April 6, 2021

Mr. Paul Miller
The RCH Group
Transmitted via email: pmiller@TheRCHGroup.com

Subject: Results of Noise & Vibration Monitoring at the Astra Rocket Development and Test Facility in Alameda, California.

Dear Paul:

Pursuant to your request, Bollard Acoustical Consultants, Inc. (BAC) has completed the noise and vibration monitoring of the Astra's rocket testing facility operations in Alameda, California. The purposes of this letter are to provide the methodology, results, and observations from BAC staff during the engine tests.

Please refer to Appendix A for definitions of acoustical terminology used in this letter.

Test Date, Conditions and Locations

Noise and vibration measurements were conducted for this assessment on April 1st, 2021. During the monitoring period, three rocket engine tests were conducted, each lasting 2 minutes in duration. Specifically, the rocket engine tests were conducted by Astra at the following times:

- 09:53:57 am – 09:55:57 am
- 10:17:27 am – 10:19:27 am
- 10:29:15 am – 10:31:15 am

On the day of testing, weather conditions were calm with no anomalous atmospheric conditions present that would have affected the collection of noise or vibration data.

Monitoring was conducted at three sites near the test facility, as identified in Figure 1. Monitoring Site 1 represented the nearest residences the east of the facility whereas Monitoring Site 2 represented the nearest residences to the north of the test facility.

Because it was extremely difficult to hear the sound generated by the first test at Sites 1 and 2, a third site (Site 3) was selected for monitoring during the 2nd and 3rd rocket tests. Due to a flash-drive malfunction, vibration data collected from Site 3 was unable to be stored, and therefore could not be provided in this letter. However, the vibration meter at Site 3 was running throughout the tests and vibration levels were observed in real time to be approximately 40 VdB at Site 3.

Photos of the monitoring sites can be seen in Appendix B, including the vibration data collected at Site 3 during the rocket engine tests.

Exhibit 2
Item 7-A, October 11, 2021
Planning Board Meeting

Noise and Vibration Monitoring Equipment

Noise measurement equipment consisted of Larson-Davis Laboratories (LDL) Model 831 Real Time Analyzers (RTA) equipped with PCB Model 377B02 1/2" microphones. The measurement systems were calibrated using an LDL Model CA200 acoustical calibrator before testing to ensure the accuracy of the results. The measurement equipment meets all of the pertinent requirements of the American National Standards Institute (ANSI) for Type 1 (precision) sound measurement systems.

Vibration measurement equipment consisted of a Larson Davis Laboratories (LDL) LxT meters, equipped with PCB Electronics velocity transducers. The vibration measurement systems were calibrated before use with an IMI 699A02 vibration calibrator to ensure the accuracy of the measurements.

To quantify ambient noise and vibration data during periods when the rocket tests were not being conducted, the noise and vibration meters at Sites 1 & 2 logged data continuously from approximately 9:20 AM to 10:35 AM. As noted previously, measurement Site 3 was added after the initial rocket test and logged noise level data continuously through the remaining two rocket tests (approximately 10:13 AM to 10:33 AM). Noise monitoring results for Sites 1-3 are shown in Figures 2-4. Vibration monitoring results for Sites 1-2 can be seen in Figures 5-6.

Data Analysis and BAC Observations

Figures 2-6 show the data collected not only during the periods when the rocket tests were occurring but also the ambient noise and vibration data collected before and after each test. The spikes on these figures were attributable to local traffic, aircraft overflights, and other extraneous noise sources. The spikes in the data were not caused by the rocket tests as the noise generated during the test was observed to be very steady-state. The Figure 2-6 data also clearly indicate there was no discernible increase in ambient noise or vibration levels during the rocket engine tests versus the periods when the rocket tests were not occurring.

At Site 1, located at the residences closest to the testing facility, noise generated by the rocket engine tests was barely audible when no other background noise was present. When noise from cars, aircraft, or other local sources were present, the rocket engine noise was completely masked by those local sources and inaudible.

At Site 2, the rocket engine test noise was not audible during any point of the three rocket tests, regardless of whether any transportation or construction noise was present.

Site 3 was the closest site to the testing facility and was exposed to lower levels of local traffic noise. As a result, rocket engine test noise was plainly audible at the location when no local traffic was present, but the sound levels generated during the rocket engine tests were, nonetheless, barely above baseline ambient conditions present when testing was not occurring.

According to BAC staff, vibration levels at all 3 sites were below the threshold of perception.

Conclusions

BAC staff subjectively considered the sound generated by the Astra rocket engine tests as faint to inaudible at the nearest residences to the rocket engine test facility, and well below noise levels generated by passing vehicles and aircraft overflights.

