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**Hallett Cove - Cable Suspended Bridge - Wind Noise**

25 November 2021

**For the attention of: Alex Cortes**

Dear Alex,

This document summarises our assessment of wind generated noise from the proposed footbridges along the Hallett Cover Boardwalk.

# 1 PROJECT UNDERSTANDING

We understand that Marion Council has approved a proposed new cable bridge linking Grey Rd and Kurnabinna gullies along the Coastal Walkway (refer to Figure 1 below), with the addition of the suspended cable bridge provides a number of key benefits to the community including:

- Significant reduction on the impact to flora and fauna
- Increased accessibility and user-friendly for all ages
- A reduced construction timeline
- Lower ongoing maintenance costs compared to existing structure

The $4.8 million project (also taking in the segment at Field River) is being funded equally between Marion Council and the State Government.

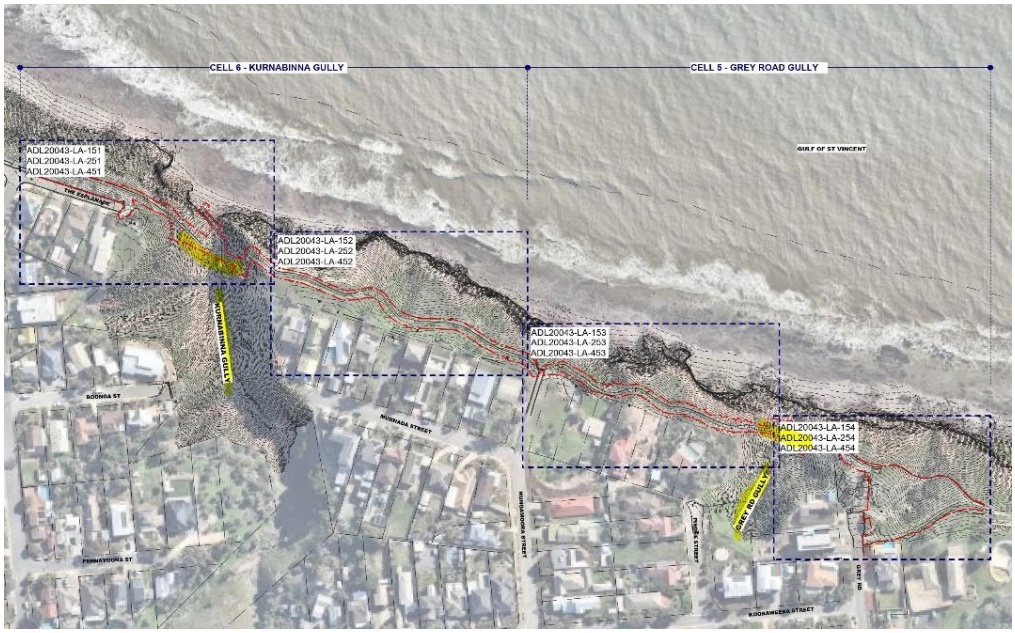



**Figure 1 Proposed bridge locations**

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The suspension bridges will be procured from local suppliers with a typical bridge shown below in Figure 4. An artistic impression of the proposed bridges is shown below in Figure 2 and Figure 3 below, with the span being ~40m.



