



GEILER & ASSOCIATES, LLC

Consultants in Acoustics and Presentation Technologies

December 10, 2014

Kara Zabilansky, CMC
Administrator / Town Clerk
Town of Morrison
321 Highway 8
Morrison, Colorado 80465

Re: Red Rocks Amphitheater, Denver, Colorado
Comments on Red Rocks 2014 Noise Monitoring and Proposed 2015 Noise Regulations

Dear Kara:

As requested, we have reviewed the noise monitoring results and data provided by Red Rocks and K2 for the 2014 concert season, and the proposed revisions for the 2015 noise regulations. The following report summarizes our comments and recommendations.

Background

In recent years, noise complaints about Red Rocks concerts have increased from some residents of Morrison. The increase in complaints appears to be primarily due to increased low-frequency (“bass”) sounds, particularly due to electronic dance music (EDM) concerts which have increased in popularity. Also, it is our understanding that the frequency and length of concerts has generally increased, which could also be contributing to less tolerance for noise heard from the venue. It is important to note that the majority of residents affected by this noise are over 5,000 feet away from the stage.

To try and address these concerns, Red Rocks hired K2 Audio, LLC to conduct a limited noise study during the 2013 season. The results of the 2013 noise study were summarized in the K2 report dated November 14, 2013. The Town of Morrison asked us to review the 2013 K2 report, the 2014 noise regulations, and the overall circumstances. We provided comments and recommendations on the 2013 K2 report in our report dated March 3, 2014, which was also presented to the Morrison Board of Trustees in a public meeting on March 4, 2014.

Recap of 2013/2014 Conclusions

The 2014 Noise Regulations implemented by Red Rocks set maximum allowable limits of 105 dBA (A-weighted) and 125 dB_{25-80Hz} (low-frequency) 1-minute Equivalent Levels (L_{EQ, 1min}) measured at the front-of-house mix position. Five consecutive or non-consecutive minutes that exceeded these levels constituted a \$10,000 violation. However, these limits only applied after 12:00am on weeknights, and after 1:00am on weekends, with concerts ending no later than 30 minutes after these curfew times.

Since the noise limits only applied for a 30-minute period late at night, we did not expect that the regulations would result in a reduction in overall noise levels heard by neighbors, or a reduction in complaints from the loudest shows.

We also commented that the stated metrics and limits (105 dBA and 125 dB_{25-80Hz} 1-minute Equivalent Levels) are probably a good starting point, but that more measurements and study would be required to provide a more reliable correlation between noise levels at front of house, noise levels south/southeast of the stage, and noise levels heard by neighboring residents to the south/southeast.

Draft-A 2015 Noise Regulations

It is our understanding that Red Rocks intends to modify their noise regulations for the 2015 season in ongoing efforts “to reduce the sound level impacts on the neighboring residents.” On November 7, 2014, we were provided with a draft of the proposed 2015 noise regulations, which Red Rocks presented to the Morrison Board of Trustees on November 4, 2014.

The Draft-A 2015 Noise Regulations proposes the following requirements:

- “Prior to and including 11:30 PM, the A-weighted Leq sound pressure level shall not exceed 108 dBA for 1-minute averages.”
- “After 11:30 PM, the A-weighted Leq sound pressure level shall not exceed 105 dBA for 1-minute averages.”
- “The flat (no weighting applied) Leq sound pressure level shall not exceed 125 dB for the frequency range of 25 – 80 Hz for 1-minute averages.” For brevity, K2’s data and documentation refer to this metric as dB1, which we will continue to use for brevity and consistency.
- Sound levels will be measured at the Front-of-House (FOH) mix position.
- “Violation Charge: \$10,000 (for every 3 times (consecutive or non-consecutive) that one of the stated limits is exceeded during a performance). Audience noise is not subject to violations.”
- Mandatory Ending Times:
 - 12:00 AM on Weeknights (Sunday night – Thursday night)
 - 12:30 AM on Weekends (Friday and Saturday night)
 - 12:30 AM on the nights before Memorial Day, Fourth of July, and Labor Day.

Draft-B 2015 Noise Regulations

We were also provided a revised “Draft-B” 2015 Noise Regulations on December 2, 2014. These regulations are identical to the first Draft, except for 15 minute earlier curfew time for reduced dBA limits, a 2 dB lower limit for dB1 low frequency levels for the entire show, and 15 minute earlier mandatory end time for weeknights.

The Draft-B 2015 Noise Regulations proposes the following requirements:

- **“Prior to and including 11:15 PM**, the A-weighted Leq sound pressure level shall not exceed 108 dBA for 1-minute averages.”
- **“After 11:15 PM**, the A-weighted Leq sound pressure level shall not exceed 105 dBA for 1-minute averages.”
- “The flat (no weighting applied) Leq sound pressure level shall not exceed **123 dB** for the frequency range of 25 – 80 Hz for 1-minute averages.” For brevity, K2’s data and documentation refer to this metric as dB1, which we will continue to use for brevity and consistency.
- Sound levels will be measured at the Front-of-House (FOH) mix position.
- “Violation Charge: \$10,000 (for every 3 times (consecutive or non-consecutive) that one of the stated limits is exceeded during a performance). Audience noise is not subject to violations.”
- Mandatory Ending Times:
 - **11:45 AM on Weeknights** (Sunday night – Thursday night)
 - 12:30 AM on Weekends (Friday and Saturday night)
 - 12:30 AM on the nights before Memorial Day, Fourth of July, and Labor Day.

Data Provided by Red Rocks / K2

For the 2014 season, Red Rocks installed a noise monitoring system at the Front-of-House (FOH). This system is understood to consist of two ACO Pacific SLARM systems which are configured to monitor and log the 1-second and 1-minute dBA and dB1 results from a microphone located at the mix position. Red Rocks also hired K2 to conduct additional monitoring for select shows, presumably shows that were expected to be the loudest, longest, or most contentious of the season.

As part of our independent review of the Red Rocks/K2 2014 noise study, we were provided with a significant amount of sound measurement data, primarily as Excel Spreadsheets. This data included:

- .PDF summary documents of 2014 noise monitoring equipment, and graphs of the sound levels for the 19 shows that K2 monitored
- A list of all 2014 shows and their official ending times (115 shows)
- FOH dBA 1-minute Leq (7 shows missing data)
- FOH dB1 1-minute Leq (18 shows missing data)
- FOH dBA 1-second data (5/16, 5/17, 5/30, 5/31, 6/20, 6/21, 7/18, 7/20, 8/13)
- FOH dB1 1-second data (5/31*(Recovered), 6/20, 6/21, 7/18, 7/20, 8/13)
- K2 measurements at neighboring resident on Wood Lane
 - dBA, dB1 and one-third octave spectral data
 - 1-second data was only logged for 5/16, 5/17, 5/30, and 5/31.
 - 1-minute data was logged for 6/19, 6/20, 6/21, 7/3, 7/18, 7/20, 7/31, 8/9, 8/29, 9/12, 9/26, and 9/27.
- K2 measurements at Mt. Falcon Parking Lot
 - Only logged 15-minute Leq data for certain shows.
- K2 1-minute night-time background noise measurements taken in Morrison on October 11, 2014
 - Measurements were only 1-minute in duration, and did not include dB1 logs, or 1/3 Octave or dBC statistical metrics.
- K2 notes on weather conditions during K2 monitored shows

Comments

We requested that Red Rocks / K2 provide us with all of the measurement data files from the 2014 season and K2 noise study. While we have received the majority of the files relevant and useful for this review, we have not yet received all of the 1-second FOH data requested. The music shows with missing data are allegedly due to operator error or technical malfunction. The noise monitoring system was not activated for the Film on the Rocks events or comedy shows.

For purposes of the regulations and for sound engineers to monitor and control their noise levels, 1-minute Leqs are appropriate and acceptable. However, for more detailed analysis and correlation between source and distant receivers, 1-second 1/3-octave data at both FOH and a distant receiver (or multiple locations) is much more useful. Unfortunately, K2 only logged 1-second data at the neighboring receiver for the first four shows they monitored, then switched to 1-minute logs to “speed up post processing” of the data. The FOH logged 1-second data, but only dBA and dB1 metrics, not third-octave.

Red Rocks / K2 has indicated the dB1 1-second FOH data for 5/16, 5/17, 5/30, and 5/31 were corrupt. However, we have reviewed the data file for the 5/31 show and appear to have recovered the dB1 1-second data. We requested to review the dB1 1-second data files for 5/16, 5/17, and 5/30, even if suspected to be corrupt, but have not yet received them.

The dB1 1-minute Leq shows clear correlation between FOH and Wood Lane for some shows. The correlation appears to show approximately 45 – 55 dB difference between FOH dB1 levels and Wood Lane levels, depending on the specific show and even varying within a show. We expect the varying level of attenuation between FOH and Wood Lane receiver is due to atmospheric effects (such as wind, wind gradients, thermal gradients) that could result in varying sound levels transmitted to distant receivers even if the FOH levels are the same. Different loudspeaker configurations for different shows could also result in more or less sound energy being transmitted to neighbors.

K2 provided some notes of weather observations for the shows that they monitored. However, most of the observations appear to be subjective, or based on “SmartPhone” weather data, which we assume is based on a weather monitoring service or website, but the location of that weather station is not stated. Also, many of the observations are missing (“n/a”) wind speed and direction. The provided observations may be useful for a more detailed analysis of specific shows to try and correlate wind speed and direction with long distance sound propagation. However, ideally, we would have continuous wind speed and wind direction data logged both at the venue and at the receiver. Also, such an analysis would be more useful if we had 1-second 1/3 octave data for both FOH and distant receivers for more shows.

The FOH logs typically stop right at or a few minutes before the official show end times provided to us. The Wood Lane measurements typically start after the show has started, and end right at or just before the end of the show. It would be more useful if measurements at both locations were started prior to show start, and concluded at least 15 minutes after the end of amplified music. This would allow us to better compare the sound levels when music was present compared to background sound levels.

Overall Evaluation of 2014 Season

The 2014 season had no violations of the 2014 Noise Regulations due to the fact that the majority of the shows ended well before the 30 minute curfew period where the noise limits applied.

Ending Times

No shows exceeded the mandatory ending times in the 2014 Noise Regulations.

There were four weekend shows that ended right at 1:00AM, and the Saturday, June 2, 2014 Skrillex show ended at 1:03 AM. Only two weeknight shows extended into the 12:00-12:30 curfew period, and by less than 10 minutes.

