SUBMISSION OF COASTAL RATEPAYERS UNITED INCORPORATED (CRU) TO THE GREATER WELLINGTON REGIONAL COUNCIL PROPOSED NATURAL RESOURCES PLAN

I. GENERAL AND WHOLE PLAN ISSUES

Whole plan - oppose and seek amendment

Reasons:
Except where support is expressed, the whole Proposed Natural Resources Plan (PNRP) is opposed, for a number of reasons including:

- The PNRP fails to give effect to the New Zealand Coastal Policy Statement 2010 (NZCPS) and has little or no regard to the provisions of the NZCPS, and in particular
    - it does not appropriately enable and address coastal hazard mitigation (including protection) activities. That is particularly the case in relation to areas of significant existing development. (NB when reference is made to hazard mitigation in this submission it includes protection).
- The provisions of the PNRP are not in accordance with the Resource Management Act 1991 (RMA) and sound resource management practice, and in particular
    - it overrides the RMA's purpose (RMA s 5); and
    - it has inadequate or inappropriate s 32 evaluations and reports;

For example, proposed Policy P3 in the PNRP, in contrast to Policy 3 of the NZCPS, fails to recognise that a precautionary approach is not appropriate in the wide-ranging circumstances set out in Policy P3.

Proposed Policy P3 is rendered even less appropriate because of the limited definitions of beneficial activities and uses in proposed Policies P7 and P8. Objective 6 of the NZCPS is very clear: it seeks to achieve community wellbeing "through subdivision, use and development", recognising that, "the protection of the values of the coastal environment does not preclude use and development in appropriate places and forms, and within appropriate limits". This overall objective is totally ignored throughout the PNRP, not just in proposed Policies P3, P7 and P8.

The PNRP also fails to give effect to the NZCPS in relation to Policy 27 of the NZCPS. Policy 27 of the NZCPS is entitled *"Strategies for protecting significant existing development from coastal hazard risk"*. It sets out a range of options that should be assessed for "areas of significant existing development likely to be affected by coastal hazards." The range of options includes, among other things, hard protection structures.

Implicit in Policy 27 is that decision makers, having assessed the range of options, will set policies that ensure appropriate options can be progressed. The PNRP does not do this.

The PNRP also fails to recognise the benefits, not only the general benefits from use, but in particular those from coastal hazard mitigation measures. It also fails to include appropriate objectives, policies and rules to enable appropriate use including coastal hazard mitigation activities, especially in areas of significant existing development.

Where activities are not permitted or are controlled activities, appropriate support and enabling in the objectives and policies are critical to the ability to obtain consent. The PNRP does not provide that.

S32 evaluations:

- there have not been adequate or appropriate s 32 evaluations; and
- adequate or appropriate s 32 reports have not been undertaken or regarded.

Section 32(1)(a) requires assessing the extent to which the objectives of a proposal being evaluated are the most appropriate to achieve the purpose of the Act. A key aspect of the purpose of the Act is to enable "people and communities to provide for their social, economic, and cultural well-being and for their health and safety" (section 5(1)(2)). Section 32 evaluations should evaluate explicitly whether an objective is worded in such black and white terms as to pre-empt consideration of this key aspect of the RMA's purpose. They also need to identify the benefits and costs of proposed provisions, quantifying those where practicable. Such tests are fundamental to good policy-making and their continued neglect would be both deplorable and inconsistent with the section 32 requirement.

Decision sought:
Ensure that the provisions of the PNRP comply with the RMA, and give effect to the NZCPS and the Regional Policy Statement for the Wellington region (RPS).

Undertake appropriate s 32 evaluations and prepare revised s 32 reports, having proper regard to s 32 matters, including in relation to the implications of the PNRP for hazard mitigation (including protection) measures. Have regard to those revised reports.

Revise the PNRP to address the concerns expressed throughout this submission.

