Tonkin & Taylor

T&T Ref: 27292
01 February 2011

Gisborne District Council
P.O. Box 767
GISBORNE

Attention: Jurgen Komp

Dear Jurgen

# Wainui Beach Management Strategy - Review

## 1 Introduction

In June 2010, Tonkin & Taylor Ltd were commissioned to carry out an independent review of the "Wainui Beach Management Strategy" (W.B.M.S). Our review has been based on a desktop review of existing reports, meetings and a site visit to the beach on 8 July 2010. At the same time Gisborne District Council (GDC) had submitted a consent application for construction of the WBMS Section 3 works. The hearing for this consent was held in mid June and consent was declined in July. This report includes our review of the WBMS and also comments on the result of the consent hearing and the Commissioners' Hearing Report.

## 2 Documents reviewed

The primary documents reviewed are as follows:

- Gibb, J.G. (1995) Assessment of Coastal Hazard Zones for Northern Poverty Bay and Wainui Beach, Gisborne District : Unpublished report for Gisborne District Council.
- Komar, P.D. (Dec 1996) The Erosion of Wainui Beach, Gisborne – Causes and Mitigation : Unpublished report for Gisborne District Council.
- Komar P.D. (2003) Review of the Wainui Beach Draft Management Strategy : Unpublished report for the Gisborne District Council.
- Gisborne District Council (2003) Wainui Beach Management Strategy : Gisborne District Council Report.
- Commissioner's Report and Decision (2010) Gisborne District Council Application for a Resource Consent by Rivers and land Drainage Department of the Gisborne District Council.

# 3 Extent of review

This review of the WBMS is substantially a desktop review of the strategy document itself and review of the base studies carried out by Dr Jeremy Gibb and Dr Paul Komar, which provided the coastal process assessment and coastal geomorphology which formed the basis of the WBMS. No new scientific work or engineering assessments have been completed as part of this review. This review is limited to comments on the appropriateness of the WBMS given recent developments in coastal protection works, and to recommend where further work would benefit the management strategy.

# 4 Wainui Beach Management Strategy (W.B.M.S)

The WBMS was developed in 2003, by the Wainui Beach Management Strategy Committee which was made up of six residents, a representative from Department of Conservation, a representative from Ngati Oneone, a Wainui Councillor and the Committee Chair.

Management strategies proposed were largely based on the 1996 report from Dr Komar, and Dr Komar reviewed and commented on the draft strategy in 2003. The WBMS divides the beach into seven management sections as follows:

Section 1 - Tuahine Point/Headland

Section 2 - Old Groyne 28/Commencement of Log/Rail Wall to Tuahine Crescent Accessway

Section 3 - Tuahine Crescent to Wainui Stream

Section 4 - Wainui Stream to the Oneroa Road/Stock Route

Section 5 - Stock Route to The Dip (Wainui School)

Section 6 - The Dip (Wainui School) to Hamanatua Stream

Section 7 - Lysnar Domain – Hamanatua Stream to Makorori Headland

Each of the seven sections is discussed briefly below.

## 4.1 Section 1 – Tuahine Point/Headland

Section 1 extends from Tuahine Point in the south to approximately the position of the old steel groyne no. 28 (as shown on Gisborne District Council Drawing EW244/1, see Appendix A).

This area has no existing protection works, and none are proposed. The land is rural with no structures at risk from erosion, and is fronted by coastal cliffs at its seaward extent. Gibb assessed the sea cliff retreat at a rate of between 0.2 m and 0.3 m per annum, which is a higher rate of erosion than elsewhere along Wainui Beach, however due to there being no risk to existing infrastructure, the strategy of allowing the erosion to occur is appropriate.

Dr Gibb's assessment took place in 1995 and given the subsequent passage of time there would be value in updating the assessment to provide information on the current rate of retreat, and any implications for the beach system as a whole.

## 4.2 Section 2 – Old groyne 28/commencement of log rail wall to Tuahine Crescent accessway

The WBMS recommends removal of the previous protection works (railway irons and log wall with rocks placed behind) and construction of a new rock revetment. This new rock revetment has already been constructed along most of Section 2, between old groyne 28 and the existing concrete groyne 27. The new revetment works were not able to be inspected during our site visit due to tide levels and wave conditions on the day.

The WBMS identifies the key design features for the revetment as follows:

- Rock slope to be 3H:1V
- Crest elevation to be to RL +3.5 m (assumed to be above Mean Sea Level)
- Rock revetment toe to be excavated 0.5 m into the papa shelf.

Also recommended in the WBMS is the construction of a cobble berm/dynamic revetment, over the toe of the rock revetment. We understand from discussion with Council that this has not been included in the constructed section of rock revetment.

The area north of groyne 27 to the Tuahine Crescent accessway is still protected by the old railway iron and log wall with large rock behind. We support the replacement of the log wall with a well designed seawall, see comments below in discussing Beach Section 3.

## 4.3 Section 3 – Tuahine Crescent accessway to Wainui Stream

Existing coastal protection works for this section include both the Log/Rail Wall backed by rock revetment, and gabion baskets backed by rock revetment. This is the section of foreshore which was the subject of the recently declined resource consent.