Table 1 – 2014 Show Ending Times

Total		Weekend		Weeknight		
#	%	#	%	#	%	
115		46		69		Total # Shows
61	53%	34	74%	27	39%	Shows Ended at 11:00 or later
44	38%	31	67%	13	19%	Shows Ended at 11:15 or later
36	31%	26	57%	10	14%	Shows Ended at 11:30 or later
27	23%	23	50%	4	6%	Shows Ended at 11:45 or later
23	20%	21	46%	2	3%	Shows Ended at 12:00 or later
20	17%	20	43%	0	0%	Shows Ended at 12:15 or later
16	14%	16	35%	0	0%	Shows Ended at 12:30 or later
11	10%	11	24%	0	0%	Shows Ended at 12:45 or later
5	4%	5	11%	0	0%	Shows Ended at 01:00 or later
0	0%	0	0%	0	0%	Shows Ended at 01:15 or later

FOH dBA 1-minute Exceedances

Of the 92 shows that we were provided FOH 1-minute dBA data for, 40 shows had had at least one 1-minute period that exceeded 105 dBA.

Table 2 –Shows Exceeded a Given dBA Threshold

92	Total # Shows w/ FOH dBA data				
0	Shows had 1-minute levels	>= 115	dBA	0%	of shows with dBA data
1	Shows had 1-minute levels	>= 110	dBA	1%	of shows with dBA data
9	Shows had 1-minute levels	>= 108	dBA	10%	of shows with dBA data
40	Shows had 1-minute levels	>= 105	dBA	43%	of shows with dBA data
78	Shows had 1-minute levels	>= 100	dBA	85%	of shows with dBA data
89	Shows had 1-minute levels	>= 95	dBA	97%	of shows with dBA data
91	Shows had 1-minute levels	>= 90	dBA	99%	of shows with dBA data
92	Shows had 1-minute levels	>= 85	dBA	100%	of shows with dBA data

FOH dB1 1-minute Exceedances

Of the 81 shows that we were provided FOH 1-minute dB1 data for, 18 shows had at least one 1-minute period that exceeded 125 dB1.

Table 3 –Shows Exceeded a Given dB1 Threshold

81	Total # Shows w/ FOH dB1 data				
0	Shows had 1-minute levels	>= 135	dB1		
2	Shows had 1-minute levels	>= 130	dB1	2%	of shows with dB1 data
18	Shows had 1-minute levels	>= 125	dB1	22%	of shows with dB1 data
27	Shows had 1-minute levels	>= 123	dB1	33%	of shows with dB1 data
39	Shows had 1-minute levels	>= 120	dB1	48%	of shows with dB1 data
54	Shows had 1-minute levels	>= 115	dB1	67%	of shows with dB1 data
67	Shows had 1-minute levels	>= 110	dB1	83%	of shows with dB1 data
76	Shows had 1-minute levels	>= 105	dB1	94%	of shows with dB1 data
79	Shows had 1-minute levels	>= 100	dB1	98%	of shows with dB1 data

Saveredrocks.com Survey Results

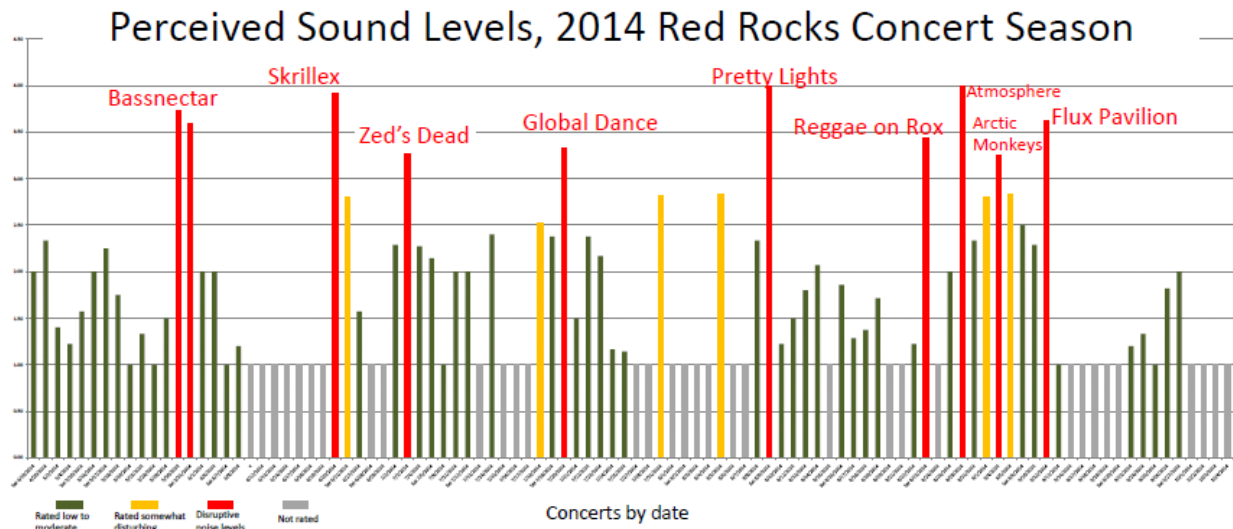
As part of our review, we asked the Town of Morrison if they had any detailed logs of complaints. While they had some records of complaints, they did not have many details. It is our understanding that part of the reason for lack of complaint data is due to the uncertainty and issues regarding jurisdiction. For example, residents with complaints might call or email Morrison Town Clerk and Trustees, the Morrison PD, Red Rocks, Jefferson County Commissioners, Denver 311, Denver Arts and Venues, or some or all of the above. Also, it is our understanding that some neighbors may have refrained from making formal complaints since they understood that Morrison and Red Rocks were working towards a solution.

We are however aware of the Saveredrocks.com website, which was started by noise-affected neighbors to help document the 2014 season. This website had publicly available surveys for the majority of the 2014 shows, and invited neighbors to rate the perceived level of noise annoyance on a scale of 1 to 5.

- 1 – “barely noticeable, not disturbing”
- 2 – “moderately noisy, somewhat disturbing”
- 3 – “noisy, annoying, couldn’t be outside”
- 4 – “kept awake or woke from a sound sleep, significantly disturbing”
- 5 – “walls and windows rattling, extremely disturbing, even indoors”

To assist in our comparison of complaint data to sound level data, Saveredrocks.com provided us with the results of their surveys in Excel spreadsheet format. Of the 115 shows in 2014, Saveredrocks.com received a total of 517 responses spread across 66 shows. Of these 66 shows, 15 shows received “5” ratings, and 29 shows received “4” ratings.

While this survey did not appear to be “scientific” or well controlled, (it did not verify that responders were in fact noise-affected neighbors, nor did there appear to be a limit on how many times one could vote on a given survey), the survey results are still expected to be useful and better than nothing. We expected that shows that received “4” and “5” results could be a good indicator of the loudest and most annoying shows of the season, as heard by the neighbors, and there may be some correlation with the FOH sound data.



(Courtesy: Saveredrocks.com)

The attached **Table 4** shows the entire 2014 season, the FOH 1-minute exceedances for various sound levels, and the Saveredrocks.com survey results. For example, the data for the 5/16 Global Dub indicates 157 minutes that were greater than or equal to 125.0 dB1, out of the 404 minutes of data recorded for that show.

The attached **Table 5** shows the same data, but limited to only the thirty-two shows that received any “4” or “5” responses to the Saveredrocks.com surveys.

It is interesting to note that 16 of the 18 loudest dB1 shows appear in the list of shows that received the highest complaints on Saveredrocks.com. This appears to show that when shows are consistently above 120-125 dB1 at FOH, there is a higher likelihood of complaints.

However, it is also interesting to note that there are also a handful of shows with dB1 and dBA levels significantly quieter than the loudest shows, but that still received some “4” and “5” complaints.

Also, there were some shows where the majority of the responses indicated a low annoyance, but there were still a few “5” complaints. For instance, the 5/16 Global Dub show had six “1s”, three “2s”, no “3s” and “4s”, and two “5s”. This show was one of the loudest shows of the season, as measured at FOH, yet this show also had observers from the community, Jefferson County Commissioners, and local news media, and the general consensus was that this show wasn’t that bad or as loud as similar 2013 shows. Another example would be the 8/23 Reggae on the Rocks show that was notably quieter than the loudest EDM shows, but still received a significant amount of “4” and “5” annoyance responses, as well as a complaint emailed directly to the Town of Morrison.

The Saveredrocks.com survey results bolster the case that appropriate FOH dB1 sound levels are a good starting point for reducing complaints. However, the variability of responses for a given show, particularly for relatively quiet shows, indicate that other factors may be involved such as the specific location of the receivers, atmospheric conditions, the loudspeaker configuration, the objective and subjective noise sensitivity of the respondents, or other variables.

Interesting Comparisons

Correlations between Front-of-House and Wood Lane Receiver

Previously, K2 asserted that there appeared to be a 50-55 dB differential (or attenuation factor) between sound levels measured at FOH, and sound levels measured at 109 Wood Lane, approximately ~5800 feet from the stage. To investigate this, we compared some of the 1-minute and 1-second data for FOH and Wood Lane. On average, the difference between FOH and Wood Lane appears to be approximately 50 dB for dB1 low frequency measurements. However, we observed certain shows or periods where the attenuation factor was higher or lower, indicating that wind, atmospheric, or speaker configurations were resulting in more or less sound being transmitted to neighbors.

We have provided a few comparison graphs to show that there is a correlation, and that the dB1 levels at 109 Wood Lane were above background levels (clearly audible) when music was playing.

The attached **Graph 1** shows the dB1 1-minute and 15-minute Leq data over a 1-hour period of the 5/31 show. The 1-minute data shows clear signs of trends between the two locations, but some of the detail is lost due to the 1-minute averaging.

The attached **Graph 2** shows the dB1 1-second and 1-minute Leq data over a 5-minute period of the 5/31 show. The 1-second data makes it much easier to see clear trends between peaks and dips at both the FOH and Wood Lane Receiver.

From inspection of Graph 2, and additional K2 measurements, we expect that the background dB1 level (in absence of music) is approximately 65 – 75 dB1 at the Wood Lane receiver (Note that there were limited “background” noise measurements conducted by K2 at Wood Lane or other locations). The Wood Lane 1-second dB1 data showed clear peaks in the 80 – 85 dB1 range that clearly correlated with the peaks and dips seen in the FOH data. The 1-second dB1 peaks at Wood Lane appear to be approximately 15 – 25 dB higher than the quietest dips, and approximately 5 – 10 dB higher than the presumed “background” dB1 level of 65 – 75 dB1. Since the “signal” is clearly above the background noise, it was likely plainly audible, especially since it is rhythmic in nature. Since this show was running ~125 – 130 dB1 1-minute averages at its loudest, this show would’ve needed to be ~5-10 dB1 quieter to safely comply with the proposed 2015 Noise Regulations, which should result in a similar reduction in the peaks seen at Wood Lane. A 5 dB reduction is typically noticeable, and a 10 dB reduction is significant and usually considered half as loud subjectively.