**Figure 2 Proposed footbridge – Artistic impression**

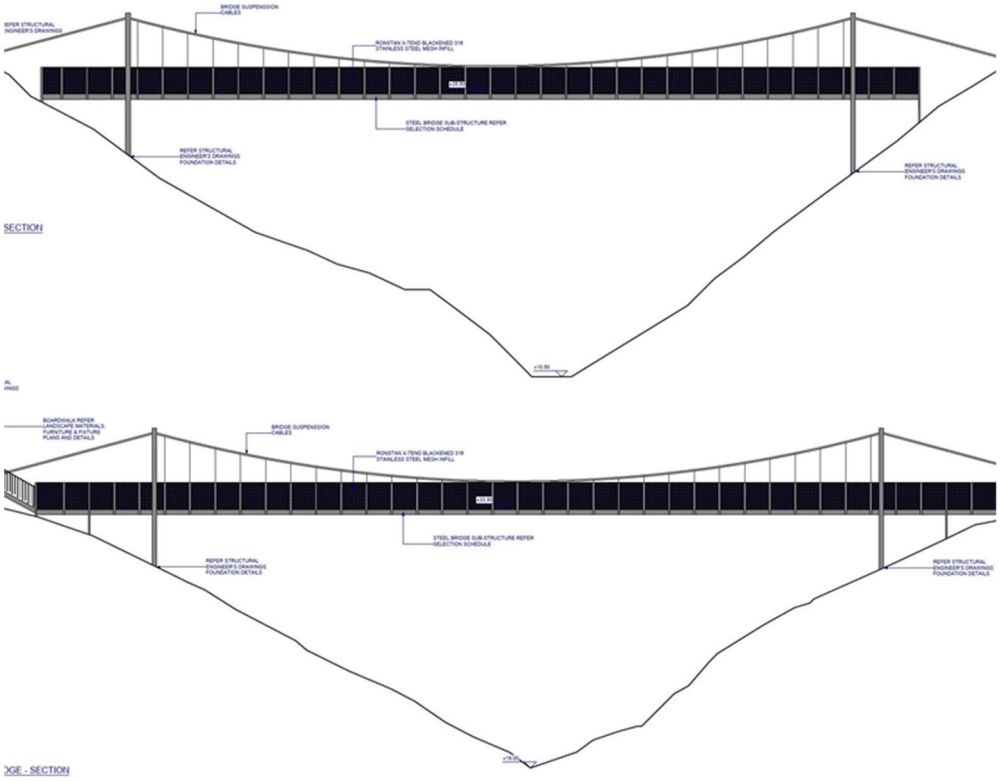



**Figure 3 Documented bridge span**

The community has raised concerns regarding noise from wind interaction with the bridges. Mott MacDonald have been engaged to review the proposed structure and comment on it's potential to generate noise from wind interaction with the structure. Our scope of work excludes:

- Wind induced vibration
- Human induced vibration



**Figure 4 Proprietary bridge (courtesy https://www.moodie.com.au/)**

## 2 WIND NOISE – AEOLIAN TONES

Wind induced noise is generated due to vortices being shed as wind blows across a slender object (cylinder), as shown in Figure 5. The frequency of the tone depends on the form of cylinder (eg. Circular, square, triangular etc), it's characteristic cross-dimension (eg. Diameter) and the wind speed. Refer to wiki-vortex shedding for more information.

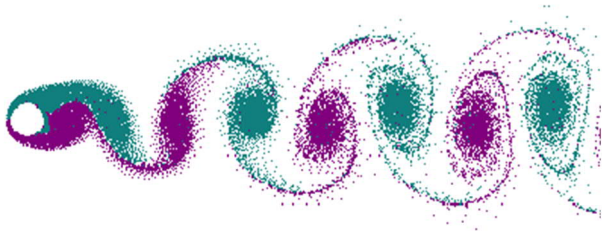


**Figure 5 Vortices being shed from a cylinder**

## 3 DESIGN REVIEW

We have reviewed the design documents and note the cables as design elements that will likely give rise to wind generated noise. To enable prediction of noise levels from wind interaction with the bridge structures, we will assume (refer to Figure 6 below):

- Main cables (Catenary): ~48mm dia.
- Secondary cables (vertical): ~12mm dia.
- Balustrade mesh: ~3mm