Reconsider the whole plan, including definitions, objectives, policies, rules, other methods, schedules and maps that relate directly or indirectly to climate change, coastal hazards and mitigation (including protection) measures, both within the coastal marine area and otherwise e.g., in beds of rivers and streams to ensure that:

- the definitions are clear, consistent and appropriate and will allow all relevant activities;
- the definitions (existing or newly-created ones) and other relevant provisions relating to coastal hazard mitigation (including protection) appropriately address the concerns expressed throughout this submission;
- all aspects of the PNRP distinguish between hazard identification/risk assessment which is science-based and objective (rather than precautionary) and risk management which is policy-based and enables judgements to be exercised;
- the objectives and policies enable and encourage appropriate use including hazard mitigation measures;
- the rules:
    - provide for as many activities as possible as permitted or controlled activities;
    - provide that the rest are restricted discretionary or discretionary activities;
    - do not result in activities becoming non-complying activities by virtue of any other rules, e.g., rules that refer to the Schedules or rules that refer to vehicles, or because rules permitting activities are not appropriately inclusive;
    - do not make any activities non-complying or prohibited; and

- aspects from the whole plan including definitions, objectives, policies, rules, other methods, schedules and maps are added, revised or deleted to achieve these outcomes.

In relation to all of the decisions sought in this submission, this submission also seeks such other decisions as would address the concerns expressed. Where specific wording is suggested, that wording is an example of what might be acceptable wording but other wording or outcomes may be preferable and the decisions sought include such other options.

Where a more effective resolution of concerns expressed in the reasons is available that decision is also sought.

Please note that when reference is made in this submission to hazard mitigation that includes protection.

Whole plan – failure to address a range of matters relating to the coastal environment in accordance with RMA and NZCPS statute – seek amendment

Reasons:
Firstly, there is a need to assert an overarching objective of the plan in respect of use and development in the coastal environment to prevent it inadvertently preventing activities that might otherwise be contemplated by the NZCPS. A suggestion to remedy this deficiency is:

> *"Objective Oxx*
>
> *To enable people and communities to provide for their well-being through the sustainable use and development of the coastal environment."*

The corresponding Policy could be:

> *"Policy Pxx: Community well-being through the use of the coastal environment*
>
> *The importance of enabling people and communities to provide for their social, economic, and cultural wellbeing and their health and safety, through appropriate subdivision, use, and development of the coastal environment is recognised."*

This could be associated with Policy P7.

In addition there is the need to deal with the specific issue of coastal hazard mitigation and protection. A suggestion to remedy this deficiency is:

> *"Objective Oxx*
>
> *Coastal hazard mitigation and protection*
>
> *The importance of appropriate coastal hazard mitigation and protection measures, balancing benefits and costs to those affected is recognised."*

A suggestion for the drafting of a policy, modelled on proposed "Policy P16: New flood protection and erosion control" is:

> *"Policy Pxx: Coastal hazard mitigation and protection in areas of significant existing development*

The social, cultural, economic and environmental benefits and costs to those affected of existing and new coastal hazard mitigation and protection activities in areas of significant existing development are recognised."

Other objectives and policies should also be developed to address the concerns expressed.

In terms of the rules, consider the most appropriate option for addressing coastal hazard mitigation (including protection) methods. This could include:

- revising individual rules; or
- creating a new section dealing with coastal hazard mitigation (including protection) and including relevant rules in that section.

Decision sought:
Develop and include an overarching objective in respect of use and development in the coastal environment to prevent the Plan from inadvertently preventing activities that might otherwise be contemplated by the NZCPS.

Develop and include a corresponding policy.

Develop and include an objective to deal with the specific issue of coastal hazard mitigation and protection.

Develop and include a corresponding policy.

Develop and include any other objectives and policies to address the concerns expressed throughout this submission.

Consider the most appropriate option with respect to the provision of rules for addressing coastal hazard mitigation (including protection) methods and develop and include such rules.

Whole plan - failure to address a range of matters relating to risk (including the definitions of "risk" and "risk-based approach (natural hazards)"), risk assessment, and risk management, including in relation to climate change and coastal hazard mitigation issues - seek amendment

Reasons:
The PNRP has its statutory basis in the RMA and NZCPS. The former under Section 32 requires the PNRP to explicitly address issues of risk in managing resources and in evaluating actions under it. Risk management is central to the NZCPS in assessing and managing coastal hazards.

