REPORT

Coastal Assessment

ARCH ROCK RESORT, FARM PORTION 5 OF 296 KEURBOOMSTRAND

Coastal Engineer's Report

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Prepared for:

Keurbooms Rock (Pty) Ltd

Prepared by:

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CONSULTING ENGINEERS

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Cover image from Twitter.com @Arch_Rock

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1 Introduction

1.1 Background

WML Coast was appointed to perform a Coastal Assessment for the redevelopment of Arch Rock resort on Portion 5 of 296 Keurboomstrand. The proposed redevelopment involves demolition of the current chalets and bungalows and re-construction of new chalets in the same positions.

Figure 1: Location of Arch Rock resort on Portion 5 of 296 Keurboomstrand

Figure 2: Setting and current layout of the property (left, Google Satellite) and new dwelling site plan (right, Malherbe Rust Architects)

Figure 3: Photographs showing the beachfront site (archrock.co.za)

1.2 Scope of work

The Coastal Engineer's investigation for this site involved:

- review of the supplied relevant site information (topographical surveys, spatial development plans, services information, site photographs, etc.);
- analysis of historical images in order to determine the dominant coastal processes at play and possible implications for the property;
- review of the extreme run-up levels expected for the site considering waves, winds, storm surges and sea level rise;
- suggestion of risk mitigation measures considered appropriate for the site and the proposed development; and
- presentation of the findings in the form of a technical report.

1.3 Limitations

The findings are based on a purely desktop study of information obtained from the client, published literature and engineering assumptions made which are deemed representative of the local site conditions. They are intended to provide a high level assessment of the coastal risks and potential solutions. All solutions proposed require expert detailed design prior to implementation.

2 Site characteristics

2.1 Topographical levels and description

The contour levels on the seaward side of the property above mean sea level (MSL) are shown in Figure 4 (extracted from the provided surveyor's drawings). *There is a general fall (1.2%) across the site from the north to the south, with a steep slope (42%* or 1:2.4*) on the south down towards the beach* (deVilliers&Hulme, Aug 2020).