The attached **Graph 3** shows the dBA 1-second and 1-minute Leq data over a 5-minute period of the 5/31 show. While there are still faintly identifiable trends between some of the the FOH dBA and Wood Lane dBA results, the correlation is not nearly as clear, even when looking at 1-second data. This makes sense, since the background noise level at Wood Lane is expected to be ~50 dBA based on available data and limited review. Also, low-frequency sound (dB1) tends to travel much further than mid- and high-frequency sound (dBA), and the complaints have tended to be primarily due to low-frequency sound.

5/16 Global Dub vs 5/31 Bassnectar

The 5/16 Global Dub and 5/31 Bassnectar shows were two shows with the loudest dB1 low-frequency noise levels at FOH.

It is our understanding that the 5/16 show received special attention and subjective monitoring from various involved parties including neighbors, Town of Morrison officials, Red Rocks and Denver Arts and Venues staff, the Jefferson County Commissioners, and local news media. Based on news coverage of the event, it is our understanding that this show was audible at some locations, but was not a major problem. In fact, some even speculated that they turned down the volume for this event, due to the increased scrutiny, however, this was one of the loudest shows of the seasons as measured at FOH.

The 5/31 show was also among the loudest shows of the season, but is understood to have resulted in more complaints than the 5/16 show.

5/31 Bassnectar vs 6/20-21 Skrillex

It is interesting to note that Bassnectar and Skrillex are both high-profile EDM artists whose shows are well-known for having significant low-frequency content and high sound levels. Both shows appeared to receive similar amounts of complaints, but the 6/20-21 Skrillex shows were approximately 10-15 dB1 quieter than the 5/31 Bassnectar show on average, based on the 1-minute dB1 exceedance data shown in Tables 4 and 5.

Comparison of Proposed 2015 Noise Regulations to 2014 Season

To evaluate the potential impact of the proposed 2015 Noise Regulations, we applied the Draft 2015 Noise Regulations to the 2014 season data.

Draft-A 2015 Noise Regulations

The attached **Table 6** lists the shows that would have incurred violations if the Draft-A 2015 Noise Regulations were applied to the 2014 season.

If the Draft-A 2015 Noise regulations were applied during the 2014 season, this would have resulted in 20 shows that incurred FOH noise level violations, and 17 shows that incurred ending time violations. There would have been a total of 169 noise level violations, and 19 ending time violations, resulting in a total of **\$1,880,000 in fines**. Note that these numbers may be somewhat higher if data was available for all of the shows.

Draft-B 2015 Noise Regulations

The attached **Table 7** lists the shows that would have incurred violations if the Draft-B 2015 Noise Regulations were applied to the 2014 season.

If the Draft-B 2015 Noise regulations were applied during the 2014 season, this would have resulted in 25 shows that incurred FOH noise level violations, and 20 shows that incurred ending time violations. There would have been a total of 368 noise level violations, and 23 ending time violations, resulting in a total of **\$3,910,000 in fines**. Note that these numbers may be somewhat higher if data was available for all of the shows.

Draft-A vs. Draft-B 2015 Noise Regulations

The increase in violations seen with Draft-B is almost entirely due to the slightly more restrictive low frequency dB1 FOH limit (125 dB1 in Draft-A vs 123 dB1 in Draft-B). There were 457 minutes that were greater than or equal to 125.0 dB1, compared to 1054 minutes that were greater than or equal to 123.0 dB1.

Recommendations Regarding 2015 Noise Regulations

The Proposed 2015 Noise Regulations are a significant improvement over the 2014 regulations, since the maximum FOH sound pressure levels will apply to the entire show.

1. We recommend that the Town of Morrison requests Red Rocks implement the Draft-B 2015 Noise Regulations for the 2015 season contracts.

We expect there will still be shows that are audible and complaint generators even if the Draft-A or Draft-B 2015 Noise Regulations are implemented. However, both proposed draft regulations represent a reduction in sound levels and ending times, as seen in our comparison of the proposed 2015 regulations to the 2014 season data, which is indicative of Red Rocks trying to compromise on sound levels and ending times. At the same time, they appear willing to do additional and ongoing noise monitoring and work with the involved parties to better understand the circumstances that generate the most complaints, and alter their operations and regulations as feasible to address the issues.

2. We recommend that the Town of Morrison request that they receive the noise violation fines collected, since the stated intent of the noise regulations is to benefit the impacted residents. The fines collected would be used at the discretion of the Town of Morrison, but we suggest they be used to offset costs incurred in ongoing mediation efforts, independent 3rd party noise monitoring for future seasons,

documentation and review of complaints, and review and verification of Red Rocks noise logs and violations.

3. We recommend that the Red Rocks Noise Regulations clarify who specifically is responsible for paying the fines. For example, is it the promoter, specific sound engineer, or specific band that creates the exceedance that pays? This information may be clarified elsewhere in Red Rocks contract documents and regulations that we have not reviewed.
4. We recommend that the technical definition of the low-frequency dB1 noise metric be clarified. We suggest that this be defined as “the logarithmic sum of sound pressure level energy in the un-weighted 25, 31.5, 40, 50, 63, and 80 Hz one-third-octave bands.”

Recommendations Regarding 2015 Noise Monitoring and Community Survey

5. We recommend that Red Rocks continue their current logging of 1-second and 1-minute dBA and dB1 sound levels at Front of House.
 - a. We recommend reviewing the technical procedures with the appropriate technical staff and touring engineers to ensure that data is correctly logged for all shows. We recommend that data is logged for all shows (including Film on the Rocks and non-music shows) for completeness, even if those shows are reasonably expected to not result in any exceedances or violations.
 - b. We recommend that the SLARM noise monitor be consistently started and stopped at the same times for every show, if feasible, to simplify post-processing and analysis of the data. We also recommend that the SLARM noise monitor continues logging data for some period after the shows have concluded, to verify the ending times and provide background noise levels. For instance, the noise monitoring system might be configured to run on every show date from noon to 1:30 am.
 - c. If possible, we recommend upgrading the system to allow for logging of 1-second 1/3 octave sound levels. This would provide additional useful data for comparison with 1-second 1/3 octave data taken at other measurement locations simultaneously.
6. We recommend that there be a single repository or system for noise-affected neighbors to register their complaints. The specific details of the complaint monitoring system would need to be discussed and coordinated prior to implementation, but we have the following suggestions currently:
 - a. Ideally, the complaint repository could consist of a website that neighbors would register and log-in to file complaints. This would ensure that only verified residents were leaving complaints or comments, and would also simplify the process so the complainants don't need to restate their location and contact information every time.
 - b. At a minimum, the system should allow neighbors to register complaints by leaving a voice message and/or sending an email.
 - c. Individuals making complaints should be encouraged to provide, at a minimum, the following information:
 - i. Name, Location, and Contact Information.
 - ii. Specific dates and times of complaints.

- iii. Description of what they are hearing and how it is affecting them. Is it audible indoors, or only outdoors or with windows open?
 - iv. Whether the intrusive noise is continuous for the entire show, intermittent, or only observed occasionally or over specific time periods.
 - v. Comments on the wind and weather conditions at the time of complaint.
 - d. The complete database of complaint information should be kept private to protect the identities of the complainants. However, the need for privacy should be balanced with the need for the involved parties and their consultants to review the data and determine correlations with the objectively measured sound data. During on-site detailed noise monitoring, it would be useful to have real-time access to the complaints, to subjectively and objectively observe the noise levels at the complainant's property, if possible and with the property owners consent.
 - e. It is unclear who would be responsible for implementing and administering the complaint repository, but this would need to be coordinated between the involved parties.
7. We recommend that additional detailed noise studies and monitoring of noise levels outside of the venue are undertaken to further understand the conditions that result in increased complaints.
 - a. It should be determined if a measurement location south of the stage (at the South Tower, and/or between Red Rocks and Morrison) would provide a more consistent correlation between noise levels leaving the facility, noise levels at distant receivers, and the resulting levels of complaints or annoyance. If a better correlation can be shown, this measurement location might become the basis for revised noise limits in the 2016 Regulations.
 - b. Measurements taken at all locations should include 1-second 1/3 octave logging for post-processing and comparison with FOH levels.
 - c. During detailed noise studies, particular attention should be paid to the specific loudspeaker configurations used. We suspect that certain loudspeaker configurations will result in higher levels of low-frequency noise transmitted to neighbors, even if the FOH levels are the same. A new measurement position South of the stage or venue may provide a better correlation for low-frequency sound at the venue vs. distant receivers (compared to the current FOH position).
 - d. During the detailed noise studies, particular attention should be paid to wind speed, wind direction, and other atmospheric conditions both at the venue and at the receivers.
 - e. Background noise measurements should be longer than 1-minute in duration and include the same logging and metrics as those logged for the shows. Typically, we would recommend minimum 5-minute or 15-minute measurement periods, and logging 1-second third-octave results. Additional details such as statistical 1-minute dB1 and dBA values, for instance, could be post processed from the higher resolution data as needed.
8. We recommend that Red Rocks install at least one logging weather station. We expect that there may be some correlation between the wind speed and direction, and the resulting amount of attenuation between sound levels leaving the Red Rocks venue and sound levels measured at distant receivers.

- a. The weather station should at a minimum record the wind speed, wind direction, and temperature. Barometric pressure and humidity are expected to be less useful, but should also be recorded if available.
 - b. The weather station should record data every 15 minutes minimum, and ideally every 1-minute and/or 1-second, so the wind data can be directly compared with the sound level logs.
 - c. Ideally, we suggest that a weather station be located somewhere between Red Rocks and Morrison. Also, it would be ideal if the wind speed and direction were measured at multiple heights, since wind gradients can also affect sound propagation over long distances.
 - d. Additional or alternate candidates for weather station locations include on top of the Stage-Left South Tower, and/or near the most noise affected neighbors.
9. We recommend that Red Rocks provide FOH 1-minute logs, graphs, and summaries of violations and fines to Morrison in a timely manner, so they can verify if any violations have occurred and ensure that Red Rocks is enforcing their Noise Regulations.

Comments

We look forward to discussing these issues with the Town Board of Trustees. Our analysis and conclusions are based on our best understanding of the information and data communicated to us by the Town of Morrison, Red Rocks, K2, and the City and County of Denver. We request the opportunity to revise our conclusions if additional information or clarifications are provided to us.

If you have any questions or comments, please call us at (303) 766-7100.

