Susan Wakil Health Building

Noise and Vibration Monitoring Report

26 September – 24 November 2018

S180787RP1 Revision 0

Monday, 17 December 2018

Document Information

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Revision Table

Report revision	Date	Comments
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Glossary

A-weighting	A spectrum adaption that is applied to measured noise levels to represent human hearing. A-weighted levels are used as human hearing does not respond equally at all frequencies.
Daytime	Between 7 am and 6 pm as defined in the INP.
dB	Decibel—a unit of measurement used to express sound level. It is based on a logarithmic scale which means a sound that is 3 dB higher has twice as much energy. We typically perceive a 10 dB increase in sound as a doubling of that sound level.
dB(A)	'A' Weighted sound level in dB.
Evening	Between 6 pm and 10 pm as defined in the INP.
Frequency (Hz)	The number of times a vibrating object oscillates (moves back and forth) in one second. Fast movements produce high frequency sound (high pitch/tone), but slow movements mean the frequency (pitch/tone) is low. 1 Hz is equal to 1 cycle per second. The human ear responds to sound in the frequency range of 20 to 20,000 Hz.
ICNG	New South Wales *Interim Construction Noise Guideline*
INP	New South Wales *Industrial Noise Policy*, 2000.
Intrusive Noise	Noise emission that when assessed at a noise-sensitive receiver (principally a residential premises boundary) is greater than 5 dB(A) above the background noise level.
L_{10}	Noise level exceeded for 10% of the measurement time. The L_{10} level is commonly referred to as the average maximum noise level.
L_{90}	Noise level exceeded for 90% of the measurement time. The L90 level is commonly referred to as the background noise level.
L_{eq}	Equivalent Noise Level—Energy averaged noise level over the measurement time.
L_{max}	Maximum measured sound pressure level in the time period.
mm/s	Millimetres per second—units of vibration velocity.
µm/s	Micrometres per second—units of vibration velocity.
Night-time	Between 10 pm on one day and 7 am on the following day as defined in the INP.
Rating Background Level (RBL)	Overall single-figure A-weighted background level representing an assessment period (Day/Evening/Night). For the short-term method, the RBL is simply the measured $L_{90,15min}$ noise level. For the long-term method, it is the median value of all measured background levels during the relevant assessment period.

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1 Introduction

Laing O'Rourke is constructing the Susan Wakil Health Building (the Project) at the University of Sydney.

The Project, which is Stage 1 of a Health Precinct, involves the construction of an eight-level building that will provide a range of teaching and support spaces for the co-location of the Faculty of Nursing and Midwifery, the Faculty of Health Sciences and the Central Clinical School. The Stage 1 building will be constructed adjacent to the Royal Prince Alfred Hospital (RPAH).

As part of the Project Approval issued by the Department of Planning & Environment (DPE) for the Project, Laing O'Rourke engaged Resonate to prepare a Construction Noise and Vibration Management Plan (CNVMP).[1] One of the requirements of the CNVMP was for noise and vibration monitoring to be conducted at various locations around the site.

The CNVMP came into effect on 26 September 2018 when the site establishment works commenced. EHO Consulting was engaged to conduct noise and vibration monitoring from the period from 26 September to 24 November 2018.

This report summarises the results of the noise and vibration monitoring conducted by EHO Consulting and considers the results against the requirements of the CNVMP.

[1] Resonate,

2 Monitoring details

2.1 CNVMP monitoring requirements

The CNVMP requires the following monitoring to occur at sensitive locations around the construction site:

Table 1 CNVMP monitoring requirements

Monitoring requirements at receptors	How addressed by EHO monitoring
Attended monitoring to assess typical construction noise levels at RPAH and Wesley College	Continuous noise monitoring data available at RPAH and Wesley College for extended periods.
Attended noise monitoring in response to a complaint if an appropriate response	Not applicable as continuous noise monitoring occurring during period to respond to any complaints.
Continuous vibration monitoring at RPAH	Continuous vibration monitoring data available at RPAH for majority of period from 26 September – 24 November.
Continuous vibration monitoring at Bosch 1B Laboratory Animal Services	Continuous vibration monitoring data available at Bosch 1B for majority of period from 26 September – 24 November.
Continuous vibration monitoring if works occur within safe working distance for building damage	Not applicable as works did not occur within safe working distances.
Attended vibration monitoring in response to a complaint if an appropriate response	Not applicable as continuous vibration monitoring occurring during period to respond to any complaints.

2.2 Locations

Noise and vibration monitoring was conducted by EHO Consulting at the following locations across the period considered within this report:

- RPAH
- Bosch 1B Laboratory Animal Services
- Wesley College.

Figure 1, extracted from the EHO Consulting report, shows the location of the monitors in relation to the construction site (Blackburn Building).

2.3 Monitoring dates

Noise and vibration monitoring data has been provided by EHO Consulting for the following time periods at each location:

- RPAH: continuously from 23 September to 24 November 2018, except for the period from 14 October to 20 October inclusive.
- Bosch 1B Laboratory Animal Services: continuously from 23 September to 24 November 2018, except for the period from 7 October to 20 October inclusive.
- Wesley College: continuously from 28 October to 24 November 2018.

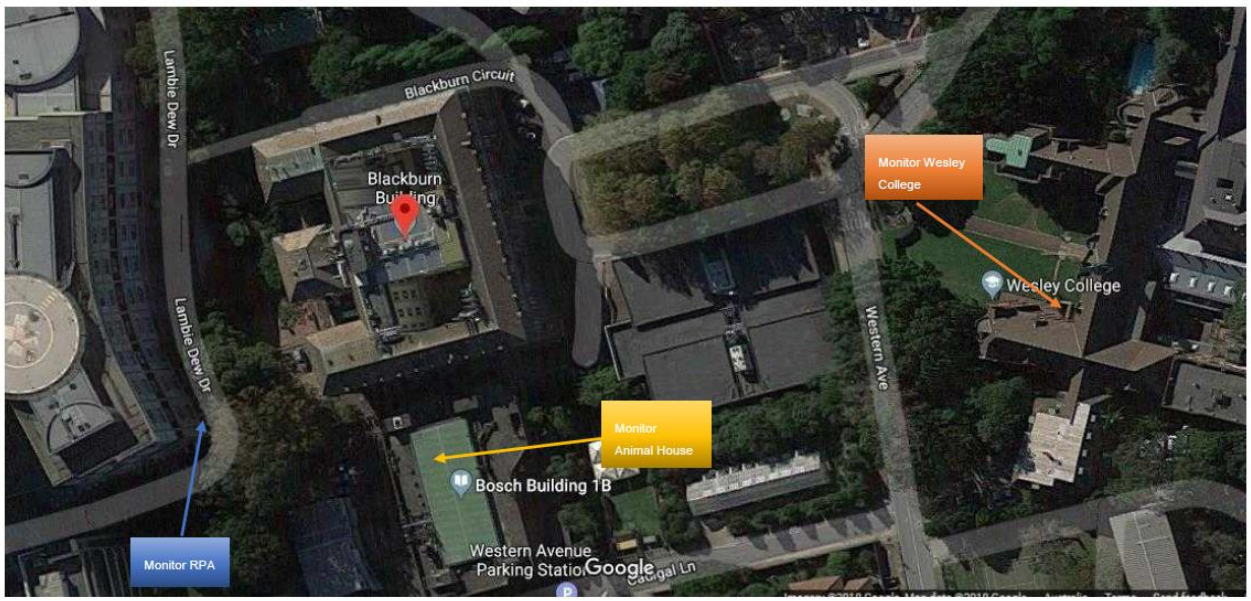


Figure 1 Monitoring locations from EHO Consulting Report

2.4 Equipment

Monitoring was conducted using Svan-958A analysers, which are suitable for conducting noise and vibration monitoring. The monitors were configured to record:

- A-weighted $L_{eq,15min}$ noise levels
- Peak Particle Velocity (PPV) vibration levels in mm/s.

The monitors were connected to SvanNet, and configured to send alerts to nominated site representatives when preset noise and vibration trigger levels were exceeded.

The EHO Consulting reports provide copies of calibration certificates for the units from a NATA-accredited laboratory that demonstrate the units were in current calibration.

2.5 Limitations and non-conformances

The noise and vibration monitoring conducted by EHO Consulting did not fully conform to the CNVMP under the Project Approval and some limitations apply to this analysis. These are summarised and discussed in Table 2.

Table 2 Limitations or non-conformances

Limitation or non-conformance	Comment
Noise monitoring at Bosch 1B Laboratory Animal Services was based on A-weighted noise levels, which is not suitable for the assessment of noise at that location as the A-weighting is designed for humans and not relevant to laboratory animals.	The noise monitoring data at Bosch 1B is not presented in this report as it is not relevant to the assessment of noise at that location. Continuous noise monitoring was not a requirement of the CNVMP at Bosch 1B and therefore this limitation is not considered a non-conformance against the CNVMP.

Limitation or non-conformance	Comment
No data was provided for some periods.	While significant data was available at both RPAH and Bosch 1B across the monitoring period, 1-2 weeks of data was not available at each location. Data was also unavailable for extended periods at Wesley College but it is noted that continuous monitoring was not required at this location under the CNVMP.
Vibration alert trigger levels for RPAH and Bosch 1B were set at 4 mm/s PPV and 2 mm/s PPV respectively, whereas more stringent trigger levels were required in the CNVMP.	This is a non-conformance and would mean that some vibration alerts would have been missed. However, it is noted that the works generally complied with the vibration management levels specified in the CNVMP.