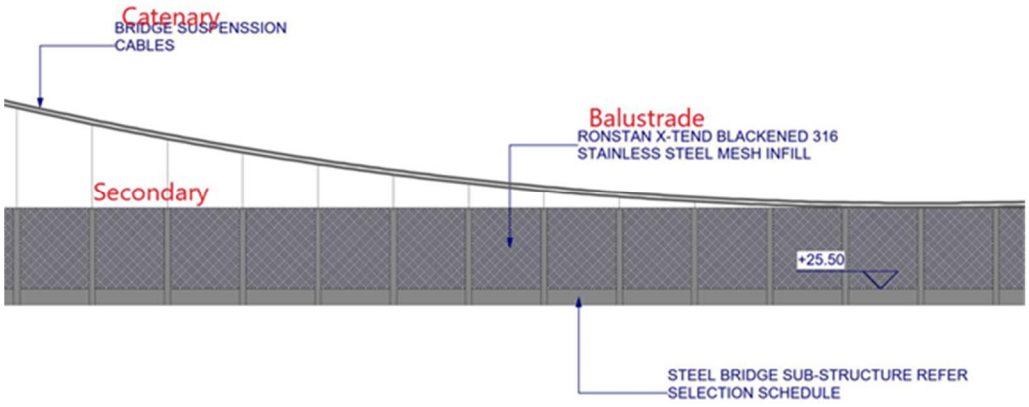



**Figure 6 Suspension bridge as documented**

# 4 SITE WIND CONDITIONS

Site wind roses for Hallett Cove and Off-Shore Glenelg are shown in Figure 7 below based on 5 year historically averaged mean wind speeds. The Hallett Cove data is affected by local suburban terrain, while the offshore data is unobstructed and demonstrates the characteristic SW/NE predominant wind directions. Frequency of wind from any direction is shown in Table 1 below, with strong winds occurring ~1% of the year or about 1 hour per week.

**Table 1 Wind speed statistics (offshore)**

| Calm | Light | Gentle | Moderate | Fresh | Strong | Near Gale | Gale |
|---|---|---|---|---|---|---|---|
| **0** | 0.5-3.5m/s | 3.5-5m/s | 5-8m/s | 8-11m/s | 11-14m/s | 14-17m/s | 17-21m/s |
| **5%** | 27% | 31% | 25% | 10% | 2% | 0.2% | 0.02% |

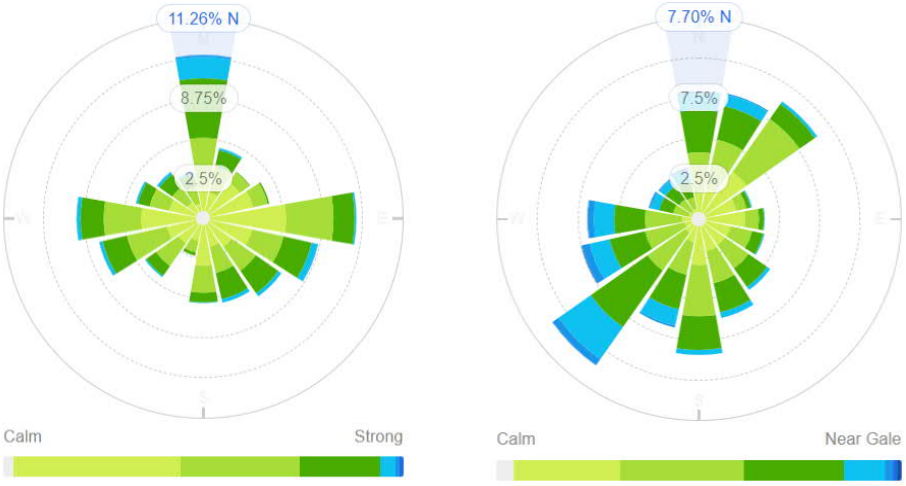



**Figure 7 Wind Rose (Left, Hallett Cove; Right, Offshore Glenelg)**

# 5 WIND / TERRAIN EFFECTS

As offshore wind approaches the shoreline/escarpment, it accelerates up the gullies due to blockages as shown by modelling below in Figure 8 and Figure 9, specific to the site location. The mean wind speed is shown to increase by ~20% due to gulley/escarpment acceleration.

