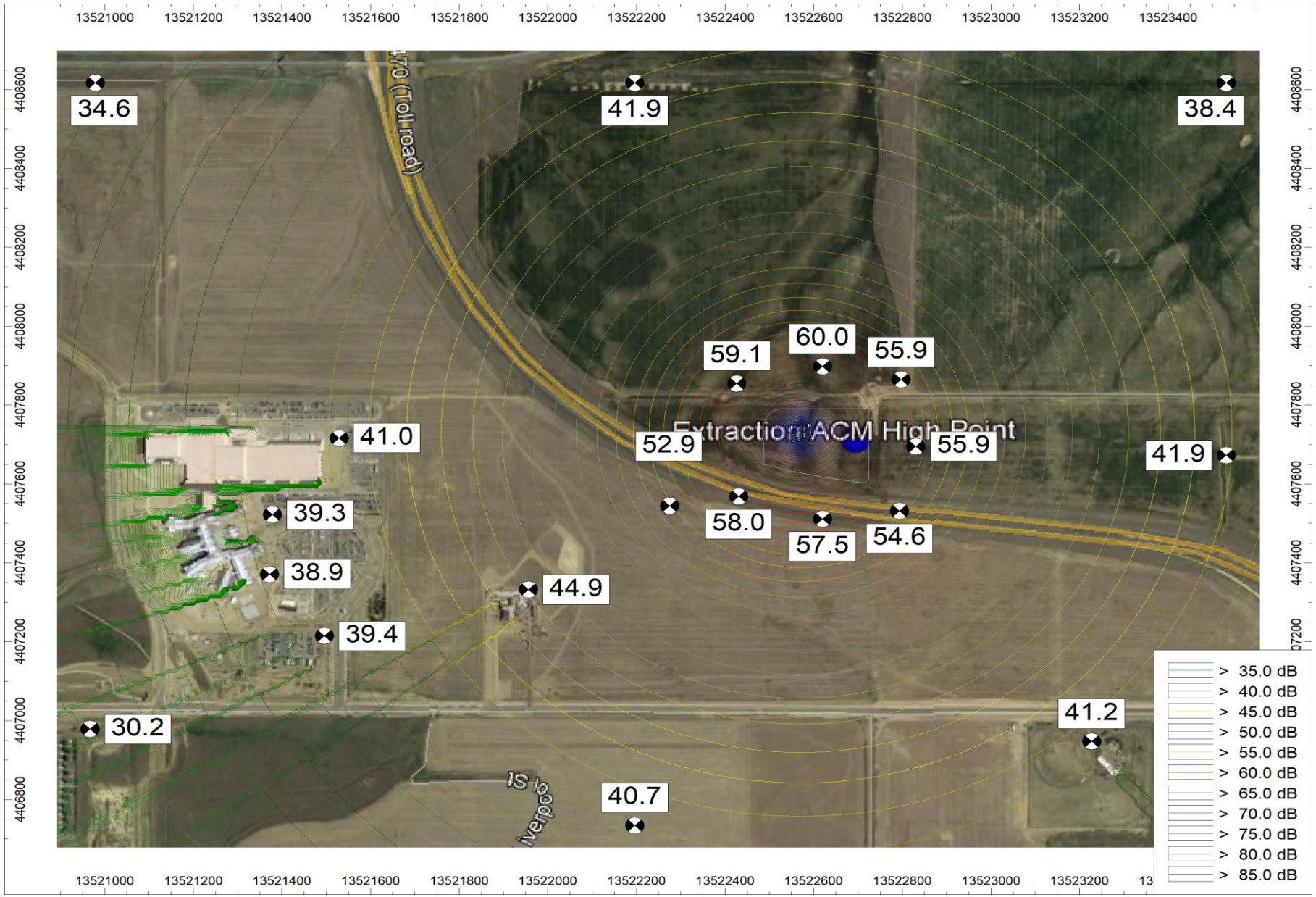
Model 9: Liberty Hybrid Completion Operations (**C-Weighted Levels**)



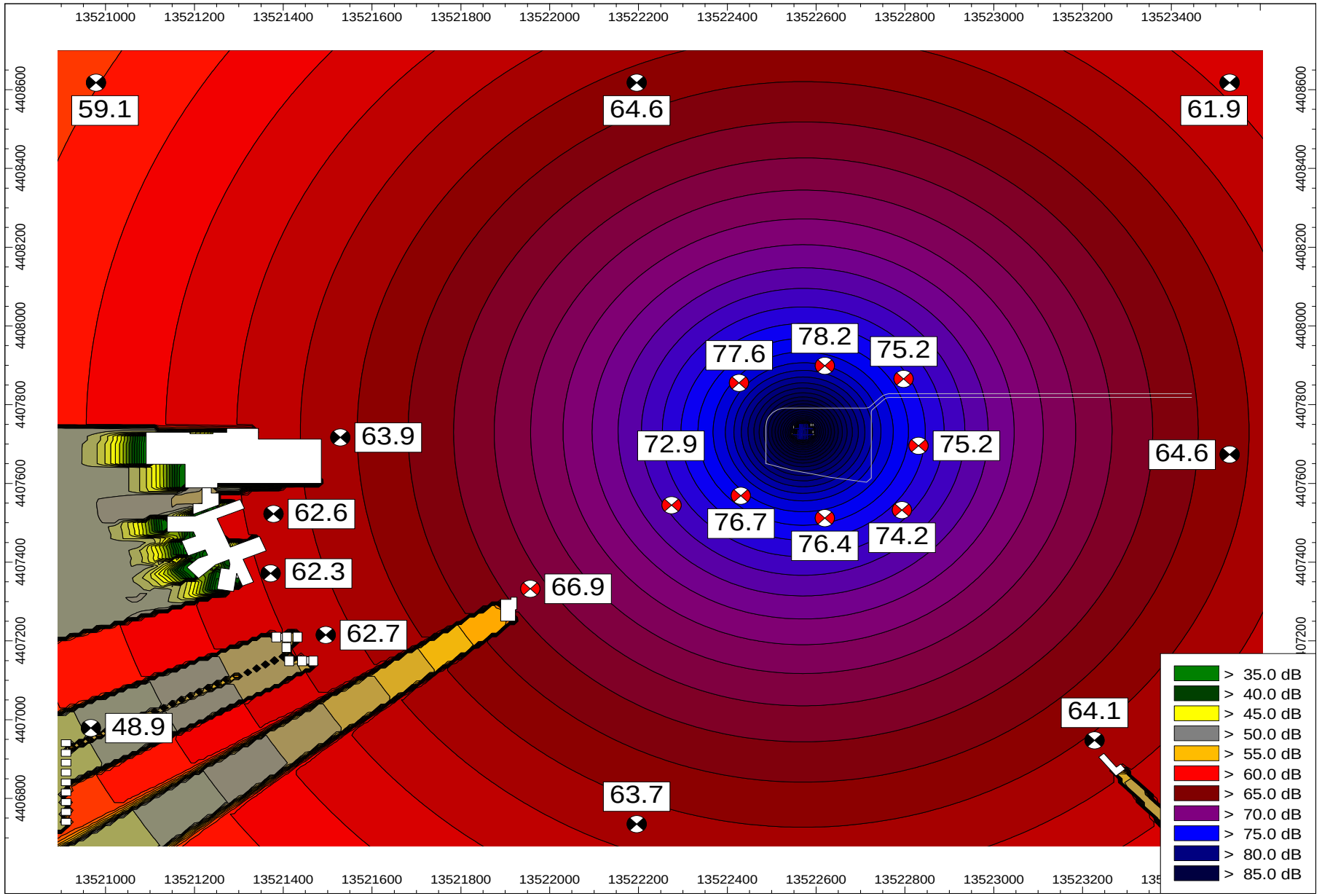
Model 10: Liberty Quiet Completion Operations (A-Weighted Levels)



Model 11: Liberty Quiet Completion Operations (A-Weighted Levels)



Model 12: Liberty Quiet Completion Operations (**C-Weighted Levels**)