3 Noise and vibration management levels

Noise and vibration management levels for the Project construction phase are documented in the CNVMP. This section presents noise and vibration management levels relevant to the monitoring locations considered in this report.

3.1 Noise Management Levels

Table 3 presents the Noise Management Levels (NMLs) for both Wesley College and RPAH.

Table 3 Noise Management Levels applicable to Project

Land use	External NML for time period in dB(A) unless otherwise indicated		
	Standard Working Hours	Extended periods on Saturdays 7:30 – 8 am, 1 – 3:30 pm	Other times (if required)
Wesley College	56 (NML) 75 (Highly noise affected)	51	51
Royal Prince Alfred Hospital and associated buildings including Chapel	70	70	70

The NML reflects the level above which there may be some community reaction to noise and for which all reasonable and feasible work practices should be implemented.

For Wesley College, a highly noise affected level of 75 dB(A) also applies. This reflects a level above which respite periods may require consideration.

3.2 Vibration Management Levels

3.2.1 RPAH and Wesley College

The CNVMP recommends an alert level of 0.6 mm/s PPV for RPAH as the basis for the continuous vibration monitoring at RPAH and this has been adopted as the Vibration Management Level (VML) for both RPAH and Wesley College. Vibration levels above 0.6 mm/s may indicate the potential for disturbance to building occupants in hospital wards and residential areas of Wesley College.

The VML reflects the level above which there may be some community reaction to noise and for which all reasonable and feasible work practices should be implemented. Note that much higher levels of vibration are required in order to pose a risk of building damage.

3.2.2 Bosch 1B Laboratory Animal Services

The CNVMP recommends an alert level of 0.1 mm/s RMS for the Bosch 1B Laboratory Animal Services. However, the monitor installed at this location was only capable of measuring PPV vibration levels and does not report RMS levels. PPV levels will always be higher than RMS levels for a particular vibration event.

In our experience it is common for PPV levels to be at least four times higher than RMS vibration levels, and therefore a VML of 0.4 mm/s PPV has been adopted for Bosch 1B Laboratory Animal Services.

4 Monitoring results

The noise and vibration monitoring results collected by EHO Consulting are presented graphically on the weekly graphs in Appendix A, compared against the relevant NMLs and VMLs. The Standard Working Hours are shaded on each graph to indicate the periods within which noise and vibration may be the result of construction activities.

Note that events that were obviously caused by extraneous sources, such as an individual coming into contact with the vibration sensor, have been removed from the graphs.

4.1 RPAH

4.1.1 Noise

Throughout the monitoring period at RPAH, measured noise levels exceeded the NML of 70 dB(A) $L_{eq,15min}$ for a total of 11 occasions during working hours throughout the entire monitoring period. It is noted that some of these occurrences may be the result of extraneous events as a number of exceedances of the NML occurred outside of working hours.

Given the relatively small number of isolated exceedances that occurred throughout the entire monitoring period, it is not considered that noise levels from the construction works are significantly impacting on RPAH. However, reasonable and feasible noise mitigation measures should be implemented on site as per the approved CNVMP.

4.1.2 Vibration

The VML of 0.6 mm/s PPV was also exceeded a total of 11 times during working hours across the entire monitoring period at RPAH. As for the noise monitoring results, some of these occurrences are likely to be the result of extraneous events as a number of additional exceedances occurred outside of working hours.

Given the small number of isolated exceedances, indicating that extended periods of perceptible vibration did not occur at RPAH, it is considered that vibration impacts from the construction works at RPAH were managed appropriately during the monitoring period.

4.2 Bosch 1B Laboratory Animal Services

4.2.1 Vibration

The VML of 0.4 mm/s PPV was exceeded a total of 13 times during working hours at Bosch 1B Laboratory Animal Services.

The majority of these events were short-term in nature, with no associated build-up of vibration levels around the event, indicating that they may have been the result of activities within the space rather than a result of construction activities. For example, staff entering a room for feeding or cleaning activities may have been the cause of a number of these events.

Regardless, only a small number of vibration exceedances occurred during the monitoring period at Bosch 1B and, on each occasion, the results were generally followed by periods of low vibration levels. This indicates that there were no extended periods of vibration above the VML at Bosch 1B and that vibration from the site was being managed appropriately.

4.3 Wesley College

4.3.1 Noise

Measured noise levels at Wesley College often exceeded the relevant NML of 56 dB(A) during Standard Working Hours but were generally below 65 dB(A). Exceedances of the NML at this level were envisaged by the CNVMP and are acceptable with the implementation of reasonable and feasible noise mitigation measures as per the CNVMP.

There was one 15-minute period on 29 October where the measured noise levels at Wesley College exceeded the 75 dB(A) level for highly noise affected. However, given it was a single occurrence and noise levels for the 15-minute periods either side were markedly lower, it may have been the result of extraneous noise rather than construction noise. Regardless, any exceedance of the highly noise-affected level was a one-off event and was not repeated throughout the remainder of the monitoring period.

4.3.2 Vibration

No vibration events occurred at Wesley College that exceeded the applicable VML of 0.6 mm/s PPV.

5 Conclusion

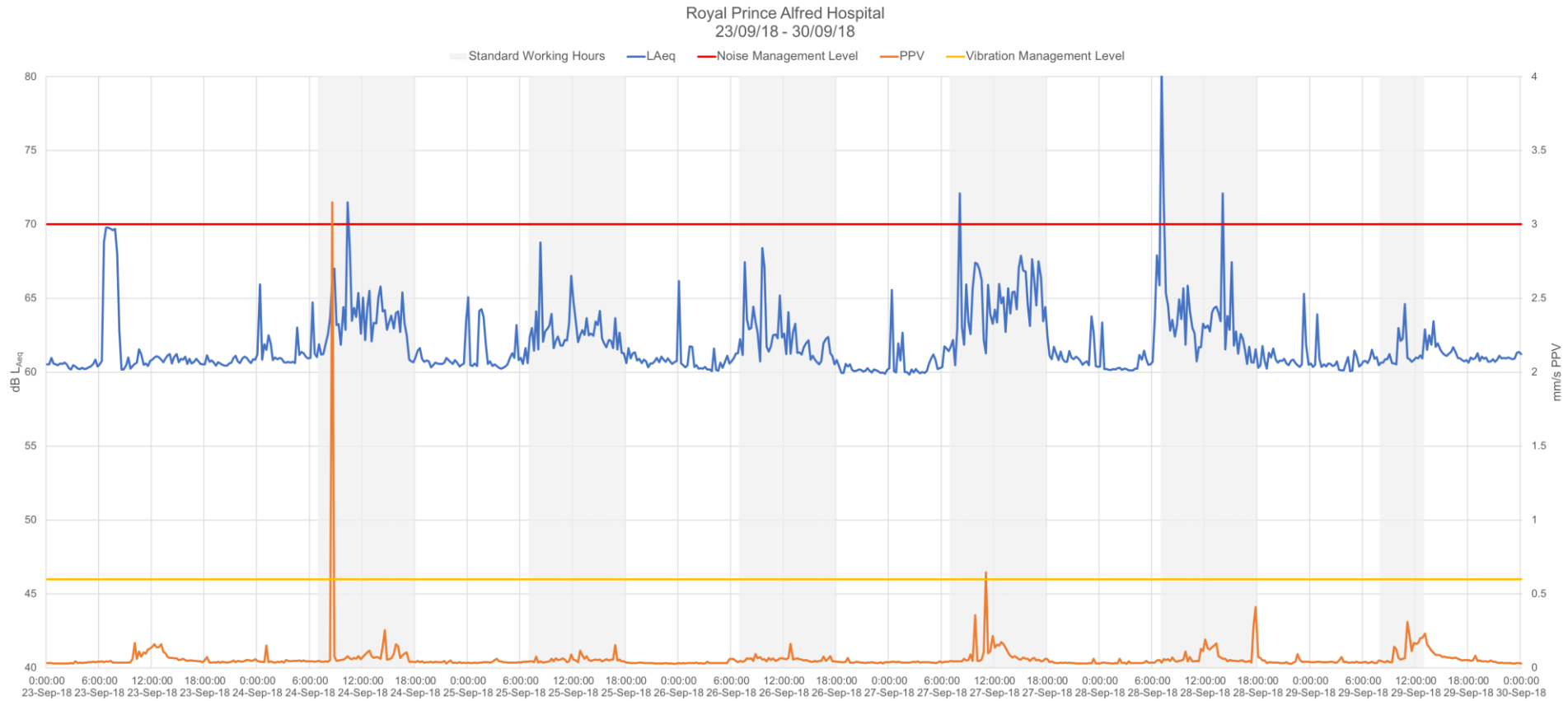
This report summarises the results of the noise and vibration monitoring conducted by EHO Consulting at three locations around the Susan Wakil Health Building construction site. The monitoring results are considered against the requirements of the CNVMP.

The monitoring results demonstrate that, despite some non-conformances in the monitoring procedures, measured noise and vibration levels were generally consistent with the NMLs and VMLs at both RPAH and Bosch 1B Laboratory Animal Services. Additionally, noise levels at Wesley College were consistent with those predicted in the CNVMP.

