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Dear Tom

**3 PAVILION STREET, QUEENSCLIFF - ALTERATIONS AND ADDITIONS
COASTAL ASSESSMENT REPORT**

Further to our recent discussions, we are pleased to set out in this letter the Coastal Assessment Report for the proposed alterations and additions at 3 Pavilion Street, Queenscliff.

1. BACKGROUND

1.1 Outline of Proposed Alterations and Additions

The proposed alterations and additions are set out in eight drawings supplied by Collins and Turner, as follows:

Drawing Number	Issue	Date	Title
338_DA_140	06	21/12/22	Lower Ground Floor
338_DA_141	06	21/12/22	Ground Floor
338_DA_142	06	21/12/22	First Floor
338_DA_143	06	21/12/22	Roof Terrace
338_DA_201	05	21/12/22	Elevations
338_DA_202	05	21/12/22	Elevations
338_DA_310	05	21/12/22	Sections
338_DA_311	05	21/12/22	Sections

A description of the proposed alterations and additions has been supplied by Collins and Turner in the following terms:

This development application seeks to update the existing dwelling to provide a contemporary home befitting the prize location whilst making necessary repairs and improvements.

On the ground floor this will include changes to the existing garage such as adding a car stacker that will descend to an expanded lower ground level. The existing curved staircase that

forms a dominant element of the existing street-facing facade will be replaced with a new stair that accesses all levels and an elevator that will reach all internal floors. Ground floor living spaces, in particular the outdoor levels, will be rationalised to provide a more flexible floor plan.

The existing lower ground level will be expanded westwards to accommodate the aforementioned car stacker. In addition, the living spaces will be expanded to include a cellar and a home gym whilst the existing swimming pool, which sits between the existing ground and lower ground levels will be demolished. A new swimming pool will be constructed on the lower ground level along with associated outdoor living spaces.

The first floor will remain largely unchanged, however, some interventions will be made, such as expanded glazing and new privacy screens and solar shading.

All facades will receive a new surface treatment whilst the existing pitched roof will be removed in favour of non-trafficable flat roofs, planter boxes and a roof terrace.

New internal stairs will continue beyond the existing first floor to a new roof terrace, which will utilise the newly built flat roof.

Of relevance to the Coastal Assessment is that the site is located near the crest of an approximately 25m high sandstone cliff face on Queenscliff headland, with a lower ground level of the building situated at 32.95m above Australian Height Datum (32.95m AHD). AHD is approximately the level of mean sea level at present.

The location of 3 Pavilion Street, Queenscliff relative to the cliff face and surrounding development is shown in Figure 1-1.



Figure 1-1 Location of 3 Pavilion Street, Queenscliff (source: Nearmap, photo date 9/01/2023)

1.2 Preliminary Geotechnical Assessment

A preliminary geotechnical assessment of the site was carried out by JK Geotechnics in February 2022. The assessment comprised:

- a site walkover inspection on 13 December 2021;
- a search of the JK Geotechnics project database to identify relevant geotechnical investigations completed adjacent to the site;
- a review of aerial photography (Nearmap and Google Earth);
- a review of the regional geology map (Sydney); and
- completion of a drone survey and review of the results.

Plate 1 shows the approximately 25m high sandstone cliff face below the site. The northern portion of the cliff face was observed to contain two potentially unstable detached rock blocks sitting towards the crest of the cliff face.

Visual observations of the southern portion of the cliff face were limited due to dense vegetation, however, based on the imagery obtained from the drone survey, it appeared there is a south facing rock face extending along the common southern boundary, as shown in Plate 2. The rock face appears to contain two sub-vertical joints, identified as Joints J1 and J2 in Plate 2. There was also evidence of a possible undercut, however due to the vegetation and inherent limitations of the drone survey, the extent of the undercut could not be confirmed.

A number of other relatively shallow undercuts were observed across the cliff face, however none appeared to extend significantly into the subject site.

