# Vibration Monitoring Assessment Report

## 771 Cudgen Road, Kingscliff NSW

## Prepared for: Delta Group

DLT-01-Q1013 / VIB2
v1. final
4th October 2019

ADE CONSULTING GROUP
SOLUTIONS THROUGH INNOVATION

**Prepared for:**

Delta Group

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## 771 Cudgen Road, Kingscliff NSW

| Version | Details | Date |
|---|---|---|
| v1. final | Written by [redacted] | 4th October 2019 |

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**Date:** 4th October 2019

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**VIBRATION MONITORING ASSESSMENT REPORT**
**ADE Report No. DLT-01-Q1013 / VIB2 / v1. Final**

TABLE OF CONTENTS




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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 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 dominate 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'. The Site was previously agricultural land and has been cleared of vegetation for soft mobilisation and preparation of the site.

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 4150-3:1999 guidelines.<br>• Avoid or minimise vibration impacts from activities which could affect the nearby buildings (Kingscliff Tafe and residential properties).<br>• To minimise the generation of vibration which could affect the neighbours of the site, workers on the site and associated building and other members of the public.<br>• 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.<br><br>A pre-work vibration assessment was carried out and compared to the DIN 4150-3:1999 Vibration Standards for Buildings, this information will determine possible impacts of other sensitive premises identified in the area.<br><br>The PPV values for each time period (Day/Evening/Night) are listed below. 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).*<br><br>The POEO Act is a key piece of environmental protection legislation and regulates activities via:<br><br>• Environmental protection licensing, as per schedule 1;<br>• Regulation of scheduled and non-scheduled activities;<br>• Environmental protection offences and penalties; and<br>• Establishment of a general duty of care to notify environment harm. |

**Table 1** – Continued…

| | |
|---|---|
| | *Vibrations in buildings Part 3: Effects on structures DIN4150-3 February 1999.*<br><br>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 as regards dynamic loading.<br><br>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 / VIB1 / v1. final) for details from earlier monitoring periods.

## 1.3 Monitoring locations

The three (3) vibration monitors are located within the confines of the site adjacent to Cudgen Road *(refer to Figure 1 – Aerial Photograph)*.

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

The vibration monitors are operational from 6.45am to 7pm daily, commencing Sunday 1st of September 2019.

## 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 1999.* 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. Given that the monitoring being undertaken is ground monitoring on-site and not structural monitoring at a receiver, ADE is confident that an exposure level of 20mm/s is suitable as the maximum short-term velocity at all frequencies for the duration of the project.

**Table 2** – Guideline values for vibration velocity to evaluate the effects of short-term vibration on structures.

| Line | Type of Structure | Peak Vibration Velocity, mm/s | | | |
|---|---|---|---|---|---|
| | | At foundation at a frequency of | | | Highest floor |
| | | 1 to 10 Hz | 10 to 50 Hz | 50 to 100 Hz | All Frequencies |
| **1** | **Buildings used for commercial purposes, industrial buildings and buildings of similar design** | **20** | **20 to 40** | **40 to 50** | **40** |
| 2 | Dwellings and buildings of similar design and/or occupancy | 5 | 5 to 15 | 15 to 20 | 15 |
| 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 |