Sincerely,



Prepared By:
Joe Erickson
Acoustic Designer



Reviewed By:
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Red Rocks Draft-A 2015 Proposed Noise Regulations
Red Rocks Draft-B 2015 Proposed Noise Regulations

Reference: K2 Summary Reports of dB1 and dBA Noise Monitoring
(.PDFs provided by the Town of Morrison on November 7, 2014)

Table 4 - Comparison of All Shows - 1-Minute Exceedances vs. Annoyance Ratings on Saveredrocks.com

Red Rocks - 2014			dB1 1 min Exceedances (Over Entire Show)								dBA 1 min Exceedances (Over Entire Show)								Saveredrocks.com Survey Results									
Show ending times			>=135	>= 130	>= 125	>= 123	>= 120	>= 115	>=110	>= 105	>= 100	>= 0	>=115	>=110	>= 108	>= 105	>= 100	>= 95	>=90	>= 85	>= 0	Total res	1	2	3	4	5	
Date	Event	Ending																										
Jan 31, 2014	Friday	Icelandic	11:26 PM	1126																								
Apr 19, 2014	Saturday	Slightly Stoopid	10:45 PM	1045																								
Apr 20, 2014	Sunday	Snoop Dogg	10:58 PM	1058																								
May 2, 2014	Friday	Ellie Golding	10:47 PM	1047																								
May 4, 2014	Sunday	Toby Mac	10:33 PM	1033																								
May 10, 2014	Saturday	Shpongle	12:25 AM	1225																								
May 16, 2014	Friday	Global Dub	12:47 AM	1247	0	6	157	246	327	364	373	385	397	404	0	0	0	2	152	362	376	393	404	13	4	6	2	1
May 17, 2014	Saturday	Gramatik	12:47 AM	1247	0	0	26	67	153	271	303	341	370	401	0	0	0	1	181	323	335	366	409	14	5	2	3	1
May 18, 2014	Sunday	Brantley Gilbert	10:45 PM	1045	0	0	0	2	21	114	152	178	212	277	0	0	0	0	25	135	178	242	276	7	2	5		
May 19, 2014	Monday	Lana Del Ray	10:38 PM	1038	0	0	0	0	4	42	61	66	70	170	0	0	0	0	37	72	103	121	169	9	9			
May 25, 2014	Sunday	Red Dirt on the Rocks	10:45 PM	1045	0	0	0	0	0	56	173	216	236	294	0	0	0	0	9	155	232	249	282	6	4	2		
May 28, 2014	Wednesday	One Republic	11:02 PM	1102	0	0	3	21	86	128	144	162	176	259	0	0	0	10	100	183	193	195	258	3	3			
May 29, 2014	Thursday	One Republic	10:59 PM	1059	0	0	0	3	37	116	134	148	159	254	0	0	0	9	112	172	188	197	244	2	1	1		
May 30, 2014	Friday	Bassnectar	12:25 AM	1225	0	0	10	56	116	192	243	298	324	399	0	0	0	12	187	249	321	337	433	15	1	1	2	8
May 31, 2014	Saturday	Bassnectar	12:28 AM	1228	0	11	139	178	240	270	295	317	327	422	0	0	0	34	219	293	323	344	450	12	3		2	1
Jun 1, 2014	Sunday	John Prine	11:02 PM	1102	dB1 data missing								dB1 data missing								dB1 data missing							
Jun 6, 2014	Friday	John Butler Trio	11:30 PM	1130	dB1 data missing								dB1 data missing								dB1 data missing							
Jun 7, 2014	Saturday	BHTM	12:00 AM	1200	dB1 data missing								dB1 data missing								dB1 data missing							
Jun 8, 2014	Sunday	The Fray	10:48 PM	1048	dB1 data missing								dB1 data missing								dB1 data missing							
Jun 11, 2014	Wednesday	Lionel Richie	10:45 PM	1045	dB1 data missing								dB1 data missing								dB1 data missing							
Jun 12, 2014	Thursday	Brit Floyd	11:03 PM	1103	dB1 data missing								dB1 data missing								dB1 data missing							
Jun 13, 2014	Friday	Theivery Corp	11:43 PM	1143	dB1 data missing								dB1 data missing								dB1 data missing							
Jun 14, 2014	Saturday	OAR	10:52 PM	1052	dB1 data missing								dB1 data missing								dB1 data missing							
Jun 17, 2014	Tuesday	James Taylor	10:51 PM	1051	dB1 data missing								dB1 data missing								dB1 data missing							
Jun 18, 2014	Wednesday	James Taylor	10:58 PM	1058	dB1 data missing								dB1 data missing								dB1 data missing							
Jun 19, 2014	Thursday	Feed on the Rocks	12:08 AM	1208	0	0	3	12	98	204	273	323	373	563	0	0	1	18	170	247	313	386	558	0				
Jun 20, 2014	Friday	Skrillex	12:54 AM	1254	0	0	0	5	38	101	166	331	379	570	0	0	0	0	107	294	362	389	570	11			4	4
Jun 21, 2014	Saturday	Skrillex	1:03 AM	1303	0	0	0	6	37	86	157	240	281	482	0	0	0	0	108	219	323	360	482	5	1		3	1
Jun 27, 2014	Friday	WSP	11:00 PM	1100	0	0	0	0	0	147	158	163	166	230	0	0	0	0	104	157	166	215	232	7	4	2	1	
Jun 28, 2014	Saturday	WSP	11:18 PM	1118	0	0	0	0	10	153	164	170	183	235	0	0	0	0	118	161	182	213	235	0				
Jun 29, 2014	Sunday	WSP	9:03:00 PM	903	0	0	0	0	1	83	93	96	101	127	0	0	0	0	43	91	97	116	128	0				
Jul 2, 2014	Wednesday	Sarah McLachlan	10:40 PM	1040	0	0	0	0	0	0	3	32	164	0	0	0	0	0	26	81	118	164	0	7	4	1		2
Jul 3, 2014	Thursday	Zeds Dead	12:53 AM	1253	0	0	14	40	79	155	224	269	289	419	0	0	1	6	103	279	361	374	419	12	2	1	2	5
Jul 4, 2014	Friday	Blues Traveler	11:28 PM	1128	dB1 data missing								dB1 data missing								dB1 data missing							
Jul 5, 2014	Saturday	Umpheys McGee	1:00 AM	1300	0	0	0	0	2	108	176	241	254	364	0	0	0	33	170	245	255	289	335	11	6	1	1	2
Jul 6, 2014	Sunday	Michael Franti	11:26 PM	1126	0	0	0	0	0	0	20	163	216	297	0	0	0	1	134	245	264	286	365	7	3		4	
Jul 10, 2014	Thursday	Wait, Wait Don't Tell	10:00 PM	1000	dBA and dB1 data is missing								dBA and dB1 data is missing								dBA and dB1 data is missing							
Jul 11, 2014	Friday	Avett Bros.	11:55 PM	1155	0	0	0	0	0	0	62	103	223	0	0	0	0	0	19	143	183	223	0	3		3		
Jul 12, 2014	Saturday	Avett Bros.	11:10 PM	1110	0	0	0	0	0	0	3	85	224	0	0	0	0	0	71	159	191	225	0	6	2	3		1
Jul 13, 2014	Sunday	Avett Bros.	11:35 PM	1135	0	0	0	0	0	3	111	189	222	249	0	0	0	0	0	27	118	249	0					
Jul 14, 2014	Monday	Mayhem Festival	11:04 PM	1104	0	0	0	0	1	98	200	218	231	302	0	0	0	9	189	234	248	272	299	5	1	2	1	1
Jul 15, 2014	Tuesday	Goo Goo Dolls	10:49 PM	1049	0	0	0	0	0	6	72	139	154	202	0	0	0	0	83	150	165	191	203	0				
Jul 16, 2014	Wednesday	Old Crow Med. Show	10:50 PM	1050	0	0	0	0	0	0	4	70	114	213	0	0	0	0	16	117	163	181	214	0				
Jul 17, 2014	Thursday	CSO/ Devotchka	11:30 PM	1130	0	0	0	0	0	0	8	66	242	0	0	0	0	3	51	124	176	243	0					
Jul 18, 2014	Friday	Global	1:00 AM	1300	0	0	10	46	204	374	446	472	482	569	0	0	0	1	42	282	406	467	570	23	7	3	7	6
Jul 19, 2014	Saturday	Global	1:00 AM	1300	0	0	35	79	146	280	361	417	466	570	0	0	0	5	158	344	421	484	567	8	1	4	2	1
Jul 20, 2014	Sunday	Global	12:04 AM	1204	0	0	18	51	117	262	372	412	415	506	0	0	0	0	71	311	415	423	506	6	6		4	2
Jul 21, 2014	Monday	NIN	11:03 PM	1103	0	0	0	0	4	64	179	188	192	266	0	0	2	18	127	177	198	203	267	6	3	3		
Jul 22, 2014	Tuesday	NIN	10:57 PM	1057	0	0	0	0	0	81	163	174	184	242	0	0	0	7	132	164	189	195	242	8	2	3	1	2
Jul 23, 2014	Wednesday	Dierks Bently	11:09 PM	1109	0	0	0	0	0	0	28	149	179	228	0	0	0	1	106	189	191	212	229	6	3		2	1
Jul 24, 2014	Thursday	ABBA	10:24 PM	1024	0	0	0	0	0	0	3	71	136	0	0	0	0	0	4	76	99	137	0	6	5	1		
Jul 25, 2014	Friday	Tedeschi Trucks	11:11 PM	1111	0	0	0	0	0	0	40	125	157	238	0	0	0	0	27	151	178	199	238	7	6	1		
Jul 26, 2014	Saturday	AVMA Concert	9:05 PM	905	dBA and dB1 data is missing								dBA and dB1 data is missing								dBA and dB1 data is missing							
Jul 27, 2014	Sunday	Indigo Girls	9:40 PM	940	0	0	0	0	0	0	0	0	134	0	0	0	0	0	0	47	79	134	0					
Jul 28, 2014	Monday	Lyle Lovett	11:56 PM	1156	0	0	0	0	0	0	0	5	223	0	0	0	0	2	68	141	170	223	0					
Jul 31, 2014	Thursday	Hard Festival	11:58 PM	1158	0	0	8	47	165	253	292	342	419	452	0	0	0	11	177	280	322	363	453	11	1	5	1	3
Aug 1, 2014	Friday	Amos Lee	9:45 PM	945	0	0	0	0	0	0	1	26	39	172	0	0	0	0	1	40	105	133	173	0				
Aug 2, 2014	Saturday	Railroad Earth	12:51 AM	1251	dB1 data missing								dB1 data missing								dB1 data missing							
Aug 3, 2014	Sunday	CSO/ Jerry Garcia	10:55 PM	1055	0	0	0	0	0	0	0	5	129	0	0	0	0	0	12	79	102	129	0					
Aug 4, 2014	Monday	Chicago/ Reo	10:51 PM	1051	0	0	0	0	0	0	47	133	148	187	0	0	0	0	29	144	158	163	188	0				
Aug 5, 2014	Tuesday	CHROMEO	11:45 PM	1045	0	0	0	0	21	90	154	244	281	364	0	0	0	0	87	144	221	308	364	6	1	1	2	2