The report did not recommend applying any new structural loads closer to the cliff line than the current loading of the existing pool and house.

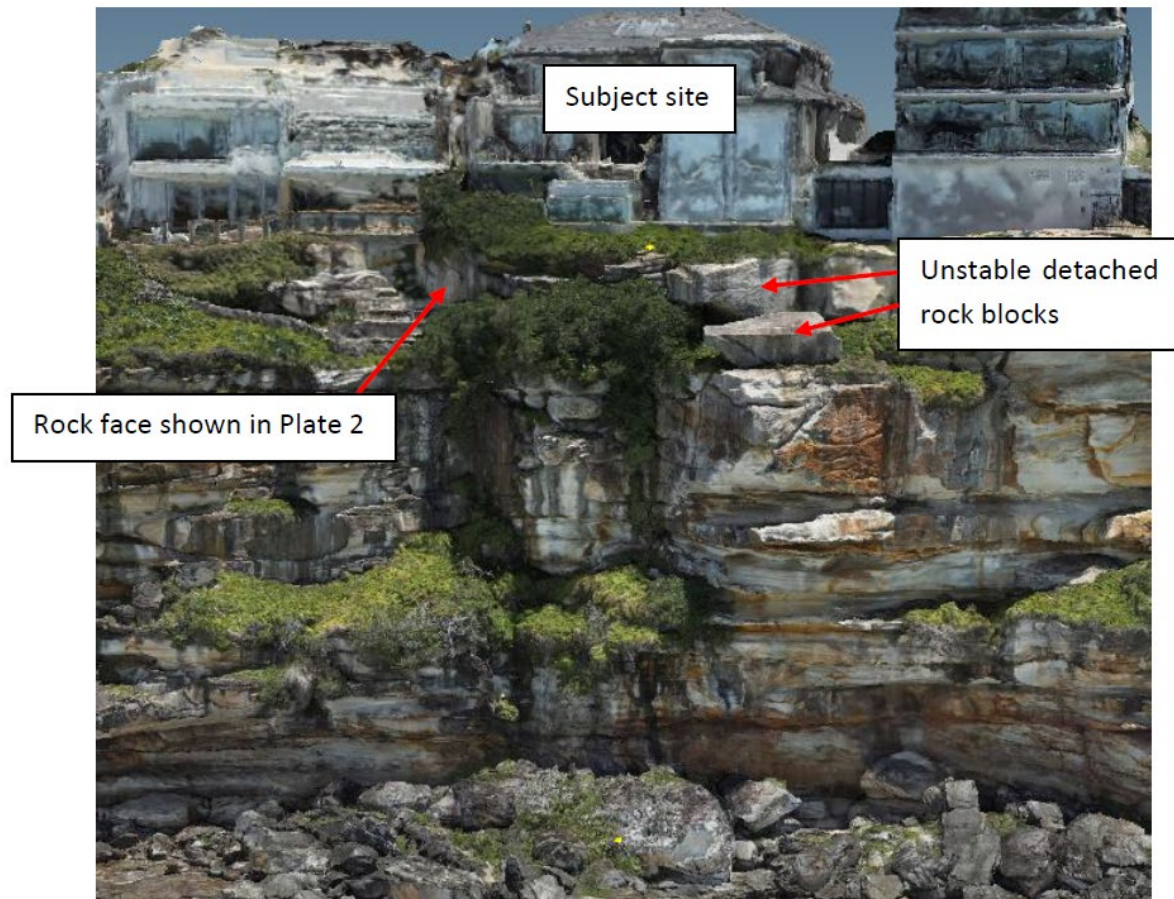


Plate 1 Cliff face below 3 Pavilion Street, Queenscliff (from JK Geotechnics, 2022)

