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Attachment 2

MEMORANDUM

DATE:	2021-09-20	**RWDI Reference No.:** 2104113
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FROM:	Matthew Johnston, P.Eng. Brett Sorestad, E.I.T. Laura Dailyde, P.Eng., PMP	**EMAIL:** matthew.johnston@rwdi.com **EMAIL:** brett.sorestad@rwdi.com **EMAIL:** laura.dailyde@rwdi.com
RE:	**Noise and Vibration Monitoring Summary** **City of Pitt Meadows** Pitt Meadows, BC	

The City of Pitt Meadows retained RWDI to conduct an environmental noise and vibration monitoring program at residences next to the rail corridor between Kennedy Road and Golden Ears Way within Pitt Meadows, BC. The purpose of the monitoring program is to draw a comparison with monitoring results presented in the 2020 BKL Consultants Ltd. (BKL) study entitled “Pitt Meadows Road and Rail Improvements Environmental Noise and Vibration Assessment” (the “BKL Study”) as well as provide existing noise and vibration levels at additional distinct communities along the corridor. The BKL Study was prepared for the Vancouver Fraser Port Authority (VFPA) in order to assess the effects of future rail improvements along this corridor associated with the Pitt Meadows Road and Rail Improvements.

Monitoring was conducted at seven (7) different locations for a minimum of 14 days, ranging from June 30 to August 18, 2021. This memorandum summarizes the results of the monitoring program.

Noise and vibration terminology within this memo is consistent with the BKL Study unless otherwise stated. Please refer to the BKL Study for noise and vibration terminology definitions.

Measurement Locations

The seven monitoring locations were active for at least 14 days and were configured to measure noise, vibration, or both noise and vibration. In addition, a meteorological station was setup at R1. The monitoring locations are listed as R1 – R7 and are identified in Table 1, below.

Table 1: Monitoring Location Details

Receiver	Location	Measuring	Approximate Distance to Closest Track (m)	Start-Stop Dates (All 2021)
R1	13071 Kennedy Road	Noise & Met	295	June 30 – July 14
R2	28 – 19034 McMyn Ave	Noise & Vibration	26	July 14 – July 27
R3	Advent & Harris Road	Noise Only	16	July 21 – August 6 [1]
R4	19363 – 121b Ave	Noise & Vibration	18	July 7 – July 20
R5	12138 McMyn Ave	Noise & Vibration	11	July 14 – July 27
R6	19649 Poplar Drive	Noise & Vibration	22	July 7 – July 20
R7	11768 Herring Place	Vibration Only	113	August 4 – August 18

Notes:

[1] There was a loss of power on August 1, power was restored on August 4.

For comparison purposes, we have identified a noise and vibration receptor from the BKL Study (19167 Advent Road - N4/V4) which will be compared to the findings in this report. RWDI's R3 receptor is in very close proximity to N4/V4 and is therefore ideal for comparison. R3 was a noise only monitoring station so the vibration levels for R4 were used for comparison purposes due to matching setback distances from the rail line (approximately 18 m). The results of this comparison are presented within this memo but all other comparable monitoring locations were reviewed as well.

Placement of the microphone at the monitoring location takes a number of factors into consideration including residence access restrictions, power considerations and local topography. The location of the monitors are shown in Figure 1 below.

Figure 1: Location of the noise and vibration monitoring locations

Measurement Method

Continuous monitoring was conducted using RWDI's internal remote monitoring system.

For noise measurements, the transducer package used for the measurements is the PCB Model 378B02. The package uses the microphone model 377B02 with the preamplifier model 426E01. The microphone and preamp are housed in a Larson Davis EPS2116 environmental shroud and wind screen. The noise monitoring station meets the following requirements:

- Type 1 measurement system per the IEC standard 61672-1 Sound Level Meter, Part 1: Specifications;
- Class 1 microphone systems;
- Constant frequency response in the 20 Hz to 20,000 Hz frequency range;
- IEC 61620 for Class 1 filters; and
- Audio recorded continuously during the measurement campaign at a sampling rate of at least 8,000 Hz.

The instrumentation was calibrated prior to and after the monitoring period for each receptor. The microphones at the six locations for noise were set up approximately at a height of 2.5 m above ground with the exception of R5 which was setup 6 m above ground in order to represent the upper floor of the dwelling. Meteorological data was collected from a meteorological unit that consisted of a rain sensor, wind speed & direction sensor and a humidity sensor set up connected to the unit at R1 approximately 3 m adjacent to the noise microphone.

For vibration, the system uses tri-axial accelerometer (PCB Piezotronics Model 356M98, nominal sensitivity 1V/g) connected to RWDI's internal remote monitoring system described above. The accelerometer was installed on a 3" x 3" steel mount. A plastic cover and sandbag were placed over the accelerometer to prevent false readings from raindrops.

The system uses a National Instruments® data acquisition system designed for sound level measurements and logged on dedicated local Intel Atom N2600 processors running Windows 7. The units logged one-minute levels continuously over the monitoring period that were continuously uploaded to servers via cellular modem.

Ideally, each monitoring station was setup at the identical setback distance from the rail line as the residence. In some instances, the monitoring location was closer to the rail line than the residence due to yard constraints. However, all monitoring is representative of the noise environment at the specified setback distance from the corridor.

Results

Train activities were considered to be typical during the monitoring period with the exception the first few days of measurement (July 1 – July 5) due to the B.C wildfires which drastically decreased the train count over this period.

