

BMYS - Safe Harbour
Project

Appendix L

**Lanepiper Report –
Cliff geomorphology**

Our Ref: 209057LetterReport01.2

30 April 2009

Beaumaris Motor Yacht Squadron C/- MDT Consulting Pty Ltd
12 Edmanson Avenue
Brighton, VIC 3186

Attention: Mark Turnbull

Dear Mark,

Cliff Face Slope Stability Assessment Beaumaris Motor Yacht Squadron, Beach Road, Vic

1 INTRODUCTION

Lane Piper was requested by Mr Peter Barnes of Beaumaris Motor Yacht Squadron (BMYS), in an email dated 16th April 2009, to undertake a geotechnical slope stability assessment of the coastal cliff face at the BMYS site at Beach Road, Beaumaris.

The slope stability assessment was carried out to investigate the potential impacts of the proposed development on the surrounding cliffs, for submission of an Environmental Effect Statement to the Department of Planning and Community Development (DPCD). The assessment involved reporting of the cliff face stability and recommendation for stabilisation or other amelioration of the impacts of any failure of the cliff face.

1.1 Proposed Development & Development Restrictions

BMYS plans to redevelop the site into a new marina, which will include a 3-tier, 78 boat dry-stack structure, some 9 m high and 88 m in length, located towards the eastern end of the site. It is understood the dry-stack structure will be constructed on the fill platform of the BMYS land, parallel to the cliff face, with a corridor left behind the structure, so that the structure does not touch the cliff face. It is also understood the dry-stack structure will have no basements and will not receive any support from the cliff face.

It is understood the cliff faces are located on Crown land, under the control of the Department of Sustainability and Environment (DSE) and managed by Bayside City Council, and not under the control of the BMYS. The BMYS has a lease for the filled land in the front of the cliff faces, but the proposed development will be constructed away from the cliff face and will not intrude onto the DSE land at the toe of the cliff face.

As a condition of the club lease, public access to the toe of the cliff face is required to be maintained by the Club. It is understood there are development restrictions imposed by the DSE on this land with particular reference to the preservation of the fossils on the seafloor.

A Public Purposes Reserve (ROW), runs along the north west boundary of the BMYS property and the embankment, which exits onto a small section of beach adjacent to the western end of the property.

The BMYS is located in an area recognised as a site of significance importance, due to the abundance and diversity of fossil assemblages. The site is listed on the Register of the National Estate of the 'Department of the Environment, Water, Heritage and the Arts'. The cliffs have also been the subject of significant geological research since the 1890's, with numerous published scientific papers.

1.2 Previous Work

The content of this report is based on the recent site inspection and previously completed geotechnical inspections of the same site carried out by Piper & Associated Pty Ltd¹.

- 26024L1 *Geotechnical Inspection of the Cliff Face, Beaumaris Motor Yacht Squadron*, dated 29th August 2005;
- 26024L2 *Geotechnical Inspection of Remediated Cliff Face, Beaumaris Motor Yacht Squadron*, dated 12th September 2005).

In summary, the previous geotechnical reports recommended work be undertaken to remove dangerous sections of rock from the cliff face, install fencing along the toe of the cliff and provide adequate signage, to alert the public and BMYS members of the dangers of falling rocks.

The loose sections of the cliff were removed with the aid of an excavator and the cliffs were reassessed to be largely stable.

1.3 Limitations of Report

The current report is limited to the discussion, assessment and recommendations on the stability of the cliff face at the BMYS site. No intrusive investigation has been undertaken. Detailed remediation measures and stabilisation options and costings are beyond the scope of this report. The ramifications of any proposed remedial measures, such as permit for works, local Council issues or environmental issues including fossil preservation, are not considered in this report.

2 SITE DESCRIPTION

The BMYS is located on Beaumaris Bay, on the seaward side of Beach Road, Beaumaris. Entry to the site is from Beach Road, opposite Cromer Road, down a moderately steep asphalt access road with concrete curb and channel. Most of the site comprises a near level platform, understood to be constructed by filling during the 1950's, which houses the clubhouse, car parking areas, pier, boat ramps, break water and parking for boats and trailers (Figure 2-1). The BMYS is secured on the landward side by a cyclone fence and motorised security gates.

