Kaipara District Council

Baylys Beach Access

Beach Erosion Assessment Report

March 2018

Table of contents

Table index

Figure index

Appendices

1. Introduction

1.1 Purpose of this report

Kaipara District Council (KDC) has commissioned GHD to undertake an assessment of the existing beach access at Baylys Beach and its surrounding site.

There are a number of issues to be considered at the site including:

1. Assessment of the existing sand hill revetment/sandbag wall
2. Identification of potential remedial options for discussion with KDC
3. Identification of a 'do minimum' maintenance based option, and
4. Identification of a rehabilitation concept option if required.

1.2 Description of existing situation

Seaview Road connects the township of Baylys Beach with access onto the beach as shown in Figure 1 below.

Figure 1 Baylys Beach

Seaview Road and beach access

The key issue relating to the brief from KDC to GHD is the condition of the True Right Bank of the Chases Gorge Stream (as shown in Figure 4 below - LINZ Topo 1:50,000 map).

Figure 2 Where Seaview Road meets the coast (Google image 2012)

Figure 3 Where Seaview Road meets the coast (site visit August 2017 photo)

Figure 4 Site plan as copied from LINZ Topo Map 1:50,000 series

As shown in Figure 3 above, revetment protection has been placed on the True Right Bank. This is now in poor condition and the bank has failed. This Figure 3 photo can be compared to the Figure 2 photo taken approximately 5 years earlier.

A further series of comparison can be seen at the end of Appendix 2 between early August and early September 2017.

This report looks at the issues and a series of potential remedial options.

1.3 Revised Scope

Since the original GHD report was presented to Council in November 2017, a meeting was held in Kaipara DC offices in Whangarei. The KDC team advised that the Opus report on Baylys Beach stormwater issues was due shortly.

GHD were asked to review the Opus report and include the findings of the Opus report as GHD sees fit for the purpose of the Beach Access Report. Also and as part of this work, the author has made contact with Warren Bird of Opus to discuss his findings that are pertinent to this report.

This report now includes a review of the Opus work. The "Stormwater Management Plan – Baylys Beach" Opus July 2015 and their subsequent memo "Baylys Beach – Erosion Analysis March 2018 is attached as Appendix D.

1.4 Scope and limitations

This report has been prepared by GHD for KDC and may only be used and relied on by KDC for the purpose agreed between GHD and the KDC as set out in this report.

GHD otherwise disclaims responsibility to any person other than KDC arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

1.5 Assumptions

This section has been left intentionally blank for this draft report.

2. Existing environment

2.1 Site background

Baylys Beach is located approximately 13 km west of Dargaville within the Kaipara District. The beach faces onto the west coast. This is a high-energy environment and subject to the impacts of storm and rain events originating mostly from the Tasman Sea.

Seaview Road provides access onto the beach from the local roading network. This access, although not unique, is one of the few two wheel drive access points to the beach over the wider area.

2.2 Geology

The geology of the area is described as sand, sandstone, mudstone and lignite from the Karioitahi Group, with weakly cemented and partly consolidated sand in fixed parabolic dunes capped by clay rich sandy soils.

The geological context is important as the description gives an indication of the likely long-term stability of the seaward cliffs.

Further, the description also gives a strong indication of the likely soil permeability in intense rainfall events. Once the top layer is saturated, we could expect high runoff occurring as near sheet flow as the top layer become saturated because of their lower permeability caused by sand with a (high) clay rich content.

2.3 Chases Gorge Stream Catchment

The Chases George Stream Catchment falls from the local high point in the area of ~115 m AMSL. The catchment area is approximately 249 Ha.

From a TP108 analysis, we could expect flows from various return events as set out in the following table.

Table 1 Storm event flows as derived from TP108, without climate change

Data	Average Recurrence Interval (ARI) Event			
	2 year	**5 year**	**10 year**	**100 year**
Rainfall (mm)	66	85	100	163
Chases Gorge catchment flows (m^3/s)	6.8	9.8	12.4	24.2

Table 2 Storm event flows as derived from TP108, with climate change

Data	Average Recurrence Interval (ARI) Event with Climate Change			
	2 year	**5 year**	**10 year**	**100 year**
Rainfall (mm)	73.4	95.1	113.2	191.2
Chases Gorge catchment flows (m^3/s)	12.40	17.16	21.20	38.94

As can be seen from the above table the expected flows are substantial. The above table takes little or no attenuation included within the existing ponded area within the catchment.

However, if climate change to 2090 is taken into consideration there will be an expected increase in expected runoff.

When the stream is flowing, it will have the ability to scour and erode bed levels around the bridge and downstream where the stream invert is the sandy beach material.

This project has not considered a formal stream and beach erosion assessment. Such assessment will be important to allow development and evaluation of the management options.

2.3.1 Opus Report review comments

The following is a summary of the key issues included in the Opus report as they relate to the beach erosion.

- Catchment Area to the beach. From Opus plan their catchments are F, A, B & C or (185 & 8 & 92 & 2 =) 287 ha. This compares with 249 Ha used in the GHD analysis above.
- There are two catchments D and E that also discharge to the beach but further to the south and beyond the area of interest.
- Opus have used the rational analysis. The non-dimensional "C" runoff factor is 0.3 and 0.5 for rural and urban land respectively.
- No 'in catchment' attenuation has been allowed for.
- Opus has designed for levels of service set out in the KDC engineering standards namely 5 year for rural and residential and 10-year event for rural culverts and industrial land.
- A summary of Opus identified flows from their drawing C200 is set out in the following table:

Catchment	Q_5 (m^3/s)	Q_{100} (m^3/s)	Comment
F	3	7.1	
A		1.0	
B		3.4	
C			
Total to Beach		11.5	

Based upon a discussion with Warren Bird, he advised that the Q_5 flows to the beach were in the order of 4 m^3/s. If attenuation were to be provided to reduce the flows to minimal sediment transport, then the flows would need to be below ~0.5 m^3/s. The attenuation to achieve this flow reduction from 4 to 0.5 m^3/s would be very significant and was not considered further by Opus.

Opus have identified a range of other works to protect overland flows from the rural catchment that are now directed down Sunset Drive. This work has been costed at $300,000. The works includes a swale drain construction within rural land to keep overland flow from the urban area. This flow diversion once in place will increase flows from the northern branch of Chases George catchment.

2.3.2 GHD commentary on the Opus Report findings

GHD have arrived at a different conclusion to the value of attenuation within the Chases George catchment. However, GHD acknowledge that until the detention / attenuation can be quantified, then the perceived value of the flow attenuation on the runoff from this catchment cannot be quantified. This work would require survey (perhaps including drone survey) and hydrodynamic/hydraulic modelling to quantify the benefits.

Site observations

A site inspection was carried out on 2 August 2017 by the author, Tony Miller and Iftikar Rahim of GHD. Mark Bell from KDC met on site and gave some background to the construction of the sand bag wall.

2.3.3 Description of the existing revetment wall

The construction of existing revetment was completed in June-July 2015. The wall is approximately 90 m long. The outer extent of the wall terminates just short of a harder natural sandstone spur. At the landward side, the wall terminates some 25 m short of the Seaview Road private bridge.