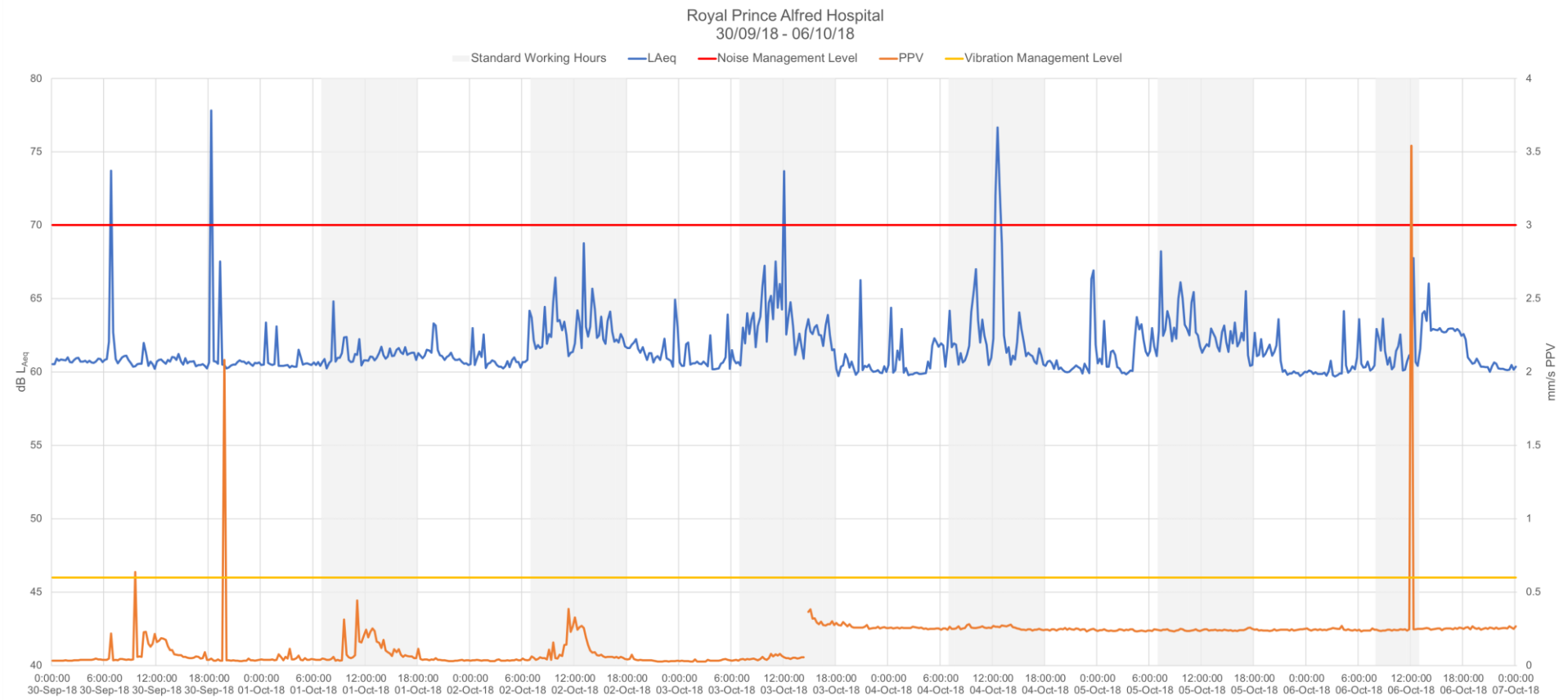
Based on the results, it is considered that noise and vibration levels from the site are as envisaged by the approved CNVMP. As works continue, reasonable and feasible noise and vibration mitigation measures should be implemented on site as per the CNVMP.

Appendix A—Measurement results

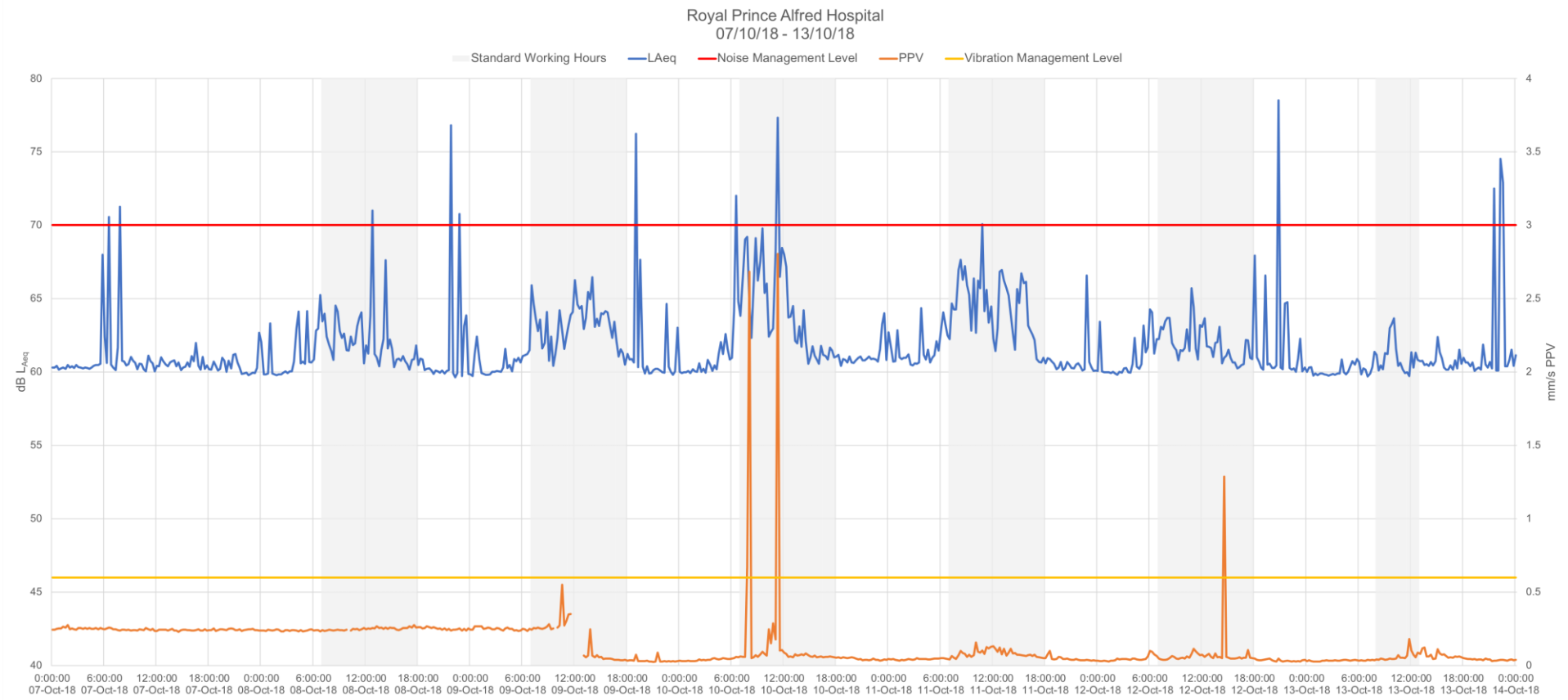
Royal Prince Alfred Hospital – 23 September to 29 September 2018



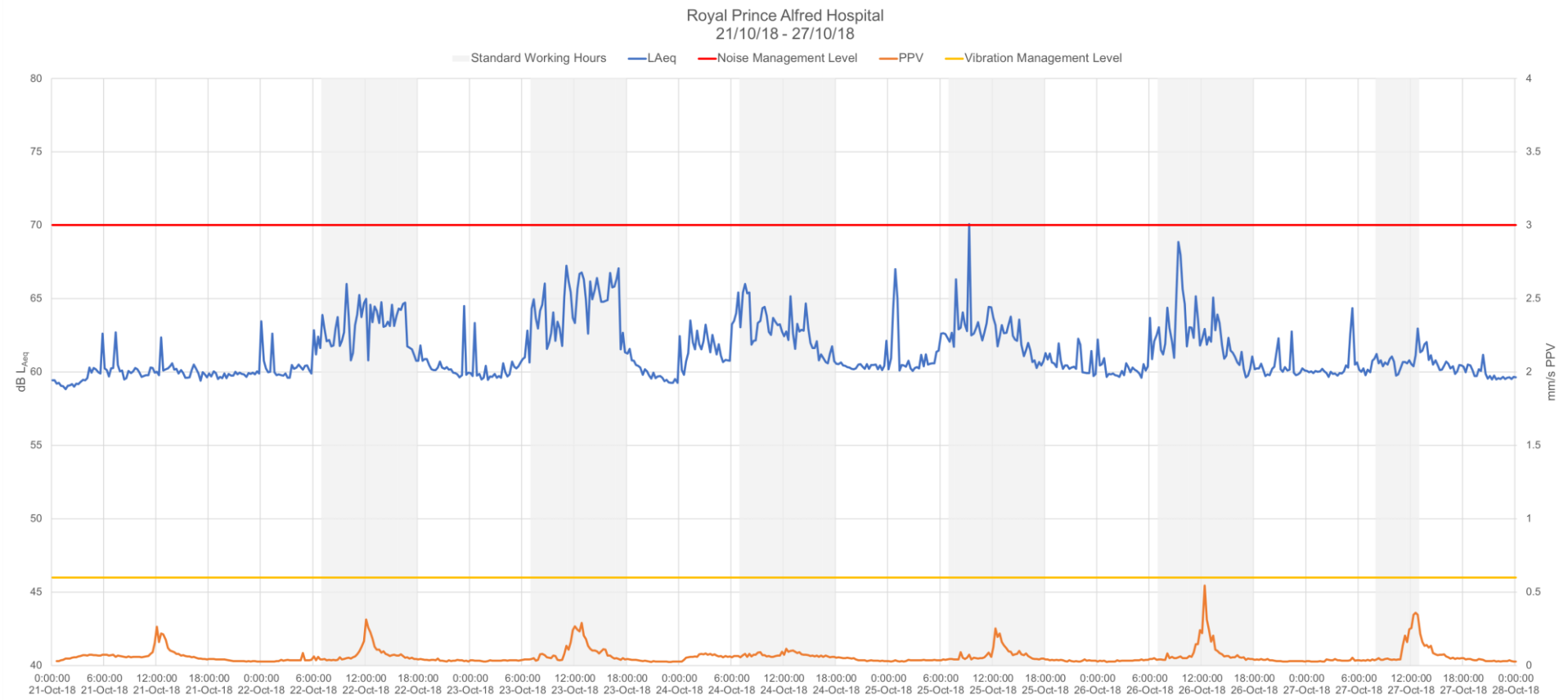
Royal Prince Alfred Hospital – 30 September to 6 October 2018