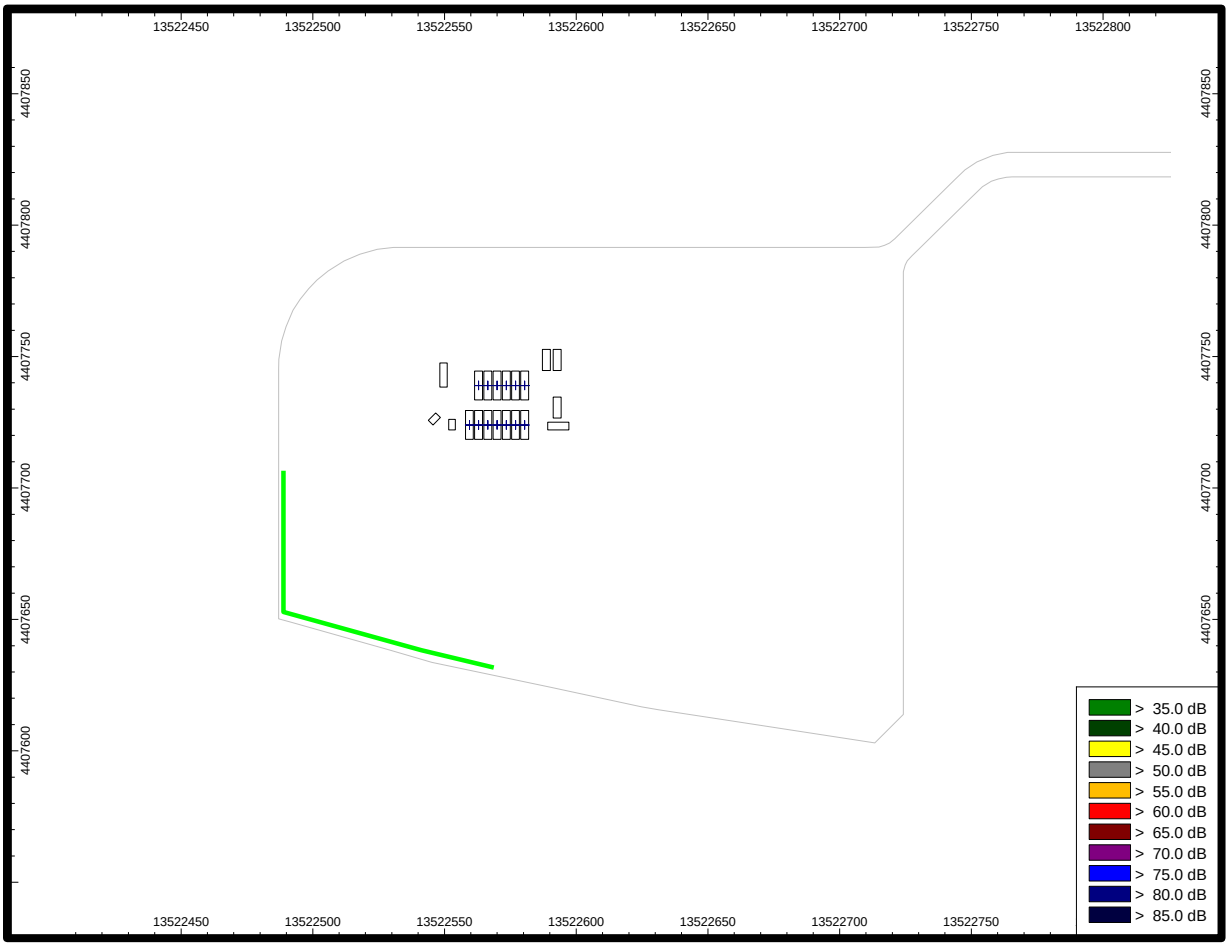
Site Recommendations

The sound levels at nearby structures are expected to require abatement based on the COGCC C-weighted limit of 65 dBC. The placement of barriers with the following configurations will reduce the noise impact for the surrounding area. The mitigation option is only recommended during hybrid completions or quiet completions operations; however, the impact of the barrier is shown for all operations. The lengths and location of all barriers are approximate; final lengths may be determined on site. **Figure 2** shows the mitigation layout; the green line denotes the recommended barrier.

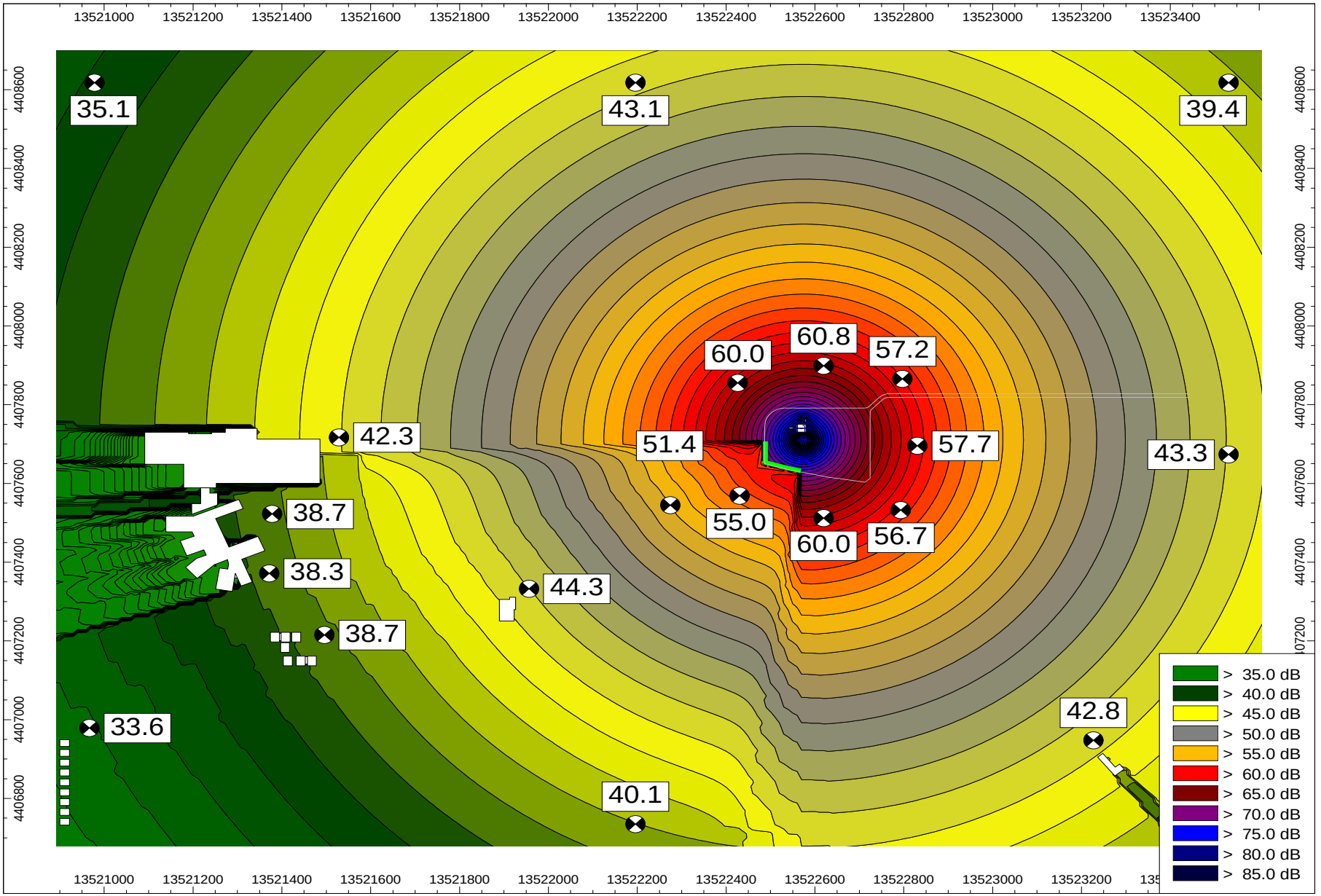
24-Foot-Tall Mitigation Option

- Approximately 280 linear feet of 24-foot-tall barrier on the south side of the pad
- Approximately 180 linear feet of 24-foot-tall barrier on the west side of the pad
    - Total linear footage: 460 feet of 24-foot-high barrier

Figure 2: 24-Foot-Tall Mitigation Layout

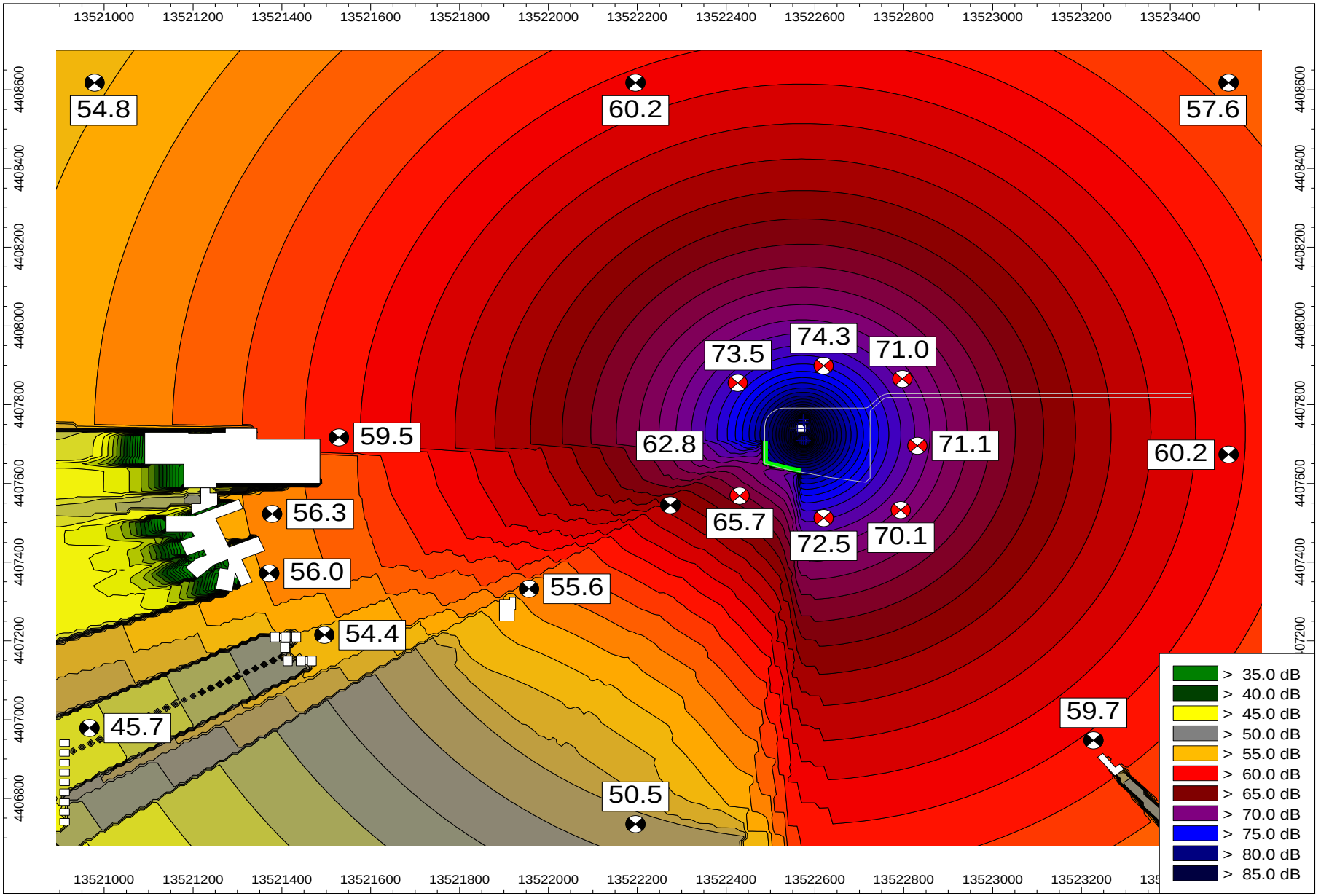


Model 13: Patterson 284 Drilling Operations with Mitigation Option (A-Weighted Levels)