The revetment wall consists of bags one high but mostly two high bags and at the base layer two bags deep. At our site visit, we did not observe whether the bags had been placed on a good quality geotextile to separate the bags from the dune behind. Further investigation will be required to establish this.

The manufacturer of the bags is not known by the author at this stage. The bags appear to be one tonne bulk bags. This is a woven geotextile material with a plastic liner.

According to the explanation provided by Mark Bell, the supplier had the bags pre-treated with a product to extend the UV life of the bags. In addition, a light hessian type cloth/netting was provided to provide additional UV protection to the bags as seen in Figure 5 below.

Figure 5 Photo of wall not long after initial construction complete (~2015)

The bags as observed in August 2017, are in poor condition. A number of the bags are undermined and have rotated. The bag material condition is poor with perhaps 30% of total bags with a hole and some of the bags had multiple holes or had split open.

A consent application for the excavation of sand from the fore dune and beach location and to place a sand bag area for the construction of the wall was sought from the Northland Regional Council. The original consent was granted on 12 September 2000 with an expiry date of 30 June 2034. Subsequently there have been variations to the original consent, which were granted under delegated authority on 28 May 2002 and 9th July 2015.

A copy of the consents are attached as **Appendix C**.

Gary Treadgold from the Regional Council advised that over the first winter following installation, the bags appeared to have performed well. However, the latest sand levels and their drop relative to recent winters have caused a significant undermining of the bags. This in conjunction with bag material degradation has led to the current failures.

2.3.4 Site photos

A series of photographs has been taken to record the condition of the wall at the inspection date. These photos are attached as **Appendix A**.

There are approximately 90 bags in a row. Some of these are two or three bags deep/or high.

A count of sand bags that have failed show that 60 out of 90 have bags that have moved in some manner. There are further bags that have holes or substantial rips in them.

2.4 Coastal processes

A range of coastal processes are at play in this environment. The following provides a brief commentary on these processes and the importance on how any final solution may take these into consideration.

The beach is a dissipative type beach with a high energy and wide surf approaching from the west. Refer Figure 6 below or to NIWA website:[1]

Figure 6 Beach types (Source NIWA)

2.4.1 Beach profile

The level of the beach will change on a cyclic basis. There are a number of expected cycles such as:

- Annual cycles where there is a build-up of the beach profile during the calmer summer months to degradation during the stormier winter months
- Longer cycles such as the IPO[2] where there is a change between the predominance of El Nino and La Nina events. This predominance would be felt with the higher prevalence of westerly and south westerly winds, and

[1] https://www.niwa.co.nz/coasts-and-oceans/nz-coast/learn-about-coastal-environments/beach-types/13-beach-types

[2] IPO – Inter-decadal Pacific Oscillation

- Long-term cycles of longshore drift patterns.

During summer, there will be a build-up of sand levels on the beach where the wash is stronger than the swash. During winter and following significant onshore winds and storms, there will be a reduction in beach level as the inshore beach is washed off shore to behind the breaker line.

The annual cycle on this beach is expected to be ± 600 mm based upon initial observation and anecdotal evidence from discussions with a few locals.

From a discussion with Gary Treadgold from Northland Regional Council (NRC), he advises that there is a long-term cycle of beach levels. Once of the predominate sources of sand is the Waikato River some 100 km to the south. This sand has a long shore drift with a cycle of some 200 years. The current cycle at Baylys is the lowest the beach has been in recent living memory. As such, there is a potential for this long-term cycle to replenish sand levels but may be some decades away.

The expected total fluctuations in the sand level at the beach may be much larger than this and may vary by some meters. Further investigation will be required to establish the likely total variations upon which a sound design can be based upon.

From the site visit, the erosion at the base of the sand hill toe suggested that beach levels are approximately 600 mm lower than when the google 2012 photographs were taken and from discussions with Mark Bell of KDC. The height of the sand when the bags were installed is not known by the author at this stage. It is expected that the bags would have been installed with an embedment depth. From our reading of the resource consent there was a requirement to embed the bags by 500 mm and we were advised this was carried out.

However, and based upon the 2017 site visit, there was no apparent embedment of the bags and the assumption is that the beach level has recently dropped, exposing the base of the bags.

This was also confirmed by Gary Treadgold from NRC. Further inshore within the confines of the streambed, the bed level is between 400 and 800 mm below recent levels from analysis of photographs between 2012 and 2017.

The relevance of this is:

- Steeper bed gradient from the private bridge servicing 73-97 Seaview Drive to the coast. The steeper gradient results in faster flows leading to deeper scour of the fine sand particles, and
- The drop in beach level over winter and following large sea storms will have a similar effect.

2.4.2 More intense storms

Because of changing climate, there is anecdotal evidence of an increase in frequency and severity of significant storm events. The science on this issue is not conclusive and further research into the frequency of storms in the Tasman and higher latitude events needs more work. In the tropics for example, the total number of storms per annum has remained relatively constant; however, the number of Category 4 and 5 tropical cyclones has increased over recent years.

This increase in frequency of intense storms would relates to both wind and rain events of which both have an impact upon sand levels at the toe of the existing coastal dunes.

The relevance of this for Baylys Beach is that:

- There would be an increase in energy for more sand to be removed from the beach in the annual cyclic processes

- More intense rain events. Runoff from these higher intensity rain events will have potential to scour and remove sand from the mouth of the Gorge Creek leading to a drop in the sand level adjacent to the existing bag wall, and
- Over the 2017 winter period, there has been a significant increase in total rain. This has led to more erosion and a drop in bed level of the stream downstream of the private bridge. The science behind the long-term trend and one wet year is not evidence of a long-term trend. However, the effects of increased runoff and the effects it has on the beach are demonstrated by this previous winter.
- This change in beach profile can be observed in two series of photographs attached to the end of Appendix B. Here photographs are taken approximately one month apart. The second series of photos taken on 10 September following significant rain show:
    - Scour and widening of the stream immediately downstream of the existing bridge, however the depth may not have got much deeper,
    - The widening of the stream continues down to the end of the bag wall,
    - The elevation of sand at the lower end of the wall has built up relative to the previous month by a couple of 100 mm.

2.4.3 Sea storms

This section provides the reader with the effect of a storm on the level of the sea. If the storm were to occur during a king tide or high tide, the effects on the land will be pronounced.

- Inverted barometric effect (IBE), where as a result of low pressure systems approach the coast, the level of the sea is drawn higher inversely proportional to the drop in pressure below 1023 mbar
- Storm surge and storm tide. Inverted barometric effect in combination with wave set up and wave run-up act in parallel to raise the wave height reaching the coast, and
- Timing of the storm relative to high tide or whether the storm were to occur during a king tide.

2.4.4 Global cycles

The Interdecadal Pacific Oscillation has a rough 20-year cycle. Depending whether the cycle is positive or negative, there is a corresponding predominance of El Nino or La Nina cycles. We are currently in an El Nino phase with a predominance of westerly and south-westerly winds.

Baylys Beach faces west and this predominance has led to more energy from wind and waves from the general westerly direction and subsequent lower beach levels. This in turn will lead to higher energy waves reaching the foreshore during higher parts of the tidal cycle.

