ENVIRONMENTAL MANAGEMENT GROUP

Technical report

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HAWKE'S BAY REGIONAL COUNCIL

SAFEGUARDING YOUR ENVIRONMENT + KAITIAKI TUKU IHO

Tonkin & Taylor

Hawke's Bay Regional Coastal Environment Plan: Coastal Hazards

Additional Advice
(Volume 1)

April 2008
EMT 08/07
HBRC Plan Number 4043

159 Dalton Street + Private Bag 6006 + Napier
Telephone (06) 835 9200
Fax (06) 835 3601
Regional Freephone (06) 0800 108 838
SAFEGUARDING YOUR ENVIRONMENT + KAITIAKI TUKU IHO

Environmental Management Group
Technical Report

Policy Section

Hawke's Bay Regional Coastal Environment Plan: Coastal Hazards: Additional Advice

(Volume 1)

Prepared by:
Richard Reinen-Hamill
Tonkin and Taylor Limited

18 April 2008
EMT 08/07
HBRC Plan Number 4043

Tonkin & Taylor

T&T Ref : 20514.002
18 April 2008

Hawke's Bay Regional Council
Private Bag 6006
Napier

Attention: Gavin Ide

Dear Gavin

**Hawke's Bay Regional Coastal Environment Plan:
Additional Advice**

1 Purpose

This letter report responds to your request for additional advice (your letter dated 7 September 2007) which included:

- A review of location-specific coastal hazard assessments presented at Haumoana, Ocean Beach, Mangakuri, Mahanga, Awatoto, Aramoana and Te Awanga.
- Outline matters that would improve the level of certainty with the existing data, with data that could be obtained in the next 3 to 6 months and over the next 3 to 5 years.
- Provide a response to the queries:
  - Why do we get different outcomes if slightly different methods are used?
  - Why should the T&T coastal hazard assessment methodology be used as opposed to other methodology?
- Review the ERZ based on additional data and information.

We note that this additional advice is focussed on the erosion aspects of coastal hazards. Inundation hazards are currently being reviewed by NIWA, with their findings likely to be provided prior to June 2008.

2 Review of location specific hazard assessments

2.1 Haumoana

No additional information was presented by Stephen Moynihan on the extent of coastal hazards at Haumoana. However, he confirms the merit for site specific assessments and also commented on Shoal Beach regarding the historic accretion of 2.5 m/yr from 1952 to the present, presumable as an indication of error associated with the regional council hazard assessment. However, I note that based on Richard Croad's review of the Shoal Bay data and supplemental assessments, the historic rates at Shoal Bay have been corrected in the supplementary statement, with a significantly lower rate of accretion resulting from 1995 to

2003 than originally stated (i.e. 0.8 m/yr as opposed to 5.0 m/yr). However, the historic data shows accretion of 1.4 m/yr from 1933 to 2003.

Mr Moynihan's main focus of his evidence was to include provision for coastal protection solutions. There is nothing presented in his statement that convinces us of the need to amend the CHZ in the RCEP.

2.2 Ocean Beach

Dr Gibb has carried out a significant study on Ocean Beach. T&T were involved in a review of his 2005 report on behalf of Hastings District Council, and Dr Gibb's latest report includes commentary on the concerns we raised at that time.

While general agreement was reached in most areas between T&T and Dr Gibb in 2006, two main areas of difference remained;

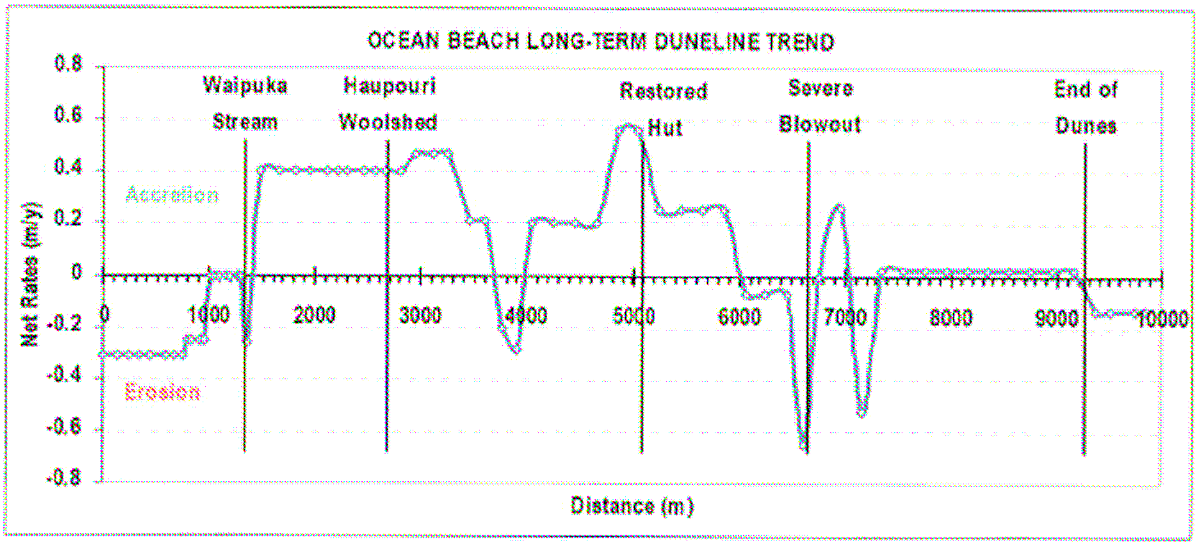
- the consideration of long term trends of the beach, represented by Factor R
- the factor applied to the dune slope stability allowance, D

Subsequent to Dr Gibb's 2007 report we have an additional concern based on his latest report due to the application of overall safety factor. These three factors and our response are discussed below.

2.2.1 Long term historic shoreline change

Dr Gibb has derived a historic rate of shoreline change based on aerial photograph analysis that is summarised in Figure 4 of this report (reproduced below). This figure shows the annual rate of change along the beach based on a 70 year record. It shows erosion to the north and south of the beach and also a decreasing trend of accretion from south to north. In our opinion, this suggested that the beach system may be at capacity at the northern end and is therefore controlled by the headland. Any new sediment transported to this area continues to move north (i.e. bypasses the beach).

While the overall trend shown in this figure appears reasonable, we note there are areas within 200 m of each other where the trend changes from erosion to accretion (i.e. at 4000 m and around 6500 m to 7500 m). At 4000 m the historic erosion trend goes from + 0.43 m/yr to -0.43 m/yr. Extrapolating these different rates over the next 100 years implies that there will be an 86 m relative difference in the shoreline between these two positions, with one part of the coast moving seawards by 43 m and the adjacent coastline retreating by 43 m. In effect this results in a local change in coast orientation of around 22 degrees. In our opinion, this is unlikely to occur, we would anticipate a more uniform and regular trend and would have preferred some running average or interpolation of the data to provide a more uniform long term trend. We note that Dr Gibb carried out some form of smoothing by averaging groups of data points. However, the justification for the group selection is unclear. Dr Gibb's current approach provides much more variability in shoreline position than is likely and in our opinion, has included short term fluctuations (such as dune blow outs and storm effects) in the long term trend assessment.



• **Figure 4**: Graph derived from smoothed data in CMCL (2005) showing the extent and averaged historic rates of erosion and accretion from 1935-2005 along a distance of approximately 10km at Ocean Beach. Adopted from CMCL (2005, figure 8, pg.22).

2.2.2 Dune safety factor

Dr Gibb has agreed that the factor applied to D is not a factor of safety, but is a reduction factor acknowledging that some slumping of the dune will take place. While we agree with his explanation, we remain convinced that to account for foundation stability issues a factor of 1 should be applied, as the eventual slumping of the dune face may not necessarily happen immediately and there will be a period where any structure may be at risk of settlement. However, this is a relatively minor matter, typically in the order of 1 to 2 m, so is not considered significant.

2.2.3 Global factors of safety

We note that Dr Gibb believes that there is sufficient safety factors within his assessment to provide a precautionary approach and presents his use of root-mean square analysis deriving a factor of safety of 1.3 that he applies both to the CHZ1 and CHZ2 set-back lines. His resulting set-back distances are included in Table A2 of his 2007 report, tables with his evidence. This is a significant modification to his original 2005 assessment, where the derived safety factor was an additional annual erosion trend, also calculated by Root Mean Square.

At each location along the beach where he assessed the historic long term trend, Dr Gibb subtracts the potential effect of sea level rise from the long term trend. The assumption made is therefore, that the historic rate of accretion will continue for the next 100 years, but that sea level rise effects will moderate or negate the historic long term trend. Where the result is positive (i.e. historic rate of accretion is greater than the potential effect of sea level rise) Dr Gibb sets the potential effect of future climate change to zero (i.e. does not allow accretion to be ongoing).

In the 2005 assessment, the inclusion of the safety factor as an additional erosion trend meant that there was always some, albeit small, resulting erosion trend taking into account sea level rise and the safety factor. The latest method, applying a multiplication factor to the resulting difference, results in no additional set back for future climate change effects (i.e. multiplying a factor to zero gives zero). In our opinion, this does not provide for a precautionary approach and assumes 100% confidence that the historic accretion will continue and offset possible climate change effects over more than 2 km of the Ocean Beach shoreline. In other areas, the long term trend does not offset climate change effects, so some allowance for sea level rise is included.

In summary, Dr Gibb's allowance for climate change, including a Factor of Safety of 1.3 varies from 0 m to 114 m, with an average of 27 m, whereas only using the Bruun Rule (Gibb's table A1), the allowance ranges from 16 m to 45 m with an average of 29 m (excluding the 1.3 safety factor). The results of the 2007 assessment, using a higher level of sea level rise, but the same historic long term trend and short term fluctuation data, has generally resulted in a narrower hazard zone north of the stream than the 2005 report. This is due to the change in safety factor from an annual rate of change to a multiplication factor.

In our opinion, there are flaws in the erosion hazard methodology presented by Dr Gibb that does not permit us to recommend his site specific assessment be adopted in lieu of the regional hazard assessment prepared by Tonkin & Taylor.

2.3 Mangakuri

Additional data for Mangakuri was presented by Mr Keith Smith and Mr Malcolm Smith (of Opus International Consultants Ltd).

2.3.1 Long term historic shoreline change

Mr Keith Smith identifies that the beach is a thin sandy deposit overlying a rock platform. He notes the results of the Opus International assessment of Mangakuri Beach, based on aerial photographs from 1952, 1972, 1980 and 1996. This analysis suggests dynamic stability, but with episodic shoreline erosion of 5 to 10 m noted.

In our hazard assessment we concluded that this beach was likely to be dynamically stable, but as it was a pocket beach, comprising a thin veneer of sand overlying rocky substrates and bound by rock headlands to the north and the south, there may be some effect from erosion of the adjacent headlands.

2.3.2 Short term beach movement

Mr Keith Smith raises concerns as to the veracity of using Waimarama Beach data due to its limited duration and infrequent recording and appears to suggest Bay of Plenty beach profile data may be more representative due to the larger data set. Much of the evidence presented related to beach profiles within the Bay of Plenty and mainly Beach Profile 39 situated just east of Mt Maunganui. Mr Keith Smith notes the vegetation line at Mangakuri is around 1.7 m above MSL compared to 3.5 to 4.5 m at Bay of Plenty. He accurately identifies that this lower elevation is due to the offshore reef that causes larger waves to break. Mr Smith did not provide any comparison of shoreline change at Beach Profile 39 with that available at Mangakuri to confirm his assumption of representative data from the Bay of Plenty.

We note that Figure 3 of his brief of evidence shows that the beach movement within the Bay of Plenty appears strongly dependent on whether there is a La Nina or El Nino phase. On this plot we note that there is no long term accretion, as the beach level has only just reached the pre 1990 level. However, as we are now in a developing La Nina phase beach erosion is the likely outcome based on this plot.

Mr Keith Smith suggests that the value of the standard deviation used by T&T is excessive at Mangakuri by assessing change within the Bay of Plenty, which he acknowledges is more exposed than at Mangakuri. He identifies that along the Bay of Plenty shoreline fluctuation ranges from 12 m to 100 m and states that Mangakuri is likely to be much less than 12 m due to sheltering. This is subjective, with no evidence presented, although the results of the aerial photograph assessment presented later in his paper suggest at least 5 to 10 m erosion of the vegetation line could be expected at Mangakuri. He concludes that storm damage will be around 30 m3/m .

At the time of the Opus report prepared in support of this submission, Mangakuri has one beach profile which has been surveyed seven times from January 2003 to December 2005. Analysis presented in the Opus report of the annual surveys identified one standard deviation of the beach profile data set is around 10 m.

While providing some useful indication of short term fluctuation, this data set is insufficient to draw any conclusions of long term trends. However, we have carried out a comparison of the relative movement of the beach compared to the movement recorded at Waimarama, using the most up-to-date data set (i.e. up to 22/12/2006).

The following plot shows the horizontal excursion recorded at Mangakuri with XS10, 12 and 15 on Waimarama Beach. We note that there are more data points at the Waimarama Beach sites (17 observations compared to 7) meaning that the plot lines are more varied for Waimarama. However, while the beach movements of both beaches are not identical, the order of magnitude changes of the 11 m contour are similar, particularly with XS12 and 15 (i.e. +13 m to -15 m at Mangakuri and -13 m to +11 m at XS10 and 12, Waimarama). Larger movements are recorded at XS15 (+15 m to – 20 m).

