BEFORE AN INDEPENDENT COMMISSIONER APPPOINTED BY THE GISBORNE DISTRICT COUNCIL

IN THE MATTER OF:

The Resource Management Act 1991

AND

IN THE MATTER OF:

The Resource Consent application for coastal erosion management works at Wainui Beach lodged by Gisborne District Council

STATEMENT OF EVIDENCE OF THOMAS DUNCAN SHAND

1.0 INTRODUCTION

1.1 My name is Thomas Shand and I am a Senior Coastal Engineer at Tonkin & Taylor Ltd ("T+T"). I hold the following qualifications:

- Bachelors Degree in Civil Engineering with Honours from Canterbury University;
- PhD in Coastal Engineering specialising in surf zone processes and wave-structure interaction from the University of New South Wales.

1.2 I am a member of Engineers New Zealand (non-chartered) and of the New Zealand Coastal Society.

1.3 I have 15 years of professional experience in all facets of coastal engineering including coastal process and hazard assessment and modelling, design of coastal protection structures, resource consent application and monitoring and condition assessment.

1.4 Recently I have designed and consented major coastal protection works for a port upgrade in the Chatham Islands and for the North Canterbury Transport Infrastructure Recovery (NCTIR) in Kaikoura and have overseen design of many smaller coastal works.

1.5 I have led coastal erosion hazard assessments in Gisborne, Hawke's Bay, Bay of Plenty, Northland, Auckland, Taranaki, Nelson and South Canterbury.

1.6 I have been lead author for a guidance manual for coastal protection works in Pacific Island countries and was a co-author on the MfE Climate Change and Coastal Hazard update document.

1.7 I appear for Gisborne District Council ("the applicant") and my evidence today is in support of their proposal to replace an existing rail iron log and rock seawall ("rail iron wall") with a rock revetment seawall ("revetment") in the vicinity of Tuahine Crescent, as well as retrospectively authorise a gabion basket structure constructed on esplanade reserve seaward of 21 Wairere Road, at Wainui Beach.

1.8 I have visited the site on several occasions, am familiar with the general locality and planned and oversaw the preparation of the Coastal Engineering Design Report[1] ("Design Report") which presents consent level design of the revetment and assesses the likely effect on coastal processes to inform an Assessment of Environmental Effects[2] ("AEE").

1.9 My preparation for this hearing has involved reviewing:

- The Design Report
- The AEE;
- The consent authorities' request for further information and the T+T response to the consent authorities' request for further information ("s 92 response");
- The peer review of the proposal undertaken by Dr Willem de Lange;
- The submissions received;
- The memo from Paul Murphy; and
- The s 42A report prepared for the consideration of the Commissioner by Mr Whittaker.

1.10 I confirm I have read the Code of Conduct for expert witnesses contained in the Environment Court's Practice Note and I agree to comply with it. The opinions expressed in this evidence are mine and within my expertise and experience.

2.0 THE SITE

2.1 The Design Report contains full details of the site, the coastal environment and processes and the existing structures. A summary is provided below.

2.2 Wainui Beach has a northeast-southwest alignment to the Pacific Ocean and comprises a sandy beach, backed by a high dune between two rock headlands – Tuahine Point to the southwest and Makorori Point to the northeast.

2.3 The cliffs at Tuahine Point reduce in elevation from nearly 100 m high at the southern extent to 5 m high by Tuahine Crescent. Intertidal and subtidal reefs extend offshore between Tuahine Point and Tuahine Crescent.

2.4 A narrow perched beach is located on reef at the toe of the cliff near Tuahine Point. This beach widens north of Tuahine Crescent becoming a wide sandy beach with patches of reef on the foreshore and offshore. The backshore transitions to modified dune between Tuahine Crescent and (approximately) the Wainui Beach School before becoming more natural and active (i.e. able to accrete and erode) along the northern part of Wainui Beach.

2.5 Erosion processes at Wainui Beach are dominated by cyclical storm and recovery processes with beach levels able to fluctuate by up to 2.5m. Over the longer term the beach can rotate with predominant NE or SW winds and waves and has been found[3] to be in an overall state

[1] Entitled *Erosion Protection Works-Wainui Beach-Resource Consent Engineering Design Report* dated July 2017 T+T reference 1000724.v1

[2] Entitled *Erosion Protection Works-Wainui Beach-Resource Consent Applications and Assessment of Environmental Effects* dated May 2017 T+T reference 1000724.