In Gibb (1995) there are four stations within this section of coast, WB-3 to WB-7, and long term erosion rates have been determined as being between 0.26 m/year (toward the southern end of this section of foreshore) to 0.05 m/year at the northern end. Gibb's table 5 also gives annual rates calculated over defined periods, and it can be seen that since approximately 1953 there was no erosion measured at WB4 (which is protected by the log/rail wall and substantial quantities of rock). At stations WB5 and WB6 erosion appeared to be substantially halted by the protection works until the severe storms in 1992 destroyed the gabions at the toe of the protection works.

The WBMS identifies that the log/rail wall is in poor condition and hence it proposes that existing protection works be replaced along this section of beach by a new sloping rock revetment similar to that proposed for Section 2 works.

While Dr Gibb's assessment of short and long term erosion rates shows that the existing structures have been largely successful in protecting the adjacent land and structures from erosion, we support the removal of the existing structures, and replacement with a well designed sloping rock seawall.

The existing structures perform poorly from a beach preservation perspective, with vertical log and rock outer toes which increase wave reflection and beach lowering. They also present significant health and safety risks to all forms of beach users at varying beach states (i.e. beach sand levels and tide and wave conditions). The existing structures should be removed to improve beach safety and amenity value and replaced with an appropriately designed seawall to protect the adjacent property assets.

Constructing a hard rock sloping seawall in this location is considered appropriate, due to:

- the proximity to the edge of the low coastal cliffs of a number of houses, requiring protection;
- the reduced wave reflection properties of a sloping rock wall will reduce beach lowering;
- the durability of the rock under long term wave attack will give protection works an appropriate design life;
- the flexible nature of a rock revetment which can be topped up if necessary in the future to allow for settlement or sea level rise;
- the fact that for the majority of the time the bulk of the rock revetment will be buried beneath the beach sand when the beach is in full profile.

The new sloping rock revetment should be suitably designed, and we note that the existing proposed design has some limitations. These are discussed in Section 6 of this report, and we also note that the design was questioned by the Resource Consent Commissioners in the recent consent hearing.

## 4.4 Section 4 to 6– Wainui Stream to Hamanatua Stream

Existing coastal protection works for this section include combinations of timber retaining walls fronted in places by gabions anchored in place by vertical steel rail irons, rock revetments, and vertical concrete walls.

Gibb (1995) includes two stations in beach section 4 as WB-07 and WB-08. Long term erosion rates at these stations are low and assessed as -0.05 m and 0.02 m per year. Also notable from Table 5 in Gibb (1995), is that erosion has substantially stopped from 1953 (in the case of station WB-07) and from 1975 in the case of station SB-08. This is no doubt due to the construction of coastal protection works, however GDC Drawing EW 244/1 does note damage to gabions, repair of gabions and augmentation with considerable amounts of rock boulders, over subsequent years in order to provide erosion protection.

There are also two stations located in each of beach section 5 and 6 which were assessed for long term erosion in this section of beach. Gibb determined the long term erosion trend for these stations as -0.01 m per year erosion at WB-09, and 0.02 m per year erosion at WB-10 (in beach section 5), and rates of 0.03 m per year for Station WB-11, and 0.14 m per year for Station WB-12 (in beach section 6).

As for beach Sections 2 and 3, Dr Gibb's assessments of long term erosion rates generally show that existing protection works have provided a reasonable degree of protection against erosion, albeit requiring repair following extreme storm events.

The management strategy for beach Sections 4 to 6 involves seven separate strategies generally consistent throughout these beach sections with minor variations to treatment at access locations. Each of the strategy points are discussed below.

i. Gabion Basket Maintenance

The strategy is generally to maintain existing gabion baskets where they are in reasonably condition and replace them with geotextile sand-filled bags ('cushions') where the gabions are deteriorating.

In general terms we support the long term removal of gabions from the beach. The gabion baskets are generally buried below the beach face and as such are lasting a longer time than if they were continually exposed to the abrasive action of waves and sand. When exposed and deteriorated, the wire baskets can be a safety risk, and the baskets break down spilling their contents onto the beach so long term they require maintenance or need to be replaced with a better solution.

We have some reservations regarding the use of geotextile sand cushions as the replacement protection works. They do have some advantages in that they present a softer form when in contact with beach users, and can be readily replaced when required. However they are poor at absorbing wave energy and will consequently cause greater beach lowering from reflected wave energy and wave back-wash than a sloping rock seawall would. They will not last as long as a rock seawall and will require more maintenance. For further discussion refer section 6.2 below.

We note the statement on page 21 of the WBMS, that "unserviceable gabions and fronting rail irons from Cooper St to the Oneroa Road Stock Route and 75 m beyond... must be removed". We believe this needs to be expanded to include the long term removal of all rail irons at all locations to remove their consequent safety risk to beach users. In some places the remaining gabions may be able to stay in the short to medium term if in reasonable condition, however the removal of the rail irons is likely to make the remaining gabions more vulnerable during storms, and their replacement with an alternative backstop seawall will most likely become more pressing.

ii. Foreshore Protection and Rebuilding Using Geotextile Sand Cushions/Bags

This management strategy item discusses further the desire to eventually replace all existing protection works in beach sections 5 to 6 with geotextile sand-filled cushion protection works. As discussed above and in section 6.2 of this report there are some limitations with using geotextile sand-filled bags as a long term foreshore protection works.

iii. Emergency Use of Geotextile Sand Bags in Erosion Events

The WBMS discusses the strategy of having a stockpile of geotextile bags on hand and sand source available, whereby bags could be filled and put in place during an erosion event. Once the erosion event has passed the bags could be "left in place or re-arranged if necessary".