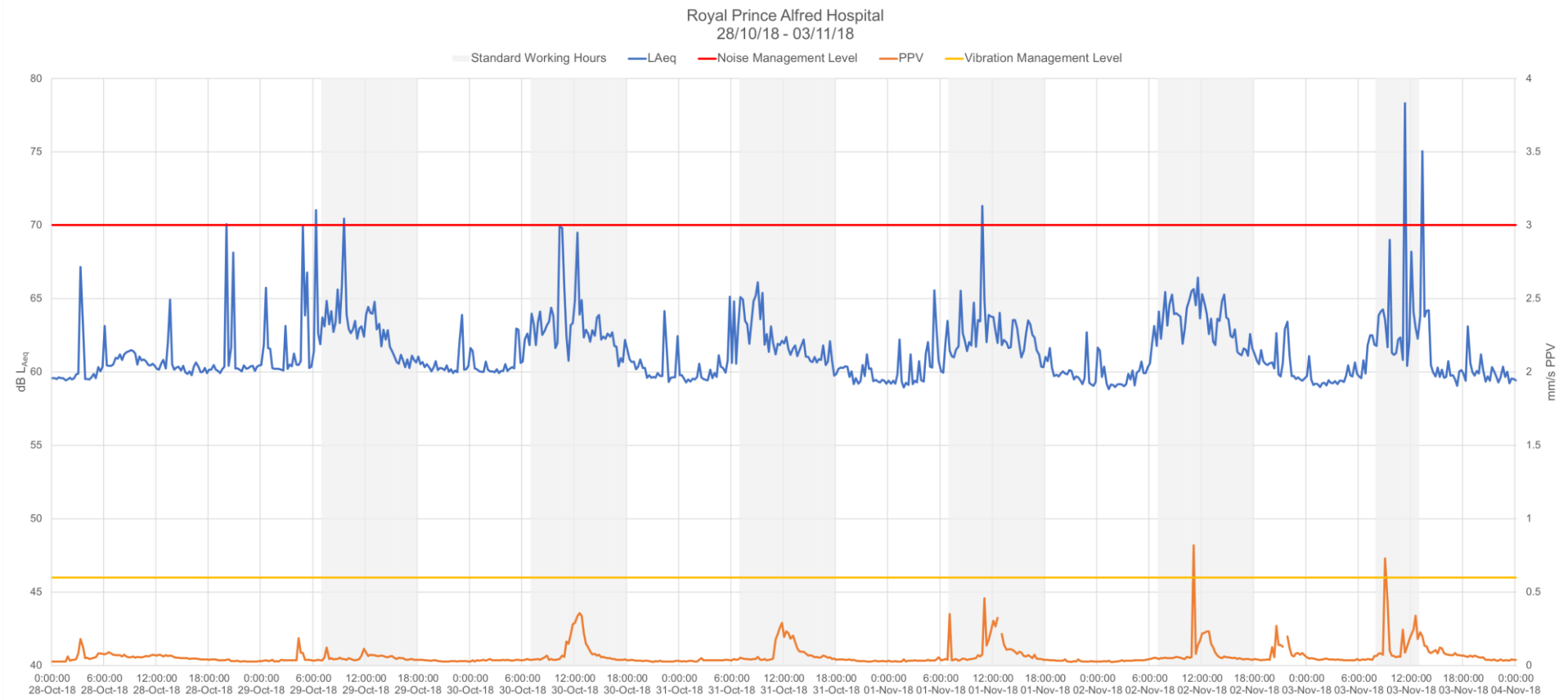
Royal Prince Alfred Hospital – 7 October to 13 October 2018



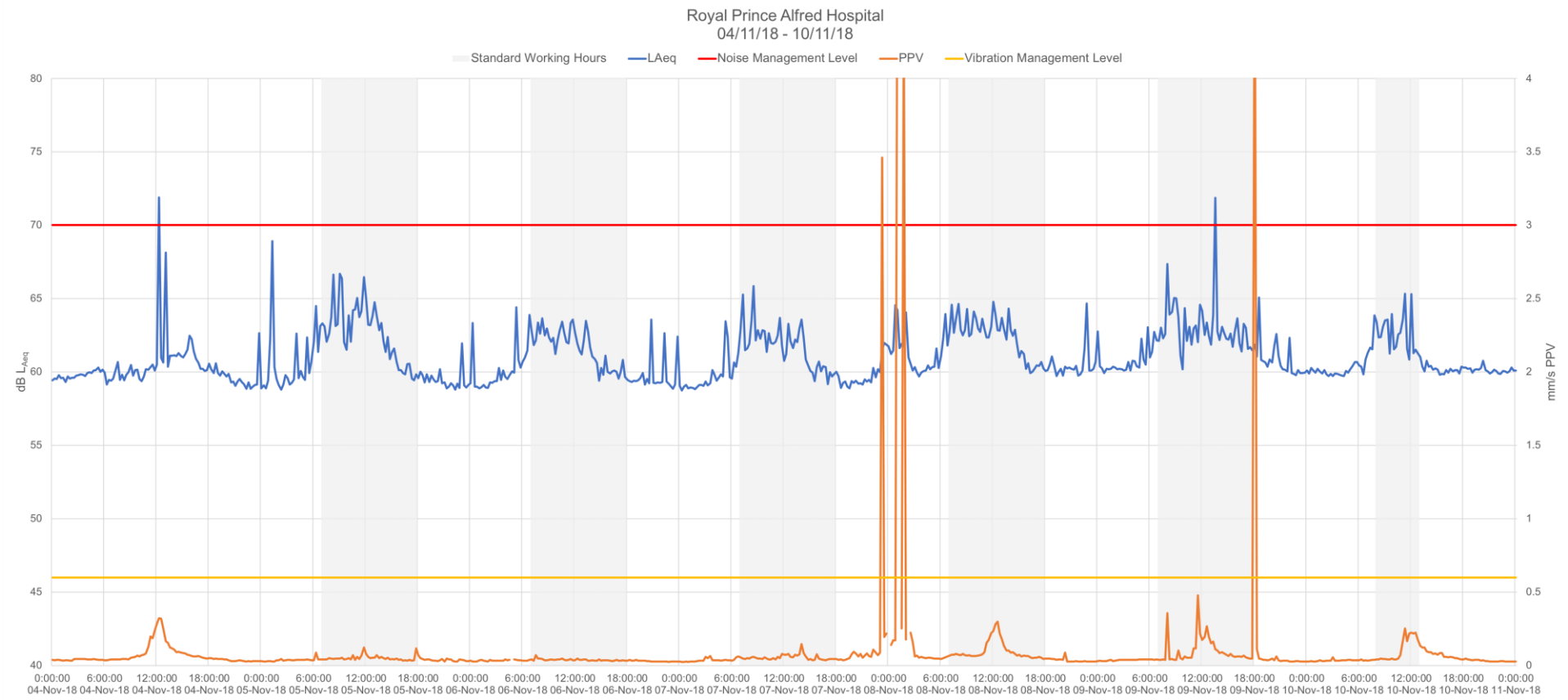
Royal Prince Alfred Hospital – 21 October to 27 October 2018