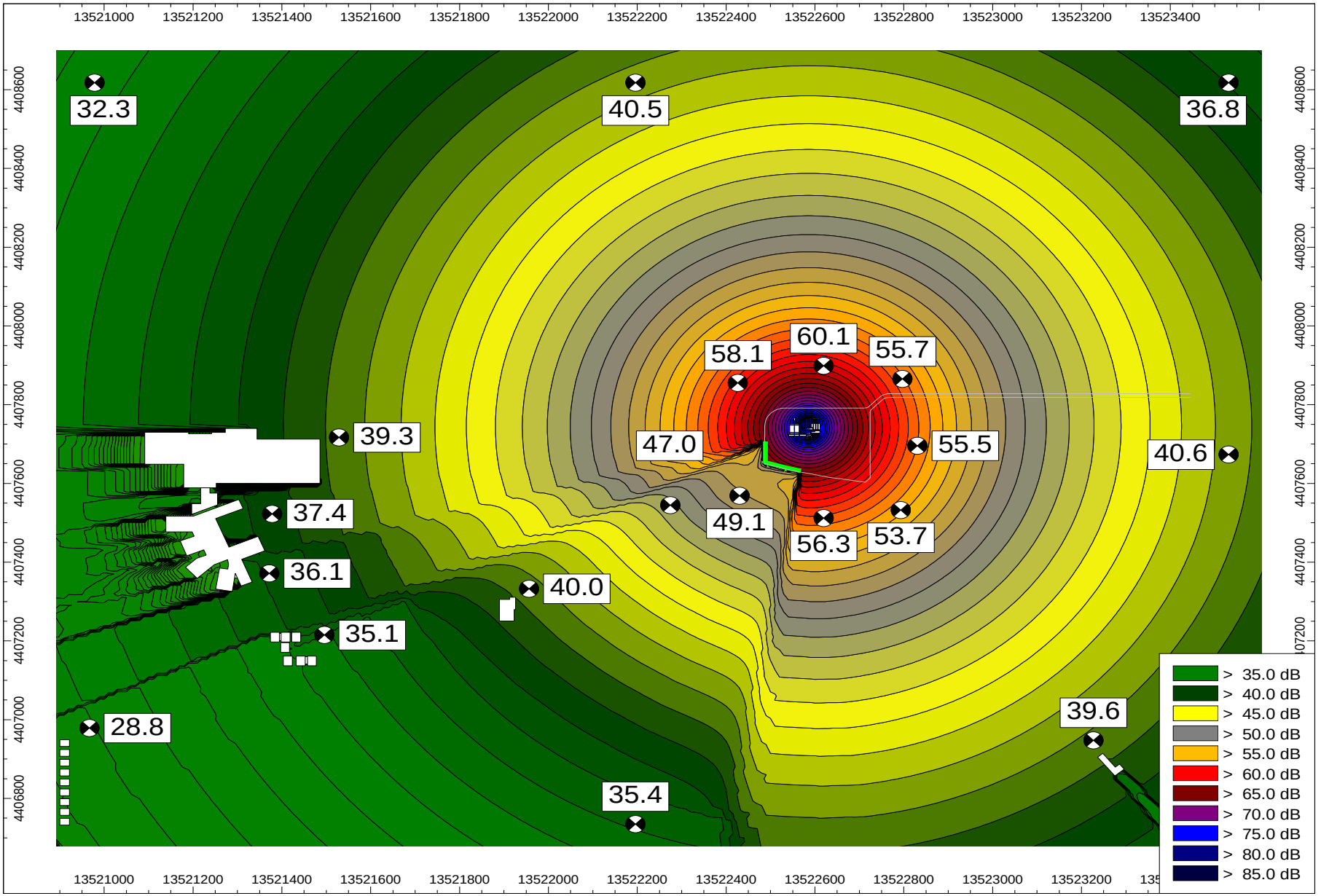


<u>Model 14</u>: Patterson 284 Drilling Operations with Mitigation Option (A-Weighted Levels)

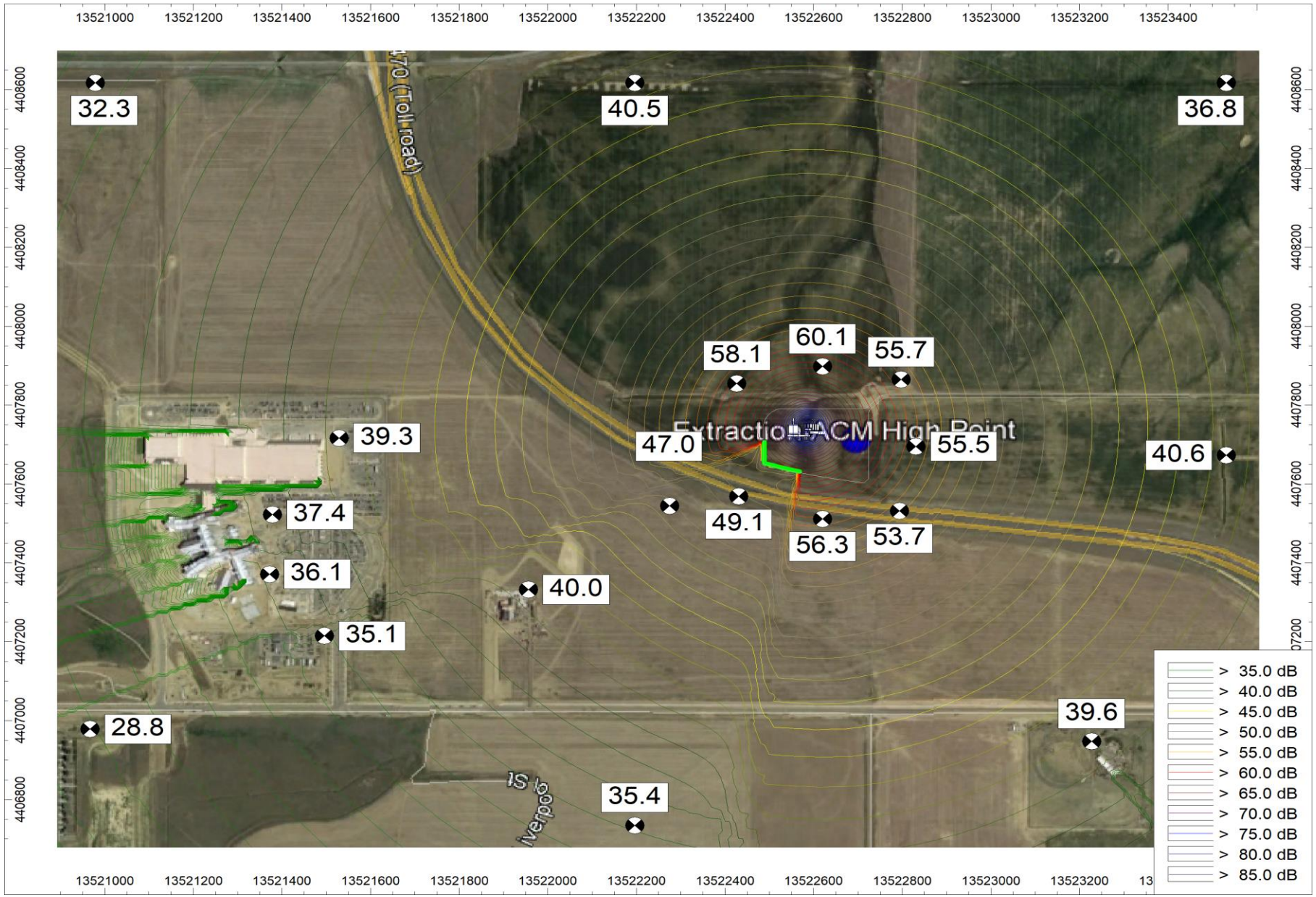
<u>Model 15</u>: Patterson 284 Drilling Operations with Mitigation Option (**C-Weighted Levels**)



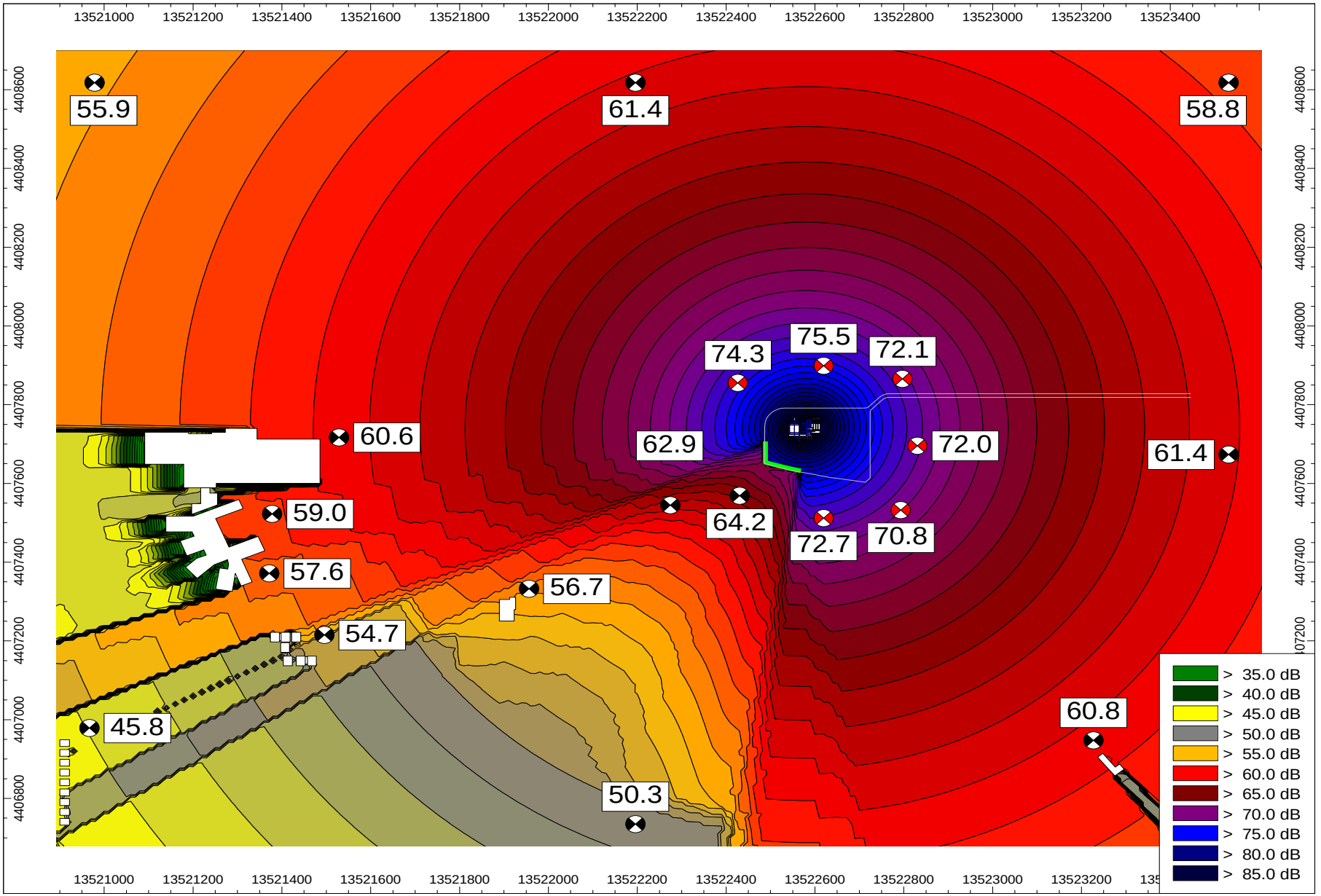
Model 16: Patterson 346 Drilling Operations with Mitigation Option (A-Weighted Levels)