As a concept this sounds good, however we understand that Council do not have either the pre-purchased geotextile bags, or the sand source arranged to implement this strategy. There are also likely to be difficulties implementing this strategy during a storm as access along the beach to place the bags may not be possible, and access to the top of the bank from private properties may also be difficult.

If sandbags are not proposed as a long term solution, then their use will only be limited to short term emergency work when existing structures fail. In our opinion this is an appropriate use of the sandbags, with their subsequent replacement with a more permanent solution. In order for sandbags to be an effective strategy for emergency repair Council will need to pre-purchase a reasonable number of bags, already have a design for the protection works in hand, and be prepared to remove any failed existing structures and replace them with a short term geotextile cushion structure immediately following a storm event, using sand from elsewhere on the beach. While only a relatively minor revision to the proposed management procedure, it is probably more achievable. More permanent solutions would then require a resource consent and this should be investigated with consent authorities in advance of a storm rebuild being required.

iv. Beach Scraping Trial

Beach scraping is proposed as a post-storm dune recovery strategy. Little information is included in the WBMS relating to this, and care would need to be taken in deciding where to source the sand for beach scraping. It can be a successful strategy if suitable sand reserves exist.

v. Retreat of Specific Dwellings

The WBMS appears to have adequately assessed the need to relocate specific dwellings within beach sections 4 to 6.

vi. Replacement of Collapsed Walls

The measures proposed in the WBMS appear appropriate.

vii. Beach Access

The WBMS includes specific recommendations for various public beach access locations on beach sections 4 to 6, and all management philosophies appear appropriate

## 4.5 Section 7 – Lysnar Domain – Hamanatua Stream to Makorori Headland

This section of beach has no existing coastal protection structures and none are proposed in the WBMS. The strategy does include a number of recommendations, predominantly focussed around 'Dune Care'. We support all strategies in this beach section.

# 5 Existing structures

On the day of our inspection beach levels were high and many of the existing structures were covered by sand and unable to be inspected. Comments in this report are therefore largely based on photos provided by Gisborne District Council and our experience with similar structures.

## 5.1 Log-piled walls

Log-piled walls shown in Photo 1 (see Appendix B) with rock behind, were only visible at the Tuahine Crescent beach access on the day of our site visit. The piles are old steel railway irons which we understand are severely corroded in places. The WBMS describes them as "ugly and becoming dangerous as they break up, leaving jagged edges". As can be seen from the photographs there is a large quantity of rock placed behind the log-piled wall extending back to the current extent of the shoreline.

The railway irons protrude above the logs and when the sand level approximately matches the level of the top log the railway iron and the steel ties between them are a hazard to beach users. When the sand level is low the vertical exposed face of the log wall reflects wave energy and causes increase sand undercutting in front of the wall lowering the beach levels. When the sand is low the extent of the rock behind the log wall occupies a large area of beach adjacent to the cliff backshore.

When the sand is low with these walls partially exposed the protruding rail irons represent a significant danger to swimmers and board riders. At mid to high tide levels with waves breaking over these structures and washing up the rock revetments swimmers or board riders caught in this area could be seriously injured. We therefore recommend all walls with vertical rail irons protruding above the surrounding structures should be removed with high priority.

## 5.2 Gabion and sloping rock revetment

In places sloping rock revetments have been constructed with either railway irons holding their toe (see Photo 2), or gabions and railway irons (see Photo 3). While these were not able to be seen as they were buried beneath the sand, the rock appears to be of suitable size and has survived a number of storms without being deposited on the lower beach.

The main problem with the type of construction is the hazard the railway irons present when sand is low, and the short term deterioration of the gabions which are protecting the revetment toe. If they fail the revetment could slide and unravel. Due to the Health and Safety risk to beach users (both swimmers and pedestrians), we recommend these walls be replaced with high priority.

## 5.3 Timber wall with gabion toe protection

Timber walls are shown in Photos 4 and 5, at a location just north of Wainui Stream. Buried beneath the sand are gabions which are held in place with railway irons. Vertical walls reflect wave energy and increase beach scour and lowering. If the gabions are immediately in front of the wall they may assist in reducing backwash scour of the beach in front of the walls. The vertical railway irons should be removed as discussed in 5.1 and 5.2 above. If this is done,then when the gabions are exposed, the wave climate to be expected on Wainui Beach is likely to exceed the gabion stability and an alternative seawall will be required.

## 5.4 Timber groyne on south side of Hamanatua Stream

There is a large timber groyne on the southern side of Hamanatua Stream which assists in guiding the stream toward the sea and prevents it meandering southward and eroding the incipient dune. The seaward end of this groyne is shown in Photo 6. A full inspection of this groyne wasn't possible due to tide and wave conditions, however this groyne is a significant structure in assisting the growth of the incipient dune to its south. Its condition should be monitored and a full inspection of the condition of the timber should be made with the view to programming maintenance of the structure and possible replacement when maintenance is no longer economic.