2.4.5 Sea level rise

Based upon published evidence there has been a rise in the level of the sea over recent times. The extent over 1990 levels are modest.

Based upon published MfE[3] guidance for local government there is a 500 – 800 mm sea level rise projection by 1990[4].

More recent unpublished guidance suggest a far more significant increase in sea level rise. We understand this most recent advice to government has not yet been released.

[3] MfE – Ministry for the Environment

[4] Preparing for coastal change, A guide for local government. MfE 2008

2.4.6 Future coastal erosion trends

Coastal erosion is occurring and will occur in the future. Based upon the above we expect the rates of coastal erosion to increase significantly in the future.

This coast consists of weak sandstone and siltstone and sand materials and as such not able to withstand the effects of foreshore wave attack.

This is the setting upon which the commentary around the balance of the report is set.

3. Defend or retreat

The following discussion looks at a variety of management approaches.

MfE has numerous advice for Councils on whether to invest in infrastructure and coastal projection in order to defend from the advances of coastal erosion.

This is a very significant issue and an issue that less well-off Councils need to grapple with. Baylys Beach is no exception. KDC will need to assess a range of issues such as:

- The value of the asset being protected
- Life of the works
- What happens at the end of the design life of the adopted structure
- What will it look like in the year 2100 and what action should be taken now to lessen the impact, or
- Do nothing.

3.1 KDC obligations and responsibilities

KDC has a responsibility to maintain access from the roading network to the beach. The Council receives a partial subsidy from NZTA to maintain this access.

The obligation for KDC to protect private property is much less formal. This has been undertaken in the past on a case by case basis. In future, KDC will not have the financial resources to undertake all repairs of slips and erosion and will have to prioritise.

Protection of private property from erosion and the effects of sea level rise and climate change will become more of a private funding problem.

This is a big topic and this report will not address this further.

3.2 Looking forward

If we look forward from 2017, we can expect a range of scenarios that need to be discussed in order to consider what decisions KDC needs to take at Baylys Beach and other coastal areas.

3.2.1 If nothing had been done prior to the installation of the existing one tonne bulk bags

This is important to look at this hypothetical scenario in relation to the alternative of doing nothing in 2015.

With this scenario, it is expected that some further toe erosion would occur leading to further slip failures below 97 Seaview Drive. Eventually the residential property(ies) above would have had to be abandoned and/or demolished. The cost to protect this coastline and to allow these existing coastal houses to remain will escalate; however, this is expected to remain a cost for the individual house owners.

In terms of the access to the beach, we expect the roadway (as observed in 2017) was constructed mostly of sand with some aggregate closer to the inland end. The waterway had scoured a channel beside the road and appeared relative stable at low flow.

During high flow, the channel will not be stable and will tend to meander. This will cause scour of the adjacent banks and subsequent loss of both the true right bank support beneath the houses, as well as erosion of the roadway.

Similar erosion will occur during storm surge events during high and king tide events combined with a significant onshore wind. Waves will propagate up the channel to the bridge with considerable force. The narrowing waterway may even cause a bore with little reduction in velocity. Once the wave reaches the top end, the wave will reverse direction and flow out with similar velocity and cause further erosion on the way out.

Thus, the channel does not have sufficient strength and resilience during storm conditions to remain stable.

Following storm events there will be erosion of the roadway and maintenance of the embankment will be required to replace eroded material and to re-establish a driveable roadway again.

Because of changing climate, we would expect maintenance effort to re-establish the road to be of a similar frequency for the first half of this century (to 2050). We do expect there to be more significant storms and following these events the effort required to re-establish the road will require more effort.

For the second half of this century and as the level of the sea is predicted to rise the coastal erosion rate will increase and again more effort would be required to maintain a sand access road.

3.2.2 Change in conditions following the installation of the existing, one tonne bulk bags

Because of the decision to place the one tonne bags, the apparent width of the channel between the true right bank (or northern bank) and the roadway on the true left bank (to the south) has decreased comparing 2012 and August 2017 photographs.

The result of this decrease in width has been to:

- Increase the velocity when there is a rain storm and runoff is significant, and
- Maintain or increase the velocity of waves propagating up and down the channel during sea storm events (at high tide).

The resulting impact is:

- Reduced erosion on the true right (north bank) as the bags do their work, and
- Higher erosion on the true left (south bank).

A number of options are presented below which include bags with a manufacturers stated design life of 20 – 25 years. Whether this design life can be realised without substantial maintenance is unknown.

The existing bags had a life, which we understand is significantly shorter than expected life of the existing one tonne bags.

A full bag solution will buy a number of years; however, there will be a number of consequence such as:

- Accelerated erosion of the south bank
- Deterioration and the need to repair and replace the new wall, and
- As sea level rise takes effect, these interim measures would be insufficient and more extensive measures will be needed to maintain and enhance the chosen engineered intervention.

(Post Draft Report Note: Since writing of the draft report and this final edition, a series of additional photographs has been taken on the 10 September following significant rain in the

previous month. The later series of photographs show a much-widened channel as compared by a month earlier. This erosion and removal of sand as the stream tends to meander will remove material from both banks and transport this seaward. We expect some of this sand to return during quieter sea states over the summer period.)

3.2.3 Sea level rise to the year 2090 (in 73 years' time)

The predicted rise in sea level has the potential to meet or exceed the 0.8 m advice given by MfE in 2008 based upon more recent evidence coming out of the IPCC[5] #5 advice on global sea level predictions.

Sea level rise on its own does not increase the rate of erosion. However, it is the raised level of the sea in combination with higher energy waves that have the highest impact.

In the author's opinion, there will be serious coastal erosion as sea level rise increases. The extent and rate of erosion will vary and is dependent upon the geology or the degree of engineered solutions installed to protect the coast and coastal property.

The KDC at some stage will need to make a call on what areas of the coastline to protect and which areas to retreat from as their expected future budget for coastal protection will be finite. The key question raised in this report is whether KDC will be prepared to consider whether to consider coastal as a viable for this section of their coast in 2017.

3.3 Maintenance & Levels of Service

This is a dynamic environment with high wave energies and stormwater runoff. This case is competing with a land use (in this case a roadway) that cannot be engineered in any way cost effectively or economically to provide a consistent level of service for its intended use.

Maintenance costs to deliver a consistent level of service will only increase as the projected intensity of rainfall increases. NIWA has just released a report on anticipated climate change that could be of use for this site as it covers the entire Auckland Region. This report might provide some insights to the west coast north of Kaipara. (*Auckland Region climate change projections and impacts: Summary Report Revised January 2018* [6])

[5] IPCC, International Panel on Climate Change

[6] http://knowledgeauckland.org.nz/assets/publications/TR2017-031-2-Auckland-region-climate-change-projections-and-impacts-summary-revised-Jan-2018.pdf

4. Design standards and design criteria

The report would usually cover the design standards to be adopted for the project.

The author remains silent on this topic for the purposes of this initial report.

4.1 Design assumptions

Catchment areas were derived from a site visit and an initial desktop study.

Wave heights and onshore waves have not been derived at this stage, although these would be required prior to detailed design.

The above methodology is considered appropriate for the level of detail required in this study.