The BMYS site is separated from the cliffs along the foreshore reserve, by a Right of Way (ROW), for public access to Keepers Cove and the western foreshore area. A 3-4 m wide ROW track, runs west from the bottom of the BMYS access road, along the toe of the embankment to the western end of the BMYS property. Access to the boatyard area at the eastern end of the BMYS property, is through a gate in the security fencing.

The area between Beach Road and the top of the cliff is characterised by footpath / cycle path leading onto a narrow, near level reserve area with a pathway which leads to a lookout. The

¹ Piper & Associates Pty Ltd, merged with Lane Consulting Pty Ltd in July 2006, to form Lane Piper Pty Ltd.

lookout is precariously located on the cliff edge. The area is fenced off for public safety. The reserve comprises scrubland with small trees and bushes.

Reference to the Australian Heritage website (www.environment.gov.au), indicates the cliff top vegetation in this area is dominated by a coastal scrub of coast tea-tree, coast wattle, mirror bush, coast beard-heath, common boobialla drooping sheoke, black wattle, and spike wattle. cliff faces.

Figure 2-1: Aerial Photo of BMYS Site



3 SITE GEOLOGY

The geological map of the area (Ringwood 1:63,360), and 'Engineering Geology of Melbourne (1992), indicates the site to lie in the region of Brighton Group sediments of Quaternary age, which cover extensive areas of the southern and south-eastern suburbs. The Brighton Group sediments are locally overlain by undifferentiated sandy clays, sands and clayey sands, including thin dune and swamp deposits of Recent Quaternary age.

The upper section of the coastal cliffs along the BMYS site, expose the 'Red Bluff Sands Formation', comprising orange and light brown sandy clays, fine to coarse sands, clayey sands, often lenticular calcareous with variable iron oxide cementation. The Red Bluff Sands are unconformably underlain by the 'Black Rock Sandstone Formation', comprising green-brown to grey-green, well consolidated, slightly to moderately weathered sandstone, with abundant ferruginous cement. The Black Rock Sandstone Formation overlies clays of the Fyansford Formation.

The cliffs are aligned parallel to the axis of a major tectonic structure known as the Beaumaris Monocline, which has downthrown the sedimentary strata to the south-east. The parallel rock strata are striking north-west to south-west, and can be seen exposed in the seabed (see Figure 2-1).

4 SITE INSPECTION OBSERVATIONS

The site inspection was carried out on 21st April 2009, and involved a detailed walkover study by an experienced, senior geotechnical engineer, who logged and photographed the cliff face along the BMYS boundary. Particular emphasis was placed on instability and erosion features evident in the cliff face behind the proposed dry-stack structure.

For the purposes of the report, the site can be broken down into three zones;

Section 1: Eastern cliff section, in area of proposed drystack structure;

Section 2: Central section in the area of access road;

Section 3: Western section to the rear of the BMYS car park;

4.1 Section 1

The cliff face in the area of the proposed dry stack structure, is typically near vertical and approximately 8 to 9 m in height. The rock is mostly massive and highly ferruginised, with prominent, near horizontal, ironstone bands in the lower half of the exposed face. The closely spaced, parallel ironstone layers are more erosion resistant than the surrounding sandstone matrix, and form a highly contoured profile in the cliff face (Figure 4-1).

The runoff from the cliff top has been concentrated in channels forming near vertical rill erosion channels, which are typically 100 mm wide and 150mm deep, but in isolated areas are up to 500 mm deep (Figure 4-2).

Based on the inspection from the base of the cliff, the upper 1 m of the cliff appears to be unconsolidated sediments (i.e. clay, sand and silt), which are part stabilised at the exposure by the surface vegetation. Some of this vegetation has grown over and down the cliff and certain localities there are small trees growing from the cliff face.