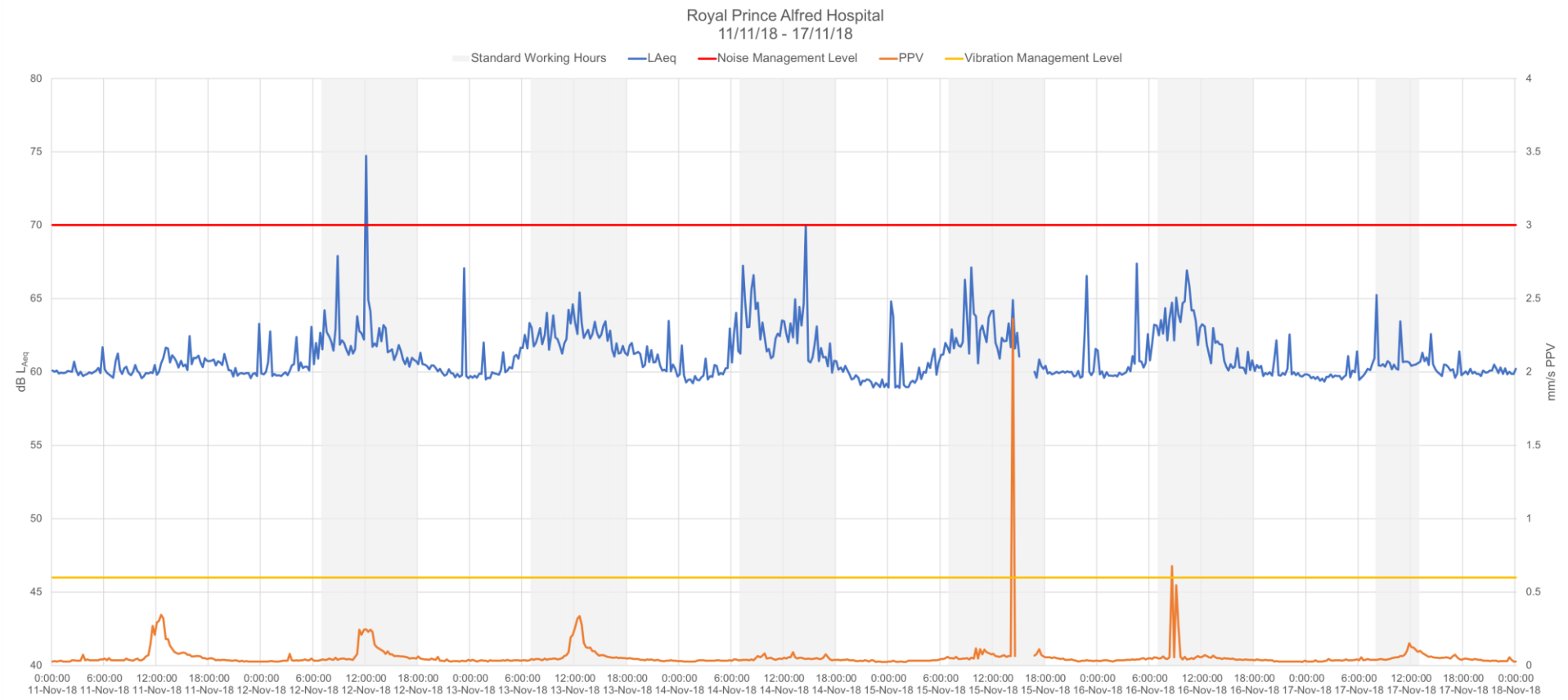
Royal Prince Alfred Hospital – 28 October to 3 November 2018



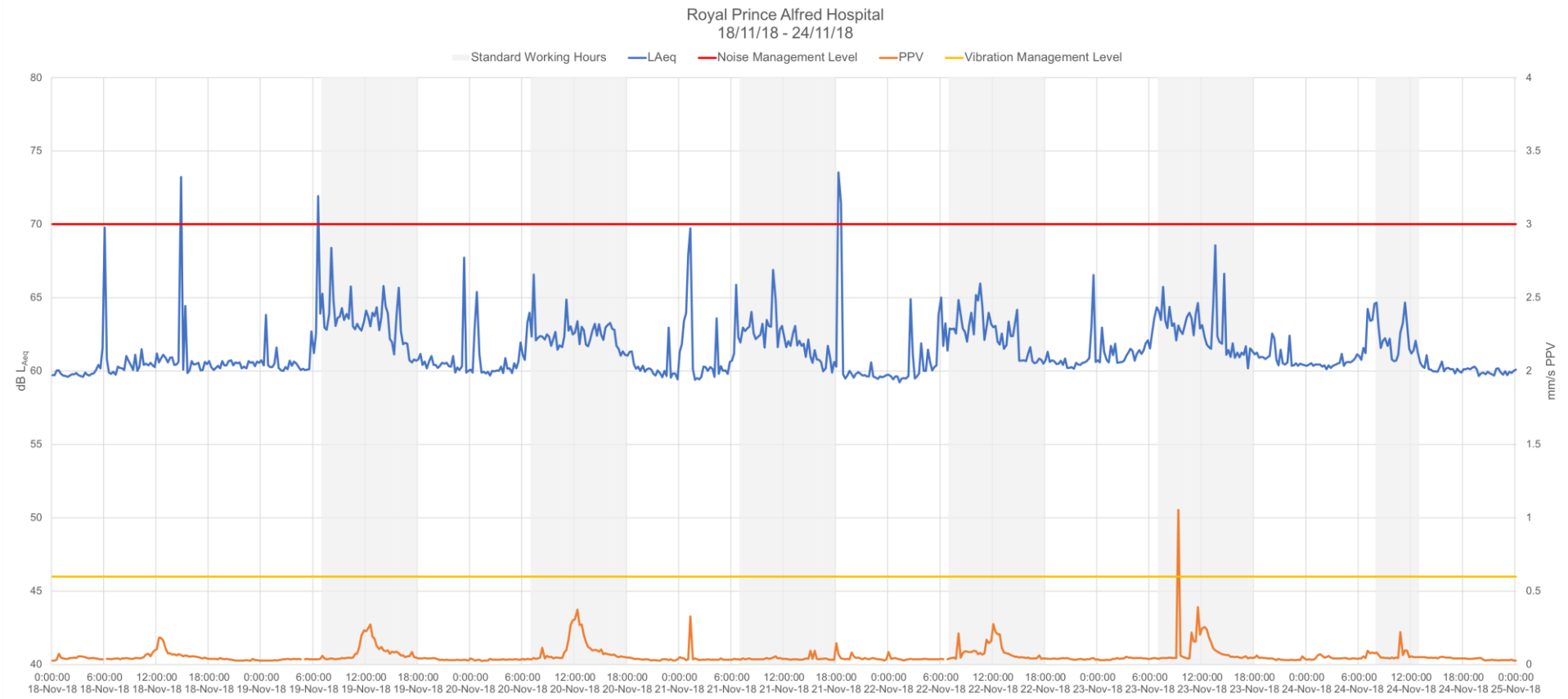
Royal Prince Alfred Hospital – 4 November to 10 November 2018



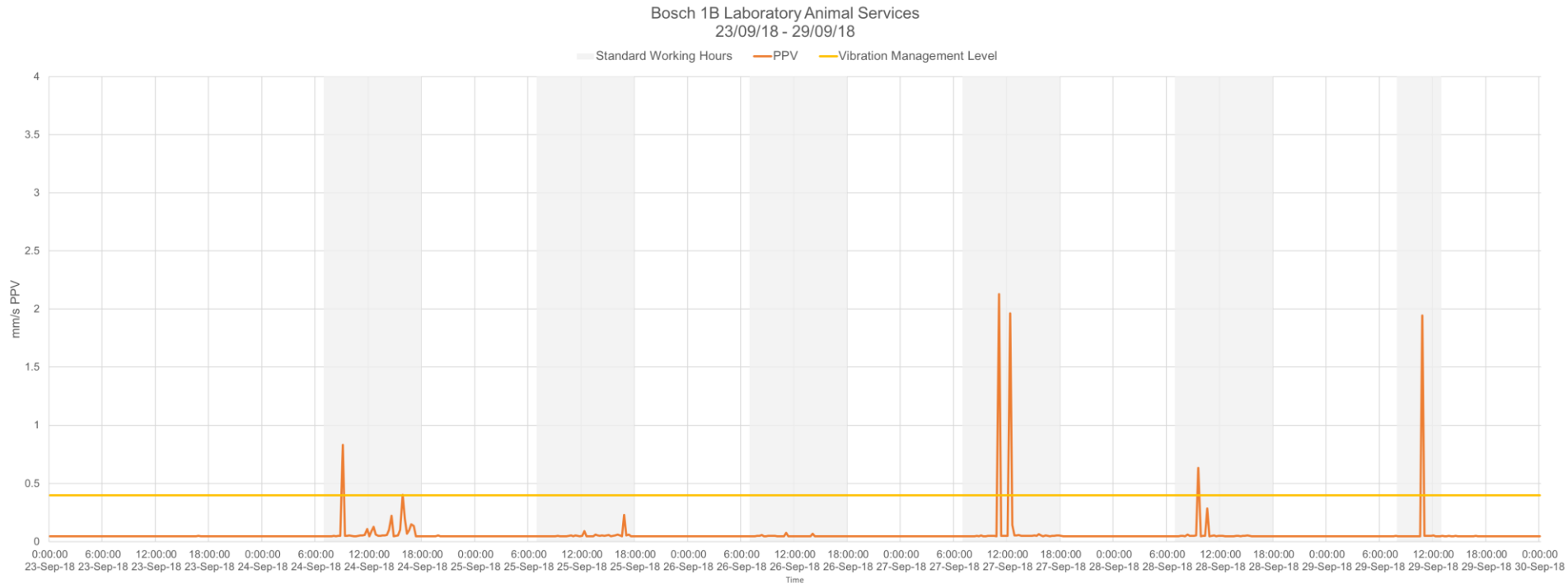
Royal Prince Alfred Hospital – 11 November to 17 November 2018