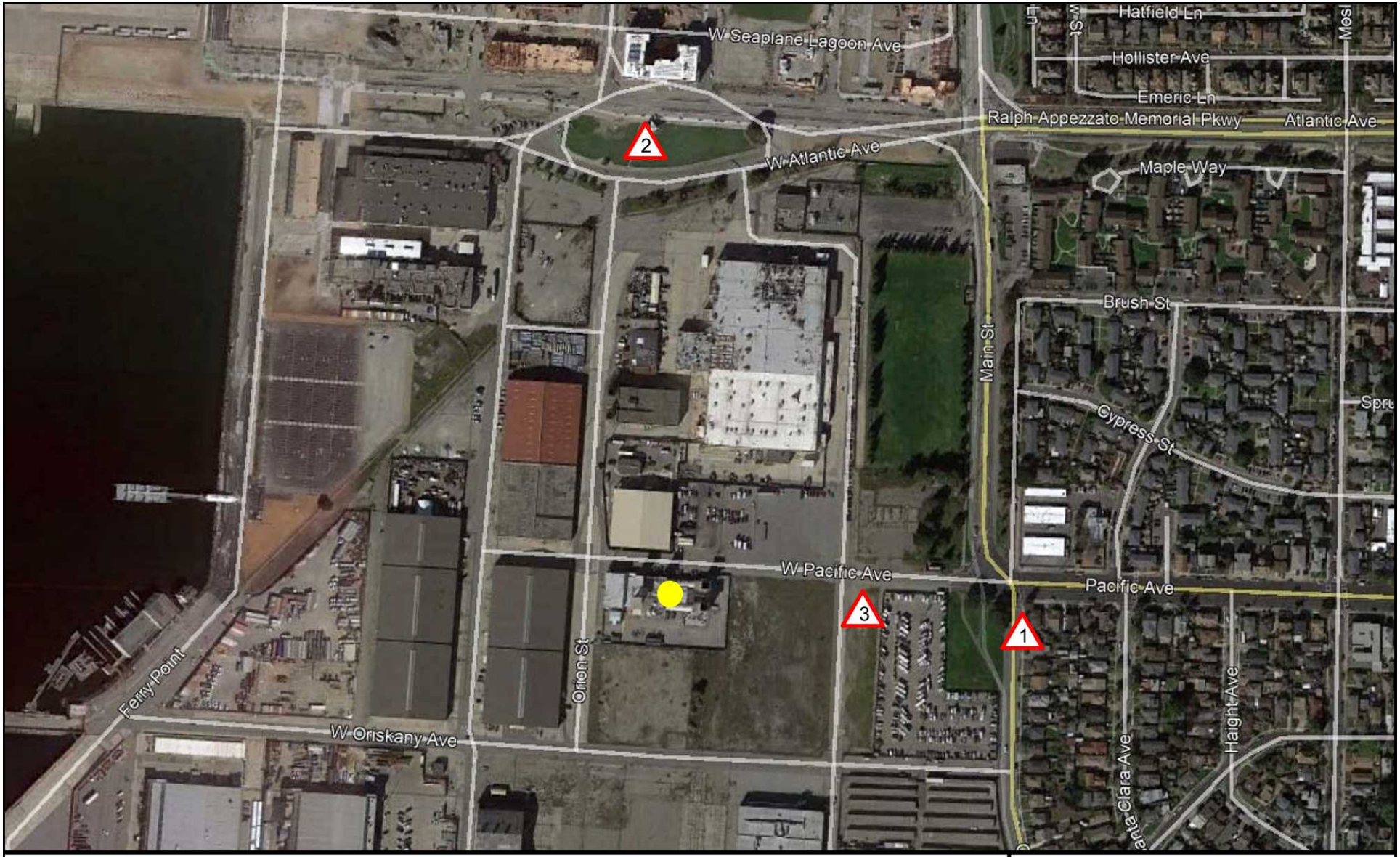
At measurement Site 1, had BAC staff not been made aware by Astra representatives that the rocket tests were underway, it is likely that the noise generated during the tests would have gone unnoticed. At measurement Site 2, the rocket engine test noise was completely inaudible.

This concludes BAC's noise and vibration monitoring analysis of the Astra Rocket Development and Test Facility. Please contact me at (916) 663-0500 or paulb@bacnoise.com if you have any comments or questions.

Sincerely,
Bollard Acoustical Consultants, Inc.