Table 2 shows the overall daytime (L_d), nighttime (L_n) and day-night average (L_{dn}) sound levels for the monitoring period. For the overall daytime and nighttime sound levels, the average equivalent sound level (L_{eq}) as well as the approximated sound level exceeded 90% of the time (L_{90}) were presented. These overall values were calculated using an arithmetic average of each day over the 14 days, which is consistent with the BKL Study monitoring results. Charts showing a 1-day sample period at each receptor is provided in Attachment A. The charts demonstrate how the noise or vibration levels during pass-by events compare to background levels. Attachment A shows the results of the monitoring day starting July 11 (at R1, R4 and R6), July 23 (at R2, R3, and R5) and August 7 (at R7). A complete set of monitoring results for all monitoring locations is provided in a separate document.

The meteorological readings indicated no periods of high winds that met the exclusion criteria (>15 km/h) or any rain events that were to be excluded from the measurement period. Audio recordings were reviewed in order to exclude any periods where community noise was present that would otherwise contaminate the measurement.

Table 2: 14-day Overall Noise Summary

Receptor	L_d (L_{eq})	L_d (L_{90})	L_n (L_{eq})	L_n (L_{90})	L_{dn} [2]
ID	dBA				
R1[1]	59	46	55	41	64
R2	57	38	56	35	63
R3	68	57	67	43	74
R4	62	42	62	40	69
R5	66	41	66	39	73
R6	60	39	62	36	68
R7	N/A[3]				

Notes:

[1] Monitoring took place between June 30 – July 15 however the values are an average of July 6 – July 15 due to irregular train activity from B.C wildfires issues.

[2] Calculation of L_{dn} includes a +10dB penalty for nighttime and +5 dB penalty during weekend daytime as per the BKL Study.

[3] Location R7 only collected vibration data, so noise summary values are not applicable

Train pass-by events were identified by RWDI staff by analyzing sound level and vibration data combined with listening to the audio recordings during the monitoring period in order to determine the noise or vibration level associated with individual events. For monitoring periods where audio was not available, an analysis tool was used to identify train pass-by events. Pass-by event metrics for noise include the peak pass-by level (LAFmax) and the low frequency noise level (LLF). For vibration, the pass-by event metric is the maximum measured RMS 1-second which was recorded for each axis. The highest noise and vibration levels associated with individual pass-by events are presented in Table 3.

Table 3: 14-day Single Pass-by Noise and Vibration Summary

Receptor	LA_{Fmax} [1]	L_{LF} [1,2]	$RMS_{1s, max}$ (X-axis) [1]	$RMS_{1s, max}$ (Y-axis) [1]	$RMS_{1s, max}$ (Z-axis) [1]
ID	dBA	dB	mm/s (dB) [3]		
R1	73	75	N/A		
R2	79	86	0.13 (102)	0.13 (102)	0.3 (109)
R3	92	91	N/A		
R4	89	89	0.42 (113)	0.51 (114)	0.54 (115)
R5	93	88	0.24 (107)	0.25 (108)	0.62 (116)
R6	88	88	0.26 (108)	0.27 (109)	0.31 (110)
R7	N/A		0.13 (103)	0.11 (101)	0.32 (110)

Notes:

[1] The values presented represent the highest typical pass-by levels. These levels are the 95% percentile value for all identified pass-by events. Although these values are representative of the highest typical pass-by events, with the monitoring period, there are events with higher levels.
[2] A logarithmic summation of 20 Hz to 80 Hz 1/3 octave bands.
[3] re 1 nm/s

Train Classes and Frequency of Train Pass-bys

Current trains on the rail line through Pitt Meadows are both CP/freight and the TransLink West Coast Express train. Sound levels and pass-by frequency and durations for the TransLink West Coast Express trains are less than the freight trains so are not the dominant source along the rail line. From the analyzed data at the receivers during normal operations, a typical day includes eight-teen (18) freight trains and six (6) West Coast Express trains during the weekdays. On weekends, there are no West Coast Express trains.

Comparison with the BKL Study

A comparison of results between BKL's Study and RWDI's monitoring are in Table 4.

Table 4: Comparison of RWDI and BKL Noise and Vibration Data

Receiver		L_d	L_n	L_{dn}	LA_{Fmax}	L_{LF}	$RMS_{1s, max}$ Z-axis
Study	ID	dBA				dB	dB (re 1 nm/s)
BKL (2020) [1]	N4 & V4	68	68	75	88	N/A	105
RWDI (2021)	R3	68	67	74	92	91	115 [2]

Notes:

[1] Found in Table 6-1 and 6-2 of the BKL Study. BKL did not present existing L_{LF} measured values.
[2] No vibration measurements were taken at R3. The value presented is taken from RWDI's R4 vibration monitor as it is the same distance as the comparable BKL vibration monitor.

As is shown in Table 4 the overall noise metrics L_d, L_n and L_{dn} are comparable within 1 dB. This is within a typical variance for noise measurements.

When comparing the metrics for pass-by events (LA_{Fmax} and $RMS_{1s,\ max}$ (z-axis)), there is a significant difference. The difference is most likely related to the fact that BKL used the average level of small dataset (six train pass-bys over the entire monitoring period) to determine the LA_{Fmax} and $RMS_{1s,\ max}$. Alternately, the RWDI results represent the absolute highest values recorded at the monitoring station within the entire 14-day monitoring period.

Additional monitoring locations were compared and the overall noise metrics showed good agreement between the two monitoring programs. Similarly, metrics associated with pass-by events did vary significantly.

