Tonkin+Taylor

Job No: 1001107.0000
26 May 2017

Ministry of Education
48 Hereford Street
Christchurch
8013

Attention: Deb Taylor

Dear Deb

Redcliffs Park
Coastal inundation and coastal erosion

1 Introduction

The Ministry of Education (MoE) are looking to relocate Redcliffs School to a new school development at Redcliffs Park and are currently undertaking their due diligence process for this new site, which is shown in Figure 1 (below). The area of the playing fields within the site is within the Coastal Inundation Hazard Zone (CIHZ) and Coastal Erosion Hazard Zone (CEHZ) identified in a report for Christchurch City Council (CCC) issued by Tonkin & Taylor Ltd (T+T) in 2015. The MoE has asked T+T to provide further detail on the potential coastal inundation and erosion hazards relating to the site. The letter report provides further detail on the background site evaluation work already undertaken, discusses the current status of the portion of shoreline closest to Redcliffs Park and summarises additional coastal hazard assessment work undertaken since the 2015 report was issued.

Figure 1: Site plan

Tonkin & Taylor Ltd | Level 3, PwC Centre, 60 Cashel Street, West End, Christchurch, 8013, New Zealand | PO Box 13-055, Christchurch 8141
P +64-3-363 2440 F +64-9-307 0265 E chc@tonkintaylor.co.nz

2 Background

A previous report discussing geotechnical and land contamination aspects of various potential sites for the relocated school was provided by Tonkin & Taylor Ltd (T+T) in 2016[1]. This Site Options Study report noted that:

- The Redcliffs Park site can be characterised into the playing fields area that is at an elevation of approximately 1.8 m relative to the Lyttelton Vertical datum 1937 (LVD) and the area adjacent to Main Road at an elevation of around 4.5 mLVD.
- It is expected that new school buildings will likely be located largely on the Main Road portion of the site. However, given the required floor area for the primary school development some building footprint may extend into the existing playing fields area.
- The floor level for any new buildings located within the Redcliffs Park site are expected to be at an elevation of at least 3.3 mLVD. This will require the foundations for any buildings that extend beyond the Main Road portion of the site to be elevated on suitably designed piles, engineered fill or other system, to achieve the required floor level elevation.
- Most of the lower lying portion of the site is within the Christchurch City Council Coastal Inundation Hazard Zone (CIHZ) and the Coastal Erosion Hazard Zone (CEHZ), as reported in 2015[2]. This report is currently being updated to reflect the comments and suggestions made through a peer review process. At the time of the Site Options Study (T+T, 2016) the extent of the CIHZ and CEHZ were as shown in the following excerpts from that report. Note that the label "Location B" indicates possible building locations mainly within the Main Road portion of the Redcliffs Park site.

Panel I: Coastal Inundation Hazard Zone.

Reference: *Tonkin + Taylor (2015) "Coastal Hazard Assessment: Avon – Heathcote Estuary"; project no. 851857.001.*

Figure 2a: CIHZ from T+T 2016 Site Options Study

[1] Tonkin & Taylor Ltd (2016). Redcliffs School Site Options Study. Report prepared for the Ministry of Education, reference 53062.3000.v2

[2] Tonkin & Taylor Ltd (2015). Coastal Hazard Assessment: Avon – Heathcote Estuary. Report prepared for Christchurch City Council, reference 851857.001

Figure 2b: CEHZ from T+T 2016 Site Options Study

3 Existing shoreline adjacent to Redcliffs Park

Review of historical photographs dating back to 1941 (refer Appendix A of the T+T 2016 Options Study) indicates that the area of land immediately to the north of Beachville Road was reclaimed some time between 1965 and 1973. This strip of land in its current form is shown on the following photograph:

The face of the reclamation was protected from erosion with a rock revetment supplemented in places with large concrete blocks, although the details of the design of the works are uncertain. The revetment in its current condition is shown in the following photographs:

A small beach area has been formed at the eastern end of the rock revetment, as shown below:

5 Coastal inundation

The current update of the coastal inundation hazard for Christchurch includes assessment of four different future global emissions scenarios over the next 100 years. Each of these different emissions scenarios, defined by the Intergovernmental Panel on Climate Change (IPCC)[3], results in different sea level rise scenarios. The inundation assessment has been carried out on the basis of a 1% Annual Exceedance Probability (AEP) extreme storm tide occurring under different emissions scenarios and two different climate change time horizons, which are up to years 2065 and 2120.

