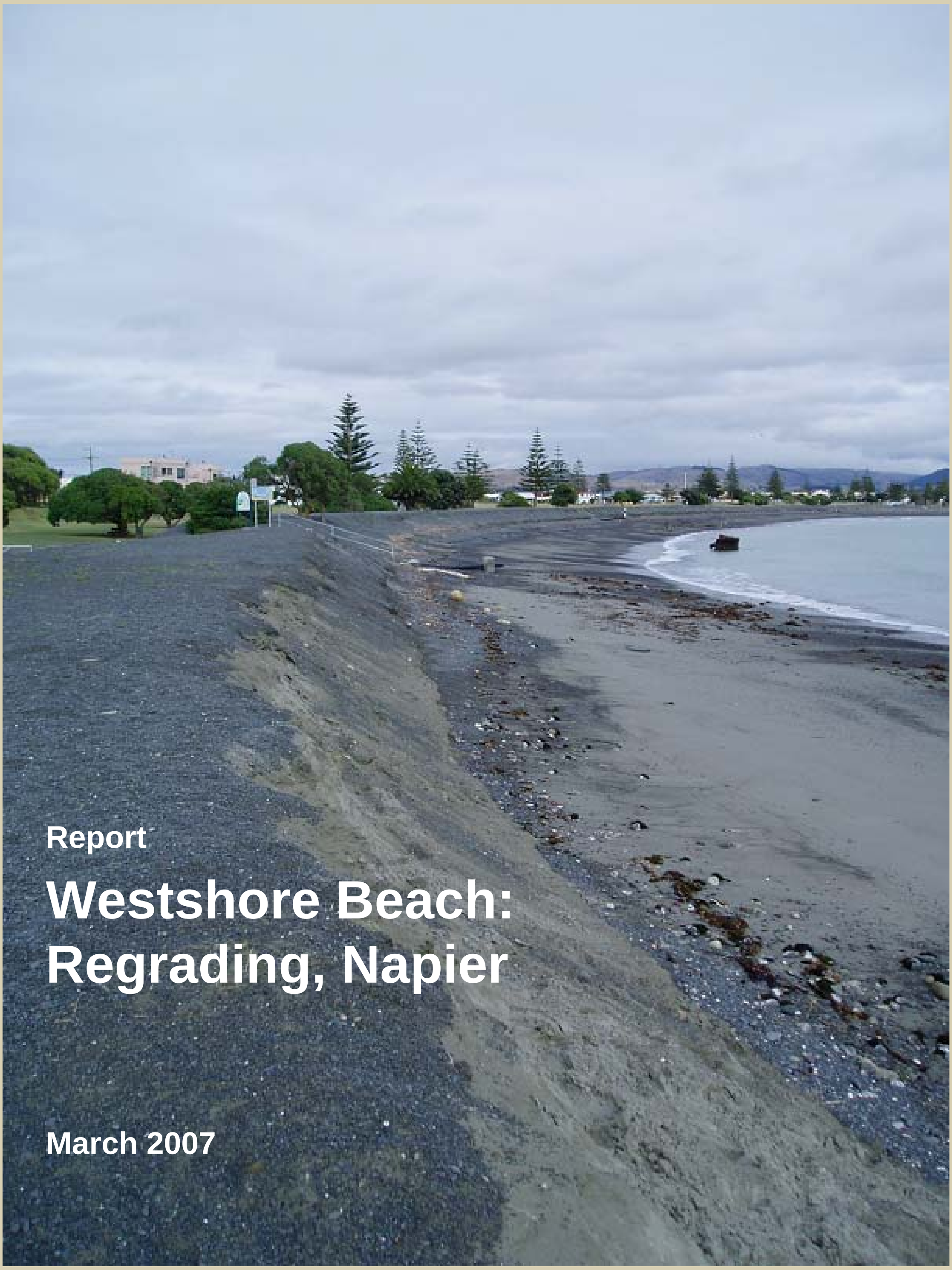

Report

Westshore Beach: Regrading, Napier

March 2007

Prepared for

Napier City Council

▪ report

Westshore Beach: Regrading

Prepared for

Napier City Council

By

Beca Infrastructure Ltd

March 2007

Revision History

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Approved by	Stephen Priestley		06/09
on behalf of	**Beca Infrastructure Ltd**		

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Appendices

1 Introduction

In February 2006, Napier City Council commissioned Beca Infrastructure to investigate the feasibility of regrading Westshore Beach from Charles Street to the Surf Club, a length of some 900m.

The purpose of the regrading works is to improve access to the beach and to provide for a greater amenity in the backshore area. In addition this report is to assess the interaction of any regrading works with the proposed "counter erosion works" at Whakarire Ave, as described in Beca (2003).

Westshore Beach is regularly renourished with beach gravel and sand from Pacific Beach. This activity is to counter recognised erosion on Westshore Beach. This renourishment project commenced in 1988 and delivers on average 15,000 m^3 of beach material each year. The proposed regrading works relate to the reshaping of the renourished beach at the southern end of Westshore Beach.

Dr J Gibb in his report to Council (2003) made recommendations for maintaining and enhancing the amenity values of the Westshore coastal environment. He proposed reshaping of the profile by reducing the slope of the beach mechanically and to maintain a swale at the backshore. As a follow up to Gibb's work, Beca prepared a preliminary engineering assessment of re-grading the beach in 2004. It investigated the likely profile requirements and costs to achieve the works but also cautioned on the lack of understanding as to how gravel/sand beaches behave. This conclusion was reinforced in a review by Professor Paul Komar in 2005 of the earlier work. This report is more detailed and follows up the above investigation works.
The study area is shown in Figure 1.

2 Beach Processes

Offshore, nearshore and beach processes have been investigated in some detail by many studies, the most comprehensive of which was Komar (2005). This section draws information from some of those studies, but the reader is referred to the original study for more detail.

2.1 Wave Energy

The shallow nature and geometry of Hawke Bay affects the refracted waves as they approach the beaches. In addition the shelter provided by Bluff Hill and the Port breakwater more significantly affects the incident waves through diffraction processes. The wave climate has to a degree been quantified by Gorman et al (2003) using hindcasting techniques for deepwater waves (in 200m CD) over the period 1979-1998, and by Port of Napier deploying a wave rider buoy over 4 years in 16m CD depth of water seaward of their breakwater. Direct comparison of the results is difficult because of the different record periods and base locations. Tonkin and Taylor (2004) used a nearshore wave model to transform the deepwater waves (1979-1998) into 10m CD of water. Comparison of results indicated that the Port of Napier data gave a mean significant wave height of 0.86m with a mean wave period of 11.4 s, and the Tonkin and Taylor analysis a mean significant

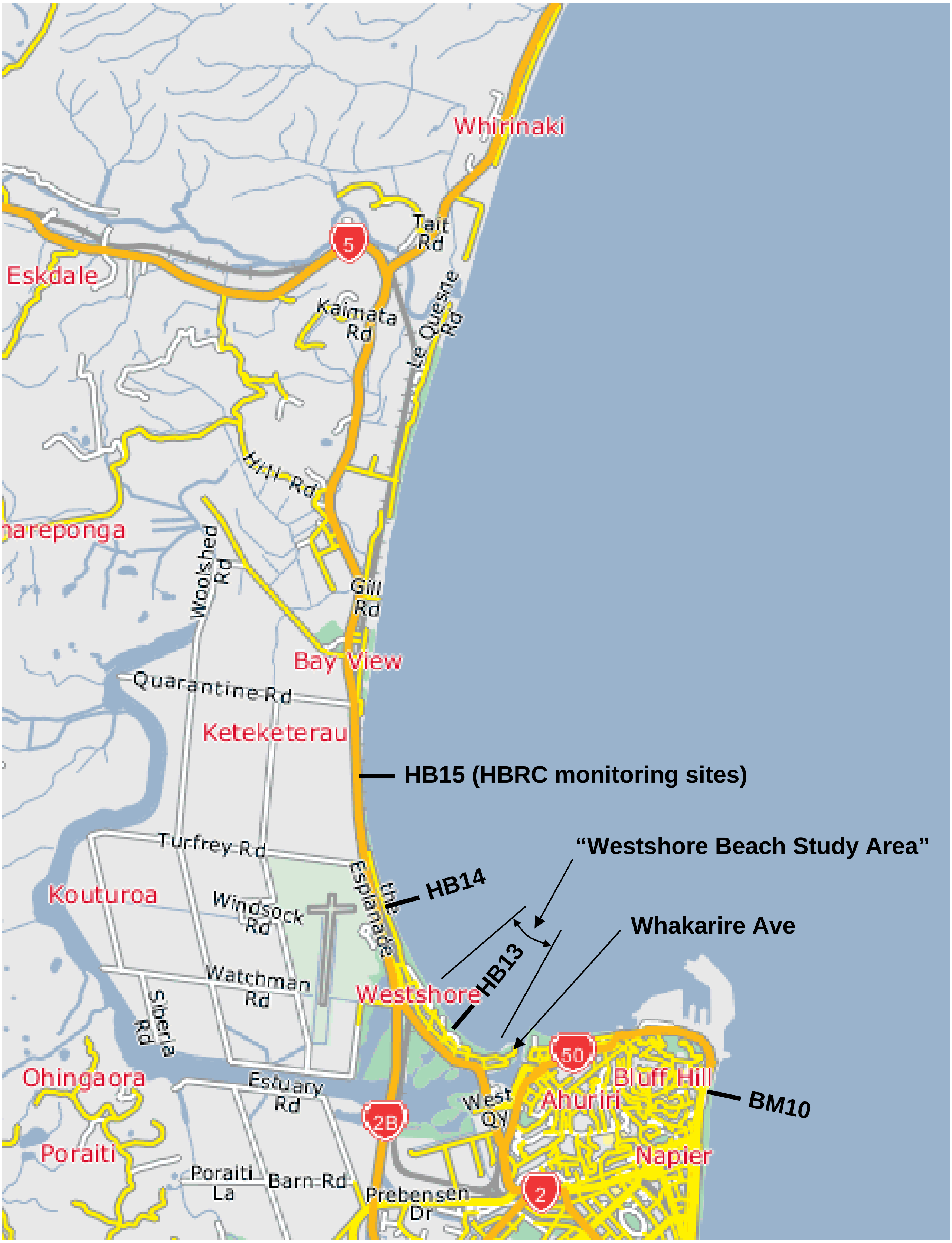

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Figure 1
Location of Study Areas

wave height of 0.70m with a mean wave period of 10.8s (and a mean approach angle of 116° true north). A summary of the wave statistics for the Port of Napier buoy is presented in Table 1.

Table 1: Significant Offshore Wave Heights (m) based on Port of Napier wave data (2000 –2004)

Return Period (years)	Significant Wave Height (Hs-m)
Mean of all data	0.86 *
2	4.0
5	4.5
10	4.9
25	5.4
50	5.8
100	6.2

*mean swell period is about 11s.

Wave transformation from either 10m CD or 16m CD to the wave breaking zone will undergo further transformation with shoaling, refraction and diffraction processes. Wave analysis by Worley (2002) for the Port of Napier demonstrated that the wave transformation coefficient between the wave buoy and Westshore varied between 0.48 to 0.68 for a 90° wave direction and 0.41 and 0.53 for 120°. This is supported by a short term deployment of wave rider buoys by ASR (2001). They gave the wave transformation coefficient as 0.4 at the southern end of Westshore and 0.76 just south of Bayview, compared with the wave buoy off the Port breakwater.

2.2 Beach response to the wave environment

Waves breaking on Westshore beach is the predominate process which creates and alters the shape of the beach. Any angle between the wave approach and the beach alignment in the surf zone (referred to as the breaker angle) will cause sediment to move in the direction of the incident wave. In general terms the coarser the beach sediment, the less the transport of sediment and the steeper the beach profile.

Each storm and swell condition will have varying wave energies and breaker angles, resulting in sediment moving in both directions. The entire bay is subjected to a number of headland constraints which creates a sheltered wave environment. The Eastern Mole, Port of Napier Breakwater and Portland Island all cause waves to diffract and the seaward shoaling reef causes waves to refract. See Figure 2.

