WHEN IS ENOUGH, ENOUGH?

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1 Introduction

Noise from Oil & Gas facilities in Alberta is regulated by the Alberta Energy Regulator (AER) in Directive 038, *Noise Control* [1], while noise from utilities (e.g., power generation and distribution) is regulated by the Alberta Utilities Commission (AUC) in Rule 012, *Noise Control* [2]. Both documents are very similar. In British Columbia (BC) the Oil & Gas Commission regulates noise from Oil & Gas facilities in the "British Columbia Noise Control Best Practices Guideline" [3], a document inspired to a large extent by Directive 038.

If sound measurements are made near a residence to verify the noise impact or the ambient sound level (ASL), a minimum of 3 hours of valid data should be gathered in both the daytime (07:00 – 22:00) and the nighttime (22:00 – 07:00) period, according to [1 - 3]. This requirement can be hard to meet in practice. We therefore revisited several ASL surveys that met the regulatory requirements and assessed how much data would be needed to acquire a value, similar to the original answer.

2 Methods

2.1 Regulatory Requirements

The ASL is defined in [1] as "The sound level that is a composite of different airborne sounds from many sources far away from and near the point of measurement. The ASL does not include any energy-related industrial component and must be measured without it". According to [2] wind noise is also not included and therefore, wind speeds more than 3 m/s are excluded. The definition included in [3] does not contain such a direct requirement but points out that sound measurements can be affected by wind, and therefore limits acceptable wind speeds. All three documents assess the ASL as L_{eq}, except [2] that includes a separate, customized regime for wind turbines.

According to ANSI Standard S1.13-2005 [4], measurement uncertainty depends on many factors and is hard to quantify exactly. Rarely will the uncertainty in the measured average sound level L_{eq} exceed a value of ± 3-4 dB, and seldom will the uncertainty be less than 1 dB.

The parameter typically used in [1 - 3] is the L_{eq} in dBA. We used the same parameter throughout this article.

2.2 Approach

We selected two field programs where we conducted week-long (7 days) ASL surveys. The acquired data in one-minute intervals was processed according to the requirements included in [1 - 3]. The amount of data gathered in individual 24-hour periods met the volume requirements discussed earlier, usually by a large margin. Maximum wind speed included was 3.4 m/s, and erroneous samples (e.g., sounds close to the microphone) were excluded.

Using the processed data only, we applied the "bootstrap" method to sample each individual day or night in various time bins. Bootstrapping is a process where the sample population is randomly re-sampled (with replacement) many times, in our case a 1,000 times. In each iteration, we sampled 180 minutes (3 hrs) from the "clean" data per day or night, as well as 120 minutes, 60 minutes, 45 minutes, 30 minutes, 15 minutes and finally 8 minutes. Each iteration yielded both the average sound pressure as well as the 95% confidence interval for each bootstrap sample size, expressed as $L_{eq.}$ We compared the thus acquired L_{eq} to the original L_{eq} from all samples for each day or night.

2.3 Site Description

The first site (site A) was located approximately 2.5 km east of the QE2 Highway, and 100 m west of a farmhouse. Residents were present during the survey. This site can be qualified as rural. The 2nd site (Site B) was located atop of a river valley, near an unoccupied residence. The river valley can be qualified as natural, with minimal man-made disturbance (if at all). For site A we processed the night time data and for site B the day time data.

3 Results and Conclusions

A comparison between the "real" L_{eq} values based on the full data set and the bootstrap values for the various time bins, indicated a difference of between 0.1 and 0.5 dB, well within the accuracy of the Type 1 instrumentation used for data collection (± 1 dB).

Calculated bootstrap values were identical within 0.1 – 0.4 dB, regardless of sample size. For site A for example, the last night yielded a bootstrap value of 37.9 dBA (180 samples) compared to 37.7 dBA (8 samples). What differed is the 95% confidence interval; the smaller the sample size, the larger the spread in the confidence interval. Please refer to the figures and table on the next page.

A 95% confidence interval of ± 3 dB seems a good value to strive for in this type of survey: threshold values included in [1 - 3] increase in steps of 3 dB, and [4] indicates a measurement value of within that range as to be expected. Typically, less than 180 minutes of valid data suffice to achieve such an accuracy, but not always. Instead of a fixed requirement for data volume, it would be better to assess a confidence interval associated with the available data.