We can accept the 10 m standard deviation approach presented by Opus. However, due to the short data set, we should include a 25% factor of safety, similar to that applied at Shoal Beach, Aramoana.

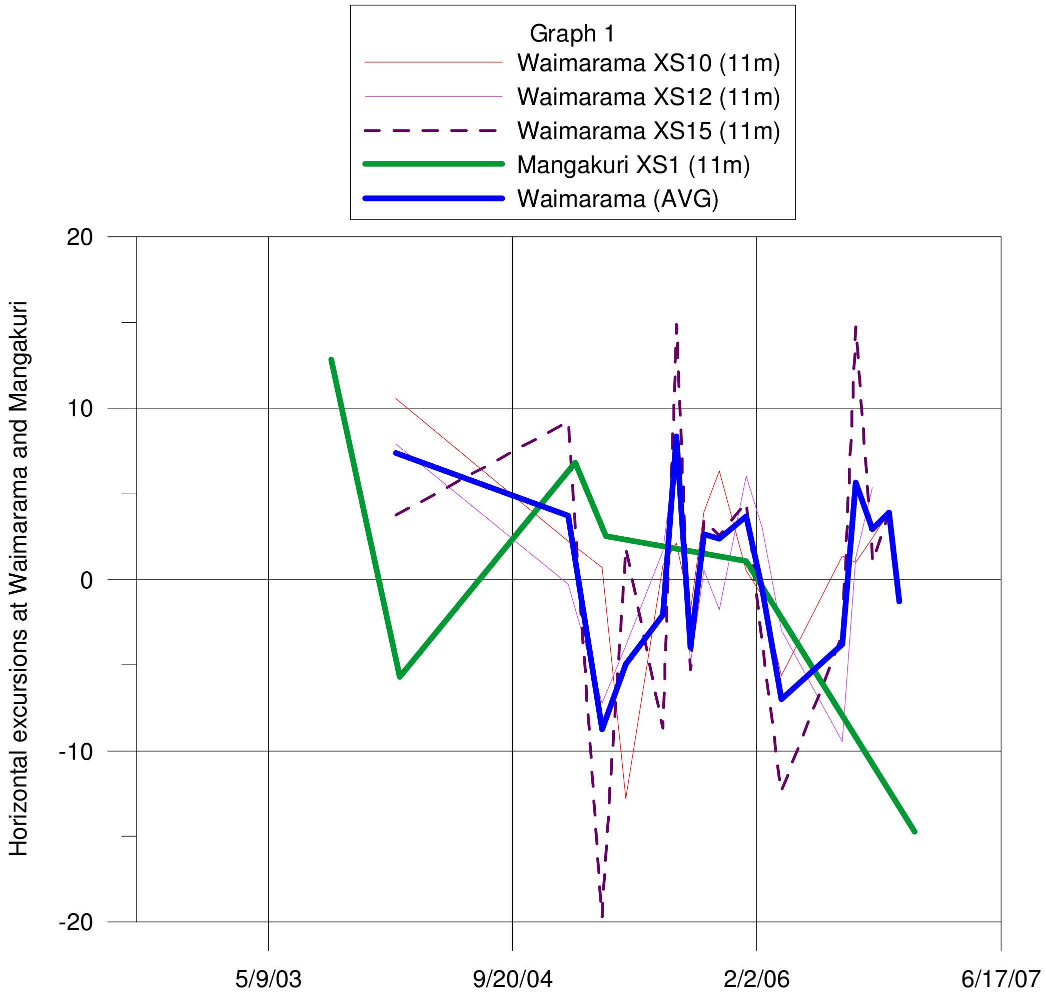
2.3.3 Inundation

Mr Keith Smith concludes that storm surge and wave set-up can raise water levels by 1.4 m or 12.4 m RL (excluding Sea Level Rise effects) assuming storm occurred at MHWS, although no justification for this level is presented by Mr Smith. Our desk top assessment identified current storm surge and set-up levels of 13.3 m RL, with an additional allowance of sea level variation of 0.2 m to provide a current level of 13.5 m and 14.0 m with the addition of 0.5 m sea level rise. Insufficient evidence is presented by Mr Smith to convince us there are valid reasons to amend the inundation level in the RCEP.

2.3.4 Sea level rise

Mr Smith gives a range of information about relative sea level rise, much of which is dated (1992 study in the South Pacific) or not local (Indian Ocean evidence taken from Kear (2006) based on a TV programme aired in 2004). He concludes that, taking into account tectonic uplift of 0.5 mm/yr, the likely relative rise of sea level along the east coast will be 0.07 m and will have negligible effect on Mangakuri because the continuous supply of sediment coming from the south will compensate for any inundation caused by rising water.

Significant work has been carried out since 1992 by the Australian government after their initial review in 1992 found much of the existing gauges in the pacific could not reliably be used to assess sea level rise. Since that time more accurate tide gauges that are precisely levelled to take out barometric and tectonic effects have been installed at 12 locations around the Pacific. The following table shows the net trend since the early 1990's. The net trend ranges from 1.7 mm/yr to 7.0 mm/yr, with an average trend of 4.9 mm/yr.



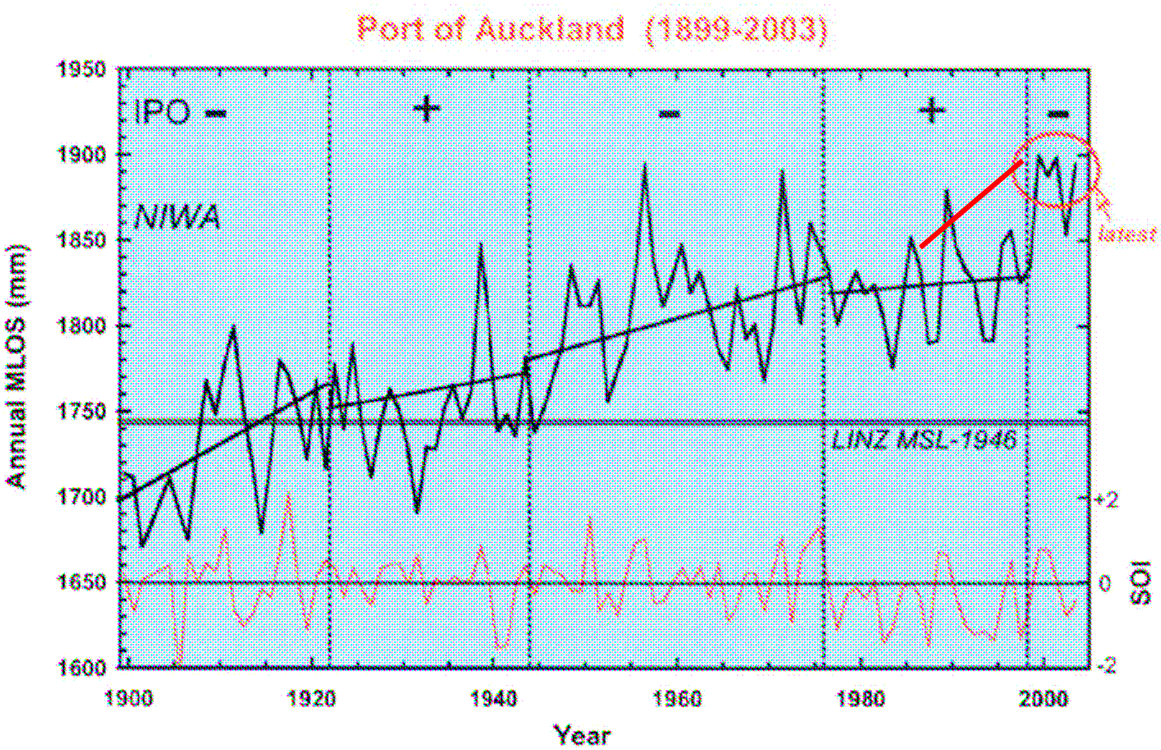
While these figures cannot be used as a long term trend, the results show a significantly greater rate in rise than the 0.7 mm/yr rise recommended by Mr Smith. Comparing the Pacific data with annual mean sea level recorded at the Port of Auckland, New Zealand's longest water level recorder, the increase in rate observed around the Pacific matches the observed short term increase in sea level at Auckland as a result of moving to a negative phase of the IPO. The long term record at Auckland matches the reported global sea level changes (IPPC, 2007).

Tectonic activity and associated changes in land elevation, as shown in the Napier earthquake, can be episodic, rather than continuous. Our position is to ignore the effect of tectonic activity as the time scale for change is longer than the period under investigation. Therefore, we do not accept Mr Keith Smith's suggestion of allowing only 0.7 mm/yr sea level.

The suggestion by Opus that allowance for protection afforded by the reef should be taken into account is reasonable. However, as seen in the aerial photographs attached to their report, there are gaps in the reef where waves can propagate to shore and also where sand can be transported offshore during storm events. Therefore, we do not recommend any change to this area.

Net relative sea level rise in mm/year through June 2006				
No.	Location	Installation Date	Net Trend (mm/yr)	Change from October 2005
1	Cook Is	19/02/1993	2.5	1.7
2	Tonga	21/01/1993	7.0	-0.5
3	Fiji	23/10/1992	1.7	-0.2
4	Vanuatu	15/01/1993	2.2	-0.8
5	Samoa	26/02/1993	5.4	1.6
6	Tuvalu	02/03/1993	5.7	0.8
7	Kiribati	02/12/1992	5.3	-0.5
8	Nauru	07/07/1993	6.5	-0.2
9	Solomon Is.	28/07/1994	6.7	2.7
10	PNG	28/09/1994	6.2	1.1
11	FSM	17/12/2001	n/a	n/a
12	Marshall Is.	07/05/1993	4.4	-0.2

Table 5. *The net relative sea level trend estimates after vertical movements in the observing platform and the inverted barometric pressure effect are taken into account.*



2.3.5 Factor of safety

No recommendation on safety factors is made by Mr Keith Smith. We note our original assessment did not include a factor of safety as it was felt that the 3 standard deviation approach using Waimarama data was reasonably precautionary. However, with a refinement of the standard deviation approach based on local but short term data sets, a factor of safety will be required due to the short data set.

2.3.6 Summary

Mr Keith Smith does not provide any additional information that can reliably be used to modify the existing coastal hazard assessment at Mangakuri. However, useful information is presented in the Opus report based on HBRC's ongoing data acquisition and applying a similar method to that applied at Shoal Beach by Opus International, we would accept:

- removal of the long term erosion trend as a result of adjacent cliff erosion (reduces CHZ1 by 1.3 m and the CHZ2 zone by 13.7 m)
- replace the one standard deviation of 14 m by 10 m at Mangakuri (SE + LT = 30 m cf. 42 m). We note that Mr Keith Smith's assessment of 30 m^3/m volume change of the beach equates to around a 10 m to 15 m retreat of the vegetation line. This is within the range of fluctuations derived from the short term data set.

However, similarly to Shoal Beach a 25% safety factor would then be applied to the short term fluctuation data, but not to the Bruun Rule.

Therefore:

The CHZ1 (as measured from edge of vegetation) = (3 x 10) x 1.25 = 37.5 m (cf. 43 m).

The CHZ2 line set back as per our Bruun Rule calculations in the February 2006 report, i.e. 33.6 m, say 34 m (i.e. total set back of both CHZ1 and CHZ2 of 77 m compared to 88 m). We recommend no change to inundation levels.

2.4 Mahanga

A site specific assessment for Lots 1 and 2, Mahanga Beach North was presented by Dr Gibb (Report dated July 2007). The assessment used commonly accepted empirical coastal hazard techniques and allowed for sea level rise of 0.8 m in 100 years (conservative).

2.4.1 Short term fluctuations

Short term fluctuations of 9 m were obtained from aerial photograph data from 1942 to 2002. HBRC has installed a beach profile in close proximity to this site, with data from February 2003 to July 2007 (9 profiles). These profiles show fluctuations of -6 m to + 9 m, suggesting the 9 m may be reasonable, but certainly not conservative and therefore requiring a factor of safety.

2.4.2 Long term trend and sea level rise

We note that the site is situated in a sensitive location between an eroding and accreting zone. We can accept Dr Gibb's site specific findings of this area.

2.4.3 Overall hazard

The overall hazard zone is calculated with an accepted empirical formula, with appropriate safety factors. Sea level rise effects have been assessed with the Bruun Rule. The resulting CHZ1 zone is 14 m from the surveyed dune line and the CHZ2 zone is 102 m landward.

2.4.4 Summary

The CHZs in the RCEP can be amended by the hazard zones identified in the site specific assessment provided by Dr Gibb for this specific property.

2.5 Awatoto

Dr Single suggests that data from HB08, including profile shape and long term trend, is more representative of the shoreline in front of the Winstone site than the HB07. Also, based on the outcome of the Foreworld Decision, recommends no allowance for short term fluctuations and the same sea level rise induced erosion allowance of 3 m per 100 years as calculated at that location by Dr Gibb.

2.5.1 Representative profile

Based on the justification provided by Dr Single, we can accept that HB8 can be used as being representative for the entire Winstone site, at least to within 300 m north of HB7 where some localised impact of river mouth fluctuation could still occur.

2.5.2 Results of the Foreworld Decision

At the Foreworld site, the Environment Court preferred a single hazard line, representing 100 years potential risk. A single line was preferred at this location due to the slight difference between the 50 year and 100 year as there were only low rates of significant long term trend of erosion at the site and therefore the difference due to sea level rise effects was small. At other locations within the Hawke's Bay, erosion trends and the potential effects of sea level rise are significantly larger and we therefore recommended the use of graduated lines.

