StylesGroup
Acoustics & Vibration Consultants

ASSESSMENT OF AIRBORNE NOISE EFFECTS

SAND EXTRACTION
MANGAWHAI - PAKIRI EMBAYMENT

PREPARED FOR

McCallum Brothers Ltd

DATE

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Assessment of noise effects prepared by Styles Group for McCallum Brothers Ltd.

REVISION HISTORY

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1	10/03/20		Final Draft	Jon Styles, MASNZ Director and Principal Styles Group
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Appendices

Executive summary

Styles Group has assessed the airborne noise effects of proposed sand extraction in the Mangawhai - Pakiri embayment. This report has been prepared to accompany the resource consent application and Assessment of Environmental Effects for the proposal.

To accurately predict the dredging noise levels that will be received at the coastal interface and the adjacent zones, Styles Group have prepared a computer noise model of the dredging operations, calibrated using noise measurements of the newly commissioned trailing suction dredge vessel- the *William Fraser*. The noise level predictions show that in the most favourable conditions for the propagation of noise towards the beach, the dredging noise levels will be less than approximately 35dB L_{Aeq}.

To understand the predicted dredging noise levels in the context of the Pakiri/ Te Arai beach environment, Styles Group also undertook a series of ambient noise measurements at the coastal interface. These measurements show that the noise levels of the beach environment are generally elevated due primarily to wave action, and in most conditions, the ambient noise level in the coastal environment will be well over 50dB L_{Aeq}. When very calm, the ambient noise level can drop to close to 30dB $L_{Aeq(1sec)}$. As the ambient noise levels will rarely be lower than the predicted dredging noise levels, the dredging noise will be unnoticeable in most conditions.

The noise from the proposed dredging will comply with the relevant Auckland Unitary Plan noise limits by a significant margin, including at night when the noise limits applying at any notional boundary in the Rural - Coastal Zone is 40dB L_{Aeq}. The noise level at any existing or future notional boundary is likely to be less than 20-25dB L_{Aeq}.

With reference to the ambient noise measurements, and the timing, occurrence and duration of the low dredging noise levels that will be experienced on land, the noise emissions from the proposal can be considered to be reasonable in terms of section 16 of the Resource Management Act. We do not consider that any specific noise mitigation measures are required.

1.0 Introduction

McCallum Brothers Ltd (MBL) have engaged Styles Group to predict and assess the noise effects arising from sand extraction activities within the Mangawhai - Pakiri embayment. This report sets out an assessment of the proposal from an acoustics perspective, including:

i. Noise level predictions at the adjacent zones prepared using Brüel & Kjær Predictor computer noise modelling software;

ii. An assessment of the noise in accordance with the Auckland Unitary Plan (AUP), section 16 of the Resource Management Act (the Act) and the relevant New Zealand acoustics standards.

This report sets out the potential airborne noise effects arising from the activity. Our underwater noise report assesses the underwater noise effects.

This report should be read in conjunction with the application site plans and the Assessment of Environmental Effects (AEE). A glossary of acoustical terms used within this document is attached as Appendix A.

2.0 The proposed sand extraction

MBL seek resource consent to authorise sand extraction from a new extraction area (the proposed Extraction Area) located in the Mangawhai - Pakiri embayment. The proposal and extraction volumes are described in detail in the AEE.

Figure 1 displays the boundaries of the proposed Extraction Area in relation to the existing inshore consent area held by MBL. The northern and southern boundaries are defined by the same boundaries as the inshore consent area, which extends a distance of 10.4km between the Poutawa Stream (Pakiri), and the Auckland- Northland territorial boundary in Mangawhai. The landward and seaward boundaries of the proposed Extraction Area are defined by the 15m and 25m water depth contours[1] and cover an area of 6.6km^2.

MBL propose to undertake sand extraction using trailing-suction hopper dredging (TSHD) vessels, including the use of the newly commissioned TSHD vessel, the *William Fraser*. TSHD involves the suction of sand slurry from the seabed using a trailing suction head. As the suction head trails over the seabed of the extraction area, the sand slurry is pumped onto the vessel and passed through sand screens once onboard. Following screening, the sand is deposited in the onboard hopper where sand settles, and water passes back into the CMA. The vessel then transports the dewatered sand to the MBL depot at the Ports of Auckland.

[1] To avoid confusion, the proposed consent area is to be demarcated by the coordinate references described in the application, rather than water depths.

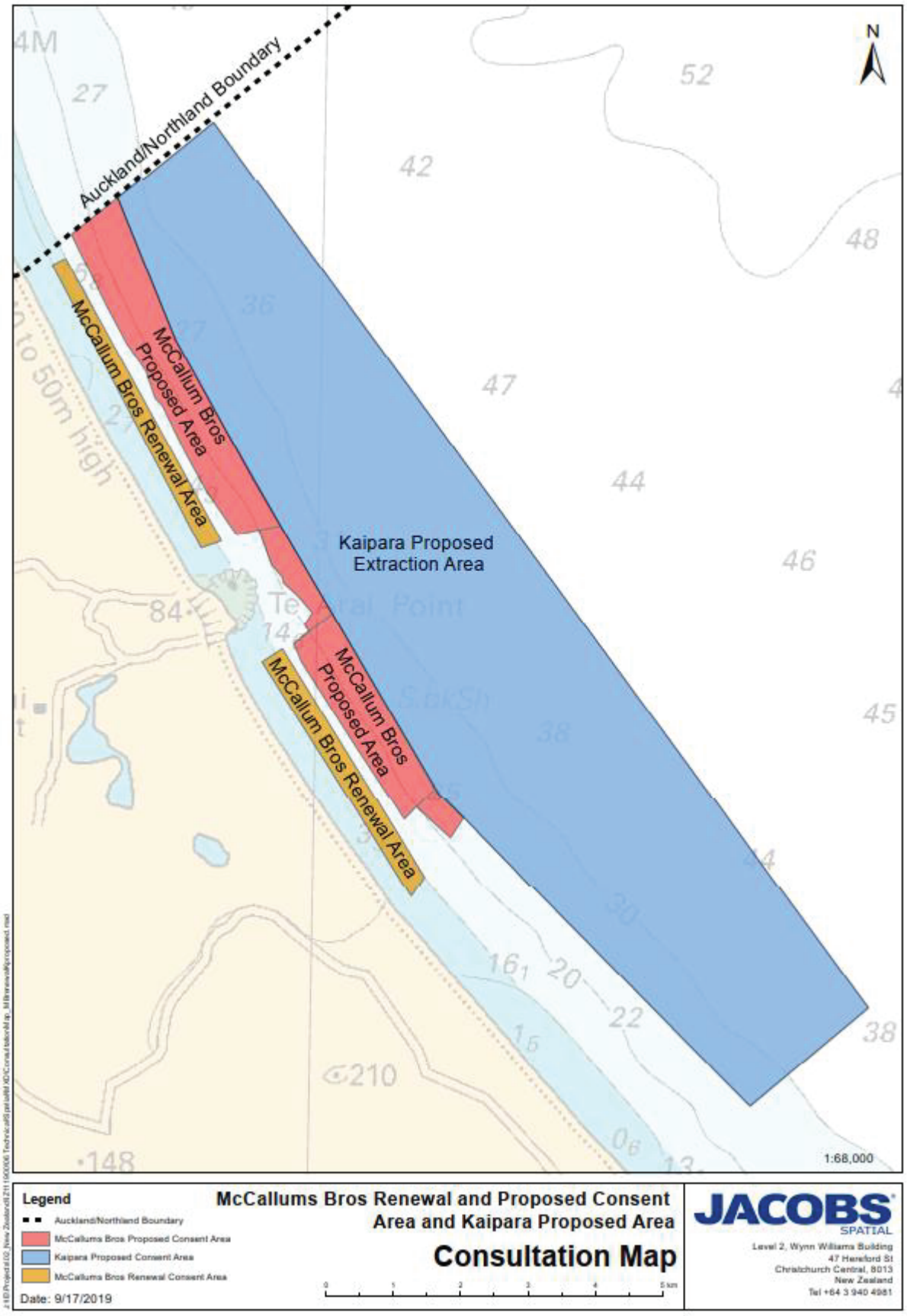

Figure 1: MBL Proposed Extraction Area (shown in red) Source: Jacobs

2.1 Zoning of Extraction Area and adjacent land

Figure 2 displays the zoning of the proposed Extraction Area and the adjacent land under the AUP. The proposed Extraction Area (within the coastal marine area) is located within the General Coastal Marine Zone (GCMZ). The Coastal Transition Zone[2] (CTZ) occupies the narrow margin above mean high water springs and between the back-dune area and stream margins within the Open Space Conservation Zone (OSCZ).

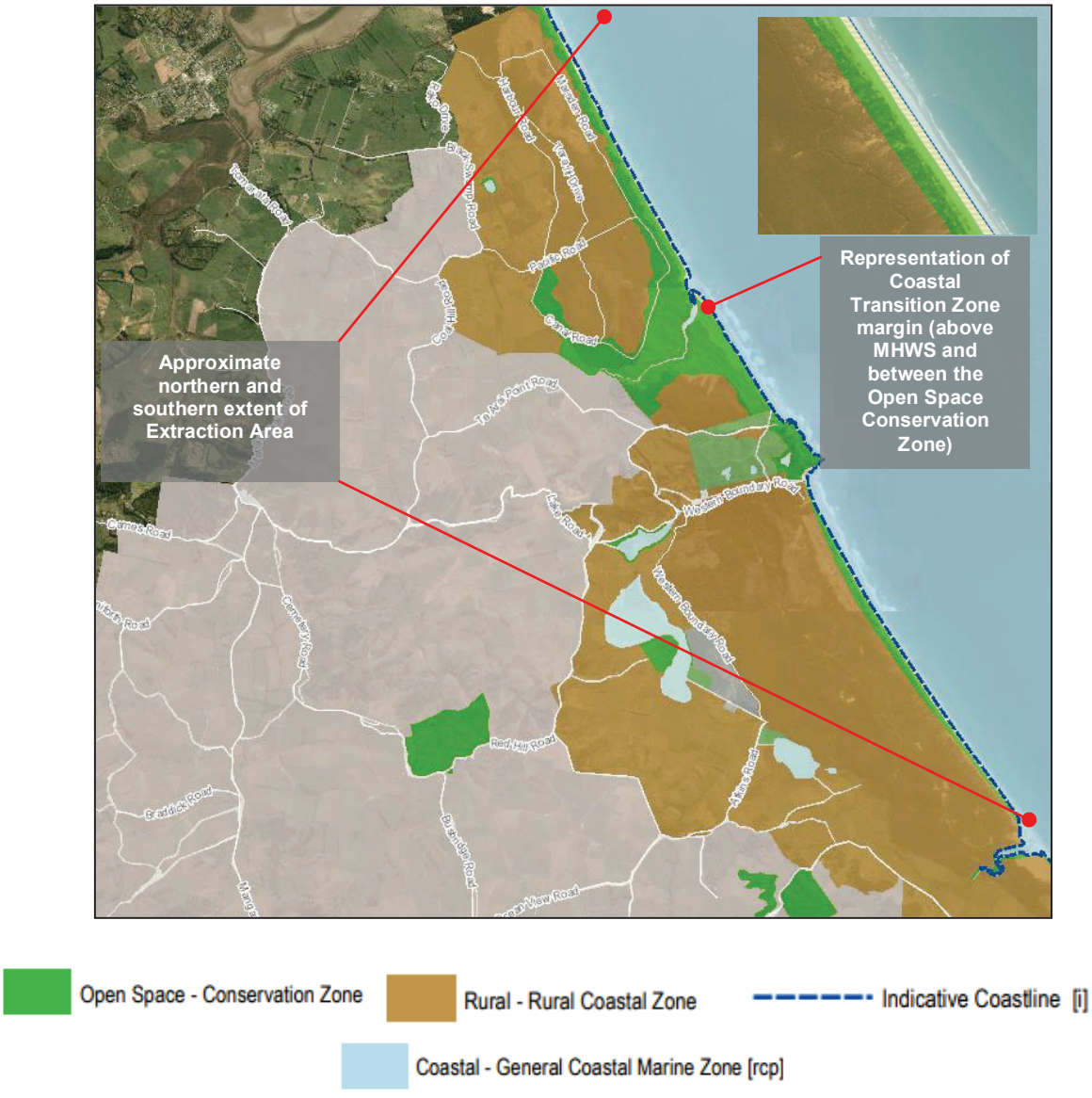

Figure 2 AUP Zoning of Extraction Area and adjacent land (Source: Auckland Council Geomaps)

[2] Chapter F8 of the AUP states "*this zone applies to land above mean high water springs that was typically un-zoned in previous district plans. The zone is administrative and has been introduced to account for improvements in the quality of information on the location of the line of mean high water springs*."