Komar (2004) outlines the importance to have the ability to predict how the beaches respond to the ocean processes, in particular how their slopes and elevations change

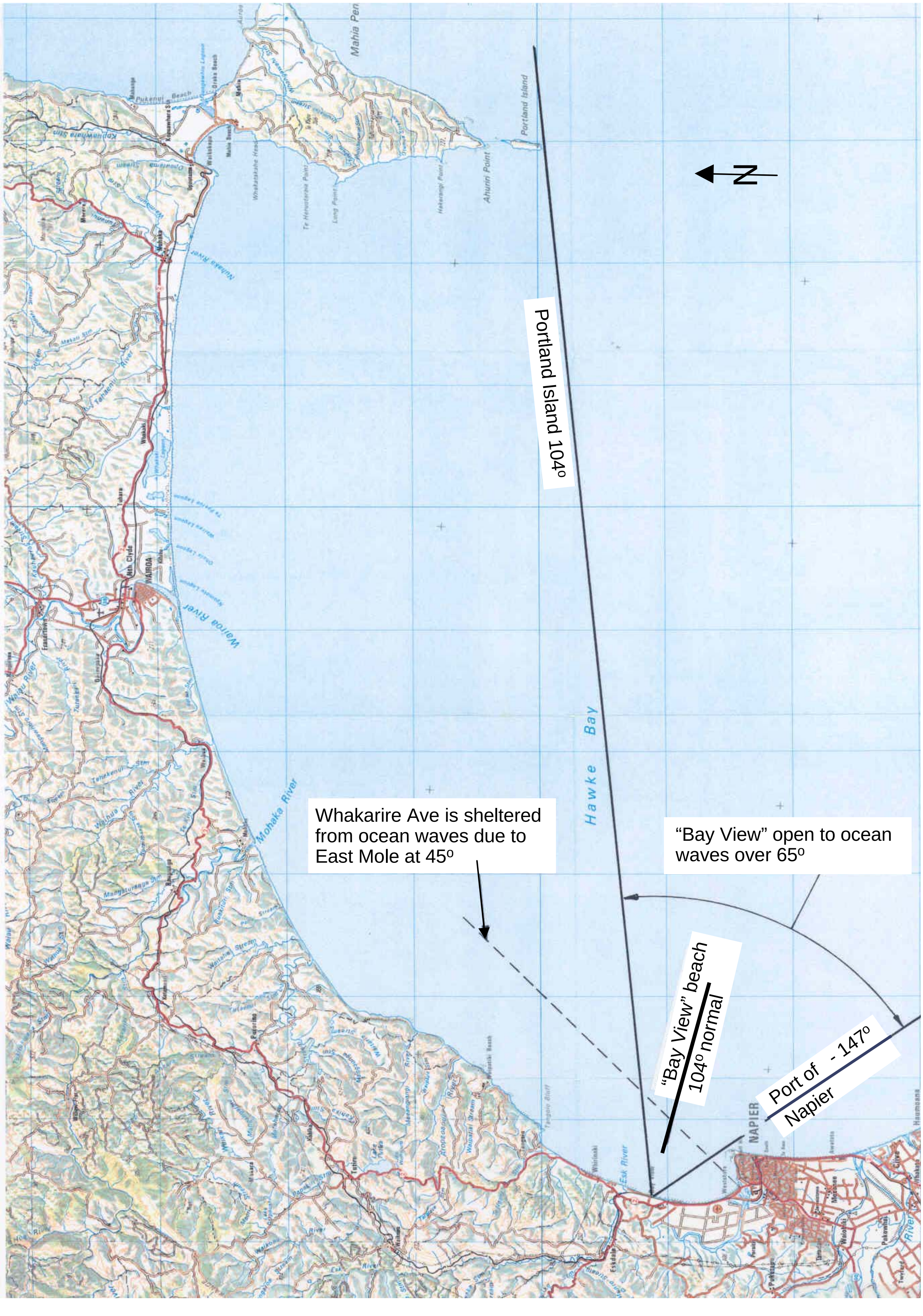


Figure 2
Headland Constraints

during a major storm, perhaps leading to the erosion and flooding of backshore properties. Such predictions have been a problem for the bay in that beaches are composed of mixtures of sand and gravel, a type of beach that has been the focus of much less scientific and engineering research than sand or gravel beaches.

The beaches can be classified based on their proportions of coarse sediments versus sand, with resulting differences in their morphologies. The beach slope for a mixed sand and gravel beach, such as at Westshore, is classed as reflective, where the profile slope is steep so the waves reach close to shore before breaking and immediately develop into a strong swash up the beach face, not having lost energy in first crossing a wide surf zone. They can reflect a significant portion of the wave energy, so one can often observe waves returning seaward after having been reflected from the beach. The stability of mixed sand-and-gravel beaches is uncertain and often unpredictable due to the added proportions of sand which can fill the voids between the gravel particles, reducing the extent of the wave swash runup so it retains more of its energy, resulting in the cut back of the beach profile during storms (Komar, 2005).

The breaking of waves at an angle to the shoreline causes the longshore transport of the beach sand and gravel, with an interruption of sediment transport occurring around jetties, groynes or breakwaters, structures which may cause sediment accumulation. A consequent advance of the shoreline occurs at the accumulation point, and subsequent erosion of the shoreline and bordering properties occurs due to the loss of sediment down-drift.

At Westshore, significant ranges in the proportions of sand versus gravel occur where the sand tends to accumulate at the ends of the littoral cells largely owing to the changing directions of waves that reach the shore. When waves arrive from the southeast, beach sediment is transported northwards along the shore with sand accumulating at Tangoio, with transport interrupted by the headland. Sand is transported to the south, when waves arrive from the northeast, and it accumulates at Westshore. Sand can remain at these beaches for a lengthy period as they are sheltered by the headlands and also by the Port breakwater at Westshore. There is a continuous gradation from the gravel upper beach, to an intertidal sand and gravel beach, which appears to continue into offshore sand deposits. The amount of sand accumulation is significant enough that it can be classed as a composite beach. Processes of grain sorting and beach shape variability, when at their most extreme, can cause this change in classification.

The origin of the gravel particles is Greywacke, a relatively soft rock. Transport of the gravel within the littoral system causes the particles to abrade, resulting in a further loss of sediment from the system. This process can often be seen from the air causing discolouration of the nearshore zone.

Westshore falls into the Bay View littoral cell as there is little sediment input into this (apart from a small input from the Esk River). With little sediment input the shoreline attempts to reach an equilibrium condition with the net incident wave environment. Worley (2002), assuming a net overall wave direction of 116^{o} true north, estimated that the long-term equilibrium shoreline shape to have a crenulate form (Silvester & Ho, 1972). Based on the existing planform shape, some further erosion would occur at the southern end of Westshore as shown on Figure 3. The existing beach shape is east of this location indicating that the beach will remain in an erosional phase. This erosion is currently countered by the beach re-nourishment system which has largely been successful at alleviating erosion. South Westshore beach acts as a feeder for the nourishment process. Sediment from the system travels north and accumulates along the Esplanade and northwards, reducing storm erosion and flooding problems there. Further work is still required however in the Westshore area as it continues to act as a feeder to the nourishment programme exposing itself to erosion.

Predictions of wave runup and beach shape for mixed sand and gravel beaches are problematic due to the effects of the proportions of sand and gravel on the overall permeability of the beach. The high mobility of the sand component means that its distribution within the littoral cell responds quickly to changing waves and currents. The beaches can be mixed sand and gravel or composite but reality shows that there is a continuum of beach compositions and morphological forms along the beach making it difficult to categorise into any one beach classification. Attempting to formulate any relationship between the wave environment beach shape and overall runup will be complex on composite beaches, in that it depends on the degree of energy loss of the waves as they cross a dissipated sand beach and then only re-break and swash up the gravel beach.

Holman (1986) empirically derived a relationship for total runup that has been applied to sand beaches with a basic dependence on the beach slope with a wave height and period. Application of this relationship for a mixed sand and gravel beach for runup may be possible but for this study the shape of the beach profile is more critical and no insight is provided by this relationship.

CUR (1991) presents a relationship for crest height and beach shape for gravel beaches. This relationship was developed for gravel beaches with a particle size of greater than 20mm, but its application for Westshore beach is discussed later in Section 2.3.

Komar (1998) presents a range of relationships for berm height, beach slope and beach shape, principally for sand beaches. These relationships are also discussed in Section 2.3.

Probably the best guide to understanding the processes of morphologies of a coast with mixed sand and gravel beaches is the work undertaken by Kirk (1980) on similar beaches of the Canterbury Bight of the South Island. His work established a primary correlation between the measured breaker height and the length and elevation of the resulting swash runup. He concluded from his measurements that only 20% - 60% of the incident wave energy is translated into runup and backwash velocities. The proportion decreasing as wave energies increased. However, this research is missing a number of components that would enable prediction of morphological responses of beach profiles at times of storms or during more quiescent periods. (Komar, 2005).

A clear picture of the beach slope relationship between sand and mixed sand and gravel beaches is given in Figure 4 (after Komar (1998)). Whereas there is an increasing slope relationship with grain size for sand beaches, for mixed sand and gravel beaches with grain sizes between 0.5 to 2mm the beach slope is static. This is explained by poor sorting of the mixed sand and gravel beaches and its effect on beach permeability. It should also be recognised that the relationship for the mixed sand and gravel beach was developed for the Canterbury coastline (McLean and Kirk, 1969). A different relationship for beach slope