In 2009 a new standard for risk management was adopted in Australia and New Zealand and this standard was incorporated in the NZCPS 2010 by reference (AS/NZS ISO 31000:2009 Risk management – Principles and guidelines, November 2009). Risk is defined as "the effect of uncertainty on objectives". Thus both positive and negative consequences need to be taken into account (not just losses), the full range of objectives need to be considered (and when it comes to matters of public policy the objectives of different interests) and the uncertainty in the assessments of both the event occurring and its impact are essential to properly assess and manage the risks.

The RPS definition of "risk" as carried through to the PNRP is based on the earlier (2004) standard[1]. This is no longer appropriate. That definition implicitly assumes only losses (a

[1] In an explanation to Policy 29 (but not in the policy itself) the RPS refers (at page 110) to the superseded Standard, not the current Standard.

"hazard"), there is a single likelihood associated with the event (the "probability [sic] of a natural hazard") and that the consequences are inherent in the natural resource (the "vulnerability") rather than being a function of the various objectives the community has for those resources.

Given the reference in the NZCPS 2010 to the AS/NZS ISO 31000:2009, and the history of relying on the then current standard within the RPS, the PNRP needs to be updated to reflect the now current standard[2]. This Standard should be added to the list of standards referenced by the PNRP.

A number of recommendations to remedy these deficiencies include:

Recommendation:
Definition of "Risk (hazards)"

Replace the current definition with:

> *"The effect of uncertainty in hazards on the objectives people and communities have to provide for their well-being through the sustainable use and development of the coastal environment. Ref. AS/NZS ISO 31000:2009 Risk management – Principles and guidelines, November 2009"*

Similarly, this same need for updating to give effect to NZCPS 2010 and AS/NZS ISO 31000:2009 also applies to the definitions of:

1. "Risk-based approach" to natural hazards to bring it into line with AS/NZS ISO 31000:2009 and the NZCPS;
2. "Hazard management strategy" to reflect the requirements of NZCPS 2010;
3. "High hazard areas" to clarify their status in terms of Policy 24 of the NZCPS.

1. "Risk-based approach"

The NZCPS 2010 sets out the process it requires to manage coastal hazard risks. First there is an objective identification and assessment (Policy 24) then based on that assessment, a range of management responses need to be considered (Policies 25 – 27). The NZCPS 2010 is clear that the risk identification and assessments and the trade-offs between competing interests and objectives occur by persons exercising functions and powers under the Act rather than others without this authority.[3]

It is critical that the provisions of the PNRP maintain this separation between identification and assessment on the one hand and management on the other. The PNRP must demonstrate an understanding of these separate and fundamental concepts with respect to risk management and the PNRP must follow those risk management processes set down in the relevant Policies in NZCPS 2010. The proposed definition of "risk-based approach" in the PNRP fails to maintain this separation, mixes the two activities up (assessment and management) and misleads on the nature of the risk assessment.

Use of the term "risk management" is appropriate in the PNRP wherever uncertain hazards impact on the objective of using the coastal environment to enhance the community's well-being. As drafted, the PNRP uses the term "risk-based approach" twice, in Policies P27 and P28 and then in the narrow context of assessing risks. Subsequently, we address both the definition and the related policies below:

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[2] The NZCPS 2010 requires local authorities to update plans to give effect to it "as soon as practical". P7. NZCPS 2010.
[3] See "Application of this policy statement" P.7 NZCPS 2010.

Recommendations:
Definition of "Risk-based approach":

Delete existing complete entry and replace with:

> *"Risk management approach (natural hazards)"*
>
> *"Objective identification, assessment, and prioritisation of risks and related uncertainties ("Risk assessment') followed by the coordinated and economical application of resources to minimise, monitor, and control the uncertainty of a hazard and its impact or to maximize the realisation of opportunities ("Risk management"). Policy 24 and Policies 25-27 of the NZCPS respectively exemplify risk assessment and management. Ref. AS/NZS ISO 31000:2009 Risk management – Principles and guidelines, November 2009"*

Delete Policies P27 and P28.