The Foreworld decision also ignored short term fluctuation effects and only took into account long term trends measured along the raised berm based on detailed and long term data. This approach can be used in Bay View, the uplifted beach areas where wave action does not regularly act, but is not suitable in areas that experience wave action up-to and over the beach crest. Dr Single notes that wave swash can reach 14.7 m RL and the Winstone's site level is 14.3 m RL (Single, para 32). Even for long term stable shorelines it is possible that the crest level will fluctuate and therefore, we do not accept this as a general approach to apply to this location.

2.5.3 Sea level rise

Dr Single recommends the method of Dr Gibb applied for Foreworld that is based on relative sea level rise (i.e. the predicted future rate of sea level rise minus the historic observed sea level rise). This resulted in a net rise of around 2 mm/yr up to 2100 (i.e. 3.64 - 1.7 mm/yr), or around 0.2 m. All estimates of sea level rise were based on the 2001 IPC report.

We did not subtract historic sea level rise from projected sea level rise, but recognising the likely conservatism also did not apply a factor of safety on the Bruun Rule calculation.

However, accepting the method of Dr Gibb, the answers would now change due to findings presented in the latest IPCC reports (IPCC, 2007) and the more recent reports completed within the Hawke Bay by Dr Gibb. He used 0.8 m as the possible increase in sea level rise by 2090 to 2100 at both Ocean Beach and Mahanga. From this he subtracts 0.16 m based on the historic average of 1.6 mm/yr (we note that this is lower than the 1.7 mm/yr he applied at Foreworld) to get a value of 0.64 m, or 6.4 mm/yr. Using this value of sea level rise and assuming the same foreshore slope applies at Awatoto as it does at Foreworld, the rate of shoreline retreat at Awatoto would be around 8.6 m by 2100. Dr Gibb would then apply a 1.3 factor of safety providing a final set back due to sea level rise of 11.2 m.

Using Komar's method as an alternative to the Bruun rule using the average beach profile at HB 8, this provides a set back allowance of 10.2 m for 0.5 m sea level rise (c.f. 9 m for T&T method) and 13.0 m for a 0.64 m rise in sea level (c.f. 11.2 m for Gibb). This suggests a reasonably similar set-back allowance irrespective of the two methods used, the main difference being the amount of sea level rise to take into account.

At the Winstones site, we could modify our method and use the relative sea level rise approach and add a safety factor. However, the net result is a very similar set-back width to that which we originally proposed. The change could be made to provide a consistency of approach, particularly given the Foreworld decision. However, the net result is unlikely to be significant at the Winstones site.

2.5.4 Summary

We do not accept that it is possible to ignore short term fluctuations at this location as the beach crest is affected more regularly by wave conditions. This differs from the Foreworld site, where the crest was uplifted during the 1931 earthquake and is less affected by wave conditions.

We can accept the methodology of Dr Gibb as applied at Foreworld. However, to be consistent we would also have to take into account the latest IPCC predictions, Dr Gibb's use of 0.8 m and the application of a safety buffer.

Based on the additional information and site specific assessment provided by Dr Single, we can accept that the Awatoto site generally behaves more similarly to HB8 than HB7 and therefore should apply the values of short term fluctuation and long term trends derived at HB8 to the site to within 300 m of HB7 with the modification of the DS value provided by Dr Single. The following table shows the possible set-back widths, using the data of Dr Single and Dr Gibb and the method of T&T, based on HB8. We recommend a set back distance of 59m from MHWS to represent the landward boundary of CHZ2.

Table 2-1 Comparison of approach by Dr Single and T&T (2004)

Term	Using Dr Single/Dr Gibb data	HB8 as per T&T
LT (m/yr x 100)	0.0	0.0
SE (m)	3.65	3.65
ST (m)	7.3	7.3
DS (m) (Based on Dr Single's assessment)	37.0	26.53

Term	Using Dr Single/Dr Gibb data	HB8 as per T&T
SL (m/yr)	11.2	9
Rounded up total (m)	59	47

2.6 Aramoana

A review of the evidence and supplementary information presented by Dr Croad was undertaken and reported separately to Central Hawke's Bay District Council. A copy of the letter report is attached with this letter. We found that a revision to the hazard line could be supported due to the combination of increased beach profile data and the additional site specific information and analysis completed by Dr Croad. The findings of that letter report remain unchanged and the modified hazard line can be adopted by HBRC at this location.

2.7 Te Awanga

Te Awanga Society Inc believe the original approach (T&T, 2004) has produced an excessively wide hazard zone. Mr Keith Smith's statement of evidence supports their view and raises concerns that the annual maximum method to assess short term fluctuations may be unduly conservative and that the Bruun Rule is not a suitable method to assess shingle and sand beaches. No alternative assessment is made by Mr Smith.

2.7.1 Short term trends

The short term trend analysis in our 2004 report resulted in a 6.45 m fluctuation at HB1 and a 15.48 m fluctuation at HB2. These results are consistent with Mr Smith's expectation that HB1 should have less fluctuation as it is more sheltered. However, the long term trend analysis shows a higher erosion rate at HB1 that appears largely to have occurred between 1973 and 1995, with a reduced erosion rate since 1995. However, utilising the entire data set, the erosion rate is still 0.69 m/yr (compared to the 2004 rate of 0.75 m/yr). It is this long term rate that has a significant effect on the width of the hazard zone, rather than the short term fluctuation.

2.7.2 Sea level rise

A modified Bruun Rule was used to take into account potential sea level rise effects, resulting in an additional 5 m set back to 2060 and 8 m by 2100 at HB2 (Te Awanga). While accepting the limitations of the Bruun Rule, it is still applied internationally, with modifications and assumptions as appropriate for a range of shoreline types including sand and gravel. We note that in Komar's method, based on the intertidal beach slope and no other assumptions, the derived set-back due to 0.5 m sea level rise is around 11 m (cf. 13 m). We note that Mr Smith provided no alternative method to evaluate potential sea level rise effects.

2.7.3 Summary

We recommend no change to the approach and methodology carried out in our original (2004) assessment. However, we acknowledge that as a result of ongoing data acquisition through ongoing coastal profile surveys there will be a need to update and modify both the long term trend and shoreline fluctuation. Any updates would be presented in future Regional Coastal Hazard Assessment Studies and incorporated into the RCEP through a formal variation or plan change process.

2.8 Pourerere Beach

Pourerere beach has been assessed and the review report is attached with this report. Due to the combination of increased beach profile data now available at the site and the additional site specific information and analysis completed by Dr Gibb, we support the reduction of the coastal hazard extents along the southern end of Pourerere Beach. However, we do not support the values used by Dr Gibb to define the CHZ-1 zones, or his approach of offsetting potential climate change effects with extrapolations of historic shoreline change.

Based on our assessment, averaged results indicate a CHZ-1 zone of 17 m and a CHZ-2 zone of 21 m applied from the edge of vegetation line, giving a total hazard zone width of 38 m from the edge of vegetation. However, with 3 new profiles actual setbacks will be variable with greater and lesser set backs. Consideration of the recommended setback width is included in Section 4 below.

3 Outline matters that would improve the level of certainty with the existing data, with data that could be obtained in the next 3 to 6 months and over the next 3 to 5 years.

HBRC have a long term programme of coastal research to infill gaps in knowledge and understanding. Copies of this long term monitoring plan are available from Gary Clode or Mike Adye (HBRC Plan No. 3841 *Coastal Processes Monitoring Strategy: 2006-2017*).

The most significant improvement to the level of certainty to the existing data in the short term is better resolution aerial photographs and the base map information. This should be high resolution ortho-rectified images that can be used as base maps for placing the hazard lines. We note high resolution satellite data is not yet available for all areas from Google, so this cannot be used as a comprehensive solution. Improving the aerial base plan will not improve certainty of data, but will improve the public level of confidence through improved presentation.

Over the longer term, the ongoing beach profile monitoring data is essential to provide longer data sets to enable better quantification of long term trends and cyclical fluctuations and should continue. This information, coupled with monitoring of wave run-up and better definition of longshore drift potential and therefore, better understanding of the sediment supply and loss mechanisms, will provide improvements to the level of certainty on existing data. These aspects are being considered by Council's long term monitoring strategy.

Future climate change effects are likely to remain uncertain, certainly over the next IPCC reporting period (6-7 years). However, the current negative Southern Oscillation Index and La Nina conditions suggest increased storminess and erosion can be expected over the next few years, irrespective of climate effects.

4 Provide a response to the queries:

4.1 Why do we get different outcomes if slightly different methods are used?

While there are a range of different methodologies presented during the submission process, the general approach of identifying trends and extrapolating them out to a 100 year period is reasonably consistent. The main differences occur in the values used and whether all or some processes are allowed for (i.e. short term fluctuations and/or long term trends). For example, short term fluctuations and long term trends have been obtained both from aerial photograph analysis and beach profile measurement. Both methods have positives and negatives with their approach. Aerial photographs require careful interpretation but even so it is often difficult to determine the dune toe. In addition, they provide irregular information and few data points which may or may not represent ideal times for data acquisition.

However, they do provide spatial information along the coastline. Beach profiles on the other hand provide more detailed information along a transect and it is easier to identify morphodynamic features. However, judgement is required as it is necessary to estimate the extent of shoreline that the profile is representative of (i.e. movement recorded at any single profile is not always representative movement of the beach some distance from the profile). The most contentious area is assessing the potential effects of sea level rise and the use of the Bruun Rule, although as discussed above, the Komar method also provides similar setback distances. The approaches to future climate change range from virtually no allowance to very large set backs, with our approach somewhere in the middle.

4.2 Why should the T&T coastal hazard assessment methodology be used as opposed to other methodology?

We have reviewed the submissions and still retain the view that the T&T approach considers in a consistent way all the factors that are required to be taken into account. However, as discussed above, there has been additional information presented during the submission process as well as almost 5 years of beach profile data collected by council that can be used to improve the original hazard zone, particularly along the Southern Hawke Bay beaches and in the vicinity of Mahanga and Mahia, where originally there was only limited data.

Updating and reviewing the hazard lines every 5 to 10 years based on improved information was always anticipated during the original hazard assessment that was based solely on existing information available at that time. By adopting the revisions discussed above as a result of a thorough consideration of other expert's opinion, we believe that much of the concerns raised will be taken into account. However, we remain at odds over some recommendations and/or approaches, such as Dr Gibb subtracting historic accretion from possible climate change effects and Dr Single's recommendation not to include short term fluctuations. We note that even with these changes, mapping on improved resolution ortho-rectified aerial photographs, or satellite imagery, would be required to improve the visual impression of the lines.

4.3 Revising the ERZ

As discussed above, there is now some information to enable site specific assessments to be made at the southern and northern beaches to better quantify local short term fluctuations and we have also evaluated the various methods of assessing the potential effect of sea level rise.

The following table shows a comparison of the potential effect of 0.5 m sea level rise to 2100 based on Bruun and Komar and the relative difference. We have also included the same assessment based on relative sea level rise (subtracting the historic rate from the expected rate) as per Bay View and then applying a Safety Buffer of 1.25. The table also includes a total average rate based both on Bruun and Komar (excluding relative sea level rise effects) at the bottom of the table for a broad summary of net effects. When comparing the effect of the Bruun Rule with that of Komar, there is reasonable similarities in the results, but localised differences, both in the positive and negative occur. This is due to the differences in measured intertidal slope used in Komar with the evaluated active beach profile used in the Brunn Rule. On average there is a slightly greater hazard width using Bruun (1.7 m), although locally there are difference of +20 m to -15 m.

Considering relative sea level rise with Komar provides a similar answer to that agreed at Bay View. This is because Dr Gibb used the gravel beach slope that matches the intertidal slope. This approach may provide a consistent approach across the region and remove the issues of assumptions of closure depth and wave energy. On average this will result in a narrower hazard zone width compared with the 2004/2006 results, particularly along the Hawke Bay shoreline, due to the steeper gravel beaches.