Paul Bollard
President

Attachments



Legend

- # — Sound and Vibration Testing Sites
- Rocket Test Location

N

Scale (Feet)

0 150 300

Astra Rocket Testing

Alameda, CA

Measurement Testing Locations

Figure 1

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Figure 2
Measured Sound Levels: Site 1
Alameda, CA - April 1, 2021 - 9:50 am to 10:34 am

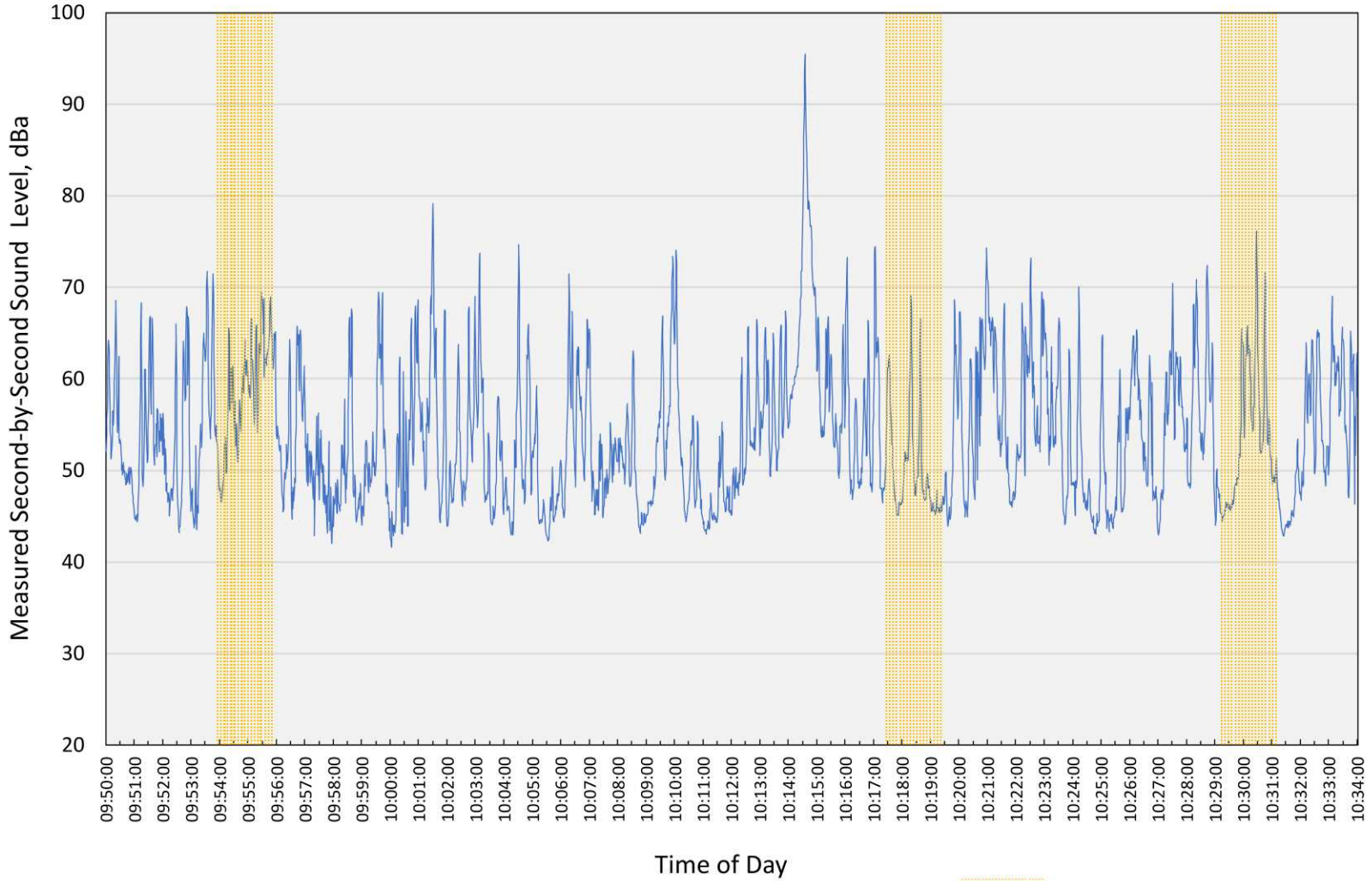

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Figure 3
Measured Sound Levels: Site 2
Alameda, CA - April 1, 2021 - 9:50 am to 10:34 am