Add a replacement policy:

> *"Policy Pxx: Risk management approach*
>
> *"Use and development shall be managed using a risk management approach, particularly when hazard risks impact upon the achievement of use and development objectives."*

2. "Hazard management strategy"

The definition of "Hazard management strategy" is in practice little more than the application of the risk management approach. It is referenced in Policy P28. It allows hard engineering where the risks of not permitting it are unacceptable and the environmental effects are considered to be more than minor.

Recommendation:
Definition of "Hazard management strategy":
Replace entry with:

> "A hazard risk assessment along with a plan to manage any hazard risks, developed using the risk management approach and approved by the local authority."

3. "High hazard areas"

"High hazard areas" are defined in the PNRP as "all areas in the coastal marine area and the beds of lakes and rivers". It is used in Objective O21 and Policy P27. This definition cuts across Policy 24 of the NZCPS 2010 that lays down a process for identifying "areas at high risk of being affected [by coastal hazards]". It also fails to comply with the management provisions of NZCPS Policies 25-27.

Objective O21 should better reflect Objective 5 of the NZCPS 2010 and focus on a range of means to manage the risks rather than just avoidance of use and development. Objective O19 suffers from a similar problem where interference from use and development is "minimised" rather than the risk managed, and Objective O20 seeks to have all risks to be "acceptable risks" again rather than risk managed.

These objectives should be recast in the language of Objective 5 of the NZCPS 2010 to ensure the PNRP is compliant with it.

Recommendations:
Delete Objectives O19-22 and replace with a single objective as follows:

> *"Objective Oxx:*
>
> *Ensure that natural hazard risks taking account of climate change, are managed by:*
> - *locating new development away from areas prone to such risks;*
> - *considering responses, including managed retreat, for existing development in this situation; and*
> - *protecting or restoring natural defences to such hazards."*

To further give proper effect to the NZCPS Objective 5, delete Policies P26-30 and replace them with policies that use risk management and reflect the risk assessment and management policies in the NZCPS 2010 generalised to natural resources.

Delete the definition of "High hazard areas" and refer instead to "areas at high risk of being affected by coastal hazards" as per the NZCPS.

Decision sought:
Implement all changes as enunciated in the above Recommendations.

Whole plan – failure to incorporate the principles of AS/NZS ISO 31000:2009 – seek amendment

Reasons:
Following on from the discussion of risk management in general, the definitions, objectives, policies and methods of the PNRP currently do not incorporate some of the principles of AS/NZS ISO 31000:2009 as well as they should, in particular:

"d) **Risk management explicitly addresses uncertainty.**

Risk management explicitly takes account of uncertainty, the nature of that uncertainty, and how it can be addressed.

f) **Risk management is based on the best available information.**

The inputs to the process of managing risk are based on information sources such as historical data, experience, stakeholder feedback, observation, forecasts and expert judgement.

However, decision makers should inform themselves of, and should take into account, any limitations of the data or modelling used as well as the possibility of divergence among experts.

...

h) **Risk management takes human and cultural factors into account.**

Risk management recognizes the capabilities, perceptions and intentions of external and internal people that can facilitate or hinder achievement of the organization's [organization is a wide-ranging term] objectives.

i) **Risk management is transparent and inclusive.**

> Appropriate and timely involvement of stakeholders ... ensures that risk management remains relevant and up-to-date. Involvement also allows stakeholders to be properly represented and to have their views taken into account in determining risk criteria."

The failure of the PNRP to address a number of these matters, including the failure to explicitly take account of uncertainty and the range of likely outcomes, instead of unreasonable, very unlikely outcomes or an inappropriately precautionary approach, needs to be remedied.

As AS/NZS ISO 31000:2009 instructs, it is relevant to take into account the human factor and recognise the capabilities, perceptions and intentions of external and internal people that can facilitate or hinder achievement of the objectives.

A critical factor relevant to coastal hazards that is currently problematic in New Zealand is the human factor of coastal scientists/engineers. There exists an underlying assumption that property owners are unreasonable and that scientists and engineers are objective experts. The Kapiti experience proved otherwise.