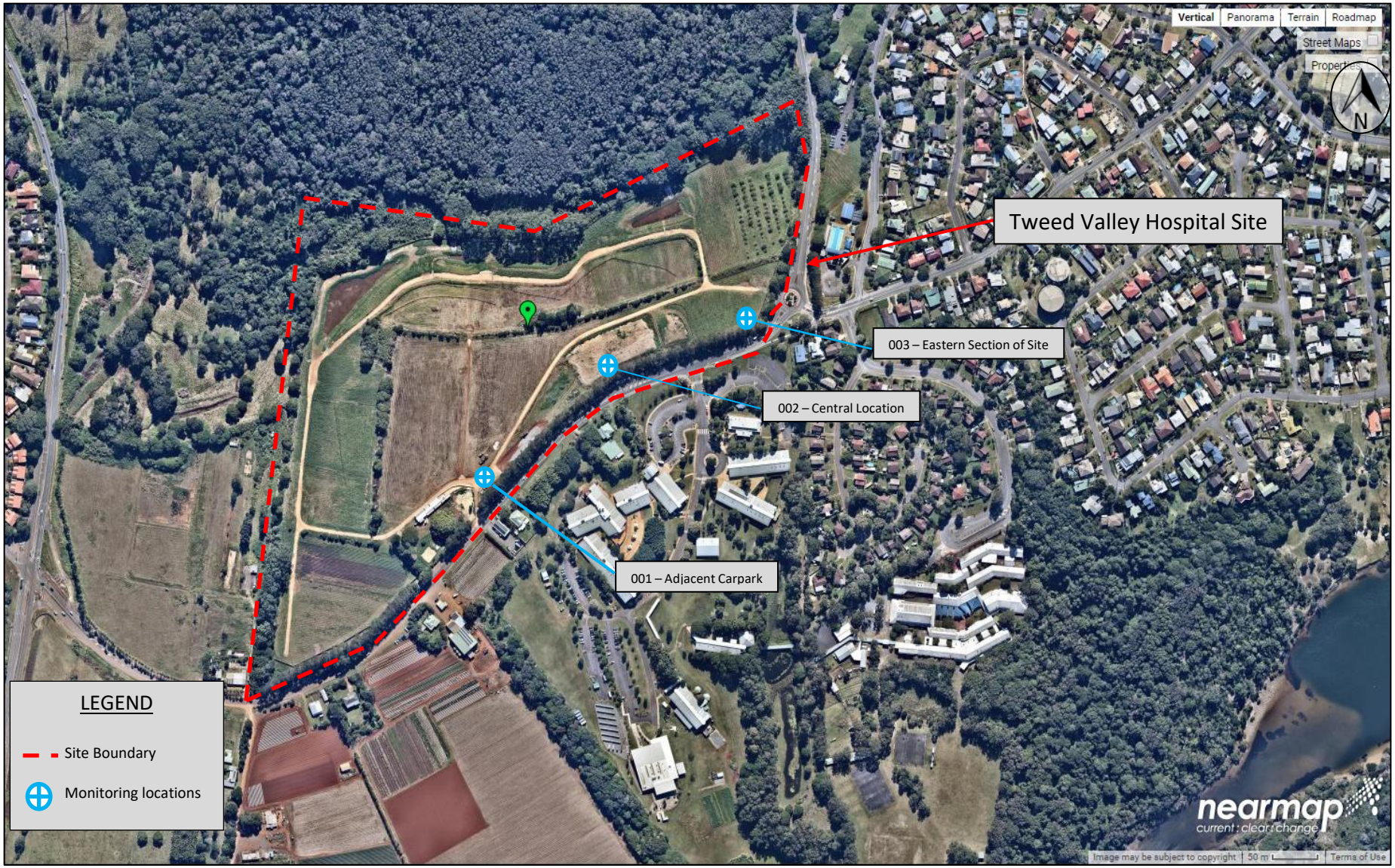


**Figure 1.** Aerial photograph of the DLT works area at Kingscliff NSW.

## 1.5 Monitoring Frequency

Vibration monitoring was carried out for a period from Sunday 1st September 2019 to Monday 30th September 2019 to determine the level of ground vibration that is experienced on the boundary of the site before travelling off-site as per the German Vibration Standard DIN4150. Vibration monitoring was completed during the hours 6.45am – 7pm every day commencing Sunday 1st September 2019 to Monday 30th September 2019.

## 1.6 Survey Instrumentation and Methodology

The vibration monitors were enclosed in a tough case with the noise monitors which remained at ground level with the accelerometer placed firmly against the soil surface with sandbags over top to minimize external interference. The monitors were positioned within the site along the boundary adjacent Cudgen Road.

The vibration measurements were recorded using Profound Vibra+ vibration monitors.