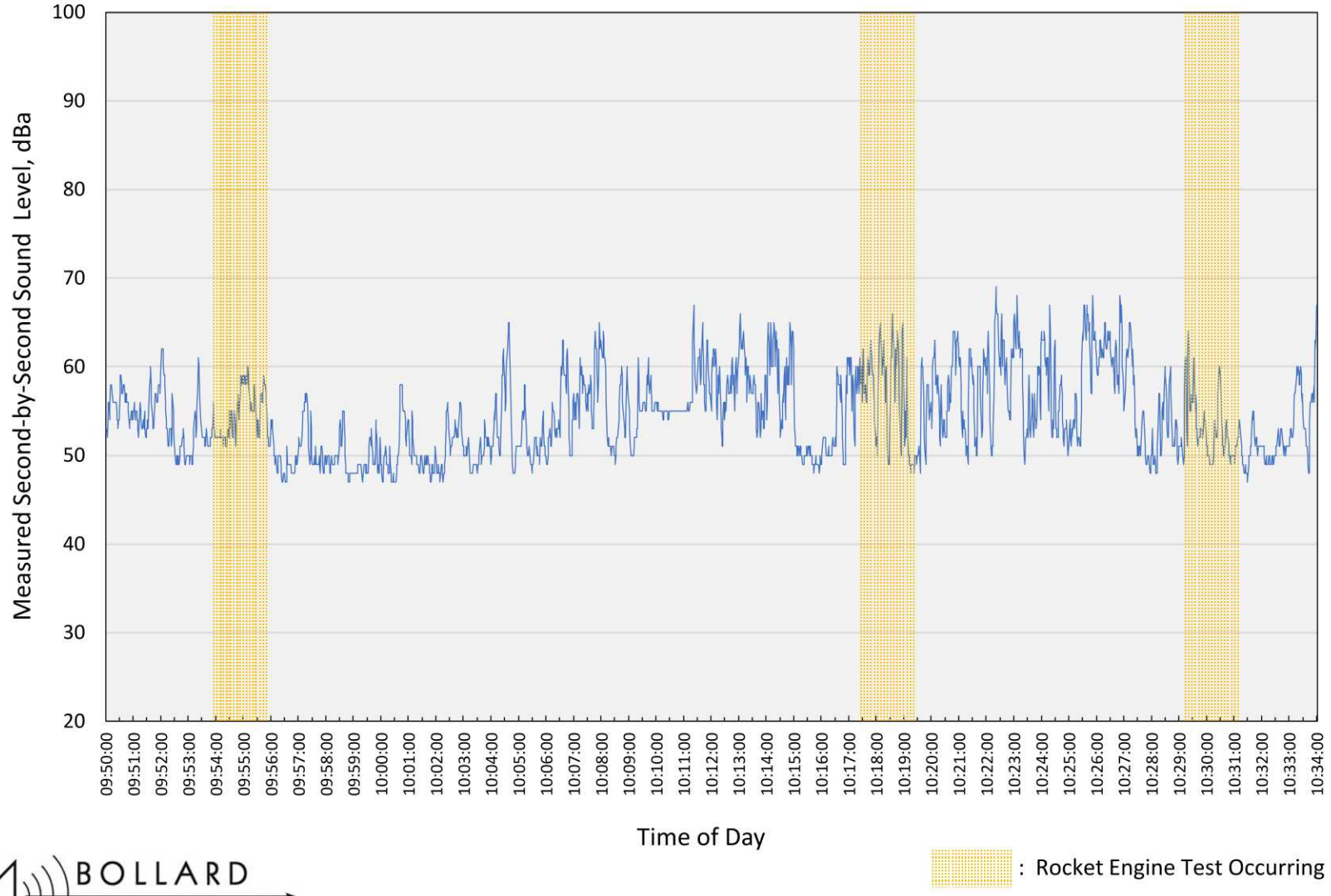

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Figure 4
Measured Sound Levels: Site 3
Alameda, CA - April 1, 2021 - 10:13 am to 10:32:30 am