In Appendix C of the BKL Study, the results of the six-train pass-by dataset was provided. A comparison of the highest recorded events levels are compared in Table 5.

Table 5: Comparison of RWDI and BKL Noise and Vibration Data

Receiver		LA_{Fmax}	$RMS_{1s,\ max}$ Z-axis
Study	**ID**	**dBA**	**dB (re 1 nm/s)**
BKL (2020) [1]	N4 & V4	95	109
RWDI (2021)	R3	92	115 [2]

Notes:

[1] Found in Appendix C of the BKL Study.

[2] No vibration measurements were taken at R3. The value presented is taken from RWDI's R4 vibration monitor as it is the same distance as the comparable BKL vibration monitor.

The values presented in Table 5 demonstrate that BKL's highest LA_{Fmax} value is higher than RWDI's highest representative value. However, the $RMS_{1s,\ max}$ (z-axis) value is still significantly lower (6 dB) than RWDI's highest representative value. As mentioned above, BKL chose a six-train dataset. BKL did not mention how the six trains were chosen. If the dataset were larger, they may have found instances with higher $RMS_{1s,\ max}$ values.

As mentioned above, the noise and vibration monitoring locations are not all positioned at a distance equal to the façade of the residence compared to the corridor in all instances. The levels presented above therefore do not precisely represent the expected impact levels at the residence. As well, these values do not include Health Canada Guideline adjustments that may be applicable for noise characteristics such as impulse noise and/or tonality. For these reasons, the measured levels are not directly compared to applicable criteria. For reference, the criteria presented in the BKL Study includes the following:

- Speech Interference from noise – 55 dBA (L_d);

- Sleep Disturbance from noise – 40 dBA (L_n) & 72 dBA (L_{Fmax});
- High Annoyance from noise - 75 dBA (L_{dn}), 6.5% change in %HA & 70 dB (L_{LF}); and
- High Annoyance from vibration – 103 dB with at least a 3 dB increase above baseline.

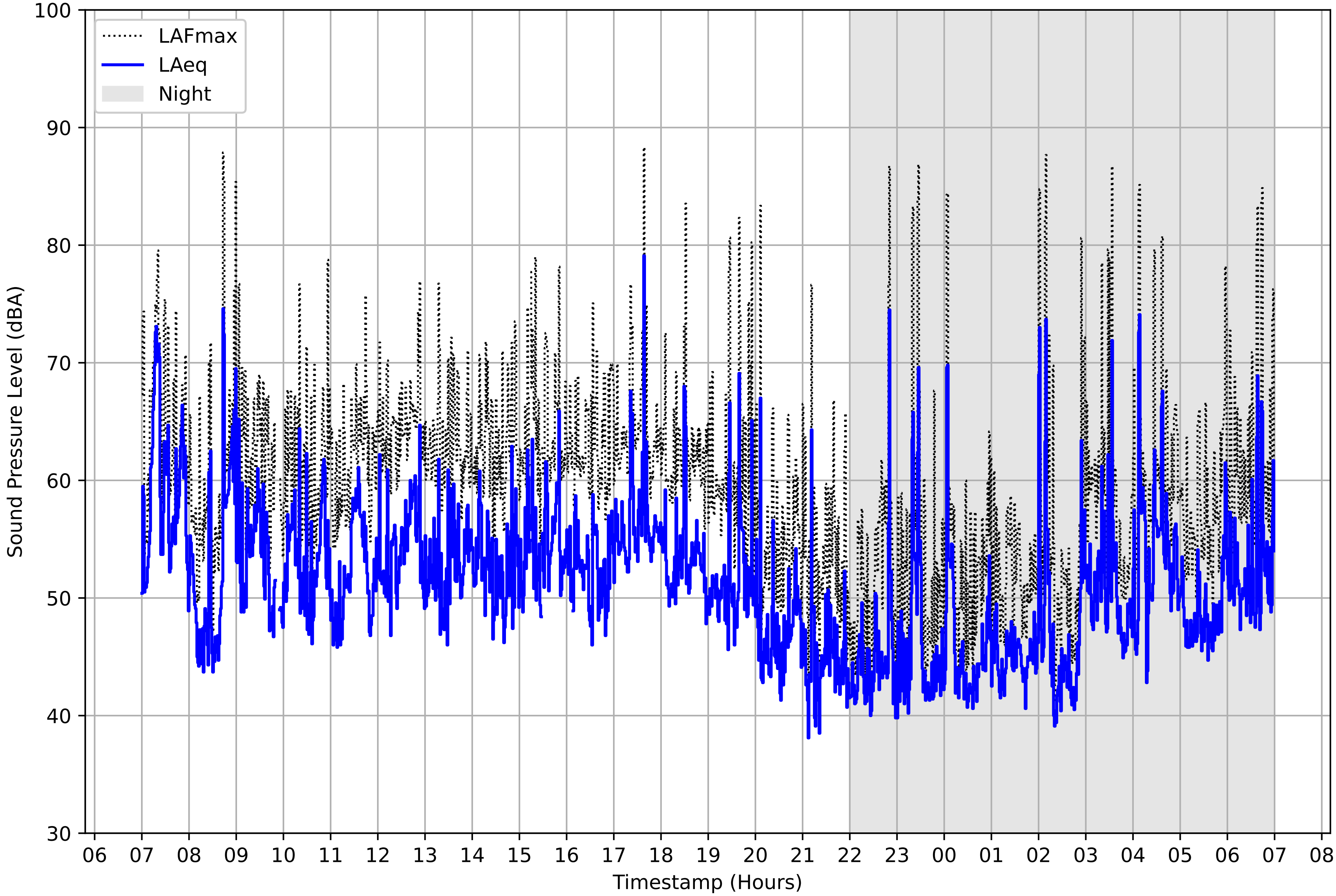
The results of the monitoring will be used moving forward to evaluate the noise and vibration levels at impacted residents for proper comparison to the above criteria.