[3] Gibb, J. (2001). Review of the 1995 Wainui Beach Coastal Hazard Zone. Report prepared for Gisborne District Council.

of erosion with higher rates (-0.2 to -0.5m/year) in the southern end and lower rates to stable (0 to -0.2m/year) in the central parts.

2.6 There are several coastal structures present along the Wainui Beach shoreline. Around Tuahine Crescent is a low wall comprised of staggered and driven railway iron with logs placed between and fixed by wire and armour rocks placed behind on a relatively flat slope. The rock and rail wall extends, on average, 8 m from the cliff toe and extends along approximately 130 m of the coastline. It is in a relatively degraded condition, with the railway irons exposed and rusted and wave-washed wooden debris at the top of the structure indicating periodic overtopping.

2.7 The structure has generally functioned to limit erosion but some erosion scarps are evident in the bank behind the wall. The structure is likely to become less effective over time with sea level rise and as the rail and log wall fails and rocks are lost onto the beach face.

2.8 To the south of the rail and rock wall is a 12 m long concrete groyne and beyond this a rock revetment constructed in 2007 and consented until 2042. This wall is relatively flat and wide at a slope of around ~3(H):1(V) and low crested with wave-washed logs evident at its crest.

2.9 To the north of the rail and rock wall are a mixture of timber, rock, low gabion baskets and sheetpile groynes in various, although typically poor, states of repair.

2.10 At 21 Wairere Road, a 15m long gabion basket seawall wall was constructed in August 2016 with widely graded riprap rock placed directly above the baskets on top of the eroded dune face after a storm event caused failure of the previous seawall and damage to the backing land.

3.0 PROPOSED WORKS

3.1 Gisborne District Council (GDC) have developed and adopted the Wainui Beach Erosion Management Strategy (WBEMS) for managing coastal erosion along Wainui Beach. This Strategy, developed with assistance from coastal experts and key stakeholders, considered the risk that coastal erosion posed along Wainui Beach and identified options to manage the risk while also achieving the wider values and goals of the community; namely retaining beach access, protecting property and conserving and enhancing the natural environment.

3.2 Replacement of the rock and rail wall between the mass concrete groyne near the southern end of the beach and Tuahine Crescent beach accessway with a more robust rock revetment structure was identified in the WBEMS as a key action for GDC to implement.

3.3 A rock revetment is proposed to replace the existing rock and rail wall between the concrete groyne south of the Tuahine beach accessway and 2 Tuahine Crescent (Figure 1). The works involve the removal of the existing railway irons and log wall, stockpiling of the existing rock, construction of a new rock revetment and removal of all debris and construction material from the CMA.

Figure 1 Location of proposed rock revetment between the existing concrete groyne and Tuahine Crescent accessway

3.4 A 15 m long gabion basket and rock seawall has been constructed in the esplanade reserve in front of 21 Wairere Road under the emergency works provisions of the RMA following a storm event in August 2016. Rock has been placed above the baskets on top of the eroded dune face. A review of the structure[4] found that the rock placed above the gabion baskets consists of a widely graded riprap placed directly on the ground without a geotextile to adequately contain the backshore materials. There appears to be some larger rocks, which may be appropriate for the wave climate at the site, but also a high proportion of small rock which is likely to be displaced onto the beach during storm events. The rocks above the gabion baskets at 21 Wairere Road are proposed to be removed as part of the retrospective consent.

4.0 DESIGN CONDITIONS

4.1 A design life of 50 years has been initially assumed for the rock revetment. This is an ‘industry standard’ life based on the typical design life of geotextile and placed rock.

4.2 A 100 year average recurrence interval (ARI) event has been selected. This has an annual likelihood of being exceeded of 1% but over a 50 year design life has a 39.3% likelihood of being exceeded some time within that period (Table 1).

[4] Tonkin + Taylor, Retrospective Resource Consent for Tipped Rock and Gabion Baskets - Esplanade Reserve, Wainui Beach, February 2017.