Catchment areas and flow estimates have been derived to determine the likely magnitude of expected runoff generated from this catchment. It is expected that the peak flow in the stream at the coast will be less than the peak runoff as there is attenuation likely to occur in the two dune lakes.

The predicted flows to the coast can be refined through further investigations such as stormwater modelling and detailed options design for additional attenuation at a later or subsequent stage.

4.2 KDC criteria

GHD has been asked to view the site and report on their observations and conclusions without reference to previous reports. This approach has advantages such as a fresh approach, but disadvantages such as learning from previous mistakes and from previous research.

This approach has limitations and does not address published and non-published KDC own criteria in relation to their coastal objectives and policies.

This report does not address the political and self interest groups that are all likely to have their own opinions. The report does not address the individual property owners on the coast immediately above the existing coastal revetment bag wall.

The report in this draft stage remains silent upon KDC criteria, objectives, local interests etc. and what may be important to Council in this instance. The report rather focuses on a range of issues and potential solutions that look forward more than 50 years.

Coastal management options discussed will require further investigation and research to establish KDC short and longer-term goals. This report should open the debate for some serious issues to be discussed.

5. Immediate issues for KDC

There are some immediate issues that need to be addressed as follows:

- Whether to leave, repair, remove or completely replace the existing sand bag wall,
- As part of our GHD inspection, we identified significant scour of the abutments of the private bridge on Seaview Road extension. The abutments are undermined. Although the bridge is private, we recommend KDC take immediate action to make contact with the owners of that bridge such that repairs can be undertaken, and
- Maintain access to the beach. The discussion below looks at a range of options. Some of the more structural options will restrict the flow of water down the existing channel. As such, these will raise the scour potential and lead to more frequent road closures and more regular maintenance requirements.

5.1 Opus Report issues raised for KDC

Following review of the Opus report, they have identified a further range of works to protect property in the Sunset Drive catchment. The consequences of the proposed swale, will be to divert flows to the north and into the Chases George catchment. The Opus report has identified this work package as a lower priority with a suggested timeframe in the 2020/21 financial years.

Opus have also identified additional works in the Cynthia Place Upstream Diversion Drain. These works are outside the scope for the GHD works, however these works will need to be funded which has an impact upon community affordability. Opus has assigned a higher priority with these works scheduled in the 2017/18 financial year based upon their 2015 report findings.

5.1.1 GHD commentary on the Opus recommendations

Opus do not discuss a number of issues associated with the above works including:

- Consultation including community and iwi consultation
- Consenting requirements for the diversion drains, whether the proposed works have the support of the Regional Council.
- The houses and properties at risk and because of the works, what is the costs and benefits of that work. (I.e. how many habitable floor levels will be raised beyond 50 or 100-year floods)?

6. Options considered

GHD have identified a long list of options. These could include:

- Do nothing (i.e. leave the existing bags in place and delay decision to undertake any works)
- Remove the existing bags, with and without a vegetated dune planting programme
- Beach nourishment
- Undertake attenuation within the upstream catchment to reduce flows and reduce erosion potential
- Revetment wall at base where the existing bag wall has been installed
- Beach nourishment and beach scraping, sand recycling and groundwater defences, and
- Wave attenuation devices.

This long list of options has been considered by GHD based upon a range of considerations and the long list shortened to a list that is likely to be feasible based upon engineering judgement of the author and reviewer.

The shortened list has been set out below in detail as follows.

6.1 Option 1: Do nothing

Do nothing; this option would involve acceptance of a poor solution has been developed and installed along the north back of the Chases Gorge Creek. The following comments are pertinent to the discussion:

- This option is unsightly. The bags are currently failing and presumably from UV degradation of the bulk bags together with undermining and overtopping
- Over time, it would be expected that the bag fabric would degrade further and disintegrate. The bags can be expected to undermine further with more failures and more bag rotations
- Wave attack will further demolish the wall and eventually begin to erode the toe of the bank these bags were intended to protect, and
- If the current beach level were to remain at its current level or drop further then we can expect higher energy waves reaching the coast during future king tide and storm events. As a result, waves will propagate up the channel and cause further undermining of the bags, rotational failures, washouts on the access to the beach and further undermining of the private bridge abutments, and undermining the access to the toilets and toilet block.

In respect of road maintenance to the beach, we would expect that between major sea storms and major rain events that the beach access will remain relatively stable. However, following larger rain events the stream will meander and care out each bank. The true right will be partially protected by the existing bags whilst they hold themselves together, however scour and widening of the true left will occur (reference September 2017 photos in Appendix 2).

6.2 Option 2: Remove existing bulk bags

This option would be a brave move and set a precedent for this Council. If adopted this option has the potential to hit local and national media and as such its adoption although brave needs to be handled with care.

The option would involve removal of all bulk bags and pushing the sand up to support the toe of the embankment above. The sand would provide little support and can be expected to wash out to sea over time. The resulting stormwater channel for the Chases Gorge Creek would widen and begin to meander.

This would be the most natural of the options presented. This option perhaps provides the lower maintenance requirements for the vehicle access as the water within the creek is less confined, has less energy and hence less ability to carry sand out to the open beach.

This option has the highest impact upon private property with the expected demolition of houses over time as coastal erosion eats away at the coastline.

This option has not been properly costed however for the purposes of this estimate we recommend KDC allow $50,000 for planting and passive maintenance of the slope above the true right stream. This planting programme would assist with retaining the sand but only up to a modest storm event.

6.3 Option 2a: Flood attenuation in the upstream catchment

This is a combination of Option 2 above in conjunction with flood attenuation measures to be carried out in the catchment above. Flood attenuation is discussed again later in the report.

The advantage of flood attenuation is to reduce the intensity of the peak flood flows and gradually allowing the dammed floodwaters to flow out over time. In this way, the peak runoff and associated peak velocities would be attenuated leading to less sand lost from the section where the existing bags have been placed.

The damming of the catchment has a number of benefits including reduction of scour in this section of Chases Gorge Creek. Depending upon the level of attenuation provided the costs could range from $30,000 for some smaller rock and gabion dams to provide limited attenuation to over $0.75M for a more serious 5 - 7 m high dam.

There are at least two potential sites where more modest attenuation dams can be constructed at 1200 and 2200 m from the mouth where existing ponds/wetlands are located.

For the purposes of this report, we consider a budget allowance of $300,000 (GST exclusive) would provide attenuation for the more frequent storms up to a 6 month to 2-year event with more limited attenuation above these levels.

In terms of effect on the roadway maintenance, this option would have a modest to significant effect up to the level of attenuation provided in the dams upstream. For these modest rain storm events the dam outlet would control out flow and as such the flows in the Gorge Creek would have insufficient energy to remove large quantities of sand as has happened in the August to September 2017 period. This in turn would reduce road access maintenance.

6.4 Option 3: Partial removal and replacement of the existing wall

We have considered a range of products for the replacement of the failed bulk bags.

Cirtex is a company in the geofabric industry. Their sea revetment product “SoftRock” has an outer bag with a 1000 gsm/m² weight. The SoftRock bags in comparison to the existing 2015 bags are made from substantially heavier material. Their recommended design life is 20 years and as such, the Council if it chose this product would need to make a similar choice of replacement in say 2040 to 2050.