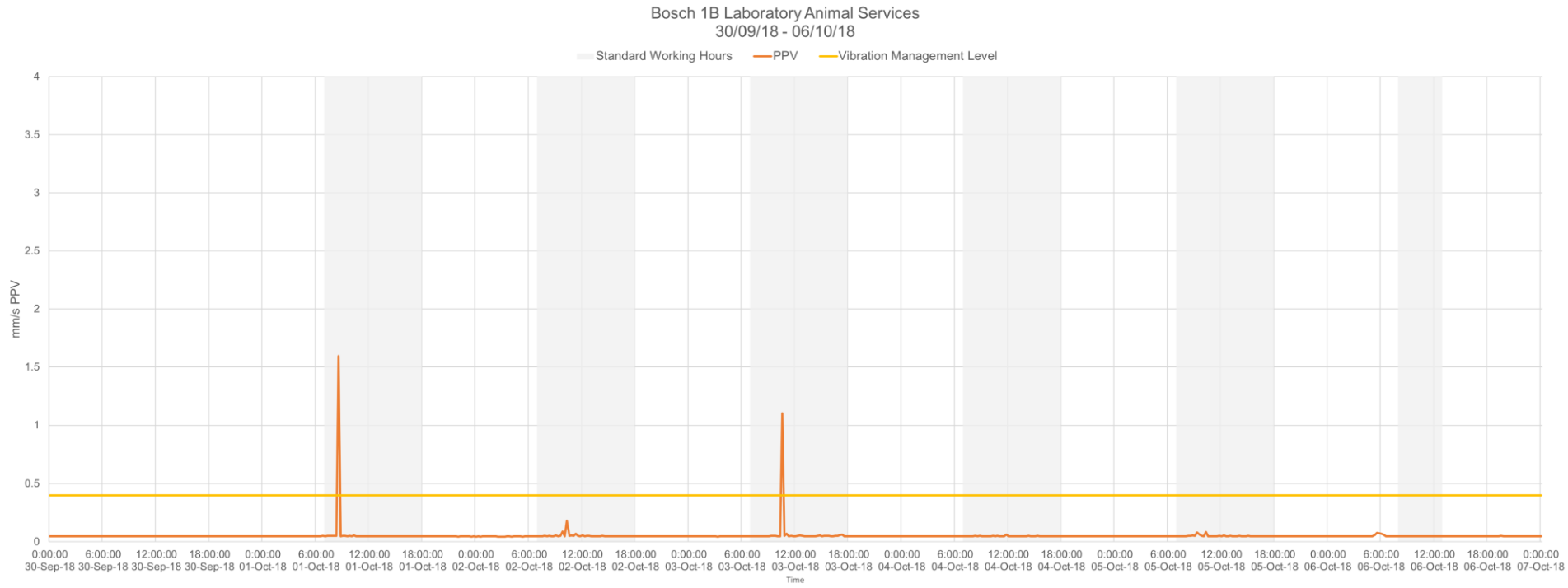
Royal Prince Alfred Hospital – 18 November to 24 November 2018



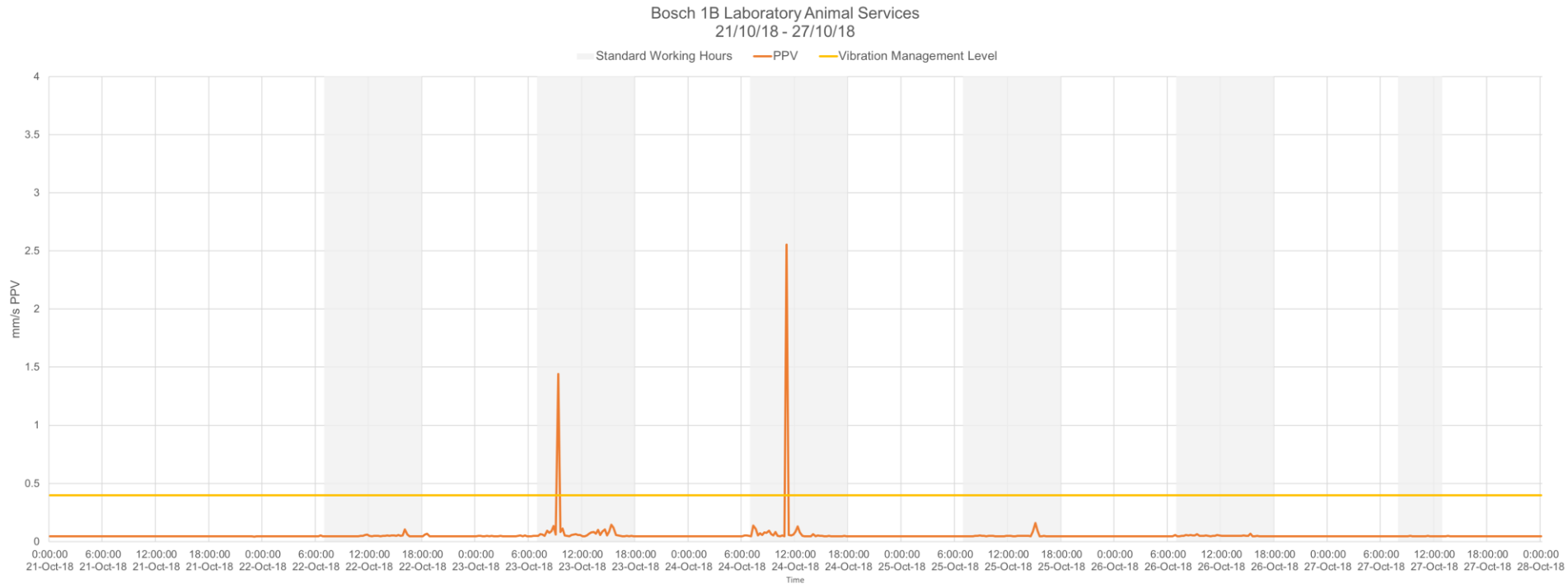
Bosch 1B Laboratory Animal Services – 23 September to 29 September 2018



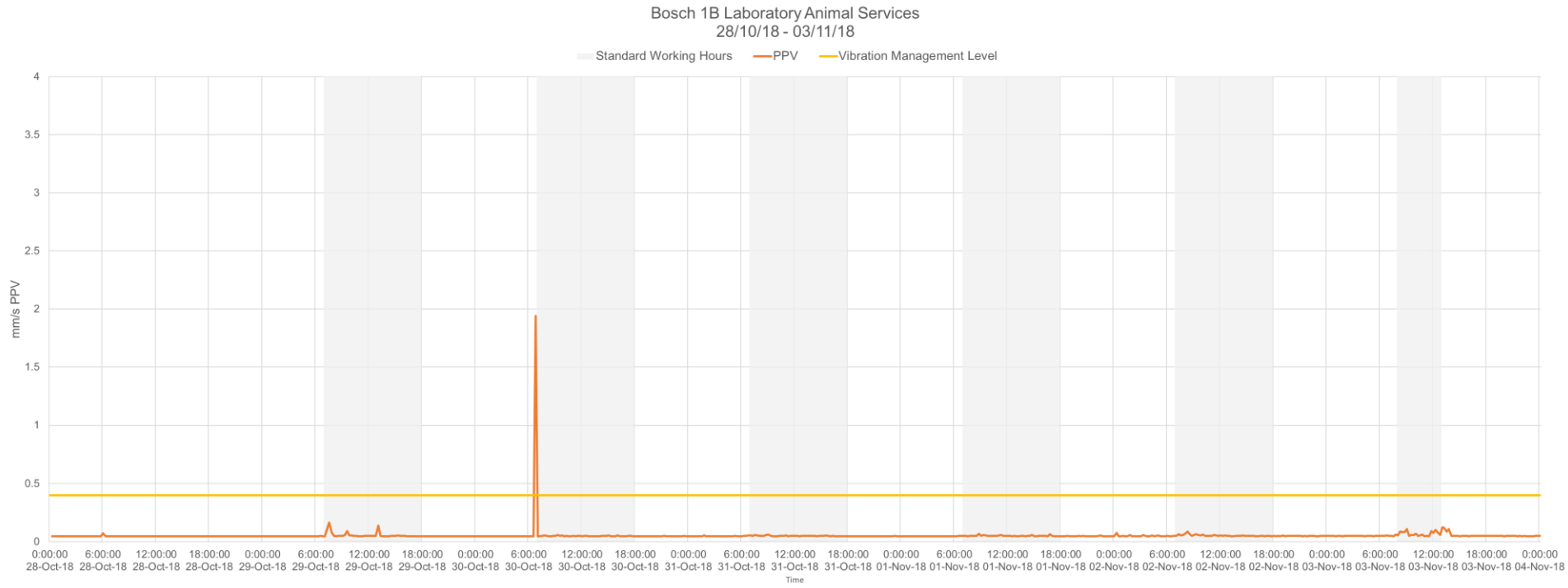
Bosch 1B Laboratory Animal Services – 30 September to 6 October 2018