# 6 Proposed structures

As discussed earlier, the WBMS generally promotes two types of coastal protection structures to replace existing structures: sloping rock revetments for beach sections 2 and 3, and geotextile sandbags for beach sections 4 to 6. Each of these structures are discussed briefly below.

## 6.1 Sloping rock revetment seawall

The proposed sloping rock revetment, which was included in the recent Resource Consent, is shown in Appendix C. It generally involves large rock armour on a layer of smaller rock on a layer of fill including beach cobbles and sand. The revetment has a slope of 1 vertical to 3 horizontal, and its toe is embedded 0.5 m into a trench excavated into the underlying papa/estuarine silt layer. The toe is shown as being at an elevation of 0.25 m above Mean Sea Level (M.S.L.) and the crest at an elevation of 3.0 m above MSL.

As part of this review we have not checked the hydraulic stability of the design of the revetment, as that would require more specific work relating to defining near shore beach wave climates, review of historical beach profiles, and evaluation of options, which is beyond the current brief.

However, we have the following general comments which potentially improve the design.

- While rock armour size and layer thickness is not shown on the drawing, we note that a conventional rock armour layer involves a two-stone thick layer with surface layer stones the same size and the lower layer of stones in the same armour construction. The drawing depicts a single layer of larger armour on top of smaller stones. This construction has less permeability than ideal and absorbs less energy. It also has less interlock between stones which reduces the stability of the surface armour stones.
- The drawing shows the crest of the armour layer being formed with smaller stones than the main armour stones. Crest stones should in fact be the same size as the main armour, particularly where severe wave action can overtop the crest as smaller stones can be readily plucked from the crest and removed by wave action.
- We support the toe of the armour being constructed in a trench cut into the underlying papa. The depth of this trench should be approximately equivalent to the average size of an armour stone. As the size of the armour stones is not shown on the drawing we are not able to comment as to whether the 500 mm depth proposed is adequate. The aim should be to construct a relatively smooth transition between exposed papa shelf in front of the revetment and the general line of the rock armour.
- The depth of toe excavation may need to be greater in the estuarine silt material to allow for some future down-cutting of this material in front of the wall. In areas away from the papa formation, the extent of toe embedment should be considered in relation to the lowest recorded level of the beach profile at those locations, with the rock armour extending approximately 1.0 m below the lowest recorded beach elevation.
- Material excavated from the toe is often used as fill beneath the armour and secondary rock layers (underlayers), to form the correct slope of the revetment. Beach cobbles should ideally be left on the beach as these help to armour the beach in front of the revetment when beach levels are low, see Photo 3, and will reduce further down-cutting of the beach. This has also been identified by Komar, and we support maximising the use of natural beach cobbles in front of the revetment.
- Fine-grained fill material (e.g. sand or silt material), needs to be contained and prevented from washing out through the revetment causing cavities and slumping of the revetment. This is usually achieved with a suitable geotextile layer placed between the fill and the rock underlayer. This geotextile should also extend into and cover the base of the toe excavation, and should extend up the cliff or embankment to armour crest level. No geotextile is shown on the current Council cross-section.
- Armour slope has been set at 1 vertical to 3 horizontal. Flatter armour slopes generally reduce wave run-up levels, as do more porous armour textures. If the armour layer is redesigned as a two-stone thick layer of equivalent stone size throughout, this will have greater porosity than the design shown on the Drawing. This would then allow the armour slope to be steepened to

be 1 vertical to 2 horizontal, or even 1 vertical to 1.5 horizontal thus minimising the footprint of beach utilised by the revetment. The area occupied by the revetment was a significant issue in the Resource Consent Hearing.

## 6.2 Geotextile sand-filled containers

The solution proposed in the WBMS for beach areas 4 to 6 is to replace existing structures (mainly gabions and timber walls), with sand-filled geotextile containers (sometimes called cushions, pillows or bags).

Geotextile sand-filled bags are gaining greater popularity as coastal erosion control works, particularly when used as temporary structures or for training works for stream outlets onto beaches. They have some appeal as they present a softer form when in contact with beach users and modern geotextiles contain a thicker outer fabric which has some ability to trap sand resulting in the works visually blending into the surrounding sand dunes better than rock solutions.

There are some disadvantages however in relation to rock alternatives as follows:

- Their long-term durability is questionable. Accelerated UV resistance tests on current geotextiles indicates a minimum design life of 10 years can be expected. This is however significantly less than for rock seawalls.
- In addition to long term UV damage they can also be subject to vandalism and consequently require greater levels of maintenance.
- Design parameters for stability assessments is limited and based on small scale laboratory tests. In a recent paper prepared by ELCO Solutions Pty Ltd (refer Appendix D), they advise that:

  > "no reliable stability formula is available to assess required container mass, however evidence from field observations allows the following suggestions:
  >
  > Revetments
  >
  > 1.5 tonne containers – maximum wave height 1.5 m
  >
  > 4.5 tonne containers – maximum wave height 2.5 m"

On an open coast beach such as Wainui, when beach levels are low and storm surge elevates water levels, these maximum wave heights are likely to be exceeded.

