Vibration Monitoring Assessment Report (July 2020)

Tweed Valley Hospital Project, Kingscliff NSW

Prepared for: Delta Group

DLT-01-Q1013 / VIB12 / v1f
7th August 2020

ADE CONSULTING GROUP
SOLUTIONS THROUGH INNOVATION

Prepared for:

Delta Group

Vibration Monitoring Assessment Report

771 Cudgen Road, Kingscliff NSW

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v1f	Written by [redacted]	7th August 2020

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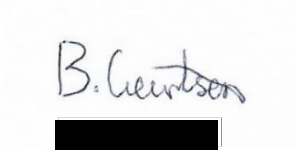
Date: 7th August 2020

Written By:



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VIBRATION MONITORING ASSESSMENT REPORT
ADE Report No. DLT-01-Q1013 / VIB12 / v1f

EXECUTIVE SUMMARY

ADE Consulting Pty Ltd (ADE) has been commissioned by the Delta Group to prepare an assessment of the vibration aspects of the construction phase for Tweed Valley Hospital Project located at 771 Cudgen Road, Kingscliff NSW. Kingscliff is located in the Northern Rivers region of New South Wales. The Site is bounded by Tweed Coast Road to the West, Cudgen Road to the South and Turnock Street to the East.

The Vibration Assessment consisted of the real time data observation and discussion to achieve the following;

- Compliance with regulatory requirements and standards for vibration management;
- Avoid excessive vibration generation through site planning and the adoption of appropriate work methods and practices; and
- Prevent or minimise to the greatest extent, the impact of construction vibration on neighbours and to establish and maintain positive relationships with project stakeholders.

The outcome of the vibration assessment did not identify any health exposures presenting an immediate danger to life, health or environment. The report details the outcome of the real time vibration assessment conducted by ADE Consulting Group Pty Ltd from **1st July – 31st July 2020**.

All results from vibration monitoring undertaken during the monitoring period (July 2020) were **below** the threshold used to assess the effects of short-term vibration on structures according to DIN 4150-3:2016.

Works were only conducted between 7am and 6pm, Monday – Friday from the 1st – 31st July 2020 and only data within this range should be considered.

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DEFINITIONS

Vibration:	The mechanical oscillations occurring about an equilibrium point. The oscillations may be periodic such as the motion of a pendulum or random. Vibration is most commonly expressed in terms of displacement, velocity, acceleration and frequency, all of which are related.
Displacement:	The change in position of an object, is a vector quantity (Stress indicator).
Velocity:	The rate of change of displacement, is a vector quantity (Fatigue indicator).
Acceleration:	The rate of change of velocity, is a vector quantity. (Indicator of force).
Frequency:	The number of times a periodic function or vibration occurs or repeats itself in a specified time, often 1 second – cycles per second. Frequency is measured in Hertz.
Hertz (Hz):	The unit of frequency or pitch of a sound. One hertz equals one cycle per second.
Peak Particle Velocity (PPV):	The greatest instantaneous particle velocity during a given time interval if measurements are made in 3-axis. The resultant Peak Particle Velocity (PPV) is the vector sum i.e. the square root of the summed squares of the maximum velocities, regardless of when in the time history those occur.
Root Mean Square (RMS):	The RMS value of a set of numbers is the square root of the average of their squares. Best used when assessing building damage.
Vibration Dose Value (VDV):	The vibration dose value (VDV) is used for assessing intermittent vibration. A cumulative measurement of the vibration level received over an 8-hour or 16-hour period. Best used when structure is occupied.
Peak:	The peak is the maximum amplitude during a measurement period.
Peak to Peak (P-P):	The peak to peak (P-P) is the difference between the maximum positive and maximum negative amplitudes of a waveform.
Logarithmic Scale:	Comparing frequency with large amplitude differences can be accomplished using a logarithmic scale. Critical vibration components usually occur at low amplitudes compared to the rotational frequency vibration. These components are not revealed on a linear amplitude scale because low amplitudes are compressed at the bottom of the scale. But a logarithmic scale shows prominent vibration components equally well at any amplitude.
Zero Crossing Frequency:	Determining the apparent dominant frequency of a given sample can be achieved by using the Zero Crossing Frequency.

Primary Waves (P Waves):	Alternating compressions ('pushes') and dilations ('pulls') in the same direction as the wave is propagating. P waves are the first arriving energy, smaller and higher frequency than S waves.
Secondary Waves (S Waves):	Alternating transverse motions perpendicular to the direction of propagation. Slower than P waves.
Rayleigh Waves (R Waves):	Motion is both in the direction of propagation and perpendicular (in a vertical plane). R waves are also dispersive, and amplitudes decrease with depth.
Accelerometer:	A vibration sensor whose electrical output is directly proportional to the acceleration component of the vibration. The two most common accelerometer types are the traditional charge type and the IEPE, integrated electronic piezoelectric type with a built-in line-drive amplifier to enable the output signal to be transmitted over 'longer cable runs'.
Filter:	A device for separating components of a signal on the basis of their frequency. It allows components in one or more frequency bands to pass relatively unattenuated, and it attenuates components in other frequency bands. Modifies the frequency spectrum of a signal usually while it is in electrical form.
Short-term vibration	Vibration which does not occur often enough to cause structural fatigue, and which does not produce resonance in the structure being evaluated.
Long-term vibration	All types of vibration not covered by the definition of ‘short-term’ vibration.

1 INTRODUCTION

1.1 Project Background

Kingscliff is located in the Northern Rivers region of New South Wales. The Site is bounded by the Tweed Coast Road to the West, Cudgen Road to the South and Turnock Street to the East.

Delta Group are undertaking Earthworks for the Tweed Valley Hospital Project located at 771 Cudgen Road, Kingscliff NSW, hereafter referred to as 'The Site'. Excavation works were on going during July 2020.

The purpose of the Vibration Monitoring Assessment (VMA) report is to assess the impacts of piling, excavation and general construction works from the Tweed Valley Hospital Project upon the surrounding community.

Table 1. Project Specific Information.

Project Specific Information	
Scope:	This vibration report provides detailed real time vibration monitoring results at three locations within the site.
Objectives:	• Comply with DIN 4150-3:2016 guidelines and conditions C21 - C24 of the consent. • Avoid or minimise vibration impacts from activities which could affect the nearby buildings (Kingscliff Tafe and residential properties). • To minimise the generation of vibration which could affect the neighbours of the site, workers on the site, associated buildings and other members of the public. • Establish and maintain good relationships with the neighbours and wider community.
Key Issues and Risks:	While using mobile plant and conducting piling operations, nearby residential and commercial buildings and their occupants may be affected by vibration. A pre-work vibration assessment was carried out and compared to the DIN 4150-3:2016 Vibration Standards for Buildings, this information will determine possible impacts on other sensitive premises identified in the area. Vibration generating activities that has likely contributed to the level of current vibration are listed in Appendix 2 and 3 of the Lendlease Noise and Vibration Management Plan.
Key Legislation/ Standards/ Guidance:	*Protection of the Environment Operations Act 1997 (NSW) (POEO Act).* The POEO Act is a key piece of environmental protection legislation and regulates activities via: • Environmental protection licensing, as per schedule 1; • Regulation of scheduled and non-scheduled activities; • Environmental protection offences and penalties; and • Establishment of a general duty of care to notify environment harm.

Table 1. Continued…

Project Specific Information	
Key Legislation/ Standards/ Guidance:	*Vibrations in buildings Part 3: Effects on structures DIN4150-3 February 2016.* This standard specifies a method of measuring and evaluating the effects of vibration on structures designed primarily for static loading. It applies to structures which do not need to be designed to specific standards or codes of practice regarding dynamic loading. This standard also gives guideline values which, when compiled with, will not result in damage that will have an adverse effect on the structure's serviceability. In some cases, guideline values for a simplified evaluation are also given.

1.2 Previous Report

Refer to the previous report (DLT-01-Q1013 / VIB11 / v1f) for details from earlier monitoring periods.

1.3 Monitoring Locations

The three (3) vibration monitors are located within the site adjacent to Cudgen Road. Monitoring locations were determined by the client (refer to **Appendix I – Aerial Photograph***)*.

Vibrations were recorded at the above-mentioned locations throughout the preparation works of the Tweed Valley Hospital Project.