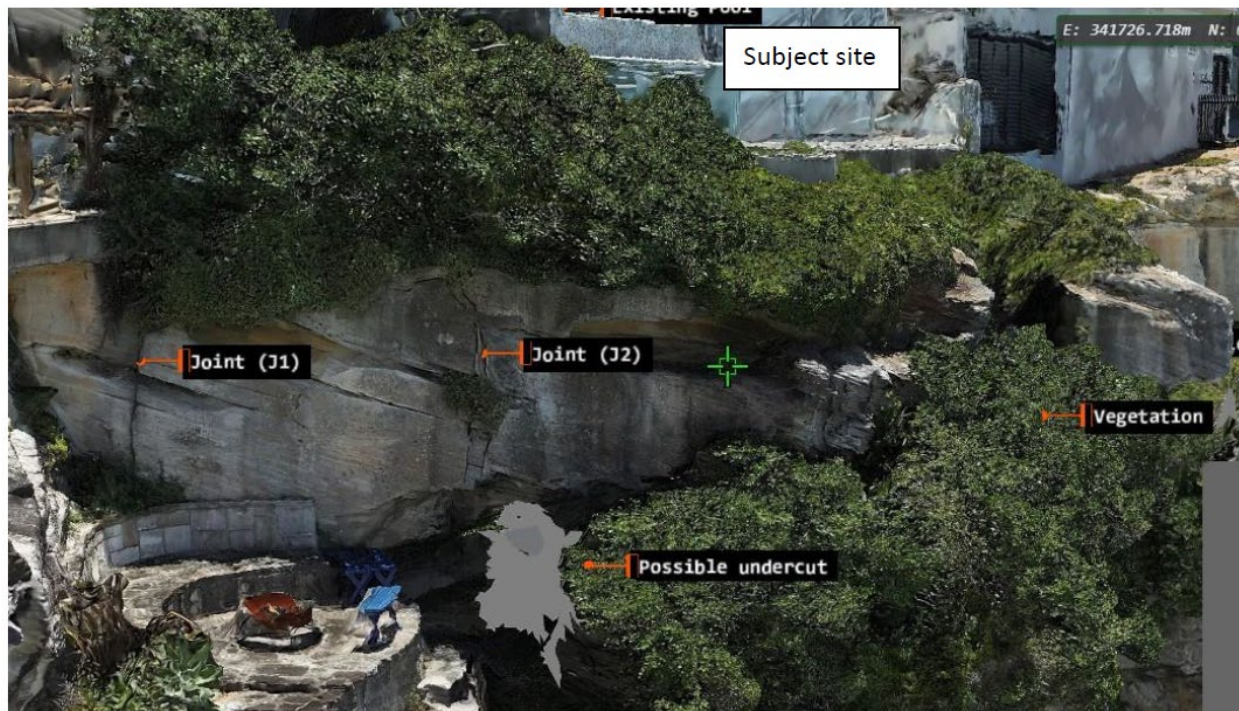


Plate 2 Cut face exposed in neighbouring southern property (looking approx. north) (from JK Geotechnics, 2022)

1.3 Provisions within Warringah Development Control Plan 2011

Contact was made with Ms Jodie Crawford, Manager Coast & Catchments, Northern Beaches Council to confirm the policy or guideline documents that may be relevant for a Coastal Assessment Report for sites adjacent to coastal cliffs.

Ms Crawford drew attention to two controls within the Warringah Development Control Plan 2011 (WDCP 2011):

- Part B Built Form Controls – B13 Coastal Cliffs setback; and
- Part E The Natural Environment – E10 Landslip Risk.

B13 Coastal Cliffs setback applies to 3 Pavilion Street, Queenscliff. The objectives of B13 Coastal Cliffs setback are as follows:

- to limit the bulk and scale of highly exposed cliff top development;
- to maintain the scenic quality of the cliffs; and
- to ensure views are maintained from the land to which the Coastal Cliffs setback applies.