A detailed near-shore extreme wave climate would need to be assessed for Wainui Beach in order to confirm whether the recommended maximum wave heights were likely to be exceeded, prior to recommending geotextile sandbags as a long term erosion protection backstop wall for Wainui Beach.

- Because the bag present a largely flat surface to incoming waves, albeit with a stepped face, they absorb less wave energy than tipped rock seawalls with the result that more wave energy is reflected which has the potential to scour beach sand in front of the sandbag wall to a greater extent than in front of tipped rock seawall.
- In order to provide as stable a wall profile as possible they require the front face to be constructed with a slope similar or greater than tipped rock seawalls therefore potentially occupying a greater area of exposed beach in front of dunes or sea cliffs.

For all of the above reasons we do not recommend geotextile sandbag revetment seawalls as a long term solution for Wainui Beach.

# 7 Commissioners' comments

In addition to questioning the adequacy of Council's rock revetment design, the Resource Consent Commissioners also suggest updating Dr Gibb's 1995 work to include the latest predictions on climate change. This potentially relates to the design crest level of the revetment as it was stated in the Hearing that the revetment crest level of +3.0 m above MSL would not provide full protection. We believe the best way to clarify this would be to define the near-shore beach wave climate for the situation where the beach is in its eroded profile, and calculate the wave run-up height, and any resulting overtopping flow, and assess the eroding potential of the overtopping flow. Then increase the design sea level to include predicted sea level rise for the next 35 years (the term of the consent) and repeat the exercise and set the revetment crest level dependent on the results of the analysis.

While Dr Gibb's analysis is now 15 years old most of the parameters assessed will not have changed. Some may have e.g. climate change effects, and long-term erosion trends, and it may also be useful to update this data and refine the coastal risk zones, however updating Dr Gibb's previous work will not help to define the appropriate rock seawall crest elevation.

# 8 Achievement of vision statement

The Wainui Beach Management Strategy states that the vision statement for the beach is:

> "The protection and enhancement of Wainui Beach and adjoining reserves for the use and enjoyment of future generations."

Existing seawalls and protection works have provided a reasonable degree of protection for reserves and private property fronting Wainui Beach (albeit with periodic post-storm maintenance and upgrading). Existing structures have not however enhanced the beach for the enjoyment of future generations, as they occupy a large area of beach when beach levels are low, exacerbate beach scour, and present health and safety risks to beach users.

Of the two long term replacement options proposed in the WBMS, suitably designed tipped rock seawalls potentially occupy less beach area, absorb greater wave energy with less consequent beach scour, and are more durable with a significantly longer design life for protecting landward assets. Accordingly a rock seawall solution appears to better fulfil the vision statement from both a land protection and beach enjoyment perspective, than a sandbag wall options.

We therefore recommend that the WBMS be amended to reflect this.

# 9 Conclusions

Tonkin & Taylor Ltd have completed a desktop review of the Wainui Beach Management Strategy, together with review of available literature and the recent Resource Consent Application for a replacement rock revetment in Section 2 and 3 of the beach, as defined in the WBMS.

The existing foreshore protection structures vary along the beach depending on the degree of exposure to wave attack and have had varying degrees of success in the past. Disadvantages of the existing structures include:

- The vertical face of the log wall, and to a lesser extent the gabion toe of the sloping rock revetment, causes increased wave reflection and consequent down-cutting of the beach.
- When exposed the log wall and railway irons are unsightly and unnatural.
- Protruding railway irons are a significant health and safety risk to beach users.
- Existing revetments occupy large areas of the upper beach face when beach levels are low.
- Gabion revetment toes and protection works deteriorate with time and require maintenance or replacement.

The WBMS seeks to improve the above deficiencies with the existing structures by replacing them with a new sloping rock revetment in sections 2 and 3 of the beach and a geotextile sand cushion revetment (or similar) in sections 4 to 6 of the beach together with dune planting and beach scraping policies, to assist dune growth.

Generally we agree with the solutions proposed in the WBMS for beach sections 2 and 3, however the currently proposed sloping rock revetment design needs to be modified to include the details discussed in Section 6.1 above. We have not completed a detailed design of the revetment but recommend that this be done together with a detailed assessment of near-shore wave climate, allowing for predicted sea level rise, prior to finalising the preferred revetment design.

A geotextile sandbag revetment for beach sections 4 to 6 is not recommended as there is little current design literature which suggests that it would be successful in the short term. There are also significant long term durability concerns for its use as a permanent structural solution. We recommend the use of tipped rock seawalls as the permanent long term replacement for existing structures in beach sections 4 to 6.

All new seawalls should be constructed as "back-stop" seawalls with the seawalls constructed as far landward as possible ensuring the maximum volume of sand contained in dunes and incipient dunes is available for beach processes.

Dune care planting should be initiated as proposed in the WBMS. Other dune care initiatives of controlling public access across the foredune and the incipient dune to restrict damage to planting should also be initiated.