The RCZ is the closest zone to the proposed Extraction Area where a residential dwelling is permitted under the AUP zone standards (one dwelling per site). The proximity of the RCZ to the coastline varies along the corresponding extent of the proposed Extraction Area. Along Pakiri and Te Arai beach, existing residential dwellings (or vacant lots on which a residential dwelling may be established) are generally separated from the coastline by a distance of at least 150m. At the northern extent of the Extraction Area, the recent development of a golf course on Tara Iti Drive, and residential subdivision around Tara Iti Drive will enable further residential receivers in the RCZ, however these lots are typically separated from the coastline by at least 120-200m.

Figure 3 provides an aerial perspective of the adjacent land to the Extraction Area. This extent of coastline is generally characterised by the beach, coastal dune environment, areas of production forestry and sporadic settlement patterns. There is currently a very low level of built development along this coastline.

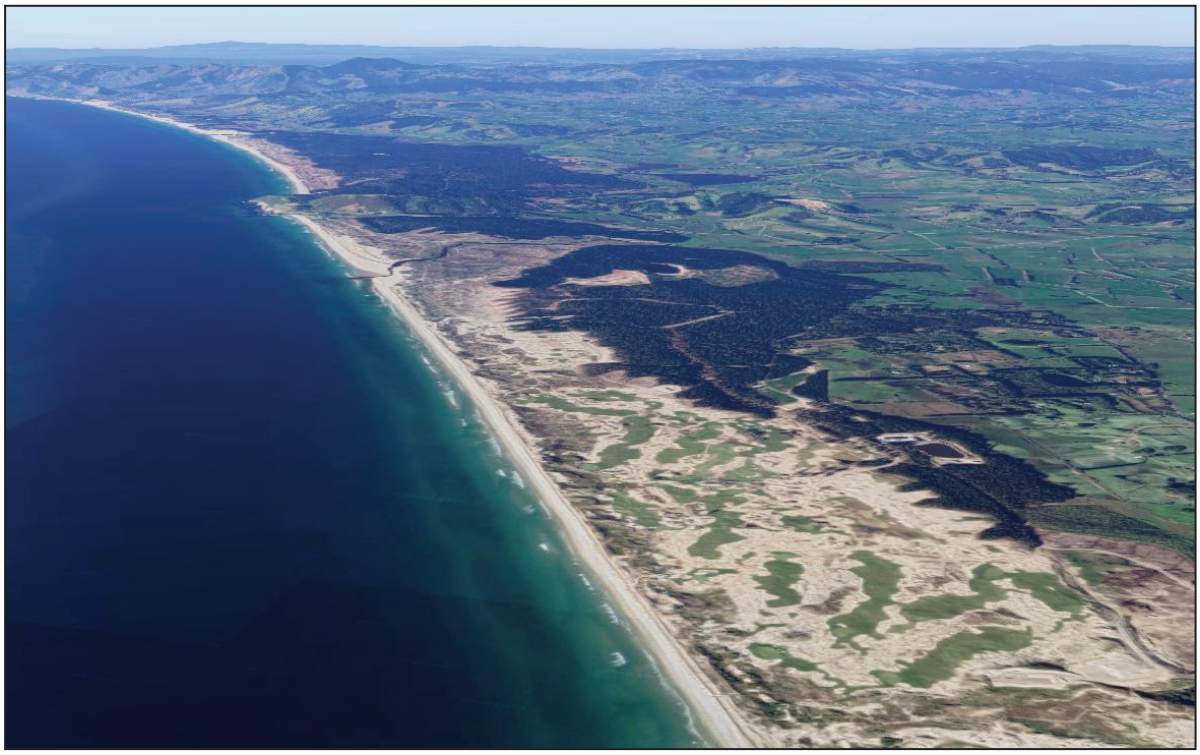

Figure 3 Adjacent land to Extraction Area (Pakiri- Te Arai) Source: Google map data 2020

3.0 Regulatory framework

This section sets out the framework for the management of noise effects under the AUP, relevant New Zealand acoustics standards for the measurement and assessment of noise, and the Act.

3.1 Auckland Unitary Plan

The AUP combines the Regional Coastal Plan and District Plans into a single combined plan. Activities within the Extraction Area (located in the GCMZ) are regulated by the Regional Coastal Plan (Chapter F of the AUP). To determine the relevant noise limits for activities in the GCMZ and received in other zones (i.e. on land) Standard F2.21.1.1 of the AUP states:

> **F2.21.1.1. Noise and vibration**
>
> (1) Interface with other zones:
>
> (a) activities in the coastal marine area must not exceed the relevant levels specified E25 Noise and vibration.

Essentially, there are no noise limits for (airborne) noise generated and received within the GCMZ under the AUP. However, Chapter E25 of the AUP provides the following interface controls for noise generated in the CCMZ and received in other land based zones.

3.1.1 Noise received in the Coastal Transition and Open Space Conservation Zones

The zoning map provided in Figure 2 identifies the zones most exposed to noise from dredging within the Extraction Area.

Standard F8.2(b) of the AUP requires that where the CTZ is adjacent to an open space zone, the rules of that open space zone will apply.

There is no specific rule for noise generated in the GCMZ and received within the CTZ or OSCZ. However, the "catch-all" interface Rule E25.6.22 states:

> **E25.6.22. All other zone interfaces**
>
> (1) Except as provided for in Standards E25.6.14 to E25.6.21 above, where noise generated by any activity on a site in one zone is received by any activity on a site in a different zone, the activity generating the noise must comply with the noise limits and standards of the zone at the receiving site.

Table E25.6.18.1 prescribes noise limits for any activity in the OSCZ when measured within the boundary of a site in the residential zone/ notional boundary of a site in a Rural Zone. Essentially, E25 provides noise limits for activities undertaken within the OSCZ, however there are no specific noise limits for noise *received* within the CTZ or OSCZ.

3.1.2 Noise limits received in the Rural- Coastal Zone

The zoning map provided in Figure 2 demonstrates that the distance from the RCZ to the coastline varies along the corresponding extent of the Extraction Area. E25.6.14 *Noise levels at the coastal interface* requires that the dredging noise levels (received at the notional boundary of any dwelling in the RCZ) must comply with a noise limit of 50dB L_{Aeq} Monday to Saturday from 7am – 10pm and Sunday between 9am- 6pm, and 40dB L_{Aeq}/ 75 dB L_{AFmax} at all other times.

Sites within the RCZ containing a residential dwelling, or vacant lots on which a residential dwelling can be established, are typically separated from the beach by at least 150m. The separation distance between the Extraction Area and receivers within the RCZ means that compliance with the noise limits of Rule E25.6.14 will be achieved by a significant margin. We have undertaken noise level predictions to demonstrate this and to confirm compliance.

The relevant noise limits for noise received within the RCZ are reproduced below:

> **E25.6.14. Noise levels at the coastal interface [rcp/dp]**
>
> (1) The noise (rating) level generated by any activity in the coastal marine area or on a lake or river must not exceed the levels in Table E25.6.14.1 Noise levels at the coastal interface when measured within the boundary of a site in a residential zone or **notional boundary of any site** in the Rural – Rural Production Zone, Rural – Mixed Rural Zone, **Rural – Rural Coastal Zone**; Rural – Rural Conservation Zone, Rural – Countryside Living Zone, Rural – Waitākere Foothills Zone and Rural – Waitākere Ranges Zone.
>
> **Table E25.6.14.1 Noise levels at the coastal interface**

Time	Noise level
7am-10pm	50dB L_{Aeq}
10pm-7am	40dB L_{Aeq} 75dB L_{AFmax}

3.2 Summary of noise limits

In summary, the AUP does not prescribe noise limits for noise that is generated within the GCMZ and received within the CTZ or OSCZ.

The AUP prescribes a daytime noise limit of 50dB L_{Aeq} and a night time noise limit of 40dB L_{Aeq} and 75dB L_{AFmax} for noise generated within the GCMZ and received at a notional boundary within the RCZ.

Policy E25.3(8) of the AUP requires activities to be protected from unreasonable levels of noise emitted from the coastal marine area.

Notwithstanding the absence of noise limits within the CTZ and OSCZ, we have undertaken an assessment of the potential noise effects within the CTZ and OSCZ and on-land based users of the beach environment. Our assessment of effects considers the relevant assessment criteria under E25.8.2. These assessment criteria include:

> The extent to which the noise generated by the activity:
>
> i. will occur at times when disturbance to sleep can be avoided or minimised; and
>
> ii. will be compatible with activities occurring or allowed to occur in the surrounding area; and
>
> iii. will be limited in duration, or frequency or by hours of operation; and

iv. will exceed the existing background noise and vibration levels in that environment and the reasonableness of the cumulative levels; and

v. can be carried out during daylight hours.

3.3 New Zealand acoustics standards

Rule E25.6.1(1) *General Standards* of the AUP requires that noise levels are measured and assessed in accordance with the New Zealand Standard NZS 6801:2008 *Acoustics-Measurement of environmental sound* and the New Zealand Standard NZS 6802:2008 *Acoustics - Environmental noise* except where more specific requirements apply.

Where an adjustment is applied to any noise containing special audible characteristics in terms of Appendix B4 Special Audible Characteristics in New Zealand Standard NZS 6802:2008, Rule E25.6.1(2) stipulates that an adjustment noise may apply to the A weighted level, but an adjustment must not be applied to any level measured in the 63Hz and 125Hz octave bands.

All measurement and assessment of noise has been undertaken in accordance with the requirements of NZS 6801:2008 and NZS 6802:2008. Further discussion on the application of NZS 6802:2008 to this assessment is set out below.

3.3.1 NZS6802:2008 Special audible characteristics

Section 6.3 of NZS 6802:2008 states that where the sound being assessed has a distinctive character which may affect its subjective acceptability (for example it is noticeably impulsive or tonal), the representative sound level shall be adjusted to take this into account (in accordance with Appendix B4 of the Standard).

It is our opinion that an adjustment for special audible characteristics is not required for the activity. This is based on our noise measurements of the William Fraser, and also based on the fact that the noise levels on the beach and further inland will be barely audible, if at all, meaning that any possible special audible character would not be audible.

3.3.2 NZS6802:2008 Duration adjustment

Section 6.4 of NZS 6802:2008 states that if a sound is not present all of the time it is likely to create lesser annoyance than the same sound if it were continuously present. The Standard recommends that an adjustment of up to 5 dB shall be applied to the representative sound level to take this into account. The more the sound under investigation is present, the less the duration adjustment value is. If a sound is continuous then no duration adjustment is warranted.

Because of the importance of protecting sleep, no adjustment is allowed during a prescribed time frame defined in a consent condition, rule or national environmental standard as night-time.

The activity will involve the use of a dredging vessel operating in the proposed Extraction Area generally during the night, but sometimes during the day. Given that the dredging may

be undertaken at night when sleep disturbance is a potential concern, no duration adjustment has been made to the predicted noise levels.