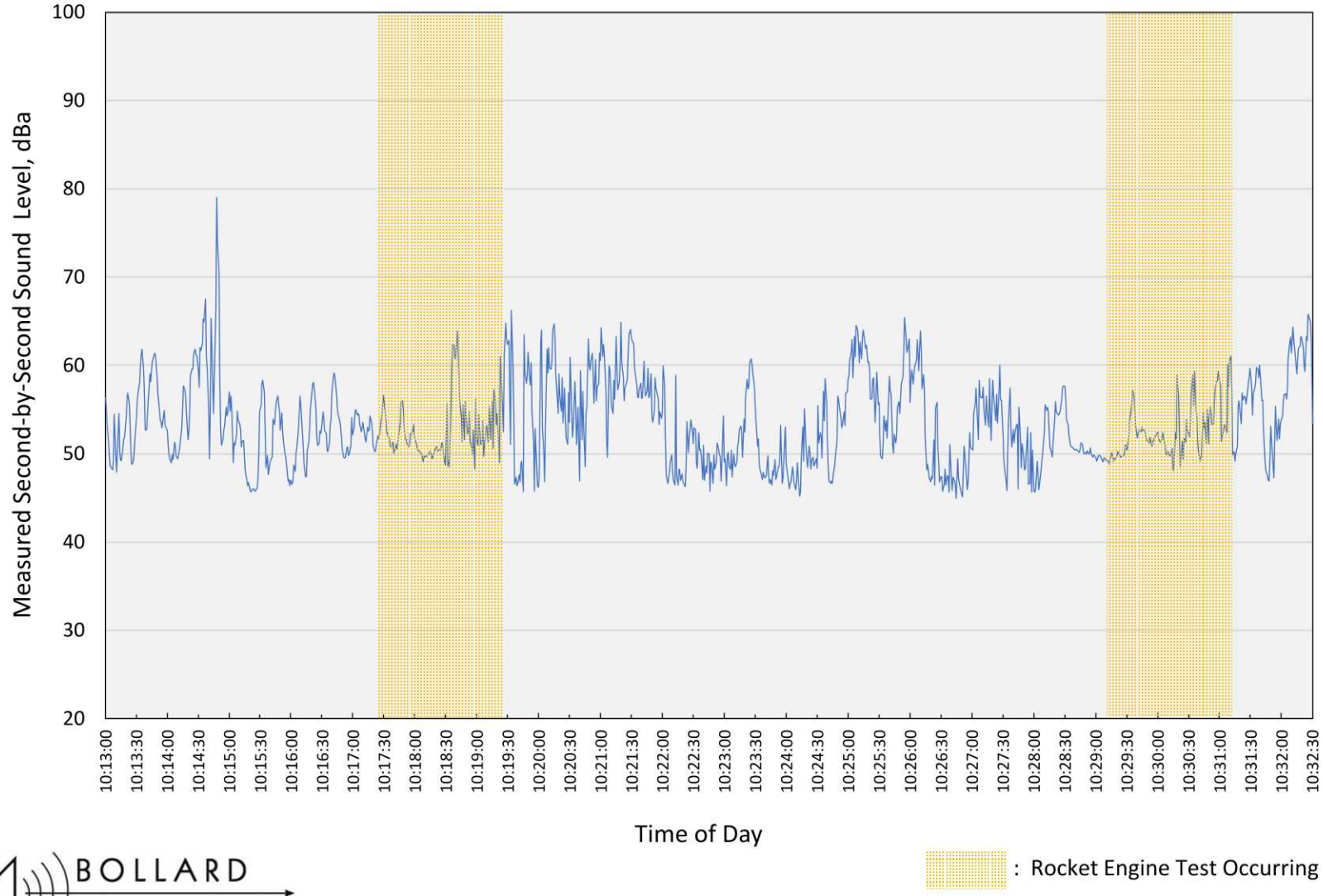

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Figure 5
Measured Vibration Levels: Site 1
Alameda, CA - April 1, 2021 - 9:50 am to 10:34 am