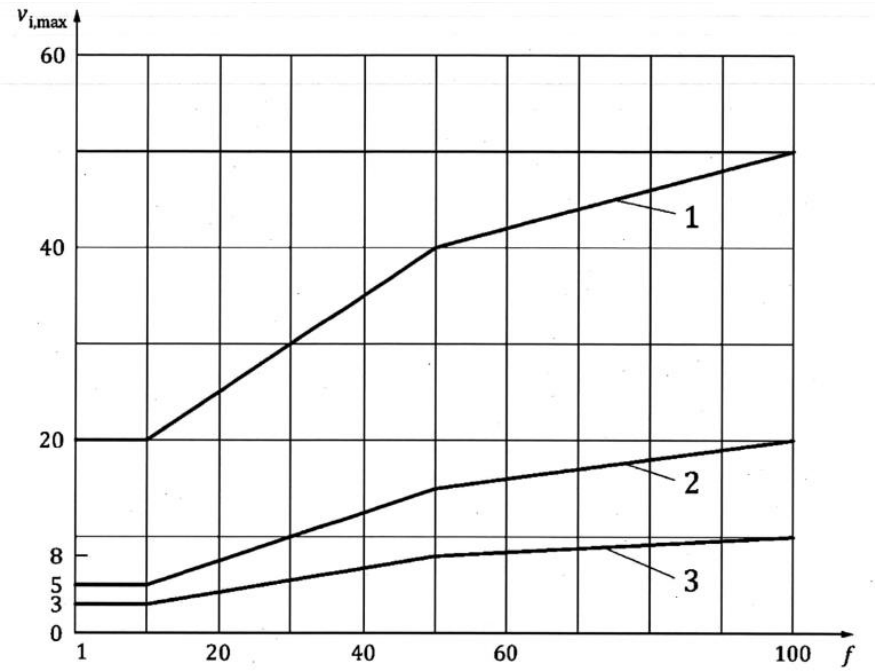
The vibration monitors were operational from 6.45am to 7pm, from 1st – 31st July 2020.

1.4 Limits for Vibration

The Peak Vibration Velocity (PVV) limits for the duration of work have been adopted from *Vibrations in buildings Part 3: Effects on structures DIN4150-3 February 2016.* Lines 1 and 2 in Table 2 below apply to the surrounding structures of the Tweed Valley Hospital project, including the Kingscliff TAFE and nearby residences. A visual representation of Table 2 is also shown below in Graph 1.

Table 2. Guideline Values for Vibration Velocity (Evaluating Effects of Short-Term Vibration on Structures).

Line	Type of Structure	Peak Vibration Velocity, mm/s				
		At foundation at a frequency of			Highest floor, horizontal direction	Floor Slabs, vertical direction
		1 to 10 Hz	10 to 50 Hz	50 to 100 Hz	All Frequencies	All Frequencies
1	**Buildings used for commercial purposes, industrial buildings and buildings of similar design**	**20**	**20 to 40**	**40 to 50**	**40**	**20**
2	**Dwellings and buildings of similar design and/or occupancy**	**5**	**5 to 15**	**15 to 20**	**15**	**20**
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10	8	20



Graph 1. Graph of the lines 1, 2 and 3 according to Table 2.

1.5 Monitoring Frequency

This reporting period, vibration monitoring was conducted during the hours of 6.45am to 7pm every day, from 1st – 31st July 2020 to determine the level of ground vibration that is experienced on the boundary of the site before travelling off-site.

1.6 Survey Instrumentation and Methodology

The vibration monitors are enclosed in a tough case which was placed on the ground and covered with a tarp to aid in keeping temperatures below 60°C, to ensure continuous monitoring. The accelerometer was placed firmly against the soil surface and covered with a sandbag to minimize external interference. The monitors were positioned within the site along the boundary adjacent to Cudgen Road.

The vibration measurements were recorded using Profound Vibra+ vibration monitors. On the 7th of July 2020 the three (3) existing monitors were replaced with new Vibration monitors due to ongoing issues with the modem and telemetry uploads.

1.7 Existing Vibration Environment

The main on-going vibration source in the area prior to site establishment was:

- Cars and Trucks passing by on nearby Cudgen Road.

The main cause for vibration throughout this monitoring period (in addition to cars and trucks from nearby Cudgen Road) is:

- Earthworks and excavation works being undertaken by Delta Group (i.e. the use of excavators, bulldozers, piling machines, trucks).

An alarm beacon was set-up with the vibration monitors in order to alert Delta and the Site Supervisor in the case of an exceedance (in real-time). If the alarm was triggered, Delta and the Site Supervisor would receive a text SMS and need to note the date, time and activity, then consider implementing controls and reviewing work practices before re-commencing works.

Delta and Lendlease have established a daily check list on site to ensure all monitors are operating in the field correctly, have adequate sunlight to power the units and that they are reporting consistently. Delta will report any issues immediately to ADE. Furthermore, ADE are performing daily checks via telemetry to ensure the monitors are operating and recording correctly. ADE are to immediately advise Delta of any issues detected during these checks. Monitors will not be removed unless consultation with Delta/Lendlease, TSA and HI has occurred and alternative locations are agreed upon.

2 RESULTS

The results of the **total velocity** in mm/s from the monitoring performed for July 2020 are summarised in Figures 1 – 6 below.

If there is a day in which the velocity is above 5 mm/s, a graph of the velocity and the frequency will be added, and results will be compared against Line 1 and Line 2 of the DIN 4150 (refer to Graph 1, above). Velocities greater than 5 mm/s were detected on the following days:

- Location 001 (Figures 1 and 2):
  - July 1st, 2nd, 3rd, 8th, 9th, 21st
- Location 002 (Figures 3 and 4):
  - July 24th
- Location 003 (Figures 5 and 6):
  - July 7th

ADE notes that values >5mm/s recorded at on the 7th, 22nd, 24th and 28th of July coincide with ADE site visits (refer to **Appendix III – ADE Site Time Summary**). ADE visits to monitor the instruments caused false readings not related to construction works and therefore have been omitted from the report.

Works were only conducted between 7am and 6pm, Monday – Friday from the 1st – 31st July 2020 and only data within this range should be considered.

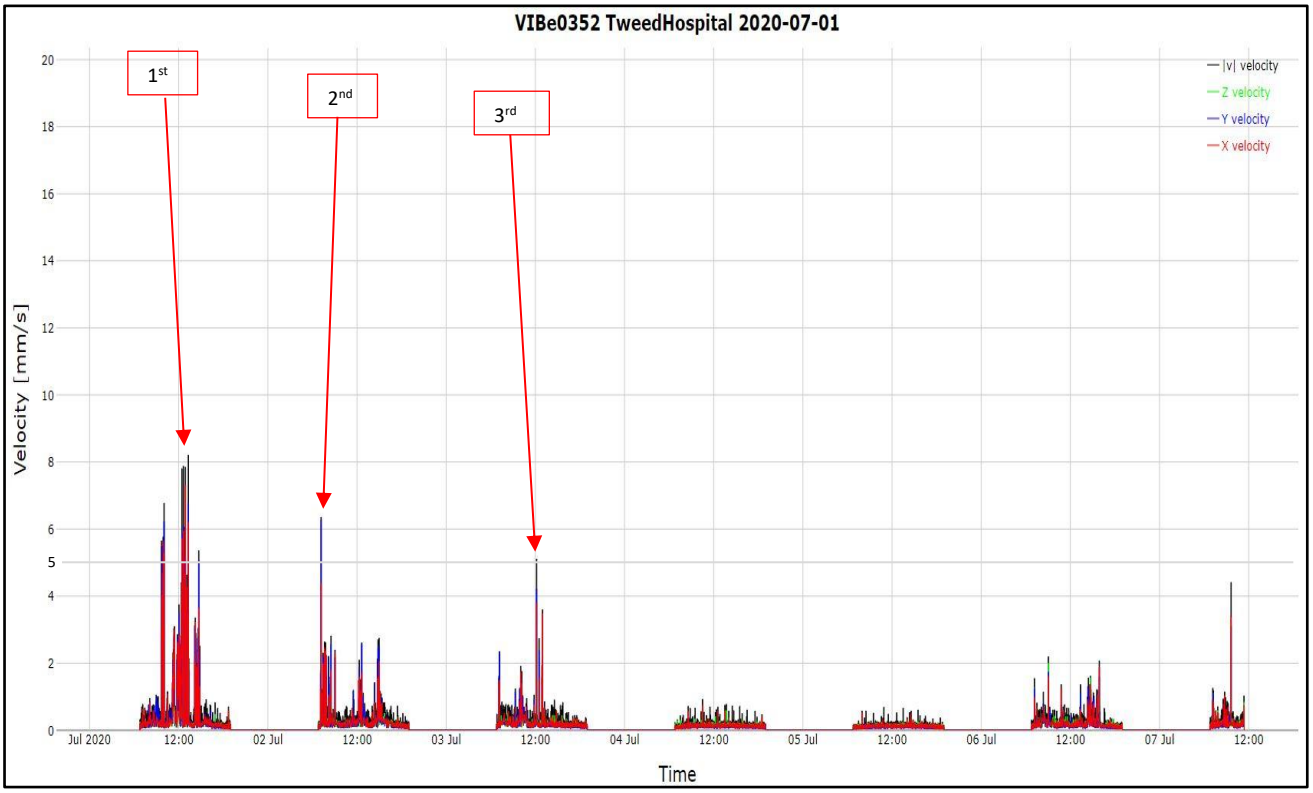


Figure 1. Results of the vibration monitoring from 1st – 7th July 2020 at monitoring location 001 – Adjacent to the carpark.