Table 1 Likelihood of event occurrence for a range of design life spans

Event Average Recurrence Interval (ARI; Years)		Design life					
		1 year	5 years	10 years	25 years	50 years	100 years
	1	63.2%	99.3%	100.0%	100.0%	100.0%	100.0%
	5	18.1%	63.2%	86.5%	99.9%	100.0%	100.0%
	10	9.5%	39.3%	63.2%	97.0%	99.3%	100.0%
	20	4.9%	22.1%	39.3%	82.6%	91.8%	99.3%
	50	2.0%	9.5%	18.1%	50.3%	63.2%	86.5%
	70	1.4%	6.9%	13.3%	39.3%	51.0%	76.0%
	100	1.0%	4.9%	9.5%	29.5%	39.3%	63.2%
	200	0.5%	2.5%	4.9%	16.1%	22.1%	39.3%
	500	0.2%	1.0%	2.0%	6.8%	9.5%	18.1%
	1000	0.1%	0.5%	1.0%	3.4%	4.9%	9.5%

4.3 Design offshore wave and water levels have been derived based on Stephens et al. (2014)[5] who calculate the joint probability of offshore wave and storm tide (tide + storm surge) conditions. The numerical model SBeach has been used to assess the total water level (including tide, storm surge and wave setup) at the toe of the structure and wave height has been calculated based on a depth-limited wave height for a low steepness beach[6] of 0.55 times the water depth.

4.4 Allowance for sea level rise has been based on the MfE (2008)[7] guidance which recommends consideration of between 0.31 and 0.45 m for the 2060-2069 time period. The new MfE (2017)[8] guidance recommends consideration of 0.2 to 0.32 m by 2045 (25 years) and 0.32 to 0.61 m by 2070 (50 years). Studies of vertical land movement[9] indicate Gisborne to be stable to slightly subsiding (~-1 mm/year) indicating that upper end sea level rise estimates are likely appropriate.

5.0 ROCK REVETMENT DESIGN

5.1 Design of a rock revetment includes five main parts:

- Rock sizing and filters,
- Crest level and detailing,
- Toe level and detailing,
- Planform, alignment and tie in details,

[5] Stephens, S., Robinson, B., & Gorman, R. (2014). Extreme sea-level elevations from storm-tides and waves along the Gisborne District coastline. Report prepared for Gisborne District Council.
[6] Nelson, R C (1987), Design wave heights on very mild slopes – an experimental study. Civ. Eng. Trans. Inst. Eng. Aus., CE29(3): 157 – 161
[7] Ministry for the Environment (2008) Coastal hazards and climate change. A guidance manual for local government in New Zealand. 2nd edition Ministry for the Environment. 129p.
[8] Ministry for the Environment (2017) Coastal hazards and climate change. Guidance for local government.
[9] Beavan R.J. and Litchfield, N.J. (2012) Vertical land movement around the New Zealand coastline: implications for sea-level rise, GNS Science Report 2012/29. 41p.

- Access across the structure.

5.2 Rock sizing has been based on a 1(V):1.5(H) slope to minimise footprint and has been sized to withstand a 100 year ARI design wave height including 0.45m sea level rise with minor damage (less than 2%). This results in 1 to 6.3 ton armour rock which would be placed in two layers with a 0.7 m thick underlayer of smaller rock (50 to 500 kg) overlying a geotextile filter fabric. The total thickness is 2.5m. This sizing and thickness could be reduced slightly if a shorter design life (i.e. 25 years) or lower design event (i.e. 50 year ARI) was adopted but this is not recommended for rock sizing as retrofitting larger rock is difficult and expensive (i.e. compared to raising crest elevation at a later date).

5.3 The crest height has been set to limit average wave overtopping during a 100 year ARI event to less than 10 litres/s/m which is the upper threshold for damage to a vegetated backshore. The level has been assessed for present day and future (+0.45m) sea levels and a crest level based on present day sea levels is initially recommended which can be upgraded in the future if needed. A conventional crest width of three rock diameters has been adopted.