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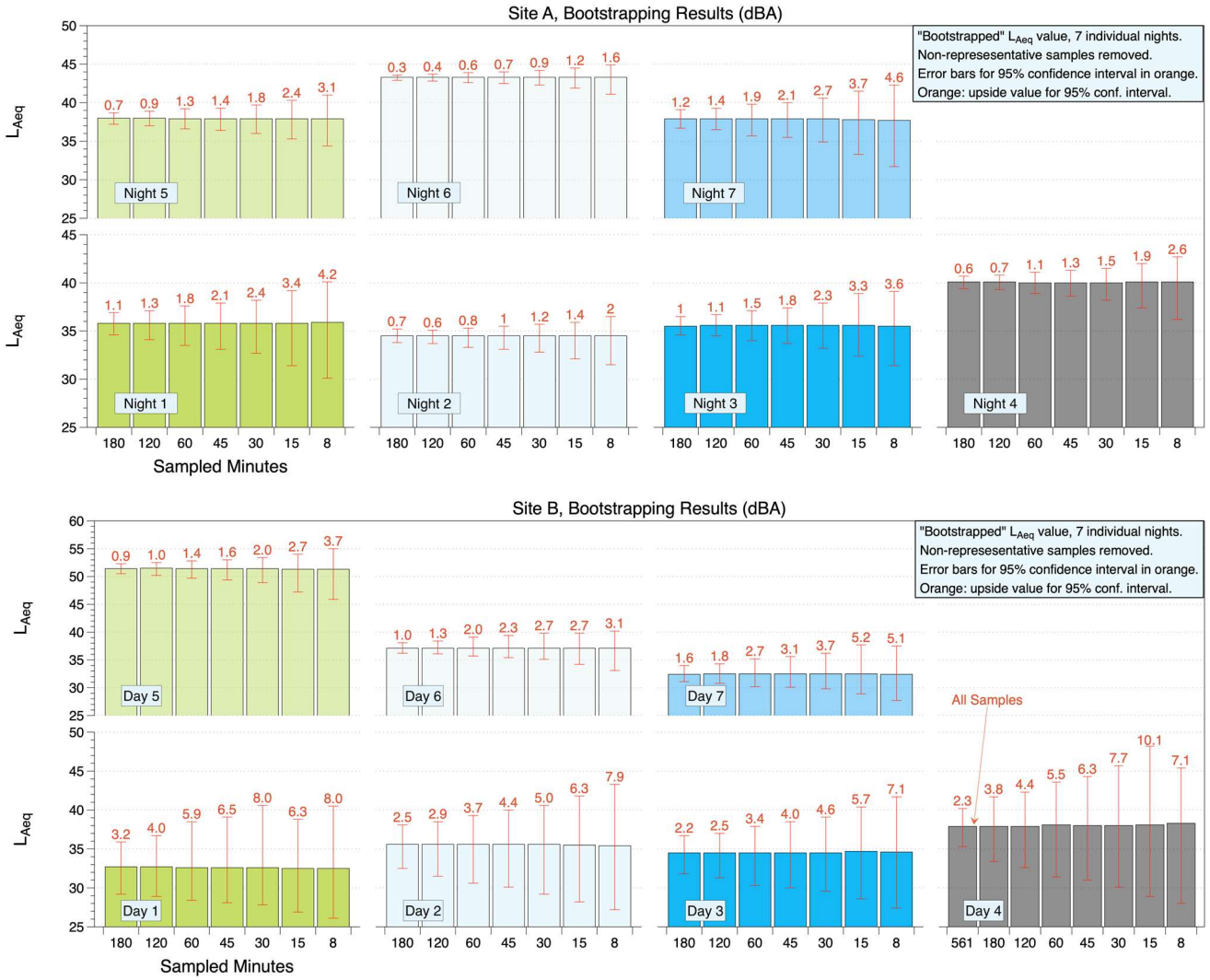

Figure 1: Bootstrapped result site A &B incl. 95% confidence intervals (dB)

Table 1: Results in dBA and required minutes of data

	Site A (Nighttime)			Site B (Daytime)		
Description	Measured L_{eq}	B. strapped L_{eq}	Req. Mins.	Measured L_{eq}	B. strapped L_{eq}	Required Mins.
Night 1 / Day 1	35.7	35.8 – 35.9	15 – 30	32.6	32.5 – 32.7	180
Night 2 / Day 2	34.4	34.5	8	35.4	35.4 – 35.6	120
Night 3 / Day 3	35.1	35.5 - 35.6	15 – 30	34.7	34.5 – 34.7	60 – 120
Night 4 / Day 4	39.8	40.0 – 40.1	8 - 15	37.9	37.9 – 38.3	All
Night 5 / Day 5	37.5	37.9 – 38.0	8 - 15	51.4	51.3 – 51.4	15
Night 6 / Day 6	43.1	43.3	8	37.0	37.1	8 -15
Night 7 / Day 7	38.1	37.7 37.9	15 - 30	32.7	32.4 – 32.5	45

References

[1] Directive 038: Noise Control, Alberta Energy Regulator, (AER ,formerly ERCB), February 16, 2007

[2] Rule 12, Noise Control, Alberta Utilities Commission (AUC), March 1, 2021

[3] British Columbia Noise Control Best Practices Guideline, Version: 2.2, British Columbia Oil & Gas Commission (BCOGC), July 2021

[4] Measurement of Sound Pressure Levels in Air, ANSI S1.13-2005, American National Standard Institute (ANSI), Reaffirmed March 5, 2010.