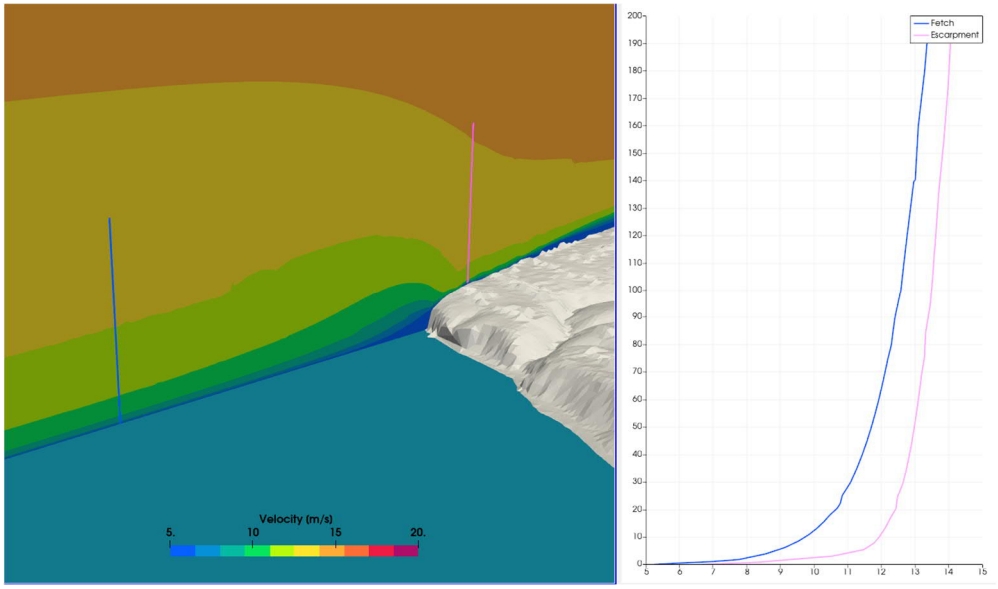



**Figure 8 Predicted wind speed acceleration up gully and escarpment**

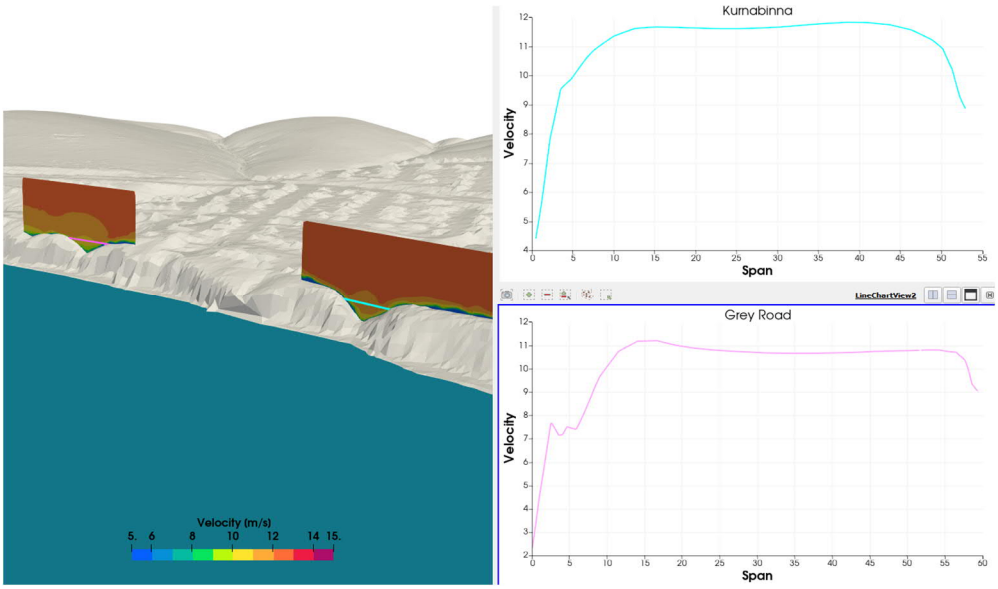



**Figure 9 Predicted mean wind speed along span**

## 6 ENVIRONMENTAL NOISE CRITERIA

There is no specific legislation or guidelines for the assessment of wind generated noise impact at residences. Therefore, reference has been made to the Environment Protection (Noise) Policy 2007 (the Policy) for guidance on appropriate noise criteria to protect noise amenity at residences.