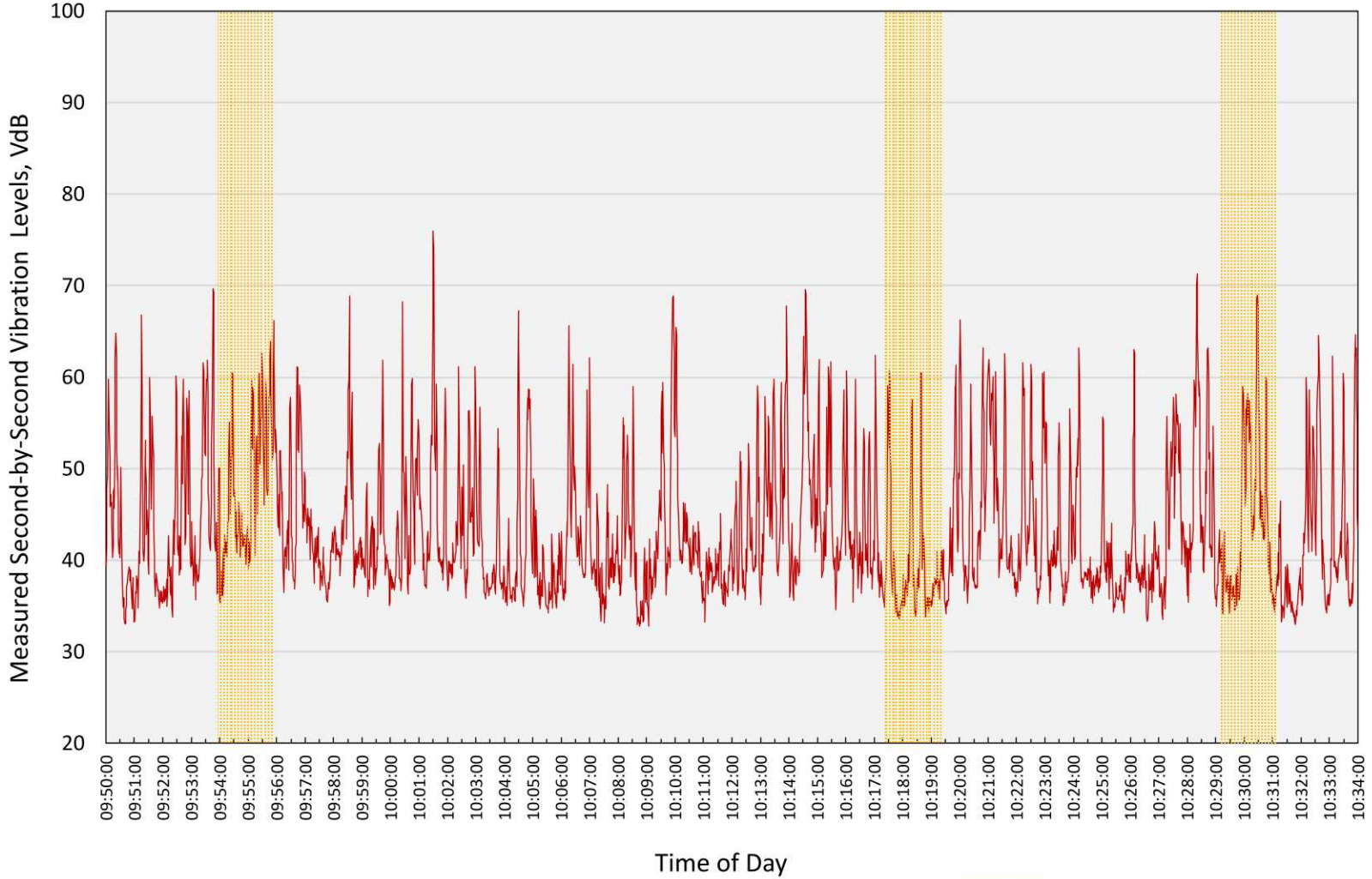

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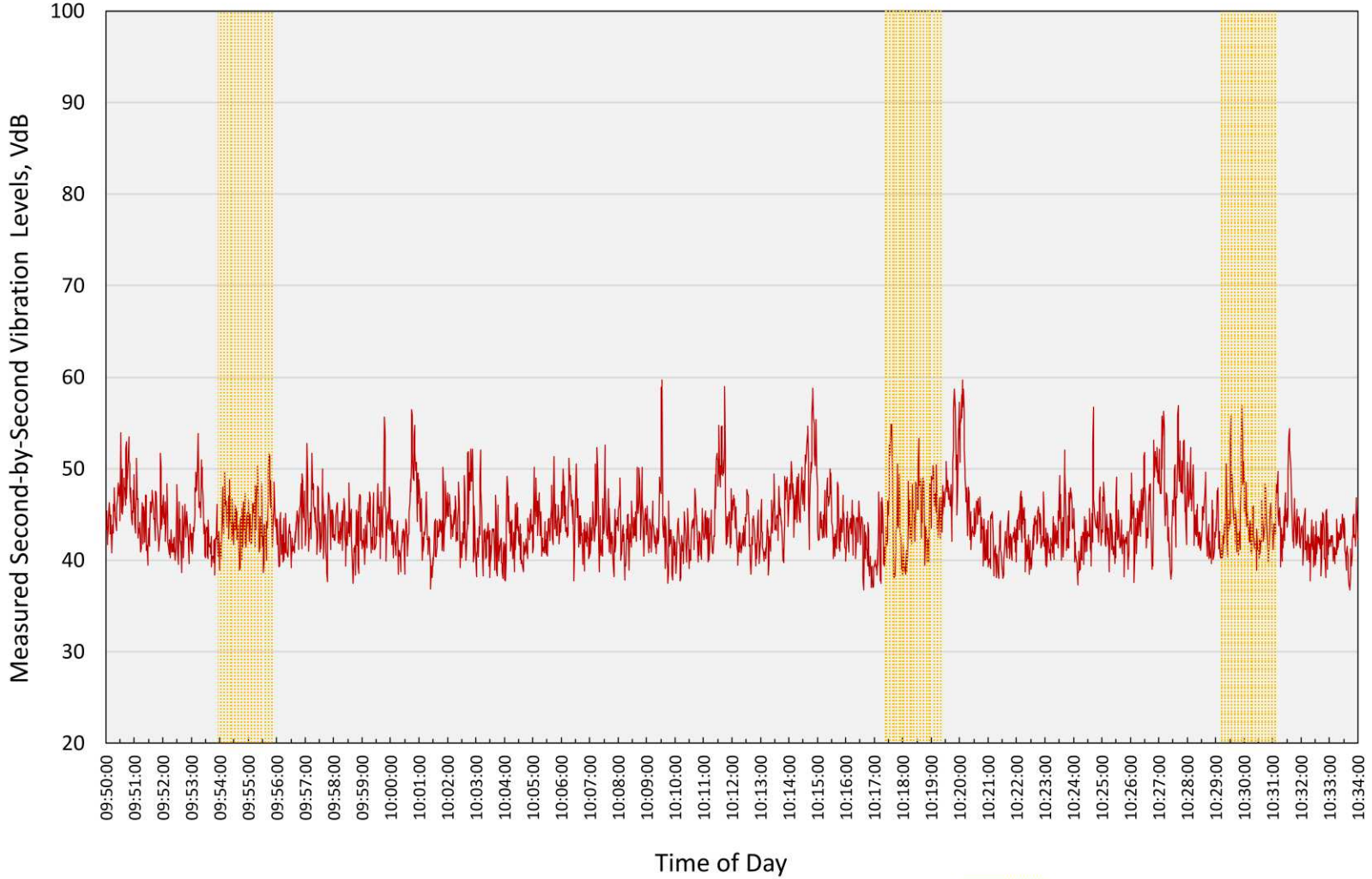
Figure 6
Measured Vibration Levels: Site 2
Alameda, CA - April 1, 2021 - 9:50 am to 10:34 am