Geofabrics is another company in the geofabric industry. Their product is a large bag 2.4 m long by 1.8 m wide by 650 mm high. The bag is much more stable than the 2015 upright bulk

bags. The Geofabrics product name is Elcorock. They no longer offer the single bag solution and only offer the double bag vandal resistant alternative. The outer layer is a coarse weave and has the ability to trap sand particles and thus reduce UV penetration to the inner bag.

The representative from Geofabrics advised the bag would have an expected design life of 25 years although we have not yet seen written evidence of this.

The product is stacked as per the diagram below and a number of NZ and world wide applications have been carried out. The solution shown is a single layer solution although double bag width solutions have also be used at other installations where it deemed necessary to resist the coastal forces.

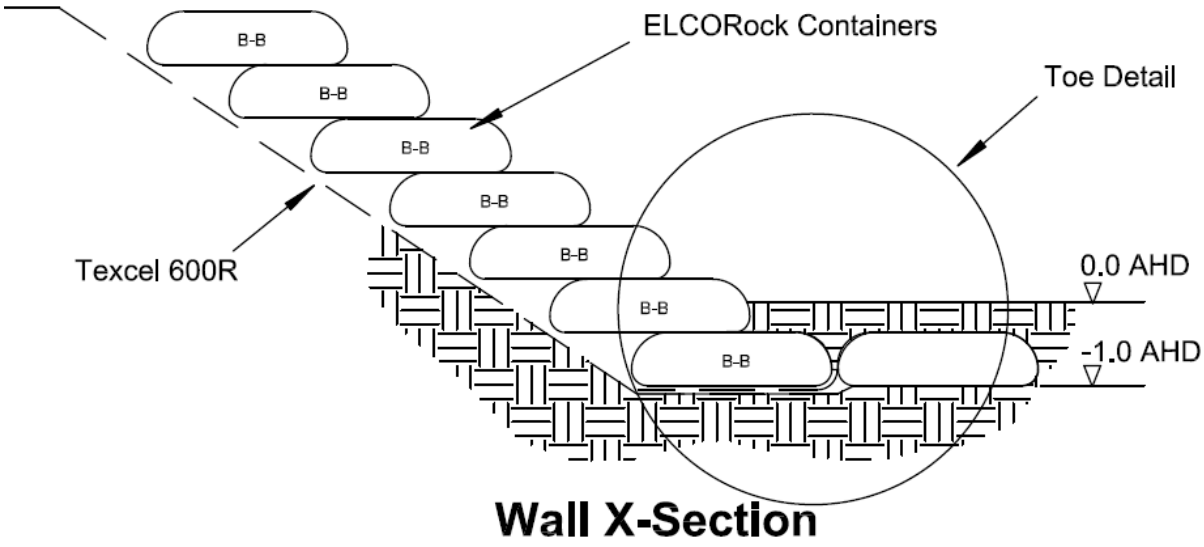


Figure 7 Geofabrics diagram showing a typical installation

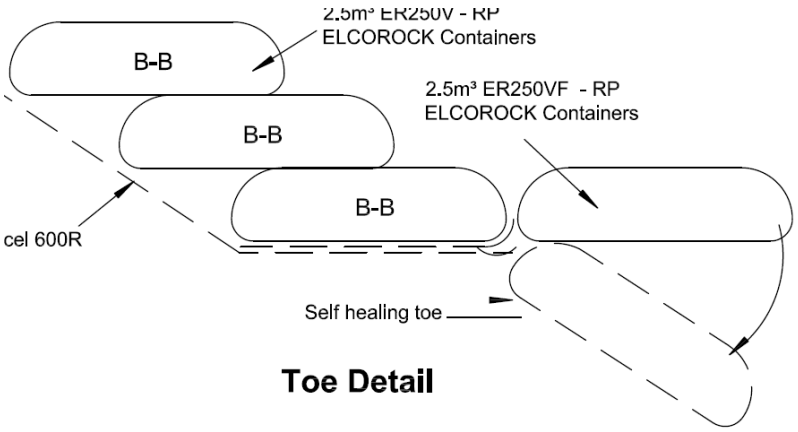


Figure 8 Geofabrics diagram showing a toe detail installation

The toe detail shown in Figure 8 above allows a hinged mechanism to function in event of toe scour.

For the purposes of this Option 3 we have allowed to partially remove the seaward 50 m of bulk bags and replace with Ecorock bags up to a finished height of ~2.4 m above August low flow channel. The base of the bags has a tentative level approx. 1 m below the existing stream bed

level. However, before this design is adopted, further investigation as to the cyclic levels of sand would need to be established

This tentative design would require 6-bag high wall with a seventh toe support to be buried out in front of the wall and in line with the diagram above. The indicative embedment depth has been assessed at 1 m below the 2017 sand level, or 1.5 m below the 2012 sand level.

This option would require approximately 145 bags over a 50 m length.

Rough order cost for a limited 50 m replacement wall to 2.4 m above current streambed.

- P&G $35,000
- Tidy and remove existing including partial re-use of existing bagged sand $15,000
- 145 bags $255,000 (balance of sand sourced from beach using existing consent)
- Tidy and move out $25,000

Total **$330,000 (excluding GST)**

More modest partial replacement options can also be considered where by more limited maintenance of the existing bag wall at strategic sections of the failed wall.

Further geotech and coastal geomorphology investigations would be required to establish an adequate founding depth.

This option would provide good toe protection for the existing slope above the new protection. At some time in the future further bags would would be required above the top bag to increase that protection.

This option would allow the wave energy of waves propagating up the channel to reflect off the bag surface and cause erosion of the roadway and embankment on the opposite bank. The narrowing channel could form a bore during king tide and storm surge events in the narrowing channel and cause more or substantial erosion further up the channel up to the bridge from rain events.

This option would have a detrimental effect on the access road to the beach unless this option was carried out in conjunction with option 2A above or in conjunction with revetment protection to the roadway.

6.5 Option 4: Partial removal and replacement of the existing wall over full 90 m

Based upon a pro rata basis the estimated cost for this option would be $600,000 (GST exclusive).

At the top end and up to the bridge and following detailed design, the recommendation may be for a further extension for the remaining 25 m.

As stated above, the proposed wall as set out in Options 3 and 4 above will cause a narrowing of the channel leading to higher stream velocities and faster propagation of waves up the channel from breaking waves during king tide and storm surge events.

A potential outcome is for further work on the south bank to replicate part or all on the north side remedial works.

As for Option 3 above, we would expect a higher level of maintenance of the beach access road unless other remedial works (ref Option 2A) and or revetment for the beach access road.

6.6 Option 5: Beach replenishment

Although a viable option in some circumstances we consider progressing this option high risk as with a high-energy coastline, all beach replenishment could be lost in one storm.

This option has not been considered further for this site.

6.7 Option 6: Offshore breakwater

Another consideration may be for an offshore breakwater opposite the entry to the beach.