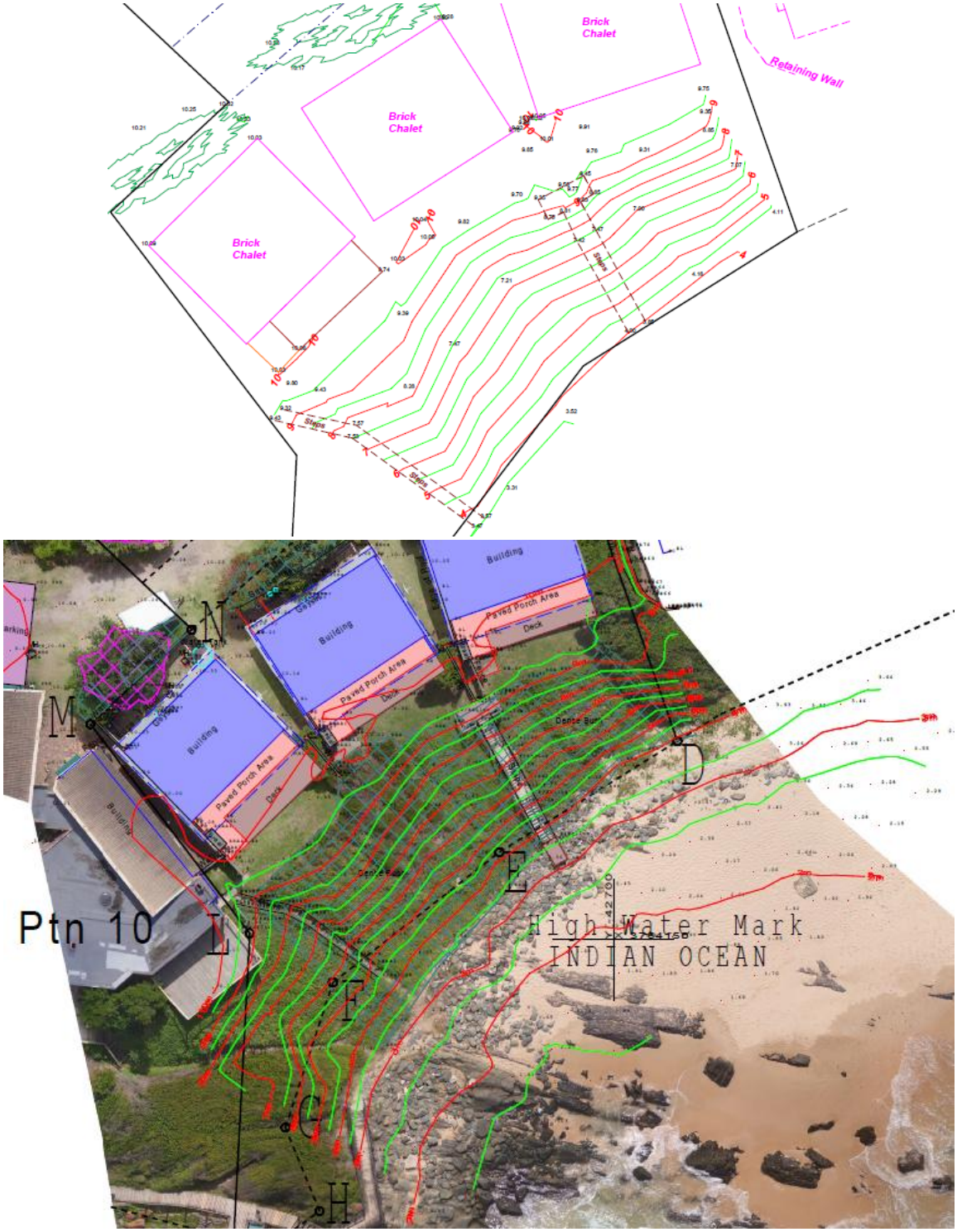

Figure 4: Extracts of site plans showing topographical levels (above MSL) on the seaward (southern) boundary (top: Beacon Survey, December 2019; bottom: VPM surveys, September 2020). See the original plans for full resolution.

2.2 Bathymetry

The nearshore bathymetry is shown in the Figure 5 below. The foreshore here has a moderate slope of about 1:30. A nearshore rocky reef offers some protection from wave attack (see Figure 6).