Extreme tide elevations (referenced to mLVD) for both Lyttelton Harbour and for Sumner Head are summarised in Table 1 (below). Consideration of coastal hazards typically uses the mean high water Springs (MHWS) tide level as the basis for the assessment of potential event-based inundation. For the Christchurch area the MHWS tide level is 1.33 mLVD.

From Figure 3 and Figure 4 it can be seen that the inundation extent across Redcliffs Park for both of these scenarios (years 2017 and 2120) does not differ by much. While the levels for these scenarios are different, due to relatively steep ground at the edge of the predicted inundation extent, the area covered is similar across these scenarios. We also understand that any buildings to be constructed on the site are expected to have a minimum floor level elevation of around 3.3 mLVD. This elevation, although needing to be confirmed as part of any building consent application process, is considerably higher than the estimated 2017 storm tide level. It is also considerably higher than the assessed inundation level due to an extreme storm tide combined with climate change scenarios out to 2065 (inundation level of 2.7 mLVD from Table 2), which about covers a typical building design life of 50 years from the present day.

[3] IPCC (2015). Climate Change 2014: Synthesis Report. Report by Intergovernmental Panel on Climate Change

Table 1: Extreme Tide Levels for Lyttelton Harbour and Sumner Head

Site	Storm tide level (RL m)	
	1% AEP	2% AEP
Lyttelton	1.92	1.87
Sumner Head	1.85	1.8

The assessed area of inundation within Redcliffs Park is shown in Figure 3 (below) for a 1% AEP storm tide level (1.85 mLVD) modelled at the present time i.e. in 2017. To be clear, this does not represent any sea level rise scenario but is inundation from extreme storm tide events. Overlaid on this figure are the underlying ground elevations. It can be seen that the lower lying parts of the site are potentially subject to relatively shallow inundation in response to a 1% AEP storm tide event (which combines tide level, wind set-up and barometric set-up). The depth of inundation generally ranges between approximately 0.31 m and 0.1 m.