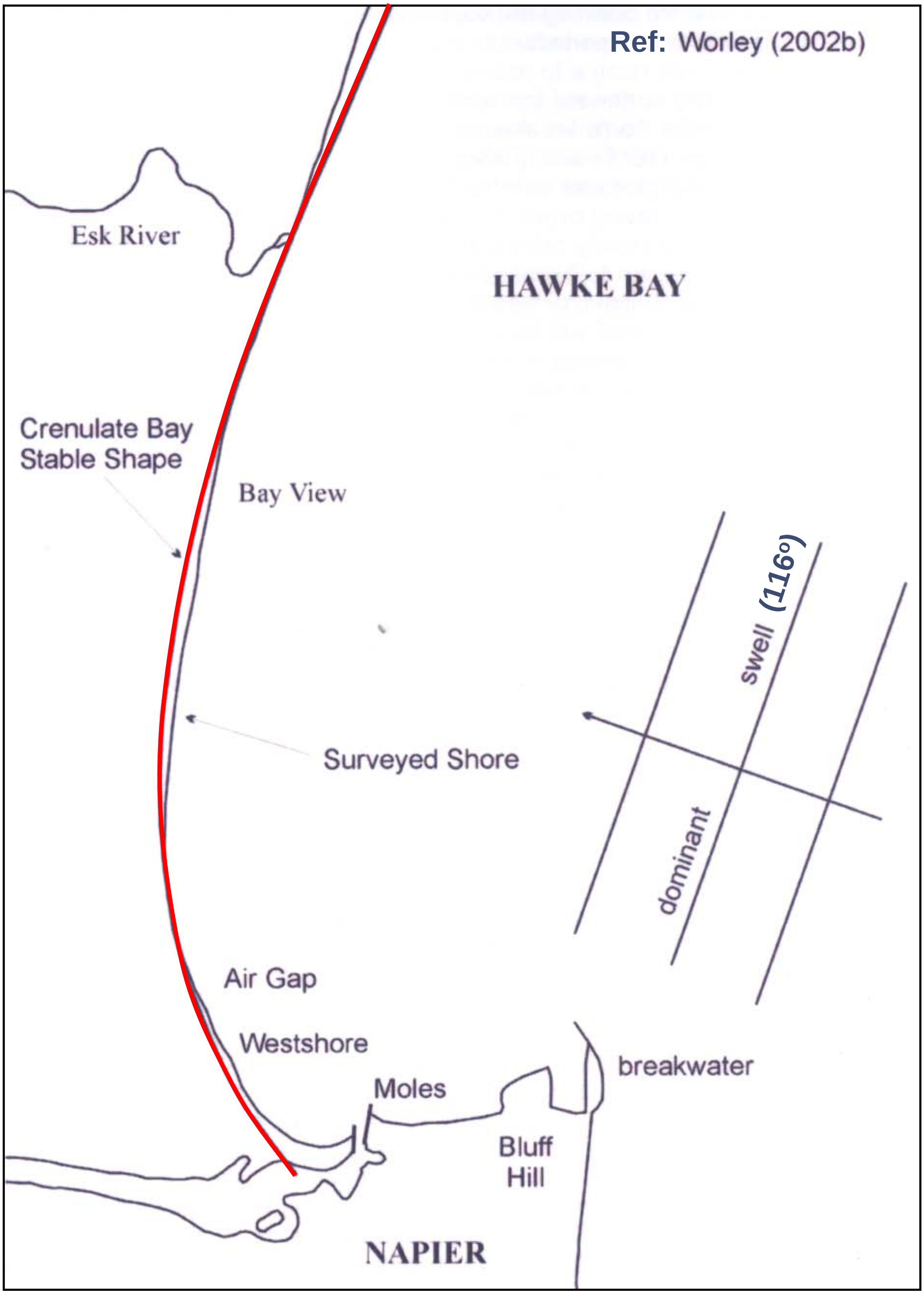


Figure 3
Crenulated by Shape

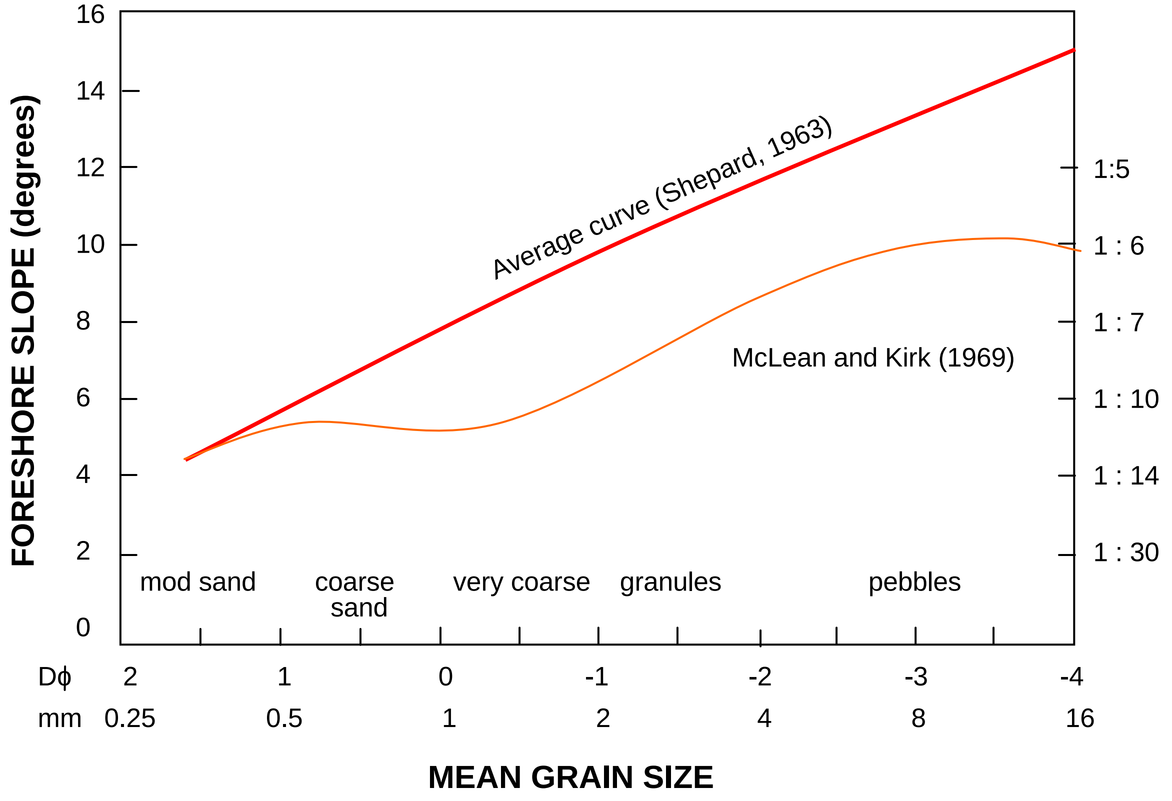


Figure 4
Beach Face Slope and Grain Size

would probably apply to the Hawke Bay coastline due to the substantially different wave environment.

2.3 Beach Shape at Westshore

The Hawkes Bay Regional Council conducts regular beach surveys at the salient points along the Hawkes Bay coastline. For the study area, these are shown in Figure 1. Beach samples were taken at a number of reference sites and information on the beach composition and profile is summarised in Table 2.

Table 2 – Beach Composition and Profile

Sample Location (See Figure 1)	% sand (below 2mm)	D_{50} (mm) **	Beach Slope *		Wave transmission co-efficient (relative to Pacific Beach)
			At MSL	Upper Slope	
BM 10 – Pacific Beach	1	4	1 in 14	1 in 7	1.0
HB 15 – Beacons on Westshore	0	6	1 in 10	1 in 4	0.8
HB 14 – Cross runway at Westshore	65	2	1 in 10	1 in 3	0.6
HB 13 – South of Surf Club	24	3	1 in 12	1 in 3	0.45

* Taken from 2005 HBRC profiles.

** Grading Curves are given in Appendix A.

Pacific Beach was taken as a reference sample because it is where the gravel is extracted for nourishment for Westshore. It also contains a beach profile which is considered acceptable as a profile for amenity purposes (i.e. upper slope at 1:7). Comparative beach profile data is illustrated in Figure 5. The wave climate is less on Westshore compared to Pacific Beach. In general the material in the nourishment zone is finer than Pacific Beach. This is due to the recent mixing of some sand with the nourishment material and may also be due to some onshore movement of sand from the nearshore onto the beach. Further north along Westshore the gravel becomes coarser as the fine material is winnowed from the sediment. In general the mean sea level and upper beach profile slopes are shallower at Pacific Beach. Along Westshore, with upper slopes between 1:3 and 1:4, these are very difficult to walk over.

The gravel model that was presented in CUR (1991) was applied to assess whether that relationship could apply to Pacific Beach and Westshore. See Figure 6 for the application to Pacific and Westshore Beaches. Initially the model was compared to Pacific Beach, but its correlation was poor. At both Pacific Beach and Westshore, for the given causation factors such as wave climate and grain size, the modelled profile was significantly shallower than the observed profile and the beach crest levels were underestimated. An attempt was made to calibrate the model with Pacific Beach profile but this was not successful.

The approach given in Komar (1998) (using Eqn 7.15 for beach-face slope, Eqn 7.17 for berm height, and beach profile similar to Eqn 7.4) gave a better comparison. The Pacific Beach profile modelled well compared to the recorded data, with no calibration. See Figure 7. When the same relationships were used on Westshore flatter upper slopes and lower berm levels were derived. See Figure 7 for HB 13. According to these relationships, an upper beach profile of 1:7 could be sustained. The milder wave climate causes the slope to be steeper but this is countered to some degree by the finer grain size. However the modelled profile is shallower compared with the actual profile, indicating that other processes are causing a steeper profile and higher crest levels.

A significant factor appears to be that Pacific Beach is generally accreting while the Westshore Beach is eroding, although occasionally being renourished. Although all the beach profiles have similar beach slopes around mean sea level, the eroding beach sections have steep scarps caused by the erosion processes. That is, in between each renourishment campaign the more frequent milder waves eat into the nourishment stockpile causing undermining and collapse resulting in the upper beach slope being loose and near its angle of repose.

The current nourishment method results in a 'stop bank' of material being placed above mean high water springs. Wave attack causes the mean sea level profile to eat into the stop bank which then feeds sediment into the active beach system. Through this process a steep upper beach profile is created. Occasionally a larger long period swell comes in and flattens the beach to make access easier but subsequent milder wave conditions cause it to revert to a steeper slope.

2.4 Beach Inundation Level

Extreme storms, which could be coupled with high tide levels and storm surge, will cause significant runup and potential inundation of the backshore area. Tonkin & Taylor (2004) assessed the potential inundation levels for the 1:100 year event for the Hawkes Bay Regional Council. A summary of results for the Westshore Beach are given in Table 3. Their results indicate that the beach crest would only overtop for extreme inundation and run up events south of HB14.

It is also noted that in the 1931 earthquake there was a general uplift of the ground level by some 2 metres which significantly improved the ability of the backshore area to accommodate wave runup. As a result of this, most of the existing developed area is not subject to extreme inundation caused by infrequent wave events.

Table 3 – Inundation Levels for 100 year event (above MSL at RL10)

Location	Beach Crest Level	Hs (Max)	Inundation Level		Runup Level	
			No SLR	With SLR	No SLR	With SLR
HB 13	14.1	3.4	13.0	13.5	14.4	14.9
HB 14	15.5	3.9	13.2	13.7	14.8	15.3
HB 15	16.3	3.9	13.2	13.7	14.8	15.3

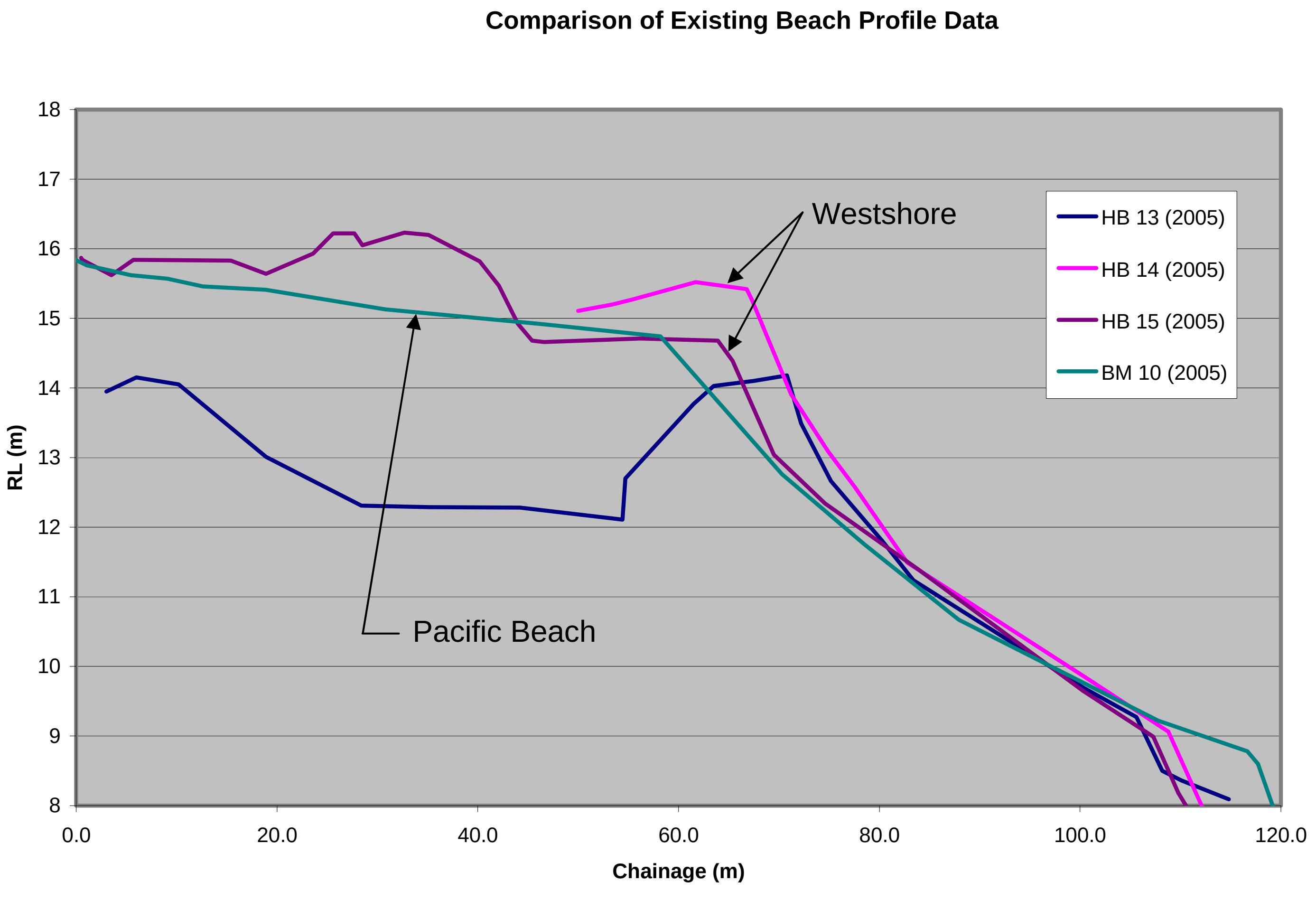
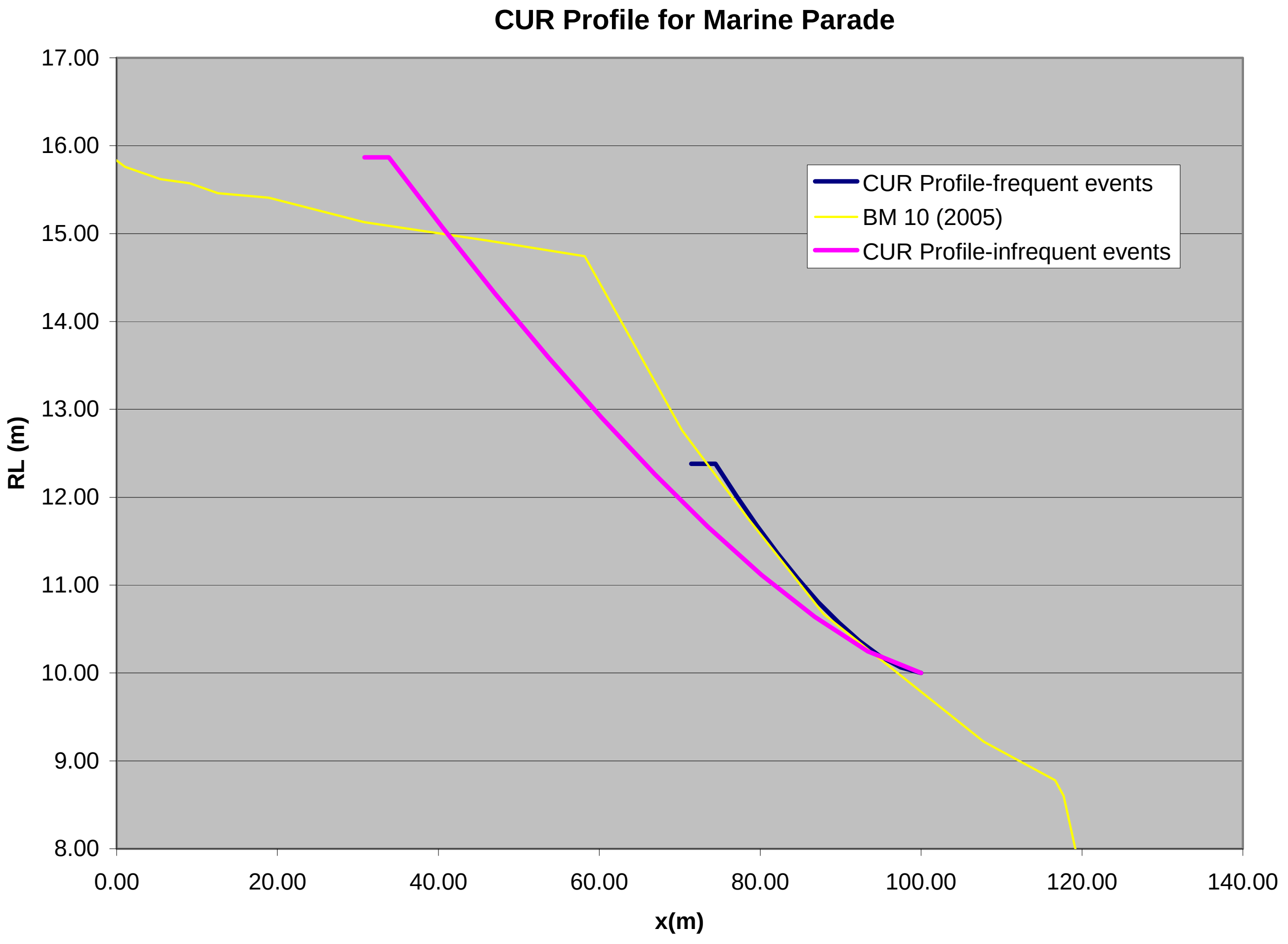