Aug 6, 2014	Wednesday	Foster the People	10:46 PM	1046	0	0	0	1	22	103	148	171	198	229	0	0	0	0	91	161	175	199	230	0		
Aug 7, 2014	Thursday	Ray LaMontagne	10:33 PM	1033	dBA and dB1 data is missing										dBA and dB1 data is missing										0	
Aug 8, 2014	Friday	Pretty Lights	12:32 AM	1232	0	0	0	6	16	50	149	206	264	312	366	0	0	0	2	151	204	294	350	365	9	
Aug 9, 2014	Saturday	Pretty Lights	12:36 AM	1236	0	0	0	8	41	122	190	239	299	343	368	0	0	0	0	95	231	320	359	368	6	
Aug 10, 2014	Sunday	Train	10:20 PM	1020	0	0	0	0	0	76	117	134	149	172	0	0	0	0	33	121	148	164	173	9		
Aug 12, 2014	Tuesday	Fall Out Boy	10:56 PM	1056	0	0	0	17	114	168	174	182	189	268	0	0	0	1	5	155	187	191	197	268	8	
Aug 13, 2014	Wednesday	Pepper Dirty Heads	11:34 PM	1134	0	0	0	5	15	70	158	208	226	275	0	0	0	0	6	65	196	208	243	271	10	
Aug 14, 2014	Thursday	Head and Heart	11:36 PM	1136	0	0	0	0	0	73	102	106	222	0	0	0	0	1	35	85	125	161	222	14		
Aug 15, 2014	Friday	Beck	10:44 PM	1044	0	0	0	0	4	48	75	117	126	182	0	0	0	2	31	90	130	138	144	183	7	
Aug 16, 2014	Saturday	Trampled by Turtles	11:27 PM	1127	0	0	0	0	1	11	61	153	213	266	0	0	0	1	21	176	211	235	267	0		
Aug 17, 2014	Sunday	Rodrigo Y Gabriela	10:16 PM	1016	0	0	0	0	0	18	61	109	125	169	0	0	0	0	4	66	115	138	171	7		
Aug 18, 2014	Monday	J. Johnson	10:55 PM	1055	0	0	0	0	0	0	24	105	178	0	0	0	0	0	57	132	140	179	8			
Aug 19, 2014	Tuesday	Wiz Khalifa	11:10 PM	1110	0	0	0	4	22	52	124	213	279	342	0	0	0	1	13	99	247	314	319	343	7	
Aug 20, 2014	Wednesday	Jack White	11:00 PM	1100	0	0	0	0	1	100	142	165	180	0	0	0	1	40	118	140	163	180	181	0		
Aug 21, 2014	Thursday	Honda Civic	11:12 PM	1112	0	0	0	0	2	40	54	58	229	0	0	0	0	0	80	142	175	195	229	0		
Aug 22, 2014	Friday	1964 The Tribute	10:15 PM	1015	0	0	0	0	0	0	0	0	123	0	0	0	0	0	2	75	102	124	9			
Aug 23, 2014	Saturday	Reggae on the Rocks	11:32 PM	1132	0	0	0	0	42	268	424	499	550	635	0	0	0	3	164	437	478	524	634	14		
Aug 24, 2014	Sunday	D. Chapelle	11:20 PM	1120	dBA and dB1 data is missing										dBA and dB1 data is missing										0	
Aug 26, 2014	Tuesday	John Legend	10:13 PM	1013	0	0	0	0	0	18	39	54	165	0	0	0	0	0	15	77	97	165	1			
Aug 29, 2014	Friday	Atmosphere	11:55 PM	1155	0	0	0	5	28	97	206	272	291	316	0	0	0	18	177	253	311	313	314	2		
Aug 31, 2014	Saturday	Joe Bonamassa	9:13 PM	913	0	0	0	0	0	18	94	112	138	0	0	0	0	7	89	119	130	133	139	3		
Sep 1, 2014	Monday	One Republic	11:00 PM	1100	0	0	0	1	20	57	92	100	114	195	0	0	0	2	8	46	114	137	146	149	196	5
Sep 4, 2014	Thursday	Arctic Monkey	10:51 PM	1051	0	0	0	0	8	95	111	115	122	158	0	0	0	19	83	118	122	155	159	4		
Sep 5, 2014	Friday	STS9	12:35 AM	1235	0	0	0	0	78	159	217	236	302	0	0	0	0	0	11	165	231	247	303	6		
Sep 6, 2014	Saturday	STS9	12:39 AM	1239	0	0	0	0	38	148	214	236	296	0	0	0	0	0	54	174	234	285	297	4		
Sep 7, 2014	Sunday	Oddball Comedy	10:49 PM	1049	dBA and dB1 data is missing										dBA and dB1 data is missing										0	
Sep 10, 2014	Wednesday	Drake	11:02 PM	1102	dBA and dB1 data is missing										dBA and dB1 data is missing										0	
Sep 12, 2014	Friday	Flux Pavillion	12:36 AM	1236	0	0	0	6	22	101	259	304	328	383	631	0	0	0	0	75	284	325	352	628	8	
Sep 13, 2014	Saturday	CSO	9:15 PM	915	0	0	0	0	0	0	0	1	298	0	0	0	0	0	0	0	0	26	298	7		
Sep 14, 2014	Sunday	Alabama	10:45 PM	1045	0	0	0	0	0	0	49	114	424	dBA data is missing										0		
Sep 17, 2014	Wednesday	J. Aldean	10:32 PM	1032	0	0	0	1	5	49	122	133	160	279	0	0	0	11	118	134	165	231	279	0		
Sep 18, 2014	Thursday	J. Aldean	10:32 PM	1032	0	0	0	0	2	57	119	131	157	272	0	0	0	0	112	134	164	205	272	0		
Sep 19, 2014	Friday	Lotus	12:28 AM	1228	0	0	0	0	14	194	266	322	524	0	0	0	0	12	126	214	227	283	404	0		
Sep 20, 2014	Saturday	Grace Potter	11:20 PM	1120	0	0	0	0	6	96	196	217	350	0	0	0	0	16	150	220	233	250	319	0		
Sep 23, 2014	Tuesday	CSN	10:30 PM	1030	0	0	0	0	0	10	63	104	392	0	0	0	0	0	45	114	144	162	391	5		
Sep 24, 2014	Wednesday	Kings of Leon	11:00 PM	1100	0	0	0	0	6	91	199	221	421	0	0	0	0	0	54	175	189	193	240	6		
Sep 25, 2014	Thursday	Led Zepplin	9:56 PM	956	0	0	0	0	0	0	49	85	192	0	0	0	0	0	75	120	131	133	150	4		
Sep 26, 2014	Friday	Big Gigantic	12:50 AM	1250	0	0	0	4	24	100	262	303	324	379	626	0	0	0	0	75	284	325	352	622	11	
Sep 27, 2014	Saturday	Big Gigantic	1:00 AM	1300	0	0	0	2	30	188	331	367	406	579	0	0	0	0	15	271	314	335	383	419	5	
Sep 30, 2014	Tuesday	Tom Petty	10:45 PM	1045	0	0	0	0	0	1	92	142	229	0	0	0	0	1	72	155	173	188	228	0		
Oct 1, 2014	Wednesday	Tom Petty	10:50 PM	1050	0	0	0	0	0	0	94	143	204	0	0	0	0	0	55	145	170	191	204	0		
Oct 2, 2014	Thursday	Casting Crowns	10:08 PM	1008	0	0	0	0	0	14	55	95	188	0	0	0	0	0	5	78	117	138	188	0		
Oct 3, 2014	Friday	Tom Petty	10:43 PM	1043	0	0	0	0	0	1	91	133	230	0	0	0	0	0	68	156	177	183	227	0		
Oct 4, 2014	Saturday	OAR	10:15 PM	1015	0	0	0	0	13	71	140	146	196	0	0	0	0	0	92	163	178	193	196	0		
FOTR	DATE	EVENT	TIME		dBA and dB1 data is missing										dBA and dB1 data is missing										0	
Jun 3, 2014	Tuesday	FOTR Caddyshack	10:57 PM	1057	dBA and dB1 data is missing										dBA and dB1 data is missing										0	
Jun 10, 2014	Tuesday	FOTR Fight Club	11:32 PM	1132	dBA and dB1 data is missing										dBA and dB1 data is missing										0	
Jun 16, 2014	Monday	FOTR Labyrinth	10:55 PM	1055	dBA and dB1 data is missing										dBA and dB1 data is missing										0	
Jun 24, 2014	Tuesday	FOTR This Spinal Tap	11:22 PM	1122	dBA and dB1 data is missing										dBA and dB1 data is missing										0	
Jul 1, 2014	Tuesday	FOTR Fast and the	11:00 PM	1100	dBA and dB1 data is missing										dBA and dB1 data is missing										0	
Jul 8, 2014	Tuesday	FOTR Hunger Games	11:34 PM	1134	dBA and dB1 data is missing										dBA and dB1 data is missing										0	
Jul 29, 2014	Tuesday	FOTR Pitch Perfect	10:47 PM	1047	dBA and dB1 data is missing										dBA and dB1 data is missing										0	
Aug 11, 2014	Monday	FOTR Top Gun	10:46 PM	1046	dBA and dB1 data is missing										dBA and dB1 data is missing										0	
Aug 25, 2014	Monday	FOTR Who framed	10:36 PM	1036	dBA and dB1 data is missing										dBA and dB1 data is missing										0	
Sep 2, 2014	Tuesday	FOTR Big Lebowski	11:00 PM	1100	dBA and dB1 data is missing										dBA and dB1 data is missing										0	

Table 5 - Comparison of Shows that received "4" and "5" Annoyance Ratings on Saveredrocks.com