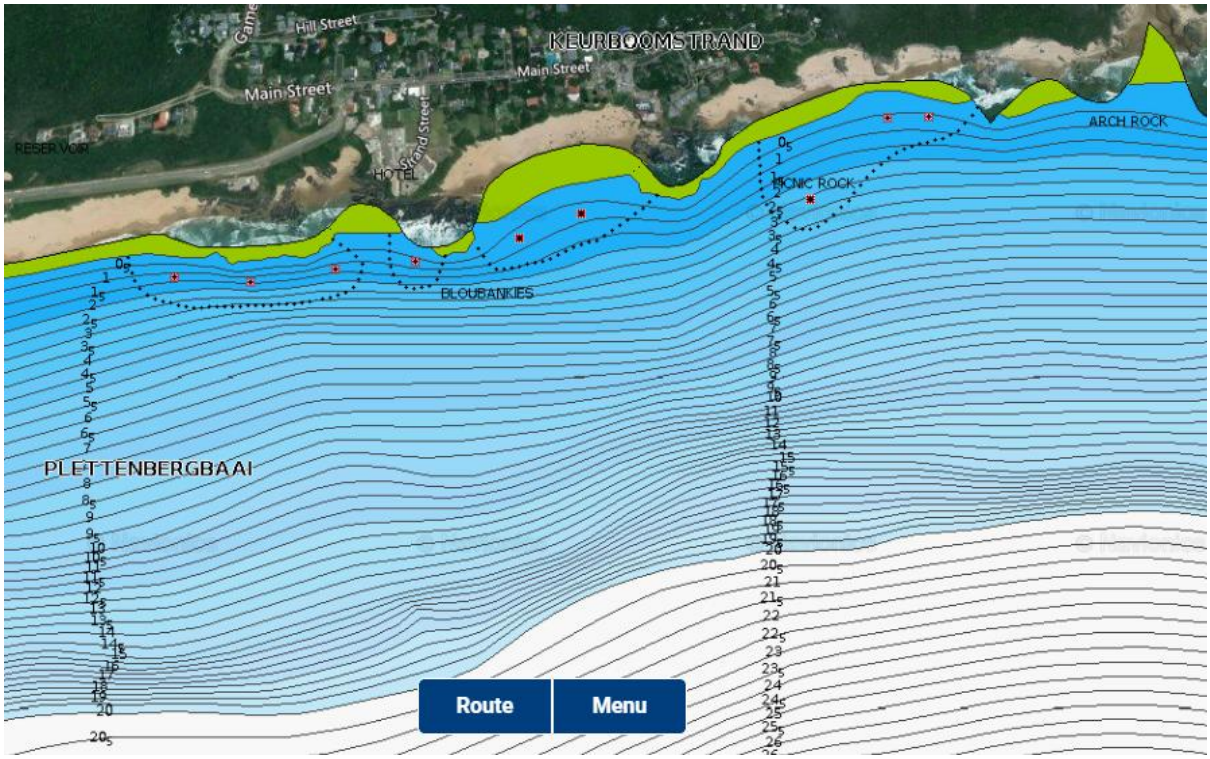

Figure 5: Nearshore bathymetric levels (m below Chart Datum) in front of Keurboomstrand according to Navionics SonarChart™ (Navionics, 2021)

Figure 6: Photograph of the shoreline (archrock.co.za). A rocky reef provides some protection from wave attack and helps to retain sand on the beach in front of the property.

2.3 Geotechnical conditions

UPDATE (ISSUE 1): Geotechnical investigations were performed by Kantey & Templer Consulting Engineers (report issued November 2021). These indicate bedrock at a depth of 6-8 m and low strength soils along the beachfront embankment. Piling is recommended for the foundations of the new beachfront cottages.

No geotechnical reports for the site have been provided. The soil and geology description closest to the site from the Environmental Potential Atlas of South Africa (see Figure 7 below) is "grey regic sands and other soils; aeolian sands and marine terrace gravel and sand, partly calcareous". The services report (deVilliers&Hulme, Aug 2020) contains the following geotechnical description:

> *Based on the initial face value opinion of a Geotechnical Engineer, the in-situ soils will be aeolian sand on bedrock. The depth of the bedrock would have to be determined by further investigation, but this will become very relevant when we consider the proposed basements. The depth of the water table would also have to be established. It is recommended that a formal geotechnical investigation be conducted prior to commencement of detail design and tendering. This will confirm the existence of near-surface bedrock, the suitability of excavated material as fill material and also the depth of the ground water table.*

We reiterate the need for understanding the depth of bedrock below the site as this significantly affects the coastal erosion risks and will influence the design of the foundations of the new beachfront cottages to ensure stability in the event of shoreline erosion.

Figure 7: Soils & Geology near the site from Environmental Potential Atlas of South Africa (CFM, 2021)

2.4 Historical trends

The beach sand erodes and accretes intermittently over time and appears to be "dynamically stable" over the past 17 years (the period of available historical satellite imagery of sufficient resolution). The vegetation line appears to have remained stable over this period and the density of vegetation on the steep seaward slope (natural erosion protection) appears to have improved following replacement of the older beach access pathways with an elevated wooden staircase (see Figure 9). The effects of climate change (including sea level rise and increased storm intensity) can nonetheless be expected to pose increasing risk to the beachfront properties in this area.

Figure 8: Selected satellite images of Keurboomstrand Beach between 2004 and 2021 (Google Earth)

Figure 9: The vegetation density on the seaward slope appears to have improved following replacement of the older beach access pathways (top, archrock.co.za) with an elevated wooden staircase (bottom, twitter.com @Arch_Resort)

2.5 Tidal and extreme water levels

The estimated tidal and extreme still water levels relevant to the property are presented in the table below.