Figure 5
Beach Profile Data



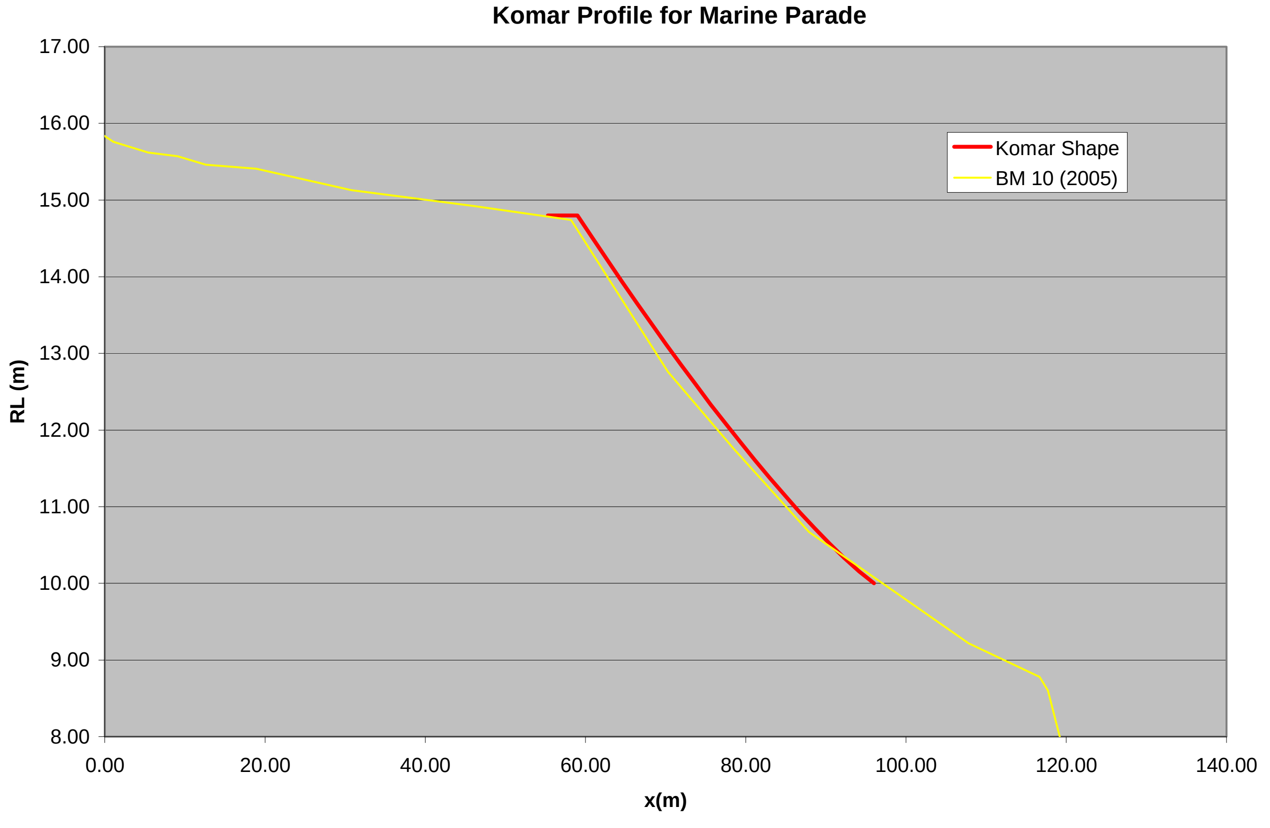
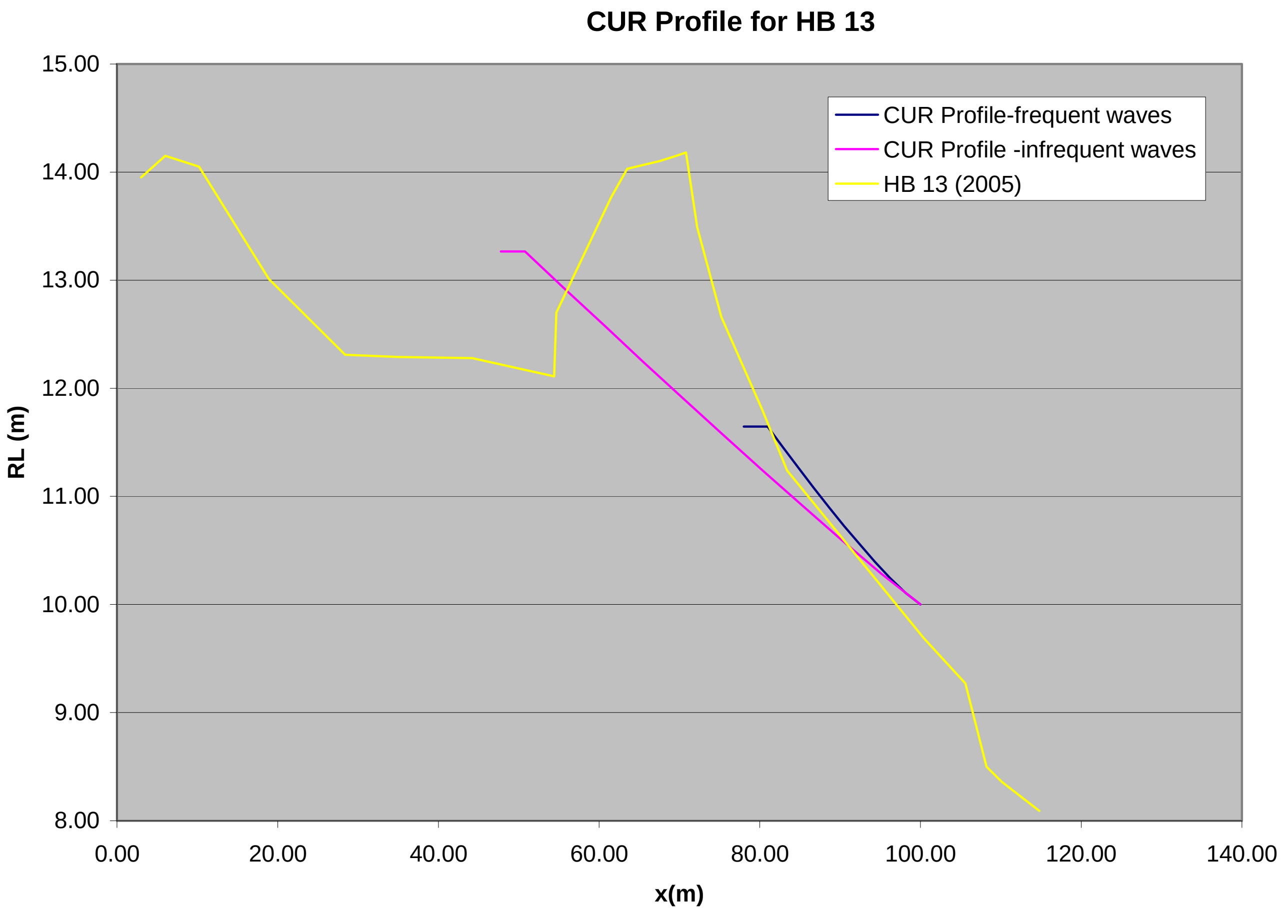


Figure 6

Model Application – Pacific Beach



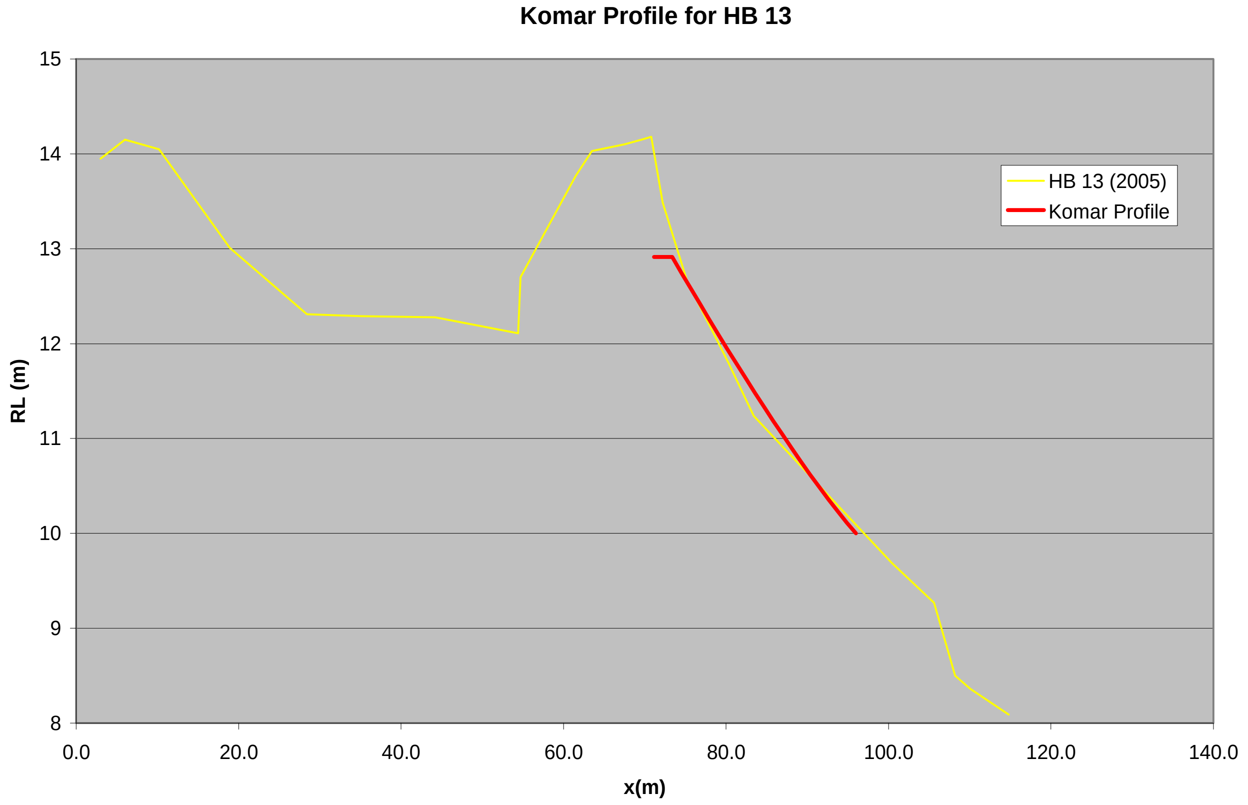


Figure 7

Model Application – Westshore Beach

3 Whakarire Ave Project

3.1 Background

Beca (2003) indicated that coastal erosion seaward of Whakarire Ave is primarily due to a lack of sediment supply. Owing to a number of factors, the natural inputs of sediment into the southern end of the Westshore beach system have ceased. The construction of training moles, the reduction in the tidal prism of the Ahuriri Estuary, the loss of direct sediment input from the Tutaekuri River and the introduction of the Port of Napier breakwater system are such factors. As the coastline orientation and the incident wave climate are no longer in equilibrium, any new material introduced into the local beach system is normally driven northwards by wave action.

