

## Minutes

HaskoningDHV UK Ltd.  
Water

Present: Professor Nick Rosser (Durham University), Dr Nick Cooper (RHDHV), Paul Knight (RHDHV)

Apologies:

From: Paul Knight

Date: 21/04/2020

Location: Zoom Conference Call

Copy: File, Emma Hick, Allison Hughes, Stewart Rowe, Dave Robinson

Our reference: PB9388-RHD-ZZ-XX-MI-Z-0001

Classification: Internal use only

Enclosures:

**Subject: Cowbar Erosion Rates & StAR Options**

Number	Details	Action
1	<p>PK introduced himself and Dr Nick Cooper and outlined the role that RHDHV are playing in terms of producing a Strategic Appraisal Report (StAR) for Scarborough Borough Council (SBC) for the Staithes.</p> <p>PK stated that RHDHV have looked at a number of options for the Cowbar Nab / Cowbar Cottage unit and wanted to discuss the long list, short list and preferred options with Durham University (DU) in light of their ongoing monitoring and familiarity with this eroding coastal cliff and its rock platform.</p>	
2	<p>Ahead of the meeting PK submitted to NR three specific queries which are copied below for information, together with a summary of the discussions / conclusion for each of these issues;</p> <p><b>Issue 1</b> – does your survey data show whether the 2 rock armour locations at the toe of the cliff in front of Cowbar Cottages are having any impact on reducing the rate of erosion? Whilst these may reduce the localised risk of erosion to the lower face of the cliff, these would not appear to have any impact on reducing the rate of weathering and therefore would not seem to play a role in delaying the next intervention date for relocating the road.</p> <p>NR stated that the DU monitoring shows that the dominant erosion process is convex failure of the cliff face due to wave action and weathering, resulting in a vertical failure profile. A significant amount of erosion and loss of material has occurred since the rock revetments were installed, with some notable rockfalls in, for example, May 2016.</p> <p>There have been some anecdotal concerns reported from local residents to NR that the rock revetments may be exasperating the rate of erosion. The concern is that the</p>	

	<p>voids in the rock revetment are becoming infilled due to constant material loss from the cliff above and due to deposition from the tides/waves. This is then creating a ramp which allows waves to run up the cliff face, rather than dissipating the energy as designed. DU monitoring does show continuing erosion of the cliff face immediately above the revetment.</p> <p>Weathering of the cliff is as significant a factor for material loss as wave action, if not more so. Therefore, even if the rock revetments were effective, the rate of erosion in the mid and upper sections of the cliff face would still continue, as per current observed rates.</p> <p>In conclusion therefore it was agreed that installing partial or full rock revetments at the toe of the cliff in front of Cowbar Cottages does not and would not provide an effective engineering solution in terms of preventing or slowing the rate of erosion to the mid and upper cliff and therefore would not result in a delay of the date of next intervention for realigning the road or for other options such as Coastal Adaptation.</p> <p><b>Issue 2</b> – in your opinion what impact do the mini piling / soil nailing and slope stabilisation netting works have in terms of delaying the next intervention date? Whilst these works would appear to have stabilised the glacial till and soils adjacent to the road, weathering erosion is continuing a below these works which would seem likely to result in a significant overhand developing in the short term and then a larger collapse in the longer term. i.e. rather than losing 1 m of upper slope every 10 years, will this result in a loss of 2-3 m in 20 to 30 years' time?</p> <p>NR confirmed that DU have not modelled or directly assessed information relating to how these specific works stabilise the glacial till on the upper slope of the cliff and how this could impact on the date of next intervention.</p> <p>PK / NC / NR discussed what would the potential impact of these works be? The erosion of the cliff toe and the weathering of the mid-section of the cliff face would continue irrespective, resulting in continued incremental failure of the cliff which would continue to ultimately undercut the glacial till cliff top / road. Previous assessments by Highpoint Rendel (1999) have indicated that the glacial till slope fails as it is undercut by loss of rock from the cliff face below, typically losing a 1m depth of cliff edge in a single failure event every 10 years, as opposed to the gradual recession observed in the mid and lower cliff faces. The cliff top therefore responds episodically in response to incremental erosion below, and so no erosion of the cliff edge is not a good indication of future stability and / or retreat.</p> <p>It would therefore seem likely that as the upper slopes became undercut, failure would still occur as a significant</p>	
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	<p>event, but rather than the complete loss of say a 1m section of glacial till the initial failure event would likely be observed as cracks and exposure of the engineering works. As undercutting continues it would eventually become so significant as to completely undercut the full depth of restrained glacial till, resulting in a significant failure event.</p> <p>In conclusion therefore, it was considered that these engineering works may change the failure mode, but as the rate of undercutting remains unchanged then there will be little if any impact on delaying the date of next intervention.</p> <p><b>Issue 3</b> – in your opinion would placing a complete length of rock revetment along the toe of the cliff in front of Cowbar Cottages help to reduce the rate of erosion?</p> <p>See the discussions re Issue 1 above. In conclusion, a full length revetment is unlikely to have a significant impact on delaying the rate of erosion to the cliff and therefore no beneficial impact on delaying the date of the next intervention.</p>	
<p><b>3</b></p>	<p><b>Erosion Rate Discussions (1) – Rate of Erosion</b></p> <p>The average rate of erosion is being monitored by Durham University through ongoing laser scanning (airborne and terrestrial) of the cliff. The latest report on the erosion was provided by NR, ref;</p> <p><b>COASTAL CLIFF MONITORING COWBAR NAB, STAITHES, N. YORKSHIRE</b> Monitoring period: September 2018 to December 2019 March 2019</p> <p>From this report the latest erosion rate stated in ref to the area in front of Cowbar Cottages is;</p> <ul style="list-style-type: none"> <li>• The area-averaged rate of retreat observed in the period May 2015 to December 2019 for the focus zone was 0.058 myr<sup>1</sup>.</li> </ul> <p>RHDHV propose to use a rate of 0.1m per year in the StAR to assess potential dates for interventions, together with a safety buffer zone of 5m to allow sufficient time for planning and funding of any actions.</p> <p>This variance is recorded and predictive erosion rates was discussed and RHDHV will present erosion mapping using both rates so that we are presenting two potential variant 'best case' &amp; 'worst case' scenarios.</p> <p>In reviewing this process RHDHV have also decided to reduce the buffer zone to 3m. This allows in the 0.1m rate of</p>	