Table 4-1 Comparison of potential sea level rise effects to 2100 using Komar and Bruun

	0.5 m Sea level rise no FOS			Relative sea level (0.34 m) with FoS		
Location	**Bruun Rule (m)**	**Komar (m)**	**Difference (m)**	**Bruun Rule (m)**	**Komar (m)**	**Difference (m)**
Porangahau	-20.2	-25.9	5.7	-17.2	-22.0	4.8
XS1	-20.2	-18.7	-1.5	-17.2	-15.9	-1.3
XS2	-20.2	-22.2	2.0	-17.2	-18.9	1.7
XS3	-20.2	-36.7	16.5	-17.2	-31.2	14.0
Blackhead	-20.5	-31.1	10.5	-17.4	-26.4	9.0
XS1	-20.5	-40.2	19.7	-17.4	-34.2	16.7
XS2	-35.0	-32.8	-2.2	-29.8	-27.9	-1.9
XS3	-20.5	-20.2	-0.3	-17.4	-17.2	-0.3
Aramoana	-20.5	-25.4	4.9	-17.4	-21.6	4.2
XS1	-34.1	-24.5	-9.6	-29.0	-20.8	-8.2
XS2	-20.5	-26.3	5.8	-17.4	-22.4	4.9
Pourerere	-20.5	-24.7	4.2	-17.4	-21.0	3.6
XS1	-20.5	-21.8	1.3	-17.4	-18.5	1.1
XS2	-33.6	-22.4	-11.2	-28.6	-19.0	-9.5
XS3	-20.5	-30.0	9.5	-17.4	-25.5	8.1
Mangakuri	-20.2	-18.3	-1.9	-17.2	-15.6	-1.6
XS1	-33.2	-18.3	-14.9	-28.2	-15.6	-12.7
Kairakau	-20.2	-23.7	3.5	-17.2	-20.1	2.9
XS1	-20.2	-23.4	3.2	-17.2	-19.9	2.7
XS2	-20.2	-25.1	4.9	-17.2	-21.3	4.2
XS3	-23.0	-27.5	4.5	-19.6	-23.4	3.8

Location	0.5 m Sea level rise no FOS Bruun Rule (m)	Komar (m)	Difference (m)	Relative sea level (0.34 m) with FoS Bruun Rule (m)	Komar (m)	Difference (m)
XS4	-20.2	-18.6	-1.6	-17.2	-15.8	-1.4
Waimarama	ND	ND	ND	ND	ND	ND
Waimarama	ND	ND	ND	ND	ND	ND
Waimarama	ND	ND	ND	ND	ND	ND
Waimarama	ND	ND	ND	ND	ND	ND
Waimarama	ND	ND	ND	ND	ND	ND
Waimarama	ND	ND	ND	ND	ND	ND
Waimarama	-20.0	-23.4	3.4	-17.0	-19.9	2.9
Waimarama	-19.2	-21.5	2.3	-16.4	-18.3	1.9
Waimarama	-19.8	-20.7	0.9	-16.8	-17.6	0.8
Waimarama	-20.4	-21.0	0.6	-17.4	-17.9	0.5
Waimarama	-19.6	-20.7	1.1	-16.7	-17.6	0.9
Waimarama	-19.8	-21.3	1.5	-16.9	-18.1	1.3
Waimarama	-21.0	-22.5	1.5	-17.9	-19.1	1.2
Waimarama	-21.5	-25.8	4.3	-18.3	-21.9	3.7
Waimarama	-22.2	-31.0	8.8	-18.8	-26.4	7.5
Waimarama	-25.5	-20.7	-4.8	-21.7	-17.6	-4.1
Waimarama	-25.5	-22.3	-3.2	-21.7	-19.0	-2.7
Waimarama	-25.8	-14.0	-11.8	-21.9	-11.9	-10.0
Ocean Beach	-20.6	-15.0	-5.6	-17.5	-12.8	-4.7
XS1	-20.5	-17.5	-3.0	-17.4	-14.9	-2.6
XS2	-20.5	-19.7	-0.8	-17.4	-16.7	-0.7
XS3	-20.5	-14.6	-5.9	-17.4	-12.4	-5.0
XS4	-20.5	-11.1	-9.4	-17.4	-9.4	-8.0
XS5	-20.5	-16.1	-4.4	-17.4	-13.7	-3.7
XS6	-20.5	-11.0	-9.5	-17.4	-9.4	-8.1
Clifton HB1	-16.0	-5.3	-10.7	-13.6	-4.5	-9.1
Te Awanga HB2	-13.3	-5.5	-7.8	-11.3	-4.7	-6.6
Haumoana HB3	-15.7	-5.5	-10.2	-13.3	-4.7	-8.6
Haumoana HB4	-19.4	-7.0	-12.4	-16.5	-6.0	-10.6
Clive HB5	-17.6	-8.3	-9.3	-15.0	-7.1	-7.9
Clive HB6	-10.1	-5.3	-4.8	-8.6	-4.5	-4.1
Awatoto HB7	-12.6	-4.3	-8.3	-10.7	-3.7	-7.0

Location	0.5 m Sea level rise no FOS Bruun Rule (m)	Komar (m)	Difference (m)	Relative sea level (0.34 m) with FoS Bruun Rule (m)	Komar (m)	Difference (m)
Awatoto HB8	-9.3	-5.3	-4.0	-7.9	-4.5	-3.4
Napier HB9	-11.1	-5.3	-5.8	-9.5	-4.5	-4.9
Napier HB10	-11.9	-6.0	-5.9	-10.1	-5.1	-5.0
Napier HB11	-12.7	-5.8	-6.9	-10.8	-4.9	-5.9
Napier HB12	-11.4	-5.3	-6.1	-9.6	-4.5	-5.1
Westshore HB13	-12.0	-9.5	-2.5	-10.2	-8.1	-2.1
Westshore HB14	-11.7	-5.0	-6.7	-9.9	-4.3	-5.7
Westshore HB15	-12.5	-4.8	-7.7	-10.6	-4.1	-6.5
Bayview HB16	-10.3	-5.3	-5.0	-8.7	-4.5	-4.2
Bayview HB17	-8.2	-6.5	-1.7	-7.0	-5.5	-1.5
Esk River HB18	-7.1	-5.0	-2.1	-6.0	-4.3	-1.8
Esk River HB19	-6.3	-5.3	-1.0	-5.4	-4.5	-0.9
Esk River HB20	-5.6	-4.0	-1.6	-4.8	-3.4	-1.4
Tangoio HB21	-8.8	-5.0	-3.8	-7.5	-4.3	-3.2
Tangoio HB22	-10.8	-5.3	-5.5	-9.2	-4.5	-4.7
Tangoio HB23	-12.6	-5.0	-7.6	-10.7	-4.3	-6.5
Waipatiki	ND	ND	ND	ND	ND	ND
Aropaoanui	ND	ND	ND	ND	ND	ND
Waikari	ND	ND	ND	ND	ND	ND
Mohaka	ND	ND	ND	ND	ND	ND
Waihua	ND	ND	ND	ND	ND	ND
Wairoa	ND	ND	ND	ND	ND	ND
Tahaenui	ND	ND	ND	ND	ND	ND
Nuhaka	ND	ND	ND	ND	ND	ND
Opoutama	-20.5	-22.0	1.5	-17.4	-18.7	1.3
Opoutama	-17.5	-16.4	-1.1	-14.9	-13.9	-1.0
Opoutama	-16.9	-13.5	-3.4	-14.4	-11.5	-2.9
Opoutama	-16.6	-19.4	2.8	-14.1	-16.5	2.4
Opoutama	-19.8	-25.5	5.7	-16.9	-21.7	4.8
Opoutama	-23.9	-18.4	-5.5	-20.3	-15.6	-4.6
Whangawehi	ND	ND	ND	ND	ND	ND
Maungawhio Lagoon	ND	ND	ND	ND	ND	ND
Mahanga	-22.4	-25.0	2.6	-19.1	-21.3	2.2

Location	0.5 m Sea level rise no FOS			Relative sea level (0.34 m) with FoS		
	Bruun Rule (m)	**Komar (m)**	**Difference (m)**	**Bruun Rule (m)**	**Komar (m)**	**Difference (m)**
Mahanga	-21.5	-23.0	1.5	-18.2	-19.6	1.3
Mahanga	-20.2	-25.3	5.1	-17.1	-21.5	4.4
Taylors Bay XS1	-16.4	-8.6	-7.8	-13.9	-7.3	-6.6
Taylors Bay XS2	-16.4	-9.2	-7.2	-13.9	-7.8	-6.1
Average	-18.5	-16.8	-1.7	-15.7	-14.3	-1.4

Taking the above, the following table provides the resulting ERZ2100 based on the original method and with the local data sets providing the short term fluctuations and relative sea level rise with a factor of safety.

This is based on the same methodology as applied for the HB series, in terms of application of factors of safety which originally was not applied to the southern beaches as it was assumed the original method had built in conservatism.

Table 4-2 Comparison of coastal hazard setback line for ERZ2100 as measured from edge of vegetation

Location	Original (m)	2007 results with Bruun Rule (m)	2007 results with Komar and FoS (m)
Porangahau	-73		
XS1		-40	-36
XS2		-85	-84
XS3		-65	-76
Blackhead	-71		
XS1		-30	-44
XS2		-69	-62
XS3		-33	-30
Aramoana	-73		
XS1		-50	-37
XS2		-51	-53
Pourerere	-80		
XS1		-29	-27
XS2		-44	-30
XS3		-50	-55
Mangakuri	-75		
XS1		-43	-25
Kairakau	-75		
XS1		-71	-71
XS2		-36	-37
XS3		-36	-36
XS4		-31	-27
Waimarama	-79	-60	-58
Waimarama	-78	-60	-57
Waimarama	-82	-61	-58
Waimarama	-83	-62	-59
Waimarama	-79	-62	-59
Waimarama	-79	-62	-59
Waimarama	-102	-80	-80
Waimarama	-91	-68	-67

Location	Original (m)	2007 results with Bruun Rule (m)	2007 results with Komar and FoS (m)
Waimarama	-73	-52	-50
Waimarama	-76	-54	-51
Waimarama	-69	-44	-42
Waimarama	-87	-54	-52
Waimarama	-96	-53	-51
Waimarama	-131	-55	-55
Waimarama	-120	-85	-89
Waimarama	-130	-79	-71
Waimarama	-134	-85	-79
Waimarama	-114	-66	-52
Ocean Beach	-75		
XS1		-35	-29
XS2		-60	-56
XS3		-51	-43
XS4		-55	-44
XS5		-71	-64
XS6		-37	-26
Clifton HB1	-95	-95	-81
Te Awanga HB2	-59	-59	-49
Haumoana HB3	-67	-67	-55
Haumoana HB4	-107	-107	-91
Clive HB5	-122	-122	-109
Clive HB6	-89	-89	-82
Awatoto HB7	-99	-99	-88
Awatoto HB8	-20	-20	-15
Napier HB9	-22	-22	-15
Napier HB10	-20	-20	-13
Napier HB11	-23	-23	-15
Napier HB12	-28	-28	-21
Westshore HB13	-29	-29	-25
Westshore HB14	-26	-26	-19
Westshore HB15	-28	-28	-19
Bay View HB16	-26	-26	-20

Location	Original (m)	2007 results with Bruun Rule (m)	2007 results with Komar and FoS (m)
Bay View HB17	-34	-34	-31
Esk River HB18	-25	-25	-21
Esk River HB19	-60	-60	-57
Esk River HB20	-65	-65	-61
Tangoio HB21	-51	-51	-46
Tangoio HB22	-51	-51	-44
Tangoio HB23	-38	-38	-29
Waipatiki	-49		
Aropaoanui	-49		
Waikari	-46		
Mohaka	-45		
Waihua	-45		
Wairoa	-45		
Tahaenui	-45		
Nuhaka	-45		
Opoutama	-62	-42	-40
Opoutama	-59	-33	-30
Opoutama	-59	-49	-44
Opoutama	-58	-31	-31
Opoutama	-61	-48	-50
Opoutama	-65	-36	-27
Whangawehi	-70		
Maungawhio Lagoon	-70		
Mahanga	-45	-59	-58
Mahanga	-71	-58	-56
Mahanga	-38	-51	-53
Taylors Bay XS1		-19	-10
Taylors Bay XS2		-17	-9

These results show the new localised short term fluctuation data applied to the original methodology results generally in narrower hazard zones over most of the southern beaches shorelines, although there are locations where the revised data increases the hazard zone width (i.e. Porangahau XS2 and Blackhead XS2). In the Hawke Bay, the use of Komar generally results in a 10 m narrower coastal hazard zone.

The changes identified in Table 4.2 should remove the comparative assessment of short term fluctuation at Waimarama and concerns with the Bruun Rule. It will also bring a consistent methodology applied both to the northern southern and central beach areas.

Geology has been taken into account as best as possible. However, this will always be subject to local site evaluation. However, we remain wedded to our current approach of not taking into account uplift due to the episodic nature of these events and longer return period events.

5 Applicability

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

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Environmental and Engineering Consultants

Report prepared by:	Authorised for Tonkin & Taylor by:
....	....
Richard Reinen-Hamill	Richard Reinen-Hamill
Coastal Engineer	Water Resources Group Manager

Appendix A: Aramoana Coastal Assessment Report

Tonkin & Taylor

T&T Ref : 25077
06 December 2007

Central Hawke's Bay District Council
PO Box 127
Waipawa

Attention: John Glengarry

Dear John

Review of evidence of Richard Croad and implications for Coastal Hazard Zone assessments at Aramoana Beach

1 Purpose

This letter report sets out the results of our review of the statement and supplementary statement of Dr Richard Croad dated 1 August 2007 and 15 August 2007 respectively concerning the location of the coastal hazard zone at Aramoana Beach. The purpose of this letter is to assess whether the site specific assessment and evaluation can be used to supersede the original coastal hazard assessment carried out by Tonkin & Taylor Ltd in 2004 and our subsequent report of 2006.

2 Data sources

Dr Croad utilises historic aerial photograph and cadastral data to evaluate long term trends. The miss match of datums used to determine recent long term trends in his original statement has been corrected in the supplementary statement, with a significantly lower rate of accretion resulting from 1995 to 2003 than originally stated (i.e. 0.8 m/yr as opposed to 5.0 m/yr). However, the historic data shows accretion of 1.4 m/yr from 1933 to 2003.

3 Long term trend

Based on the site specific data and the assessment outlined above Dr Croad believes that setting the long term trend to zero is appropriate at this location. In our original hazard assessment, we identified that these beaches appear dynamically stable, but included the long term retreat rate of 0.1 m/yr representing the long term trend of adjacent cliff erosion as the representative long term trend likely to be experienced at the beach. However, based on the more detailed and site specific assessment, we can accept a long term trend of zero.