5.4 The revetment structure toe has been set at 0.5 m below the minimum surveyed beach position allowing for a small amount of additional scour beyond the maximum observed. It is not recommended that this is toe depth is lifted to minimise footprint as the structure will be at risk of being undermined.

5.5 The revetment crest has been set as far back into the backshore cliff as possible (refer drawing 1000724-03 of the Design Report). The ends of the revetment will be tied into the existing groyne at the southern end and recurved into the existing rock at the northern end. The total width of the rock revetment from the crest to the toe, adopting a crest level of 4.85 RL m and toe depth to -1.0 RL m, is approximately 11.0 m.

5.6 Public access can be provided across the structure informally by selective placement of rock faces or formally by incorporating concrete stairs into the structure or bridging the structure using timber piled stairs. This latter type of access structure is shown in the consent drawings and currently used at site. The access can be formed to remain within the structure footprint.

6.0 ASSESSMENT OF ENVIRONMENTAL EFFECTS

Rock Revetment

6.1 The toe of the revetment is expected to extend approximately 3.5 m seaward of the existing vertical toe of the rock and rail wall as shown in the Design Report, Appendix D, Drawing 03. This is primarily due to use of a sloping structure compared to the existing vertical structure (Figure 2), although this has been minimised by using the steepest practical structure face for a rock revetment (1.5(H):1(V)).

6.2 However, the visually apparent width of the structure will vary with sand level (Figure 2). At low sand levels the intersection of the beach and structure will be up to 3m seaward of the current rail and log wall and at high sand levels the intersection will be further landward. At average beach levels the intersection will be slightly seaward (<1m) and at high sand levels the intersection will be slightly landward of the existing. It should be noted that at low sand levels of public access seaward of either the existing or the proposed structure will not be possible during low tides.

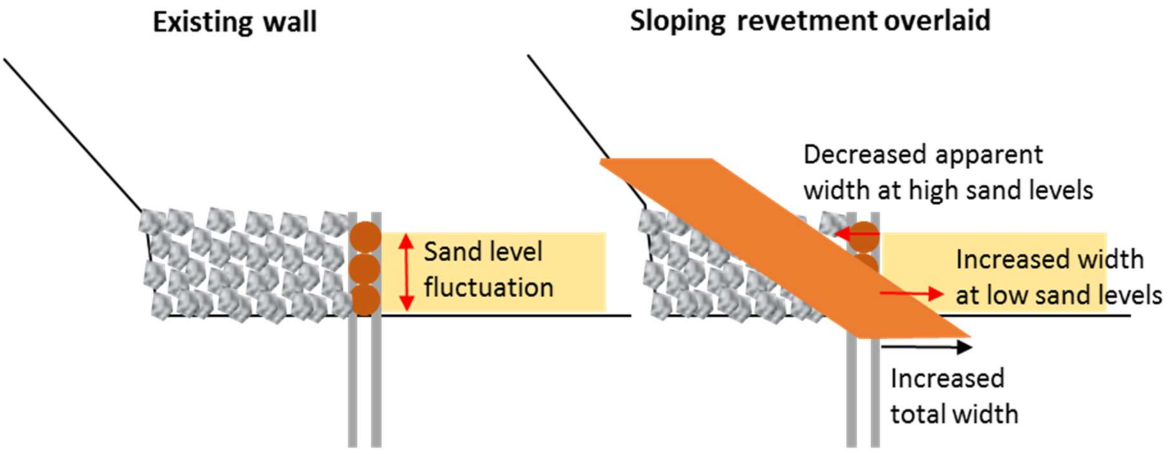

Figure 2 Change in total and apparent width for the proposed sloping structure compared to existing

6.3 The proposed rock revetment provides an effective energy dissipating slope that will reduce wave action across the revetment slope, although some minor to moderate overtopping (< 10 l/s/m) may still occur during strong storm surges at high water levels, however, we expect the rate and severity of such activity to be less than what currently occurs with the existing rock and rail wall.

6.4 The revetment is expected to be the same or less reflective than the existing rail iron and log structure which would not resulted in increased potential for scour of the existing beach at the structure toe.