The requirements of B13 Coastal Cliffs setback are as follows:

- development must not extend beyond the coastal cliffs building line. The location of the coastal cliffs building line is shown as a heavy black line measured a distance of 25m perpendicular to the street frontage property boundary;
- the area between the coastal cliffs building line and the cliff is to be free of any buildings or structure and landscaped using predominately indigenous vegetation.

The requirements in B13 Coastal Cliff setback are a matter for the Architect and would be addressed by Collins and Turner.

E10 Landslip Risk applies to 3 Pavilion Street, Queenscliff. The objectives of E10 Landslip Risk are as follows:

- to ensure development is geotechnically stable;
- to ensure good engineering practice;
- to ensure there is no adverse impact on existing subsurface flow conditions; and
- to ensure there is no adverse impact resulting from stormwater discharge.

The location of the subject land is shown superimposed on Landslip Risk Map – Sheet LSR_010 in Figure 1-2 and straddles Area B and Area C. The location of the land relative to the different Areas on the Landslip Risk Map govern the need for geotechnical and hydrological reporting. These reports are outside the scope of the coastal assessment and are being managed by Collins and Turner.



Figure 1-2: Landslip Risk Map – Sheet LSR_010 with 3 Pavilion Street, Queenscliff superimposed

2. COASTAL ASSESSMENT

2.1 General

The Coastal Management Act 2016 identifies seven coastal hazards:

- beach erosion;
- shoreline recession;
- coastal lake or watercourse entrance instability;
- coastal inundation;
- coastal cliff and slope instability;
- tidal inundation; and
- erosion and inundation of foreshores caused by tidal waters and the action of waves, including the interaction of those waters with catchment floodwaters.

Beach erosion and shoreline recession relate to sandy coastlines and are not applicable to the subject site. Similarly, coastal lake or watercourse entrance instability are not a relevant consideration.

Matters related to inundation by coastal processes, namely coastal inundation, tidal inundation and inundation caused by tidal waters and the action of waves, are discussed in Section 2.2.

Foreshore erosion caused by tidal waters and the action of waves, as it relates to coastal cliff and slope instability, is discussed in Section 2.3. A geotechnical engineering assessment of the site having regard to the requirements of E10 Landslip Risk will be reported separately, as noted earlier.

2.2 Assessment of Inundation due to Coastal Processes

Inundation of foreshore land due to coastal processes can arise from the combination of astronomical tide, storm surge, wave setup and wave runup. Consideration also needs to be given to projected sea level rise due to climate change over the design life of the proposed development. It is considered reasonable to adopt a design life of 60 years for residential development (Horton et al, 2014; Horton and Britton, 2015). This is also consistent with coastal management in other areas of the Northern Beaches.

Water levels due to astronomical tide occur independently of ocean storms, being caused by the gravitational forces exerted on the earth by the moon, and to a lesser extent by the sun, and are well understood.

Storm surge is the elevated water level above astronomical tide at the times of ocean storms caused by two effects; the inverted barometric pressure effect (water level rising under low atmospheric pressure) and wind setup (water 'piling up' along the coastline due to strong onshore winds).

Astronomical tide and storm surge are generally considered together as they are measured jointly by water level recorders. Based on Department of Environment, Climate Change and Water (DECCW)(2010), the 100 year average recurrence interval (ARI) ocean water level (in the absence of wave action) is 1.44m AHD. Accounting for sea level rise over the period 2010 to 2023, the current 100 year ARI ocean water level excluding wave action would not exceed 1.5m AHD.

Wave setup due to wave breaking adds to the 'still' ocean water level at times of storms. Water level then reaches a higher level again due to the runup of individual waves. The limit of wave runup along

the Sydney coastline in severe ocean storms having an ARI of 100 years, determined from numerical model and survey of debris lines, is in the order of 8m AHD.