The existing strategy for maintaining an emergency stockpile of geotextile sand containers for emergency repair during storms, which is promoted in the Strategy is not being implemented. Even if Council amend the management strategy to eventually replace existing structures with well designed rock seawalls, sandbags can be used for quick emergency repair providing a supply of bags is on hand.

A suitable design for the replacement beach protection works should be developed, and consents in place for replacement of existing structures as required following storm damage, or as the work can be financially programmed prior to storm damage.

Groyne no. 1 on the southern side of Hamanatua Stream is an important structure for protecting the incipient dune south of the groyne. The groyne's condition should be monitored and maintenance of the groyne programmed as necessary in the future. This should be included in the Beach Management Strategy.

We recommend all existing vertical rail iron be removed from all structures on the beach to improve health and safety risks to beach users, and to improve the visual amenity of the beach when beach levels are low. Existing strategies should be strengthened to include removal of all vertical rail irons as priority works, as Council finances permit. This will require reconstruction of a number of existing structures as anticipated in the WBMS.

# 10 Applicability

This report has been prepared for the benefit of Gisborne District Council with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Report prepared by: Reviewed and authorised for Tonkin & Taylor Ltd by:

G.W. Pearce
Project Manager

R. Reinen-Hamill
Senior Coastal Engineer

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**Appendix A:** **Gisborne District Council Drawing EW244/1**


| GISBORNE DISTRICT COUNCIL | WAINUI BEACH PROTECTION SCHEME FOREDUNE PROTECTION WORKS 1974 to 2007 | SCALE–1:2000 | FILE: EW244/1 |
|---|---|---|---|

| | | |
|---|---|---|
| SURVEYED | | |
| DESIGNED | D.PEACOCK | 3-01 |
| DRAWN | D.HEMM | 9/08 |
| CHECKED: | | |

AMENDMENTS: NAME / DETAIL / DATE

RECOMMENDED :

APPROVED :

SHEET 2 OF 2 SHEETS

## Appendix B: Photos

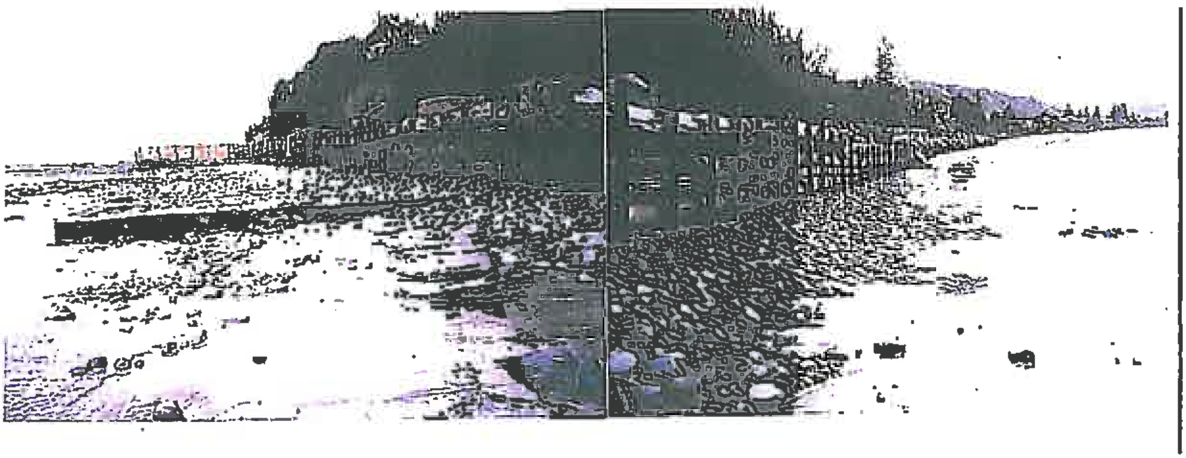


Photo 1: Log-pile wall with rock revetment behind, with beach levels low

Photo 2: Rock revetment with rail ion toe, with beach levels low

13/12/1994.