6.5 Prior to any erosion protection works, the cliff face was subject to erosion, with eroded talus temporarily deposited on the beach. This sediment is sorted by wave processes with finer material being moved offshore and courser material remaining on the beach. The rock revetment is expected to mitigate future erosion of the cliff face and therefore a potential source of sediment over some 50 m. However, this supply is likely very small compared to the overall sediment budget and has effectively already been removed by the existing structure.

6.6 At its northern end, the proposed rock revetment will be recurved into the existing rock at 2 Tuahine Crescent. The length of remaining shoreline north of this point will likely continue to be protected by the existing rock and rail wall in the short- to medium-term. If this existing revetment were to be removed or were to fail, increased reflection and turbulence off the end of the proposed revetment could induce additional erosion (end effects) for 20-30m or for approximately 70% of the structure length.

6.7 The proposed rock revetment will be tied onto into the existing groyne at its southern end. The cliff south of this groyne is fronted by a recently constructed rock revetment. We expect this cliff toe to remain sufficiently protected from erosion for the design life of the revetment.

6.8 We do not expect adverse effects from construction works as an Erosion and Sediment Control Plan will be established and approved prior to works beginning on site and works will be undertaken outside the tide (i.e. when the sea is not affecting the works area).

Gabion Baskets

6.9 Gabion baskets can provide support to the base of the dune toe but are generally only short term coastal protection structures on open coastlines (<5 years) as the PVC coating on the wire is worn away under wave and sediment action and the wire corrodes in the marine environment leading to breakages and loss of fill materials. Waves overtopping the low baskets can also cause damage to the dune face. For these reasons gabions baskets are not regarded as effective long-term structures for mitigating erosion of active beach systems.

6.10 However, the gabion baskets at the Wairere Road site are consistent with other existing structures along Wainui Beach (similar gabion baskets are located both to the north and south of 21 Wairere Road) and likely partially protected from marine action by sand accumulation thereby prolonging this life.

6.11 The bank above the gabion baskets will flatten by slumping until a stable angle of repose is reached, some loss of land above the slope is therefore expected. Planting of the exposed dune face above the gabions is recommended using salt tolerant vegetation to stabilise the sand against wave run-up and overtopping of the gabion baskets.

7.0 SUBMISSIONS

7.1 40 submissions were received from largely local residents at Wainui Beach and tangata whenua including submissions in support and in opposition to construction of the revetment in the vicinity of Tuahine Crescent, and retention of the gabions and removal of the rock at 21 Wairere Road.

7.2 I do not consider that any subject matter contained within the submissions or peer review has not already been addressed by the AEE, the s 92 response, the s 42A report, my evidence and Mr Hansen's evidence.

8.0 OFFICER'S REPORT

8.1 Mr Whittaker in his 42A report suggests that a shorter design life or smaller design event could be adopted to reduce the structure footprint. Selection of a 25 year design life would decrease the likelihood of a 100 year ARI event occurring to 29.5% over this time (refer Table 1). Likewise, a lower, more frequent design event could be selected (i.e. 50 year ARI event) but these would have a 63.2 or 50.3% likelihood of occurring over 50 or 25 years respectively. Overall we consider the selection of a 100 year ARI event provides for an appropriate level of risk for this type of structure regardless of whether design life is assumed at 25 or 50 years.

8.2 Options for further reducing the footprint of the revetment (Figure 3) may include

- Using a steeper structure,
- Sizing rock for a lesser design event,
- Reducing crest level by increasing tolerable overtopping volumes or assuming a lesser design event,
- Raising revetment toe levels,
- Moving the structure inland.