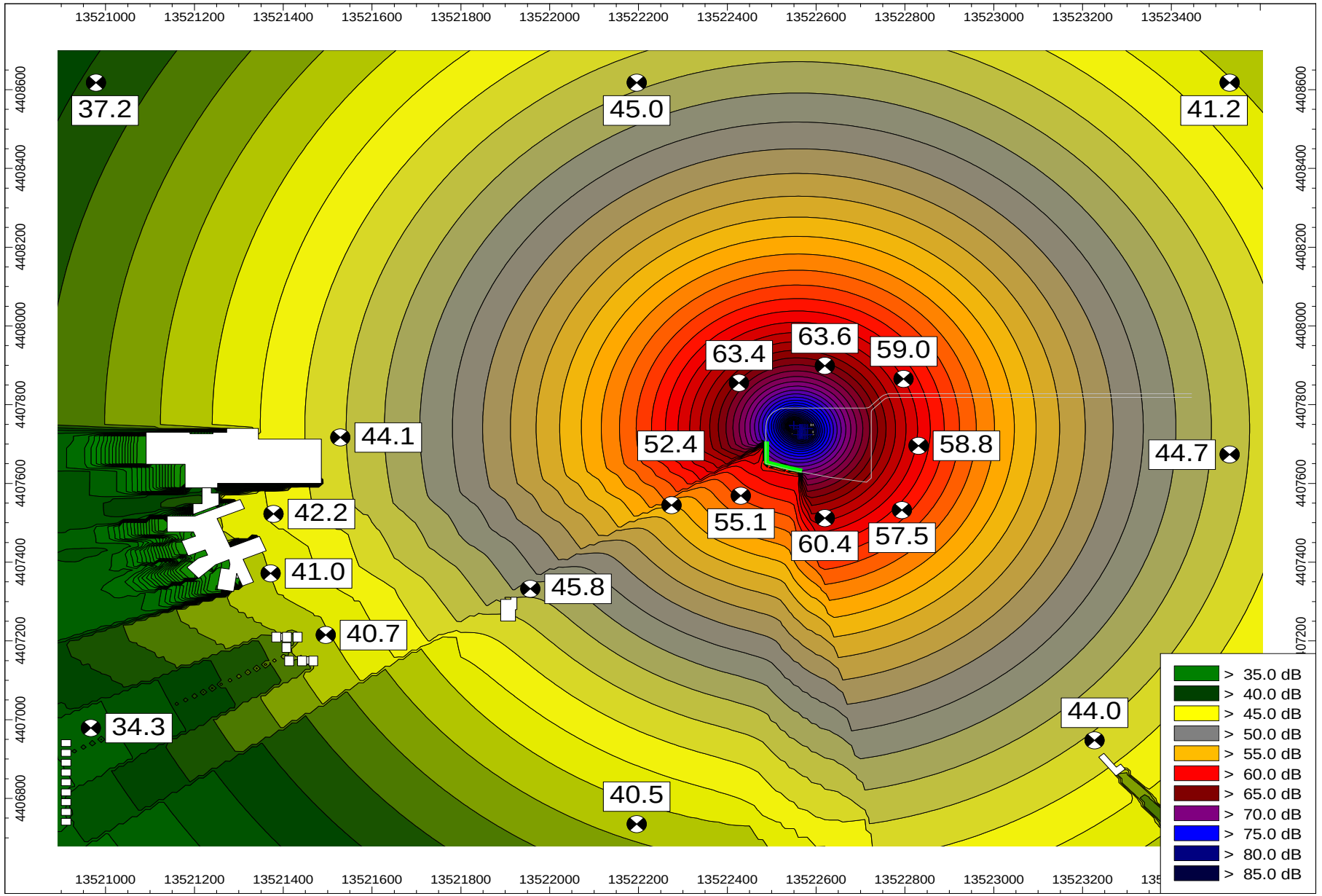
Model 17: Patterson 346 Drilling Operations with Mitigation Option (A-Weighted Levels)



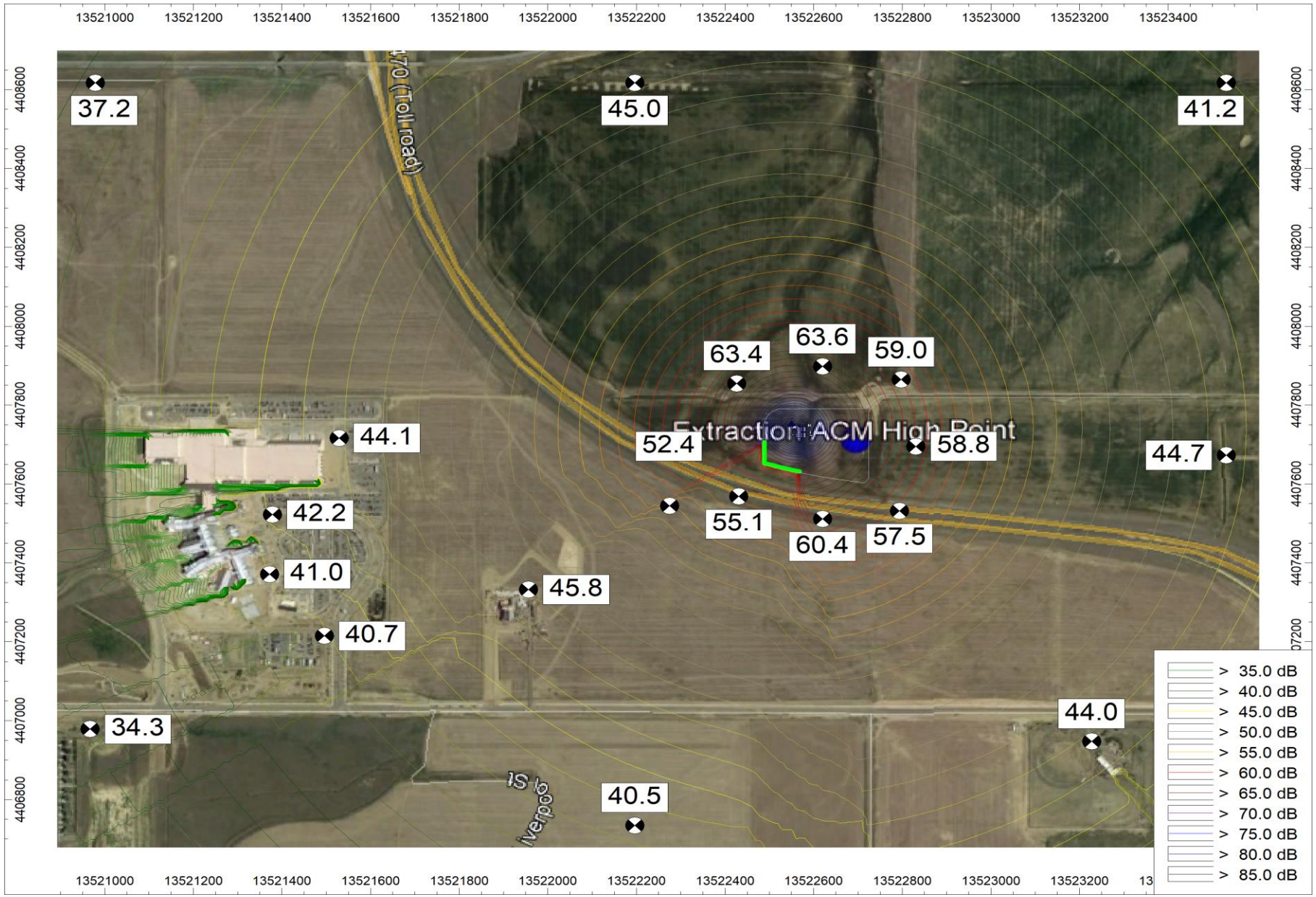
Model 18: Patterson 346 Drilling Operations with Mitigation Option (**C-Weighted Levels**)