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Appendix A
Acoustical Terminology

Acoustics The science of sound.

Ambient Noise The distinctive acoustical characteristics of a given space consisting of all noise sources audible at that location. In many cases, the term ambient is used to describe an existing or pre-project condition such as the setting in an environmental noise study.

Attenuation The reduction of an acoustic signal.

A-Weighting A frequency-response adjustment of a sound level meter that conditions the output signal to approximate human response.

Decibel or dB Fundamental unit of sound. A Bell is defined as the logarithm of the ratio of the sound pressure squared over the reference pressure squared. A Decibel is one-tenth of a Bell.

CNEL Community Noise Equivalent Level. Defined as the 24-hour average noise level with noise occurring during evening hours (7 - 10 p.m.) weighted by a factor of three and nighttime hours weighted by a factor of 10 prior to averaging.

Frequency The measure of the rapidity of alterations of a periodic signal, expressed in cycles per second or hertz.

IIC Impact Insulation Class (IIC): A single-number representation of a floor/ceiling partition's impact generated noise insulation performance. The field-measured version of this number is the FIIC.

L_{dn} Day/Night Average Sound Level. Similar to CNEL but with no evening weighting.

L_{eq} Equivalent or energy-averaged sound level.

L_{max} The highest root-mean-square (RMS) sound level measured over a given period of time.

Loudness A subjective term for the sensation of the magnitude of sound.

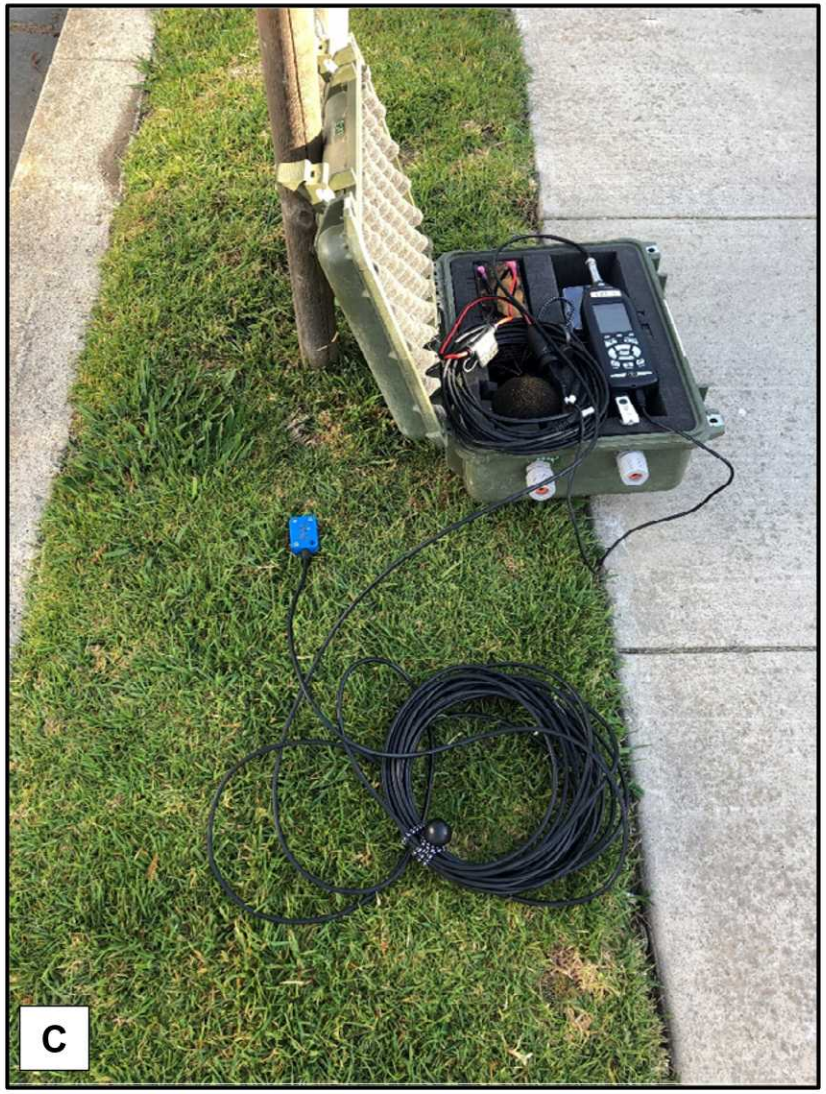
Masking The amount (or the process) by which the threshold of audibility is for one sound is raised by the presence of another (masking) sound.