Conclusion

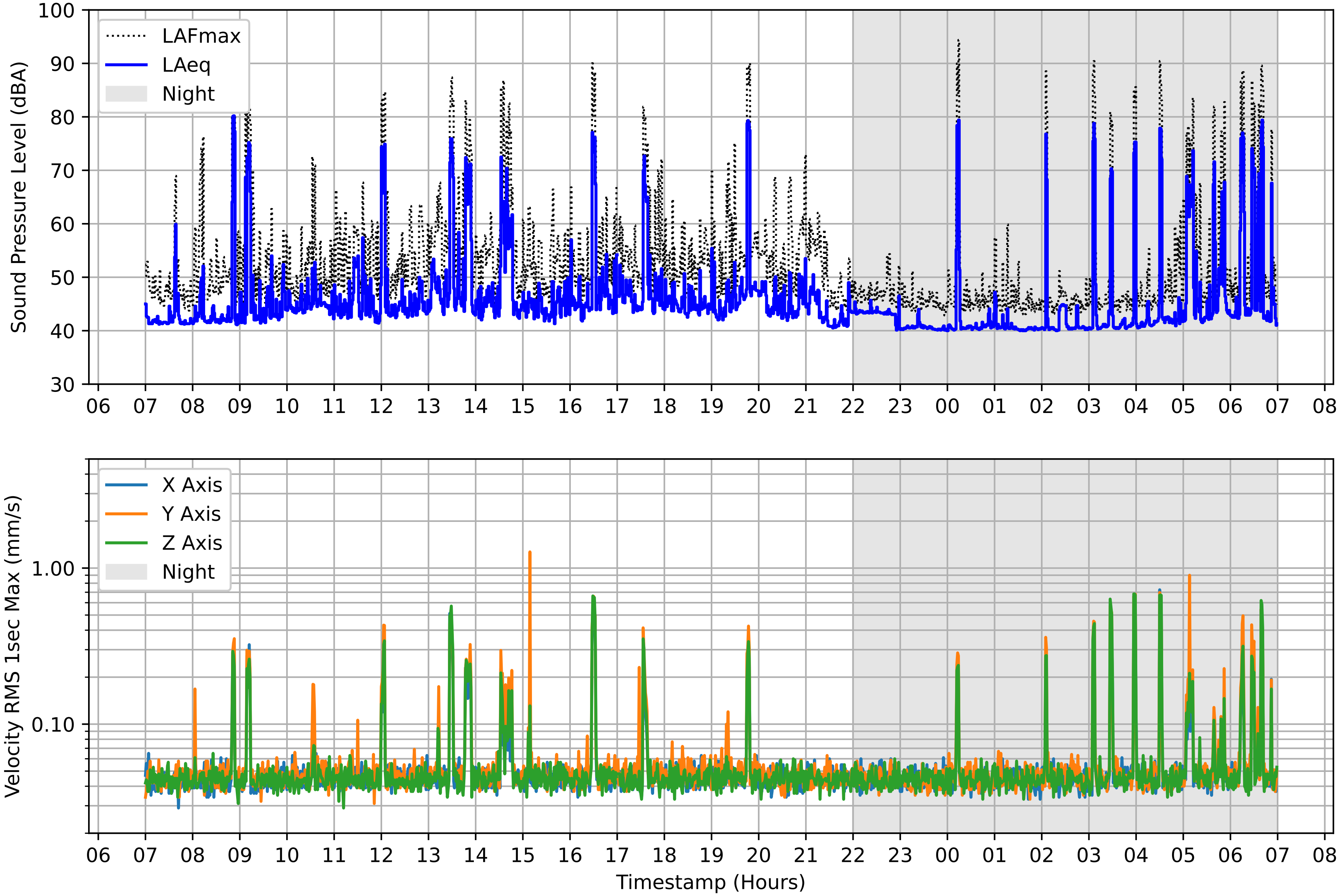
A detailed assessment of the sound and vibration levels for the rail line in Pitt Meadows was completed. RWDI placed monitors at seven (7) locations along the rail corridor between Kennedy Road and Golden Ears Way in Pitt Meadows to measure noise and vibration. The data was analyzed and compared to BKL's results in the report submitted in 2020. The overall sound levels were comparable. There was in some cases a significant difference for noise and vibration train pass-by event levels, particularly for vibration levels. The difference is assumed to be associated with the sample size included in the analysis. BKL reviewed the train pass-by levels for six events while RWDI reviewed all pass-by events for the entire 14-day monitoring period.