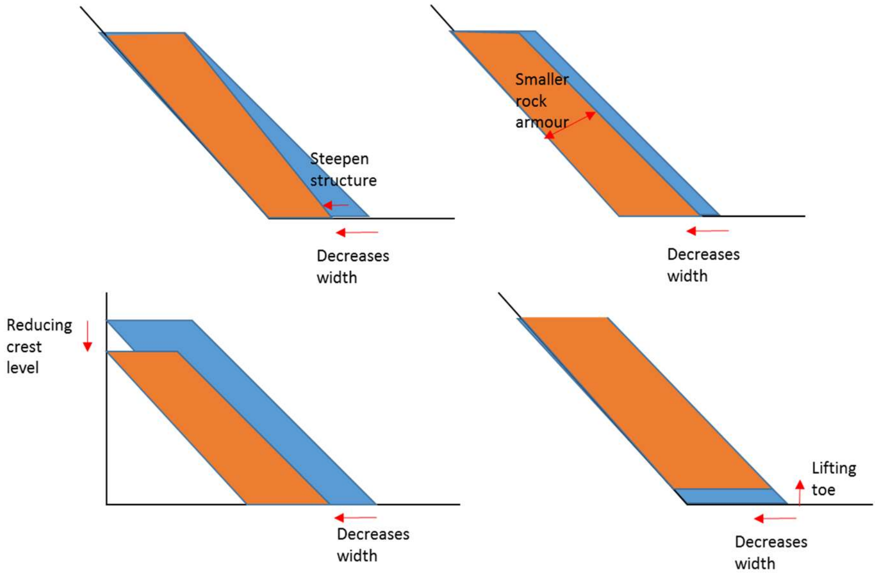

Figure 3 Typical methods for reducing structure footprint

8.3 The structure has a slope of 1.5(H):1(V) which is the steepest slope possible for an engineered rock revetment. An engineered vertical structure such as timber pile or concrete panel structure would reduce the structure footprint but these type of structures are not recommended in this active beach environment due to:

- the rigid nature of such structures and the depth to required found the structure on bedrock
- impermeable, vertical structures can result in increased wave reflection, increasing erosion potential in front and adjacent the structure and affecting offshore wave conditions
- vertical structures result in increased wave overtopping requiring higher crest elevations to achieve tolerable overtopping levels.

8.4 Rock could be sized for a lesser design event or for a shorter design life. For example a 50 year ARI event over a 25 year design life (0.3 m sea level rise assumed) would result in a smaller rock size and thinner armour structure reducing the additional footprint from 3.5 to 3.1 m. However, this event has a 50% likelihood of being exceeding during this design life and a 63.2% likelihood of being exceeded over 50 years if the structure is reconsented. These likelihoods are more suited to a temporary protection structure than a semi-permanent structure and, in my opinion, are not suitable for the proposed work.

Table 2 Rock size and structure footprint for different design events and periods.

Design Event (ARI, years)	Design period (years[1])	Likelihood[1]	Hs (m)	WL (m RL)	Median armour rock size (kg)	Total structure width (m)	Extension beyond existing (m)
100 year	50	39.3%	1.79	2.75	2540	11.5	3.5
	25	29.5%	1.71	2.6	2130	11.3	3.3
50 year	50	63.2%	1.72	2.6	2200	11.3	3.3
	25	50.3%	1.63	2.5	1870	11.1	3.1

[1]Assume 0.3 m Sea Level Rise over 25 years and 0.45 m Sea Level Rise over 50 years

[2]Likelihood of event exceeding design during design period

8.5 While reducing a crest level for a triangular structure on a vertical slope will result in a smaller footprint, this is not necessarily the case for a sloping backshore. As shown in Design Report, Appendix D, Drawing 03 and illustrated in Figure 4, where the backshore is sloping at a similar slope to the structure adjusting the crest level may not necessarily change the position of the toe.

8.6 The current design crest level of RL 4.85 m is suitable for the present day but may need to be increased in the future. This is not expected to increase the structure width. Likewise, decreasing the width to allow for higher levels of overtopping or for a more frequent event is not likely to reduce the footprint until the structure reaches the vertical part of the slope, immediately above the existing structure. However, a crest at this level is too low to provide any appreciable benefit of reducing overtopping-induced erosion compared to the existing structure and is not recommended.