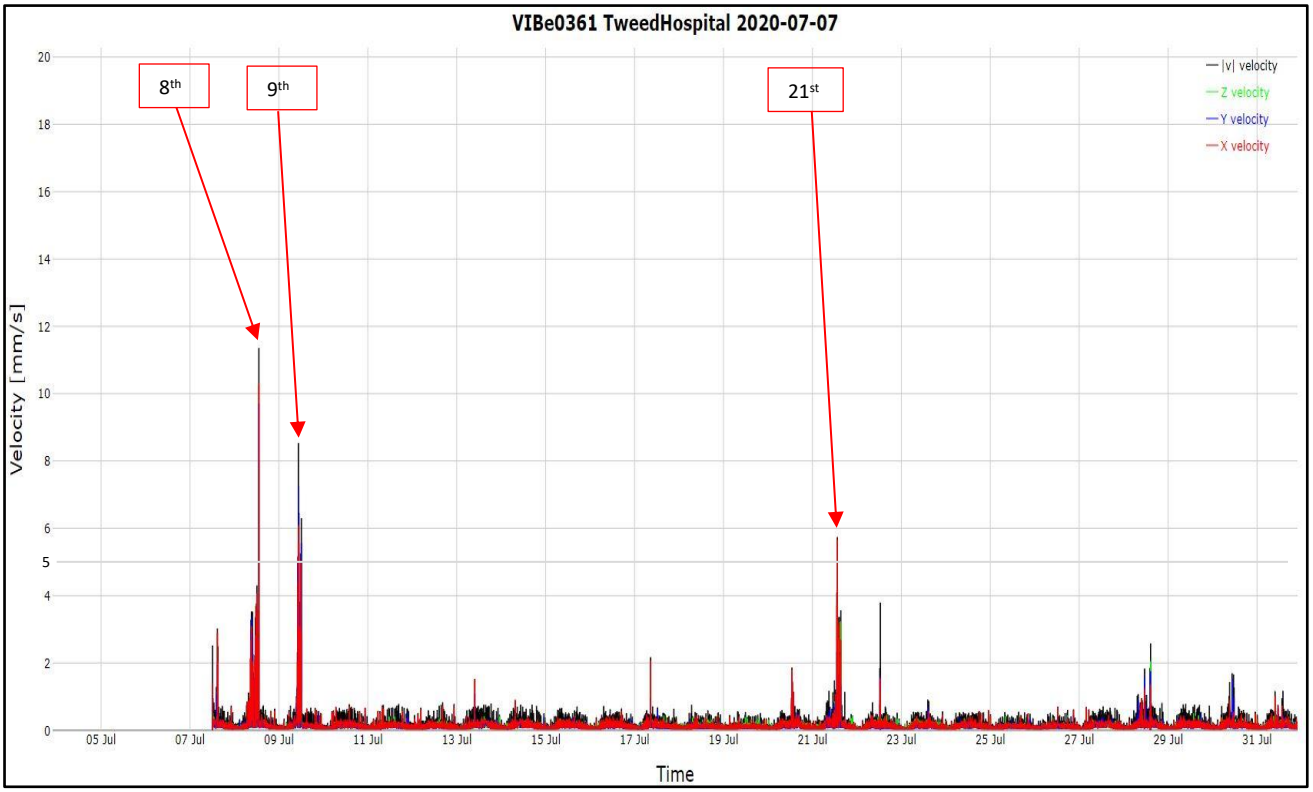


Figure 2. Results of the vibration monitoring from 7th – 31st July 2020 at monitoring location 001 – Adjacent to the carpark.

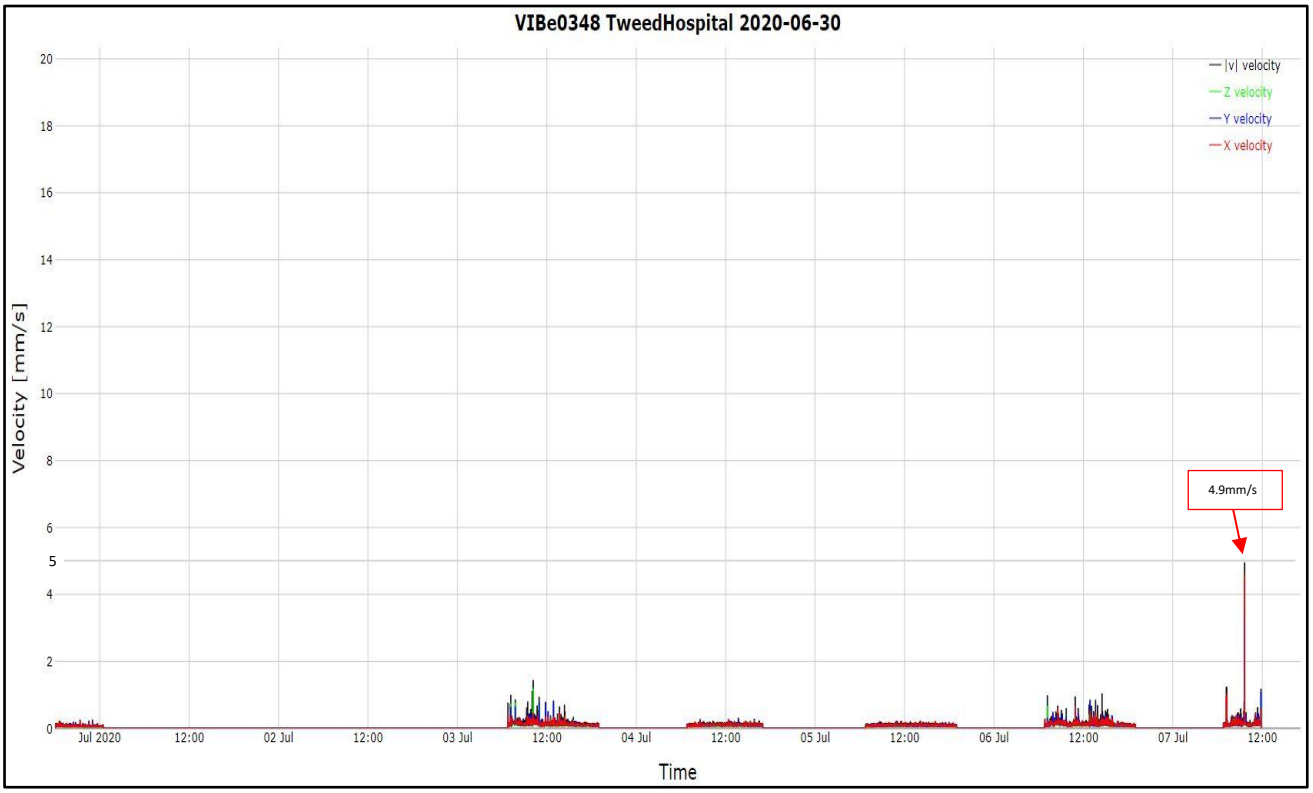


Figure 3. Results of the vibration monitoring from 1st – 7th July 2020 at monitoring location 002 – Central monitor.