The Policy provides noise criteria that are based on the World Health Organisation (WHO) recommendation for the protection against community annoyance and sleep disturbance at night. The criteria are derived based on the zoning of the noise source (i.e. the footbridges) and noise receivers (i.e. closest residences).

Based on the footbridges being within a Conservation Zone and the closest residences within a Hills Neighbourhood Zone, the Policy provides the following average noise level ($L_{Aeq,15min}$) criteria (with *Clause 20* of the Policy applied for development):

- 45 dB(A) during the daytime (7am to 10pm); and,
- 38 dB(A) at night-time (10pm to 7am).

Given wind generated noise can occur at any time during the daytime or night-time, it is the 38 dB(A) night-time noise criterion that is most relevant to this assessment.

The Policy requires a penalty adjustment be made to the predicted or measured noise levels where the noise exhibits any annoying noise characteristics such as tonality, low frequency, modulation and impulsiveness. A 5 dB(A) penalty is applied for one characteristic; 8 dB(A) for two characteristics; and 10 dB(A) for three or four characteristics. When considering wind generated noise, the noise has the potential to be tonal and modulates with wind speed, consequently attracting an 8 dB(A) penalty.

Nevertheless, it is noted that when considering a penalty, the existing acoustic environment must be taken into account and the penalty is only applied if the annoying characteristic is a dominant feature of the overall noise impact at the receiver. A penalty is not warranted if the observed noise characteristic is simply a part of the overall noise at the receiver.

In windy coastal areas such as the development site, the ambient noise levels are seldom low and are significantly influenced by other wind generated noise in the environmental such as beach waves and wind in trees or vegetation. Typically, the higher the wind speed, the higher the ambient noise (refer Figure 10 which shows the typical relationship between ambient noise and wind speed). These wind-related

environmental noise sources have the potential to mask the wind generated noise from the bridge, noting that as the noise level from the bridge increases with wind speed, so does the ambient noise (as shown in Figure 10).

Therefore, where the predicted wind generated noise levels from the bridge are lower than the expected noise from the ambient at the same wind speed (typically greater than 35 dB(A) at the wind speeds under consideration), a penalty for noise characteristics is considered not warranted.

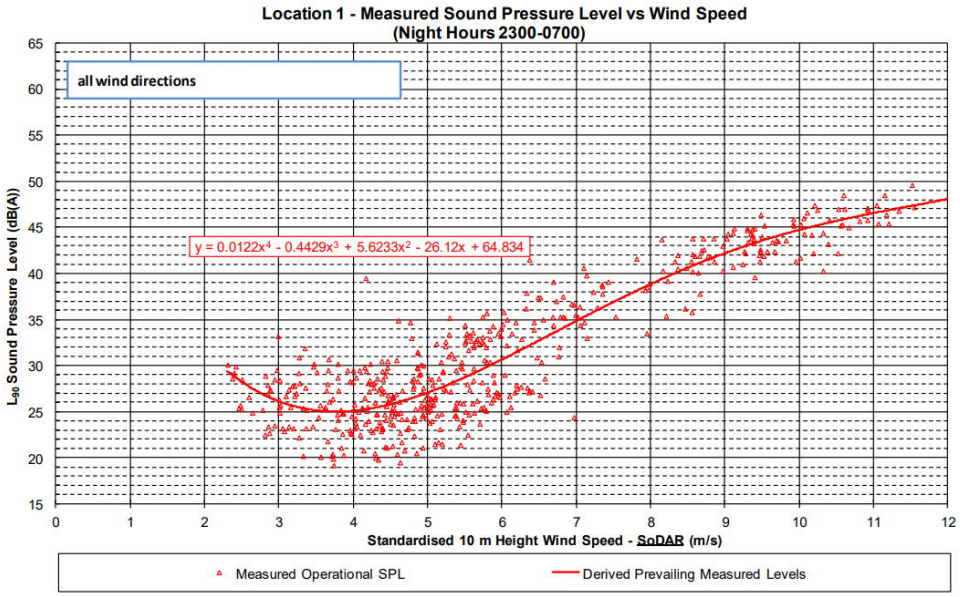



**Figure 10 Ambient noise relative to wind speed (10m AGL)**

## 7 WIND NOISE PREDICTION

The acoustic pressure levels from wind blowing across the bridge cables have been estimated using the method below provided by Phillips[1].