Red Rocks - 2014			dB1 1 min Exceedances (Over Entire Show)										dBA 1 min Exceedances (Over Entire Show)										Saveredrocks.com Survey Results (Only Those with "4" and "5" Responses)							
Show ending times			>=135	>= 130	>= 125	>= 123	>= 120	>= 115	>=110	>= 105	>= 100	>= 0	>=115	>=110	>= 108	>= 105	>= 100	>= 95	>=90	>= 85	>= 0	Total res	1	2	3	4	5			
Date	Event	Ending	dB1 data missing										dBA data missing																	
Jan 31, 2014	Friday	Icelandic	11:26 PM	1126																										
Apr 19, 2014	Saturday	Slightly Stoopid	10:45 PM	1045																										
Apr 20, 2014	Sunday	Snoop Dogg	10:58 PM	1058																										
May 16, 2014	Friday	Global Dub	12:47 AM	1247	0	6	157	246	327	364	373	385	397	404	0	0	0	2	152	362	376	393	404	13	4	6	2	1		
May 17, 2014	Saturday	Gramatik	12:47 AM	1247	0	0	26	67	153	271	303	341	370	401	0	0	0	1	181	323	335	366	409	12	2	5	4	1		
May 30, 2014	Friday	Bassnectar	12:25 AM	1225	0	0	10	56	116	192	243	298	324	399	0	0	0	12	187	249	321	337	433	11	6	3		2		
May 31, 2014	Saturday	Bassnectar	12:28 AM	1228	0	11	139	178	240	270	295	317	327	422	0	0	0	34	219	293	323	344	450	14	5	2	3	1		
Jun 1, 2014	Sunday	John Prine	11:02 PM	1102	dB1 data missing																									
Jun 20, 2014	Friday	Skrillex	12:54 AM	1254	0	0	0	5	38	101	166	331	379	570	0	0	0	0	107	294	362	389	570	15	1			3		
Jun 21, 2014	Saturday	Skrillex	1:03 AM	1303	0	0	0	6	37	86	157	240	281	482	0	0	0	0	108	219	323	360	482	16	12			4		
Jul 2, 2014	Wednesday	Sarah McLachlan	10:40 AM	1040	0	0	0	0	0	0	0	3	32	164	0	0	0	0	0	26	81	118	164	5	1			1		
Jul 3, 2014	Thursday	Zeds Dead	12:53 AM	1253	0	0	14	40	79	155	224	269	289	419	0	0	1	6	103	279	361	374	419	7	4	1		2		
Jul 4, 2014	Friday	Blues Traveler	11:28 PM	1128	dB1 data missing																									
Jul 12, 2014	Saturday	Avett Bros.	11:10 PM	1110	0	0	0	0	0	0	0	3	85	224	0	0	0	0	0	71	159	191	225	11	2	3		1		
Jul 14, 2014	Monday	Mayhem Festival	11:04 PM	1104	0	0	0	0	1	98	200	218	231	302	0	0	0	9	189	234	248	272	299	6	2	3		1		
Jul 18, 2014	Friday	Global	1:00 AM	1300	0	0	10	46	204	374	446	472	482	569	0	0	0	1	42	282	406	467	570	8	1	4	2	1		
Jul 19, 2014	Saturday	Global	1:00 AM	1300	0	0	35	79	146	280	361	417	466	570	0	0	0	5	158	344	421	484	567	23	7	3	7	6		
Jul 20, 2014	Sunday	Global	12:04 AM	1204	0	0	18	51	117	262	372	412	415	506	0	0	0	0	71	311	415	423	506	6	1		4	2		
Jul 22, 2014	Tuesday	NIN	10:57 PM	1057	0	0	0	0	0	81	163	174	184	242	0	0	0	7	132	164	189	195	242	8	2	3	1	2		
Jul 23, 2014	Wednesday	Dierks Bently	11:09 PM	1109	0	0	0	0	0	0	28	149	179	228	0	0	0	1	106	189	191	212	229	6	3		2	1		
Jul 31, 2014	Thursday	Hard Festival	11:58 PM	1158	0	0	8	47	165	253	292	342	419	452	0	0	0	11	177	280	322	363	453	11	1	5	1	3		
Aug 5, 2014	Tuesday	CHROME0	11:45 PM	1045	0	0	0	0	21	90	154	244	281	364	0	0	0	0	87	144	221	308	364	6	1	1	2	2		
Aug 8, 2014	Friday	Pretty Lights	12:32 AM	1232	0	0	6	16	50	149	206	264	312	366	0	0	0	2	151	204	294	350	365	9	4		3	2		
Aug 9, 2014	Saturday	Pretty Lights	12:36 AM	1236	0	0	8	41	122	190	239	299	343	368	0	0	0	0	95	231	320	359	368	6	1		1	4		
Aug 14, 2014	Thursday	Head and Heart	11:36 PM	1136	0	0	0	0	0	0	73	102	106	222	0	0	0	1	35	85	125	161	222	14	5	5	2	2		
Aug 23, 2014	Saturday	Reggae on the Rocks	11:32 PM	1132	0	0	0	0	42	268	424	499	550	635	0	0	0	3	164	437	478	524	634	14	1	3	2	5		
Aug 29, 2014	Friday	Atmosphere	11:55 PM	1155	0	0	5	28	97	206	272	291	294	316	0	0	0	18	177	253	311	313	314	2			2	2		
Sep 1, 2014	Monday	One Republic	11:00 PM	1100	0	0	1	20	57	92	100	114	124	195	0	2	8	46	114	137	146	149	196	5		2	2	1		
Sep 4, 2014	Thursday	Arctic Monkey	10:51 PM	1051	0	0	0	0	8	95	111	115	122	158	0	0	0	19	83	118	122	155	159	4		2		1		
Sep 5, 2014	Friday	STS9	12:35 AM	1235	0	0	0	0	0	78	159	217	236	302	0	0	0	0	11	165	231	247	303	6	1	2	1	1		
Sep 6, 2014	Saturday	STS9	12:39 AM	1239	0	0	0	0	0	38	148	214	236	296	0	0	0	0	54	174	234	285	297	4	1	1	1	1		
Sep 10, 2014	Wednesday	Drake	11:02 PM	1102	dBA and dB1 data is missing										dBA and dB1 data is missing															
Sep 12, 2014	Friday	Flux Pavillion	12:36 AM	1236	0	0	6	22	101	259	304	328	383	631	0	0	0	0	75	284	325	352	628	7	2	2	2	1		
																								8	1		1	5		

Table 6 - 2015 DRAFT-A Noise Regulations Applied to 2014 Season

Red Rocks - 2014 Show ending times			2015-A Minutes		Proposed RegsA (125 dB1; 105dBA > 11:30)				Noise	Noise	Time	Time		
Date	Event	Ending	Mandatory End	Over Exceed?	2015-A	Violations	dB1 >= 125	dBA >= 108	dBA >= 105	Total	Violations	Fines	Violations	Fines
Light Green = K2 Monitored Show											INT(Total/3)	* \$10000		
Jan 31, 2014 Friday	Icelandic	11:26 PM 1126	1230	0										
Apr 19, 2014 Saturday	Slightly Stoopid	10:45 PM 1045	1230	0										
Apr 20, 2014 Sunday	Snoop Dogg	10:58 PM 1058	1200	0										
May 2, 2014 Friday	Ellie Golding	10:47 PM 1047	1200	0										
May 4, 2014 Sunday	Toby Mac	10:33 PM 1033	1200	0										
May 10, 2014 Saturday	Shpongler	12:25 AM 1225	1230	0										
May 16, 2014 Friday	Global Dub	12:47 AM 1247	1230	YES	17	1	157	0	2	159	53	\$530,000	1	\$10,000
May 17, 2014 Saturday	Gramatik	12:47 AM 1247	1230	YES	17	1	26	0	0	26	8	\$80,000	1	\$10,000
May 28, 2014 Wednesday	One Republic	11:02 PM 1102	1200	0			3	0	0	3	1	\$10,000	0	\$0
May 30, 2014 Friday	Bassnectar	12:25 AM 1225	1230	0			10	0	4	14	4	\$40,000	0	\$0
May 31, 2014 Saturday	Bassnectar	12:28 AM 1228	1230	0			139	0	9	148	49	\$490,000	0	\$0
Jun 19, 2014 Thursday	Feed on the Rocks	12:08 AM 1208	1200	YES	8	1	3	1	14	18	6	\$60,000	1	\$10,000
Jun 20, 2014 Friday	Skrillex	12:54 AM 1254	1230	YES	24	1	0	0	0	0	0	\$0	1	\$10,000
Jun 21, 2014 Saturday	Skrillex	1:03 AM 1303	1230	YES	33	2	0	0	0	0	0	\$0	2	\$20,000
Jul 3, 2014 Thursday	Zeds Dead	12:53 AM 1253	1230	YES	53	2	14	1	4	19	6	\$60,000	2	\$20,000
Jul 5, 2014 Saturday	Umpheys McGee	1:00 AM 1300	1230	YES	30	1	0	0	0	0	0	\$0	1	\$10,000
Jul 18, 2014 Friday	Global	1:00 AM 1300	1230	YES	30	1	10	0	1	11	3	\$30,000	1	\$10,000
Jul 19, 2014 Saturday	Global	1:00 AM 1300	1230	YES	30	1	35	0	5	40	13	\$130,000	1	\$10,000
Jul 20, 2014 Sunday	Global	12:04 AM 1204	1200	YES	4	1	18	0	0	18	6	\$60,000	1	\$10,000
Jul 31, 2014 Thursday	Hard Festival	11:58 PM 1158	1200	0			8	0	0	8	2	\$20,000	0	\$0
Aug 2, 2014 Saturday	Railroad Earth	12:51 AM 1251	1230	YES	21	1	0	0	0	0	0	\$0	1	\$10,000
Aug 8, 2014 Friday	Pretty Lights	12:32 AM 1232	1230	YES	2	0	6	0	0	6	2	\$20,000	0	\$0
Aug 9, 2014 Saturday	Pretty Lights	12:36 AM 1236	1230	YES	6	1	8	0	0	8	2	\$20,000	1	\$10,000
Aug 19, 2014 Tuesday	Wiz Khalifa	11:10 PM 1110	1200	0			4	1	0	5	1	\$10,000	0	\$0
Aug 29, 2014 Friday	Atmosphere	11:55 PM 1155	1230	0			5	0	5	10	3	\$30,000	0	\$0
Sep 1, 2014 Monday	One Republic	11:00 PM 1100	1200	0			1	8	0	9	3	\$30,000	0	\$0
Sep 5, 2014 Friday	STS9	12:35 AM 1235	1230	YES	5	1	0	0	0	0	0	\$0	1	\$10,000
Sep 6, 2014 Saturday	STS9	12:39 AM 1239	1230	YES	9	1	0	0	0	0	0	\$0	1	\$10,000
Sep 12, 2014 Friday	Flux Pavillion	12:36 AM 1236	1230	YES	6	1	6	0	0	6	2	\$20,000	1	\$10,000
Sep 19, 2014 Friday	Lotus	12:28 AM 1228	1230	0			0	0	6	6	2	\$20,000	0	\$0
Sep 26, 2014 Friday	Big Gigantic	12:50 AM 1250	1230	YES	20	1	4	0	0	4	1	\$10,000	1	\$10,000
Sep 27, 2014 Saturday	Big Gigantic	1:00 AM 1300	1230	YES	30	1	0	0	6	6	2	\$20,000	1	\$10,000