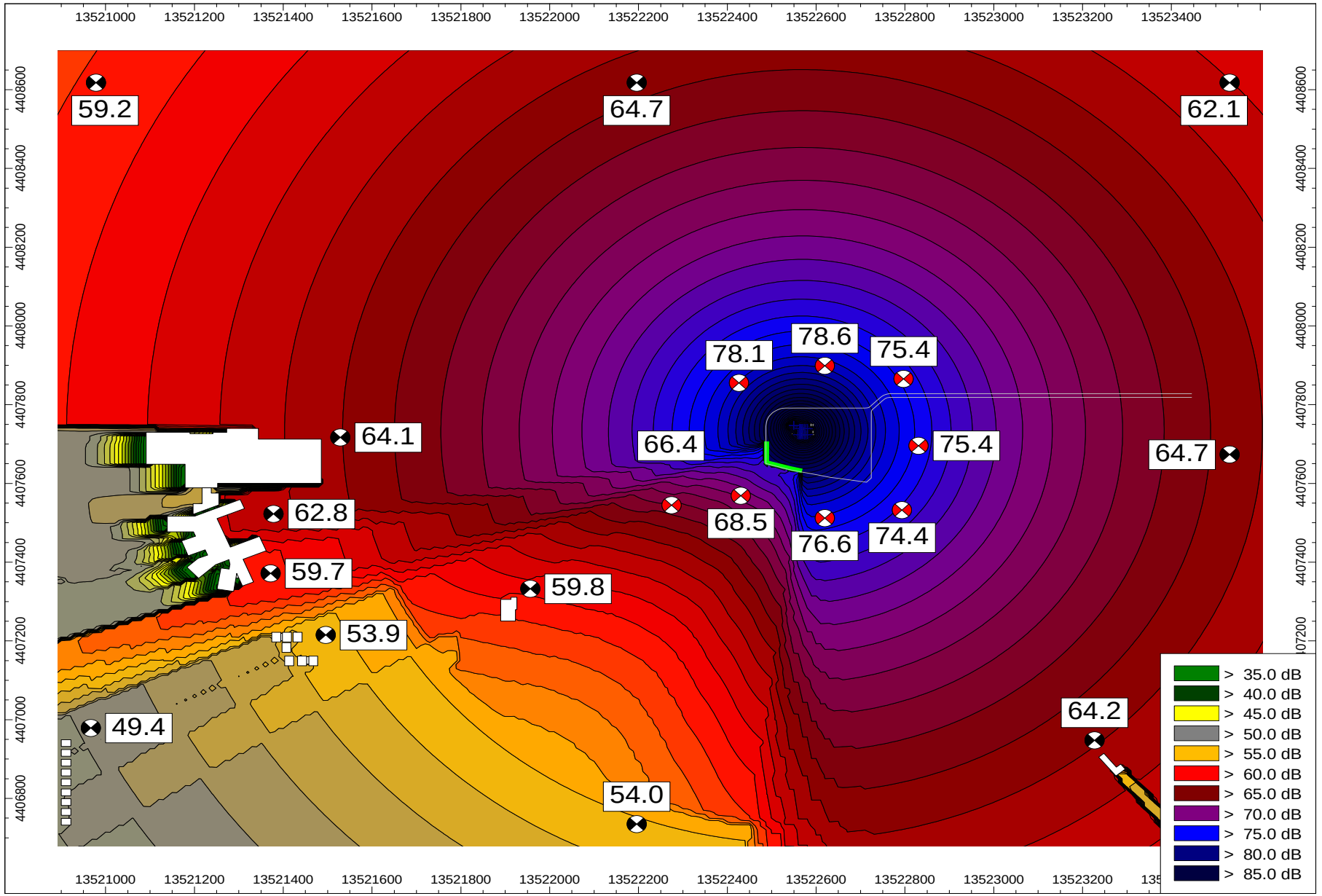
Model 19: Liberty Hybrid Completion Operations with Mitigation Option (A-Weighted Levels)



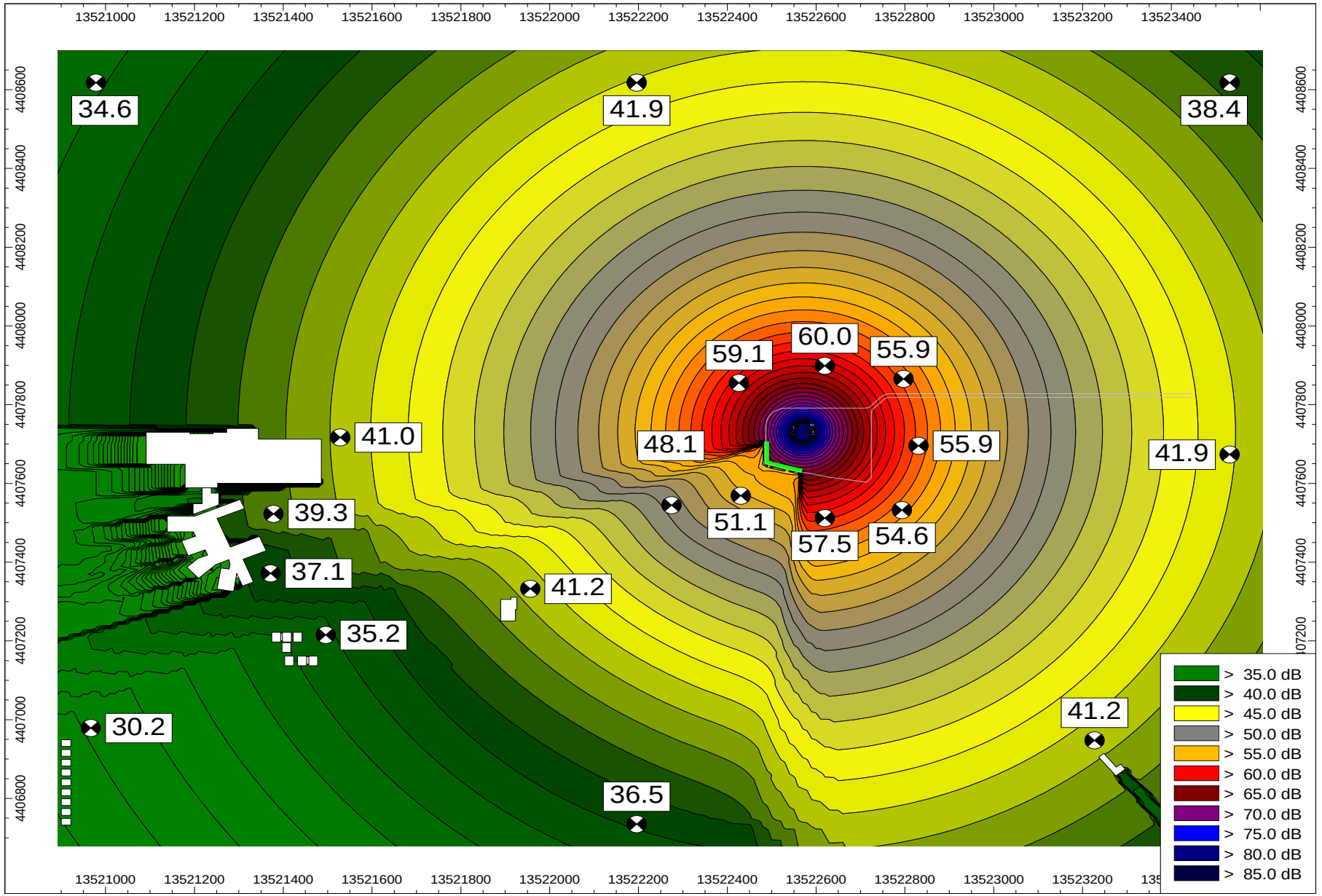
<u>Model 20</u>: Liberty Hybrid Completion Operations with Mitigation Option (A-Weighted Levels)



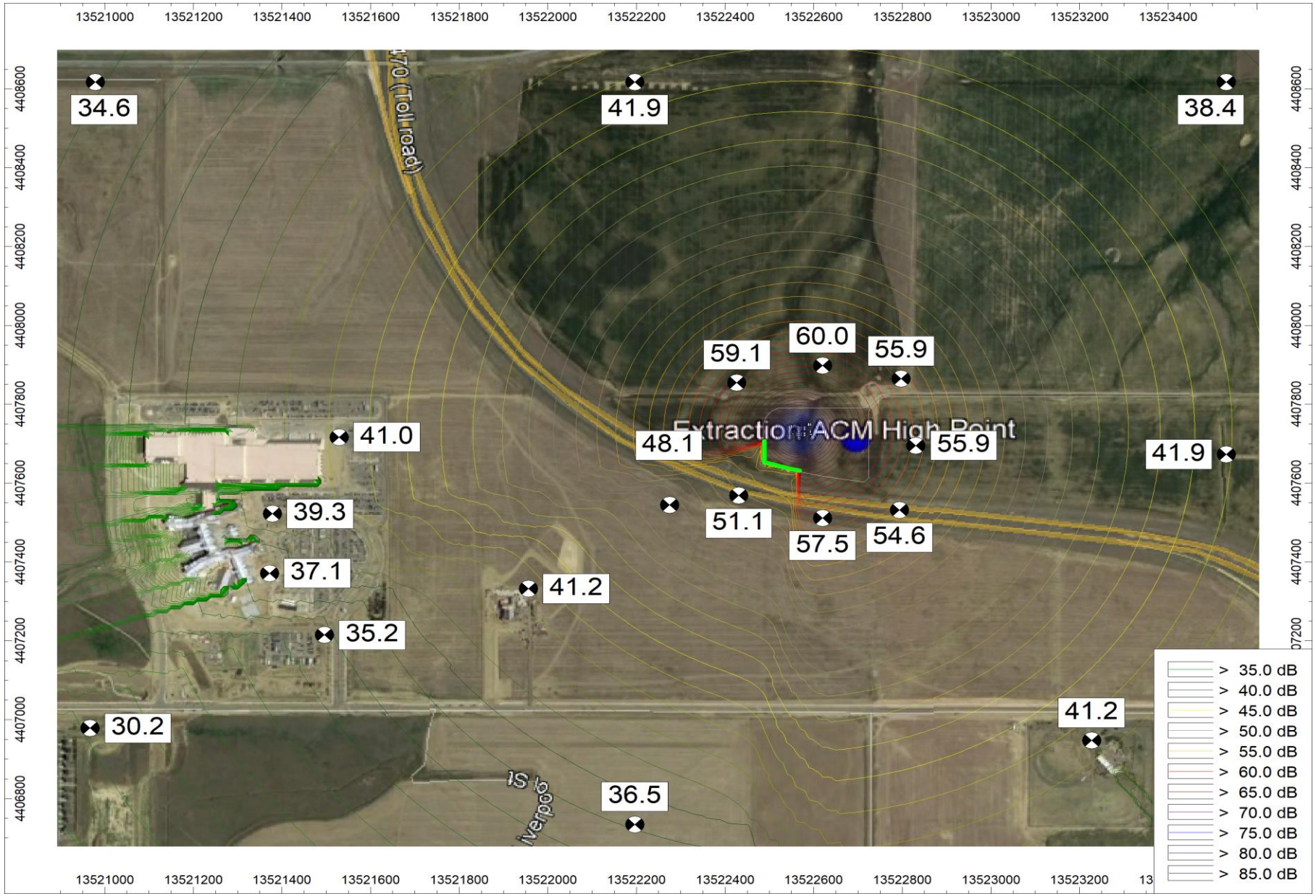
Model 21: Liberty Hybrid Completion Operations with Mitigation Option (**C-Weighted Levels**)