## 1.7 Existing Vibration Environment

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

- Car 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 excavations 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 DLT and the Site Supervisor in the case of an exceedance in real-time. If the alarm was triggered, DLT and the Site Supervisor would receive a text SMS and need to note the date and time, document the activity and consider implementing controls and work practices reviewed before re-commencing works.

# 2 Results

The results of the vibration monitoring for the dates 1st September 2019 to 30th September 2019 are summarised in Figure 2, 3 and 4, below.

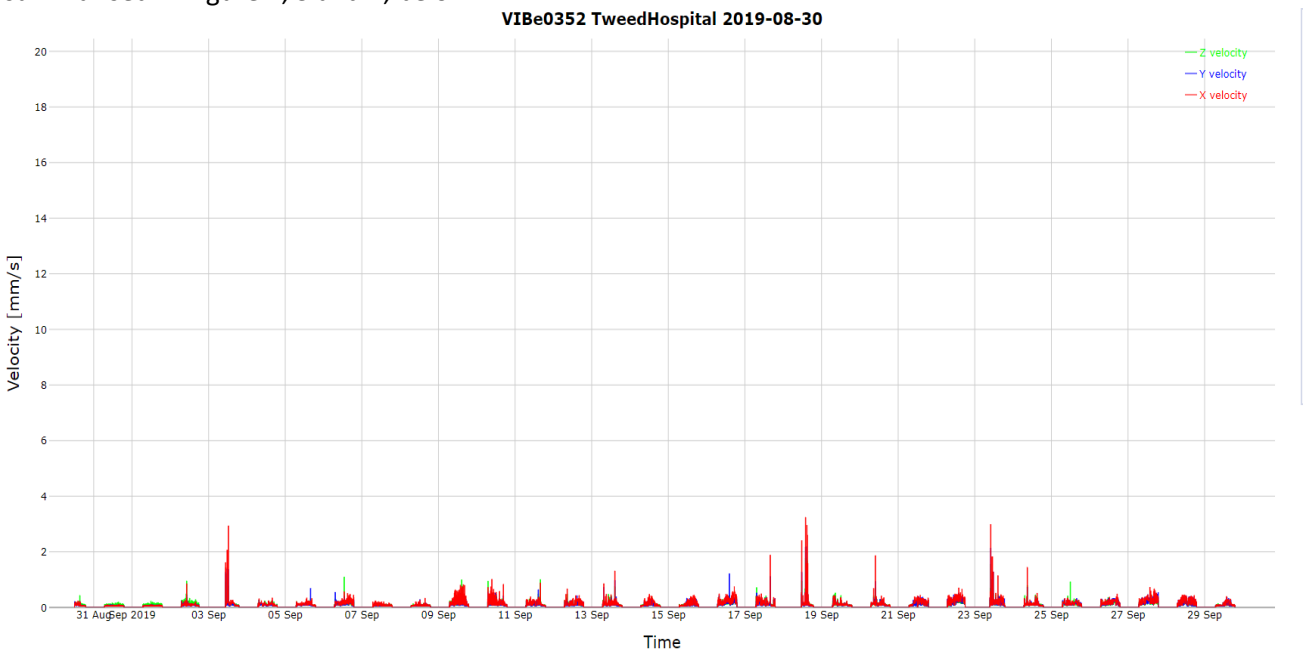


**Figure 2** – Results of the vibration monitoring from 1st September 2019 to 30th September 2019 at monitoring location 001 – Adjacent carpark.