For the purposes of this discussion, we have considered the following:

- Location: in 1 m of water at low tide
- Length: 80 m and parallel with shore
- Height: 4 m and almost level with high tide
- Volume: 6,500 m^3 (10,000 t of rock supplied in two 5,000 t barge loads
- Rock size: 600 mm to 2.0 m. (Actual rock grading would be confirmed following detailed design and consideration of the off shore wave energy)
- Source of rock: Talley's Quarry in Takaka
- P&G: $50,000
- Cost ex quarry: $500,000 (based upon similar costs to a Wellington project)
- Cost to supply by barge: Say $250,000
- Placing and other costs: $70,000
- **Budget estimate: $870,000 (GST exclusive)**

This option would provide an offshore breakwater and subsequent to construction, there would be an expected build-up of sand on the leeward side of the breakwater. The stream gradient would be reduced and could be used in conjunction with Option 2A.

6.8 Review following Opus Work

Following review of the Opus report findings we have reflected upon whether any of the above recommendations would have an effect upon the discussions and conclusions set out for this report.

The Opus report together with the discussion with Warren Bird (of Opus) has identified in their opinion the in catchment attenuation within the northern Catchment F would have little impact on flows unless the attenuation storage was significant. In Mr Bird's opinion, the attenuated flow would need to be less than 0.5 m^3/s or less than 0.5 m/s to achieve a substantive reduction in sediment transport. They also consider that as the potential land for attenuation is in private ownership then the cost of land to achieve the desired outcome would outweigh the benefits. Their opinion is subjective.

GHD have arrived at a different conclusion as follows:

- GHD would recommend undertaking:
    - Hydrology and hydraulic modelling of the catchment to understand the flows to the beach with and without intervention works

- Obtain land access and walk over to identify potential attenuation sites on private land to the immediate north of Baylys beach
- Preliminary design of low impact dams. Possibility two gabion dams 1 – 2.5 m high.
- Test the benefits for regular storm events (i.e. 1 month, six month and one year rain events) and assess pre and post, what is the likely volume of scour.

- Undertake an alternative design of the Seaview Road extension to the beach using riprap as a basecourse for the access road.

Then test the hypothesis of whether there is a significant reduction in likely road maintenance with and without new attenuation in place.

7. Options discussion / Summary

Option 1 – Do nothing

Do nothing has some reputable considerations for Council. A decision to do nothing and review in 1 – 2 or 5 years could be made with little impact apart from visual impacts of the existing cloth bags in their degrading states.

Beach access maintenance will be required at a similar frequency to now. Without flow attenuation in dams upstream we can expect sand build up or new gravel access to be required following each rain or king tide sea storm events.

Option 2 – Removal and vegetate

This option to completely remove the existing bags and focus on a limiting planting programme does have merit and we recommend KDC gives this option further consideration.

This option would need to be managed from a political perspective and begin the debate of managed retreat.

The expected beach access maintenance relative to other options can be expected to be reduced with this option. The difference is perhaps minor and after major sea storms during high tide or king tides and following significant rain events, then major replacement of the beach access roadway can be expected.

Option 2a - Catchment management

This option discusses design and installation of multiple attenuation basis within the catchment. The benefit is the reduction in peak flow and reduced loss of sand to the beach. This option would make a good partner with Option 2 although could be used with all options.

In terms of road maintenance, this option will have a significant reduction in the quantity of sand lost from the confined channel downstream of the bridge to the beach from events up to the frequency of significant attenuation provided in the dams.

We expect from casual inspection of the topography in the catchment it would be possible to contain flows up to the 6 month to one year event within the 2 or 3 potential dam sites. Thus the frequency and severity of maintenance for the road would be reduced for these rain storm events.

This option would have no impact upon a sea storm event and following a sea storm damage repair would be similar to other options.

Option 3 & 4 - Partial removal of existing and build a new wall from recognised industry supplier

Replacement of the existing wall with a recognised revetment sandbag product does have merit for protection of the north bank but comes at a price of increased maintenance of the access road and access to the stairs at the public toilets.

Without undertaking this option in conjunction with Option 2A, the runoff velocities will cause additional scour of the channel downstream of the bridge. As such road maintenance for these two options will increase from rain storm events.

For major sea storm events during high tides, the wave flow in the channel will be confined. Wave propagation up the channel will result in higher velocities leading to scour of the road and north bank embankments. Unless protection of the road embankment is made then these options will result in an increased frequency and cost of road repair.

Option 5 Beach or sand replenishment

This option not recommended for a high-energy beach where all replenishment could be lost in one storm event.

Option 6 Offshore breakwater

This option could source rock from Takaka by barge and construct a breakwater that would be partially submerged during king tide and storm events. Andersite rock is seen as more desirable than a manufactured concrete revetment product even though the latter would provide similar technical advantages.

This has a high visual impact but offers some advantages such as safer boating, higher sand levels, reduced beach erosion from rain events. It is expected that this option would require a substantive effort through the consulting and consent phase.

In terms of road maintenance, this option has good protection of the road from sea storm events and with maintenance of the off shore breakwater, the protection can be maintained for 50 years or more.

Unless this option is carried out in conjunction with 2A then there will be road maintenance required after rain events and similar maintenance if the rain event exceeds the capacity of the upstream attenuation provided in the catchment.

8. Accuracy and costing

A rough order cost estimate table is provided for comparison purposes below.

Table 3 Options rough order cost estimate

Options	Cost ($'000) excluding GST & contingency
Option 1	Future costs
Option 2	$50
Option 2A	$100 -300
Option 3	$330
Option 4	$600
Option 5	Not costed
Option 6	$870

The design considered for the options has been made upon engineering judgement with concept design only.

The costing for the project should be considered indicative at this stage and useful for comparison of options only. Further work on preliminary and detailed design will be required to refine the design, and the associated engineers estimate.

No contingency has been provided in any of the estimates. Each estimate excludes GST.

As set out in the discussion in chapter 7 above, a number of solutions are recommended to be carried out with Option 2A. As such the final sum should include the sum of the recommended options.

9. Recommended

Minimum work package before an informed decision can be made

GHD recommend that further investigation and preliminary is undertaken to reliably inform decision makers on the costs, impacts, consentability of the following options:

- Potential for attenuation to have a material effect on the amount of sand being currently lost to the open beach,
- Design of a riprap and aggregate road from the end of Seaview Road seal end to the open beach,
- Preliminary design of the Sunset Open Swale as proposed by Opus
- Preliminary design of the Cynthia Place diversion Drain as proposed by Opus.

We would recommend that the standard of preliminary design would need to:

- Include survey of the catchment or part thereof. This could include a drone survey.
- Simple hydraulic model to understand benefits of potential attenuation,
- Consultation with the affected landowners for the attenuation dams and swales. This would include potential easements but ownership remaining private,
- Consultation with iwi and interested residents / stakeholders
- Carrying out a planning scoping package of work to understand the likelihood of gaining resource consent for the proposed work,
- Understand if a building consent would be required for the dam, or adjusting the dam to a level such that building consent would not be required. (i.e. less than 3 m in height and less than 20,000 m^3 impoundment volume).
- Undertake a preliminary cost for the chosen/recommended options
- Understand the benefits for each of the options including the residual risk to various properties not protected.

Once this package has been undertaken then an informed decision can be made as a way forward by the Council.

9.1 Business Case

Start the discussion now on the business case to invest in any protection options vs what is being protected. This then turns into a discussion with the community on the level of service provided vs cost to provide this service vs risk to private and public assets.