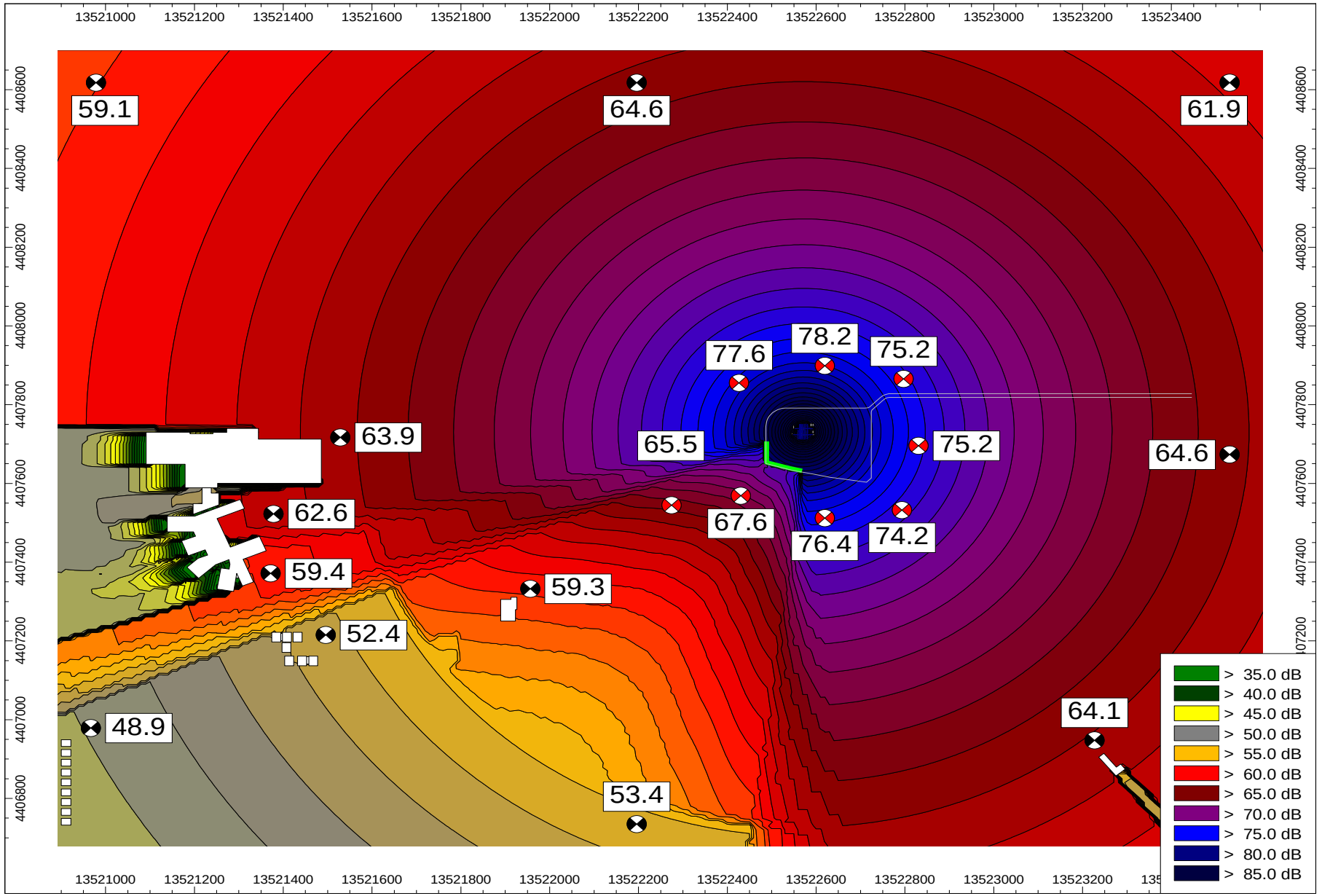
<u>Model 22</u>: Liberty Quiet Completion Operations with Mitigation Option (A-Weighted Levels)



<u>Model 23</u>: Liberty Quiet Completion Operations with Mitigation Option (A-Weighted Levels)



Model 24: Liberty Quiet Completion Operations with Mitigation Option (**C-Weighted Levels**)



ATTACHMENT 1

OPERATION LAYOUTS AND SOUND LEVELS

Layout A1: Patterson 346 Electric Drilling Operations

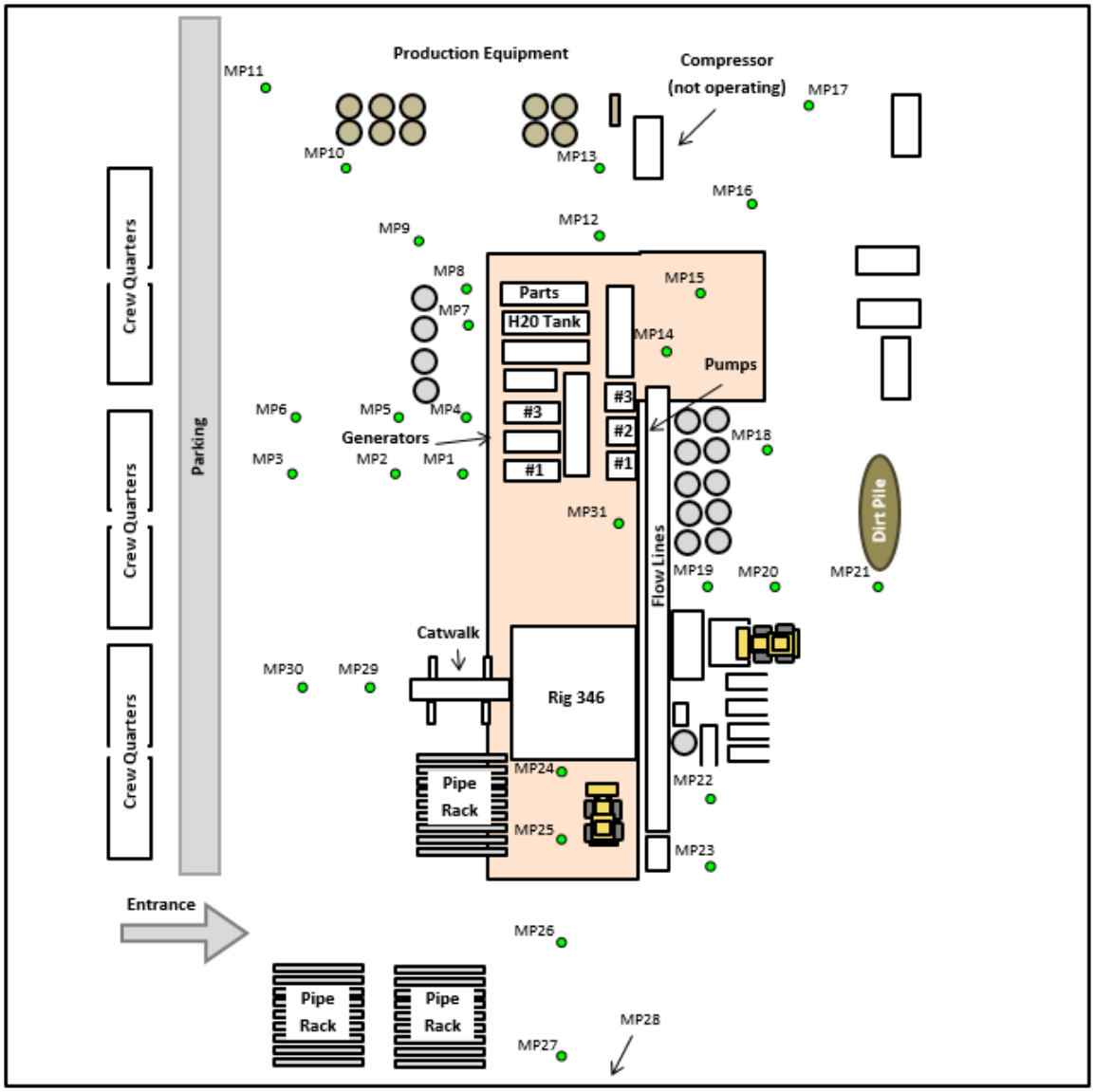


Table A1: Patterson 346 Sound Signature Sound Levels (dBA, dBC)

Monitoring Location	Distance (ft.)	Description	LAeq (dB)	LCeq (dB)
Wednesday, October 24, 2018				
1	25	North of Generator #1	88.35	99.35
2	50	North of Generator #1	84.53	95.61
3	100	North of Generator #1	79.73	91.74
4	25	North of Generator #3	89.22	99.81
5	50	North of Generator #3	83.65	95.60
6	100	North of Generator #3	79.14	91.83
7	25	North of Water Tank	78.34	90.64
8	25	Northeast of Top Drive Parts House	76.23	88.06
9	50	Northeast of Top Drive Parts House	70.18	83.23
10	100	Northeast of Top Drive Parts House	68.79	83.25
11	200	Northeast of Top Drive Parts House	69.46	81.24
12	25	East of Top Drive Parts House	73.72	81.92
13	50	East of Top Drive Parts House	71.45	80.93
14	25	Southeast of Pump #3	78.21	85.93
15	50	Southeast of Pump #3	71.69	81.56
16	100	Southeast of Pump #3	67.35	81.31
17	200	Southeast of Pump #3	64.85	76.61
18	25	South of Tanks	61.55	84.59
19	25	South of Flow Lines	79.59	91.43
20	50	South of Flow Lines	70.98	93.03
21	100	South of Flow Lines	66.74	86.22
22	25	West of Shaker	71.57	84.76
23	50	West of Shaker	67.95	81.35
24	25	West of Rig Floor	77.10	93.48
25	50	West of Rig Floor	75.52	89.24
26	100	West of Rig Floor	70.25	83.24
27	200	West of Rig Floor	64.10	75.42
28	350	West of Rig Floor	59.29	74.29
29	25	North of Catwalk	79.69	89.58
30	50	North of Catwalk	79.14	89.11
31	25	West of Pump #1	90.64	94.39