3.4 Resource Management Act

The overarching requirement is to comply with the duties under Section 16 (1) of the Act, which states:

> Every occupier of land (including any premises and any costal marine area), and every person carrying out an activity in, on, or under a water body or the coastal marine area, shall adopt the best practicable option to ensure that the emission of noise from that land or water does not exceed a reasonable level.

4.0 Noise modelling and predictions

To accurately understand the spatial propagation of dredging noise levels across the coastal marine area and received on land, Styles Group has undertaken a combination of noise measurements and predictions using Brüel & Kjær Predictor noise modelling software. The Brüel & Kjær Predictor software is globally recognised and has been successfully implemented on a large number of projects throughout New Zealand.

The software enables the accurate prediction of noise levels based on the International Standard ISO 9613-1 across large areas of land, at multiple receivers and under a wide range of meteorological and operational conditions. The computer noise models are three-dimensional and take into account the topography, the physical attributes of the sound sources and receivers and many other physical factors. The noise level predictions assume meteorological conditions that slightly enhance propagation in all directions in accordance with NZS 6802:2008. Noise level predictions have also been prepared for the common north-east wind direction that will produce the highest noise levels on land (due to enhanced propagation towards the shore).

This section sets out the information that has been integrated into the project noise model, including the noise sources, cadastral data, model input parameters and any calculation adjustments applied to the predicted noise levels in accordance with the relevant New Zealand acoustics standards.

4.1 TSHD vessel

The operation of the TSHD vessel represents the primary noise source associated with the dredging operation. The recently commissioned purpose-built trailing suction dredge vessel, the *William Fraser (*shown in Figure 4) will be used to undertake the dredging, however MBL seek flexibility on the specific vessel that may be used (but on the basis that any alternative dredge vessel will have the same or lower noise output than the William Fraser). For the avoidance of doubt, we have assumed that only one TSHD vessel will be operating in the

Mangawhai - Pakiri embayment at any one time, and cumulative noise levels are not required to be assessed.

Figure 4 TSHD vessel- the William Fraser (2019)

4.2 TSHD noise measurements

To derive a sound power (source) level for use in the noise model, Styles Group obtained noise measurements of the recently commissioned TSHD vessel, the William Fraser in November 2019.

The noise measurements were performed on the morning of the 29 November 2019, in calm conditions with low wind speeds. The noise level measurements were undertaken from above the bow of another vessel using a Bruel and Kjaer 2250 sound level meter. The frequency spectrum and noise levels, logged in 1 second intervals, were recorded simultaneously with a high quality sound recording of the pass-by, for later analysis.

The test procedure involved the measurement vessel being stationary, as the William Fraser passed by the bow at a distance of approximately 20m from the sound level meter. The William Fraser dredge equipment was operating with the draghead in the water and all systems operational. Several pass-bys were undertaken with noise levels measured from the port and starboard side of the vessel.

4.3 Te Arai/ Pakiri beach ambient noise measurements

To identify the ambient noise levels at the Te Arai and Pakiri Beach coastal interface, Styles Group undertook a series of noise measurements. These measurements have been used to identify and assess the potential audibility of the dredging noise along the beach environment.

The noise measurements were performed in a variety of meteorological and swell conditions to provide an accurate and comprehensive description of the noise environment in the area in the weather conditions commonly found on the beach.

The noise level measurement position in each case was near the top of the dunes or grass above the beach, at the border of the coastal environment and the hinterland. All noise measurements were attended, and were performed with Bruel & Kjaer 2250 or 2270 sound

level meters on tripods and with wind screens used. All noise measurements were performed in accordance with NZS6801:2008. Although some measurements were undertaken in wind speeds slightly exceeding 5m/s measured in the open, care was taken to ensure that the microphone was well protected from the higher wind speeds and our careful review of the data confirms that the wind gusts did not affect the measured levels.

The measurements undertaken on 22 May 2019 included four planes passing overhead. The effect of these aircraft pass-bys on the noise level is obvious when observing the $L_{Aeq(1sec)}$ data. The effects of the aircraft have been removed from the $L_{Aeq(15min)}$ and L_{A90} levels that are presented on the relevant results.

In every case, the noise levels in the environment were controlled by waves on the shore (aside from the four overhead aircraft in one sample). The coastal environment comprises relatively open coastline where waves break on the shore more-or-less constantly.

The meteorological and swell conditions for each of the measurements are displayed in Table 2.

Table 1 Wind and swell conditions during ambient noise measurements

Date	Wind Direction	Wind Speed	Mean Swell Height
3 May 2019	ENE (on shore)	1.9 m/s to 2.9 m/s	0.7 m
3 May 2019	ENE (on shore)	2.5 m/s to 2.9 m/s	0.7 m
3 May 2019	ENE (on shore)	Nil (wind dropped)	0.7 m
7 May 2019	E (on shore)	4.1 m/s to 5.4 m/s	0.8 m
7 May 2019	E (on shore)	3.3 m/s to 5 m/s	0.8 m
7 May 2019	E (on shore)	3.1 m/s to 4.5 m/s	0.8 m
22 May 2019	n/a	Nil	0.5 m
22 May 2019	n/a	Nil	0.5 m
22 May 2019	n/a	Nil	0.5 m
13 June 2019	NW (off shore)	1.5 m/s to 2.9 m/s	0.8 m
13 June 2019	NW (off shore)	1.5 m/s to 3 m/s	0.8 m
11 July 2019	N (on shore)	under 1 m/s	0.5 m
11 July 2019	NW (off shore)	0.5 m/s to 1.5 m/s	0.5 m
11 July 2019	NW (off shore)	0 m/s to 0.5 m/s	0.5 m

The results of the noise level measurements are shown graphically in Appendix C. The graphs set out the noise levels in terms of:

1) The $L_{Aeq(15min)}$ levels – being the energy-average of the noise levels in each 15 minute measurement period;
2) The L_{A90} noise level – being the 'background' noise level that is equalled or exceeded 90% of the time. This level is characteristic of the quieter periods between waves breaking on the shore; and
3) The $L_{Aeq(1sec)}$ levels – being the short term noise level recorded in 1-second time intervals. This shows the actual variations in noise level for the full measurement durations, including the lowest L_{Aeq} levels measured during the period.

The ambient measurements show that the noise levels in the area fluctuate considerably depending on wind and swell conditions.

In the calmest of the conditions measured, the $L_{Aeq(15min)}$ levels are typically around 50dB, with background L_{A90} levels typically between 40dB and 45dB. The lowest $L_{Aeq(1sec)}$ levels are between 30dB and 35dB. By our observations, the lowest noise levels are observed over very short periods of time (1-2 seconds) when there is a lull between the breaking waves.

On days when the wind is blowing on shore, the $L_{Aeq(15min)}$ noise levels are typically as high as 65dB, with background L_{A90} levels generally around 60dB. The $L_{Aeq(1sec)}$ noise level typically stays above 60dB on the windy days. The breaking waves are constant along the beach and there are no 'lulls' or quiet periods.

4.4 Noise model parameters

This section sets out the input parameters used, adjustments made and meteorological conditions assumed for our noise modelling.

4.4.1 Input parameters

Noise predictions have been calculated based on the International Standard ISO 9613-1/2 Attenuation of sound during propagation outdoors. Terrain contours, building footprints and parcel boundaries were imported from the Auckland Unitary Plan Geomaps service. The topographical contours encompass the entire site and a large area of the surrounding land. We have ensured the integrity of the noise model by careful scrutiny of the final three-dimensional model.

The input parameters for the noise model are displayed in Table 2.

Table 2 Predictor noise model input parameters

Parameters/calculation settings	Details
Software	Brüel & Kjær Predictor
Calculation method	ISO 9613.1/2
Meteorological parameters	Single value, C0 = 0 (downwind in all directions away from the source) and north east winds
Ground attenuation over land	General method, ground factor: 1 (sand / scrub / forestry)
Ground attenuation over water	General method, ground factor: 0 (flat water)
Air temperature	293.15K
Atmospheric pressure	101.33kPa
Air humidity	60%
Calculation contour height	1.5m above ground
Vessel speed	2 knots (3.7 km/hr)

4.4.2 Noise rating level calculation adjustments

The noise level predictions do not include any adjustment for duration or special audible character. The low noise levels predicted mean that any tonal character present close to the vessel will be indistinguishable on the shore, relative to the ambient noise levels that have been measured, even on the calmest days.

4.4.3 Meteorological conditions

We have prepared noise level predictions for the ISO standard 'slightly positive' meteorological conditions where the wind is assumed to be blowing downwind in all directions away from the vessel, and the "worst case" scenario where the wind is blowing onshore (north east) to illustrate the change in noise level propagation in real world conditions that would frequently occur in this location.

4.5 Noise rating level contours

The predicted noise level contours are provided in Appendix B for the meteorological conditions that we have predicted for. The contours illustrate the spatial extent of the noise propagation across the surrounding marine area and coastal environment.

The noise level contours demonstrate that the dredging noise levels experienced on the beach will be in the range of approximately 20-35dB L_{Aeq} depending on the dredging location, wind direction and wind strength. More specifically:

1) During meteorological conditions that enhance propagation slightly in all directions according to ISO9613, the noise level on the beach is predicted to be approximately 30dB L_{Aeq} when dredging is undertaken on the western (inner track), and approximately 20dB L_{Aeq} when dredging is undertaken on the eastern (outer track);

2) When dredging is on the inner track, and the wind direction is north east (on shore) at speeds between 1-3m/s, the noise levels on the beach are predicted to be approximately 30-35dB L_{Aeq}; and

3) The noise levels on the west side of the dunes and into the hinterland to the west will be below 30dB in all cases and below 20dB in most meteorological conditions.

5.0 Assessment of effects

The AUP does not prescribe noise limits for noise generated within the GCMZ and received on the Pakiri / Te Arai beach up to MHWS or the CTZ (which separates the GCMZ from the OSCZ further inland).

Notwithstanding, we have undertaken an assessment of noise effects in accordance with the relevant assessment criteria of E25.8 of the AUP, to determine the actual and potential noise effects on land based users of the Pakiri/ Te Arai coastal interface, including (but not limited to) recreational beach users, walkers, land based anglers and horse riders. A golf course (Tara Iti) has recently been established in the OSCZ adjacent to the northern part of the Extraction Area.

The RCZ represents the closest zone in which residential dwellings (one per lot) may be established under the AUP zone standards.

An assessment of the noise levels and the potential effects on adjacent receivers to the Extraction Area are set out in the following sections. E25.8 of the AUP provides the following assessment criteria for the assessment of noise effects:

- The effects on adjacent land uses particularly activities sensitive to noise;
- Measures to avoid, remedy or mitigate the adverse effects of noise;
- The extent to which the noise generated by the activity:
    - (i) will occur at times when disturbance to sleep can be avoided or minimised; and
    - (ii) will be compatible with activities occurring or allowed to occur in the surrounding area; and
    - (iii) will be limited in duration, or frequency or by hours of operation; and

(iv) will exceed the existing background noise and vibration levels in that environment and the reasonableness of the cumulative levels; and

(v) can be carried out during daylight hours.

- Whether the measures to minimise the noise or vibration generated by the activity represent the best practicable option.

As a general comment, the dredging noise levels and the associated degree of effects on all landward activities is so low that a detailed assessment against of all these criteria is not required.

5.1 Noise effects on users of the beach

The beach adjacent to the Extraction Area will receive the highest levels of noise from the dredging. The predicted dredging noise levels range from approximately 20dB to 35dB depending on where the dredging is taking place and the wind direction.