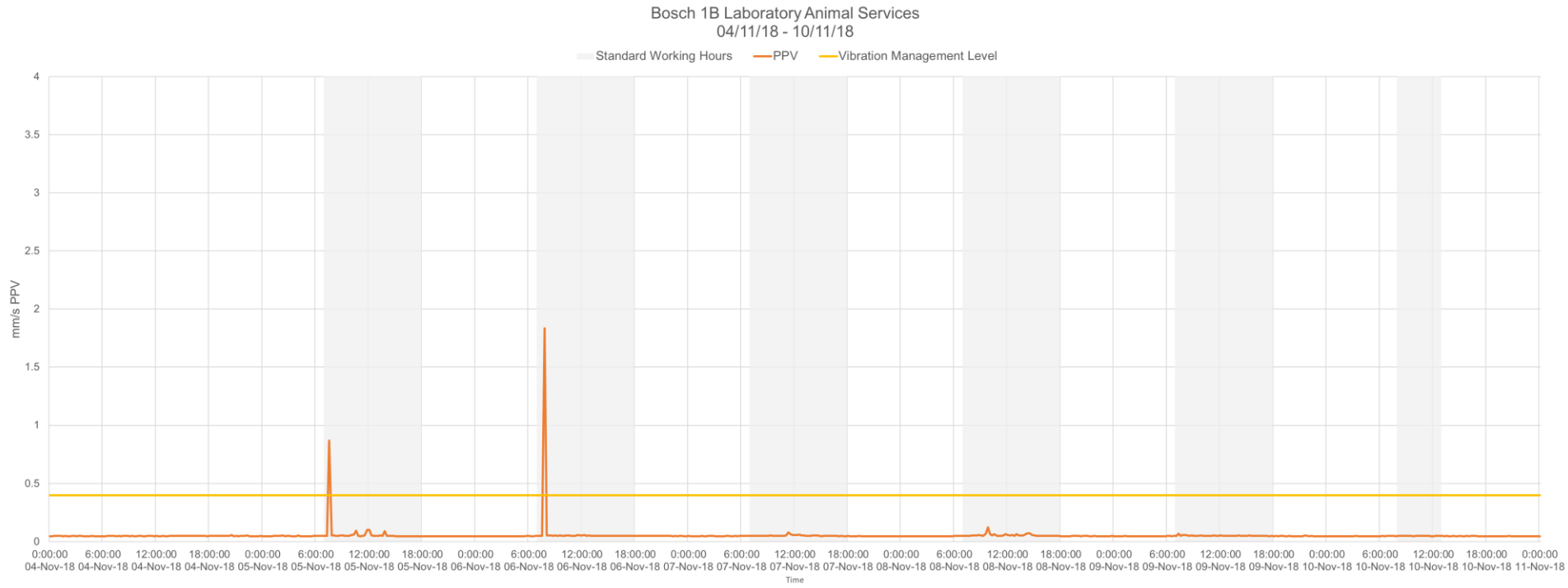
Bosch 1B Laboratory Animal Services – 21 October to 27 October 2018



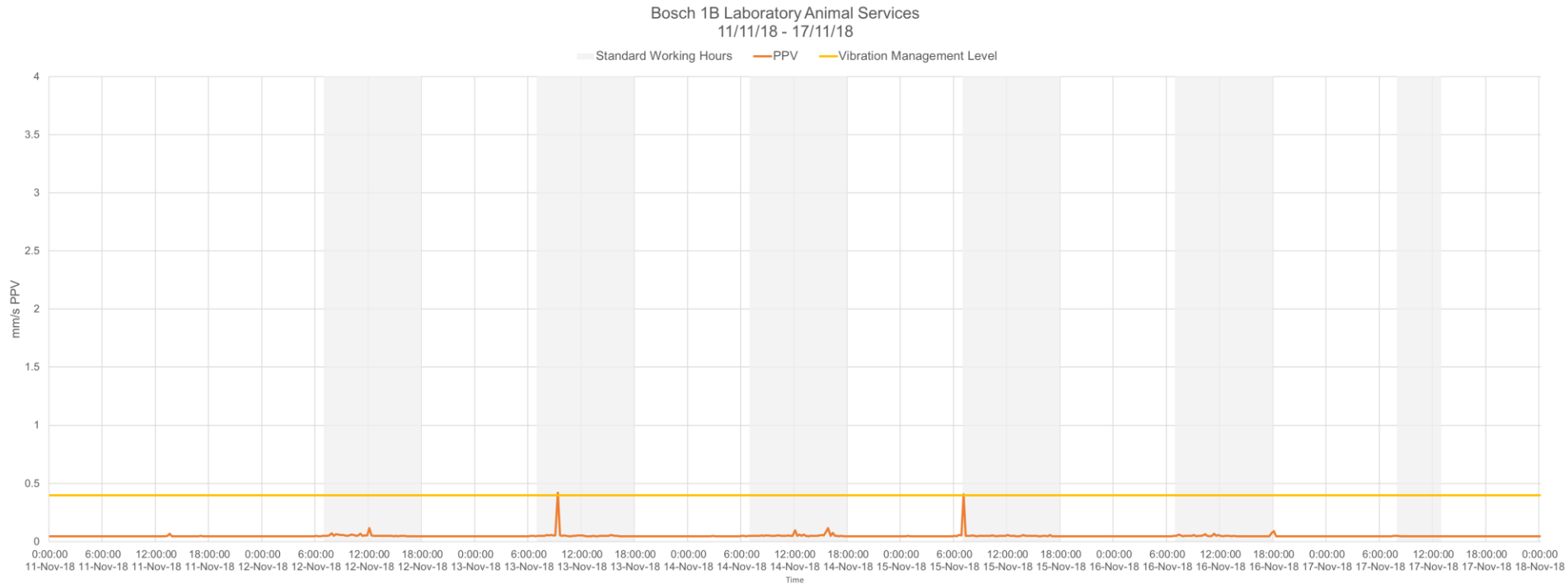
Bosch 1B Laboratory Animal Services – 28 October to 3 November 2018



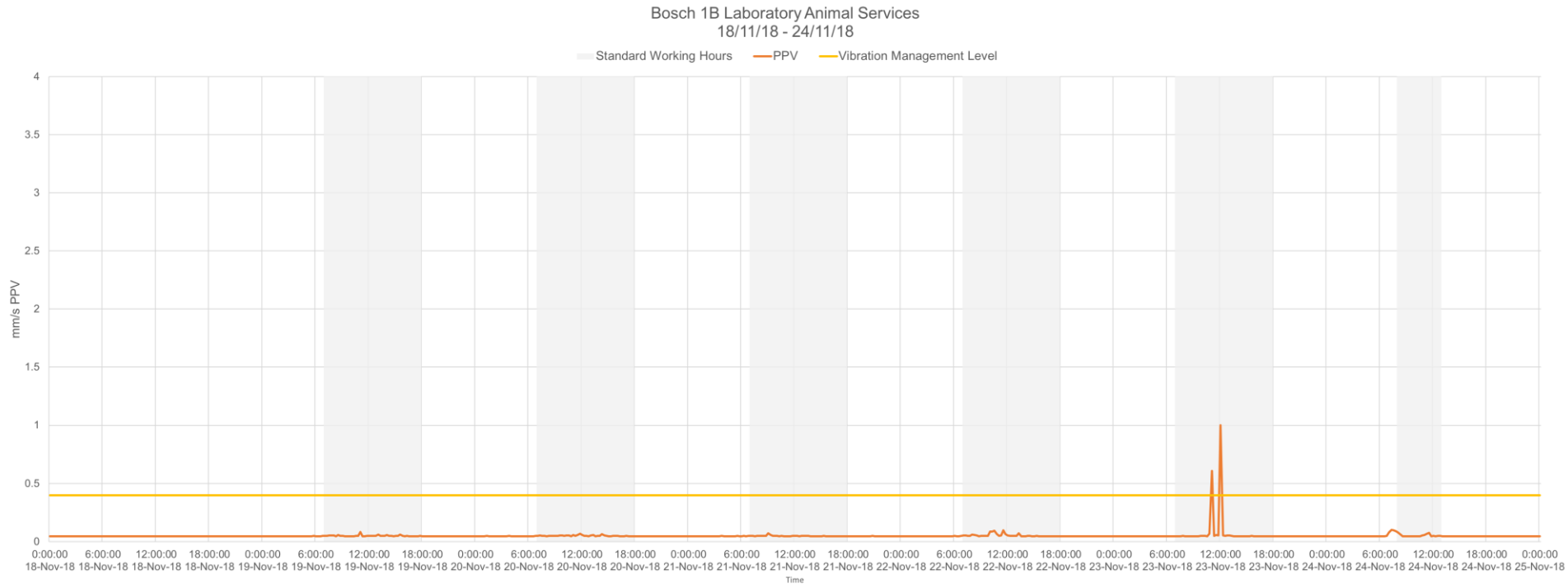
Bosch 1B Laboratory Animal Services – 4 November to 10 November 2018