ATTACHMENT A

Monitoring Results – Graphical Results



Pitt Meadows – Noise Monitoring **Monitoring Location: R1** **Monitoring Date: 2021-07-11** Pitt Meadows, British Colombia — Project #: 2104113	Figure No. A1 Date Revised: 2021-09-01	RWDI



Pitt Meadows – Noise Monitoring

Monitoring Location: R4

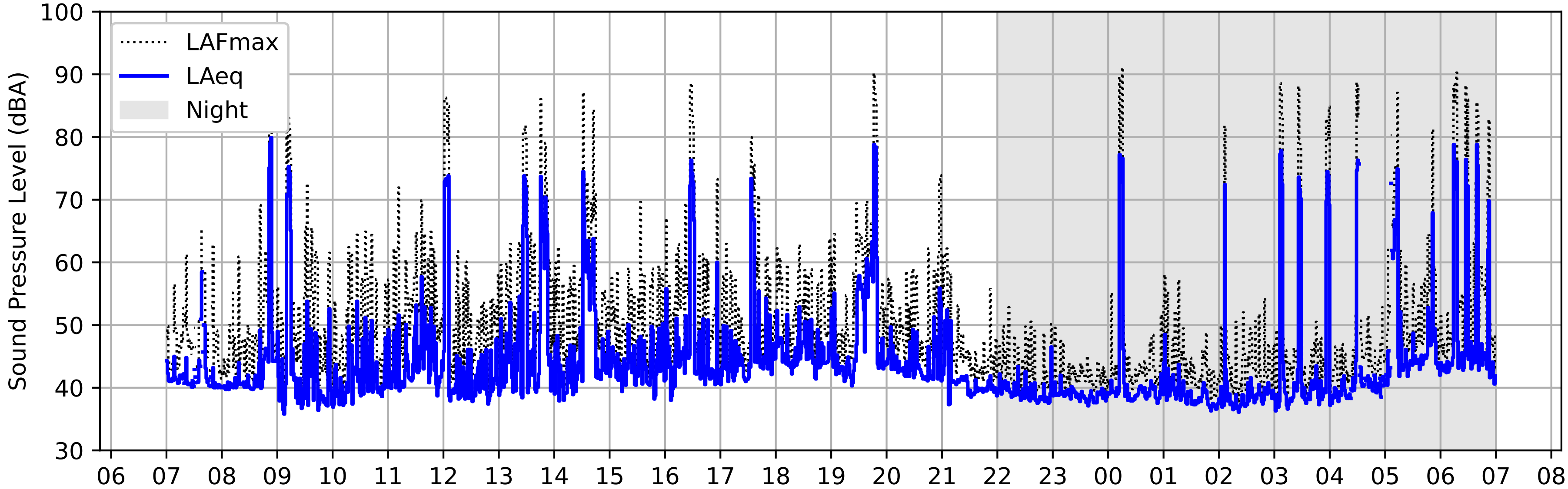
Monitoring Date: 2021-07-11

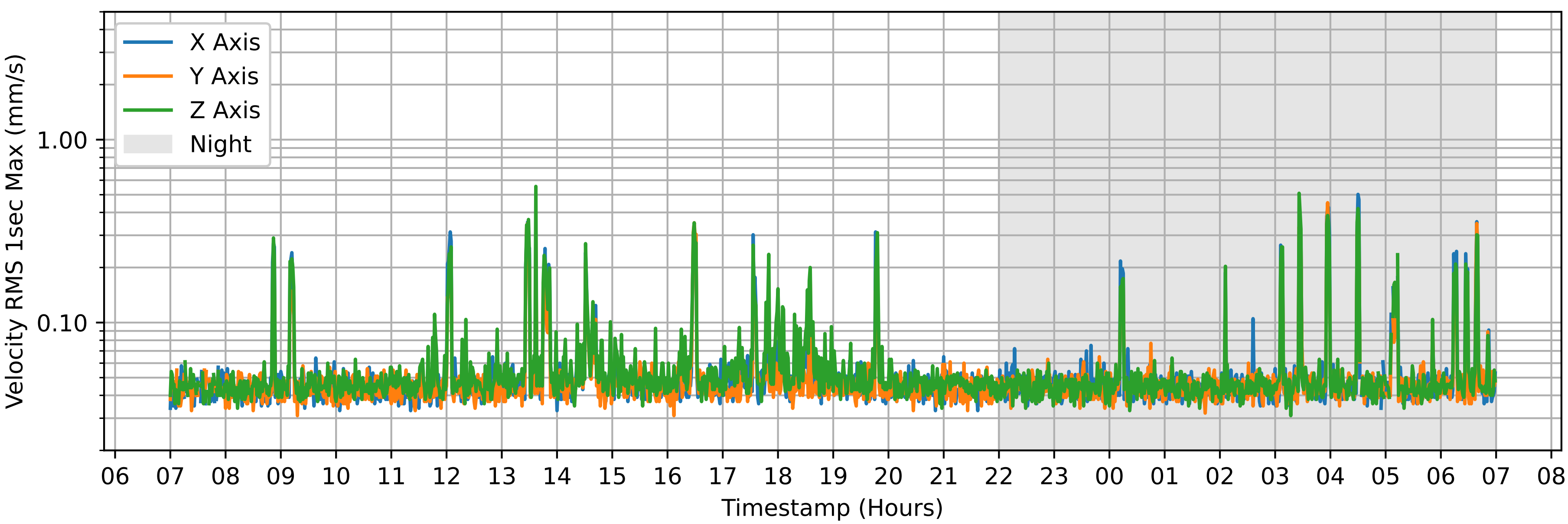
Pitt Meadows, British Colombia

Project #: 2104113