When the wind speeds are zero or close to zero, the ambient noise levels on the beach are at their lowest, but the low wind speed will not strongly enhance the propagation of dredging noise towards the shore (as shown in our 'worst-case' noise modelling). In these conditions, the predicted noise levels on the beach are approximately 35dB L_{Aeq}.

Our ambient noise measurements show that even during lulls in the noise of waves breaking on the shore, the ambient noise level does not drop below 30dB even for very short periods of 1 second. However, we consider it possible that in the very calmest of conditions, the noise of dredging may be audible when swell heights are close to nil and wind speeds are also nil. We expect such conditions to be rare, particularly during the day.

The predicted noise levels are at their highest when the wind direction is on-shore and at speeds of 1-3m/s. In these conditions, the ambient noise levels are higher than in flat calm conditions. With reference to Appendix C, the ambient noise levels in these conditions are typically greater than 62-63dB L_{Aeq} and the lowest levels reach around 60dB $L_{Aeq(1sec)}$. In these conditions, the noise of dredging will be inaudible.

When the wind direction is off-shore, the noise level on the beach is predicted to be 15dB L_{Aeq} or less. The noise of dredging is likely to be inaudible in these conditions.

The noise of dredging is likely to be barely audible even in meteorological conditions that enhance propagation towards the beach, and when the swell is very low.

Furthermore, dredging activities are likely to be carried out during the night and into the early hours of the morning. At this time of day there is likely to be few or no people on the beach to experience the noise levels.

5.2 Noise effects on the OSCZ

At distances further inland from the beach and dunes, the noise levels are predicted to be less than 20-25dB L_{Aeq} in all meteorological conditions.

We consider that the noise of dredging is unlikely to be audible in the OSCZ at any time.

5.3 Noise effects on receivers within the RCZ

With reference to the zoning map in Figure 2, the proximity of the RCZ to the shore varies along the extent of the Extraction Area. A recent Te Arai subdivision has established lots on which future residential dwellings will be established along Tara Iti Drive (the boundary of these lots are between 120-200m from the CTZ).

The AUP prescribes a daytime noise limit of 50dB L_{Aeq} and a night time noise limit of 40dB L_{Aeq} / 75dB L_{AFmax} for noise generated within the GCMZ and received at the notional boundary of residential dwellings in the RCZ.

With reference to the noise level contours provided in Appendix B, the dredging noise levels received at existing/ future dwellings within the RCZ will (at the closest receivers) will be less than 25dB. This readily complies with both the daytime and night time noise limits at all receivers within the RCZ.

With reference to the ambient noise measurements, the dredging noise is unlikely to be audible above background noise levels at the closest RCZ receivers.

6.0 Conclusion

Styles Group have prepared a computer noise model of the proposed dredging operations in the proposed Extraction Area, calibrated using noise measurements of the newly commissioned vessel *William Fraser*. The noise level predictions show that in the most favourable conditions for the propagation of noise towards the beach, the dredging noise levels will be less than 35dB L_{Aeq} on the beach.

To understand the predicted dredging noise levels in the context of the Pakiri/ Te Arai beach environment, Styles Group also undertook a series of ambient noise measurements at the coastal interface. The ambient noise measurements show that the noise levels of the beach environment will be higher than the predicted dredging noise levels, even in the calmest of conditions. In most conditions, the ambient noise level in the coastal environment will be well over 50dB L_{Aeq}. When very calm, the ambient noise level can drop to close to 30dB $L_{Aeq(1sec)}$. Due to the ambient noise levels primarily attributed to wave action, the dredging noise will be unnoticeable in most conditions.

The noise from dredging will be compliant with the relevant noise limits by a significant margin, including at night when the noise limits applying at any notional boundary in the RCZ is 40dB L_{Aeq}. The noise level at any notional boundary in the RCZ is likely to be less than 25dB L_{Aeq}.

With reference to the ambient noise measurements the timing, occurrence and duration of the low noise levels that will be experienced on land, the noise emissions from the proposal can be considered to be reasonable in terms of section 16 of the Act. We do not consider that any specific noise mitigation measures are required.

Appendix A Glossary of terms

Noise	A sound which serves little or no purpose for the exposed persons and is commonly described as 'unwanted sound'. The definition of noise includes vibration under the Resource Management Act.
dB (decibel)	The basic measurement unit of sound. The logarithmic unit used to describe the ratio between the measured sound pressure level and a reference level of 20 micropascals (0 dB).
A-weighting	A frequency filter applied to the full audio range (20 Hz to 20 kHz) to approximate the response of the human ear at lower sound pressure levels.
Ambient noise	Ambient noise is the total of all noise within a given environment, comprising a composite of sounds from sources near and far.
$L_{A90(t)}$ (dB)	The A-weighted sound level in decibels equalled or exceeded for 90% of the of the measurement interval. It is the component of the total sound that subjectively is perceived as continuously present. Used in New Zealand as the descriptor for background noise in the 2008 versions of the N.Z. Standards NZS 6801 and NZS 6802.
$L_{Aeq(t)}$ (dB)	The A-weighted equivalent sound pressure level with the same energy content as the measured varying acoustic signal over a sample period (t). The preferred metric for sound levels that vary over time because it takes into account the total sound energy over the time period of interest.
L_{AFmax} (dB)	The maximum A-weighted sound pressure level recorded during the measurement period using a fast time-weighting response.
Noise rating level	A derived noise level used for comparison with a noise limit.
Notional boundary	A line 20 metres from any side of a residential unit or other building used for a noise sensitive activity, or the legal boundary where this is closer to such a building.
NZS 6801:2008	N.Z. Standard NZS 6801:2008 Acoustics – Measurement of environmental sound.
NZS 6802:2008	N.Z. Standard NZS 6802:2008 Acoustics – Environmental noise.
s16	Section 16 of the Act states that "every occupier of land (including any premises and any coastal marine area), and every person carrying out an activity in, on, or under a water body or the coastal marine area, shall adopt the best practicable option to ensure that the emission of noise from that land or water does not exceed a reasonable level".
ISO 9613-1/2	International Standard ISO9613-1/2 Attenuation of sound during propagation outdoors

Appendix B Noise rating level contours

Noise Level Contours - Inner Track - Pakiri beach - NE Wind

10 Feb 2020

Road traffic noise - Harmonoise, [version of Te Arai - W Fraser Pakiri Wind W2S4 45deg] , Predictor V2019.3

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Noise Level Contours W Fraser - Inner Track - Pakiri beach
10 Feb 2020

Industrial noise - ISO 9613.1/2, [version of Te Arai - W Fraser Pakiri - Inner- 0 wind] , Predictor V2019.3

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Noise Level Contours W Fraser - Inner Track - Te Arai beach
10 Feb 2020

Industrial noise - ISO 9613.1/2, [version of Te Arai - W Fraser Te Araii - Inner- 0 wind] , Predictor V2019.3

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Noise Level Contours W Fraser - Inner Track - Te Arai beach - NE Wind
10 Feb 2020

Road traffic noise - Harmonoise, [version of Te Arai - W Fraser Te Arai Wind W2S4 45deg] , Predictor V2019.02

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Noise Level Contours - Outter Track - Pakiri beach
10 Feb 2020

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Industrial noise - ISO 9613.1/2, [version of Te Arai - W Fraser Pakiri - Outter- 0 wind] , Predictor V2019.3

Noise Level Contours W Fraser - Outter Track - Te Arai beach
10 Feb 2020

Industrial noise - ISO 9613.1/2, [version of Te Arai - W Fraser Te Araii - Outter- 0 wind] , Predictor V2019.3

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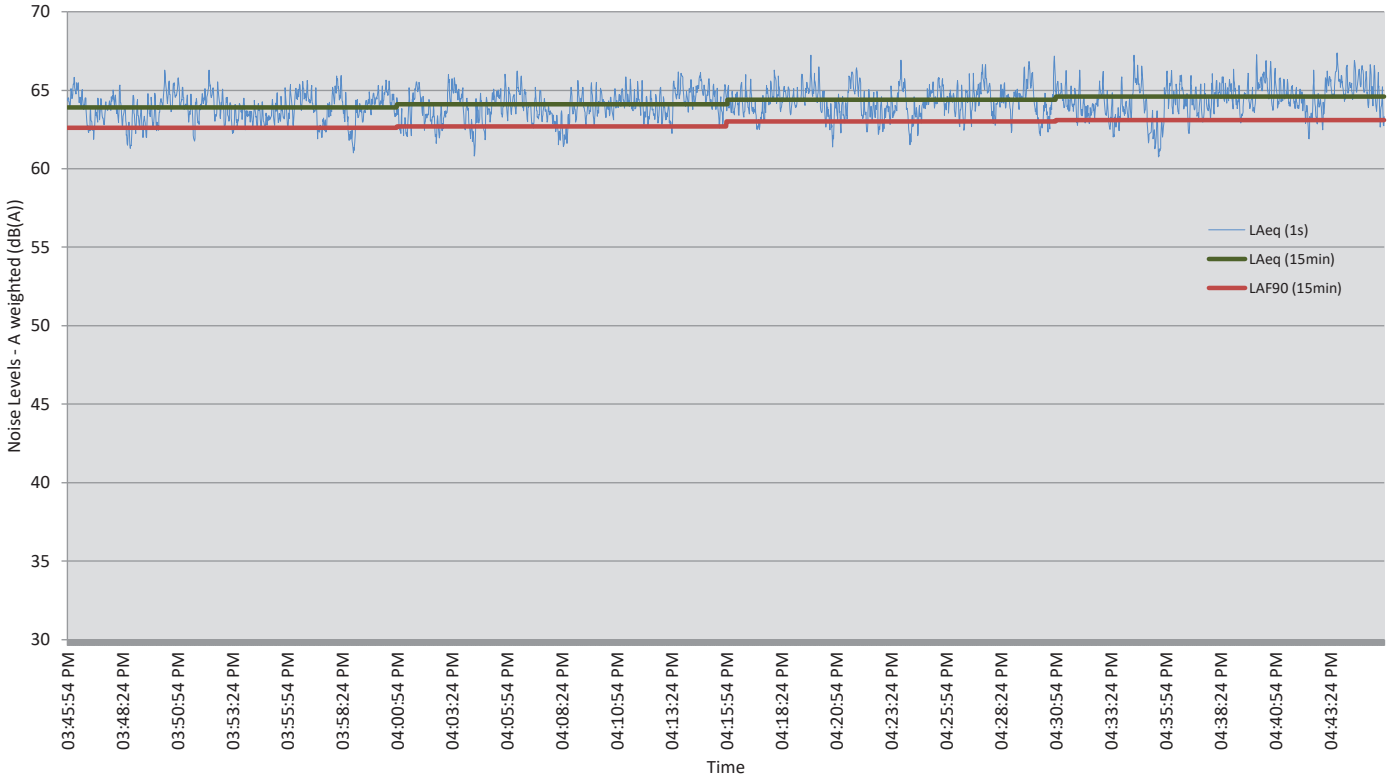
Appendix C Ambient noise measurement data

Pakiri Sand Extraction - Noise Level Measured at Position 1 - 03rd May 2019
Wind direction: East, North-East - Wind Speed: 2.5 m/s to 2.9 m/s - Swell: 0.7 m