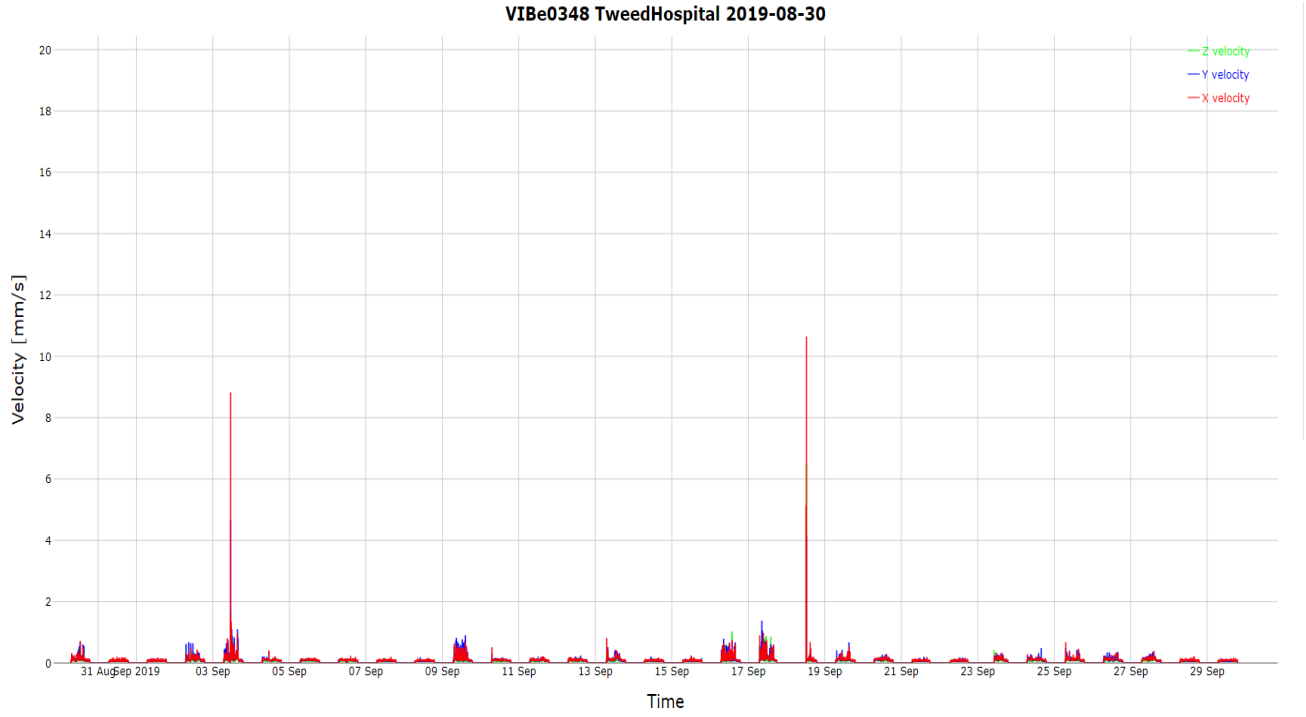


**Figure 3** – Results of the vibration monitoring from 1st September 2019 to 30th September 2019 at monitoring location 002 – Central monitor.