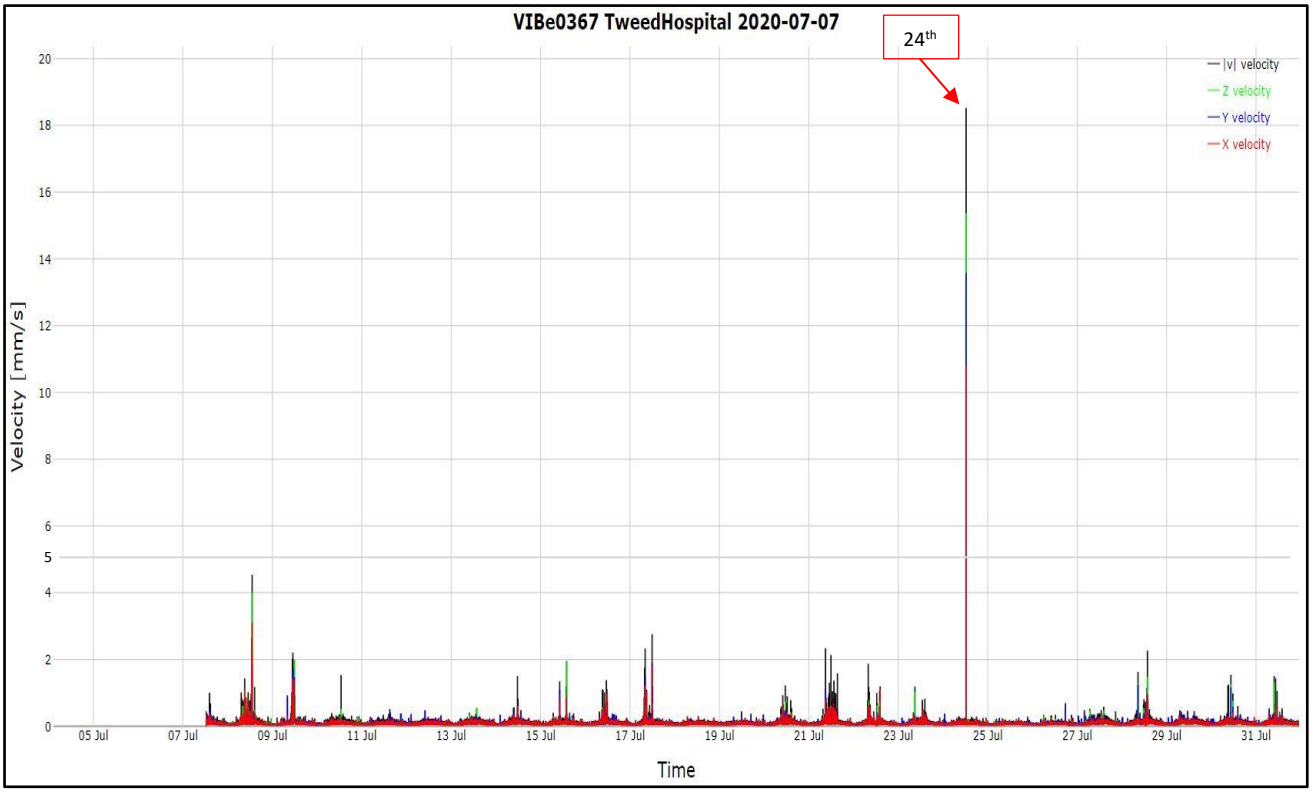


Figure 4. Results of the vibration monitoring from 7th – 31st July 2020 at monitoring location 002 – Central monitor.

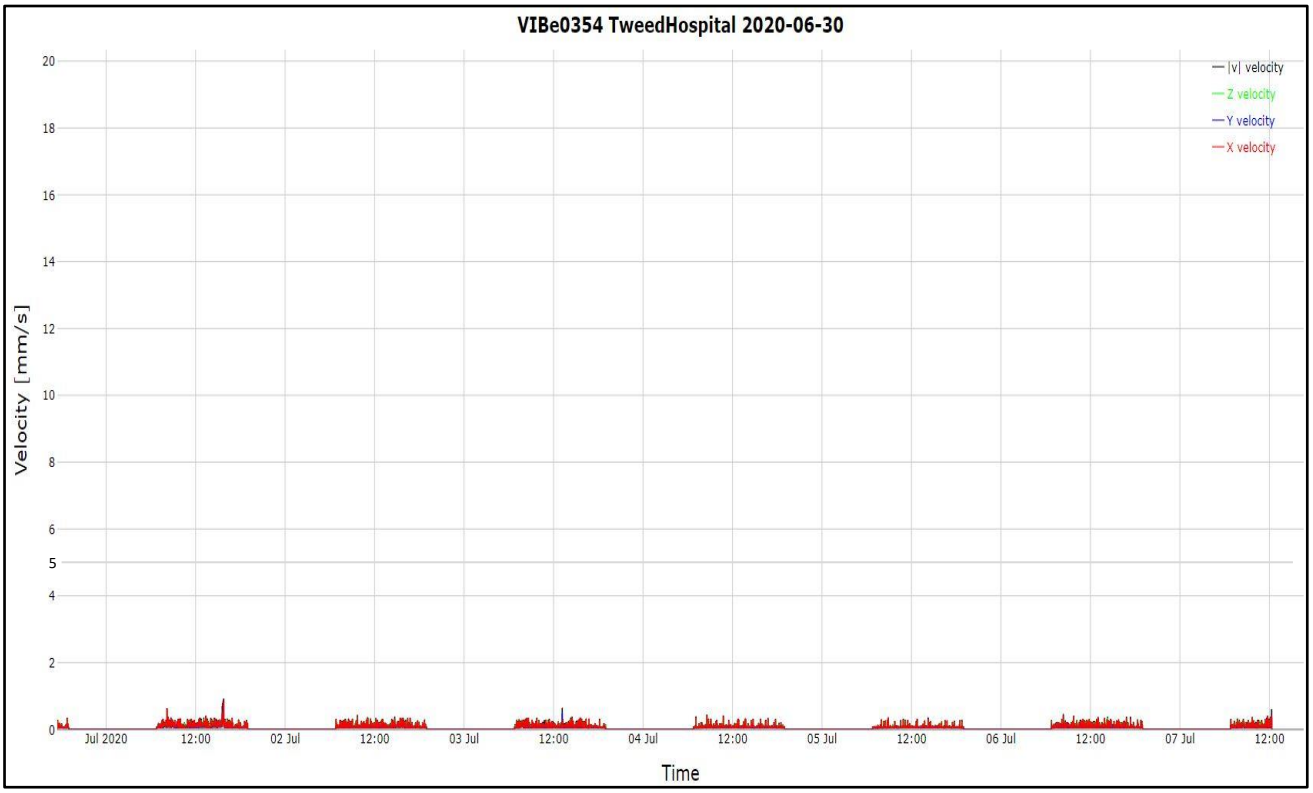


Figure 5. Results of the vibration monitoring from 1st – 7th July 2020 at monitoring location 003 – Eastern section of site.

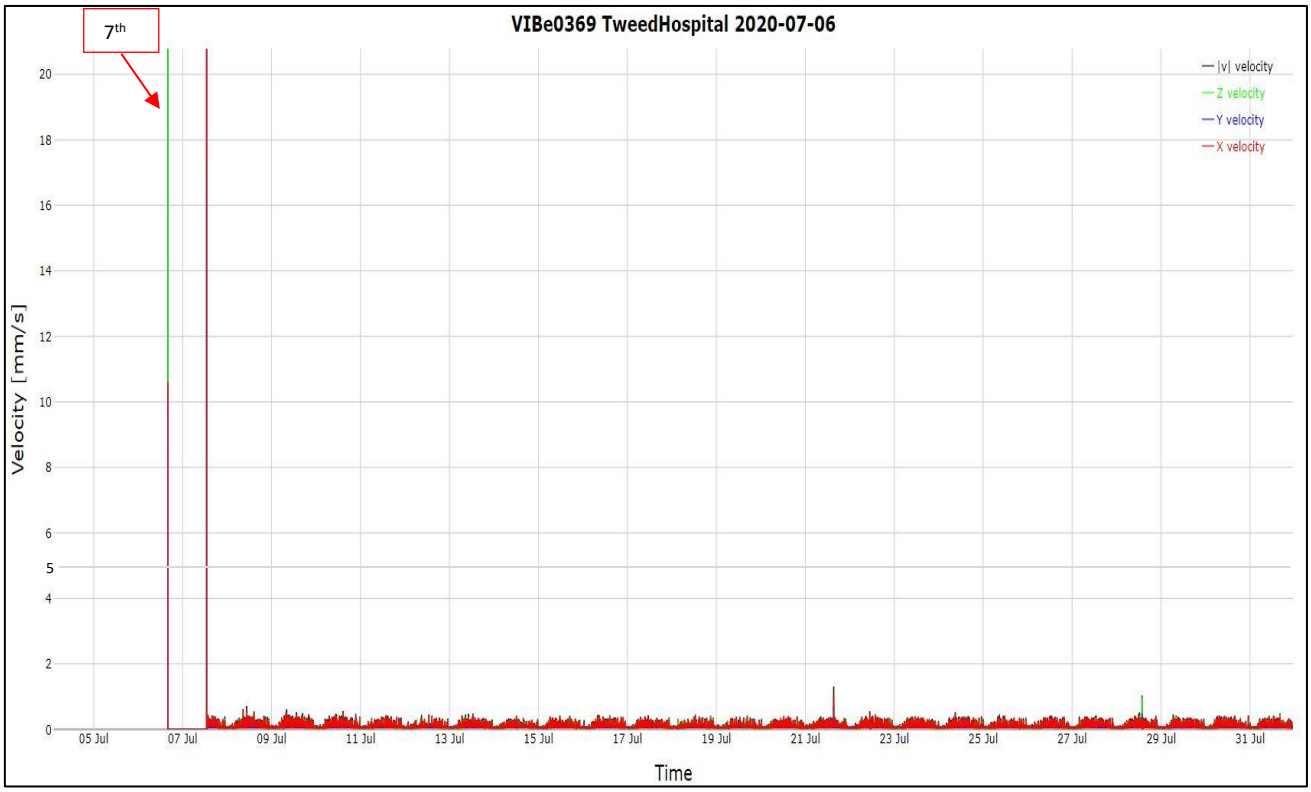


Figure 6. Results of the vibration monitoring from 7th – 31st July 2020 at monitoring location 003 – Eastern section of site.