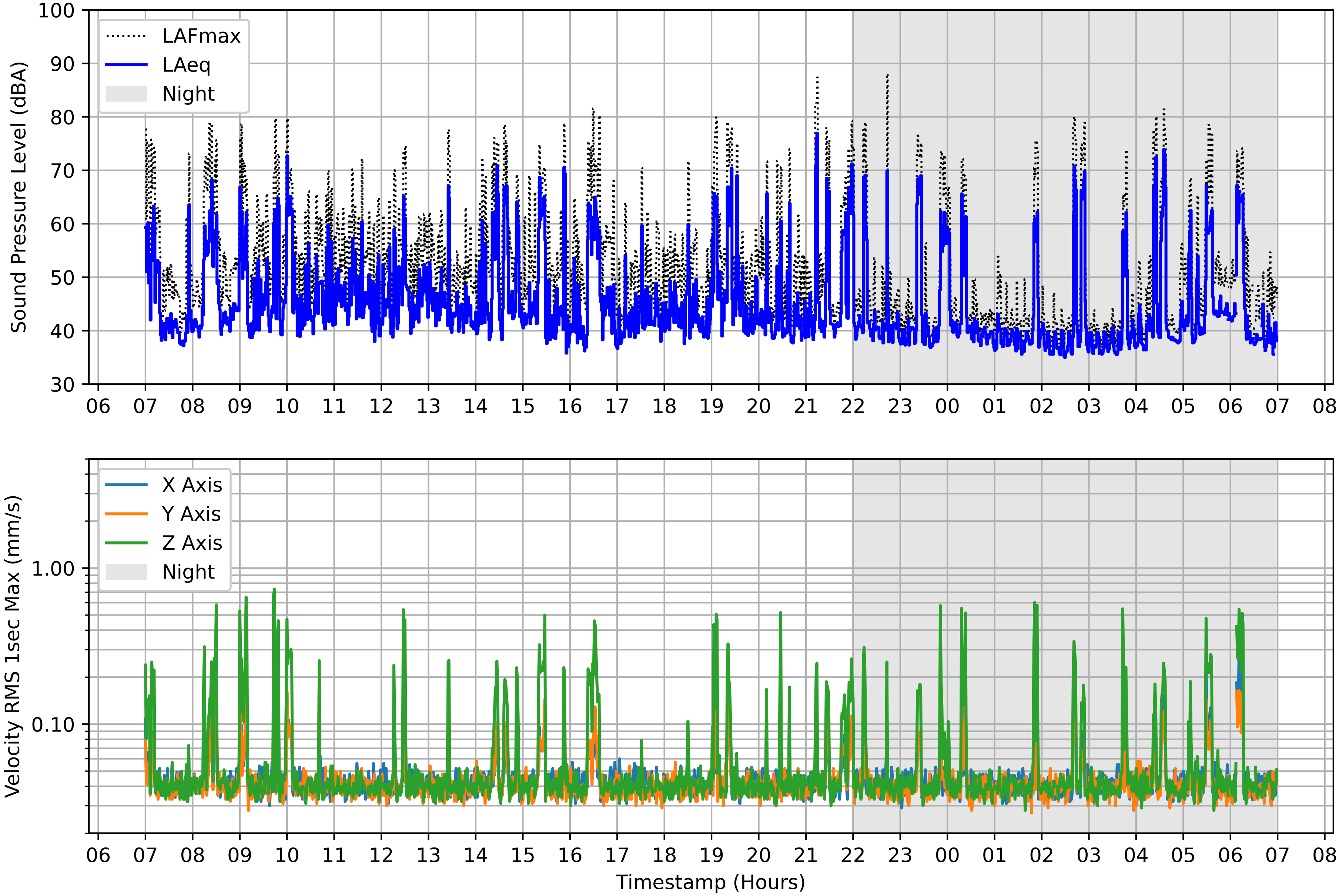
Figure No. A2

Date Revised: 2021-09-01

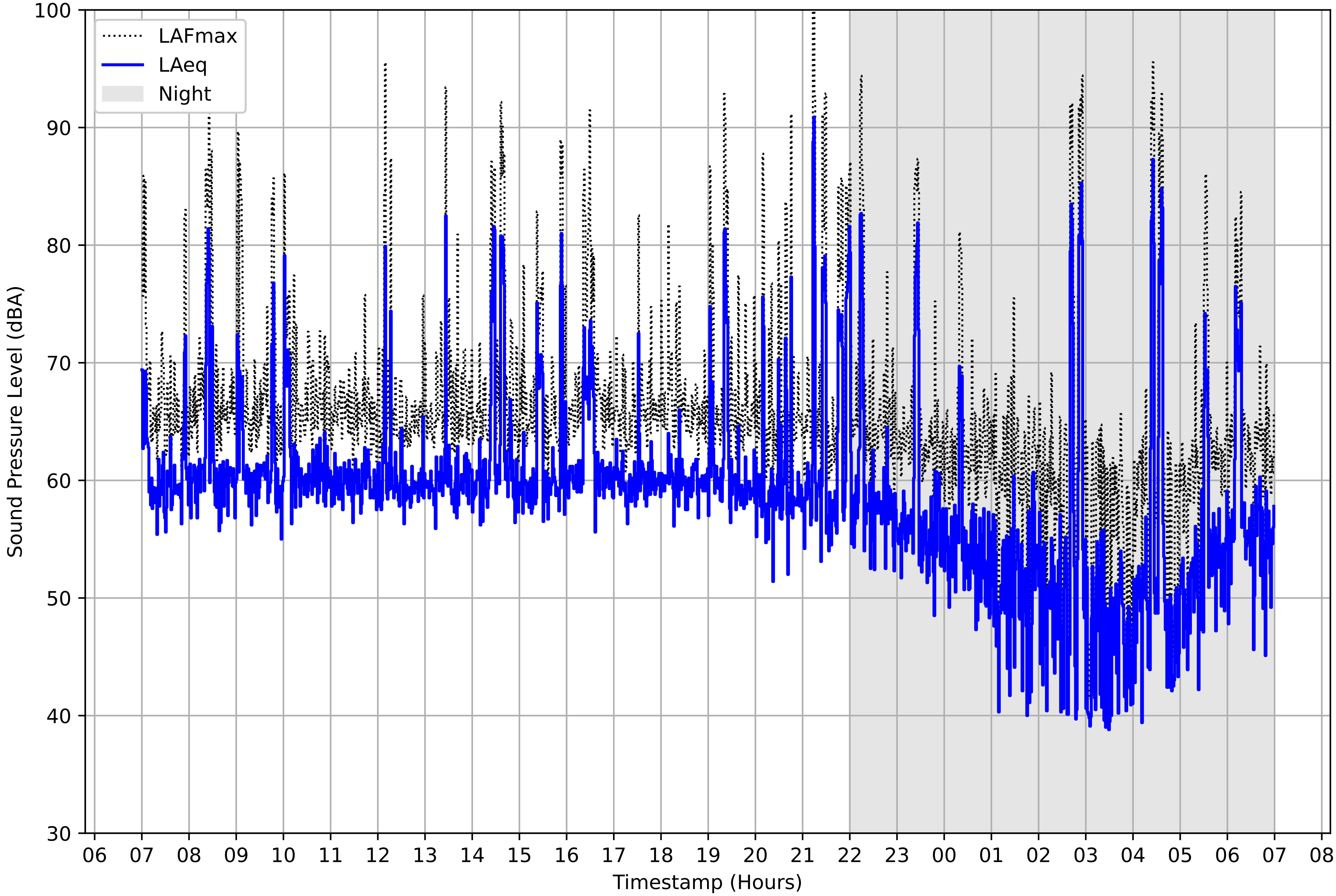




Pitt Meadows – Noise Monitoring **Monitoring Location: R6** **Monitoring Date: 2021-07-11** Pitt Meadows, British Colombia — Project #: 2104113	Figure No. A3 Date Revised: 2021-09-01	RWDI



Pitt Meadows – Noise Monitoring **Monitoring Location: R2** **Monitoring Date: 2021-07-23** Pitt Meadows, British Colombia — Project #: 2104113	Figure No. A4 Date Revised: 2021-09-01	RWDI