Projected sea level over the next 60 years can be assessed from the latest Intergovernmental Panel on Climate Change (IPCC) Assessment Report (AR6). Various sea level rise scenarios are commonly considered in coastal management, namely¹:

- SSP2 – 4.5: Intermediate emissions scenario
- SSP3 – 7.0: High emissions scenario
- SSP5 – 8.5: Very high emissions scenario

The Very High emissions scenario is very unlikely to represent the world's climate future, having regard to existing national policies and expected future policies regarding use of fossil fuels and renewable energy. Accordingly, the focus is typically on SSP – 4.5 and SSP3 – 7.0. A reasonable estimate for projected sea level rise over the next 60 years for planning purposes, based on these scenarios, is 0.5m.

On the basis of the above considerations, inundation due to coastal processes would not be expected to exceed around 8.5m AHD. Even rounding this level upwards to 10m AHD it is evident that inundation is not a concern for the proposed development where the lower ground level is more than 20m further higher at 32.95m AHD.

2.3 Foreshore (Cliff) Erosion by Tidal Waters and the Action of Waves

While coastal cliffs exist because they are formed of rock, they are not totally immune from erosion and will continue to erode. The mechanisms for their erosion is described below (AGS, 2007).

Coastal cliffs are subject to repeated cycles of wetting and drying which can include salt crystal growth and expansion within rock gaps. Wind and salt spray also play a part in eroding the face of a cliff. Additionally, direct wave action and the impact of boulders moved by wave action can cause instability at the base of coastal cliffs leading to an increased loss in strength of the cliff material. These processes increase the rate of erosion of coastal cliffs in comparison to inland cliffs (AGS, 2007).

A review of recent geotechnical and coastal assessments was undertaken for properties within the Queenscliff area and Northern Beaches more broadly by reviewing development applications through the Northern Beaches Council website. Through this search of previous studies, a geotechnical assessment undertaken by Ascent (2021) Geotechnical Consulting for a nearby property (7 Crown Road) approximately 200m north of 3 Pavilion Street (the same north facing escarpment) was reviewed. Ascent (2021) stated that the *“escarpment will be affected by both chemical and mechanical weathering, with approximate rates of regression of <10mm per year.”*

A similar coastal assessment report undertaken at Avalon Beach by Horton (2020) referenced Crozier and Braybrooke (1992) who estimated that the sandstone cliff erosion rate in Sydney's Northern Beaches is on average 4mm / year. Conservatively, Crozier and Braybrooke (1992) estimated the maximum rates of recession in the Northern Beaches to be 12mm / year.

The above information is in line with WRL's (2016) report on Sand Dune Management at adjacent Freshwater Beach, where they referenced Chapman et al. (1982) who suggested the magnitude of cliff erosion rates in Sydney are 5mm / year. Similarly, WRL also quoted Dragovich (2000) who estimated

¹ 'SSP refers to 'Shared Socioeconomic Pathways'.

erosion rates of Sydney sandstone to be 1 to 5mm / year in areas with high salt load. However, this was not in direct relation to wave action. The rates of recession for softer beds of sandstone cliffs in the southern Sydney region were estimated to be 2 to 5mm / year (Dragovich, 2000).

Sea level rise (SLR) is expected to increase wave energy reaching further inshore which in turn is expected to increase rates of cliff retreat (Shadrack et al., 2022). Regardless, it is expected that the cliff erosion rates discussed above will not change significantly over the next 60 years (the adopted design life of the proposed alterations and additions).

The above erosion rates due to tidal waters and the action of waves should be taken into account by the geotechnical engineer in the geotechnical assessment of the site.

3. REFERENCES

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Department of Environment, Climate Change and Water (DECCW)(2010), Coastal Risk Management Guide: Incorporating sea level rise benchmarks in coastal risk assessments, DECCW 2010/760, August 2010, ISBN 978 1 74232 922 2

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I trust the above meets your requirements. Please contact me should you require any clarification or additional information.

Yours faithfully



Greg Britton

Technical Director
Water