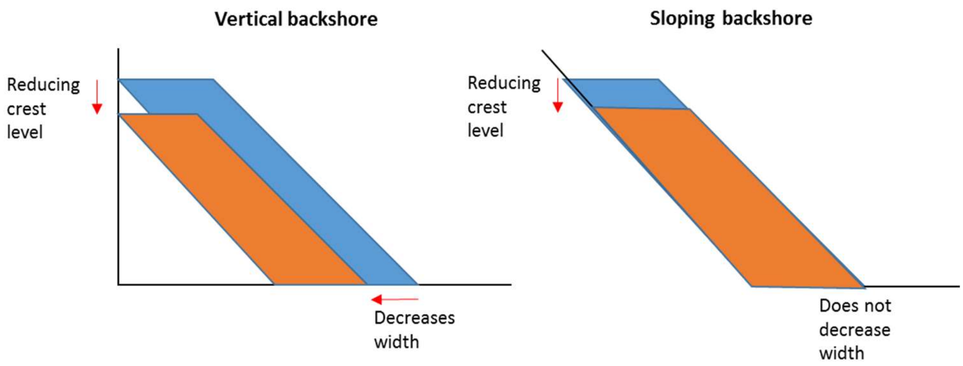

Figure 4 Change in total and apparent width for the proposed sloping structure compared to existing

8.7 Raising the revetment toe level is not recommended due to the risk of undermining by erosion and damage to the structure.

8.8 Realigning the structure inland is not feasible as the structure is already as far landward against the bank/cliff face as possible.

8.9 With the exception of the issues around the revetment's engineering design life, I generally concur with the remaining opinions expressed by Mr Whittaker in his s42A report.

9.0 PEER REVIEWS

9.1 A peer review of coastal process issues was provided by Dr Willem de Lange. While this review mainly considered the effects of beach scraping (now withdrawn) it did note that:

"*The application involves replacement and partial removal of existing structures. It is very unlikely that the proposed coastal protection structures will fundamentally affect beach processes in a manner that differs from the existing structures. Therefore, while this aspect of the consent application is unlikely to improve the beach system at Wainui Beach, it is also unlikely to have adverse effects beyond those that currently exist."*

I agree with this statement.

9.2 A review memo provided by Mr Paul Murphy (9 January 2018) recommends an alternative design which fits within the footprint of the current structure. I do not believe this is feasible for this situation for the reasons outlined above.

10.0 CONCLUSION

10.1 Wainui Beach is a dynamic beach system constrained by hard cliffs and reefs at either end and generally modified by coastal protection works along the southern half of the beach.

10.2 Gisborne District Council ("GDC") developed and adopted the WBEMS for the long term and strategic management of coastal erosion, land use and development at Wainui Beach. The WBEMS identified replacement of the rock and rail wall between the mass concrete groyne near the southern end of the beach and Tuahine Crescent beach accessway with a more robust rock revetment structure as a key action for GDC to implement.

10.3 A rock revetment has been designed based on a 100 year ARI event. This has a likelihood of being exceeded of 29.5% over 25 years and 39.3% over 50 years. This design event provides for an appropriate level of risk for this type of structure over either 25 or 50 years. Design for lower, more frequent events is better suited to a temporary structure.

10.4 The toe of the revetment is expected to extend approximately 3.5 m seaward of the existing vertical toe of the rock and rail wall due to use of a sloping structure compared to the existing vertical structure, although this has been minimised by using a relatively steep structure face of 1.5(H):1(V).

10.5 Options for further reducing the footprint by reducing the crest, raising the toe, steepening the structure or realigning further landward are not practical for reasons described above.

10.6 Effects on coastal processes including scour of the beach in front, end effects or changes in the sediment budget are not expected to substantially differ from those currently occurring and are likely to be less than minor.

10.7 A 15 m long gabion basket and rock seawall has been constructed in the esplanade reserve in front of 21 Wairere Road under the emergency works provisions of the RMA following a storm event in August 2016. The rock is undersize, is not well designed, susceptible to damage and loss onto the foreshore during large wave events and is proposed to be removed.

10.8 Gabion baskets are generally a short-term coastal protection option due to damage to wire and failure of the structures in the coastal zone. However, the gabion baskets at the Wairere Road site are consistent with other existing structures along Wainui Beach and likely partially protected from marine action by sand accumulation prolonging this life.

10.9 The bank above the gabion baskets will flatten by slumping once the rock riprap is removed until a stable angle of repose is reached, some loss of land above the slope is therefore expected until vegetation becomes established.

10.10 With the exception of the issues around the revetment's engineering design life, I generally concur with the remaining opinions expressed by Mr Whittaker in his s42A report.

Thomas Duncan Shand

22 January 2018