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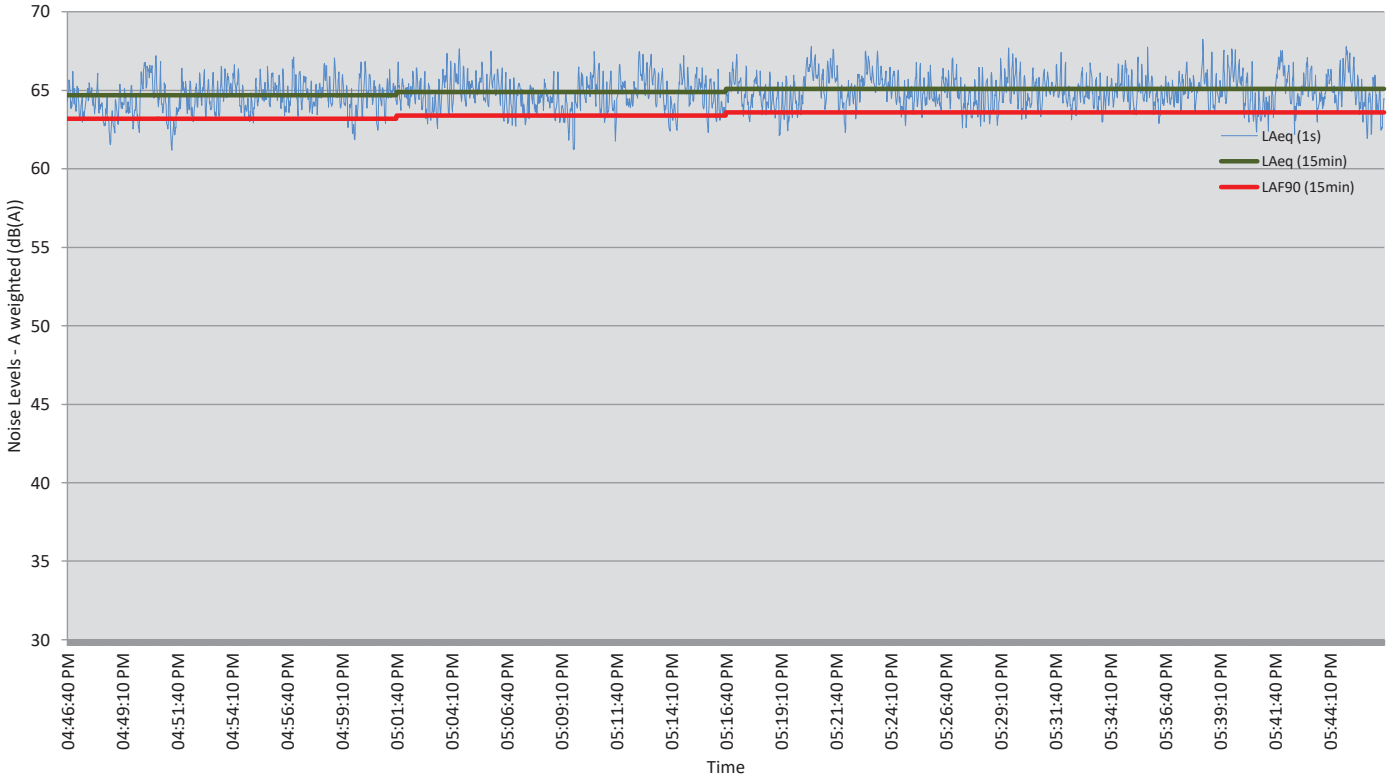
Pakiri Sand Extraction - Noise Level Measured at Position 2 - 03rd May 2019
Wind direction: East, North-East - Wind Speed: 1.9 m/s to 2.9 m/s - Swell: 0.7 m



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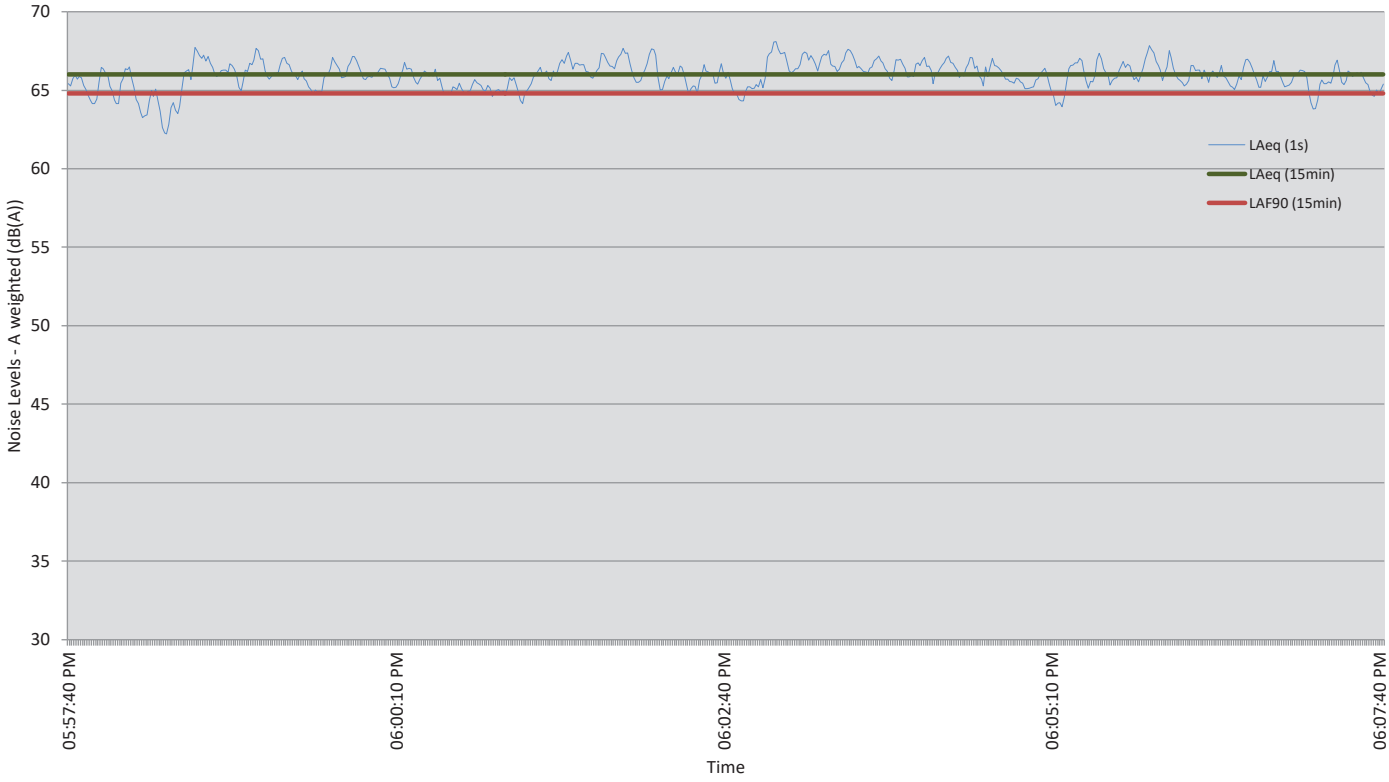
Pakiri Sand Extraction - Noise Level Measured at Position 3 - 03rd May 2019
Wind direction: East, North-East - Wind Speed: Nil - Swell: 0.7 m



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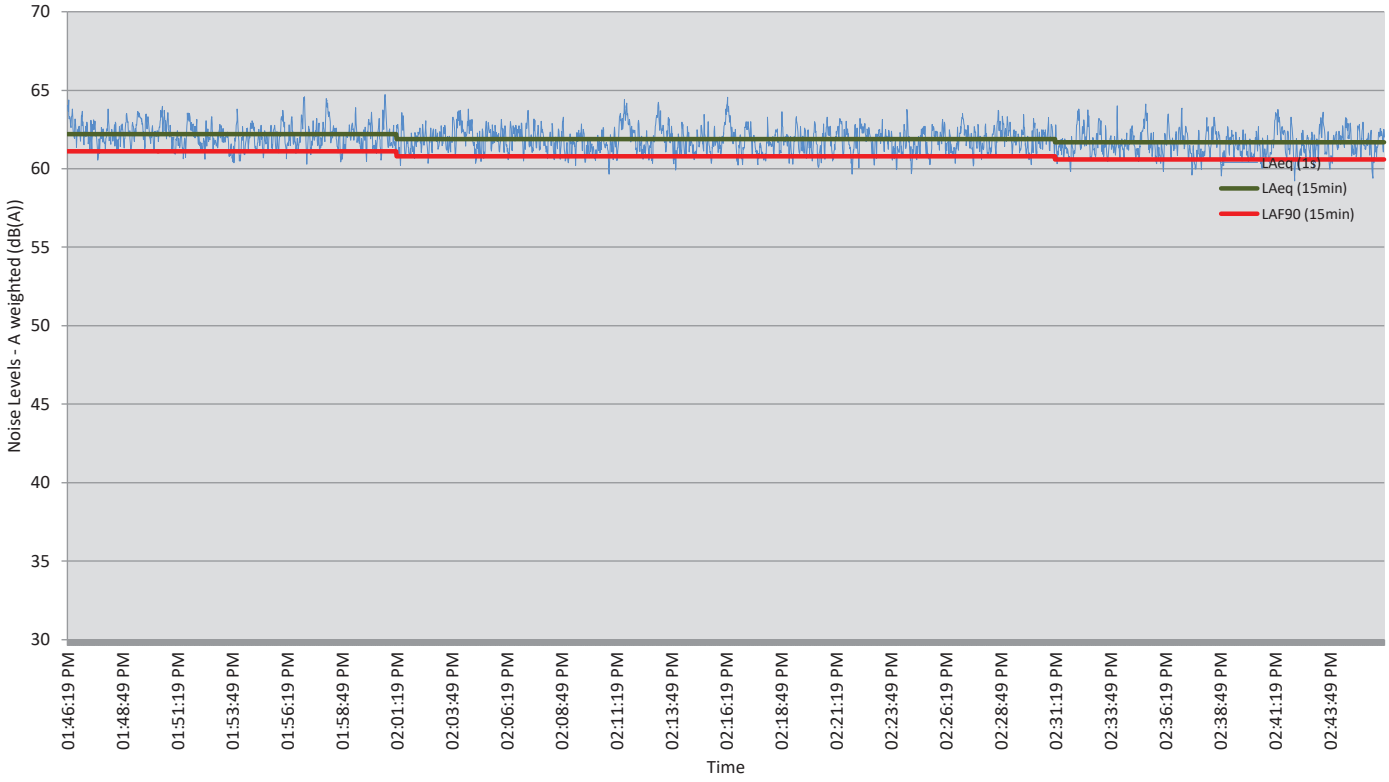
Pakiri Sand Extraction - Noise Level Measured at Position 1 - 07th May 2019
Wind direction: East - Wind Speed: 3.1 m/s to 4.5 m/s - Swell: 0.8 m