Draft-A Noise Violations	Draft-A Noise Fines	Draft-A Time Violations	Draft-A Time Fines	Draft-A Total Fines
169	\$1,690,000	19		\$190,000

345	19	457	11	56	524
Minutes	Violations	Minutes	Minutes	Minutes	Minutes
Over		>= 125 dB1	>= 108 dBA	>= 105 dBA	Over
			< 11:30pm	> 11:30pm	Total

20	shows w/ Violations	17	shows w/ Violations
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Table 7 - 2015 DRAFT-B Noise Regulations Applied to 2014 Season

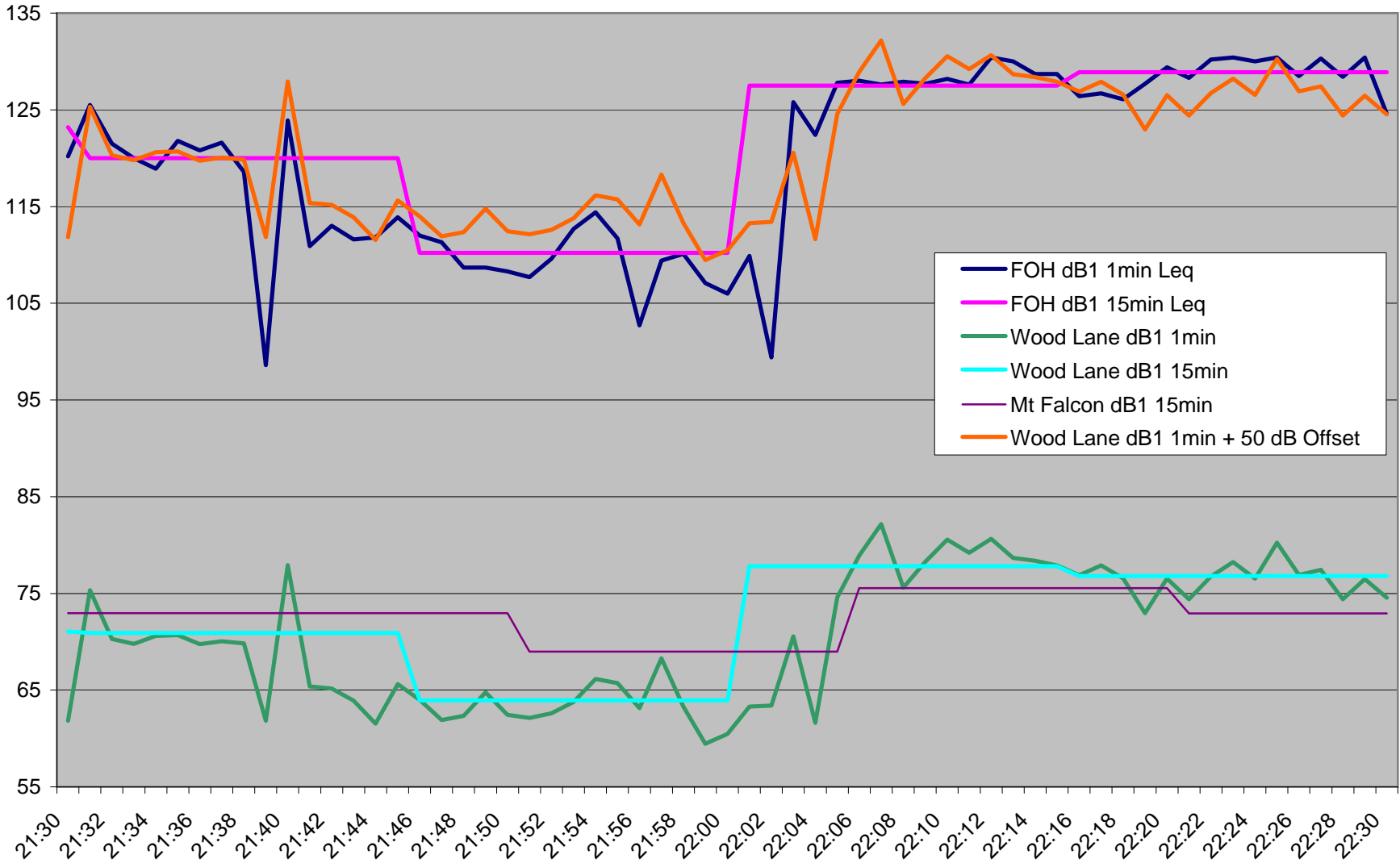
Red Rocks - 2014			2015-B		Minutes				Proposed RegsB (123 dB1; 105dBA > 11:15)				Noise	Noise	Time	Time
Show ending times			Mandatory	Over									Violations	Fines	Violations	Fines
Light Green = K2 Monitored Show			End	Exceed?	2015B	Violations							INT(Total/3)			
Date	Event	Ending														
Jan 31, 2014	Friday	Icelandic	11:26 PM	1126	1230	0										
Apr 19, 2014	Saturday	Slightly Stoopid	10:45 PM	1045	1230	0										
Apr 20, 2014	Sunday	Snoop Dogg	10:58 PM	1058	1145	0										
May 2, 2014	Friday	Ellie Golding	10:47 PM	1047	1145	0										
May 4, 2014	Sunday	Toby Mac	10:33 PM	1033	1145	0										
May 10, 2014	Saturday	Shpongler	12:25 AM	1225	1230	0										
May 16, 2014	Friday	Global Dub	12:47 AM	1247	1230	YES	17	1	246	0	2	248	82	\$820,000	1	\$10,000
May 17, 2014	Saturday	Gramatik	12:47 AM	1247	1230	YES	17	1	67	0	0	67	22	\$220,000	1	\$10,000
May 28, 2014	Wednesday	One Republic	11:02 PM	1102	1145	0			21	0	0	21	7	\$70,000	0	\$0
May 29, 2014	Thursday	One Republic	10:59 PM	1059	1145	0			3	0	0	3	1	\$10,000	0	\$0
May 30, 2014	Friday	Bassnectar	12:25 AM	1225	1230	0			56	0	6	62	20	\$200,000	0	\$0
May 31, 2014	Saturday	Bassnectar	12:28 AM	1228	1230	0			178	0	10	188	62	\$620,000	0	\$0
Jun 19, 2014	Thursday	Feed on the Rocks	12:08 AM	1208	1145	YES	23	1	12	1	17	30	10	\$100,000	1	\$10,000
Jun 20, 2014	Friday	Skrillex	12:54 AM	1254	1230	YES	24	1	5	0	0	5	1	\$10,000	1	\$10,000
Jun 21, 2014	Saturday	Skrillex	1:03 AM	1303	1230	YES	33	2	6	0	0	6	2	\$20,000	2	\$20,000
Jul 3, 2014	Thursday	Zeds Dead	12:53 AM	1253	1230	YES	68	3	40	1	4	45	15	\$150,000	3	\$30,000
Jul 5, 2014	Saturday	Umpheys McGee	1:00 AM	1300	1230	YES	30	1	0	0	0	0	0	\$0	1	\$10,000
Jul 18, 2014	Friday	Global	1:00 AM	1300	1230	YES	30	1	46	0	1	47	15	\$150,000	1	\$10,000
Jul 19, 2014	Saturday	Global	1:00 AM	1300	1230	YES	30	1	79	0	5	84	28	\$280,000	1	\$10,000
Jul 20, 2014	Sunday	Global	12:04 AM	1204	1145	YES	19	1	51	0	0	51	17	\$170,000	1	\$10,000
Jul 28, 2014	Monday	Lyle Lovett	11:56 PM	1156	1145	YES	11	1	0	0	0	0	0	\$0	1	\$10,000
Jul 31, 2014	Thursday	Hard Festival	11:58 PM	1158	1145	YES	13	1	47	0	0	47	15	\$150,000	1	\$10,000
Aug 2, 2014	Saturday	Railroad Earth	12:51 AM	1251	1230	YES	21	1	0	0	0	0	0	\$0	1	\$10,000
Aug 8, 2014	Friday	Pretty Lights	12:32 AM	1232	1230	YES	2	1	16	0	0	16	5	\$50,000	1	\$10,000
Aug 9, 2014	Saturday	Pretty Lights	12:36 AM	1236	1230	YES	6	1	41	0	0	41	13	\$130,000	1	\$10,000
Aug 12, 2014	Tuesday	Fall Out Boy	10:56 PM	1056	1145	0			17	1	0	18	6	\$60,000	0	\$0
Aug 13, 2014	Wednesday	Pepper Dirty Heads	11:34 PM	1134	1145	0			5	0	0	5	1	\$10,000	0	\$0
Aug 19, 2014	Tuesday	Wiz Khalifa	11:10 PM	1110	1145	0			22	1	0	23	7	\$70,000	0	\$0
Aug 29, 2014	Friday	Atmosphere	11:55 PM	1155	1230	0			28	0	5	33	11	\$110,000	0	\$0
Sep 1, 2014	Monday	One Republic	11:00 PM	1100	1145	0			20	8	0	28	9	\$90,000	0	\$0
Sep 5, 2014	Friday	STS9	12:35 AM	1235	1230	YES	5	1	0	0	0	0	0	\$0	1	\$10,000
Sep 6, 2014	Saturday	STS9	12:39 AM	1239	1230	YES	9	1	0	0	0	0	0	\$0	1	\$10,000
Sep 12, 2014	Friday	Flux Pavillion	12:36 AM	1236	1230	YES	6	1	22	0	0	22	7	\$70,000	1	\$10,000
Sep 19, 2014	Friday	Lotus	12:28 AM	1228	1230	0			0	0	7	7	2	\$20,000	0	\$0
Sep 26, 2014	Friday	Big Gigantic	12:50 AM	1250	1230	YES	20	1	24	0	0	24	8	\$80,000	1	\$10,000
Sep 27, 2014	Saturday	Big Gigantic	1:00 AM	1300	1230	YES	30	1	2	0	6	8	2	\$20,000	1	\$10,000

Draft-B	Draft-B	Draft-B	Draft-B	Draft-B
Noise	Noise	Time	Time	Total
Violations	Fines	Violations	Fines	Fines
368	\$3,680,000	23	\$230,000	\$3,910,000