A rock bund seawall was constructed in 1994 to protect existing properties in Whakarire Ave. Whilst providing some level of protection to the existing coastline, it is not robust enough to be considered as a long term structure for coastal protection. The existing structure currently funnels waves into Westshore beach and causes rapid transport of sediment both offshore and along shore. It does not enable a stable control point or feeder area for the current renourishment scheme which delivers on average 15,000m^3 of beach material each year.

Beca (2003) examined five coastal protection options in addition to the do nothing option. These were an enhanced seawall, am enhanced seawall and infilling of backshore, a groyne to limit wave focussing, a wave spending beach and an attached breakwater with beach creation.

The do nothing option found that Whakarire Avenue would be eroded without protection works and that the existing seawall was likely to fail in a significant storm event with elevated sea levels. If the existing seawall were ineffective in the long term, there would be the potential for the coastline to retreat and the houses located on the northern side of Whakarire Avenue could be lost. See Figure 8. The location of the control point dictated the extent of loss of property and in the event that the seawall remained intact the coastline would not retreat into the houses on Whakarire Avenue, provided the existing nourishment scheme continued. Costs associated with this option are the clean up of the existing seawall after failure occurred and the loss of private and public property. This option concluded that, with given historical rates of erosion, it would take many decades for the shoreline to become stable.

The coastal protection options focussed on land protection and enhancement of coastal processes. The effects on reef ecology, surfing conditions, landscape and heritage values were not considered. The existing nourishment scheme was assumed to continue and Westshore Beach planform was assumed to remain unchanged.

3.2 Layout of Preferred Option.

Based on existing information, the assessment of the coastal processes, consultation with and feedback from Council and local residents, Option W5 -Attached Breakwater with

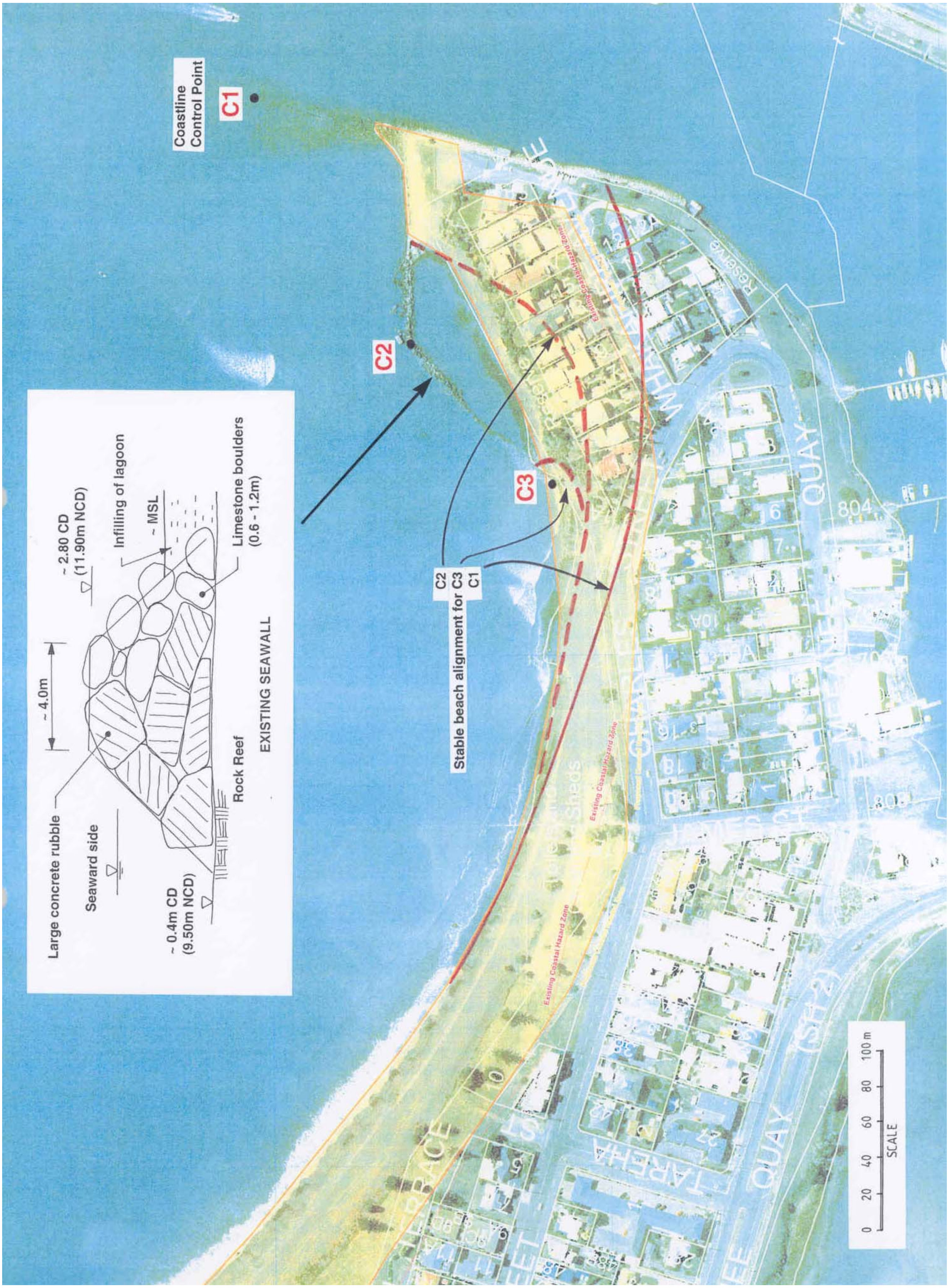


Figure 8
Whakerire Ave: Do Nothing Option

Beach Creation was recommended. This option proposed to enhance the existing seawall parallel to the coastline, extending it out a further 100 metres. See Figure 9. This option offered the benefit of allowing incident wave energy to be dissipated and reflected off the seawall which would encourage a sheltered area to be formed in lee of the seawall. It should form a crenulated shaped beach which would marry in with the existing beach, provided the existing large concrete blocks would not reflect high levels of wave energy onto the new beach. The new beach could be created from sand material that is infrequently dredged from the Ahuriri entrance channel and it is likely that any sand beach created immediately in the lee of the seawall would transition into the mixed sand and gravel beach. The estimated cost of this option was $675,000 in 2003. The extended breakwater section is relatively expensive as it would be founded in water about 1 metre deeper than the existing seawall, requiring a seawall section larger in size.

There is also the opportunity to create a higher backshore area by filling in the existing lagoon which may have wider benefits to the community.

3.3 Further Requirements

The next stage of the Whakarire Avenue project would be to gain resource consents for the project. The likely resource consents required would be:

- construction of the extended seawall which could be a restricted coastal activity
- deposition of sand onto the new beach
- occupation of the seabed for the new wall and the beach
- reclamation if the backshore lagoon area was filled in
- stormwater discharges associated with any redirection of stormwater
- removal of large concrete blocks off Westshore beach.

In preparing the resource consents application, an assessment of environmental effects will be required which will need to address the following in some detail:

- benefits to the community
- coastal processes
- surfing conditions
- reef ecosystem
- heritage values
- visual amenity.

In order to advance the engineering design of the seawall structure, a survey of the seabed along the proposed alignment would be required along with some geotechnical investigations of the rock reef to establish the best method for keying the structure into the rock. In addition samples of the sand from the Ahuriri Entrance should be tested to ascertain its suitability as beach material and, if so, the final shape of the beach.

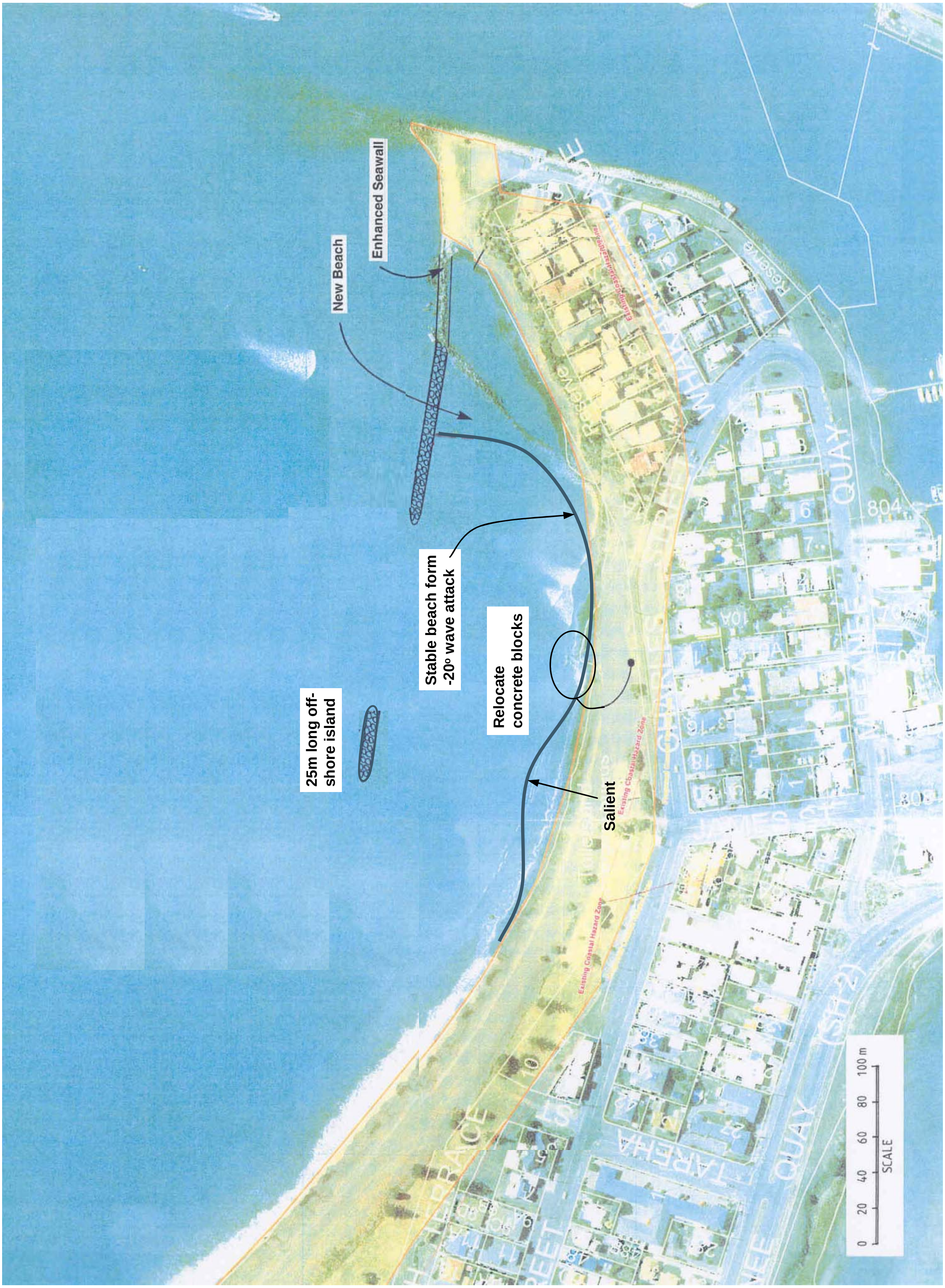


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Figure 14
Whakarire Ave: Attached Breakwater & Offshore Island

4 Beach Regrading Project

4.1 Purpose

The beach regrading project, by altering the beach profile, is intended to provide safer access onto the beach and provide a greater amenity to the backshore by raising it using fill material.

It is considered that the beach slope on Pacific Beach which is between 1:6 and 1:8 is a safe slope for access on to the beach.

Prior to this study, a number of investigations have been carried out concerning the potential enhancement of the Westshore coastal environment. Gibb (2003) initiated the idea to reshape the beach profile through slope reductions, and to maintain a swale at the backshore. Following this, a report was prepared by Beca (2004) that assessed the profile requirements and the costs to achieve the works, whilst highlighting the lack of understanding in some areas and its implications on the likely success of the options presented.

4.2 Existing conditions

The coastal processes are discussed in some detail in Section 2.3. From that discussion it is concluded that:

- Pacific Beach has a flatter beach slope due to the higher wave exposure and due to its accretional state.
- Westshore Beach is exposed to a lesser amount of wave energy than Pacific Beach. This results in more sand within the mixed sand and gravel system and a steeper overall beach slope that is also the result of its continuing erosional state. See Photo 1.

Photo 1

- As Westshore Beach is exposed to more wave energy (from south to north) the beach crest becomes flatter, the sediment coarser and the crest higher. See Photo 2.

Photo 2

- Westshore Beach shape is usually dictated by frequent waves which erode into the nourishment stockpile causing steep slopes although occasionally heavy swells will flatten out the beach.

There are a number of existing physical features in the backshore area which would require removal and/or replacement, if the backshore area were infilled. There is approximately 250 m of road, 400 m of fencing and 2,000m^2 of carparking area. There are also a number of trees and buildings located in the backshore but these have not been allowed for when estimating replacement costs.