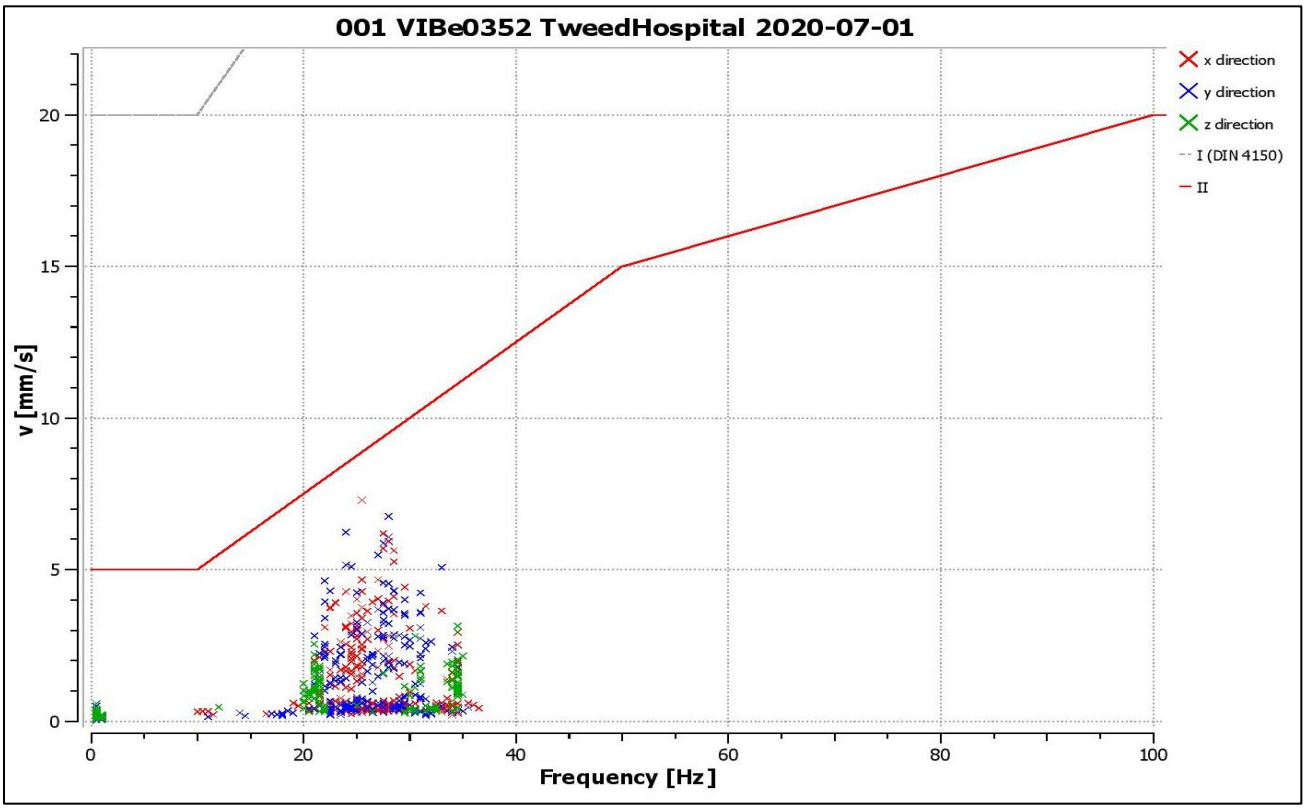


Figure 7. Results of the exceedance on Wednesday 1st July 2020 at monitoring location 001 – Adjacent to the carpark

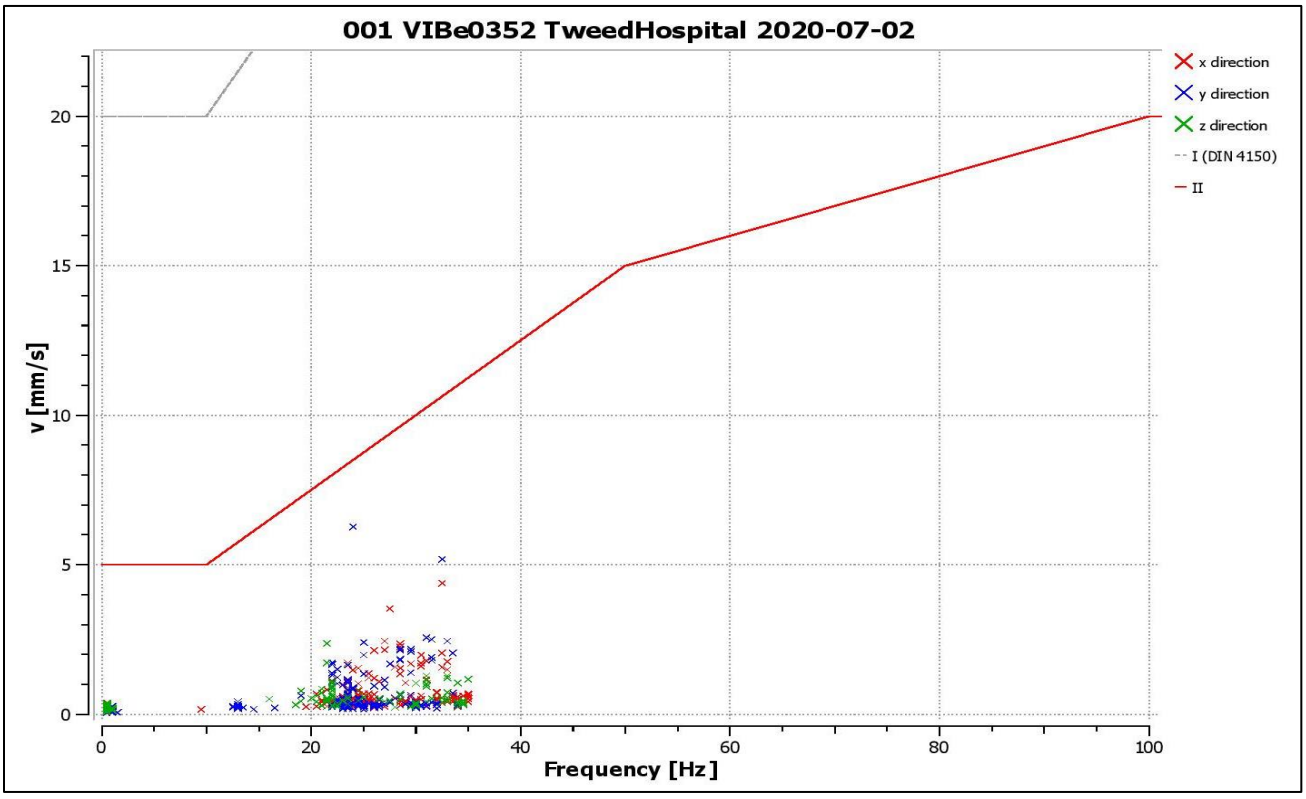


Figure 8. Results of the exceedance on Tuesday 2nd July 2020 at monitoring location 003 – Eastern Section of Site.