Figure 4-1 Resistate ironstone layer exposed in cliff face



Figure 4-2 Near vertical erosion channels and overgrown vegetation

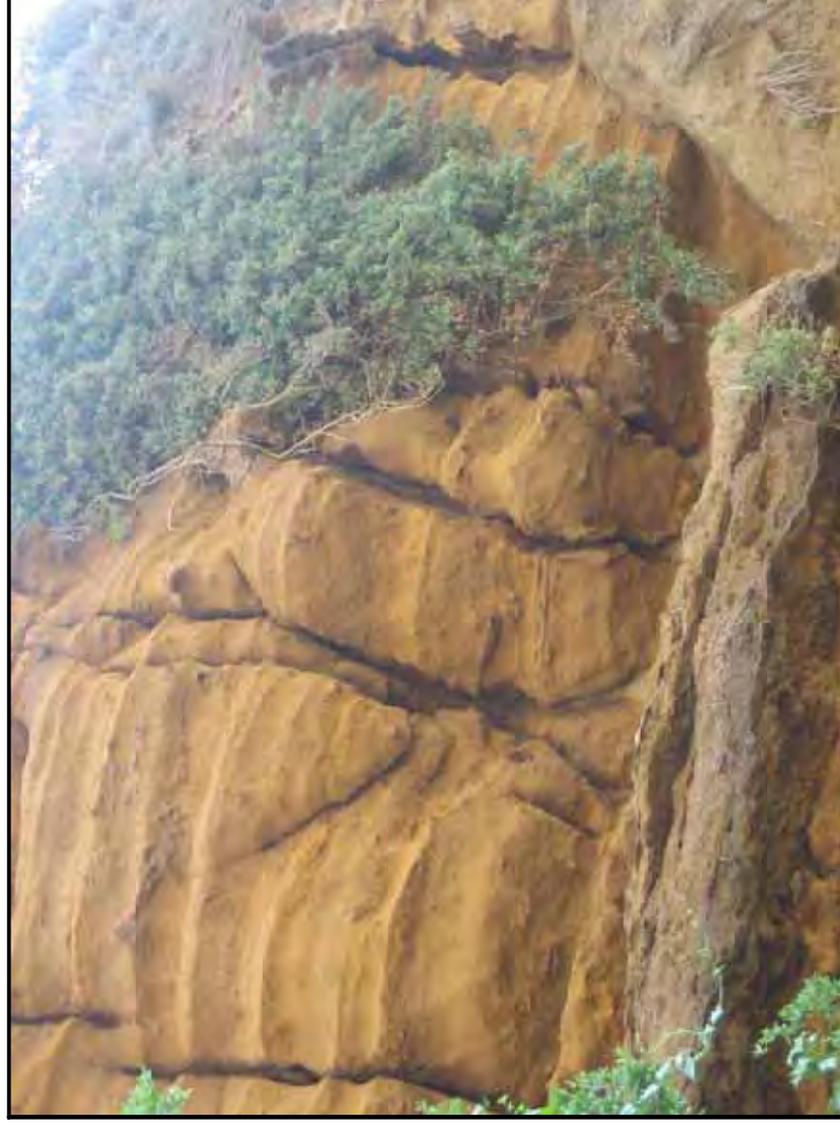
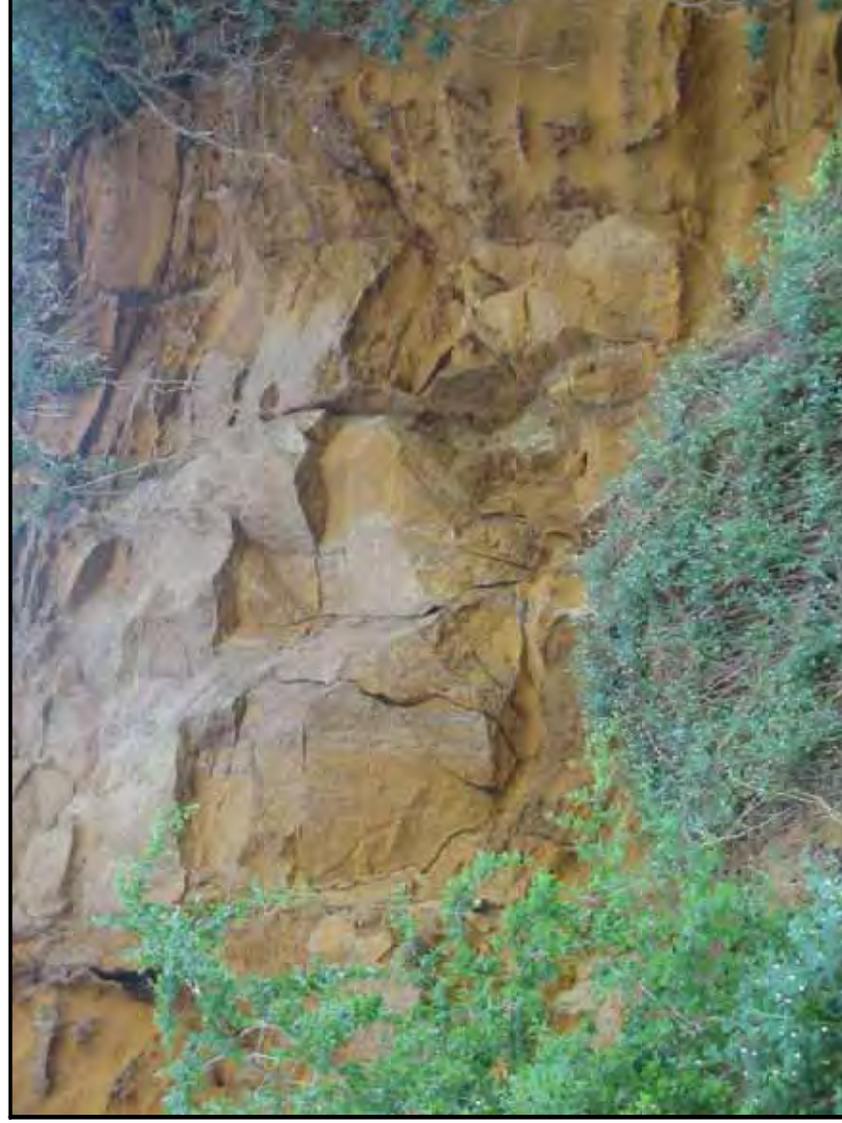
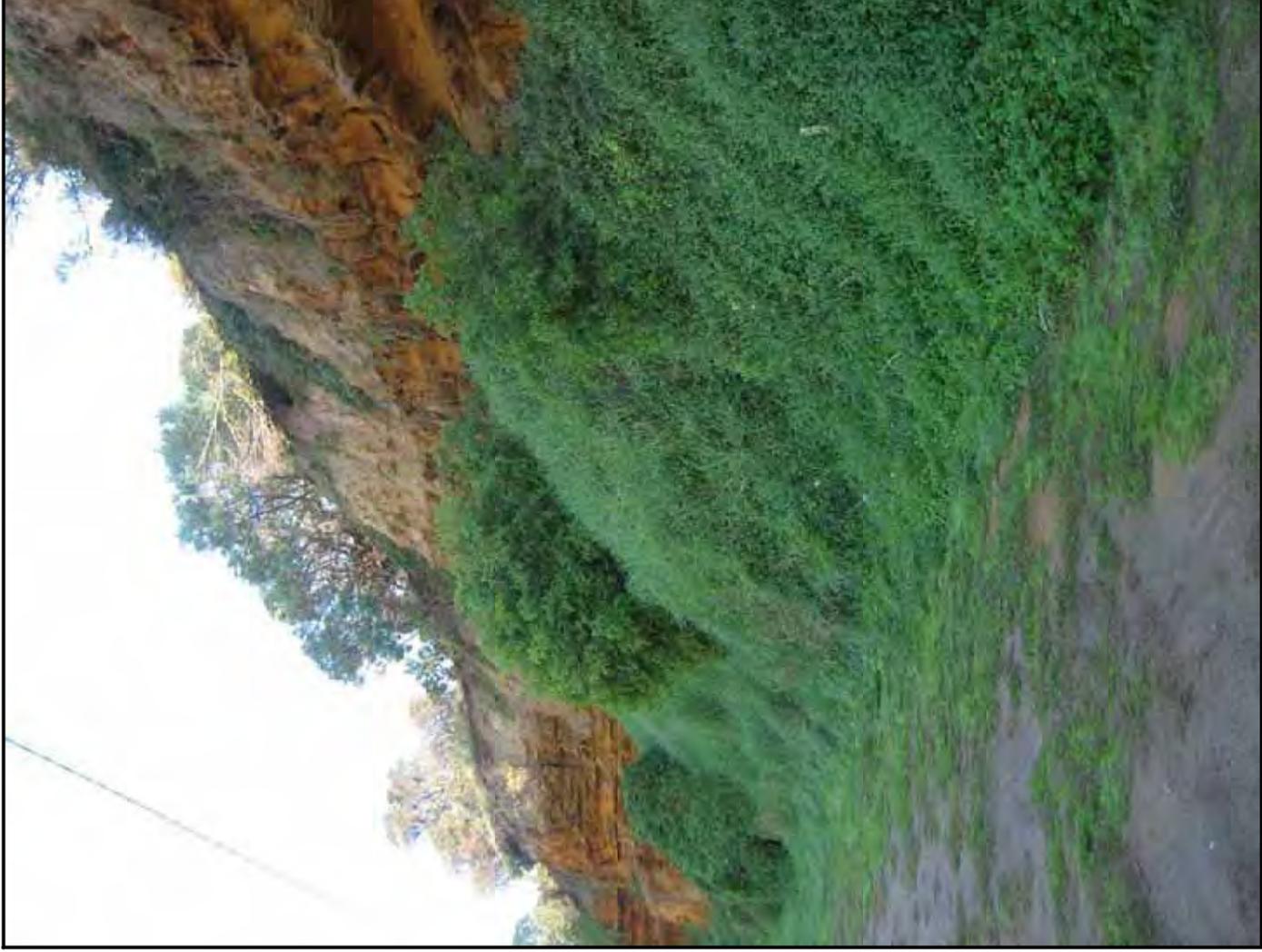