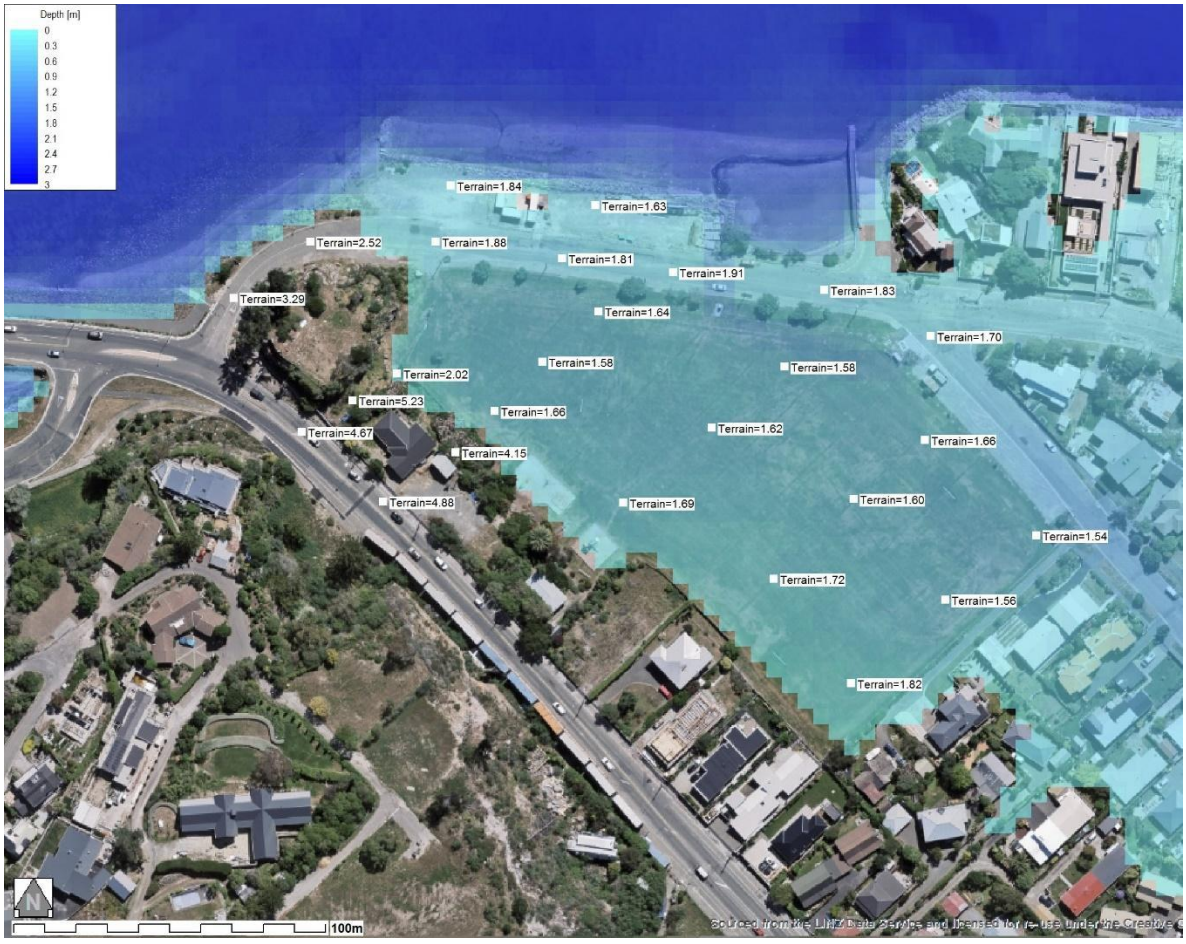


Figure 3: Assessed inundation area within Redcliffs Park due to 1% AEP storm tide for 2017

For the future climate horizons, extreme tide inundation extents were mapped using a hydrodynamic model, with extreme tide level applied at an open-coast boundary. The levels used for the different emissions scenarios (labelled as RCP2.6, RCP4.5, RCP8.5 and RCP8.5 83rd % in the column headings, which are defined by the IPCC, 2015) and the two different climate horizons (years 2065 and 2120) are shown in Table 2 (below).

Table 2: Extreme tide levels used for mouth of the Avon-Heathcote Estuary

			RCP2.6 M		RCP4.5 M		RCP8.5 M		RCP8.5 83rd %	
	Storm Tide (m)	Set-up allowance (m)	SLR (m)	Total CIHZ level (RL m)	SLR (m)	Total CIHZ level (RL m)	SLR (m)	Total CIHZ level (RL m)	SLR (m)	Total CIHZ level (RL m)
2065	1.85	0.4	0.3	2.6	0.33	2.6	0.41	2.7	0.55	2.8
2120	1.85	0.4	0.55	2.8	0.67	2.9	1.06	3.3	1.36	3.6
All levels reduced to Lyttelton Datum 1937 (LVD-1937)										

Using the RCP8.5 2120 scenario from the above table gives a resulting inundation plot as shown in Figure 4 (below). While the extreme tide level of 3.3 mLVD from Table 2 applies to this figure, it can be seen that this translates, via the hydrodynamic model, to an extreme tide level of about 3.2 mLVD at the Redcliffs Park site. In general, the depth of inundation from an extreme storm tide event for this scenario ranges between approximately 1.62 m and 1.34 m. A similar result is obtained for the other sea level rise scenarios in that the predicted inundation depths at the proposed school site will differ by the same amounts as the "Total CIIHZ levels" in Table 2 differ.