We note that there are short term trends of the data that show accretion at XS2 and erosion at XS 1. This suggests some dynamic process of long shore transport, with sand moving from

Tonkin & Taylor Ltd - Environmental & Engineering Consultants, 105 Carlton Gore Rd, Newmarket, Auckland, New Zealand
PO Box 5271, Wellesley St, Auckland 1141, Ph: 64-9-355 6000, Fax: 64-9-307 0265, Email: auck@tonkin.co.nz, Website: www.tonkin.co.nz

one part of the beach to the other, but due to the short data set does not represent any meaningful long term trend (Refer Appendix A).

4 Short term fluctuations

There has been a significant increase in beach profile data at this location as part of the ongoing monitoring programme initiated as an outcome of our hazard report. Two beach profile sites have been established, with twenty two profiles have been taken from January 2005 to April 2007. XS 1 is situated along the subject shoreline and XS2 is situated to the north of the river mouth. Surveys have been done typically every month, so the relative change between profiles represents monthly change. Analysis of the movement at 11 m has been carried out and the residual fluctuation, once the short term trend is removed, provides the range of beach movement at that elevation over time. At cross section XS1 the maximum landward movement past the average position is around 7.6 m, close to the 8 m adopted by Dr Croad and a standard error of around 3.9 m. At XS 2, the maximum landward movement past the average position is 14.2 m, with the standard error of 8.3 m.

The original assessment utilised data from Waimarama Beach as there was no local site data. A comparison of horizontal excursions at Aramoana. The standard error (deviation) was taken to be 14 m, based on the average of the results of beach profiles 8 to 18 (excluding the influence of the seawall on the southern profiles). Comparing the observed fluctuations of the two Aramoana profiles with 3 of the northern Waimarama profiles and an average of the three profiles, shows that the beaches typically respond in a similar fashion, with periods of accretion and erosion occurring in synch (refer Figure below). The amount of fluctuation also appears similar.

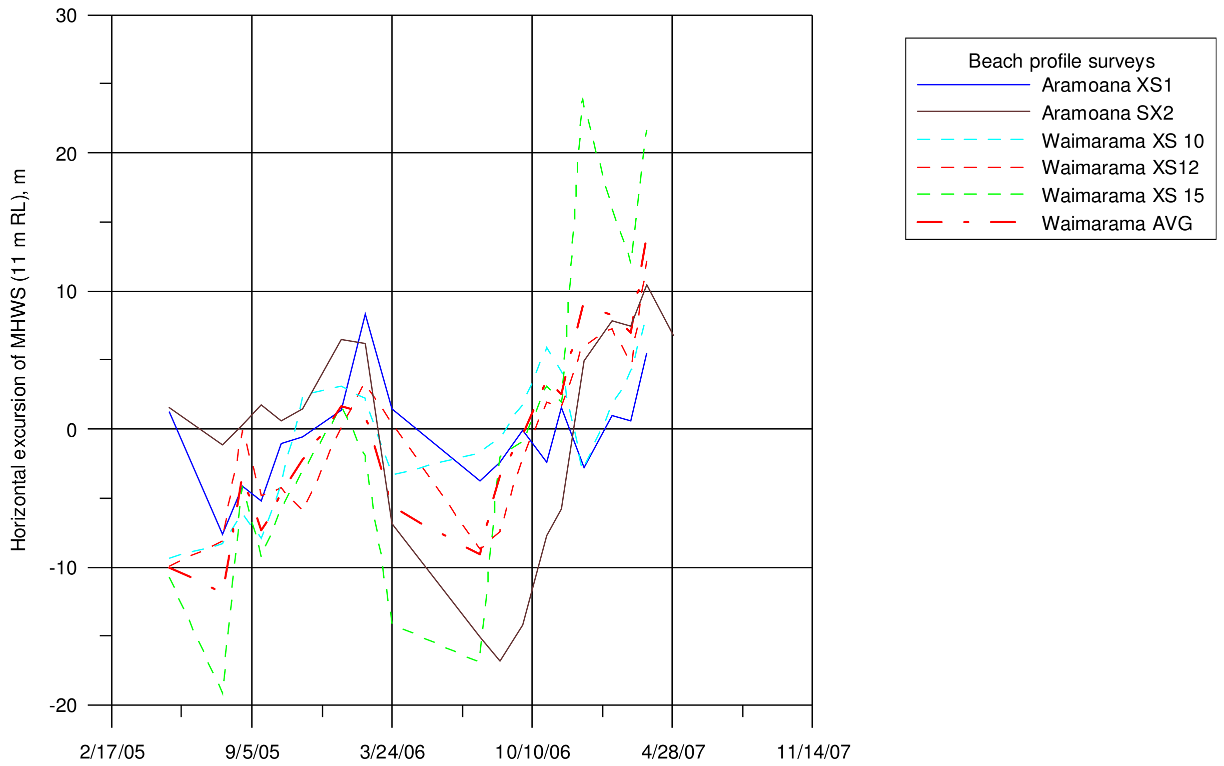

Figure 1 Comparison of horizontal excursions at Aramoana and Waimarama

The results suggest the initial assumption of similar behaviour of the beaches as reasonable. Using a standard error of 8 m as suggested by Dr Croad is not unduely conservative when examining the movements observed at XS2, but there appears less dynamic movement at XS1, presumably due to its more sheltered location. We consider 8 m therefore to be a reasonable representation of one standard deviation of movement.

5 Sea level rise

Dr Croad uses 21 m, the same value used in the T&T 2004 hazard assessment report. These values were revised to 35 m in our subsequent report (T&T, 2006). As Dr Croad does not challenge the method we will take the revised distance as this was based on actual profile measurement at the site.

6 Factor of safety

The original T&T assessment did not include a factor of safety as it was decided that the standard deviation approach of using Waimarama data was sufficiently conservative to include factors of safety. No factor of safety has been proposed by Dr. Croad, also due to the selection of 8 m as a standard deviation being conservative. However, our assessment is that the standard deviation used is reasonable rather than conservative due to the relatively short data at the project site. Therefore, a factor of safety is required, certainly for the CHZ1. In the recent Foreworld findings, the judge supported the use of a 25% factor, termed a buffer allowance, rather than a factor of safety. This is the same allowance used along the Hawke Bay coast and it is recommended that this be used at this location for the current risk zone area due to the short data set and the observed data showing orders of fluctuations similar to 1 standard deviation over the period of observation. We do not recommend applying the any safety factor to the Bruun Rule.

7 Final hazard line

Based on the analysis of Dr Croad, the CHZ1 hazard zone is 25 m from the edge of vegetation and the CHZ2 line is 45 m landward. We recommend including an additional buffer allowance of 6 m to CHZ1 (approx. 25% of 25 m), resulting in the CHZ1 being 31 m landward from the edge of vegetation and the CHZ2 line being 66 m landward. This compares to the original T&T hazard zones of 43 and 73 m respectively (2004) and the revised hazard zones of 43 m and 86 m respectively (T&T, 2006). A copy of the amended hazard line is included in Appendix C. We note that the northern end of the subdivision is bounded by the river mouth. Coastal hazards may influence and affect river bank erosion at this location, but the hazard lines do not represent the river edge erosion hazard.

8 Summary

Due to the combination of increased beach profile data now available at the site and the additional site specific information and analysis completed by Dr Croad, we support the reduction of the coastal hazard extents along the Shoal Beach development in Aramoana. However, we recommend an additional 6 m allowance for a safety buffer be added to CHZ1, in accordance with its use elsewhere along the Hawke Bay shoreline and as validated by the recent Environment Court decision at Foreworld. We also recommend the use of the more recent assessment of sea level rise potential as outlined in our 2006 report that was based on more detailed beach profile data. This increases the hazard widths to 31 m and 66 m for CHZ1 and CHZ2 respectively.

A copy of the revised hazard line as set out in this report is included in Appendix C.

9 Applicability

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

TONKIN & TAYLOR LTD

Environmental and Engineering Consultants

Report prepared by:	Authorised for Tonkin & Taylor by:
....	....
Richard Reinen-Hamill	Richard Reinen-Hamill
Coastal Engineer	Acting Water Resources Group Manager

13-Dec-07
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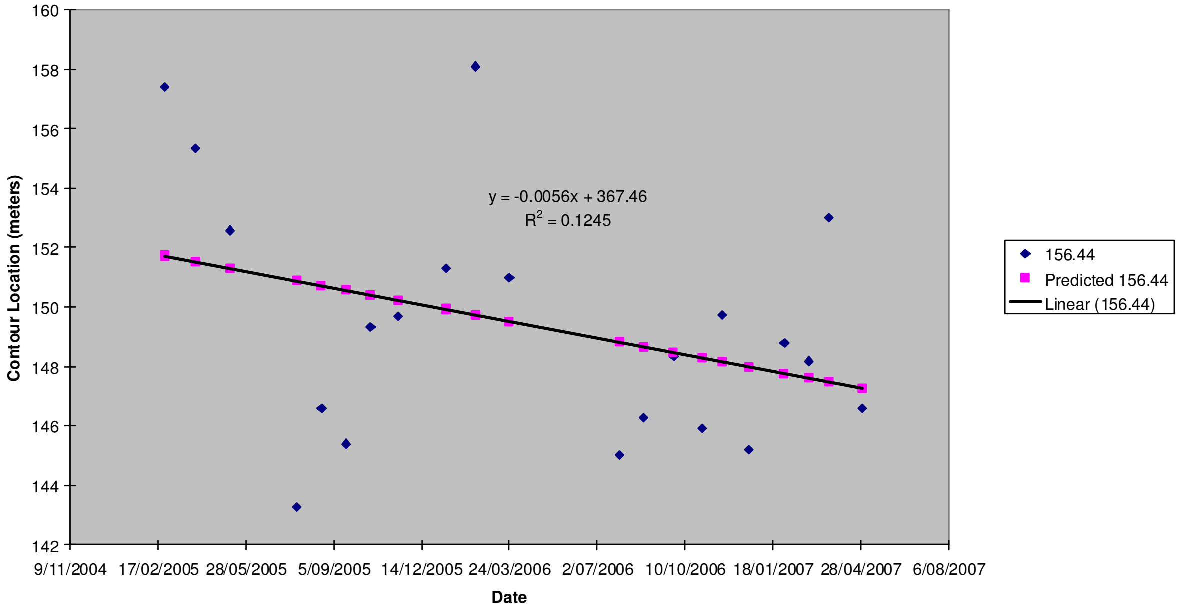
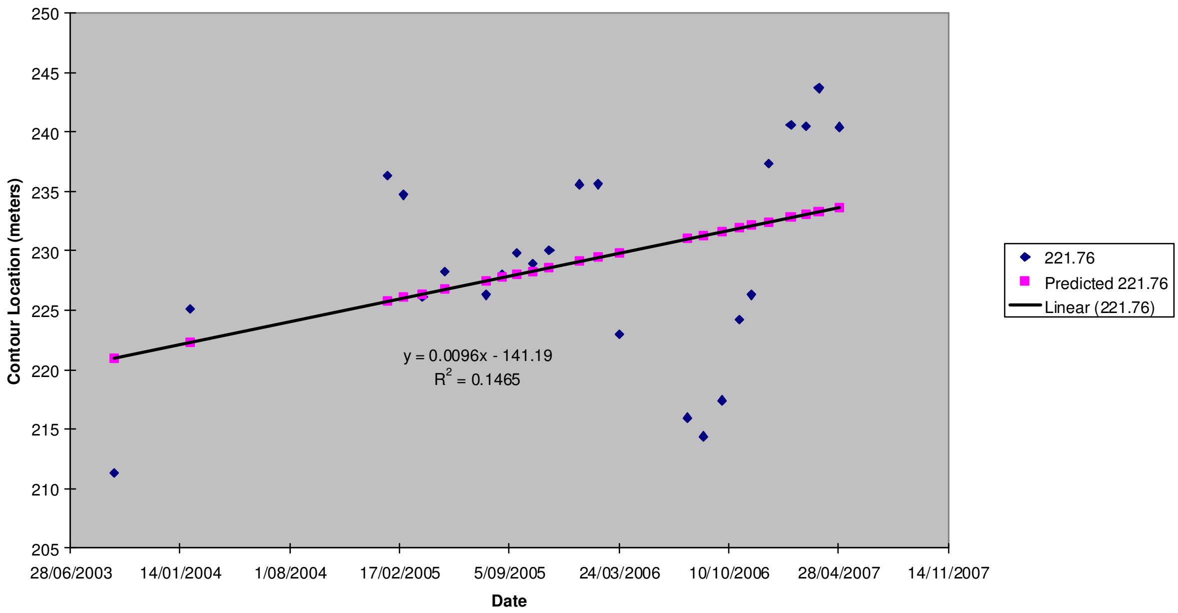
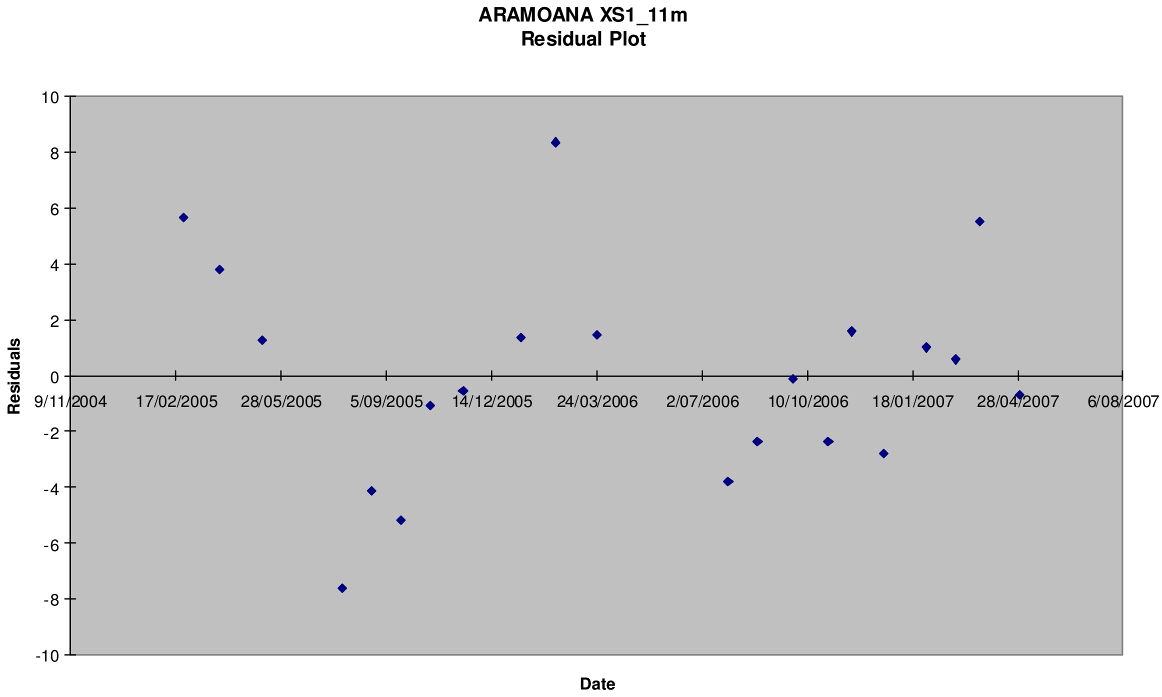
Appendix A: Analysis data