Noise Unwanted sound.

Peak Noise The level corresponding to the highest (not RMS) sound pressure measured over a given period of time. This term is often confused with the "Maximum" level, which is the highest RMS level.

RT_{60} The time it takes reverberant sound to decay by 60 dB once the source has been removed.

STC Sound Transmission Class (STC): A single-number representation of a partition's noise insulation performance. This number is based on laboratory-measured, 16-band (1/3-octave) transmission loss (TL) data of the subject partition. The field-measured version of this number is the FSTC.



Legend

A: Noise and Vibration Testing Facing Southeast
B: Noise Testing Facing West
C: Vibration Testing Facing North

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Alameda, California

Photographs of Survey Locations: Site 1

Appendix B-1

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Legend

A: Noise and Vibration Testing Facing Northwest
B: Noise and Vibration Testing Facing Northeast
C: Noise and Vibration Testing Facing South

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Photographs of Survey Locations: Site 2

Appendix B-2

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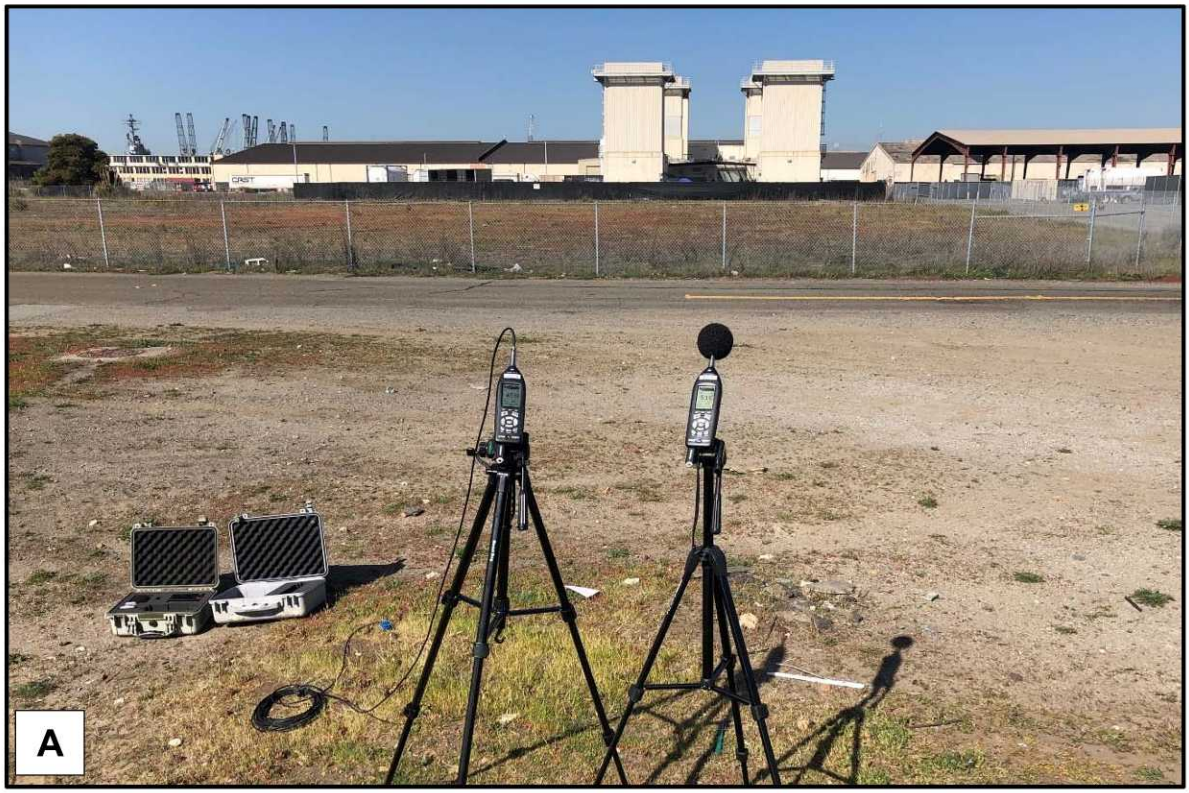

Legend

A: Noise and Vibration Testing Facing West
B: Vibration Testing during Rocket Engine Test ≈ 39 VdB
C: Noise Testing during Rocket Engine Test ≈ 50 dBA

Astra Rocket Testing

Alameda, California
Photographs of Survey Locations:
Site 3

Appendix B-3

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