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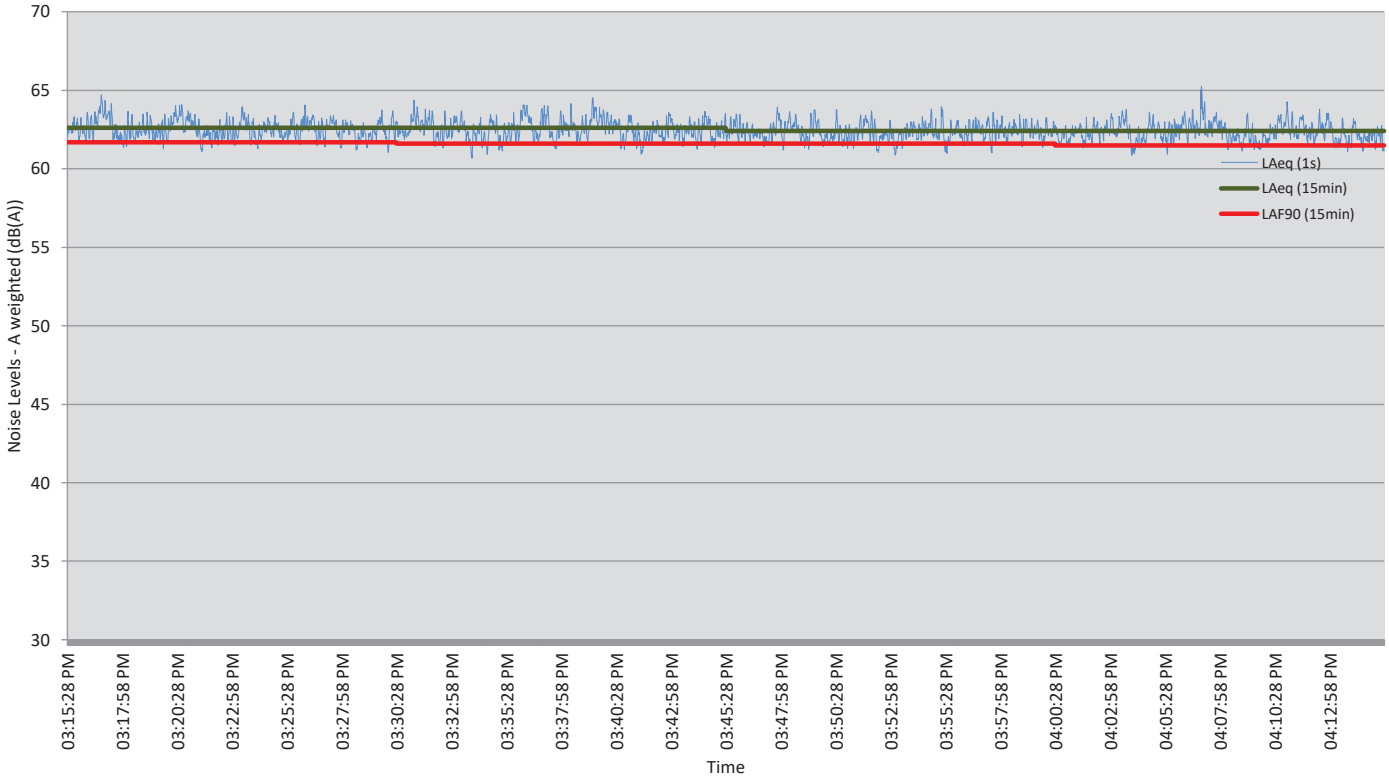
Pakiri Sand Extraction - Noise Level Measured at Position 2 - 07th May 2019
Wind direction: East - Wind Speed: 4.1 m/s to 5.4 m/s - Swell: 0.8 m



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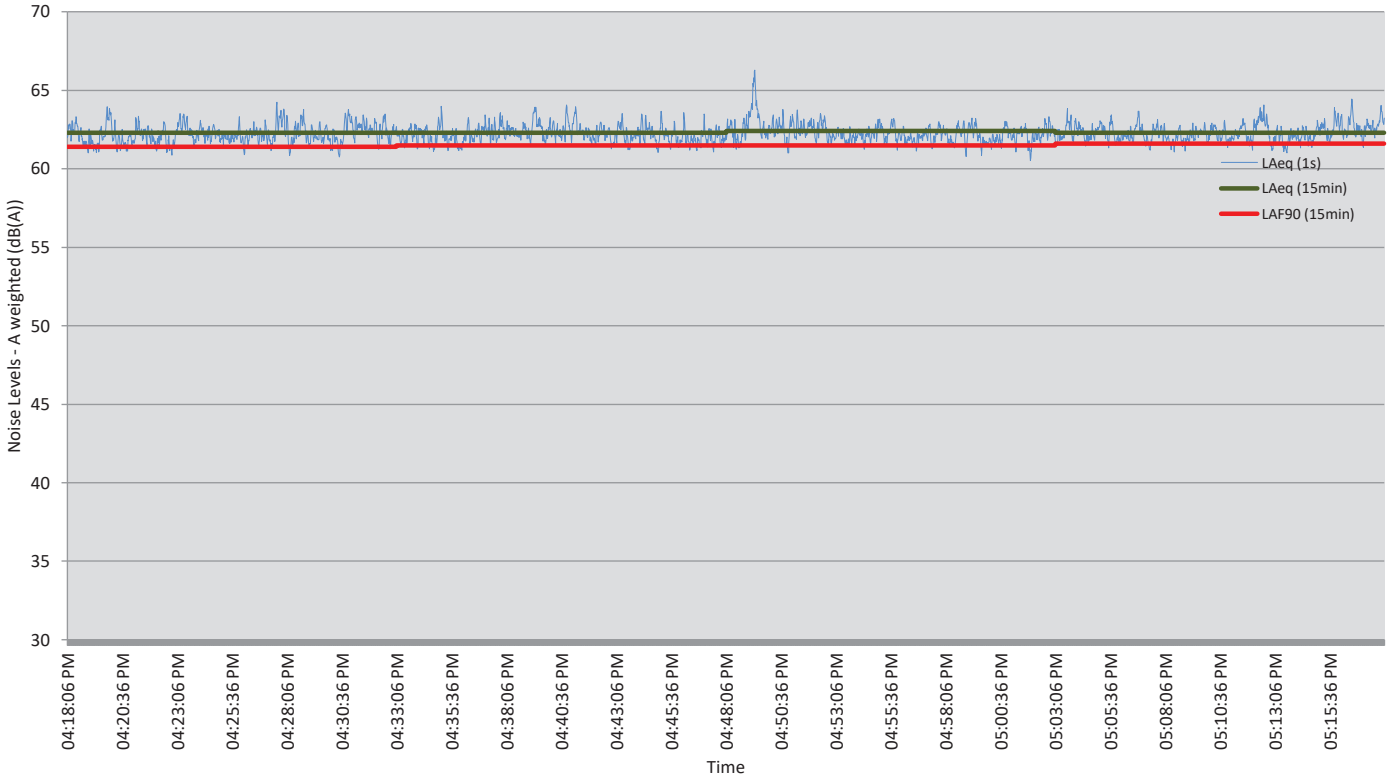
Pakiri Sand Extraction - Noise Level Measured at Position 3 - 07th May 2019
Wind direction: East - Wind Speed: 3.3 m/s to 5 m/s - Swell: 0.8 m



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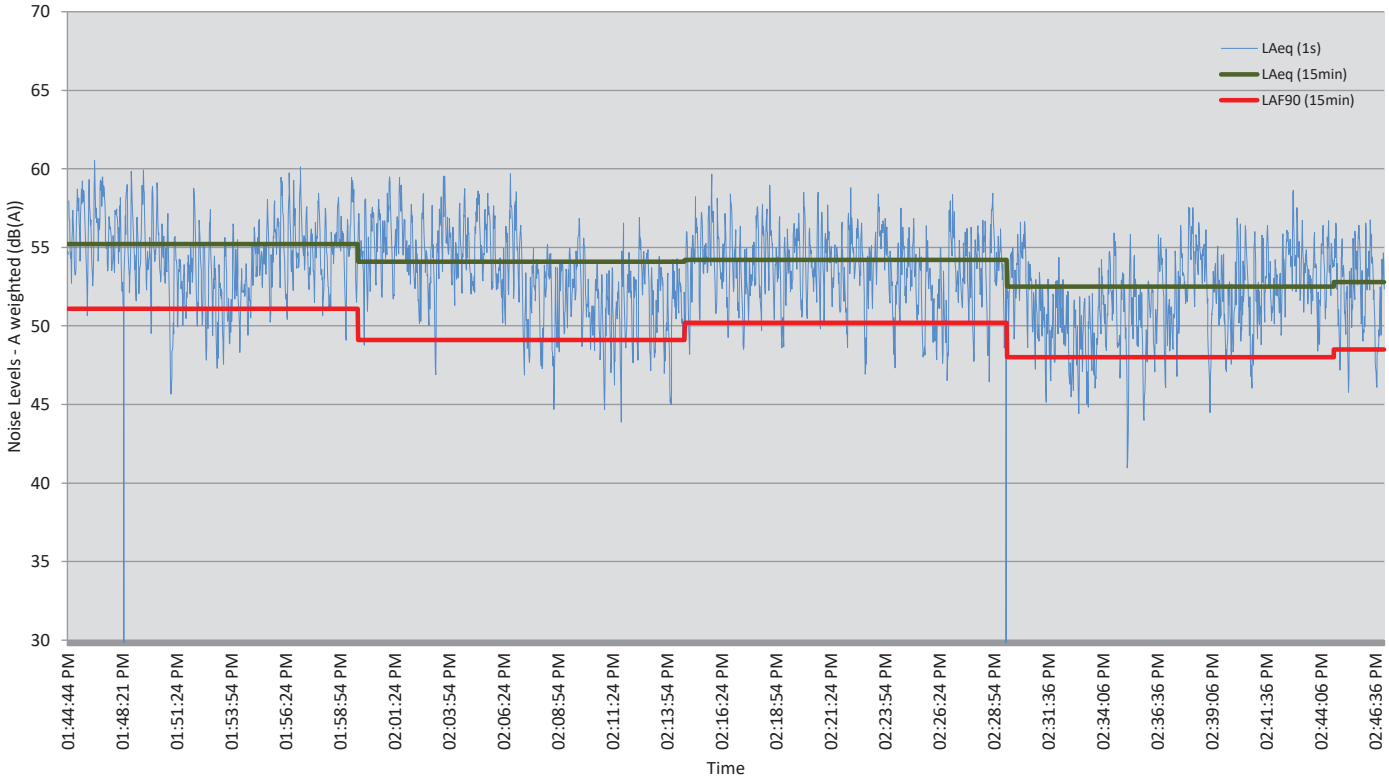
Pakiri Sand Extraction - Noise Level Measured at Position 4 - 22nd May 2019
Wind: Nil - Swell: 0.5 m



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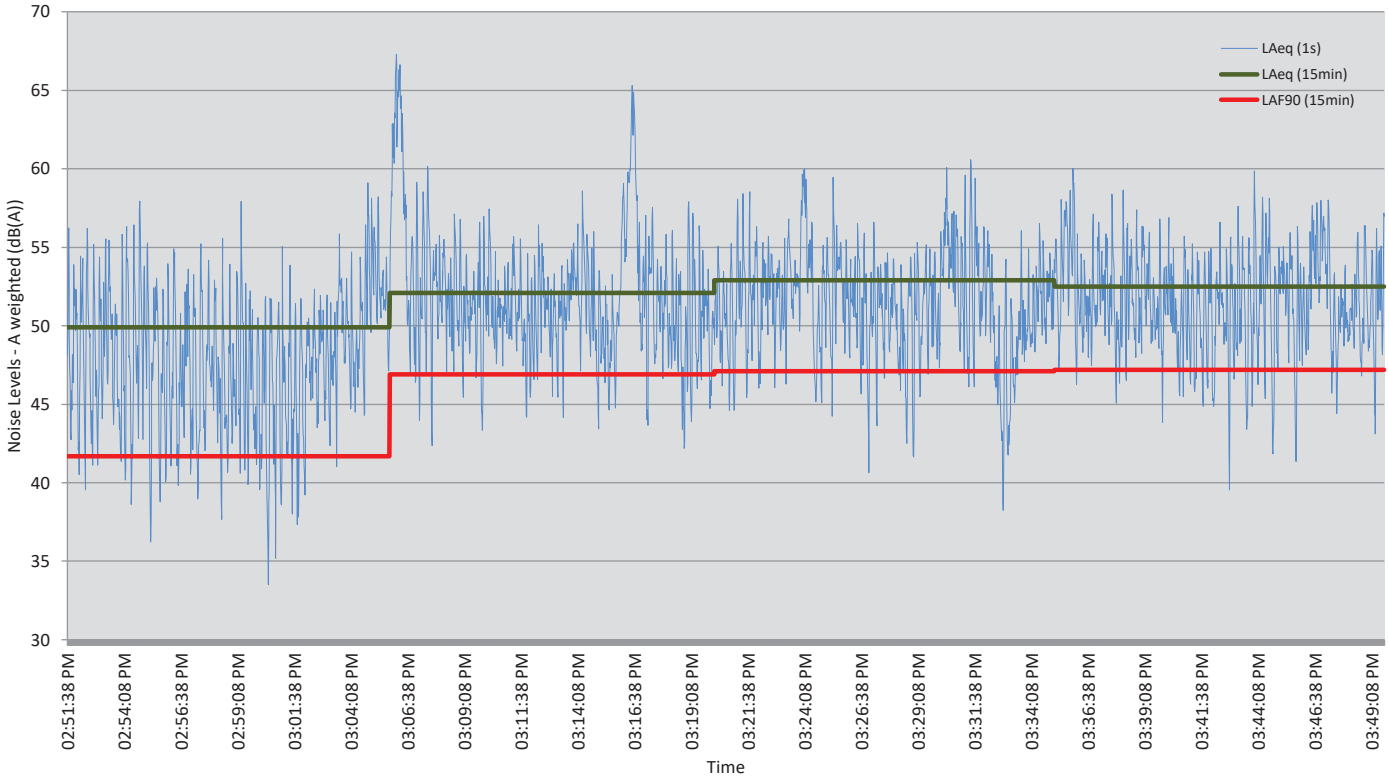
Pakiri Sand Extraction - Noise Level Measured at Position 5 - 22nd May 2019
Wind: Nil - Swell: 0.5 m