A mechanism to enable this would be I would recommend that the multi-criteria analysis (MCA) needs to include criteria developed by the community that captures what is important to them (This does not need to be a big exercise - but we would recommend including the community early before decision are made so they see a transparent process). It would also needs to include cost and needs to take out ownership. I would suggest it includes all assets at risk in this discussion including public and private - and it potentially needs to include NZTA in this discussion.

9.2 Managed Retreat

The original GHD scope was to assess the condition of the sand bag revetment wall. A work package to build the existing wall was carried out some two years ago. This work has failed through a poor selection of materials and poor design.

GHD do not recommend reinstatement of the wall and would encourage KDC to arrive at a similar conclusion. The costs for a properly designed wall made from modern synthetic materials are significant and perhaps more than $600k. If these are to be built the expected life is 20 years ±5 years. A wall out of permanent materials (rock riprap) is likely to be significantly more expensive.

GHD recommend KDC consider a plan of managed retreat option for the true right bank (and northern embankment) with little intervention. However, this will not solve continued beach access.

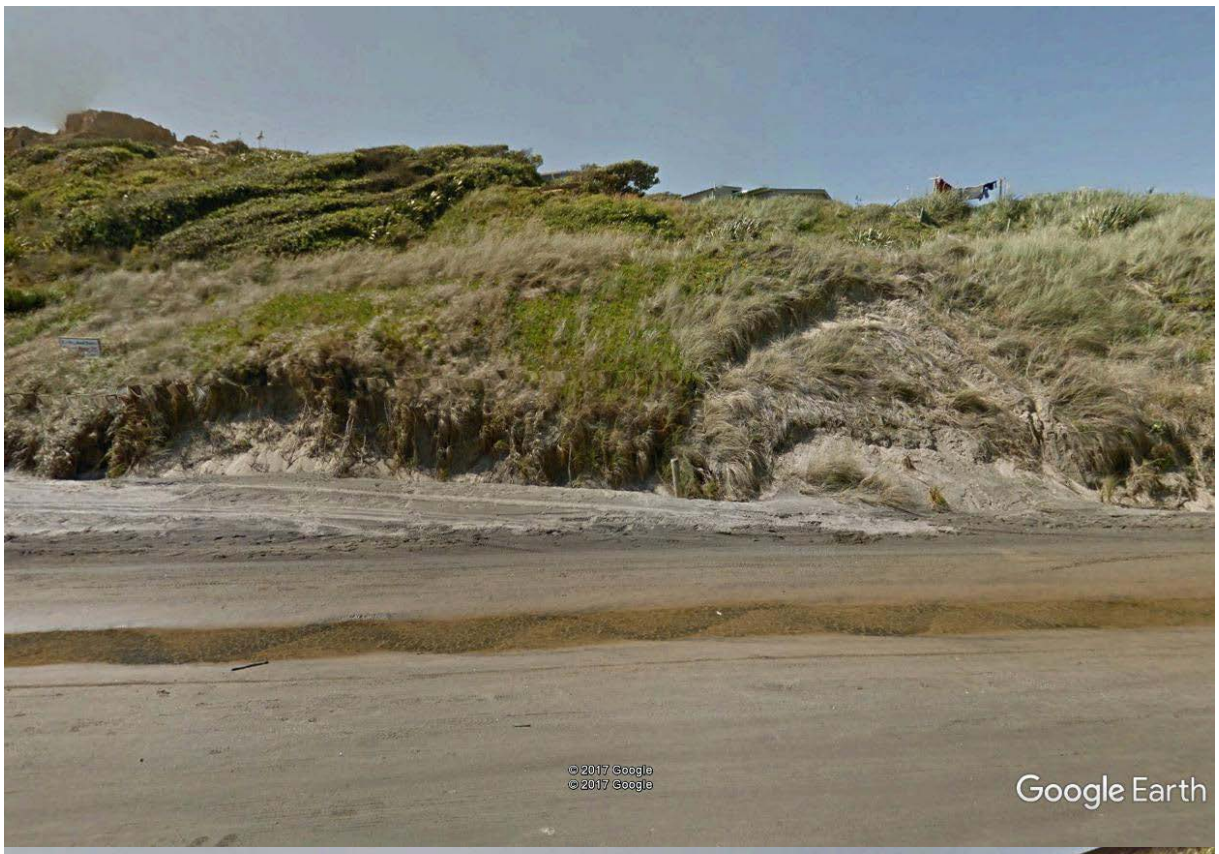
A second option to make the beach road more resilient needs further detailing and investigation. Hence and at this stage, we recommend a design for the road using permanent materials (rock riprap) together with ongoing maintenance be used to manage beach access.

Once this design work has been undertaken, then the combined work can again be presented to Council.

Appendices

Appendix A – Photos from 2012

Pre wall construction



Appendix B – Photos from site visits

Early August 2017 and

July 2015 during wall construction

Photos from 2017 early August Site Visit

Photos taken approximately every 5 m showing existing state of wall at state of wall and failures

~0 to 9m

~7 – 17m

~13 – 21m

~19-26m

~23-30m

~25 to 35m

~32 – 40m

~36 – 43m

~40-49m

~45-55m

~52 to 63m

~58 – 67m

~63 – 73m

~67-77m

~64-74m

~76 to 84m

~75 – 84m

Photos from July 2015 Site Visit During original Wall Construction







Appendix C – Resource consents

Copy of NRC Resource Consent Application document and

Consent as granted

FILE: 008964
01 to 02
Change to Conditions

Document Date: 09.07.2015

Resource Consent

Pursuant to the Resource Management Act 1991, the Northland Regional Council (hereinafter called "the Council") does hereby grant a Resource Consent to:

KAIPARA DISTRICT COUNCIL, PRIVATE BAG 1001, DARGAVILLE 0340

To carry out the following activities at Baylys Beach on Pt Lot 1 DP 20714, Lots 1, 2 & 4 DP 71221, Pt Lot 1 39303 & and Road Reserve Blk XIII Kaihu SD, Map Reference P07:776-832:

AUT.008964.01.03 To excavate sand from a foredune and beach location.

AUT.008964.02.03 To place a sand bag protection structure adjacent to the Chases Gorge Stream for the purpose of stream and bank protection works at Seaview Road, Baylys Beach.

Subject to the following conditions:

1 The Consent Holder shall ensure that the works are carried out generally in accordance with the **(attached)** Transfield Services Plans entitled:

(a) "*Baylys Beach Sand Bag Works – Proposed Alignment*", Sheet 1 (of 1), dated 10/6/2015.

(b) "*Baylys Beach Sand Bag Works – Proposed Sand Collection Area G*", undated aerial photo.

1A Excavation of sand from the beach shall be limited to the area identified as "*Area G*" in Condition 1, unless the prior written approval of the Northland Regional Council's Monitoring Manager is obtained for the removal of sand from other areas of the beach.

1B All excavation of sand from the beach shall be limited to unvegetated areas located landward of the line of and above the level of Mean High Water Springs, and shall not result in the creation of holes or depressions or the undermining of sand dunes or cliffs.

Advice Note: *The removal of sand is to be undertaken by evenly scraping a shallow depth of sand from the authorised are.*

1C The sand bag protection works shall be faired into the adjacent slope in a manner such that ensures end-effects arising from erosive stream flows do not occur.