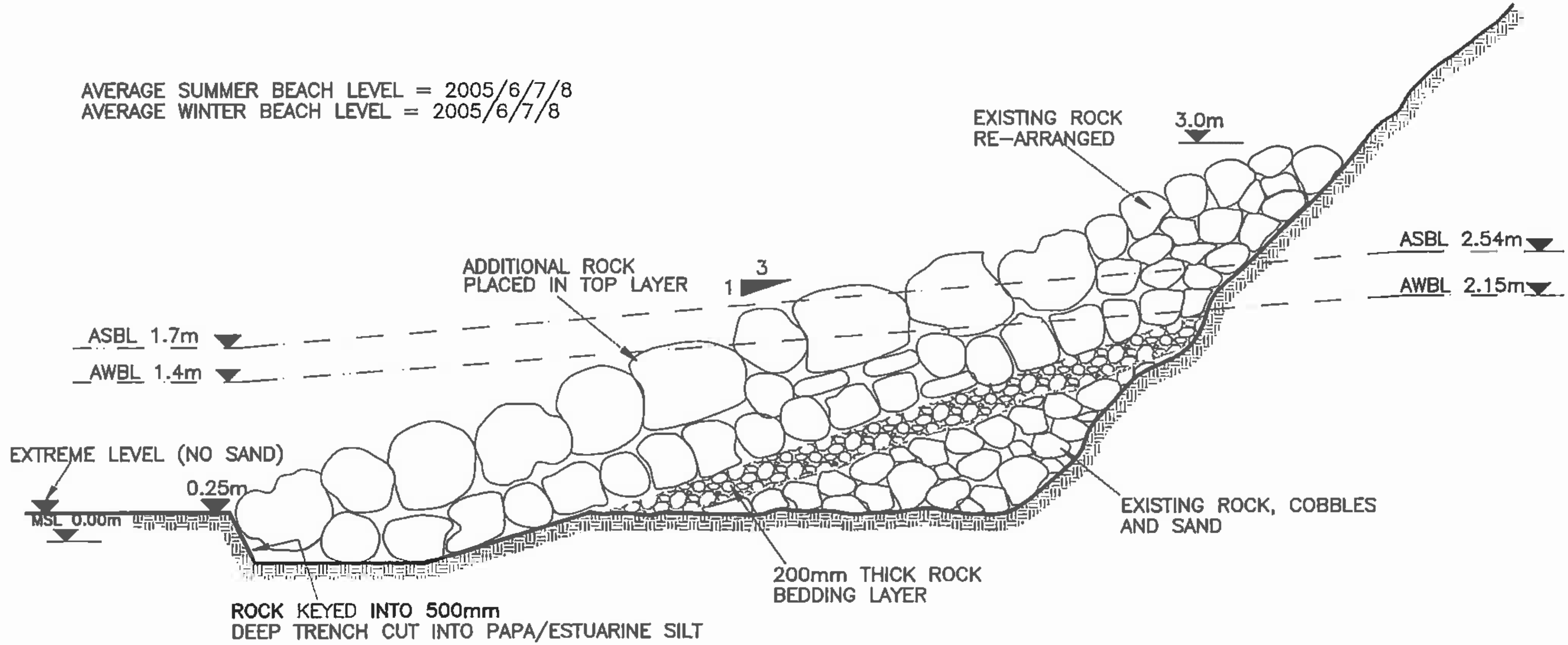
Photo 3: Rock revetment with gabion and rail ion toe, with beach levels low

Photo 4: Timber wall with buried gabions toe, with beach levels high

Photo 5: Railway lons trip hazard, beach levels high

Photo 6: Groyne at Hamanatua Stream

# Appendix C: Sloping Rock Revetment




NOTES ; 1/ LEVELS ARE IN TERMS OF MEAN SEA LEVEL
2/ DETAILS MAY VARY IN CONTRACT DRAWINGS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| GISBORNE DISTRICT COUNCIL | CONCRETE GROYNE 28 TO WAINUI STREAM PROPOSED SLOPING ROCK REVETMENT TYPICAL SECTION | SCALE : 1:50 | | | TRACED | | PLAN NUMBER EW300-2 |
| | | DESIGNED | R.BUDD | 10/09 | | | |
| | | DRAWN | D.HEMM | 10/09 | | | |

**Appendix D:** "Designing with Geotextile Sand Containers"
ELCO Solutions Pty Ltd

## Designing with Geotextile Sand Containers

## Introduction

ELCO Solutions Pty Ltd has built up considerable experience on the use of geotextile sand containers used in coastal and riverine applications since the first applications in the early 1980's. Our involvement in a number of the significant Australian coastal projects such as the, Narrowneck Reef, Kirra Groyne and the FPE Seawall, has provided us with invaluable experience and the ability to recommend the geotextile sand container best suited to a given application.

## Design Considerations

Two fundamental criteria must be addressed when designing a sand filled geotextile container structure, namely:

- Container survivability
- Container Stability

These two criteria are discussed in detail below.

### Container Survivability

Geotextiles used for sand filled containers are subjected to significantly different forces than geotextiles used in the conventional drainage and separation applications. These differences must be taken into account when designing the structure, the sections below describe the issues, which should be considered when designing a sand filled geotextile container.

*UV Resistance*

In regions such as Australia and the Middle East where UV radiation is in the order of 180 Kilo Langleys, UV degradation is the most significant factor in terms of long-term survivability of the container. Container structures used on coastal foreshore areas are exposed to UV for long periods of time and it is essential that the geotextile used to manufacture the containers has the highest possible UV resistance.

Australian Standard AS3706.11 Determination of Durability – Resistance to degradation by light and heat – utilises exposure to an MBTF lamp. For conventional geotextiles, strength retention of 50% after 672 hours may be acceptable. For geotextiles utilised in containers, we recommend a minimum of 80% strength retention. This translates to a minimum life of 10 years.

A table showing UV resistance of various geotextiles tested in accordance with AS 3706.11 is included in Appendix A.

*Abrasion Resistance*

The containers will be exposed to constant abrasion due to water born sands and gravels carried by currents and waves, this abrasion can be extreme in areas where sand, coral and shell fragments are present. There is a marked variation between various generic geotextiles. The structure of the geotextile can be significantly altered due to the dynamic wave action through the geotextile and abrasion by materials in the high-energy wave-breaking zone. The geotextile must therefore have the highest possible abrasion resistance.