Layout A2: Pioneer Wireline Truck Operations

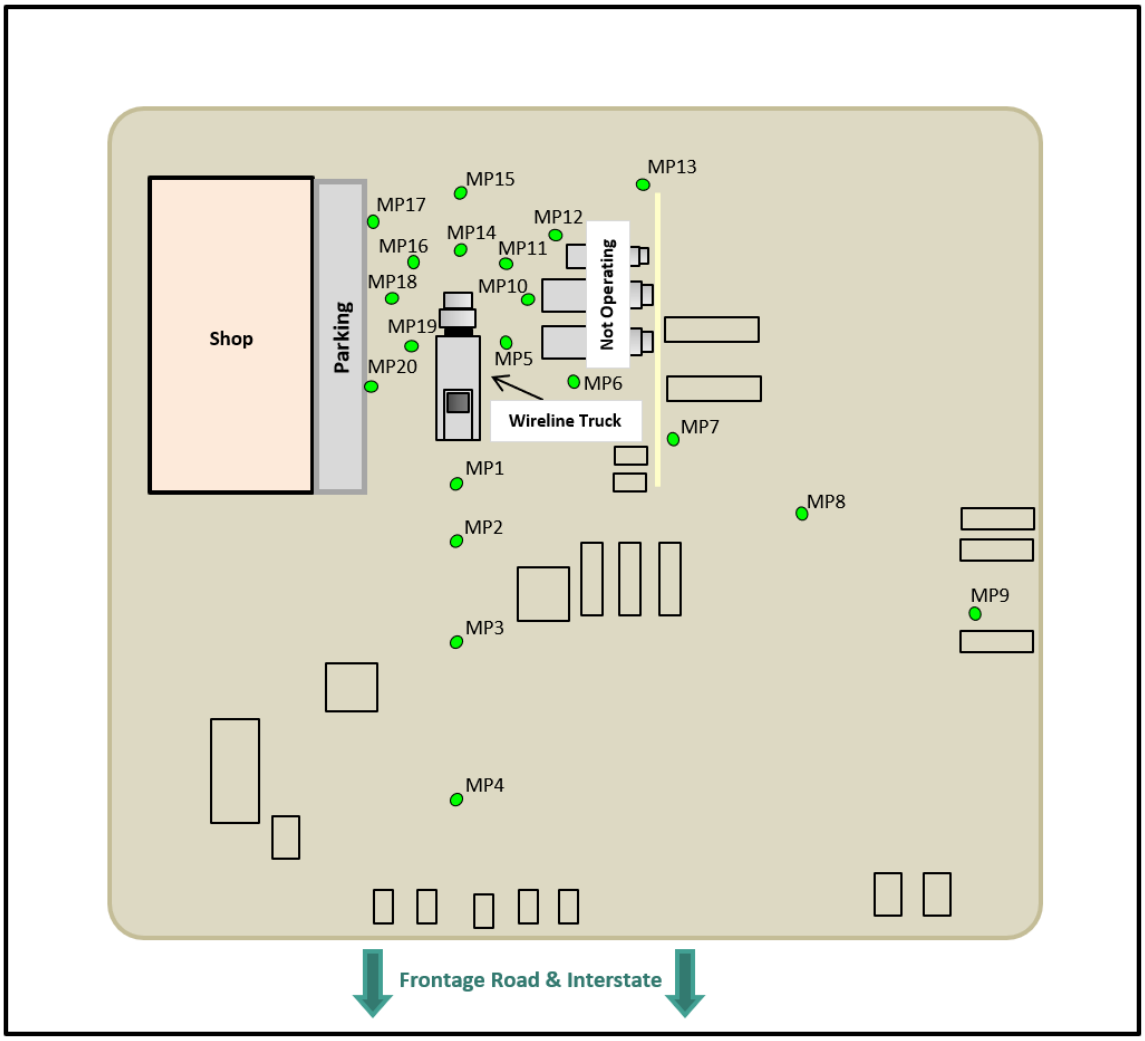


Table A2: Pioneer Wireline Sound Signature Sound Levels (dBA, dBC)

Monitoring Location	Distance (ft.)	Description	LAeq (dB)	LCeq (dB)
Tuesday, January 29, 2019				
1	25	South of Wireline Truck	72.52	81.73
2	50	South of Wireline Truck	68.61	77.87
3	100	South of Wireline Truck	63.31	74.00
4	200	South of Wireline Truck	62.18	72.70
5	25	Southeast of Wireline Truck	83.46	89.14
6	50	Southeast of Wireline Truck	78.72	84.80
7	100	Southeast of Wireline Truck	71.74	77.94
8	200	Southeast of Wireline Truck	64.39	72.75
9	300	Southeast of Wireline Truck	60.67	71.76
10	25	East of Wireline Truck	82.77	87.94
11	25	Northeast of Wireline Truck	84.20	88.78
12	50	Northeast of Wireline Truck	79.05	84.24
13	100	Northeast of Wireline Truck	70.93	76.22
14	25	North of Wireline Truck	87.05	92.51
15	50	North of Wireline Truck	84.73	91.23
16	25	Northwest of Wireline Truck	84.04	89.07
17	50	Northwest of Wireline Truck	80.26	85.65
18	25	West of Wireline Truck	82.39	87.77
19	25	Southwest of Wireline Truck	82.79	88.45
20	50	Southwest of Wireline Truck	78.47	84.50

Layout A3: Liberty Quiet Frac Completion Operations

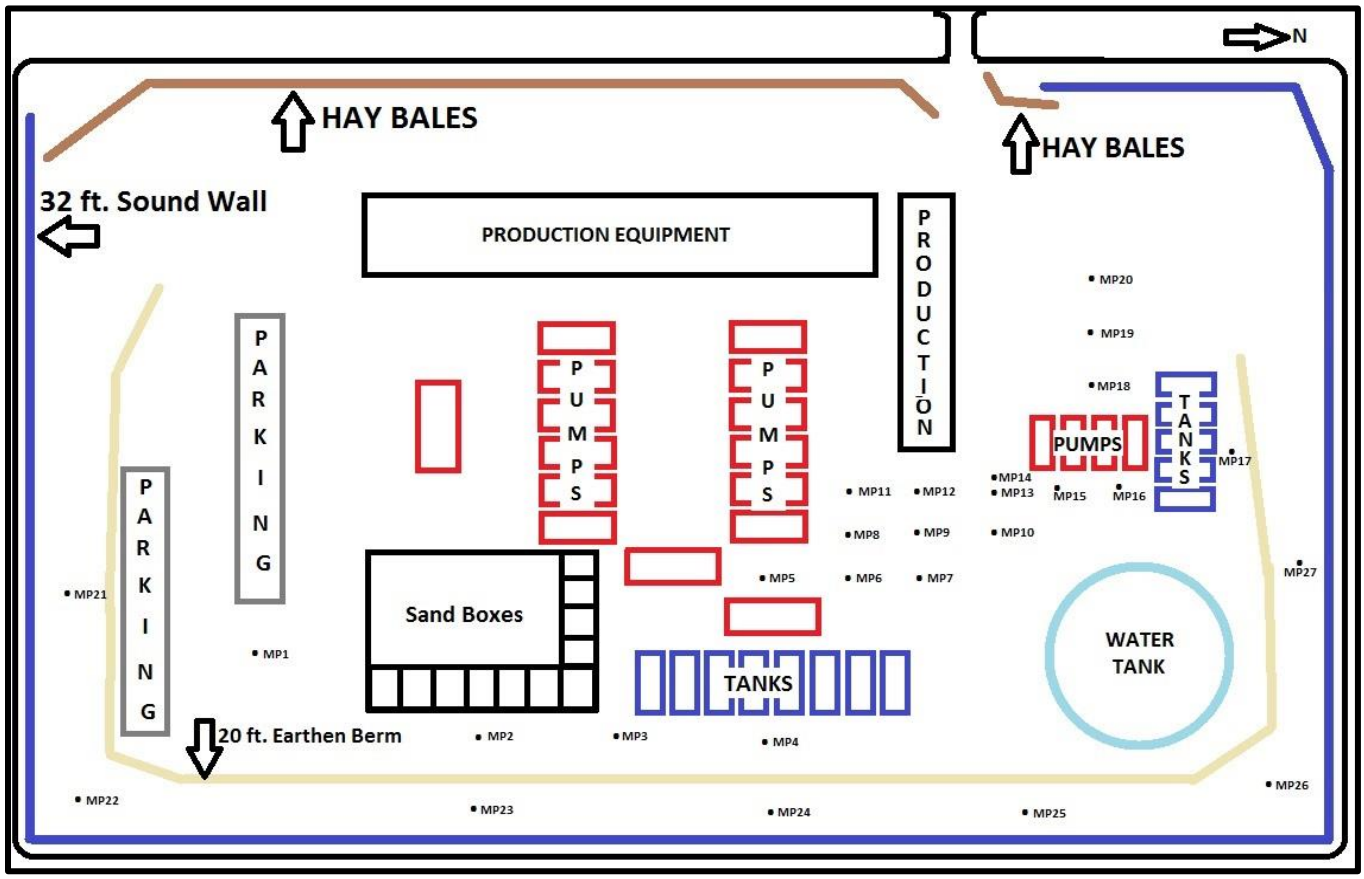
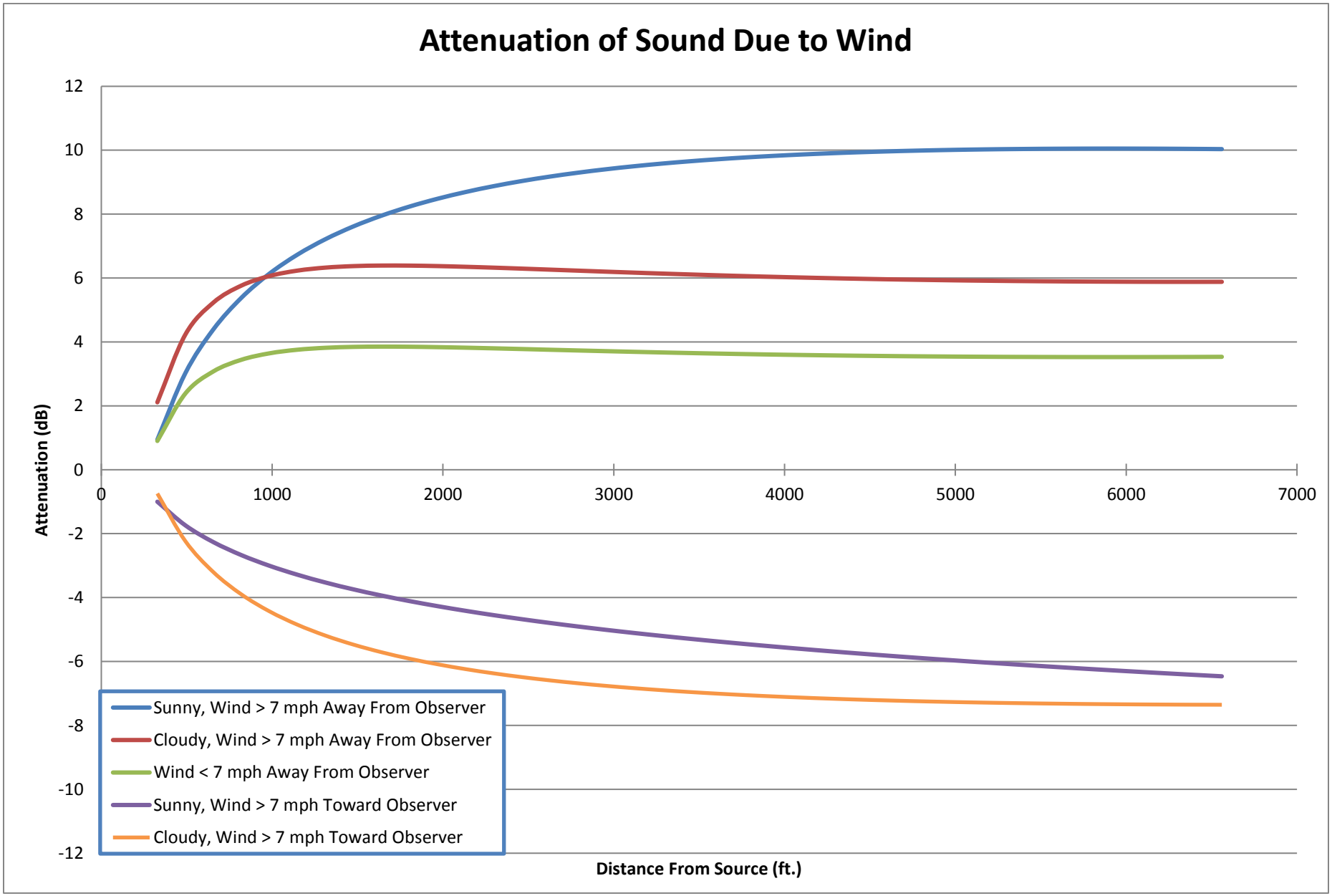