2 The area located on the slope above sand bag works shall beplanted with suitable dune vegetation species within three months, of the completion of earthworks on this site. Fencing shall The amount of sand required to carry out the sand bag construction activities is 1600 m^3 be constructed and maintained so as to prevent vehicle and pedestrian access over this site.

3 The Consent Holder shall notify the Regional Council in writing of the date sand excavation is intended to commence, at least one week beforehand.

4 Refuelling and servicing of machinery shall not be carried out in or near the bed of the stream or on the beach.

5 The Council may, in accordance with Section 128 of the Resource Management Act 1991, serve notice on the Consent Holder of its intention to review the conditions of this consent. Such notice may be served, three months after the commencement of the consent, and thereafter at six monthly intervals. The review may be initiated for any one or more of the following purposes:

(a) To deal with any adverse effects on the environment that may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or to deal with any such effects following assessment of the results of the monitoring of the consent and/or as a result of the Regional Council's monitoring of the state of the environment in the area.

(b) To require the adoption of the best practicable option to remove or reduce any adverse effect on the environment.

(c) To provide for compliance with rules in any regional plan that has been made operative since the commencement of the consent.

(d) To deal with any inadequacies or inconsistencies the Regional Council considers there to be in the conditions of the consent, following the establishment of the activity the subject of the consent.

(e) To deal with any material inaccuracies that may in future be found in the information made available with the application. (Notice may be served at any time for this reason.)

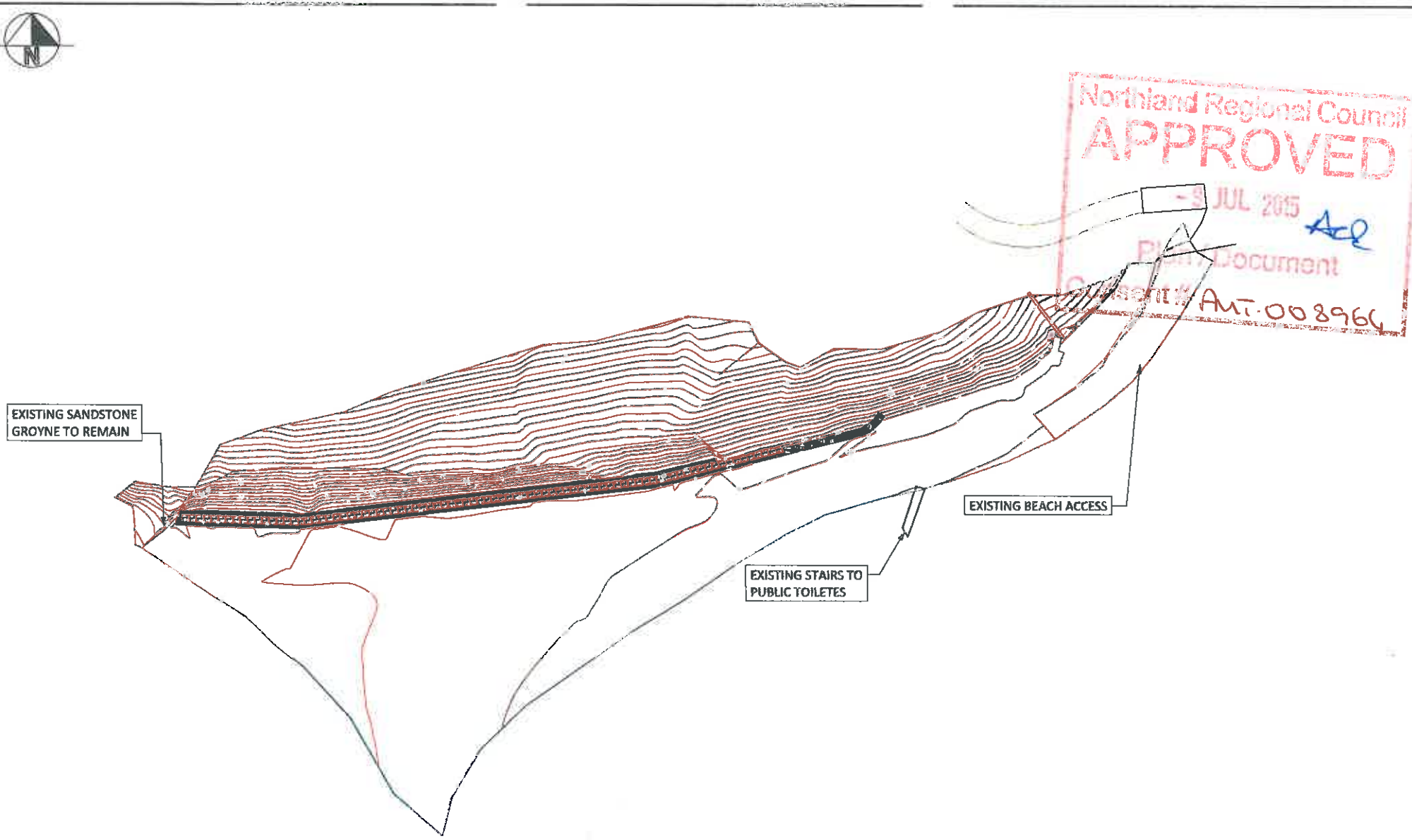
The Consent Holder shall meet all reasonable costs of any such review.

EXPIRY DATE: 30 JUNE 2034

The original resource consents (NLD 00 8964) dated 12 September 2000 were authorised by Allan Richards, Acting Consents Manager. A change of consent conditions (NLD 02 8964 (01)) was granted on 28 May 2002 by DL Roke, Consents Manager. A further change to consent conditions 1 and 2 is granted this Ninth day of July 2015 under delegated authority from the Council by:

Allan Richards
Consents Programme Manager – Coastal and Works

The date of commencement of these consents is 12 September 2000.



SCALE: 1:500	DATE: 10/06/2015
NOTES	DRAWN

BAYLYS BEACH SAND BAG WORKS
PROPOSED ALIGNMENT

TRANSFIELD SERVICES
32 Te Waiiti Place, P.O. Box 48,
Raumanga, Whangarei, 0110
Phone (09) 470 4400, Fax (09) 470 4401

JOB NUMBER

Sheet Number: 1
Total Sheets: 1

C:\Documents and Settings\ward\Desktop\Baylys Beach Dune Protection\Baylys Beach Sanddunes LONGSECTION.ccx - Drawing001


BAYLYS BEACH SAND BAG WALL WORKS
PROPOSED SAND COLLECTION AREA G
DISTANCES REFERENCED TO EXISTING ROCK GOYNE AT
TERMINATION POINT OF PROPOSED BAG WALL
BAYLYS BEACH
AREA G
APPROX 500m
APPROX 200m
PROPOSED SAND BAG WALL AREA
TRANSFIELD SERVICES

Appendix D – Opus Report and Memo

Including:

Stormwater management Plan – Baylys Beach July 2015

Baylys Beach – Erosion Analysis – Opus Memo March 2018

GHD

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Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Draft	Tony Miller	Craig Dengate				21/08/17
Final	Tony Miller	Iftikar Rahim		Iftikar Rahim		13/3/18

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