Figure 4-3 Fractures in cliff face



In isolated areas, there was fracturing and tension cracks evident in the rock. The fracturing is generally identified from the rilling, by the more angular surfaces and the non-linear and variable orientation of the failure surfaces, some of which extend into the cliff face, creating wedge shape blocks of variable size Figure 4-3. Above the BMYS fence which runs perpendicular to the cliff, near the eastern end of the site, there is one such large wedge shaped block, which juts out from the cliff face. The rilling and fracturing are mostly confined to the upper half of the cliff face, above the ironstone layers.

Figure 4-4 Accumulation of talus at base of cliff



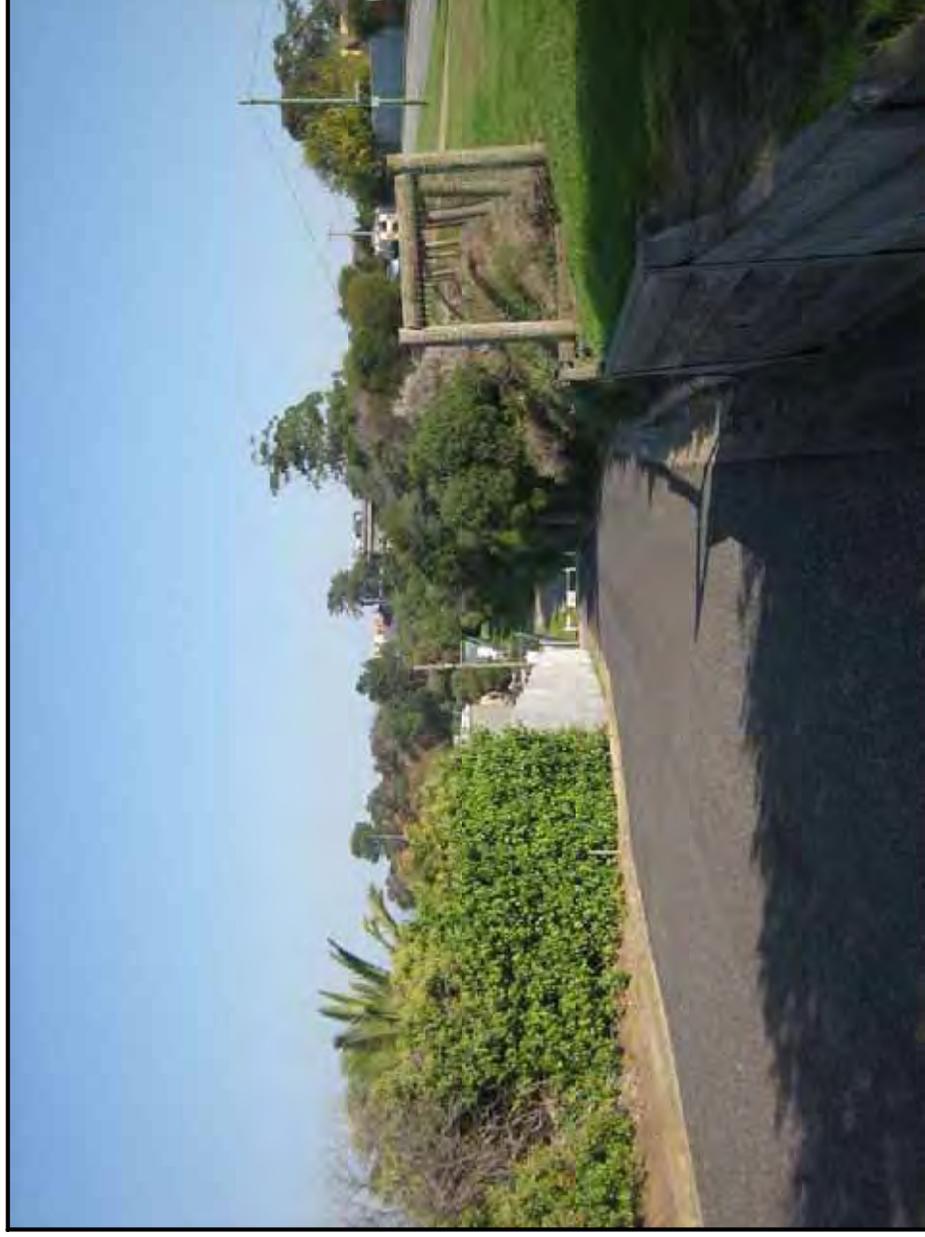
On the seaward side of Beach Road, above Section 1, there was a kerb but no channel. Runoff from the top of the cliff has washed soil down the cliff face. In areas where the cliff face forms ledges, the soil has accumulated. Along the toe of the cliff, there is considerable accumulation of heavily vegetated debris (talus), from the cliff. Mostly the talus is steeply sloping and reaches to nearly half way up the cliff face in places (Figure 4-4). No surface water, or groundwater seeping through the cliff face was detected during the site inspection, however, the inspection was conducted on dry day.