Table A3: Liberty Completion Sound Signature Sound Levels (dBA, dBC)

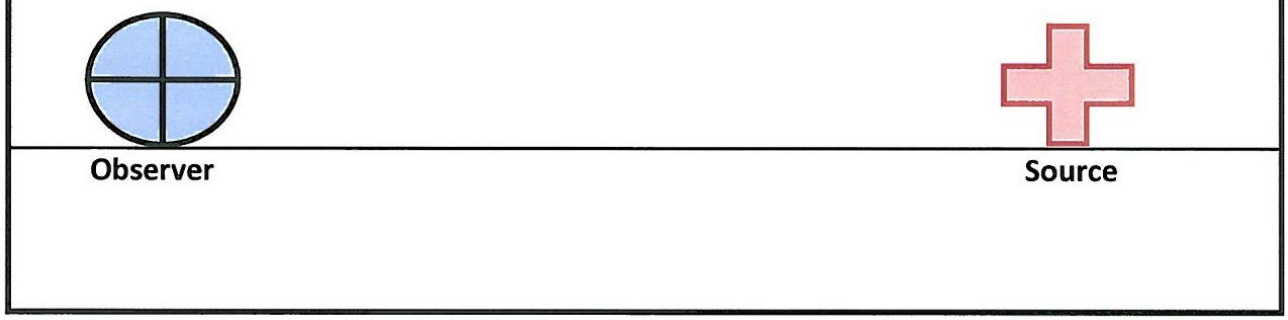
Monitoring Location	Distance (ft.)	Description	LAeq (dB)	LCeq (dB)
Tuesday, August 9, 2016				
1	65	South of Sand Boxes	66.20	80.11
2	20	East of Sand Boxes	61.23	79.84
3	20	East of Sand Boxes/ Water Tanks	68.97	83.47
4	15	East of Water Tanks	68.88	85.29
5	25	North of Pump Trucks/ West of Water Tanks	80.60	90.51
6	50	North of Pump Trucks/ West of Water Tanks	77.76	90.59
7	75	North of Pump Trucks/ West of Water Tanks	77.18	89.44
8	25	North of Pump Trucks	77.35	89.97
9	50	North of Pump Trucks	78.72	89.87
10	75	North of Pump Trucks	76.44	87.56
11	25	North of Pump/ Wells / Middle	78.15	88.85
12	50	North of Pump/ Wells / Middle	76.00	87.35
13	75	North of Pump/ Wells / Middle (Idle All)	70.04	84.90
14	75	North of Pump/ Wells / Middle (On/Off All)	82.61	93.24
15	25	East of Pumps (2nd Group towards Entrance)	82.30	95.54
16	25	East of Pumps (2nd Group)	81.25	93.73
17	25	North of Water Tanks	69.36	83.74
18	25	West of Pumps (2nd Group)	81.23	91.59
19	50	West of Pumps (2nd Group)	78.30	89.83
20	100	West of Pumps (2nd Group - Idle All)	66.38	83.34
21	435	South of Center of Wells/ Pumps	68.93	77.58
22	474	Southeast of Corner (Highest Point of Berm)	66.85	77.52
23	399	East of Center of Wells	66.81	77.30
24	342	East of Dead Center of East Side	71.93	80.43
25	378	East of Dead Center of East Side	73.21	84.28
26	399	Northeast of Dead Center of East Side	69.75	80.69
27	408	North of Dead Center of East Side	71.39	82.44

ATTACHMENT 2

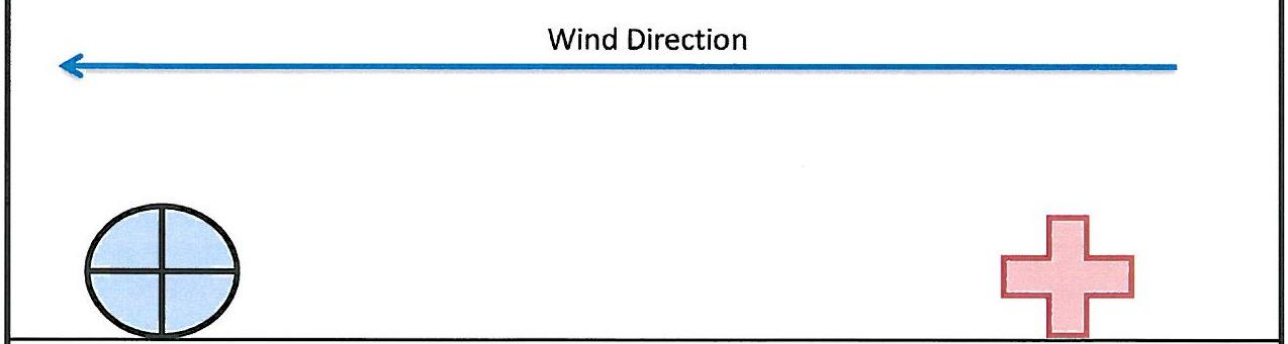
WIND CHART


Attenuation of Sound Due to Wind
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
Attenuation (dB)
0
1000
2000
3000
4000
5000
6000
7000
Distance From Source (ft.)
Sunny, Wind > 7 mph Away From Observer
Cloudy, Wind > 7 mph Away From Observer
Wind < 7 mph Away From Observer
Sunny, Wind > 7 mph Toward Observer
Cloudy, Wind > 7 mph Toward Observer

Wind Away From Observer



Wind Toward Observer



ATTACHMENT 3

TABLE OF TYPICAL SOUND LEVELS

Table B1: Typical Sound Levels Measured in the Environment

Description of Sound	Sound Level (dBA)	Human Perception of Loudness*
Threshold of Hearing	0	
Rustling Leaves	20	Just Audible
Quiet Whisper (3 feet away)	30	Very Quiet
Quiet Home	40	Quiet *(1/8 as loud)*
Quiet Street	50	*(1/4 as loud)*
Normal Conversation	60	*(1/2 as loud)*
Inside Car	70	Moderately Loud *(Reference Loudness)*
Automobile (25 feet away)	80	
Train Whistle (500 feet away)	90	
Level at which sustained exposure may result in hearing loss	90 – 95	
Diesel Truck (30 feet away)	95	
Pile Driver (50 ft.)	100	Very Loud *(8 times as loud)*
Power Mower (3 feet away)	107	
Amplified Rock and Roll (6 feet away)	110	*(16 times as loud)*
Jet Airplane (100 feet away)	120	Threshold of pain *(32 times as loud)*
Civil defense siren (100 ft.)	130	
Firearm shots near ear	140	Painfully Loud
Even short term exposure can cause permanent damage – Loudest recommended exposure WITH hearing protection	140	

*Relative to a Reference Loudness of 70 Decibels – Various Sources: Barnek, 1998, Barnes et al., USEPA, 1971