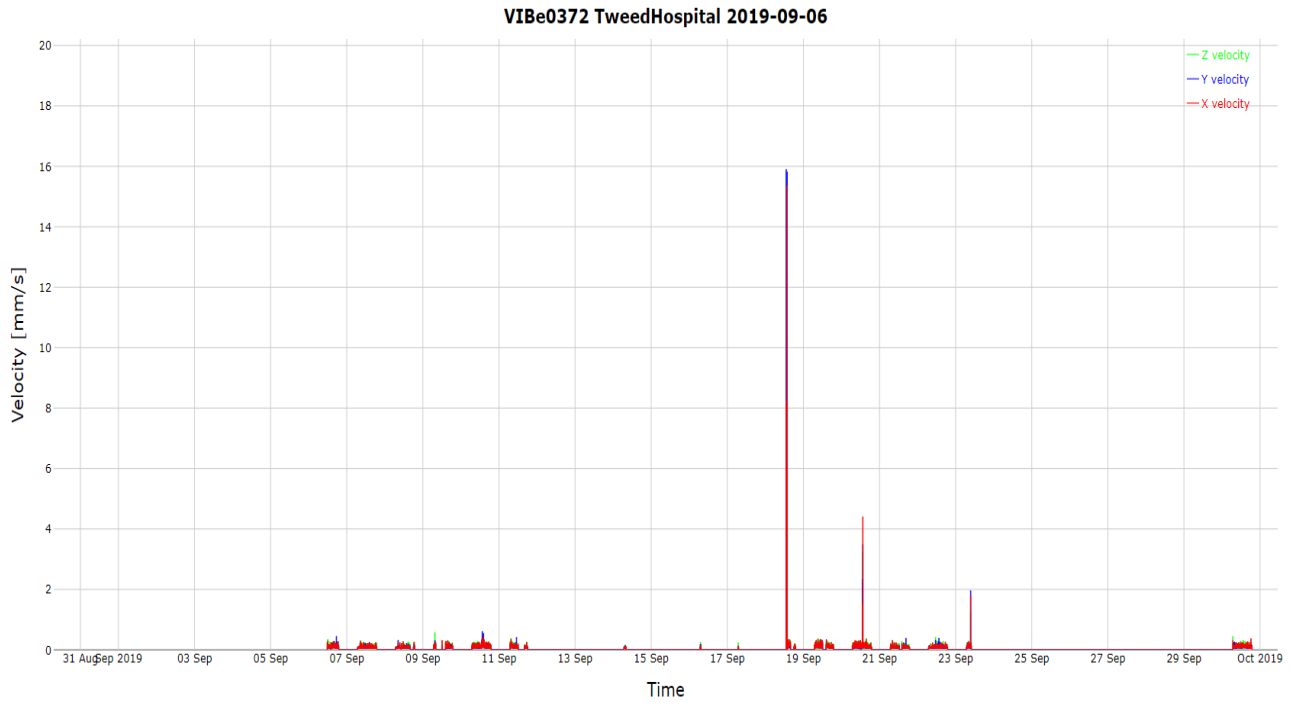


**Figure 4** – Results of the vibration monitoring from 1st September 2019 to 30th September 2019 at monitoring location 003 – Eastern section of site.

*Note all results >5mm/s in figures 2, 3 and 4 can be correlated with ADE site visits. These values directly correlate with ADE attending site to perform maintenance on the monitors and these exceedances should be disregarded (refer to *Appendix B – ADE Site Time Summary)*.

# 3 Discussion

**Table 2** outlines acceptable Peak Vibration Velocity (PVV) across different frequencies based on the type of structure. The 'Kings cliff Tafe' has been determined to be a Line 1 building, the Residential properties to the east of the site have been determined as line 2 buildings and A PVV value of 20 mm/s was adopted based on this assessment (Refer to previous report *DLT-01-Q1013 / VIB1 / v1. final*).

ADE site visits on the 3rd, 18th and 23rd of October 2019 had results >5mm/s as can be seen in figures 2, 3 and 4 of this report. The activities undertaken by ADE included manoeuvring within close proximity to the vibration sensors in the enclosure and can be correlated with the peaks on these particular days (refer to *Appendix B – ADE Site Time Summary)*.

# 4 Conclusion

- Results from vibration monitoring undertaken during the monitoring periods were **below** the threshold PVV value determined by DIN 4150 for the duration of this monitoring period;

- The peak vibration results were below the adopted threshold of 20mm/s. The distance between the boundary of the property (monitoring locations) and the receivers identified in the Lendlease Noise and Vibration Management Plan is approximately 50 metres; and

- The effects of vibration at the levels seen through September would have little to no effect on the neighbouring properties.

# 5 References


- Vibrations in buildings Part 3: Effects on structures DIN4150-3 February 1999.
- Department of Environment and Conservation, Environmental Noise Management, Assessing Vibration: a technical guideline.

# Appendix A – Photographs


**Photograph 1** – Representative photo of the monitoring location 001 – adjacent carpark, as observed on the 02.09.2018.

**Photograph 2** – Representative photo of the monitoring location 002 – central location, as observed on the 02.09.2018.

**Photograph 3** – Representative photo of the monitoring location 003 – eastern section of site, as observed on the 02.09.2018.

# Appendix B – ADE Site Time Summary

| Date of site visit |
| --- |
| Tuesday 03.09.2019 |
| Friday 18.09.2019 |
| Monday 23.09.2019 |