Table 1: Tidal and extreme still water levels for the Eden District coastline

			LEVEL			
			(m Chart Datum)	(m MSL)		***Reference***
ASTRONOMICAL TIDAL LEVELS	Lowest astronomical tide	LAT	0.00	**-0.93**		*Predicted (astronomical) tides at Mossel Bay from SANHO Tide Table 2019*
	Mean low water at springs	MLWS	0.26	**-0.67**		
	Mean low water at neaps	MLWN	0.88	**-0.05**		
	Mean level	ML	1.17	**0.24**		
	Mean high water at neaps	MHWN	1.46	**0.53**		
	Mean high water at springs	MHWS	2.10	**1.17**		
	Highest astronomical tide	HAT	2.44	**1.51**		
ADDITIONAL ALLOWANCES	Storm surge	SS	1:20 yr	1:50 yr	1:100 yr	*RHDHV (2018)*
			+ 0.86	**+0.93**	**+0.97**	
	Sea level rise	SLR	Short term	Medium term	Long term	*RHDHV (2018)*
			+ 0.20	**+0.50**	**+1.00**	
EXTREME STILL WATER LEVEL	Extreme still water level**	1:20 yr	3.16	**2.23**		*= MHWS+ SS + SLR** RHDHV (2018)*
		1:50 yr	3.53	**2.60**		
		1:100 yr	4.07	**3.14**		
**In the RHDHV modeling process (see Section 2.6) the 1:20 year run-up levels were calculated assuming an extreme still water level of MHWS tide + 1:20 year storm surge + ~ 20 years sea level rise, with 1:20 year extreme waves. It must be noted however that extreme storm surge and extreme wave heights can occur at any time.*						

2.6 Extreme wave run-up and erosion risk lines

A district level coastal process and risk modelling study for the Eden District was performed by Royal Haskoning DHV for the Western Cape Government Department of Environmental Affairs between 2016 and 2018. The wave run-up and erosion risk lines (RHDHV, 2018) at Keurboomstrand are shown in Figure 10. Table 2 provides the deep-water input wave conditions used in the modelling process. The following approximate levels are estimated for extreme wave run-up ($R_{u2\%}$)

- 1:10 year wave run-up level ~ 6.7 m MSL
- 1:20 year wave run-up level ~ 6.8 m MSL
- 1:50 year wave run-up level ~ 7.6 m MSL
- 1:100 year wave run-up level ~ 8.1m MSL

The erosion risk lines were determined by adding a horizontal offset (determined using a *geomorphological conceptual model* which describes how different processes act on areas along the coast, such as wind and wave conditions, geology, geomorphology, sediment dynamics and infrastructure interactions) to the respective extreme wave run-up levels.

Table 2: Summary of deep water input wave conditions used in the prediction of wave run-up levels at Keurboomstrand (RoyalHaskoning DHV, 2018)

Time Horizon	Extreme Water Level (m, CD)	Wave Direction - WSW		Wave Direction - SSW		Wave Direction - E	
		Offshore Wave Height (m)	Peak Wave Period (Tp, s)	Offshore Wave Height (m)	Peak Wave Period (Tp, s)	Offshore Wave Height (m)	Peak Wave Period (Tp, s)
10 year	2.10	8.81	13.48	6.56	11.49	6.49	10.94
20 year	3.16	9.26	13.82	7.09	11.95	6.90	11.27
50 year	3.53	9.85	14.25	7.77	12.51	7.49	11.75
100 year	4.07	10.28	14.56	8.27	12.91	7.98	12.13

Figure 10: DEA&DP Eden District wave run-up and erosion risk lines at Keurboomstrand

3 Discussion of coastal risks

The proposed elevations of the new beachfront cottages are clear of the 1:100 year extreme run-up level of approximately 8.1 m MSL (Royal Haskoning DHV, 2018) and are therefore deemed at **very low risk of coastal flooding**.

The DEA&DP erosion risk lines (Figure 10) indicate that significant parts of the property may be at high risk of coastal erosion in the near future. However recent historical trends at the site, which is protected to some extent by the presence of a nearshore rocky reef, indicate **relatively low coastal erosion risk at present**. We therefore believe that the erosion risk lines shown in Figure 10 over-estimate the local erosion risk at this property (Farm Portion 5 of 296, Keurboomstrand). **Nonetheless, the effects of climate change will pose increasing risk in the future and coastal erosion is a concern for this property**. The beachfront units are considered to be possibly at risk of damage due to coastal erosion. The proposed geotechnical investigations (recommended prior to detail design) will shed further light on the extent of the erosion risk.

UPDATE (ISSUE 1): Geotechnical investigations were performed by Kantey & Templer Consulting Engineers (report issued November 2021). These indicate bedrock at a depth of 6-8 m and low strength soils with potential slope instability along the beachfront embankment.

4 Coastal Engineer's recommendations

4.1 Acceptance of risk

The landowner (like most coastal landowners in South Africa and around the world) needs to be aware of and accept the increasing risk of property damage due to extreme coastal events. Note that it is never economically feasible to mitigate for all risks in design; and repair and maintenance through the life of the structure(s) may be required.