ARAMOANA XS1_11m.
Line Fit Plot



ARAMOANA XS2_11m
Line Fit Plot




ARAMOANA XS1_11m
Residual Plot
Residuals
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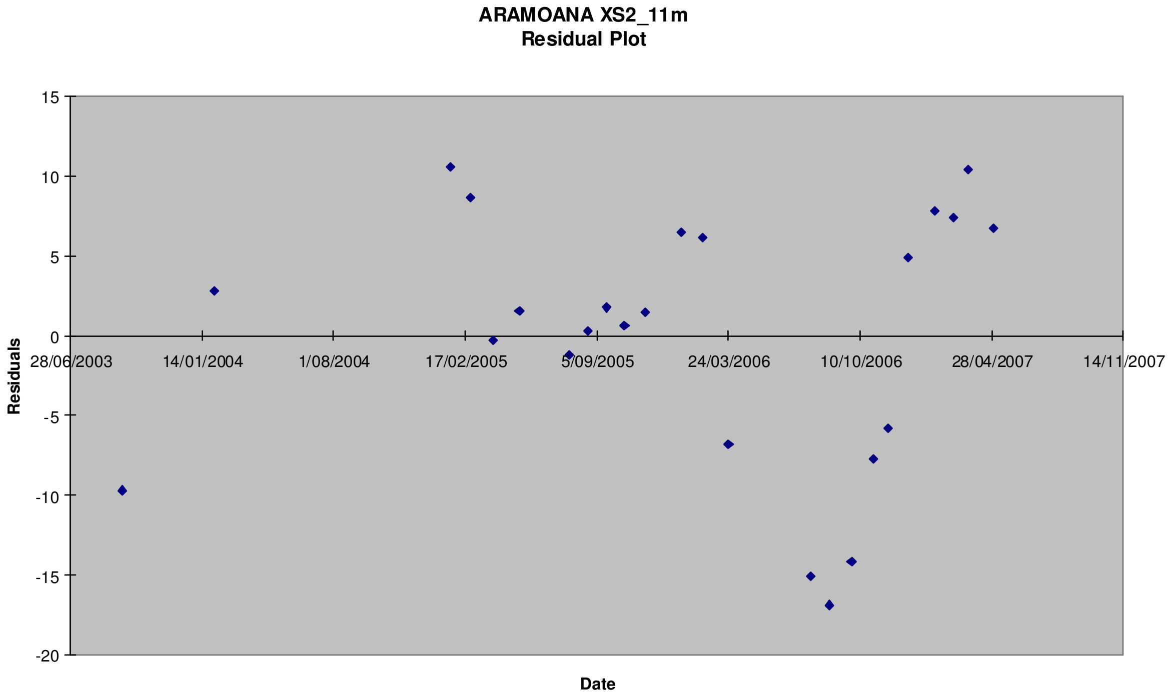
6/08/2007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1/08/2004
17/02/2005
5/09/2005
24/03/2006
10/10/2006
28/04/2007
14/11/2007

Appendix B: Table 3.1 of T&T 2006 report

Table 3–3 Revised Set back distances for Southern Hawkes Bay Beaches

	CERZ						2060 ERZ			2100 ERZ		
Location	Profile	Distance from 11 m contour to origin (m)	LT(10) (m/yr)	SE+ST+LT(10) (m)	DS (m)	Total (m)	LT (m)	SLR (m)	Total (m)	LT (m)	SLR (m)	Total (m)
Blackhead	XS 02	-86.3	0.9	42.5	86.3 *(ND)*	42	5.1	14.0 *(8.2)*	62 *(56)*	3.6	21.0 *(12.3)*	85 *(71)*
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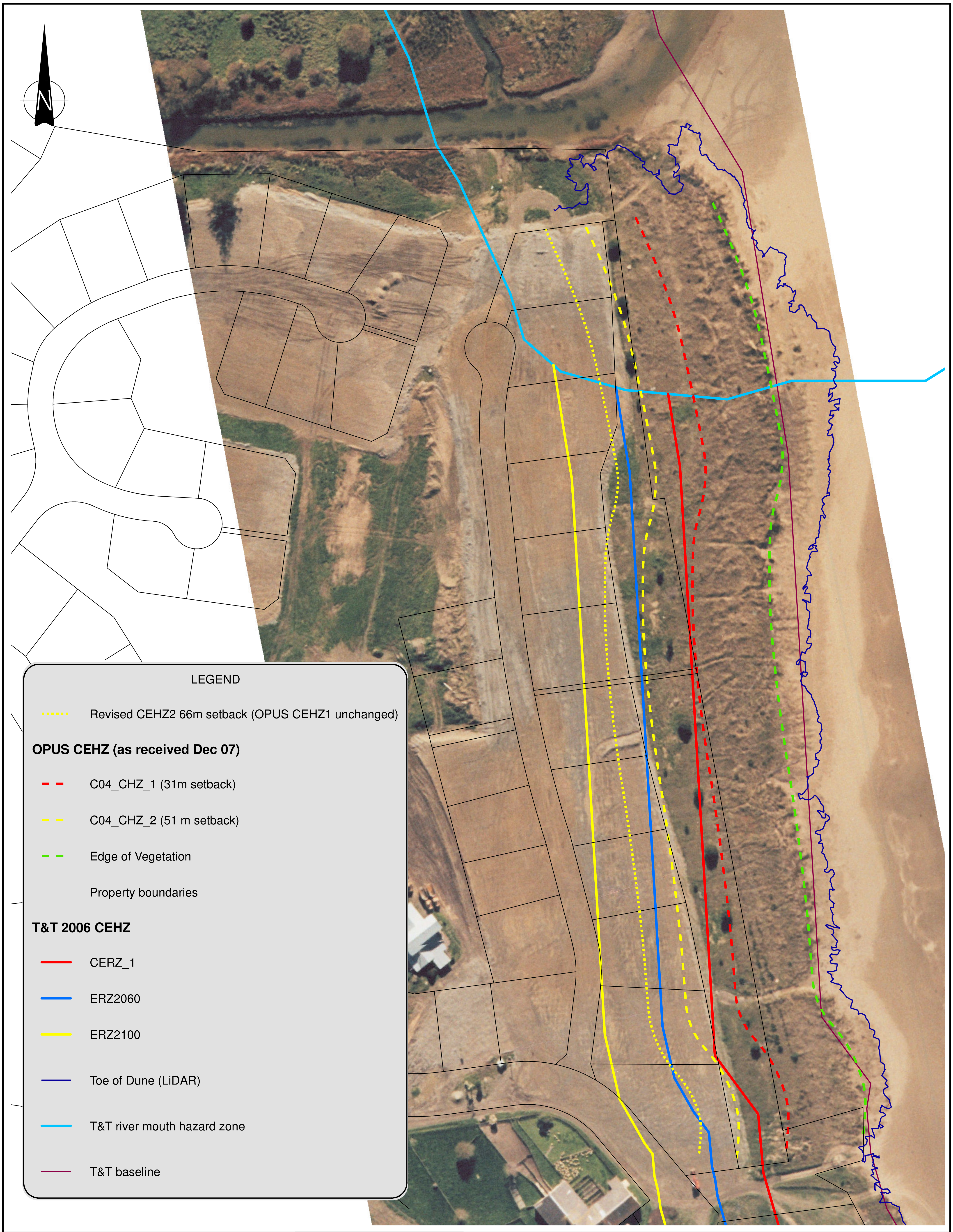
Note: Figures in brackets show original values, if changed.

Appendix C: Recommended revised hazard zone

C:\Program Files\ArcGIS\Bin\Templates\TONTAY\A3FP-MBV-MG.mxt: Wednesday, April 18, 2006 5:17:07 p.m.



Notes:

A3 SCALE 1:1,350

0 10 20 30 40 50 (m)

Tonkin & Taylor
Environmental & Engineering Consultants
Hamilton
www.tonkin.co.nz

DRAWN	Hccl	Dec.07
DRAFTING CHECKED		
APPROVED		
ARCFILE Aromoana.mxd		
SCALE (AT A3 SIZE) 1:1,350		
PROJECT No. 25077		

Hawkes Bay Regional Council
Coastal Hazard Assessment
Aramoana Site Specific Assessment
Sheet A3

FIG. No. Figure 1.A3

REV. 0

Appendix B: Pourerere Coastal Assessment Report

Tonkin & Taylor

T&T Ref : 20514.002
18 April 2008

Hawke's Bay Regional Council
Private Bag 6006
Napier

Attention: Gavin Ide

Dear Gavin

Review of report of Dr Gibb and implications for Coastal Hazard Zone assessments at Southern Pourerere Beach

1 Purpose

This letter report sets out the results of our review of the report by Dr Jeremy Gibb dated June 2007 concerning the location of the coastal hazard zone at Pourerere Beach and as referred to in his brief of evidence. The purpose of this letter is to assess whether the site specific assessment and evaluation can be used to supersede the original coastal hazard assessment carried out by Tonkin & Taylor Ltd in 2004 and our subsequent report of 2006.

2 Data sources

Dr Gibb utilises historic aerial photograph and cadastral data to evaluate long term trends, with the cadastral information dating back to 1927 and aerial photographs from May 1952, September 1971, October 1976, October 1980, March 1995, January 1999 and January 2006.

The scales for these aerial photographs varied from 1:16,000 (1952), to 1:50,000 (1999), with the 1976 survey control photos having a scale of 1:47,000. We note that these relatively small scale photographs will have an error associated with their interpretation. Based on a 1:10,000 aerial photograph, relative errors can vary from +/- 7 m to +/15m. Smaller scale photographs are likely to have similar or larger errors.

HBRC has installed 3 beach profile sites along Pourerere Beach, with regular profiling since April 2002. The southern most site is at the boundary of Lots 9/10, equivalent to Gibb's station No. 8. The two other sections are along the road linking South and North Pourerere and the third section is at Pourerere North. Twenty four surveys have been undertaken between February 2004 and November 2007.

3 Coastal processes

Dr Gibb correctly identifies that the system is likely to be in a state of geologic dynamic equilibrium, with a northerly littoral drift. He also correctly identifies that the beach at this location is controlled to a degree by the offshore reefs that produce subdued salients, or bulges along the coast and provides local controls to the incident wave direction. We note a

Tonkin & Taylor Ltd - Environmental & Engineering Consultants, 105 Carlton Gore Rd, Newmarket, Auckland, New Zealand
PO Box 5271, Wellesley St, Auckland 1141, Ph: 64-9-355 6000, Fax: 64-9-307 0265, Email: auck@tonkin.co.nz, Website: www.tonkin.co.nz

lack of sand accumulation along the foreshore south of the beach, even though this area appears more aligned to the predominant wave direction, again suggesting the local controls at Pourerere are significant.

4 Long term trend

Based on the long term aerial photographic and cadastral boundary assessment from 1927 to the present, Dr Gibb has calculated an historic rate of accretion of between 0.09 m/yr to 0.43 m/yr along the 502 m of shoreline at Pourerere South.

Dr Gibb assumes that this historic rate of longshore accretion is likely to continue at the same rate into the future. This implies accretion of between 9 m and 43 m over a 100 year period and an average rate of 0.31 m/yr or 31 m accretion in 100 years.

The beach profile data at beach profile cross-section 1 (XS1), XS2 and XS3 provide almost three years of data with three monthly profiling from February 2004 to November 2007.