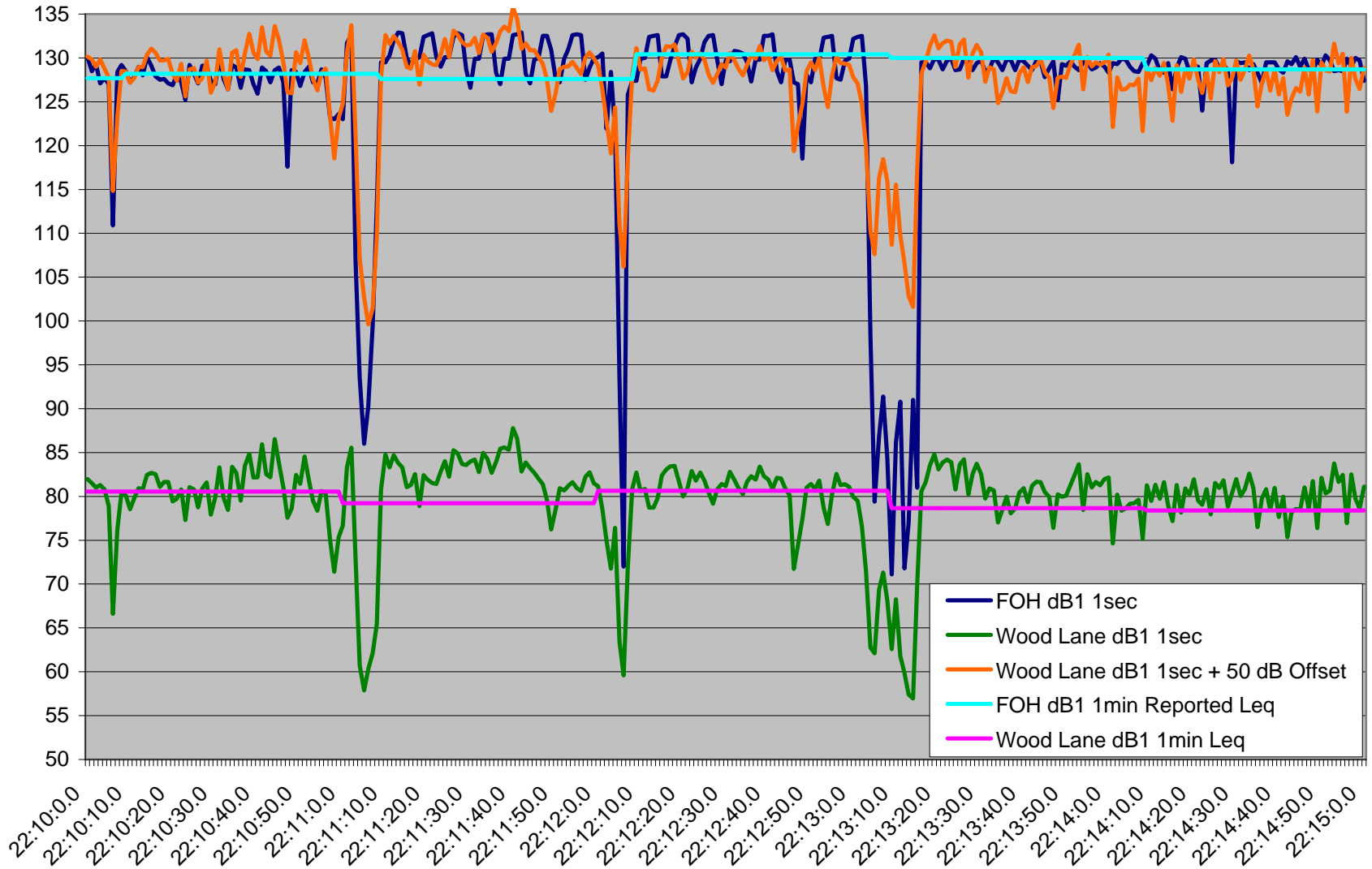
414	23	1054	12	63	1129
Minutes	Time	Minutes	Minutes	Minutes	Minutes
Over	Violations	>= 125 dB1	>= 108 dBA < 11:30pm	>= 105 dBA > 11:30pm	Over

25	shows w/ Violations	20	shows w/ Violations
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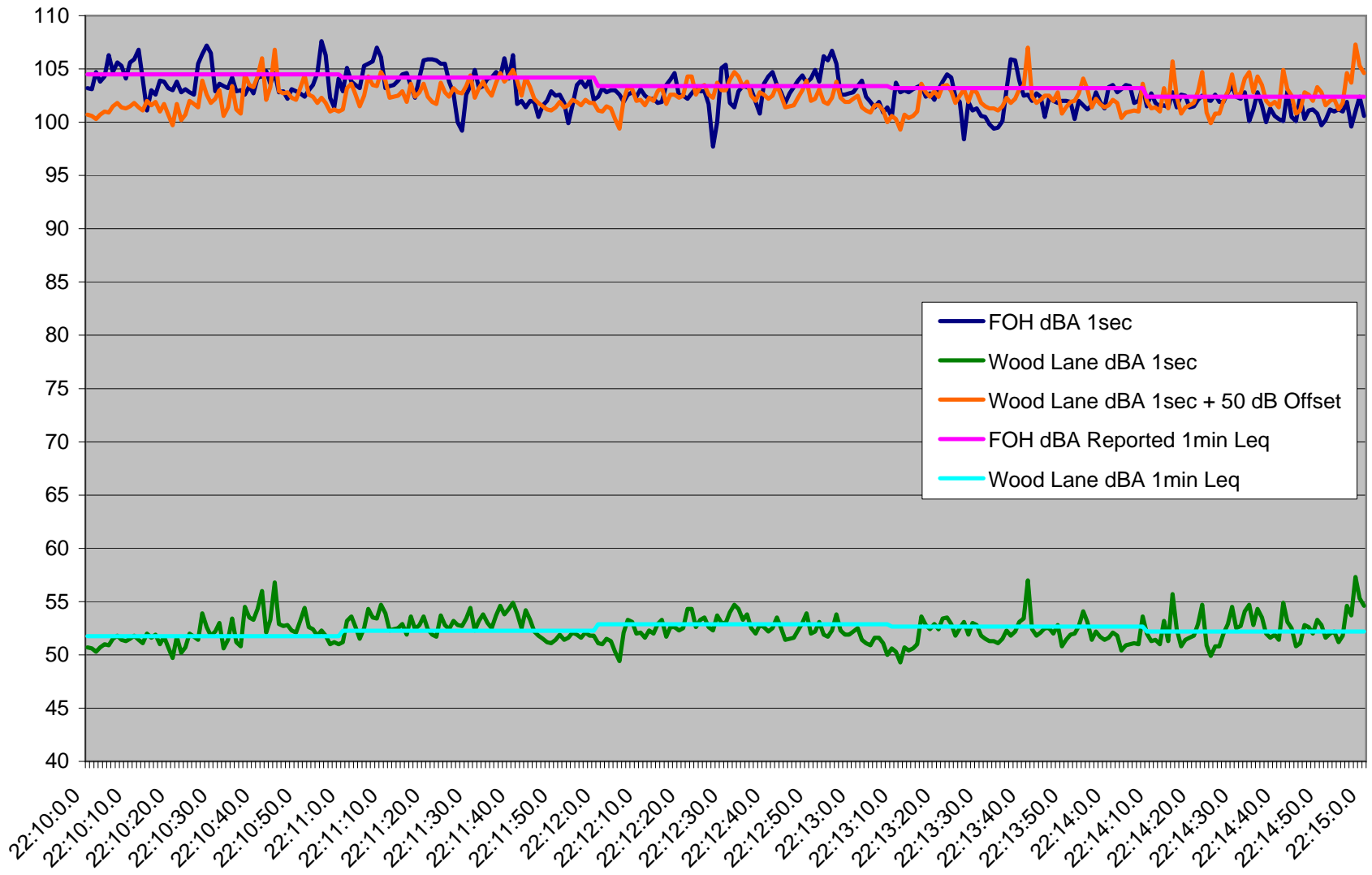
Graph 1 - 5/31 dB1 1-minute Comparison



Graph 2 - 5/31 dB1 1-second Comparison



Graph 3 - 5/31 dBA 1-second Comparison



Red Rocks Sound Pressure Level (SPL), End-time regulations & Pyrotechnics restrictions

Effective January 1, 2015 (all events commencing on or after January 1, 2015)

In order to reduce the sound level impacts on the neighboring residents from concerts at Red Rocks Amphitheatre, the City and County of Denver intends to incorporate into its user agreements for the rental of Red Rocks Amphitheatre the sound pressure levels (measured in decibel or dB levels), event ending times and pyrotechnics restrictions generally described below.

Sound Pressure Levels – measured at the fixed front of house mix position

- Prior to and including 11:30 PM, the A-weighted Leq sound pressure level shall not exceed 108 dBA for 1-minute averages.
- After 11:30 PM the A-weighted Leq sound pressure level shall not exceed 105 dBA for 1-minute averages.
- The flat (no weighting applied) Leq sound pressure levels shall not exceed 125 dB for the frequency range of 25-80 Hz for 1-minute averages.

A Sound Pressure Level (SPL) monitoring system, provided by the City and County of Denver, will be located at the front of house mix position to provide sound engineers with real time data to help them manage their sound levels.

Violation charge: \$10,000 (for every 3 times (consecutive or non-consecutive) that one of the stated limits is exceeded during a performance). Audience noise is not subject to violations.

When a violation occurs, the City and County of Denver retains the right to take corrective action as needed, including cutting power to the production. Performers/artists that incur a violation charge may not be permitted, in any form, to perform at Red Rocks Amphitheatre during the following concert season.

Ending Times

Amplified outdoor performances at Red Rocks Amphitheatre will be required to conclude no later than the following:

- Weeknights (Sunday night-Thursday night): 12:00 AM (according to venue's atomic clock)
- Weekends (Friday and Saturday night);): 12:30 AM (according to venue's atomic clock)
- Nights before the following holidays: Memorial Day, Fourth of July, Labor Day: 12:30 AM (according to venue's atomic clock)

Violation charge: \$10,000 for each ½ hour increment, effective at the start of the 3rd minute past the stated end time

When a violation occurs, the City and County of Denver retains the right to take corrective action as needed including cutting power to the production. Performers/artists that incur a violation charge may not be permitted, in any form, to perform at Red Rocks Amphitheatre during the following concert season.

Pyrotechnics restriction

The use of pyrotechnics during shows at Red Rocks Amphitheatre is only allowed by permit from the Denver Fire Department, Fire Prevention division.

The following types of pyro are not permitted at Red Rocks Amphitheatre at any time:

- Any type of airborne pyro
- Cannon simulator concussions using large or stadium charges or effects
- Any other concussions after 11 pm

Concussion pyro cannot exceed 12 shots.

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- After 11:15 PM the A-weighted Leq sound pressure level shall not exceed 105 dBA for 1-minute averages.
- The flat (no weighting applied) Leq sound pressure levels shall not exceed 123 dB for the frequency range of 25-80 Hz for 1-minute averages.

A Sound Pressure Level (SPL) monitoring system, provided by the City and County of Denver, will be located at the front of house mix position to provide sound engineers with real time data to help them manage their sound levels.

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Ending Times

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