4.2 Setback

We note that the proposed redevelopment involves constructing new cottages on approximately the same footprints as the existing units. From a coastal erosion perspective, pulling the new units further back, if possible, would be associated with lower risk. There is, however, no setback limit within the property that can be guaranteed safe. The recommendation is therefore to construct as far back as reasonably possible within the framework of the wider redevelopment goals.

4.3 Foundation protection for beachfront units

It is recommended that **the foundations of the new beachfront cottages are designed to remain stable in the event of failure of the beach facing slope due to coastal erosion**. The details of the design will depend on the depth of bedrock (to be determined during geotechnical investigations). The most economical option in this regard is likely to be piled foundation supports which are integrated into the structural design of the building.

UPDATE (ISSUE 1): Geotechnical investigations were performed by Kantey & Templer Consulting Engineers (report issued November 2021). We agree with their recommended piling options. Detail design of the foundation piles must take into account the corrosive marine environment.

4.4 Maintenance of vegetation

The vegetation covering the steep beachfront slope offers considerable erosion protection. Care should be taken to limit damage to this vegetation during construction activities and future use. A specialist dune vegetation assessment and management plan is recommended to ensure that suitable indigenous species are present to provide optimum bank stabilisation. Beach access pathways should not allow vegetation trampling / disturbance as these create vulnerable zones which can compromise the stability of larger sections of slope during a large storm event. As noted above, replacement of the older access paths with an elevated wooden stairway several years back appears to have already gone a long way to improving the natural erosion protection.

4.5 Stormwater management

No stormwater runoff (or other runoff, e.g. swimming pool backwash water) must be allowed to concentrate onto the steep seaward slope.

4.6 Revetment along the toe of the beachfront slope

A revetment (e.g. gabions or large geotextile sandbags) along the toe of the beachfront slope is an effective structural option to protect the property. A drawback of such hard structures in a beach environment is the potential exacerbation of erosion seawards of and neighbouring the structure as a result of reflection of wave energy. Where possible they should therefore be buried in a revegetated dune. A revetment is **not a preferred solution for this property in the current situation** but could be considered in the future should increasing erosion problems become evident.

5 References

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Navionics, 2021. *Navionics ChartViewer.* [Online]
Available at: https://webapp.navionics.com/?lang=en#boating

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SANHO, 2019. *South African Tide Tables,* Cape Town: South African Naval Hydrographical Office.

Appendix: Comments in line with NEM:ICMA Section 63

Comments on the parts of Section 63 of the National Environmental Management: Integrated Coastal Management Act 24 of 2008 (amended 1 May 2015) deemed relevant to this assessment are provided as follows in **blue**.

63. Environmental authorisations for coastal activities
(1) Where an environmental authorisation in terms of Chapter 5 of the National Environmental Management Act is required for coastal activities, the competent authority ***must take into account all relevant factors, including -***
... (c) whether coastal public property, the coastal protection zone or coastal access land will be affected, *and if so, the extent to which the proposed development or activity is consistent with the purpose for establishing and protecting those areas****;***
A revetment along the toe of the property's steep seaward facing slope (See section 4.6), which is not currently recommended but suggested as a response to possible future coastal erosion problems, will affect the coastal public property:

- **Possible long term exacerbated beach erosion (buried protection will mitigate this impact)**
- **Access for construction activities will be required through the coastal public property.**
- **Short and long term visual impacts for users of coastal public property.**

Other proposed activities are not expected to affect public property or coastal access land.

... (d) the estuarine management plans, coastal management programmes, ***coastal management lines*** *and coastal management objectives applicable in the area;*
Coastal management wave run up and erosion risk lines considered in sections 2.6 and 3 of the report.

... (g) the likely impact of coastal environmental processes on the proposed activity;
Risks and mitigation recommendations discussed in section 3 and 4 of the report.

... (h) whether the development or activity—
... (iv) is likely to cause irreversible or long-lasting adverse effects to any aspect of the coastal environment that cannot satisfactorily be mitigated;
Revetment solution (see report section 4.6, not currently recommended) may have adverse effects. See comment under 63.(1)(c) above. Otherwise no.
(v) is likely to be significantly damaged or prejudiced by dynamic coastal processes;
The beachfront units are considered to be possibly at risk of damage due to coastal erosion. Mitigation measures have been suggested (see report section 4)