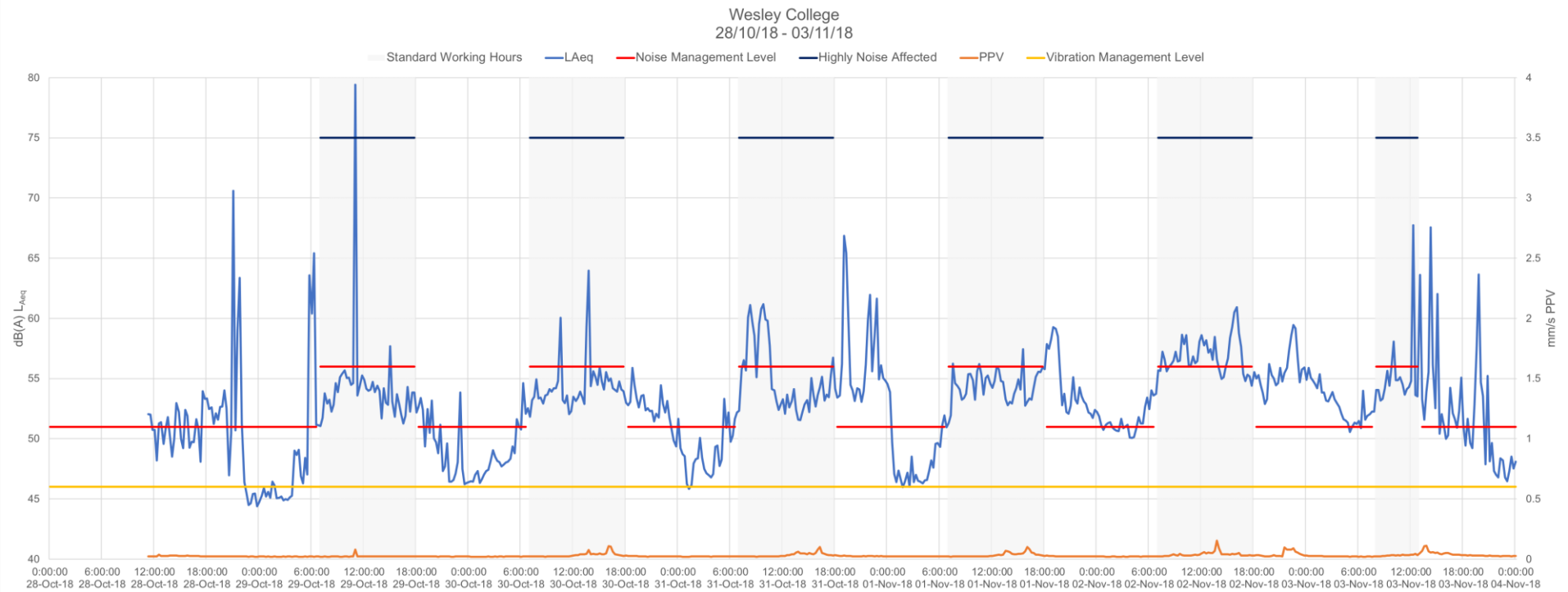
Bosch 1B Laboratory Animal Services – 11 November to 17 November 2018



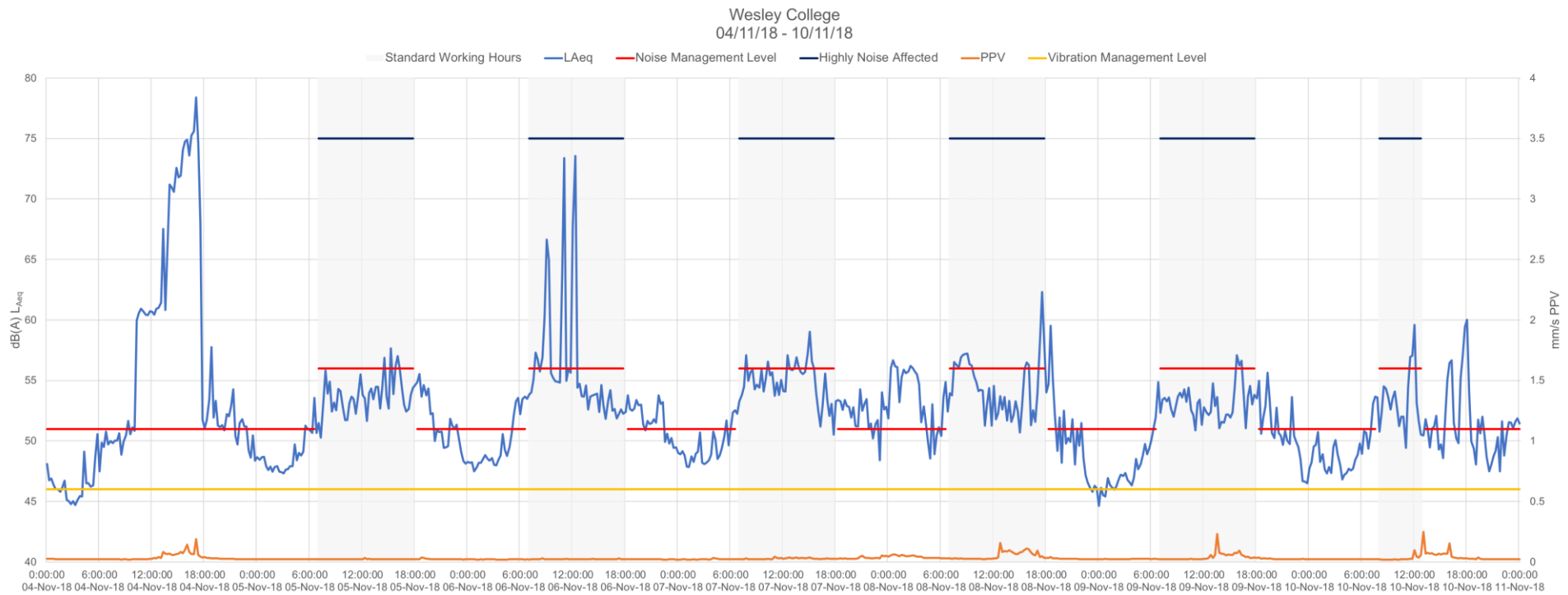
Bosch 1B Laboratory Animal Services – 18 November to 24 November 2018



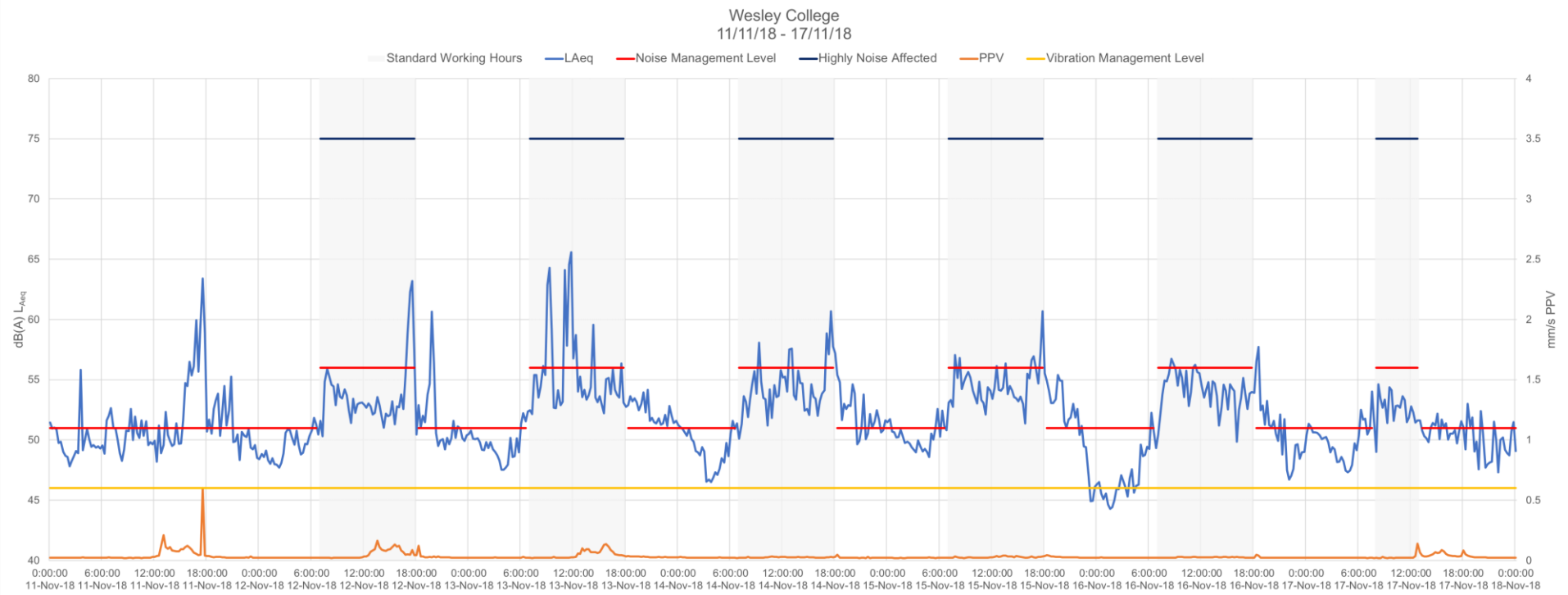
Wesley College – 28 October to 3 November 2018



Wesley College – 4 November to 10 November 2018



Wesley College – 11 November to 17 November 2018



Wesley College – 18 November to 24 November 2018