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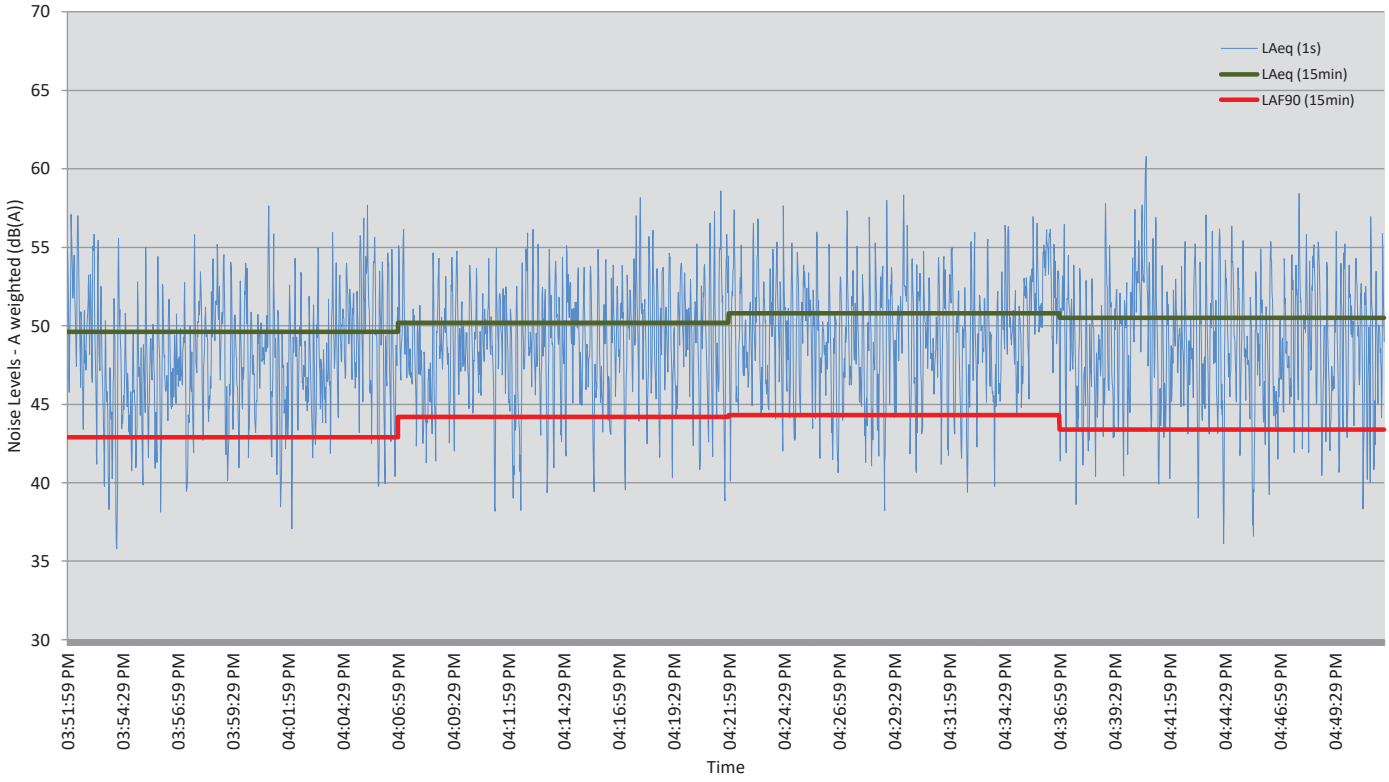
Pakiri Sand Extraction - Noise Level Measured at Position 6 - 22nd May 2019
Wind: Nil - Swell: 0.5 m



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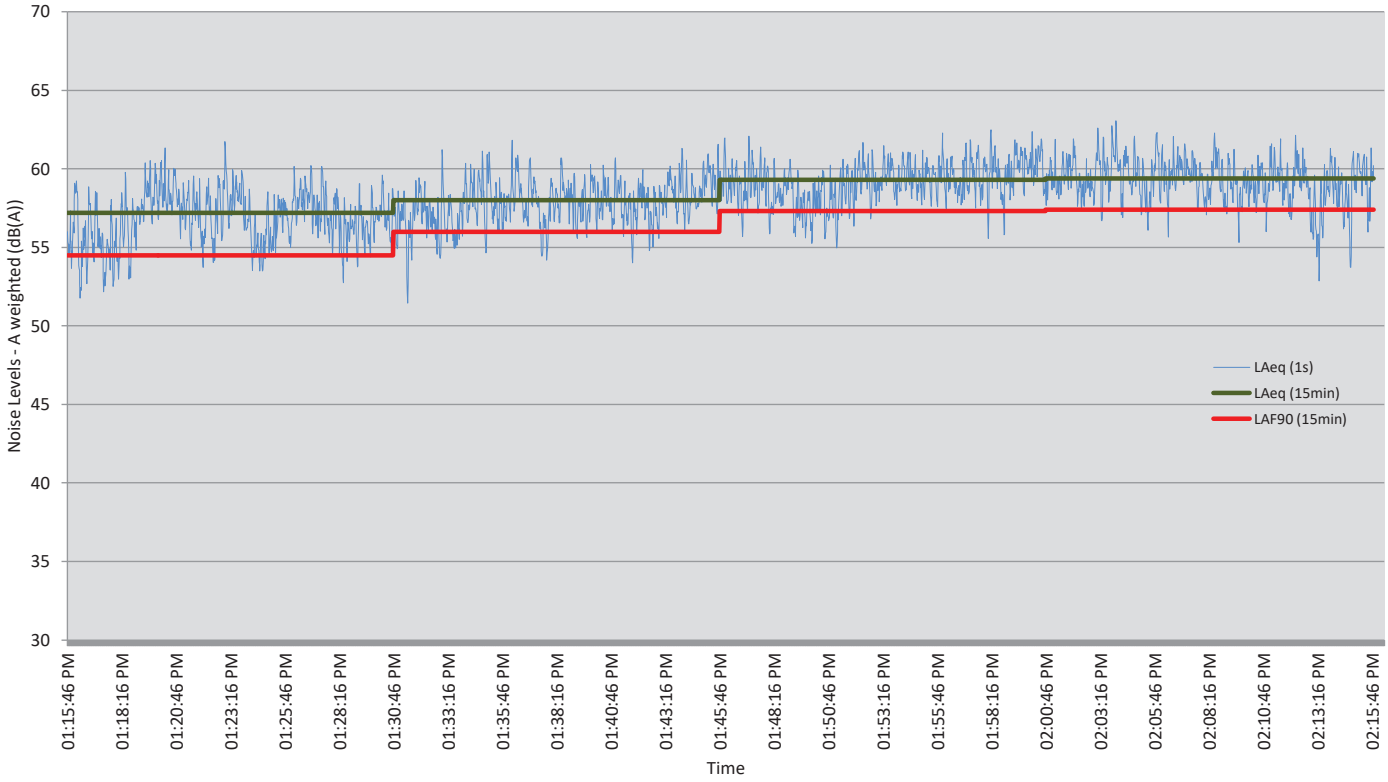
Pakiri Sand Extraction - Noise Level Measured at Position 1 - 13rd June 2019
Wind direction: North-West - Wind Speed: 1.5 m/s to 2.9 m/s - Swell: 0.8 m



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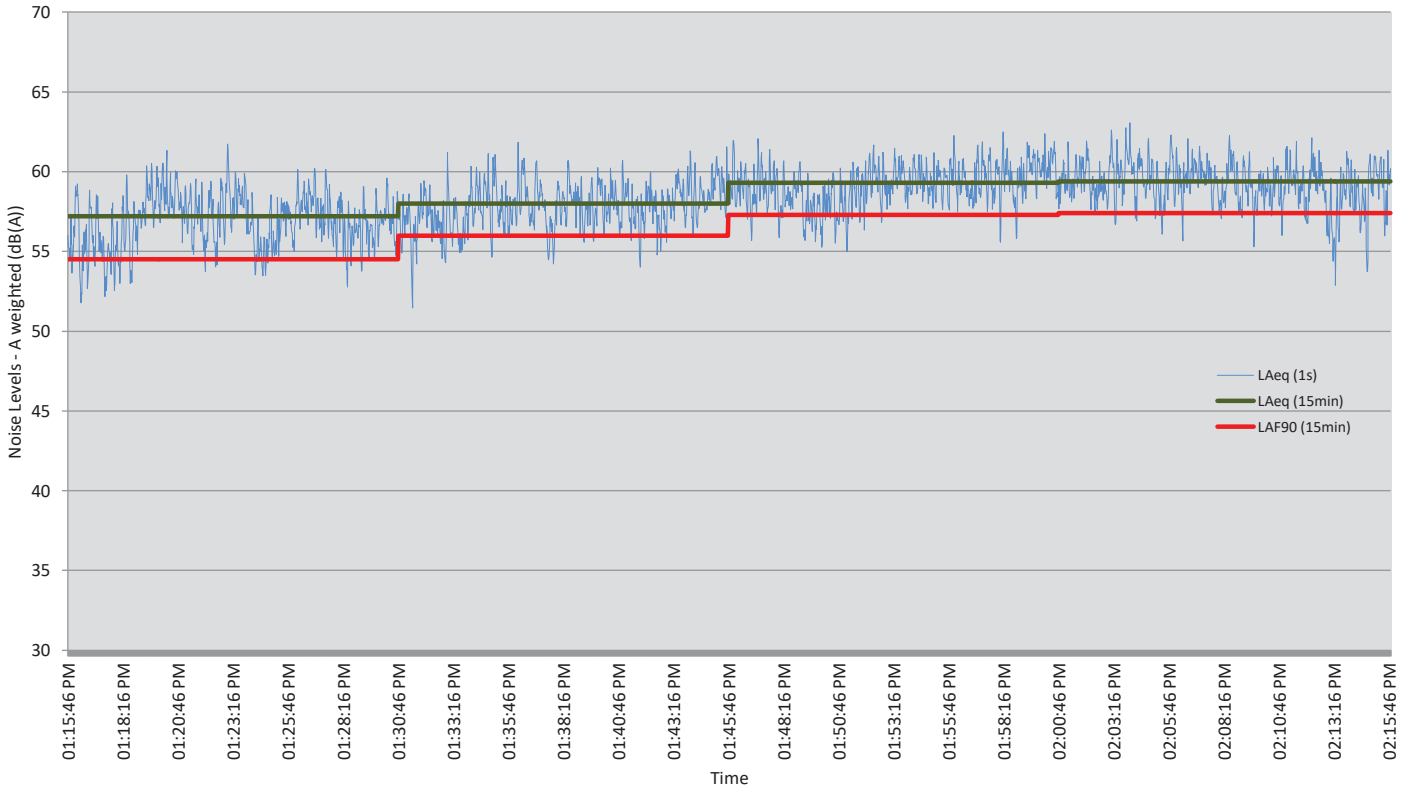
Pakiri Sand Extraction - Noise Level Measured at Position 2 - 13rd June 2019
Wind direction: North-West - Wind Speed: 1.5 m/s to 3 m/s - Swell: 0.8 m