4.3 Regrading options

Option 1

Option 1 was to adopt an upper beach slope of 1:8 with a view to attempting to optimise the cut to fill balance so as to reduce the overall quantity of material to be imported. A typical section for this option is shown in Figure 10 for the area of interest (between Charles Street and the Surf Club). This would require a cut volume of 33,000m^3 and a fill volume of 40,000m^3. Because the backshore area would be covered in gravel it would be difficult for grass to be re-established so it is proposed to import a low grade topsoil and grass an area of some 15,000 m^2. The overall cost of this option including the replacement of infrastructure is approximately $600,000, in June 2006 costs, if the material can be imported from Pacific Beach. If the infill were required to come from another Regional Council source then the cost of this project would increase to $700,000.

There is the potential for some other forms of fill material to be used such as available rubble but this could not be used extensively. It is important that during overtopping

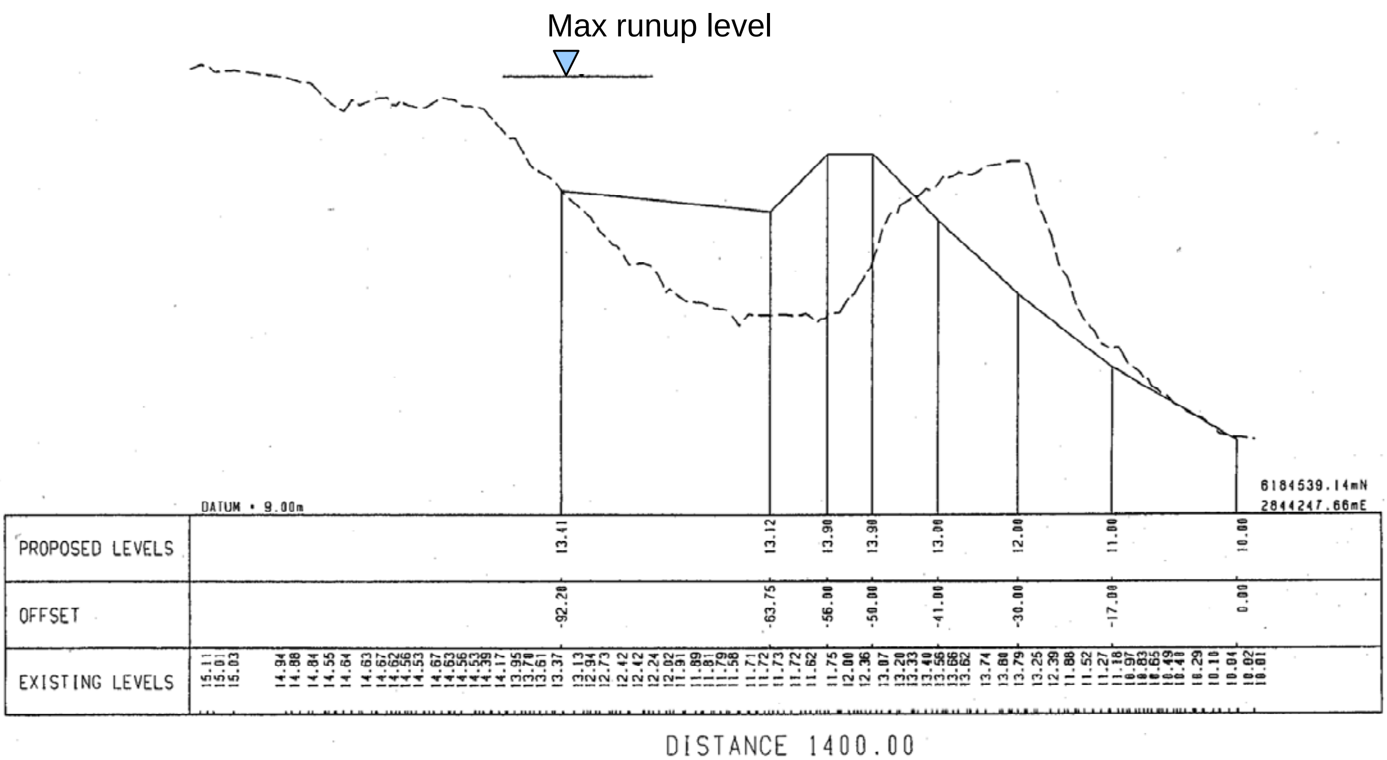

Figure 10
Regraded Beach 500m South of Surf Club

Issue: Benefits of a flatter access slope may be lost over time

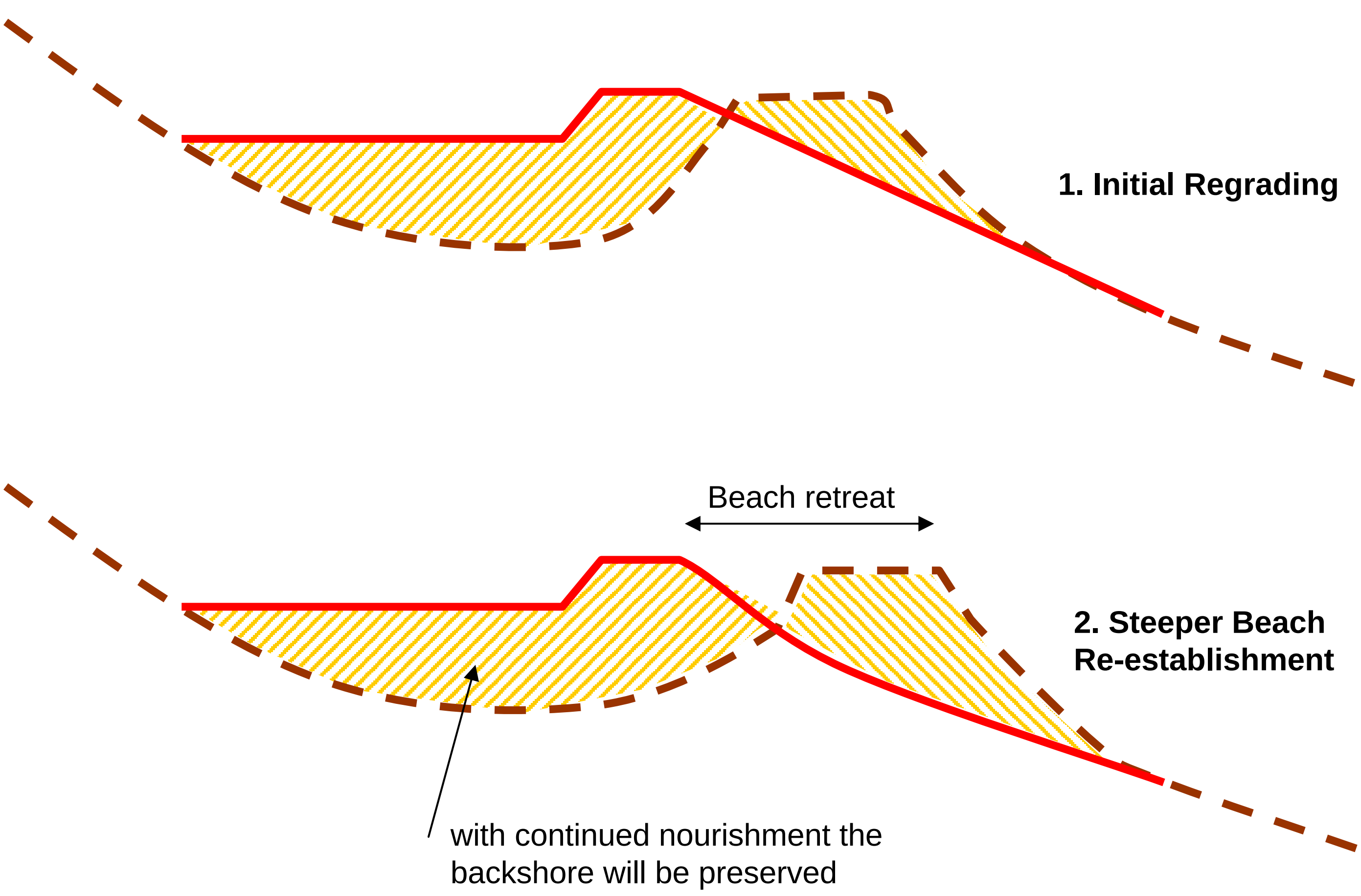

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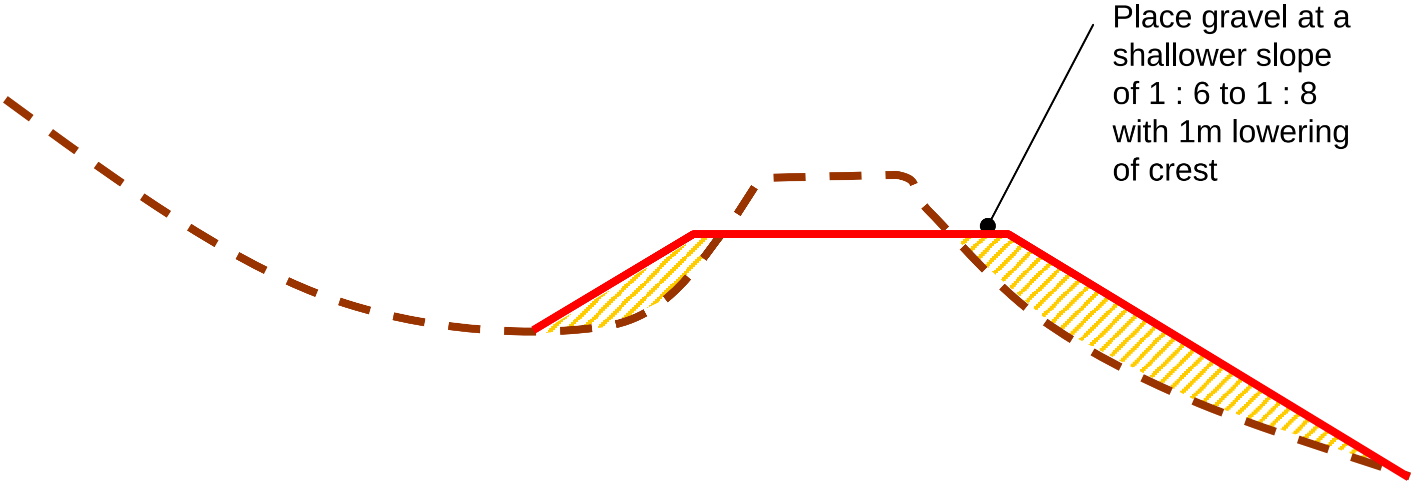
Figure 11
Potential Reshaping of Regraded Beach



Next renourishment campaign, place the material on a shallow slope and monitor the changes

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Figure 12
Trial Regrading

Acknowledge that safer access is not feasible

Provide greater amenity to the backshore area by raising it

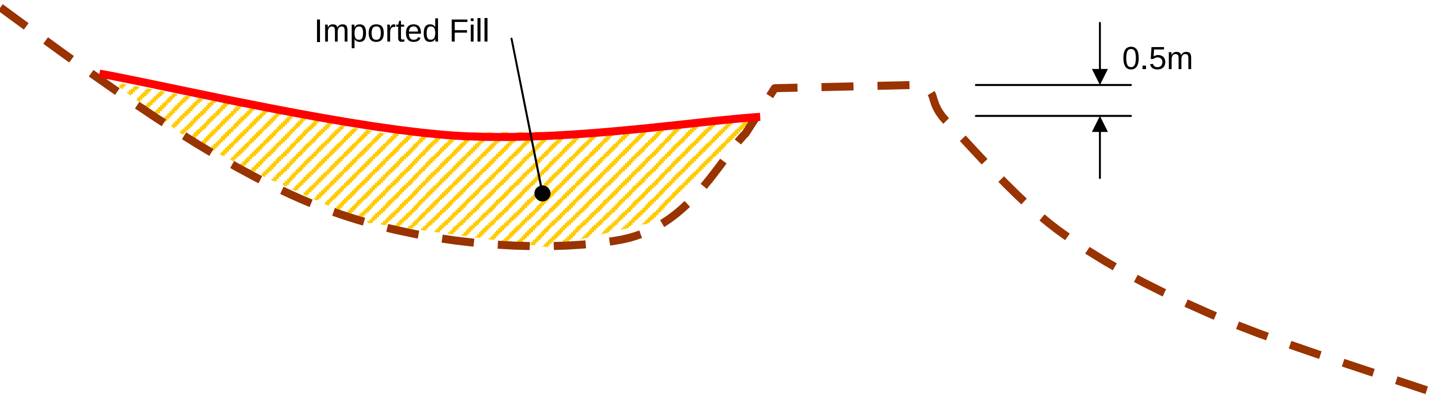

Figure 13
Infill Backshore Area

events, there is enough percolation within the backshore area for flood waters to recede and for backwash to take place.