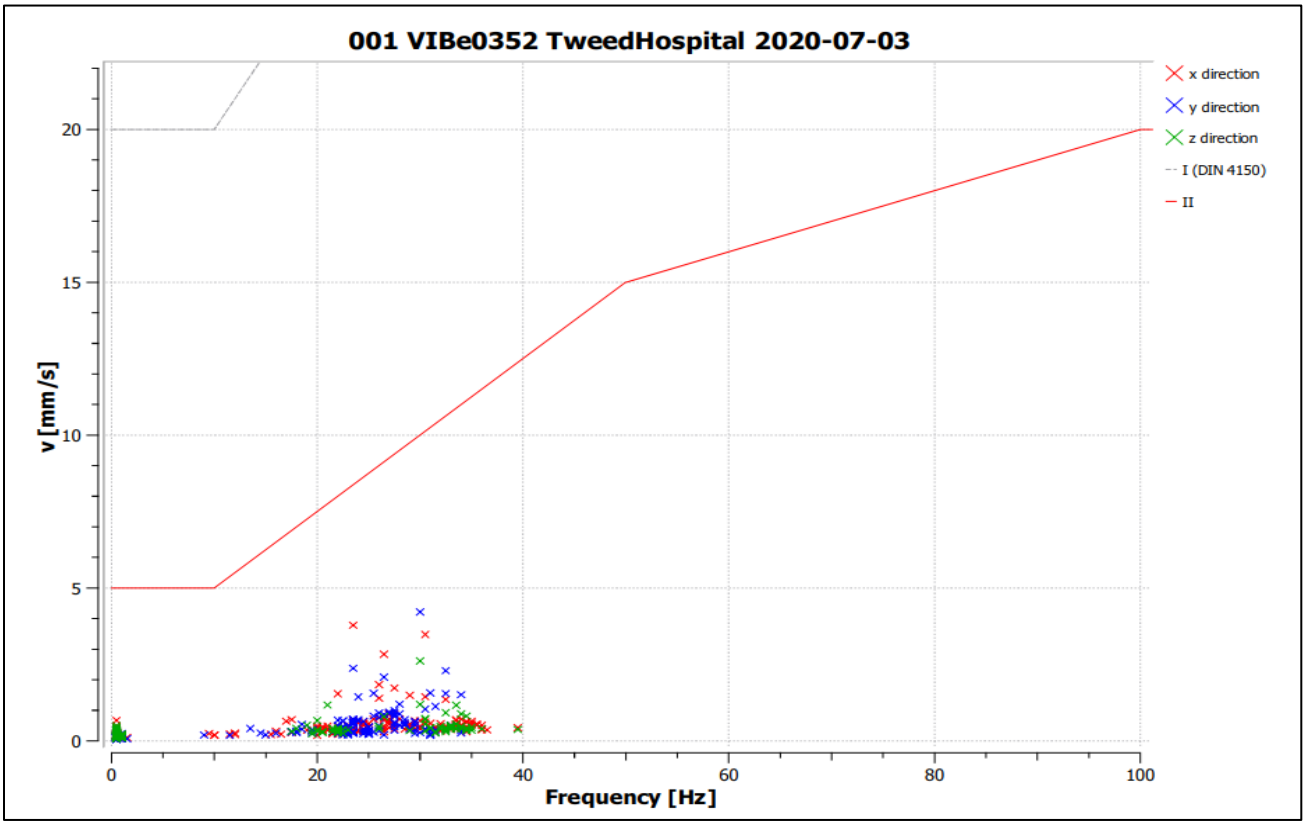


Figure 9. Results of the exceedance on Wednesday 3rd July 2020 at monitoring location 001 – Eastern Section of Site.

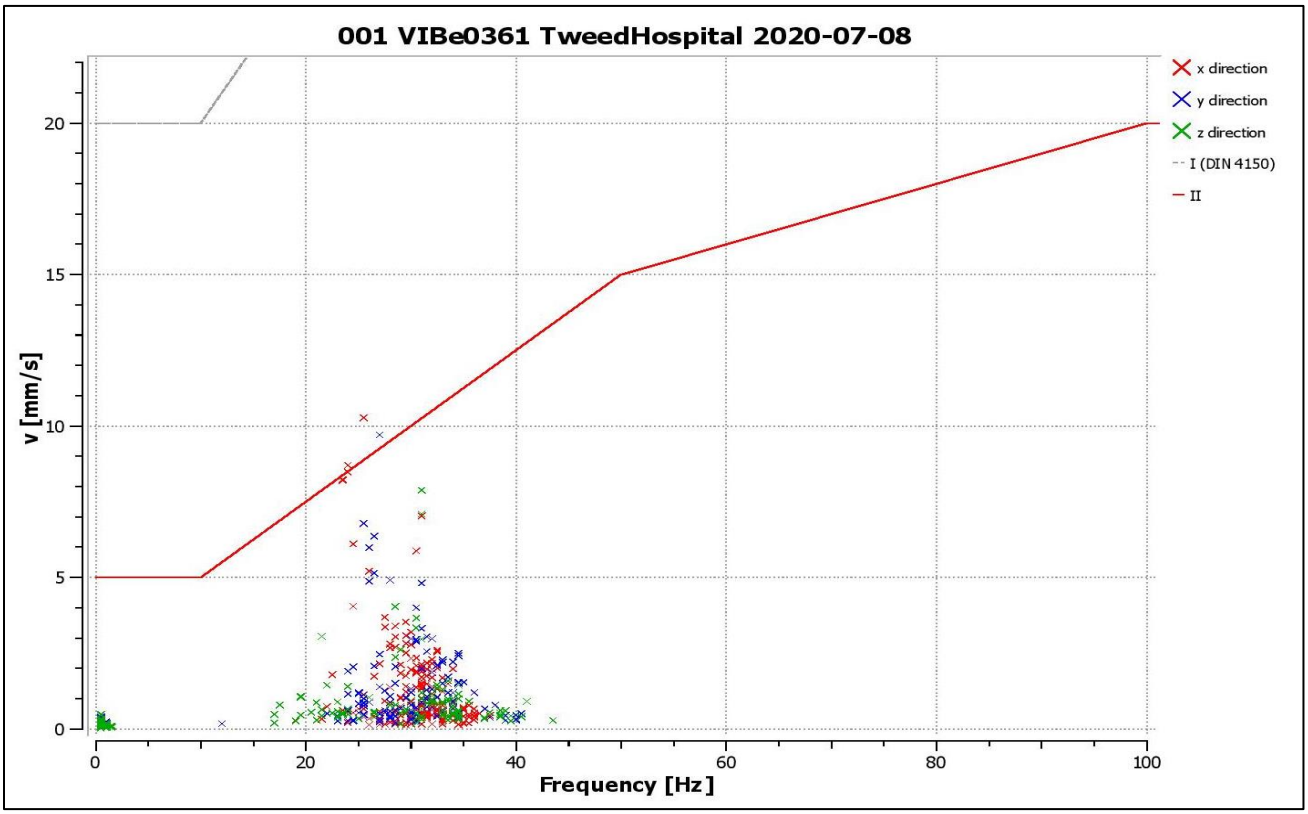


Figure 10. Results of the exceedance on Wednesday 8th July 2020 at monitoring location 001 – Adjacent to the carpark

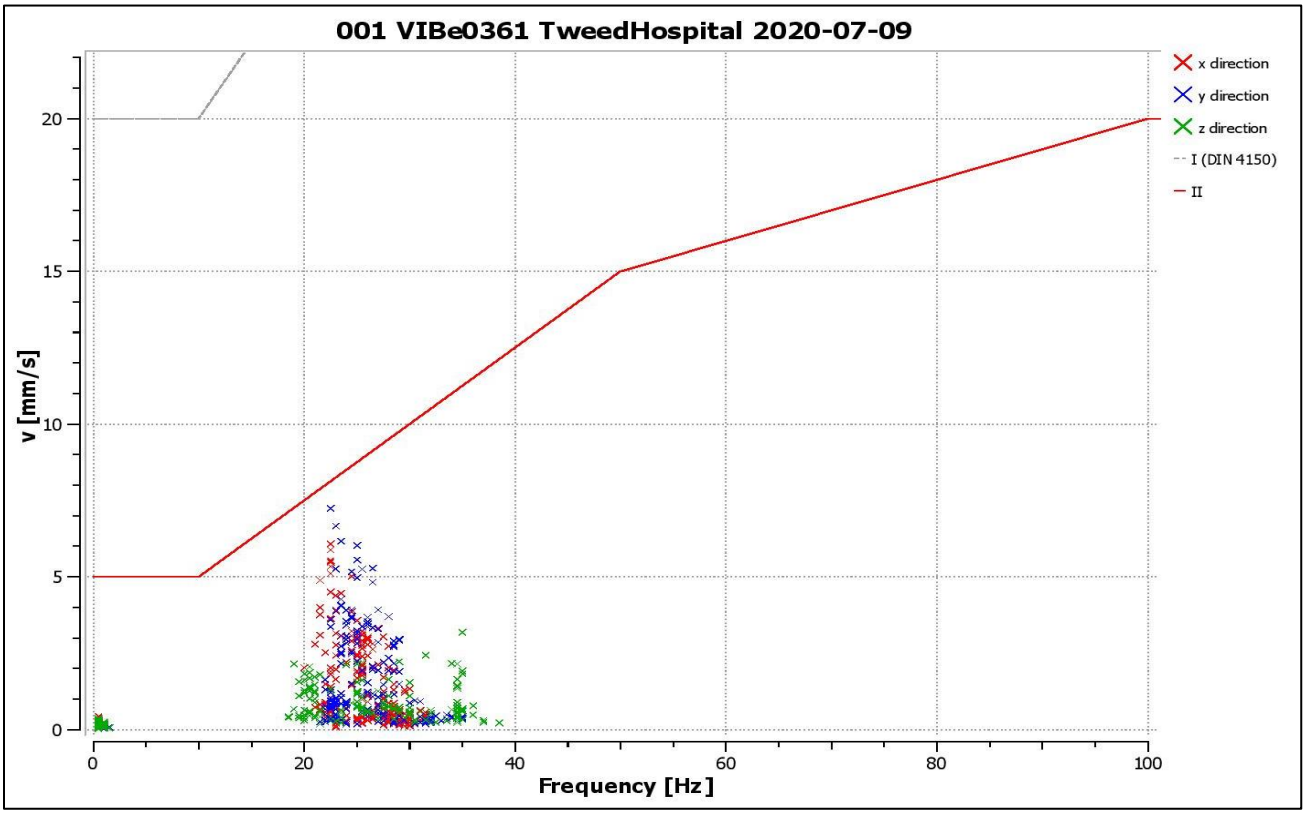


Figure 11. Results of the exceedance on Thursday 9th July 2020 at monitoring location 001 – Adjacent to the carpark