Pitt Meadows – Noise Monitoring

Monitoring Location: R3

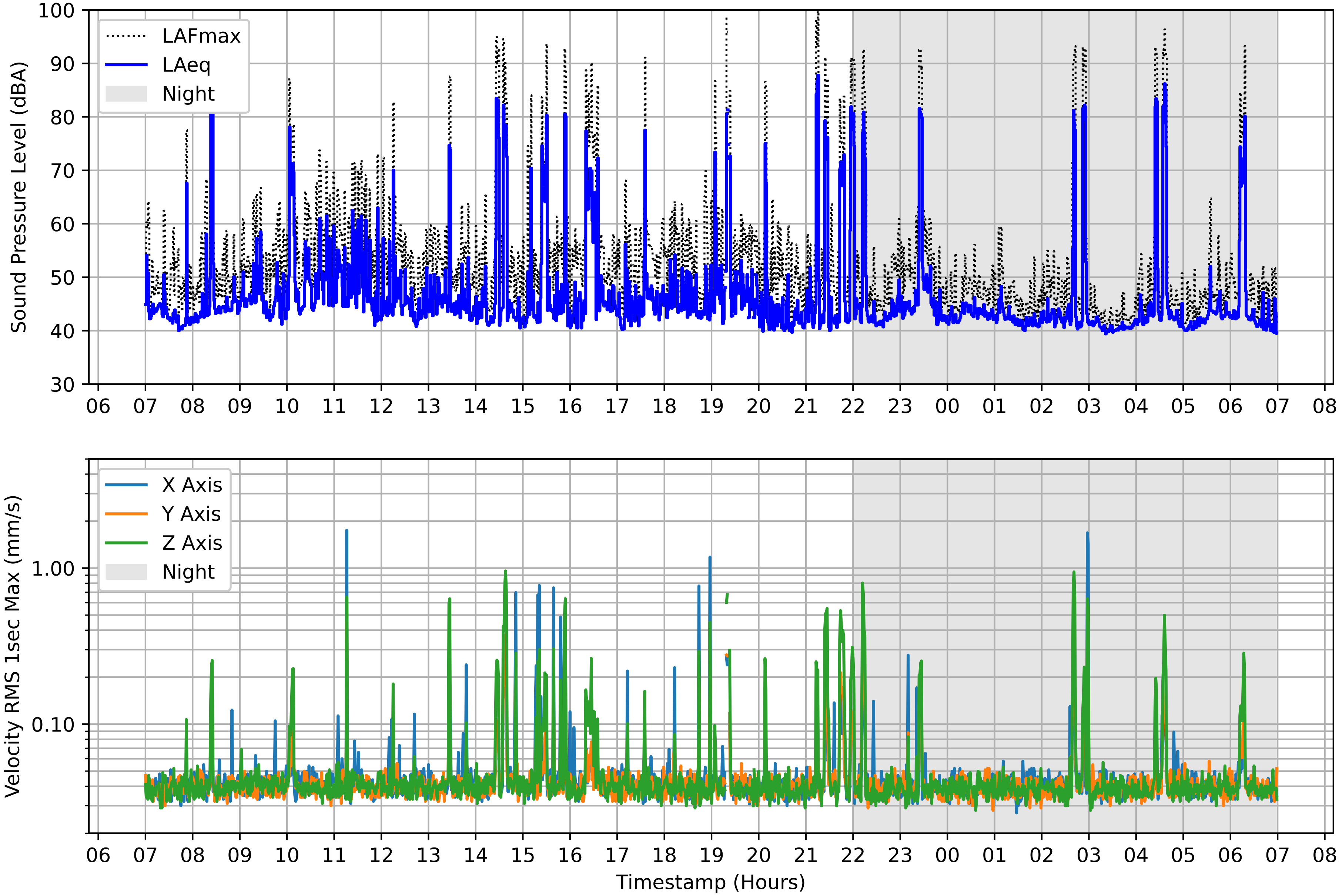
Monitoring Date: 2021-07-23

Pitt Meadows, British Colombia

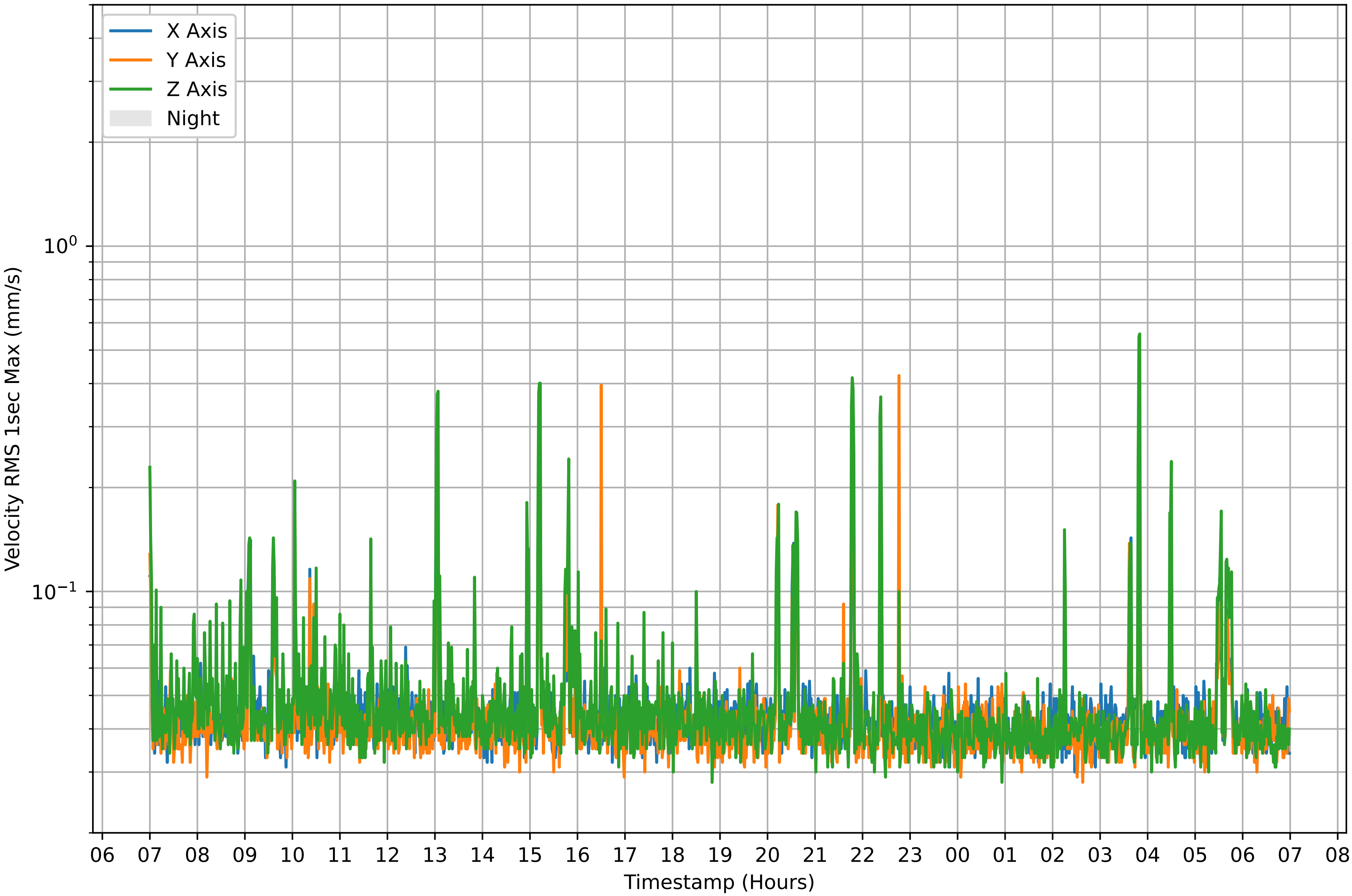
Project #: 2104113

Figure No. A6

Date Revised: 2021-09-01



Pitt Meadows – Noise Monitoring **Monitoring Location: R5** **Monitoring Date: 2021-07-23** Pitt Meadows, British Colombia Project #: 2104113	Figure No. A6 Date Revised: 2021-09-01	RWDI



Pitt Meadows – Noise Monitoring

Monitoring Location: R7

Monitoring Date: 2021-08-07

Pitt Meadows, British Colombia

Project #: 2104113

Figure No. A7

Date Revised: 2021-09-01