The main issue associated with this option is that the natural coastal processes may well steepen up the flattened beach resulting in an overall retreat of the beach head as illustrated in Figure 11. This would result in a similar beach profile as experienced on the beach today but with the beach crest moved in a more landward direction. The community may well see this as a failed project. It is noted, however, that with continued nourishment the backshore area would be preserved and that the erosional state of Westshore may slightly improve because the beach would be located closer to its equilibrium condition.

It is also noted that if a steeper beach profile were adopted, say 1:6, then more fill material would be required for the overall project. There is still a similar risk that the beach may naturally form an overall steeper profile resulting in a loss of the beach face and retreat of the beach crest as discussed above.

Option 2

Option 2 would be to carry out a trial during the next nourishment campaign by placing the nourishment material on a shallower slope rather than as a stockpile and monitor the changes to see if it re-establishes a steeper profile. See Figure 12. This option should not require any significant expenditure over and above the normal cost of renourishment.

It was also noted that during the modelling of the beach profiles the berm levels were underestimated compared with the observed crest levels. It may therefore be worthwhile reducing the crest level of the nourished berm and allowing it to extend into the swale area. This could assist in reducing the slope of the beach face as the berm height is reduced.

Option 3

Option 3 would be to accept that the beach face maintains its existing profile and that the backshore would be infilled to provide for greater amenity. This option is illustrated in Figure 13 with the backshore area being approximately 0.5m below the existing beach crest. There would be no cut material and all the backshore would require imported infill of approximately 34,000m^3 and an area of topsoil and grassing of about 25,000m^2 would be required. The overall cost for this option is $775,000 but could increase to $1.3m if material could not be imported from Pacific Beach. Safer access would not be provided with this option.

4.4 Discussion

It would appear from an understanding of the coastal processes that the chance of success of regrading the beach profile to achieve a safer access is low. This is primarily due to the relatively low energy wave environment and the erosional state of Westshore Beach. This condition is unlikely to change in the near future.

If the project were to proceed then the readjustment of the profile due to natural processes would likely be to retreat the beach face closer to its equilibrium position. This would have implications for the transition of the beach at the southern end of Westshore which is close to Charles Avenue.

Initial feedback from Hawkes Bay Regional Council indicated that they would support Option 2 which is a trial in which the material was placed at a flatter slope rather than in a stockpile and to monitor the changes to the beach profile. It could also be placed with a low crest level. If it were found that the beach face maintained a flatter slope then more confidence could be given to the overall regrading of the beach. The Regional Council also indicated they would prefer the gravel fill material not to be taken from Pacific Beach but rather from a more sustainable source.

5 Conclusions

This report has addressed two projects: Whakarire Avenue Counter Erosion Measures and Westshore Beach Regrading.

Of these two projects preference is for the Whakarire Avenue project to proceed first as it should assist in stabilising the southern end of Westshore beach and protect the properties along the Whakarire Avenue. This project could potentially provide a better feeder area for the renourishment of the wider Westshore beach area.

It is noted that the cost estimate for the Whakarire Avenue only included for the breakwater extension not for any beach infill or reclamation associated with the existing lagoon. Once the attached breakwater is constructed and more certainty is known over the final beach shape, then Council can make a decision on the benefits of infilling the backshore area so as to provide for better public access and amenity in this area.

The attached breakwater was originally investigated as a counter erosion measure for the protection of property along Whakarire Avenue. Westshore Beach at its most southern end is close to Charles Street and offers little space for the renourishment bund or beach retreat in this area. Even if Westshore Beach were to retreat to Charles Street, the new sand beach and the properties on Whakarire Avenue would be protected.

An option to provide greater flexibility as a feeder system for the nourishment system and to further stabilise the southern end of Westshore Beach would be to construct an offshore island which would encourage a salient to form on the beach and hold the position of Westshore Beach 100m north of the intersection of Charles and James Streets. The island would be about 25m long and 100m offshore, as shown in Figure 14.

The recommended immediate course of action is:

1. apply for resource consents for the Whakarire Avenue attached breakwater
2. conduct a trial of placing renourishment material at a flatter slope with a lower crest
3. consider further stabilising the southern end of Westshore Beach with an offshore island
4. construct attached breakwater if consents are obtained.

6 References

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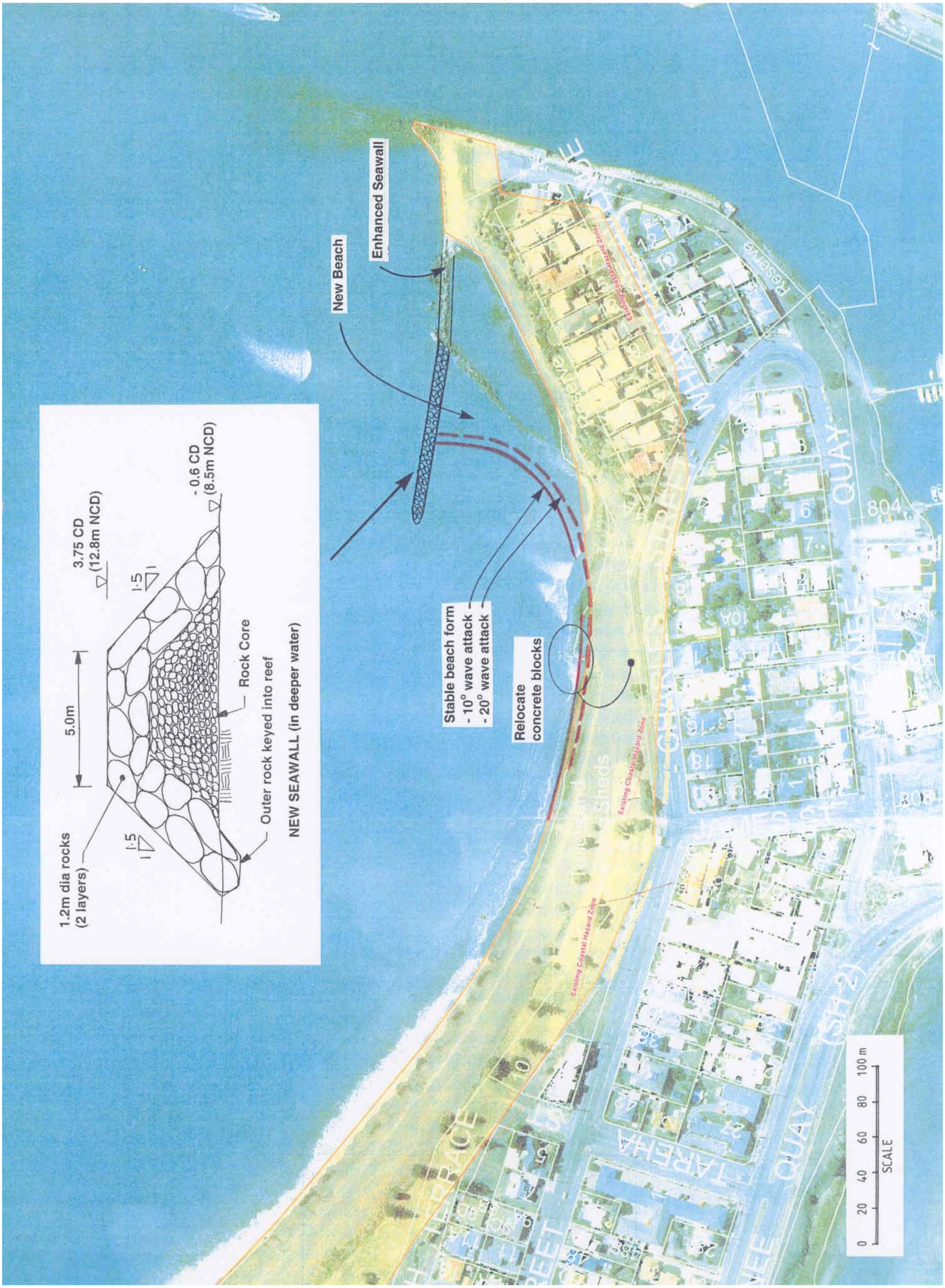

3120511/100

Whakarire Ave: Figure 9
Attached Breakwater with Beach Creation

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▪ Appendix A

Sediment Grading Curves

SUMMARY OF SOIL TEST RESULTS

Report: 1389L:01

ENVIROLAB GEOTEST

132 Vincent Street
P O Box 5585
Auckland
Ph. 300-9005
Fax. 300-9300

Job Name: West Shore Grading **Job No:** 3120511

Client: Napier CC **Date:** 16 February 2006

Test Pit No.	Sample No.	Depth (m)	Sample Type	Sample Description	Natural Mc%	Natural Bulk Density t/m^3	Atterberg Limits LL/CPL	Atterberg Limits PL	Grading	Ps t/m^3	Clay Index	Consol	CBR's	Compaction	Perm k m/s	Triaxial CUPP
HB15	1	-	SD	Bluish grey fine GRAVEL; saturated, non plastic.	2.2				X							
HB14	2	-	SD	Bluish grey GRAVELLY SAND; saturated, non plastic.	4.0				X							
HB13	3	-	SD	Brownish blue-grey SANDY GRAVEL, trace silt; saturated, non plastic.	5.0				X							
Pacific Beach	4	-	SD	Bluish grey fine GRAVEL, trace sand; dry, non plastic.	0.6				X							

laboratory

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NOTE: IANZ ENDORSEMENT DOES NOT COVER SOIL DESCRIPTIONS.

REPORT RELATES ONLY TO SAMPLES TESTED, SAMPLING WAS UNDERTAKEN BY OTHERS.

X DATA ATTACHED. SD = SMALL DISTURBED SAMPLES

TEST STANDARDS:

NZS 4402: 1986: Test 2.1,2.8.1, 2.8.2

AUTHORISED SIGNATORY

C.Laybourne – Geotechnical Lab Manager

ENVIROLAB GEOTEST

132 Vincent St
PO Box 5585
Auckland
Ph (09) 300 9005
Fax (09) 300 9300

PARTICLE SIZE DISTRIBUTION

Job Name: West Shore Grading | **Client:** Napier CC | **Date:** 16 February 2006

Job No.: 3120511 | **Tested By:** B.Wilson | **Checked By:** C.Laybourne

Bore/Test Pit No.: HB15 | **Sample No.:** 1 | **Depth (m):** Surface

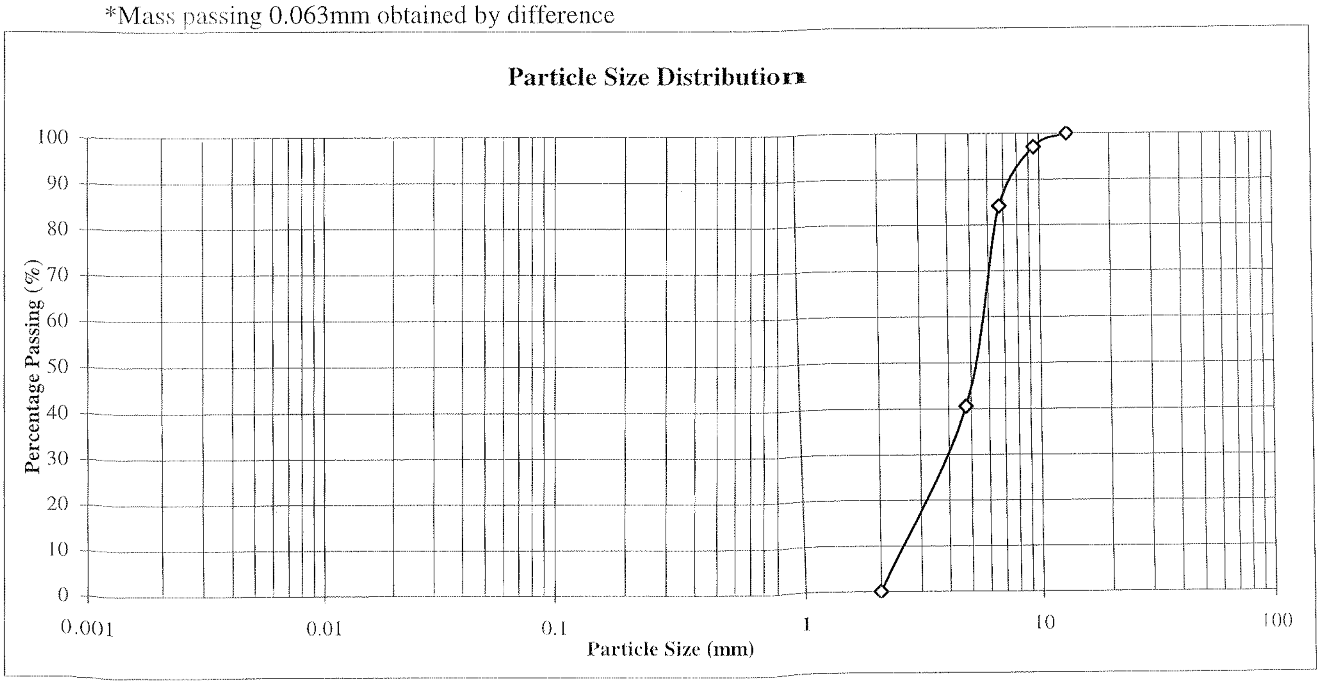
Sample Type: Small Disturbed | **History:** As received | **Report No:** 1389L:01

Sample Description: Bluish grey fine GRAVEL; saturated, non plastic.