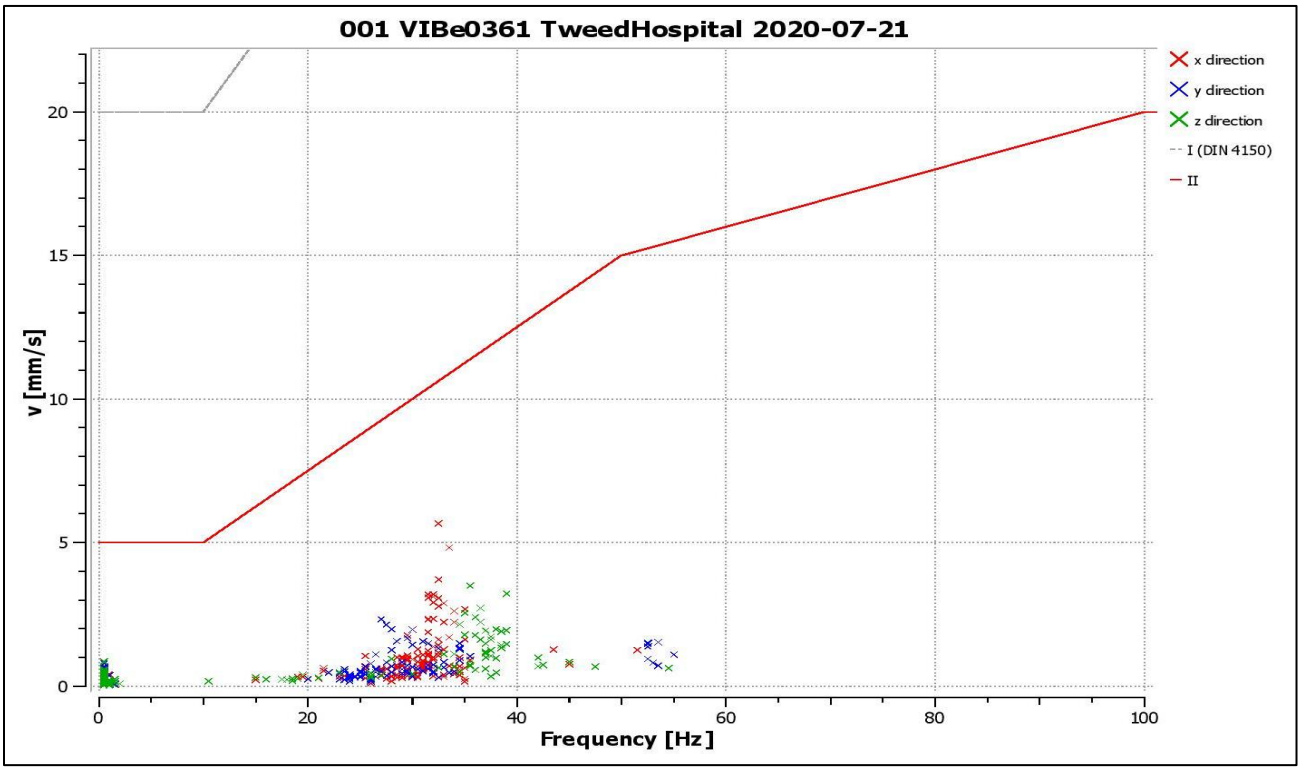


Figure 12. Results of the exceedance on Tuesday 21st July 2020 at monitoring location 001 – Adjacent to the carpark

3 DISCUSSION

One (1) exceedance of DIN 4150 Line 2 occurred during this reporting period.

The exceedance occurred at Location 001 on Wednesday 8th July 2020, between approximately 13:05 – 13:15. The vibration exhibited a maximum velocity of 10.3mm/s at a frequency of 25 Hz.

The distance from the monitor at Location 001 and the nearest sensitive receiver is 36 m, over this distance a 25 Hz vibration will reduce to 75% of the initial velocity before reaching the receiver (DIN 4150-1, 2016).

Therefore, the highest vibrational velocity observed at the receiver between 13:05 – 13:15 would be approximately 7.7mm/s, which is below Line 2 (refer to Figure 13 below).

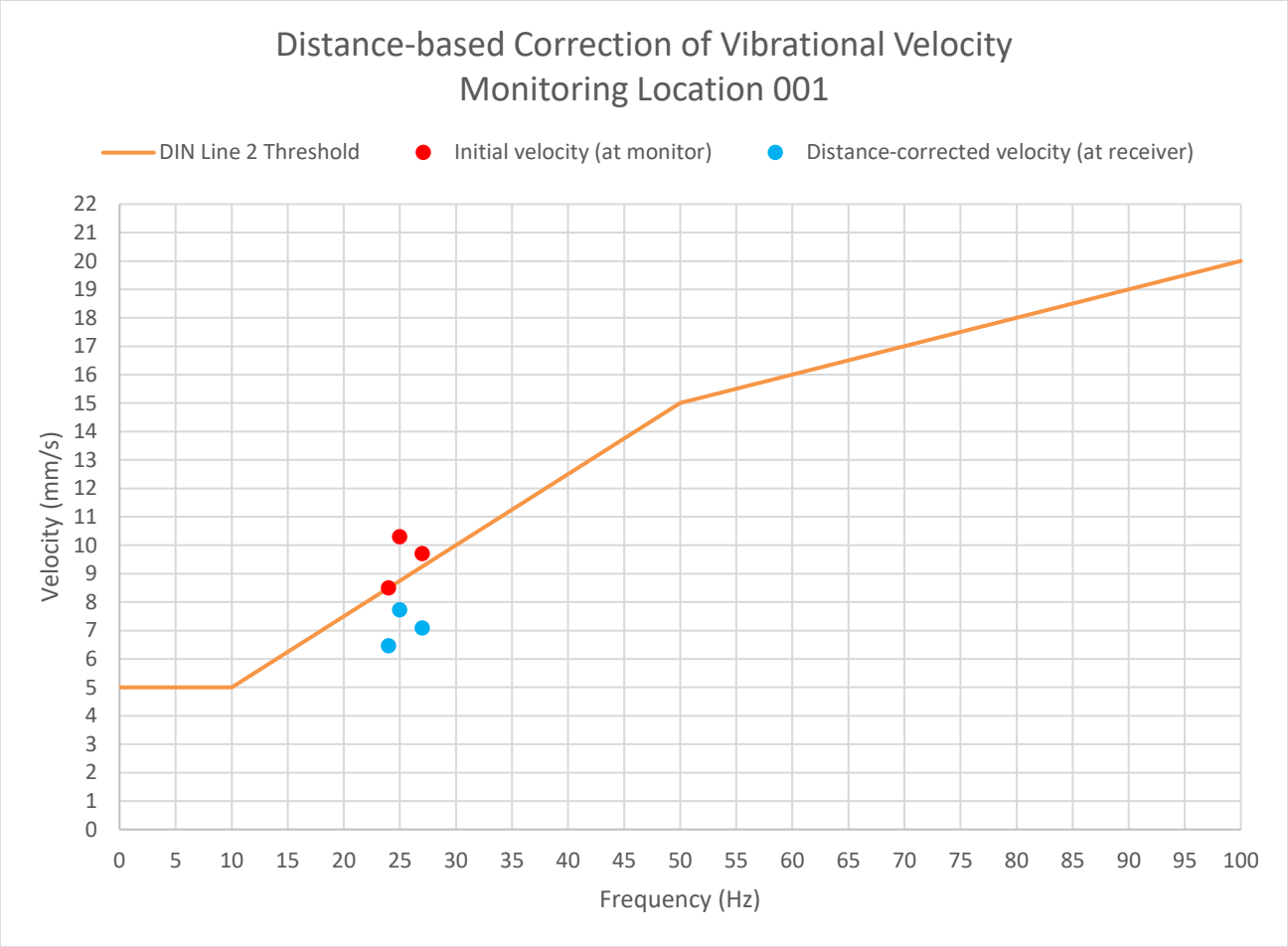


Figure 13. Velocity felt at the nearest receiver (after applying distance-based correction of the vibrational velocity), Wednesday 8th July 2020, monitoring Location 001 – Adjacent to the carpark.