Appendix A includes trend line plots and residual plots at XS1 at the 11.0 m RL contour (approximately MHWS). There is also the trend line and residual plot at XS2 at the 11.0 m contour.

The line fit and scatter suggest no strong correlation or trend and therefore due to the short data set, it is sensible to assume no significant trend of erosion or accretion (i.e. LT = 0) has occurred at this location over the survey period. This assumption supports the findings of Dr Gibb that the area has reached geologic dynamic equilibrium, but is different to Dr Gibb's estimation of historic long term accretion of 0.36 m/yr at the same location.

Using a long term future trend of zero has also been applied at the recent site specific assessment at Aramoana and, in our opinion, is a more appropriate value at Pourerere. This does not mean that the historic accretion is ignored, as the base line is taken from the recent edge of vegetation or MHWS line, but does assume that ongoing accretion cannot be relied upon.

In our original hazard assessment we identified that these beaches appear dynamically stable, but included the long term retreat rate of 0.1 m/yr representing the long term trend of adjacent cliff erosion as the representative long term trend likely to be experienced at the beach. However, based on the more detailed and site specific assessment, we can accept a long term trend of zero at this location. Based on the data available we do not believe it prudent to assume future accretion will be of the same rate of historic accretion.

5 Short term fluctuations

Dr Gibb uses the aerial photograph information to provide data on short term fluctuation and has estimated a distance of 7.1 m, representing the maximum measured fluctuation that occurred between aerial surveys from 1971 to 1975.

Based on our experience, there is a difficulty in determining short term fluctuations from aerial photograph data, as the time spans from the aerial photographs do not necessarily pick up the maximum extent of fluctuations or have the ability to separate fluctuations from trends. As such this method has limitations.

As discussed above, there has been a significant increase in beach profile data at this location as part of the ongoing monitoring programme initiated as an outcome of T&T's earlier hazard report. Analysis of the movement at 11 m has been carried out and the residual fluctuation, once the trend is removed, provides the range of beach movement at that elevation over time. The maximum observed variation at MHWS (11 m RL) is 12.9 m, with a standard error of 6.2 m. At XS 2, the maximum landward movement past the average position is 7.7 m, with the standard error of 4.8 m. We note that due to the short data set, there may not have been a significant event measured, therefore it is possible that larger fluctuations could occur (i.e. during a north-easterly storm event).

The original assessment utilised data from Waimarama Beach as there was no local site data. The standard error (deviation) was taken to be 14 m, based on the average of the results of beach profiles 8 to 18 (excluding the influence of the seawall on the southern profiles).

Comparing the observed fluctuations of the three Pourerere profiles with 3 of the northern Waimarama profiles and an average of the three profiles, shows that the beaches typically respond in a similar fashion, generally with periods of accretion and erosion occurring at the same times (refer Figure 1). The amount of fluctuation also appears similar to the average Waimarama plot, although there is more scatter with the Waimarama data hence a larger standard error than at Pourerere Beach. This may be attributed to the northerly Waimarama profiles which are more exposed to the large south-easterly swells.

The results suggest the initial assumption of similar behaviour of the beaches as reasonable although a smaller fluctuation occurs due to the reefs. Using three times the standard error for the southern part of the beach provides a short term fluctuation of 18.6 m.

6 Sea level rise

Dr Gibb uses makes allowance of -0.36 m/yr erosion due to sea level rise. This was calculated using the Bruun Rule. The rate of sea level rise was based on subtracting the national rate of historic sea level rise of 1.6 mm/yr from an allowance for 0.8 m increase in sea level by 2090 to 2100 from the 1990 level. This allowance for sea level rise is based on the most recent IPCC report (2007) inclusive of additional ice melt.

Dr Gibb has assumed a 100 year period (i.e. 1990 to 2090) to derive a future sea level rise rate of 8 mm/yr and then subtracted the historic rate to derive a relative rate of sea level rise of 6.4 mm/yr. He discounts the effects of tectonic uplift due to the episodic nature of these events and their frequency.

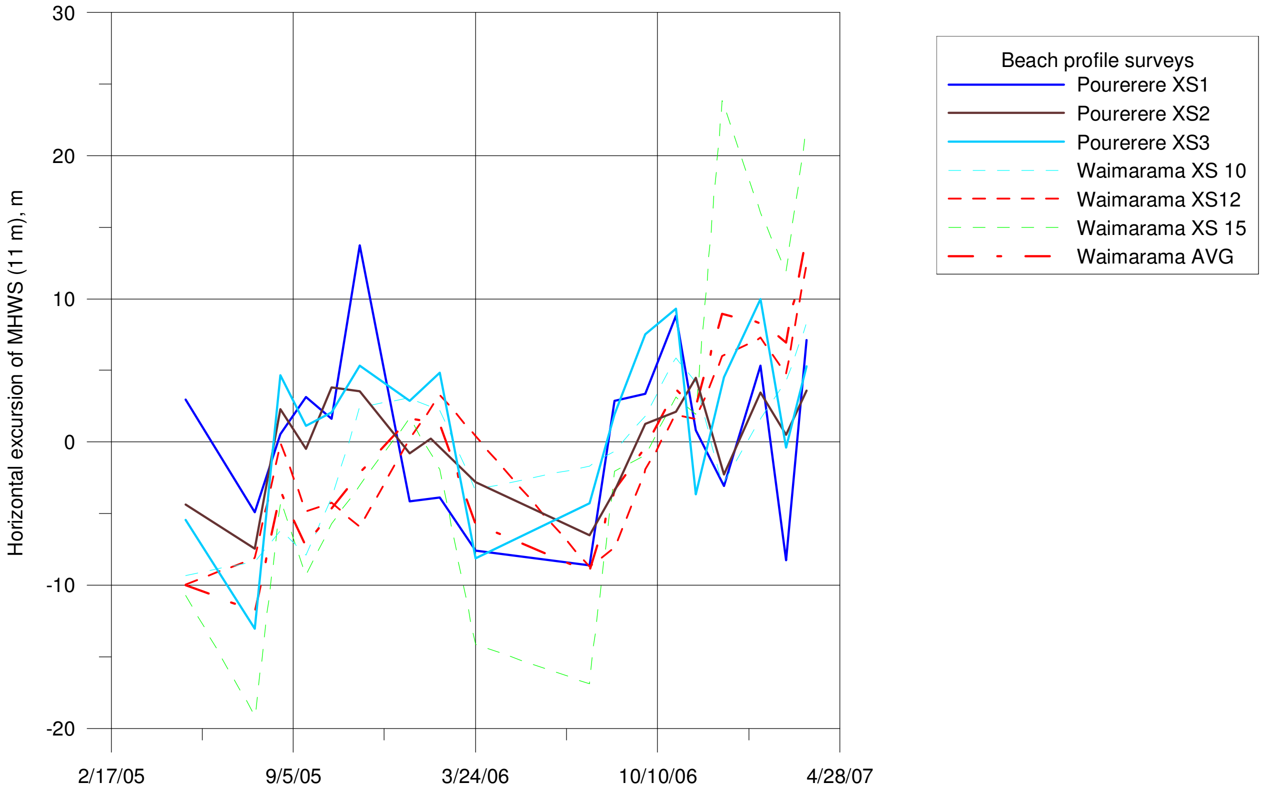


Figure 1 Comparison of horizontal excursions at Pourerere and Waimarama

The T&T hazard report (2004) assumed an increase of 0.2 m by 2060 and an additional increase of 0.3 m from 2060 to 2100 based on IPCC (2001) findings, resulting in a set back due to sea level rise of 20.5 m. No allowance was made for tectonic uplift or from historic sea level rise. Improved beach profile data used in 2006 increased the effect of sea level rise to 33.6 m. This is of a similar order to that calculated by Dr Gibb.

7 Factor of safety

The original T&T assessment did not include a factor of safety as it was decided that the standard deviation approach of using Waimarama data was sufficiently conservative to include factors of safety for short term fluctuation and that the Bruun Rule was suitably conservative.

Dr Gibb proposes a factor of safety of 1.3 and applies this to the dune slope stability, short term fluctuation and the difference between the historic long term rate of accretion and the potential effects of relative sea level rise.

In the recent Foreworld findings, the judge supported the use of a 25% factor, termed a buffer allowance, rather than a factor of safety. This is the same allowance used along the Hawke Bay coast where there is a longer data set that at Pourerere Beach. Therefore, using 1.3 as a factor is reasonable.

However, the application of the factor on the difference between the historic long term rate of accretion and the potential effects of relative sea level rise provides a non-conservative safety allowance where the historic rate of accretion is greater than the potential effects of climate change and a zero value is generated. Multiplying zero by a factor, irrespective of how big, will always give zero. Therefore, this approach assumes 100% confidence in the historic rate of accretion occurring at the same rate for the next 100 years.

At five locations this process has resulted in no coastal hazard zone for potential climate change effects and in four of the remaining seven locations the potential effect of climate change is less than 10 m. In our opinion, this factor of safety approach cannot be considered precautionary.

We recommend not taking into account any historic long term trend (i.e. assume LT = 0), applying a factor of safety of 1.5 on the short term fluctuation and dune stability factor and not applying any safety factor to the Bruun Rule results as it is already suitably precautionary.

8 Final hazard line

A comparison of the various hazard lines, measured from the dune toe is set out in Table 1. Note that T&T used MHWS in the 2006 assessment and the distance between MHWS and the dune toe is not presented in the table below.

Method	LT(10) (m)	Smax (m)	CHZ-1 (m)	LT100 (m)	SLR (m)	CHZ-2 (m)	CEHZ (m)
T&T, 2004	1.8	43.3	43	18	20.5	38.5	80.0
T&T, 2006	1.8	42	43.8	18	33.3	51.3	95.1
Gibb 2007	0	7.1	13.0	0	0 to 33	0 to 33	15 to 45
T&T 2007 (average)	0	16.3	17	0	20.5	21	38.0
XS1	0	8.9	9	0	20.5	21	30.0
XS2	0	10.6	11	0	33.6	34	45.0
XS3	0	29.3	30	0	20.5	21	51.0

Table 2 Comparison of various hazard lines at Pourerere

Dr Gibb calculates the CHZ-1 zone to be 13 m and the CHZ-2 zone to vary between 0 and 33 m, with five of the 12 locations not having any additional hazard zone allowance more landward of the CHZ-1 zone. Dr Gibb rounded to the nearest 5 m increment provides a hazard zone width of between 15 and 45 m. The revised T&T hazard line, taking into account the additional site specific data at this site, results in a CHZ-1 zone of 17 m and a CHZ-2 zone of 21 m. Therefore the total width is 38 m. We note that this is based on averaged values of the three cross-sections and the actual widths of hazard zone will at each cross-section.

9 Summary

Due to the combination of increased beach profile data now available at the site and the additional site specific information and analysis completed by Dr Gibb, we support the reduction of the coastal hazard extents along the southern end of Pourerere Beach. However, we do not support the values used by Dr Gibb to define the CHZ-1 zones, or his approach of offsetting potential climate change effects with extrapolations of historic shoreline change.

Based on our assessment, averaged results indicate a CHZ-1 zone of 17 m and a CHZ-2 zone of 21 m applied from the edge of vegetation line, giving a total hazard zone width of 38 m from the edge of vegetation.

10 Applicability

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

TONKIN & TAYLOR LTD

Environmental and Engineering Consultants

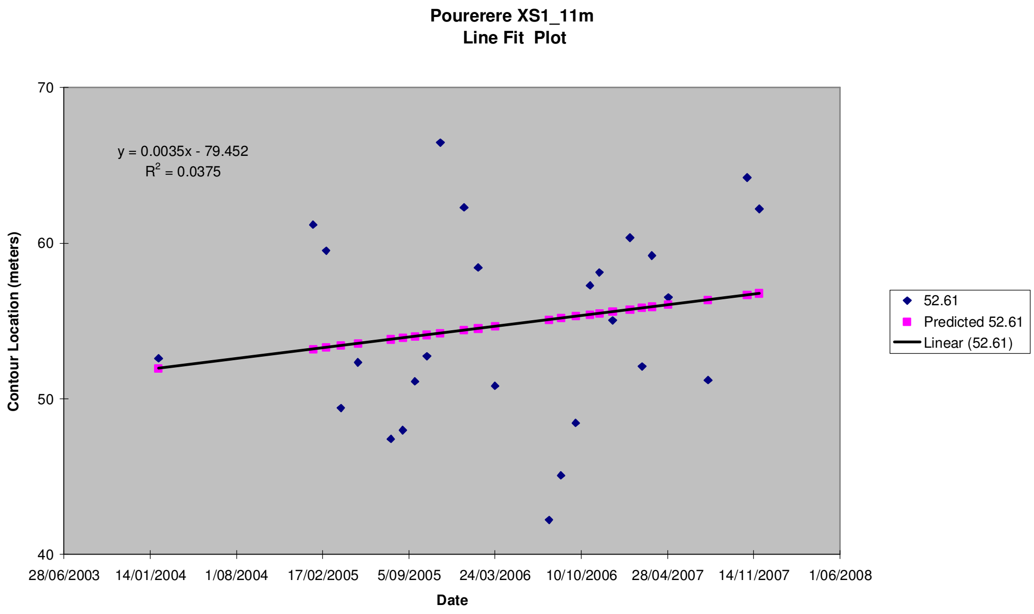
Report prepared by: Authorised for Tonkin & Taylor by:

....	....
Richard Reinen-Hamill	Richard Reinen-Hamill
Coastal Engineer	Acting Water Resources Group Manager

Report reviewed by:

Tom Shand
Coastal Engineer

Appendix A: Analysis data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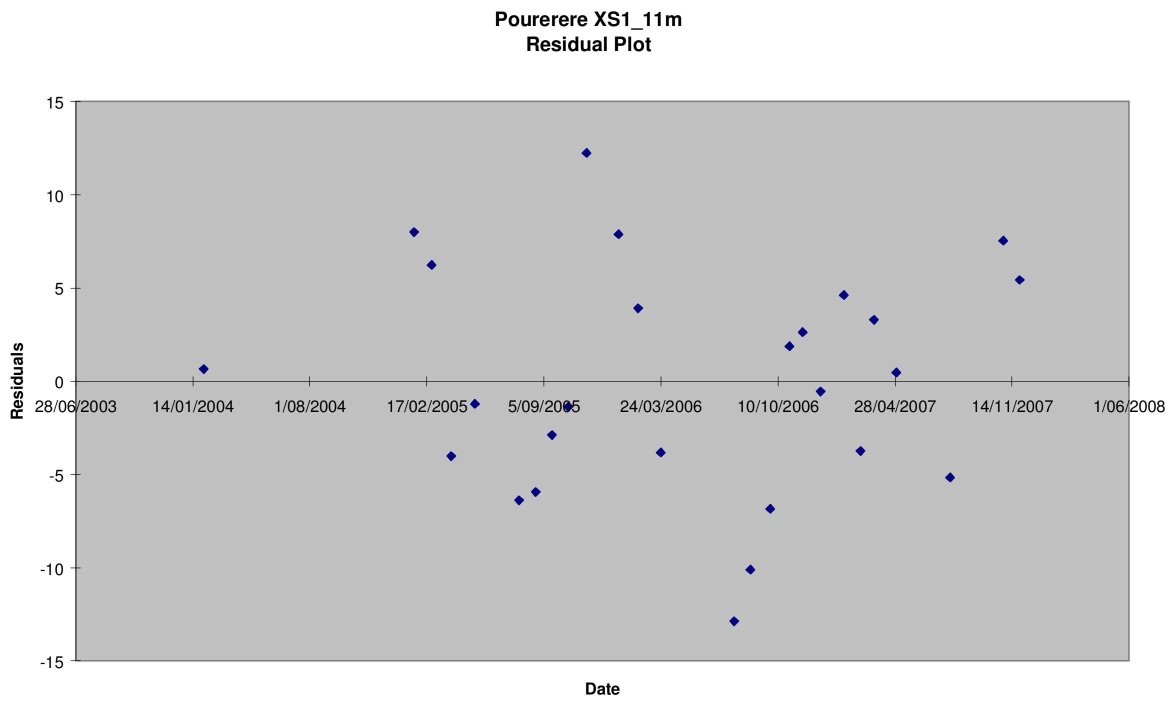
R^2 = 0.0375
70
60
50
40
Contour Location (meters)
28/06/2003
14/01/2004
1/08/2004
17/02/2005
5/09/2005
24/03/2006
10/10/2006
28/04/2007
14/11/2007
1/06/2008
Date
52.61
Predicted 52.61
Linear (52.61)


Pourerere XS1_11m
Residual Plot
15
10
5
0
-5
-10
-15
Residuals
28/06/2003
14/01/2004
1/08/2004
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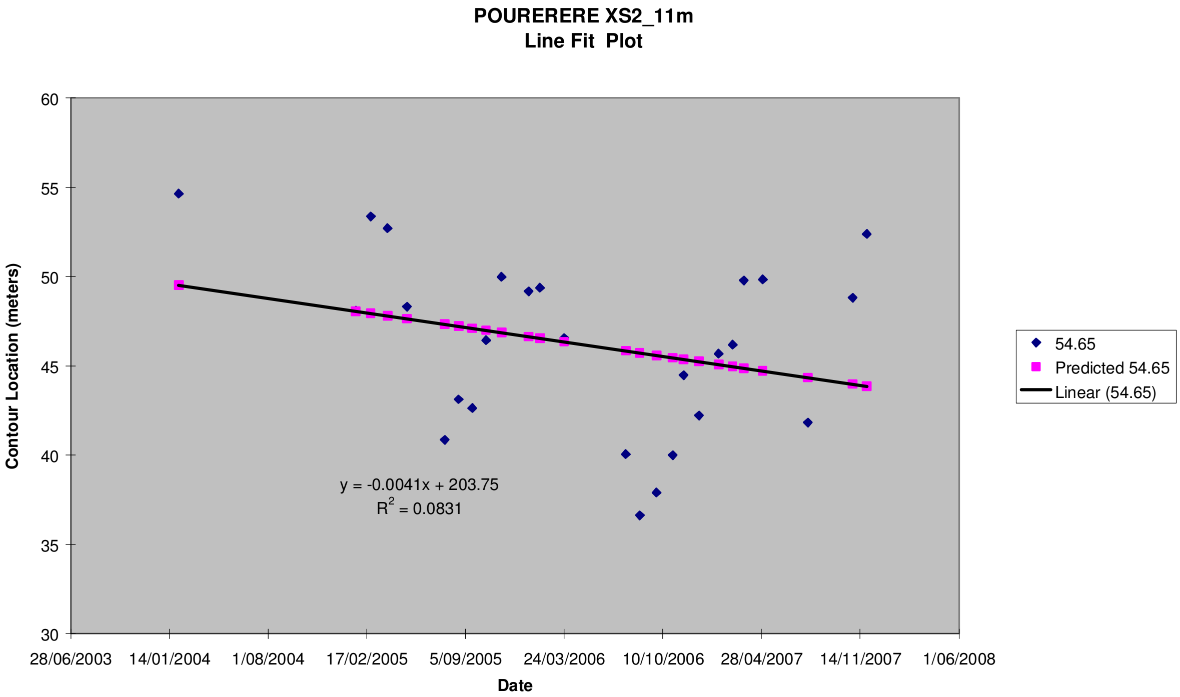
28/04/2007
14/11/2007
1/06/2008
Date


POURERERE XS2_11m
Line Fit Plot
Contour Location (meters)
60
55
50
45
40
35
30
28/06/2003
14/01/2004
1/08/2004
17/02/2005
5/09/2005
24/03/2006
10/10/2006
28/04/2007
14/11/2007
1/06/2008
Date
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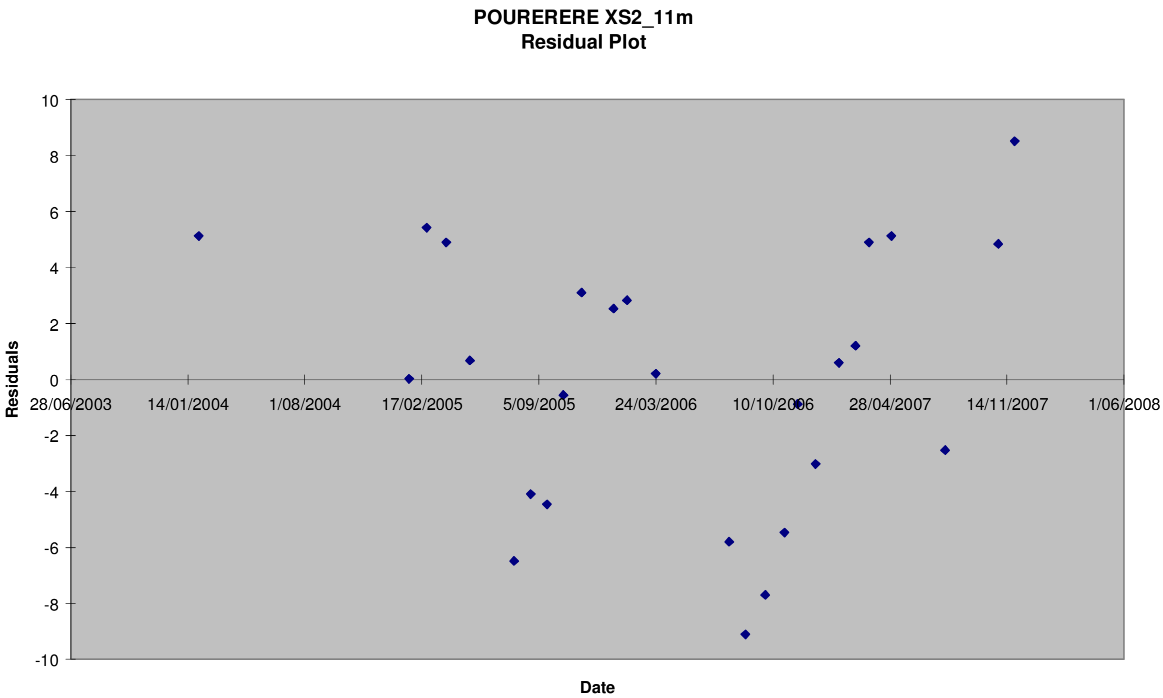
Predicted 54.65
Linear (54.65)


POURERERE XS2_11m
Residual Plot
Residuals
10
8
6
4
2
0
-2
-4
-6
-8
-10
28/06/2003
14/01/2004
1/08/2004
17/02/2005
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24/03/2006
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Appendix B: Table 3.1 of T&T 2006 report

Table 3-3 Revised Set back distances for Southern Hawkes Bay Beaches

	CERZ						2060 ERZ			2100 ERZ		
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Note: Figures in brackets show original values, if changed.

Hawke's Bay Regional Council +
159 Dalton Street
Private Bag 6006
Napier, New Zealand
Tel 06 835 9200 +
Fax 06 835 3601
Freephone 0800 108 838
www.hbrc.govt.nz +

HAWKE'S BAY REGIONAL COUNCIL

Our Ref: 12/3/1

19 September 2007

Tonkin & Taylor Limited
PO Box 5271
Wellesley Street
AUCKLAND
Attn: Richard Reinen-Hamill

Dear Richard

HB REGIONAL COASTAL ENVIRONMENT PLAN – REQUEST FOR ADDITIONAL ADVICE

1. Background

As you are aware, the Council's Hearings Committee has heard submissions on the Proposed Regional Coastal Environment Plan's coastal hazard provisions. Having heard submissions and visited many of the beaches, the Committee would like some further advice from you. The level of certainty in the hazard assessment and the assessments prepared by other coastal experts is one of the foremost considerations during the Committee's deliberations.

The Council wishes to commission you to prepare a report to specifically assess the matters outlined below.

2. Scope of Work

a) Review the following location-specific coastal hazard assessments presented during the hearing and provide recommendations whether or not these should form the basis of CHZs identified in the RCEP:

Submitter	Submitter Ref#	General Location	Expert Evidence
Bridgeman, John	10 /F4	Haumoana	Stephen Moynihan
Hill Country Corp Ltd	66	Ocean Beach	Dr Jeremy Gibb
Mangakuri Beach Management Society Inc.	86	Mangakuri	R Keith Smith and Malcolm Smith
Mexted, M and Williams, P	95	Mahanga	Dr Jeremy Gibb
Winstone Aggregates	97 / F33	Awatoto	Dr Martin Single
Shoal Beach Limited	150	Aramoana	Richard Croad
Te Awanga Society Inc.	163	Te Awanga	R Keith Smith

b) In light of a preference for improved levels of certainty and confidence in the assessment of coastal hazards, provide an outline of the matters that would improve the level of certainty:
   i) at present with existing data and information now held by the Council;
   ii) within the next six months with any additional data that should be obtained in that period
   iii) over the next 3-5 years.

c) A response to the commonly asked questions:
   i) *"Why do we get different outcomes if a slightly different method is used?"* and
   ii) *"Why should the T&T coastal hazard assessment methodology be used as opposed to other methodologies?"*

d) Reassess the ERZs incorporating the following:
   i) Beach profile survey data collected subsequent to the 2004 Regional Coastal Hazard Assessment Study was undertaken.
   ii) The effect (if any) of the off-shore reef systems along the southern beaches.
   iii) The effect (if any) of the geology and geomorphology of the Hawke's Bay coastline.
   iv) Report and information contained in Coastal Management Consultancy Limited (June 2007) "*Implications of Natural Hazards Along Pourerere Beach, Central Hawke's Bay District, North Island, East Coast: Report prepared for the Department of Conservation, East Coast Hawke's Bay Conservancy.*"

e) Any other relevant comments that you may have to assist the Hearings Committee with understanding and evaluating submissions presented at the hearing.

We are conscious that this may involve a reasonable amount of time and costs, so commencing this work, please provide an estimate of the time required and cost to prepare and complete this report.

3. Timeframes
The Committee is eager to maintain momentum on these submissions but accepts that a rushed decision without sound advice is not desirable. Your estimate of time and costs will be forwarded to the Committee for their advice, prior to establishing a more specific timeframe for the completion of work.

4. Cost
Payment can be by lump sum at the end of the work or by arrangement based on the progressive completion of key tasks.

5. Deliverables
An electronic copy of the final advice shall be provided to Council. This shall be in a format that will enable Council to readily reproduce the report. In addition, two (2) printed copies shall be provided to Council.

Please contact me if you require any clarification of matters discussed in this letter.

Yours sincerely

Gavin Ide

Gavin Ide
Senior Planner
ENVIRONMENTAL MANAGEMENT GROUP
PHONE (06) 833 8077
EMAIL: gavin@hbrc.govt.nz