$$\overline{p^2}(r) \sim 0{\cdot}27 \cos^2\theta \frac{\rho^2 l d U^6 S^2}{a^2 r^2}$$

where, $\theta$ is angle between the direction of observation and the wind incident;
$\rho$ is air density, 1.2 kg/m$^3$;
$l$ is length of cables
$d$ is diameter of cable;
$U$ is wind speed;
$S$ is Strouhal number, 0.2;
$a$ is velocity of sound in air, 343 m/s;
$r$ is distance between source and receivers.

The resultant noise level at the receiver point is then derived using the following equation (with $p^2$ derived from the above):

$$Leq = 10 \log_{10} \frac{p^2}{{p_{ref}}^2}, \qquad \text{where } p_{ref} \text{ is reference pressure, 20 µPa.}$$

The following assumptions have been made for the assessment:

- The worst-case (with highest predicted noise level) receiver point is approximately 30m from the bridge;
- The receiver point is located downwind;

[1] Phillips, O.M., 1956. The intensity of Aeolian tones. Trinity College, Cambridge.

- The wind incident is normal to the cable span/mesh plane;
- All extent of cables/mesh are located at the closest point at the bridge from the receiver (i.e. approximately 30m);
- An allowance of 25% for additional cable length during procurement;
- The 99$^{th}$ percentile wind speed considered used in lieu of average (50$^{th}$ percentile resulting in higher noise levels);
- The prediction is based on geometric spreading and does not take into account access attenuation from air and ground absorptions.

It is noted that the above assumptions and conditions are conservative, and result in higher predicted wind generated noise than would occur in practice.

Based on the above, the predicted noise level at 30m from the source, under 14m/s wind speed, are summarised below:

**Table 2 Predicted noise from cables**

| Cable | Main cables (Catenary) | Secondary cables (vertical) | Balustrade mesh |
|---|---|---|---|
| **Diameter, mm** | 48 | 12 | 3 |
| **Length, m** | 160 | 200 | 7100 |
| **Predicted noise level, dB(A)** | < 5 | <15 | 31 |
| **Tonal frequency, Hz** | 60 | 239 | 956 |

Based on the above, the predicted worst-case noise level is 31 dB(A) at the closest receiver point and therefore less than the 38 dB(A) noise criteria. With a predicted noise level of 31 dB(A) under 14m/s wind speed, the ambient noise level is likely to be greater and will mask any tonal or modulation noise characteristics. Therefore, the application of a noise penalty is not warranted.

# 8 SUMMARY AND CONCLUSIONS

Marion Council has approved a proposed new cable bridge linking Grey Rd and Kurnabinna gullies along the Coastal Walkway. The community has raised concerns regarding noise from wind interaction with the bridges. Wind statistics have been reviewed, along with acceleration of wind due to coastal features, suggesting a mean wind speed of 14m/s will occur 1% of the time. The predicted noise level due to aeolian tones is 31dBA, predominantly from the balustrade mesh. Penalties could be applied for tonality and modulation, however these are not considered warranted given the ambient noise will also increase during strong wind events. The criterion at night time is 38dBA, hence wind noise from the bridges is unlikely to exceed the noise criterion and therefore unlikely to cause annoyance to the surrounding community.

# 9 REFERENCES


1. Broneske, S. (2014) “Wind turbine noise measurements - How are results influenced by different methods of deriving wind speed?”, Inter-noise 2014
2. Phillips, O.M. (1956) “The intensity of Aeolian tones”, Trinity College, Cambridge.
3. Environment Protection (Noise) Policy 2007
4. South Australian Wind Farm Guidelines (2009), Environment Protection Authority.

We trust this information is sufficient and should you have any queries, please do not hesitate to contact us.

Yours sincerely



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