In the Kapiti situation it became abundantly clear some coastal scientists/engineers moved outside their areas of expertise and misinterpreted both the NZCPS and their role in the legal process. This caused significant problems and imposition of unreasonable costs and restrictions. What is needed with respect to hazard identification/risk assessment is transparent, objective, scientific information, including information about the uncertainties and the range of likely outcomes, to enable:

- submitters to participate effectively in the RMA process; and
- decision-makers to exercise their judgement appropriately and make informed decisions.

What is not needed are "precautionary" or "potential" results based on the scientist's or engineer's misinterpretation of the NZCPS. Legal misinterpretation should not allow a one-sided policy approach to be misleadingly dressed up as science.

Scientists/engineers who provide only unlikely or very unlikely results are not providing information that is appropriate for use in the RMA context. The duty of care in this case is to the balance of interests involved and that means facilitating the most well informed decision making.

Please see the *"Notes on the Kapiti coastal erosion fiasco and problems caused more generally by a number of NZ coastal scientists"* by Joan Allin, a former Environment Court judge. At paras 146-147, she states:

> "*146 In my opinion, submitters and decision-makers are entitled to expect that scientific reports:*
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> a. *convey objective, scientific, transparent information;*
>
> b. *are fit for purpose;*
>
> c. *have regard to the "short-term and long-term natural dynamic fluctuations of erosion and accretion" as set out in Policy 24(1)(b) and to other scientific matters referred to in Policy 24 to enable the Council to perform its functions;*
>
> d. *are based on sound statistics, involving statisticians with appropriate statistical expertise;*

e. *state all assumptions, and state the implications of the assumptions (as far as possible), clearly;*

f. not contain hidden precautionary adjustments (or precautionary adjustments that cannot readily be untangled from the results);

g. not add precautionary assumption, to precautionary assumption to precautionary assumption;

h. use, as the Coastal Panel recommends from a statistical perspective (and also recalling the Gallagher case, where the Environment Court selected the specified overtopping rate because it was the "best fit"), "best estimates" rather than precautionary values, with margins of error or factors of safety kept separate from the estimates and added at the end if appropriate;

i. not provide very unlikely results (unless for some reason they have been specifically told to do so and then the results will be described as very unlikely);

j. not describe results using ambiguous terms such as precautionary, conservative, or potential (or, if that is done, identify precautionary or conservative or potential compared to what, and by how much, so that submitters and decision-makers can understand what the coastal scientist actually means when they use those terms); and

k. identify the uncertainties e.g., by, as the Coastal Panel recommends, considering a range of plausible scenarios (e.g. low, mid, high, or best estimate and extremes).

147 From my perspective, if that is done (and especially in areas where there is significant existing development), some of the difficulties with the current RMA processes may at least diminish."

It would be most unfortunate if GWRC ended up going down the same track as Kapiti Coast District Council (KCDC), prior to KCDC's re-assessment of the issues where KCDC had relied on scientific information that was not sufficiently robust and that painted an unreasonably negative (indeed very unlikely) picture of outcomes, with all of the negative consequences of that.

The PNRP should clarify that hazard identification/risk assessment is an objective process and that any scientific or expert reports should be scientific and objective (not policy-based or precautionary), taking into account the *NZCPS 2010 Guidance Note Policy 3: Precautionary Approach* which states (p.6), "The application of the precautionary approach is a risk management approach rather than a risk assessment approach."

Because "risk" is defined in AS/NZS ISO 31000:2009 as the impact of uncertainty on objectives a critical part of the risk assessment is to report the uncertainty, not hide it in false certainty.

Decision sought:
Revise the PNRP to deal with the concerns expressed.

Incorporate relevant aspects of the joint Australian and New Zealand International Standard on risk management AS/NZS ISO 31000:2009 "Risk management - Principles and guidelines" into the PNRP, including (without limiting the breadth of the decision sought) principles d, f, h and i.

Add the standard AS/NZS ISO 31000:2009 to the list of standards referenced by the PNRP.

Incorporate relevant aspects of "*NZCPS 2010 Guidance Note Policy 3: Precautionary Approach*".