4.2 Section 2

The access road has been created by cut and fill of the cliff face. The cliff face ends near the start of the access road and is formed into a steep, heavily vegetated embankment above and below the road pavement. On the uphill side of the access road, near the entrance from Beach Road, is small section of timber retaining wall, approximately 1 m in height. Heading west from the end of the retaining wall, along the top of the embankment, is a post and mesh fence as shown in Figure 4-5. On the seaward side of Beach Road, above section 2, there was a kerb and channel, with drainage to discharge runoff from the road down and out to the sea.

Overall, there was no evidence of any instability in the area of Section 2, other than minor creep movements identified by the subtle bulging out of the retaining wall and dipping of the fence posts. However these minor movements are expected to be attributed to the inadequate supports for the retaining wall, rather than global instability of the embankment. ..

Figure 4-5 View down access road to BMYS site and ROW



4.3 Section 3

Section 3 extends from the bottom of the access road to the western end of the site. This section does not have any exposed cliff face and is characterised by a steep, heavily vegetated embankment, down to the ROW. It is understood that this section was predominantly filled in the past, with evidence of concrete, bricks and other solid waste. In the middle of the section are remnant concrete sections from a previously demolished structure. On the seaward side of Beach Road, above section 3, was a kerb and channel, with drainage to discharge runoff from the road down and out to the sea.

The inspection revealed there was no obvious evidence of any instability issues in the area of Section 3, such as head scarps, other than minor creep movements. However, due to the very dense nature of the undergrowth, inspection on the hillside was severely restricted.

5 CONCLUSIONS AND RECOMMENDATIONS

Based on the site inspections carried out, and the understanding of the supplied brief pertaining to the proposed BMYS redevelopment, the construction of the dry-stack structure, will not adversely impact the cliff face along the foreshore reserve as the structure will not be founded on or against the cliff faces, This is providing the development does not encroach onto Crown land. Furthermore there are no basements or excavations near the boundary of the site at the toe of the cliffs.

The following text is concentrated on the current and future stability of the cliff face, and the recommended management of the cliff face and area along the toe of the cliff, in conjunction with construction of the proposed dry-stack structure.

Based on the recent inspection, the cliffs exposed along the Beaumaris Motor Yacht Squadron site are overall in a relatively stable condition. However, there was evidence of fracturing, and tension cracking of the sandstone, particularly in the upper half of the cliff towards the eastern end of the site, which has created wedge shape blocks. Over time the cracks will propagate, partly due to water ingress, erosion and weathering, making the blocks less stable until eventually the block topples from the face. The vertical rilling does not appear to compromise the integrity of the cliff, but does result in debris at the toe of the cliff.