The German rotating drum test method best replicates the abrasive near shore surf environment, which these structures will be exposed to. This test subjects the geotextile to 80 000 rotations of a water/gravel mixture, a minimum of 75% strength retention is recommended for coastal applications.

Tests of the various geotextiles commercially available in Australia have been carried out (Appendix B) which show a marked difference in abrasion resistance in terms on % strength retained and retention of acceptable filtration criteria (EOS, Thickness etc).

*Damage Resistance*

Damage to sand filled geotextile containers is unavoidable, the two main causes of damage are

a. Incidental damage from driftwood or boat impact
b. Vandalism

In order to limit incidental damage a high elongation is desirable. Both the Australian and American standard geotextile specifications determine the survivability (damage resistance) based on % elongation and this philosophy holds true for container applications.

In the case of vandalism, research has shown that ingress of sand into a three dimensional geotextile can limit damage with sharp instruments. A composite vandal deterrent geotextile has been developed which traps $3kg/m^2$ of sand within the geotextile. This product has significantly improved the resilience and durability of the individual containers.

At present there are no indicator tests available, that model puncturing of the containers using a sharp instrument, hence there is very little information available to the engineer on which to base the vandal resistance of the various geotextile. One solution may be to modify the current ASTM D4833-00 puncture resistance test to from a knife-edge thereby mimicking a knife cut by a vandal.

Details of the proposed test are provided in Appendix C.

*Fines Retention*

The containers will be exposed to wave action and tidal flow conditions over extended periods of time, these extreme dynamic flow conditions will restrict the soils ability to form a natural filter and encourage migration of fines through the geotextile. As size and mass of container determines the stability of a container structure it is critical the geotextile selected retain sufficient fill material to ensure the container does not deflate and remains stable.

Basing the choice of geotextile purely on pore size is incorrect and performance testing is recommended to determine the actual fines retention capability of a geotextile. The NF.G 38.C17 Hydrodynamic test should be used to assess the fines retention capability of the geotextile. An example of the results of the fines retention potential of two geotextiles used in conjunction with Gold Coast beach sand is given in Appendix D.

*Permeability*
The containers are likely to be exposed to cyclic wetting and drying due to tidal variation, the geotextile through flow will control the period for which the sand fill remains saturated after being submerged, stability of the structure is dependant of the water release capacity of the geotextile i.e. the faster the water is drained from the container the more stable the structure.

The geotextile should have a minimum permeability of 10x that of the fill material.

*Seam Strength*
Containers will be subjected to extreme pressure during the filling and placement operation and as such high strength seams are a requirement for all containers. Containers should have single, double or triple stitching depending on the size, method of installation and risk of damage to the container.

The yarn used for the stitching must be high strength, abrasion resistant and UV stabilised. The container should have a minimum seam strength of 80% of the virgin material.

<u>Container Stability</u>
Geotextile sand container structures perform differently to tradition rock or concrete structures and as such stability calculations such as Hudson's formula cannot be applied. At present two stability calculations are available for geotextile sand containers however their accuracy should not be relied upon as little is known about the basis for the formulae. There are however a number of factors which should be considered when assessing container stability

*Container Mass*
As with traditional rock structures container mass (based on unit weight of fill material) will determine the stability of the sand container. No reliable stability formula is available to assess required container mass, however evidence from field observations allows the following suggestions:

Revetments

1.5 tonne container – Maximum wave height 1.5m
4.5 tonne container – Maximum wave height 2.5m

Groynes

1.5 tonne container – Maximum wave height 1.0m
4.5 tonne container – Maximum wave height 2.0m

*Scour Protection*

Toe stability is critical to sand container structures, as with all other coastal structures, however slumping of a sand container structure is far more noticeable than with a rock structure where disruption of the neat cascade layout is easily identified.

The toe of the structure should be at a level where it cannot be undermined by scour, unfortunately in many cases the actual long-term scour depth is difficult if not impossible to predict. The incorporation of a flexible toe detail in the design of a sand container structure will greatly improve the structures long-term factor of safety. Details of the recommended toe depth and flexible toe are shown in Appendix E.

*Container layout and proximity*

The survivability of a sand container structure is greatly improved if the containers are packed tightly together in a stretcher bond layout, preferably with a double layer of containers. This layout creates a homogeneous structure, which is far more resistant to wave attack than randomly placed containers. It has been observed that once water is able to flow between containers that these containers are easily removed from the structure by wave action.

Containers should be placed in such a way that minimal void spaces are left.

*Interface Friction*

This angle is of importance when assessing the stability of the structure, particularly when containers are placed on top of each other. The least stable section of any sand container structure is the crest where the failure mode is sliding of the upper containers off the top of the structure.

In order to increase the container factor of safety the greatest friction angle is desirable. A large 300mm x 300mm shear box should be used for this test to limit edge effects.

Interface friction results of a number of materials used for container manufacture are included in Appendix F.

*Elongation*

A high elongation geotextile allows the containers to mould itself in with the existing features and also allows a certain degree of self-healing of the structure (see Figure 1.)

An utimate elongation (wide strip) of greater than 50% is recomended, to limit installation damage and allow flexability of the structure.