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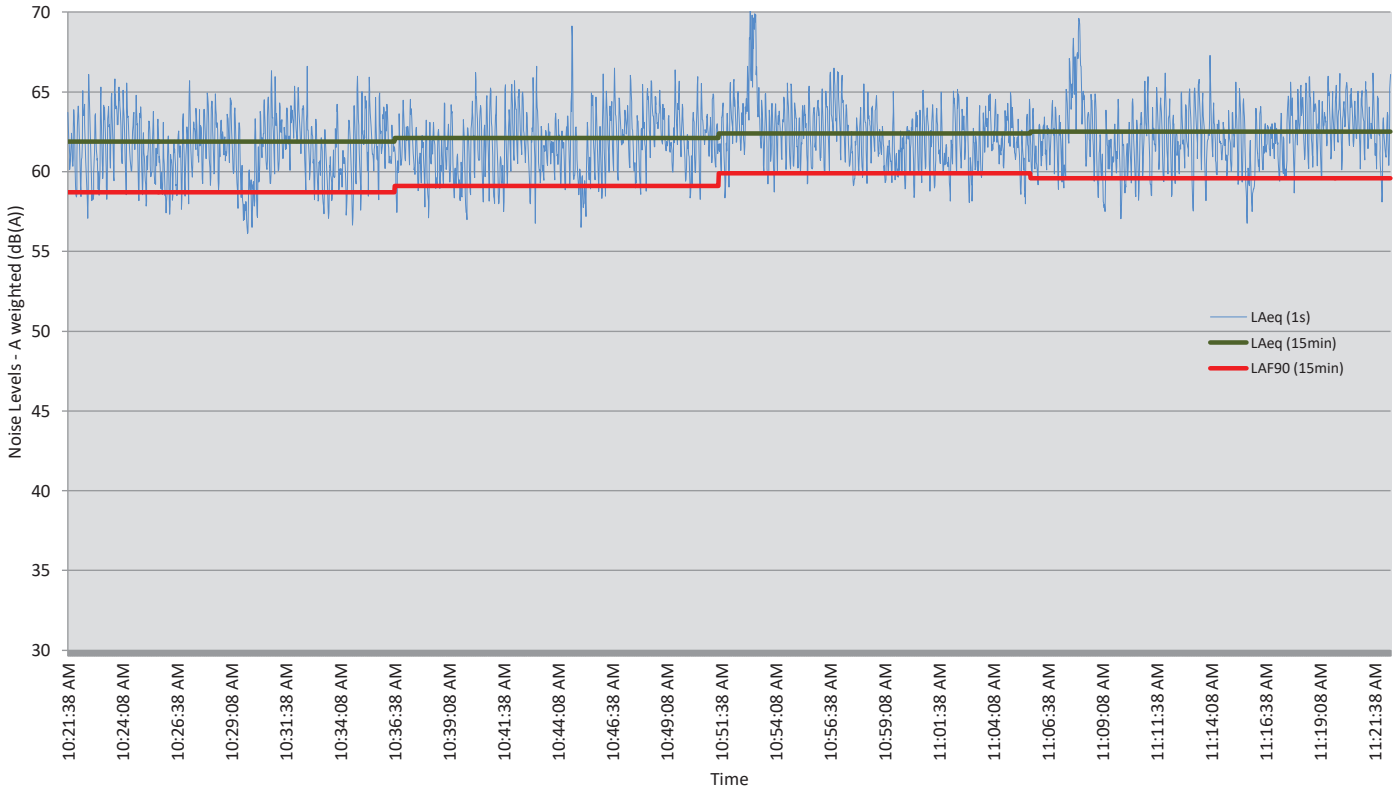
Pakiri Sand Extraction - Noise Level Measured at Position 4 - 11th July 2019
Wind direction: North-West - Wind Speed: 0 m/s to 0.5 m/s - Swell: 0.5 m



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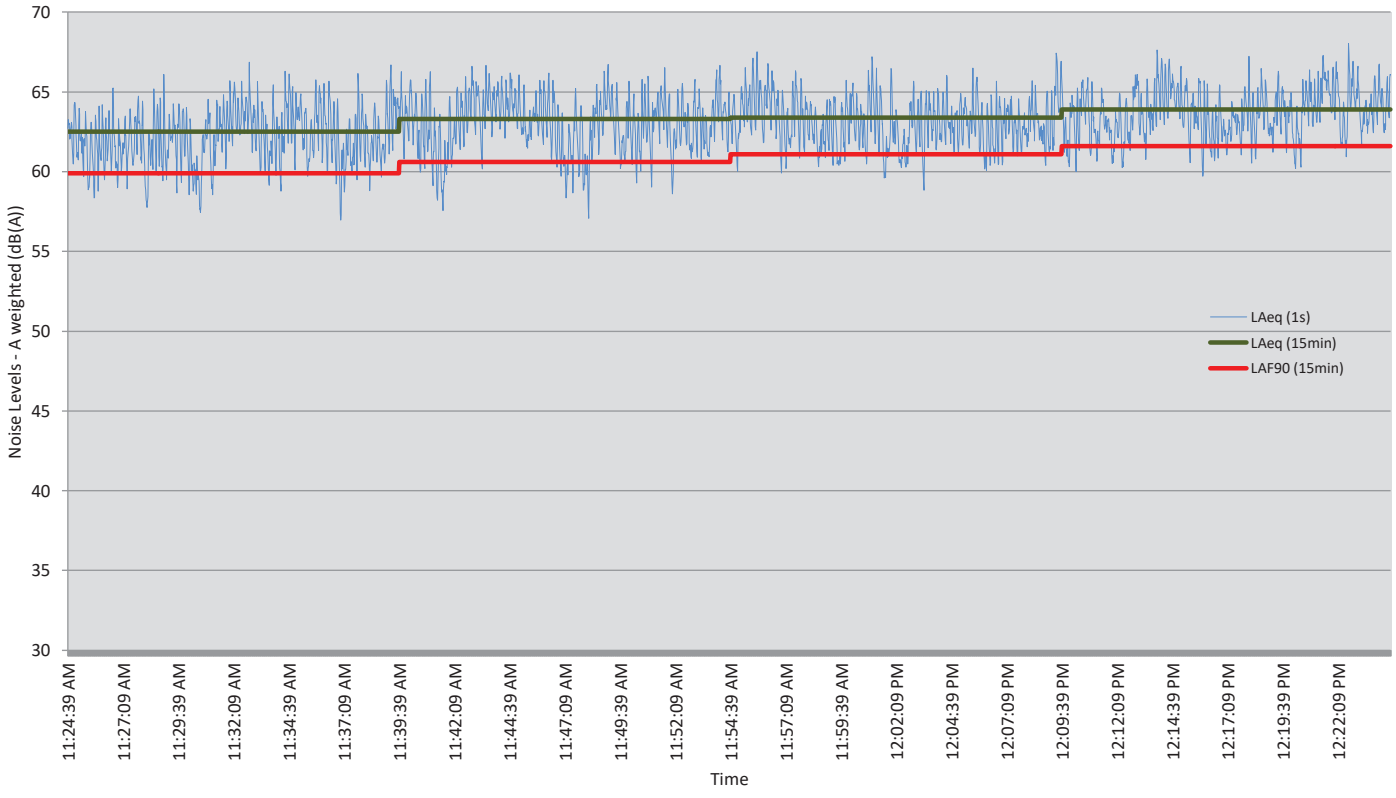
Pakiri Sand Extraction - Noise Level Measured at Position 5 - 11th July 2019
Wind direction: North-West - Wind Speed: 0.5 m/s to 1.5 m/s - Swell: 0.5 m



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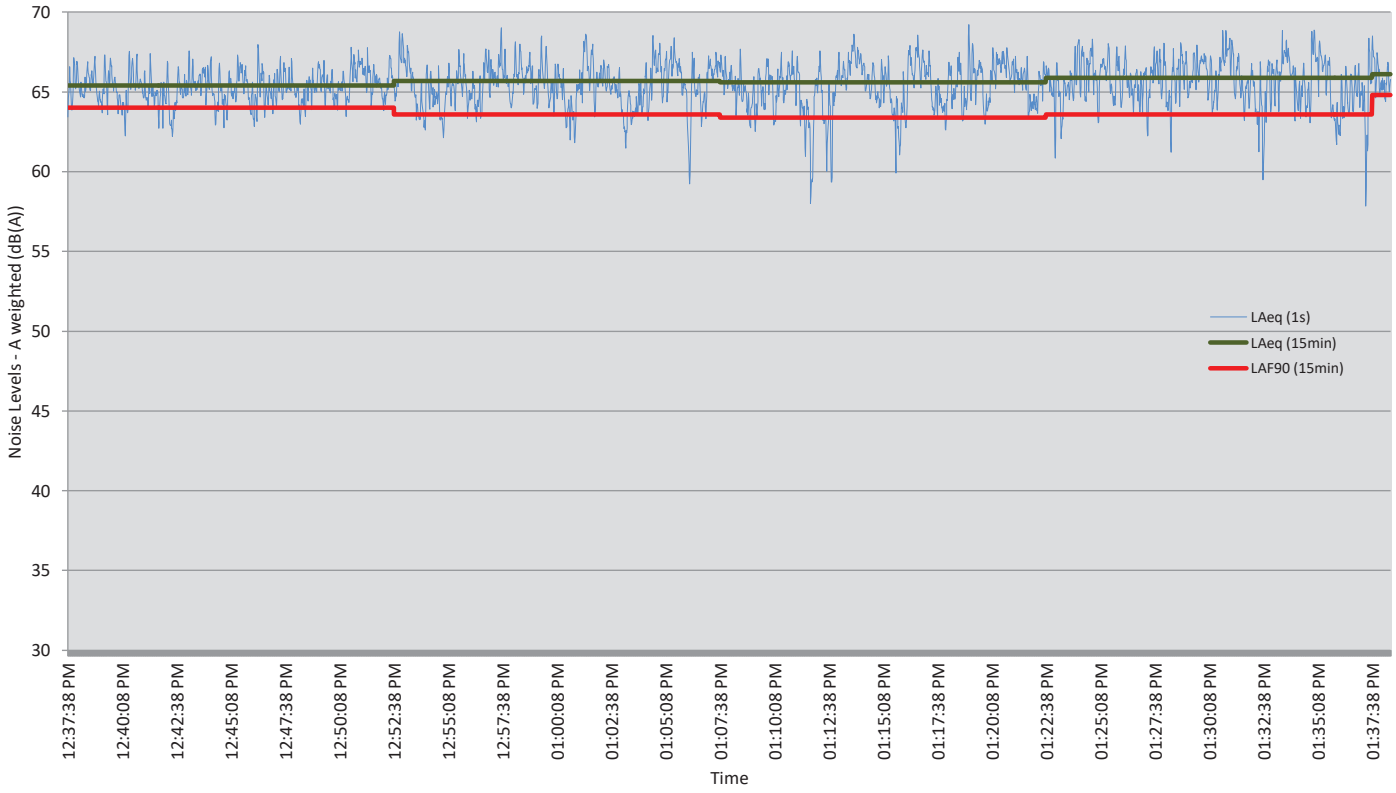
Pakiri Sand Extraction - Noise Level Measured at Position 6 - 11th July 2019
Wind direction: North - Wind Speed: under 1 m/s - Swell: 0.5 m



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