All other vibration velocities over 5 mm/s were of a high enough frequency that they did not exceed Lines 1 or 2.

4 CONCLUSION

Results from vibration monitoring undertaken during the monitoring period [July 2020] were **below** the threshold used to assess the effects of short-term vibration on structures according to DIN 4150-3 and DIN4150-1. Therefore, the site works had no impact on any surrounding priorities.

5 REFERENCES

- Structural Vibration Part 1: Predicting vibration parameters DIN4150-1 June 2001.
- Vibrations in buildings Part 3: Effects on structures DIN4150-3 February 2016.
- Department of Environment and Conservation, Environmental Noise Management, Assessing Vibration: a technical guideline.
- NSW Government, Construction Noise and Vibration Guideline August 2016.

APPENDIX I

Aerial Photograph of Monitoring Locations

Sydney Office:
ADE Consulting Group Pty Ltd
Unit 6 / 7 Millennium Court
Silverwater, NSW 2128

Melbourne Office:
ADE Consulting Group Pty Ltd
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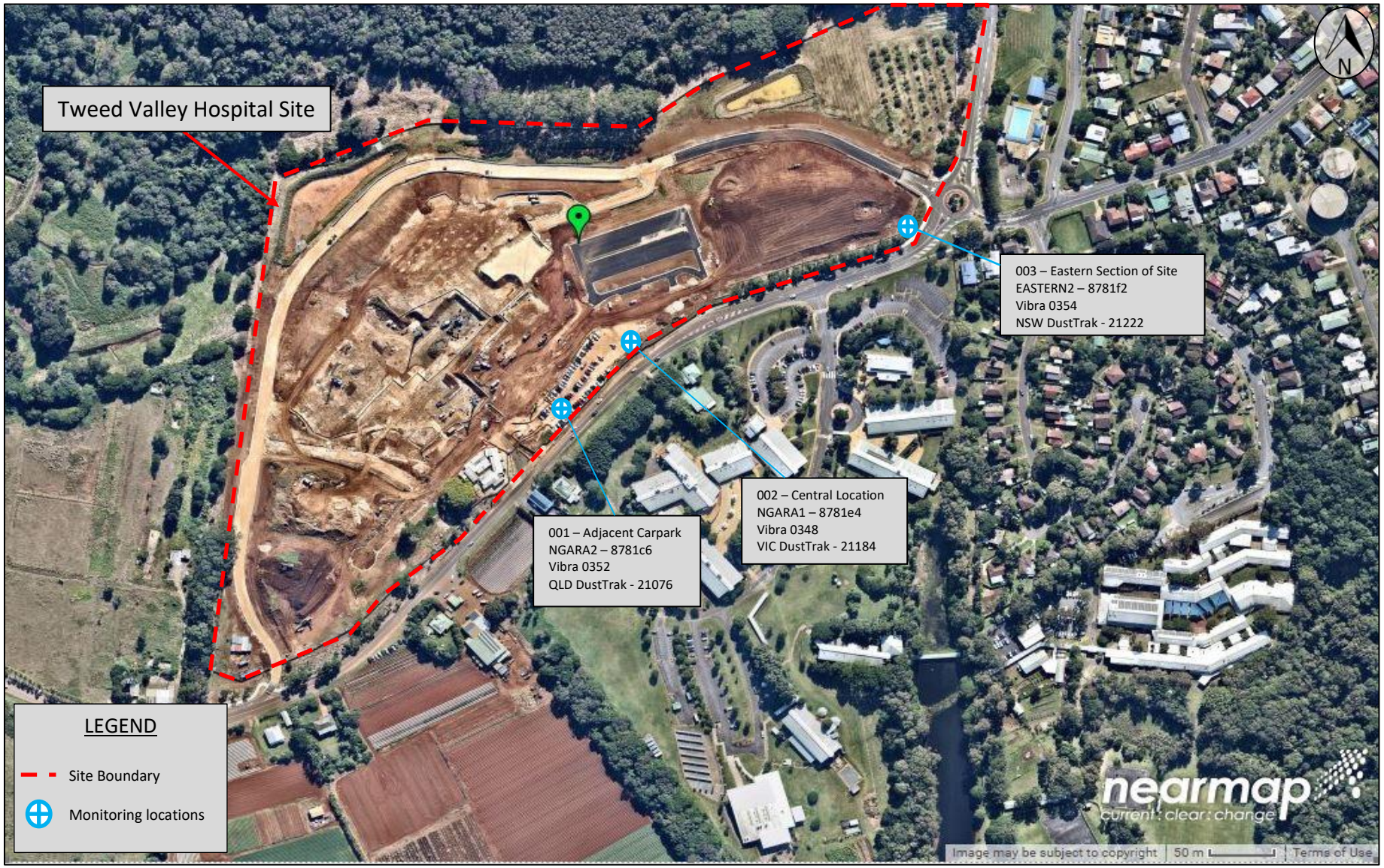
Aerial photograph of the DLT works area at Kingscliff.



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APPENDIX II

Monitoring Locations

Photograph 1. Representative photo of monitoring location 001 – Adjacent Carpark location, as observed 04.08.2020.

Photograph 2. Representative photo of monitoring location 002 – Central location, as observed 04.08.2020.

Photograph 3. Representative photo of monitoring location 003 – Eastern Section of Site, as observed 04.08.2020.

APPENDIX III

ADE Site Time Summary

Date of site visit	Time of site visit
07.07.2020	1045 to 1400
22.07.2020	0900 to 1300
24.07.2020	1215 to 1315
28.07.2020	1200 to 1430
04.08.2020	1045 to 1400

APPENDIX IV

VIBRA Technical Specifications

VIBRA-series:
VIBRA, *VIBRA*+

Profound *VIBRA*-series

Vibrations from pile driving, construction, road or rail traffic, demolition work and blasting can create nuisance or cause damage to buildings and sensitive equipment. These vibrations are accurately quantified with a system of the Profound *VIBRA*-series.

The *VIBRA*'s robust aluminium housing is IP65 watertight. The system is easily portable, lightweight and battery-operated which allows for up to 4 weeks of continuous and unmanned operation.

Depending on the chosen model *VIBRA* or *VIBRA*+, the system complies with national and international standards and is according to DIN 45669-1:2010. The specific characteristics of each model are further outlined in the *VIBRA* features overview.

Setting up the system on site is easy: attach the 3-dimensional sensor to the structure to be monitored, switch on the system and start measuring. While measuring the *VIBRA* displays date, time, time interval and the current peak vibration values including frequency in all 3 directions. In advance an alarm level can be set.

Peak values including dominant frequencies, are directly stored in memory. For full interpretation measurement signals are transferred via USB to a computer for further analysis. The *VIBRA* pc software automatically generates tables and graphs of peak values and signals for use in reports. The data can also be easily exported as a csv-file.

The *VIBRA*+ can be set up for wireless automatic data transfer including sms alerts via the integrated 3G modem. Data can also be continuously uploaded to any FTP server for real-time online monitoring. As an alternative Profound offers a turnkey online monitoring service.

Technical specifications *VIBRA*-series	
Velocity (PPV), frequency and acceleration (PPA)	In x, y, z-direction per time interval
Displacement (*VIBRA*+ only)	In x, y, z-direction per time interval
Sensor type	3-channel geophone
Geophone correction	Digital IR filter
Velocity range	0 – 100 mm/s
Resolution display	0.01 mm/s
Resolution AD-converter	0.001 mm/s (24 bits ADC)
Frequency range and accuracy	DIN 45669-1:2010-09 or SBR – part A, B 2002
Storage capacity	4 MB. Fixed or ring memory incl. buffer
Storage interval	1, 2, 5, 10, 20, 30, 60 s
Data save level	Adjustable between 0.01-100.00 mm/s (or always)
Alarm level	Adjustable between 0.01-100.00 mm/s (or none)
Data retention	10 years (minimum) at 25 °C
Clock stability	Within 5 minutes/year at 25 °C
Temperature range (operating)	- 20 °C to + 60 °C
Housing	Robust hard anodized aluminium case
Protection rating	IP65 according to DIN 40 050/IEC 529
Dimensions (l x w x h)	216 x 160 x 50 mm
Weight	2 kg
Display	≥ 4 Lines; display backlight; anti-reflex coating; anti-scratch
Batteries	3 x 1.5 V Alkaline D-size batteries
Battery life	≈ 28 days (continuous operation)
I/O functionality	Geophone, mini-USB
PC operating system	WIN10/WIN8/WIN7
Accessories	VIB.00320 Cable reel (50m) VIB.00407 Alarm beacon VIB.00420 USB adapter. External power via USB adapter: V_{mains} 100 ↔ 240 V, 47 ↔ 63 Hz