Test Standard: NZS 4402:1986, Test 2.8.2

Coarse & Intermediate Fraction		Fine Fraction	
Sieve Size	% Passing	Sieve Size	% Passing
75mm	100	2mm	0
63mm	100	1.18mm	0
53mm	100	600μm	0
37.5mm	100	425μm	0
26.5mm	100	300μm	0
19mm	100	212μm	0
13.2mm	100	150μm	0
9.5mm	97	90μm	0
6.7mm	84	63μm	0
4.75mm	41	<63μm*	0

*Mass passing 0.063mm obtained by difference



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Authorised Signatory:..
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P:\312\3120511\Geotest\Grading_Sample1.xls

ENVIROLAB GEOTEST

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PARTICLE SIZE DISTRIBUTION

Job Name: West Shore Grading **Client:** Napier CC **Date:** 16 Febraury 2006

Job No.: 3120511 **Tested By:** B.Wilson **Checked By:** C.Laybourne

Bore/Test Pit No.: BH14 **Sample No.:** 2 **Depth (m):** Surface

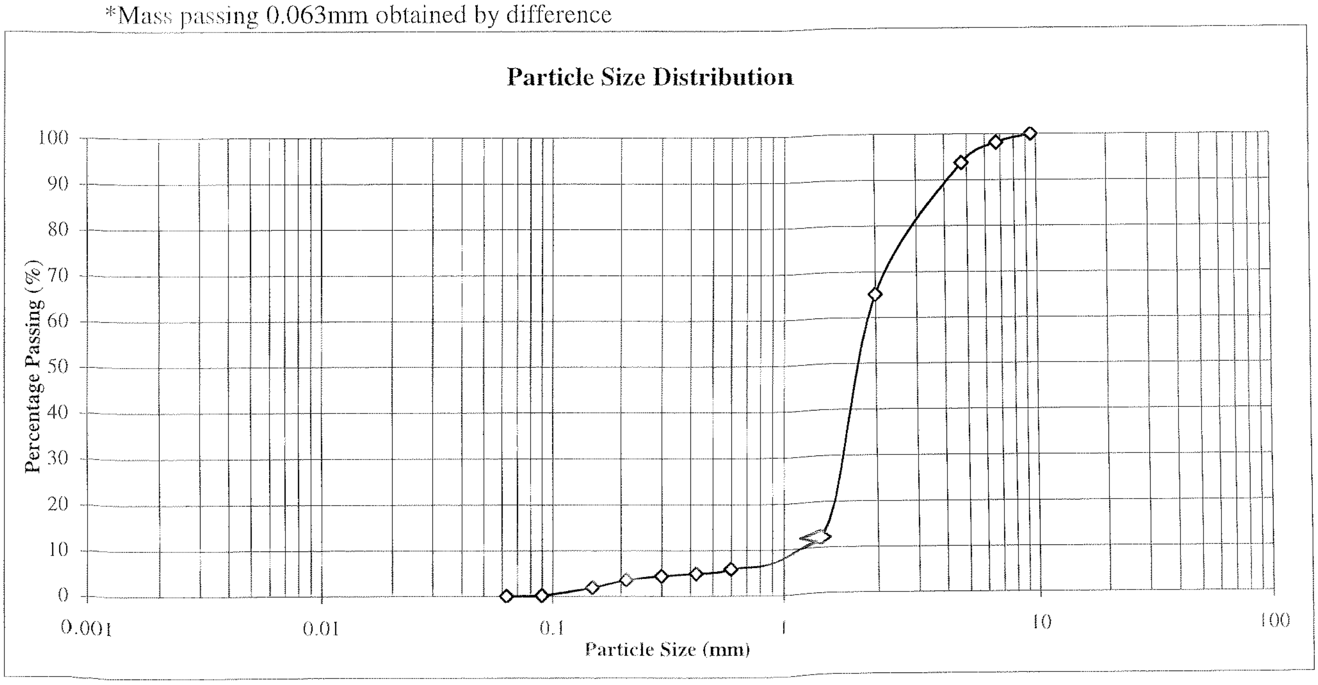
Sample Type: Small disturbed **History:** As received **Report No:** 1389L:01

Sample Description: Bluish grey GRAVELLY SAND; saturated, non plastic.

Test Standard: NZS 4402:1986, Test 2.8.1

Coarse & Intermediate Fraction		Fine Fraction	
Sieve Size	% Passing	Sieve Size	% Passing
75mm	100	2mm	65
63mm	100	1.18mm	12
53mm	100	600μm	6
37.5mm	100	425μm	5
26.5mm	100	300μm	4
19mm	100	212μm	4
13.2mm	100	150μm	2
9.5mm	100	90μm	0
6.7mm	98	63μm	0
4.75mm	94	<63μm*	0

*Mass passing 0.063mm obtained by difference



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ENVIROLAB GEOTEST

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PARTICLE SIZE DISTRIBUTION

Job Name: West Shore Grading | **Client:** Napier CC | **Date:** 16 February 2006

Job No.: 3120511 | **Tested By:** B.Wilson | **Checked By:** C.Laybourne

Bore/Test Pit No.: BH13 | **Sample No.:** 3 | **Depth (m):** Surface

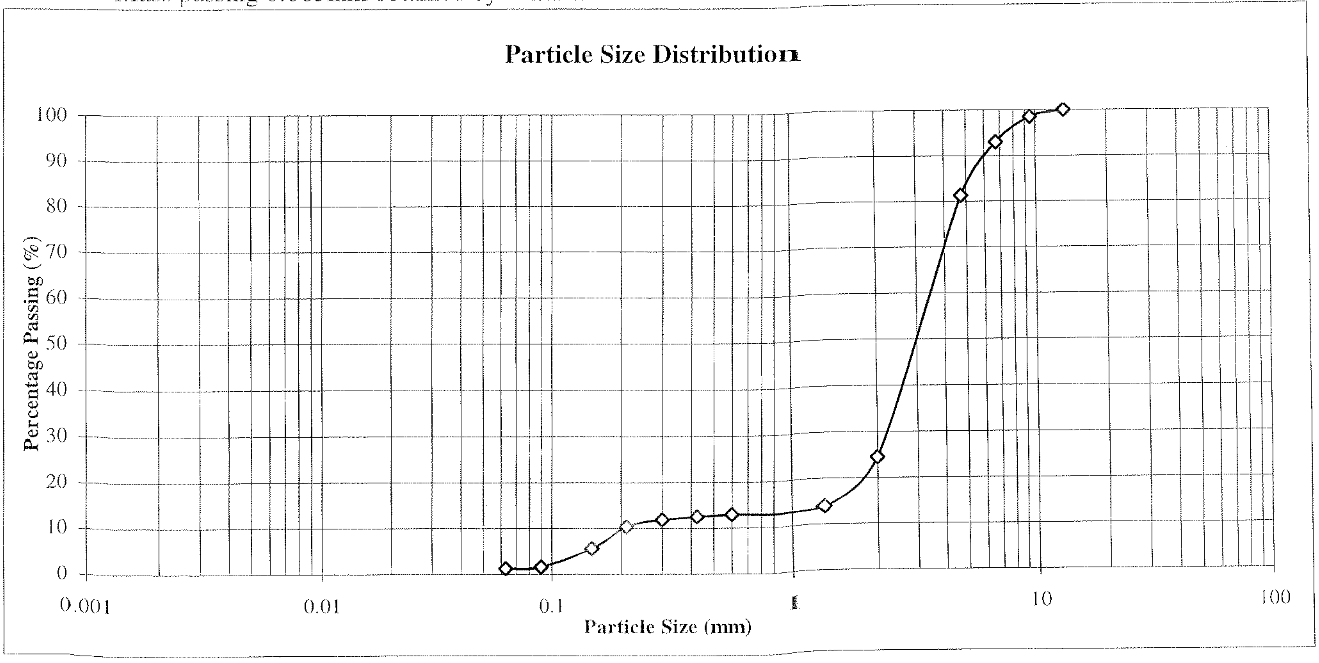
Sample Type: Small disturbed | **History:** As received | **Report No:** 1389L:01

Sample Description: Brownish blue-grey SANDY GRAVEL, trace silt; saturated, non plastic.

Test Standard: NZS 4402:1986, Test 2.8.1

Coarse & Intermediate Fraction		Fine Fraction	
Sieve Size	% Passing	Sieve Size	% Passing
75mm	100	2mm	24
63mm	100	1.18mm	14
53mm	100	600µm	13
37.5mm	100	425µm	12
26.5mm	100	300µm	12
19mm	100	212µm	10
13.2mm	100	150µm	6
9.5mm	98	90µm	2
6.7mm	93	63µm	1
4.75mm	81	<63µm*	1

*Mass passing 0.063mm obtained by difference



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C.Laybourne - Geotechnical Lab Manager
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PARTICLE SIZE DISTRIBUTION

Job Name: West Shore Grading | **Client:** Napier CC | **Date:** 16 February 2006

Job No.: 3120511 | **Tested By:** B.Wilson | **Checked By:** C.Laybourne

Bore/Test Pit No.: Pacific Beach | **Sample No.:** 4 | **Depth (m):** Surface

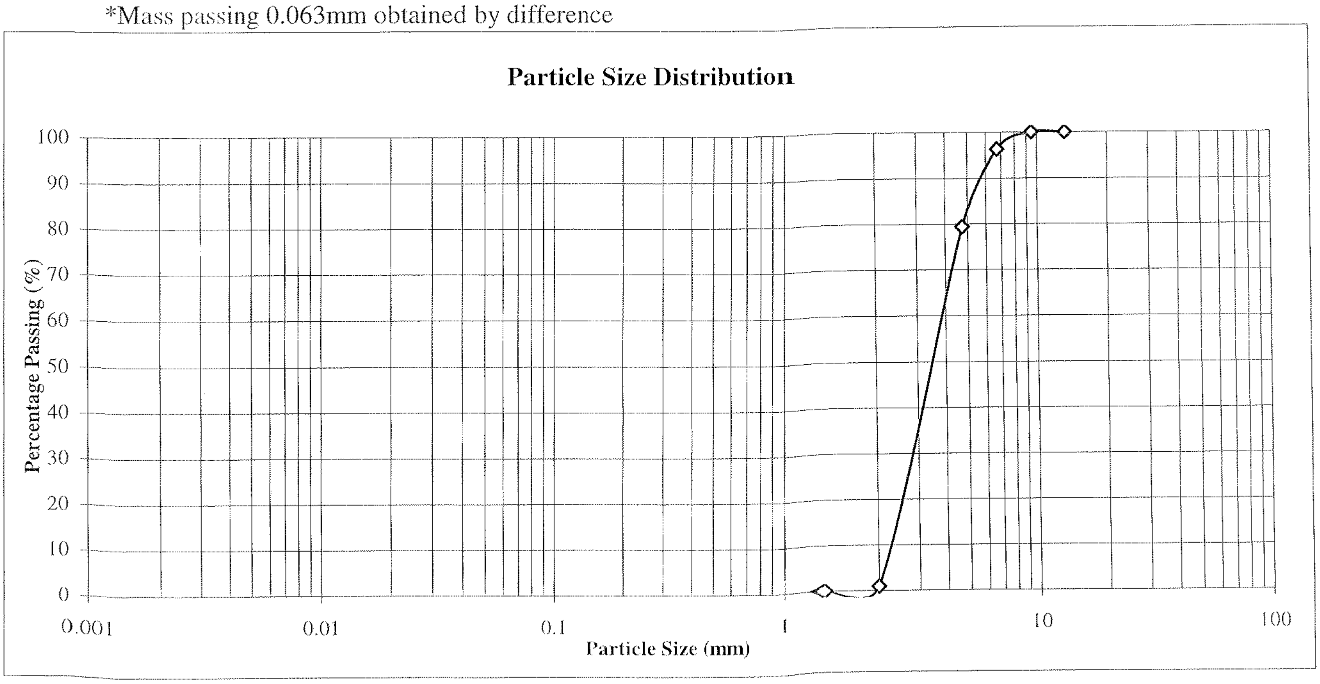
Sample Type: Small disturbed | **History:** As received | **Report No:** 1389L:01

Sample Description: Bluish grey fine GRAVEL, trace sand; dry, non plastic.

Test Standard: NZS 4402:1986, Test 2.8.2

Coarse & Intermediate Fraction		Fine Fraction	
Sieve Size	% Passing	Sieve Size	% Passing
75mm	100	2mm	1
63mm	100	1.18mm	0
53mm	100	600μm	0
37.5mm	100	425μm	0
26.5mm	100	300μm	0
19mm	100	212μm	0
13.2mm	100	150μm	0
9.5mm	100	90μm	0
6.7mm	96	63μm	0
4.75mm	79	<63μm*	0

*Mass passing 0.063mm obtained by difference



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