It is always difficult to predict the timing of failure as the strength of the rock and degree of fracturing behind the block are not known. It is understood there have been block failures over many years and there is evidence of the sandstone blocks at the eastern end of the site.

The vegetation on the cliff face will, in most areas assist to stabilise the rock surface. However, on the near vertical cliff face, the growth of tree roots will encourage the dislodgment of the rock blocks.

To a large degree, the fill platform in front of the cliff acts has protected the face from wave action and consequential undercutting (notch) erosion.

The lack of a drainage channel on Beach Road above Section 1 has potential to allow runoff during heavy rainfall events, onto the reserve area and over the cliff edge. This will help erode the surface soils and fractures, swelling and softening of the clays within the joints, and exacerbate the rilling in the cliff face. It is recommended the local Council construct a kerb and channel with associated drainage along Beach Road, or even better on the cliff side of the bike track, in the area of Section 1, to minimise runoff over the cliff face. The collected runoff should

be piped and discharged to sea. We recommend that the Club encourage the Council to do these works.

It is recommended that any loose blocks and large overhangs be removed from the cliff face to reduce the potential danger to the public and members of the Yacht Squadron. Care needs to be taken with this work to only remove the sections in imminent danger and not loosen other sections of the cliff face. The dangers should be highlighted with increased signage. However we do not consider a need for this work at this time, but on-going assessment of the cliff face is required.

It is recommended a rockfall wall be integrated into the rear of the proposed drystack structure, to help protect the boats and the drystack structure itself. The wall would typically be of precast, reinforced concrete construction. Prior to construction works for the dry-stack structure, it is recommended the debris along the toe of the cliff, in the area of the dry-stack structure be cleared.

The rockfall wall section should be at least 3 m high and be designed to accommodate the accumulation of rock debris, up to 2 m high between the cliff and the wall. The structural designer of the dry-stack structure will need to allow for this active pressure from the debris accumulation, as well as impact loads from the debris, which could be blocks or finer fill erosion. Care must be taken during construction of the dry-stack structure, to ensure that the machinery used is kept away from the cliff face as much as practicable, to ensure loose blocks do not get dislodged from the cliff, and endanger the plant operators or construction workers.

The rockfall wall needs to extend along the full length of the dry-stack structure, and be located a suitable distance from the toe of the cliff once the existing debris has been cleared, to allow for access and maintenance once the structure is complete. It is recommended the gap between the rear of the rockfall wall and the cliff face be no less than 2.5 m and preferably more. If a narrower gap was adopted, there is danger of blocks toppling from the top of the cliff onto the section of the dry-stack structure above the rockfall wall. For this scenario, a much higher rockfall wall would be required.

The BMYS needs to periodically inspect and remove the accumulation of cliff debris behind the dry-stack structure, and the cliff face, to ensure the ongoing effectiveness of the rockfall wall. During the removal of the debris, a 'spotter' should be engaged to ensure the safety of the operator and ensure that the machinery does not cause further falls. The debris needs to be removed before the debris accumulates to greater than 1 m depth up the rockfall wall (i.e. there is at least 2 m of rockfall wall above the debris).

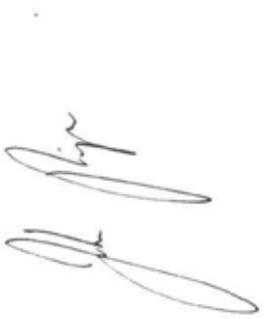
Access to this area behind the dry stack structure, other than during these clearing events, should be prohibited and public access prevented by adequate fencing and gates. A steel post rockfall fence should be constructed at a distance of at least 3m from the toe of the cliff face from the western end of the dry-stack structure rockfall wall, to near the bottom of the access road.

It is recommended that annually and after periods of heavy rainfall, an inspection of the cliff face and the accumulation of debris be undertaken by the club house. Consultation with an experienced geotechnical engineer or engineering geologist may be required at this time if there are any possible issues. Any rock falls or instability issues should be recorded for future reference.

We trust this meets your requirements, but should you have any further queries, please do not hesitate to contact either John Piper or Chris French

Yours faithfully,

Yours faithfully
Lane Piper Pty Ltd



John Piper, B.E. (Civil), M.Eng.Sci., C.P. Eng., MIE Aust., RBP EC-1027
Principal