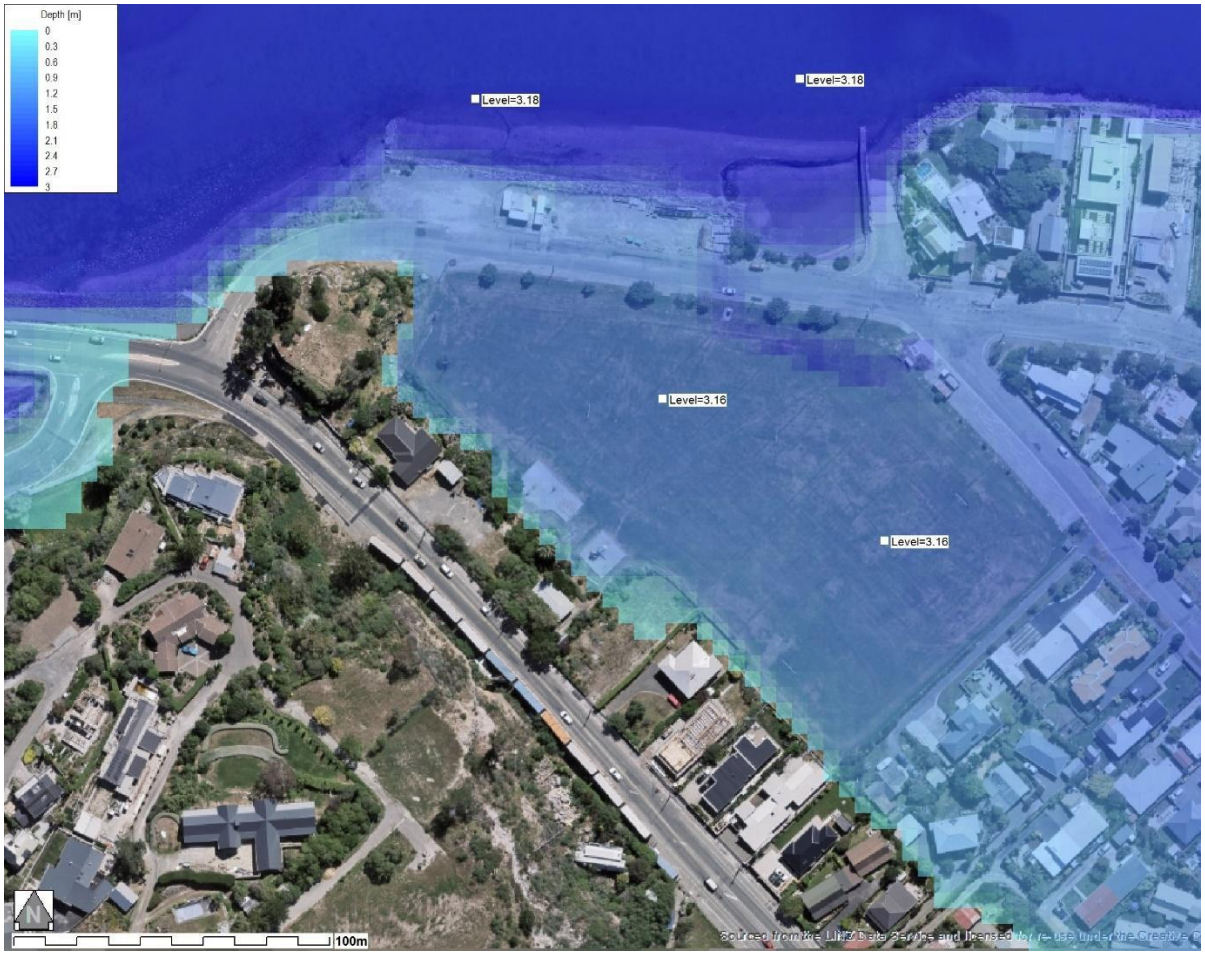


Figure 4: Assessed inundation area due to the 2120 RCP8.5 storm tide at Redcliffs Park