	<p>erosion a 30 year effective buffer zone for planning and acting by the local authorities and utilities companies.</p>	
<p>4</p>	<p><b>Erosion Rate Discussions (2) – Extrapolation / Acceleration of Erosion Rates due to Sea Level Rise impacts.</b></p> <p>NC commented that the Environment Agency typically requires coastal erosion assessments to include an allowance for the acceleration of erosion due to the impacts of sea level rise. For this location RHDHV are querying whether this is appropriate due to the nature of the foreshore, the nature of the failure mode and the analysis that DU have undertaken.</p> <p>NR responded that DU have completed a PhD thesis who has been assessing the long-term rates of erosion from assessing the exposure ages of the rock foreshore platform. This provides 7,000 years of data which concludes that on average 4.5cm (0.045m) per year of loss of vertical cliff face had occurred, with no notably increase in response to relative sea level. The short-term rates match this data and therefore it is considered that the resistance of the rock dominates the rate of erosion and not sea levels.</p> <p>On that basis it was agreed that it does not seem reasonable to apply an accelerated linear erosion profile in the StAR for plotting erosion lines over the 100 year study period and for public consultation the 0.1m /year and the 0.058 values would be used for assessing the dates of next intervention and the risk to the road and properties.</p> <p>Subsequent email from NR on the 24<sup>th</sup> May re the above matter is copied below for information;</p> <div style="border: 1px solid black; padding: 10px; margin-top: 10px;"> <ul style="list-style-type: none"> <li>• <b>Evidence for long-term rates of retreat from foreshore exposure dating</b></li> </ul> <p>I've attached a draft of a paper currently in the 2<sup>nd</sup> stage of review in the journal Nature Communications. This uses a surface exposure dating to calculate the history of the erosion of the foreshore, using a site just to the east of Staithes harbour. This demonstrates that the platform formed fully in the last 7 kyr, and derives two further important findings: (1) the long-term average rate of retreat is 4.5 +/- 0.63 cmyr<sup>-1</sup>, and (2) there is no signal indicative of a more recent acceleration associated with anthropogenic sea level rise. This would be a sound basis for use a linear, non-accelerating model to predict future cliff retreat at Staithes. The abstract summarises the key findings, and key section in the paper is perhaps lines 217 – 243. I</p> </div>	

will let you know when this paper is finally accepted. The work is also presented in the following PhD thesis (<http://etheses.dur.ac.uk/12838/>), specifically in Chapter 8 if you need more details (although the paper is perhaps a bit more refined).

- **Estimating long term erosion from short term monitoring**

The second approach we have taken is to look at whether short-term monitoring is representative of long-term erosion and retreat, using wide area airborne LiDAR to monitoring rockfalls. This is summarised in the following thesis ([etheses.dur.ac.uk/12813/](http://etheses.dur.ac.uk/12813/)), with mean average erosion rates reported on page 41, and rates specific to Cowbar – Boulby on page 42-44. Section 3.3.3 also examines to degree to which short-term measurements reflect long-term rates and finds that measurements over  $1 \times 10^5 \text{ m}^2 \text{ yr}^{-1}$  are needed to derive stable estimates. The upshot is that our relatively short-term monitoring at Staithes is a good indicator of long-term retreat. This work is currently being written up for publication, so it would be best to refer to the PhD above for now.