From Figure 3 and Figure 4 it can be seen that the inundation extent across Redcliffs Park for both of these scenarios (years 2017 and 2120) does not differ by much. While the levels for these scenarios are different, due to relatively steep ground at the edge of the predicted inundation extent, the area

covered is similar across these scenarios. We also understand that any buildings to be constructed on the site are expected to have a minimum floor level elevation of around 3.3 mLVD. This elevation, although needing to be confirmed as part of any building consent application process, is considerably higher than the estimated 2017 storm tide level. It is also considerably higher than the assessed inundation level due to an extreme storm tide combined with climate change scenarios out to 2065 (inundation level of 2.7 mLVD from Table 2), which about covers a typical building design life of 50 years from the present day.

6 Coastal erosion

Generally the Avon/Heathcote estuary shorelines have been subject to significant modification from their natural state. The majority of the coastline along the southern edge forms a major transport corridor and is generally a hardened/managed shoreline, as shown in the photographs in Section 3, above.

The updated coastal erosion assessment (yet to be published) takes account of these modifications. The coastal erosion hazard zone has been based on a nominal 5 m shoreline retreat to characterise the erosion hazard to 2065, increasing to 10 m by 2120, recognising that existing structures and hard edges will need to be maintained and potentially modified, as required, to manage future erosion hazard effects.

The current coastal hazard assessment work is aimed at two future horizons, these being the year2065 and the year 2120. Sea level rise is the major driver for the changes to the coastal hazards over the time periods to these horizons. Sea level rise is expected to continue beyond the 2120 time horizon.

The northern boundary of Redcliffs Park is at least 20 m inland from the closed point of the existing shoreline. Therefore, the current assessment of potential future coastal erosion hazard indicates that Redcliff Park is not expected to be impacted over the currently assessed climate change scenarios out to at least 2120. In any event, the new Redcliffs School buildings are likely to be positioned well away from the northern boundary of the site, which provides an even greater buffer between the shoreline and future significant structures.

7 Conclusion

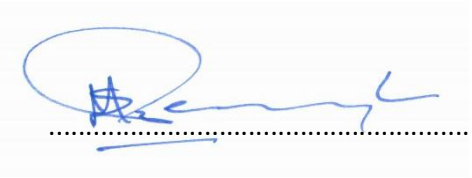
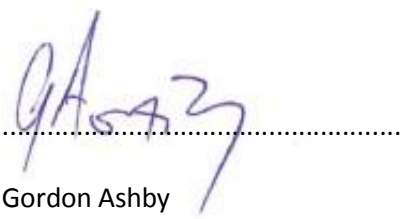
Based on our understanding of the factors contributing to coastal inundation and erosion, we believe that it will be feasible to adequately defend the proposed school infrastructure from these natural hazards at this proposed site over a 50 to 100 year timeframe. Such defences are likely to include storm surge inundation protection (by setting building floors above minimum elevations) and by an appropriately adaptive management approach to potential coastal erosion. The existing revetment is likely to provide adequate coastal erosion protection over at least a 50 year time period from the present day, provided appropriate monitoring and maintenance is carried out. Some augmentation may need to be considered beyond this period such as extending the length and possibly the height of the current rock revetment. Some form of engineered protection may also be required at the perimeter of any elevated building platform to manage localized wave action from a particular extreme storm tide event.

For the longer term i.e. beyond 2120, the ability to adequately defend the site from coastal hazards is less certain.

8 Applicability

This report has been prepared for the exclusive use of our client Ministry of Education, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
	
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Mark Pennington	Gordon Ashby
Senior Water Resources Engineer	Project Director

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