Incorporate relevant aspects of *"Notes on the Kapiti coastal erosion fiasco and problems caused more generally by a number of NZ coastal scientists"*.

Revise the PNRP to clarify that, in contrast to risk management, hazard identification/risk assessment is an objective process that calls for uncertainty to be reported, not hidden and precautionary assumptions based on "professional judgement" to be avoided.

Whole plan - coastal icon - seek amendment

Reasons:
It is useful that the coastal icon is used to identify matters relevant to the coastal marine area.

However, it is confusing because the statements in the rules "Provisions relevant to the coastal marine area are identified by his icon ..." infer that the provisions may only be relevant to the coastal marine area, however, that is not what Section 2.1 states.

Section 2.1 states, "Unless otherwise stated, provisions marked with the coastal icon apply to both the coastal marine area and the areas landward of mean high water springs where the regional council has jurisdiction."

Decision sought:
Clarify the meaning of the coastal icon and make the explanation of it consistent across the PNRP

Whole plan - Lack of consistency of language and drafting throughout the PNRP, including in the objectives, policies, rules, etc. - seek amendment

Reasons:
There are inappropriate inconsistencies in the language used, across, the PNRP.

An example:

- in a number of places there is reference to what is "practicable" e.g., Policies P4 P25, P27, and P132(g);
- in other places there is reference to what is "reasonably practicable" e.g., Policy P47;
- in other places there is reference to what is "reasonable or practicable" e.g., Policies P132(b) and (c), and P139).

There is no attempt to distinguish "practicable" "reasonably practicable", "reasonable or practicable". Presumably each word or phrase has a different meaning otherwise the drafters would have used the same language. However since the PRNP does not define any of these terms it is impossible for the average reader to know what it means by the implied distinctions, or why such distinctions exist.

It is unacceptable to convey the impression that practicable does not mean what is reasonably practicable or that what is practicable may not be reasonable. These differences in wording must be avoided.

Decision sought:
Review the use of language and drafting throughout the PNRP. Ensure that terminology is used consistently and appropriately and that use of combinations of terms are also used consistently and appropriately.

Review all of the references to "practicable", "reasonably practicable", "reasonable or practicable" and any other similar terms (or variations of those or similar terms) and use one form of wording that conveys the concept of reasonableness. "Reasonably practicable" is an option or simply "practicable" (provided that reasonably or reasonable is never used in relation to "practicable" or as an alternative to practicable anywhere throughout the PNRP) as a Court would infer an element of reasonableness (as long as the proviso is given effect to).

Where there are equivalent rules in different parts of the PNRP (or within the same parts of the PNRP), ensure that the rules are drafted in a way that is appropriate, consistent and complete.

Where there are lists of things in different rules (e.g., activities associated with the main activity dealt with in the rule), ensure that all of the lists within and across the rules are appropriate, consistent and complete.

II. SPECIFIC CHAPTERS AND PROVISIONS

CHAPTER 2 - DEFINITIONS

Please also see the submissions and decisions sought under the heading "GENERAL AND WHOLE PLAN ISSUES".

Decision sought: Please also see the submissions and decisions sought under the heading "GENERAL AND WHOLE PLAN ISSUES".

Definitions - "Beach recontouring (beds of rivers)" and "Beach recontouring (coastal marine area)" - seek amendment

Reasons:
It seems that cutting river and stream mouths is not intended to come within these definitions and, if that is the case, this should be made clear.

If these definitions do cover cutting river and stream mouths (and indeed even if they don't), the differences in wording between the two definitions are problematic e.g., referring to mechanical means in one but not the other. The reference to a "river beach" and "beach" in the first definition also seems problematic and perhaps should also include reference to "bed".

Decision sought:
Clarify that river and stream cutting is not included in these definitions.

Reconsider the differences in the wording of the provisions and make them consistent e.g., both should include reference to hand and/or mechanical methods so that provisions in the coastal marine area and in beds of rivers are drafted in a consistent and complete manner e.g., include reference to mechanical means in both.

Reconsider the use of the terms "river beach" and "beach" in the "beach contouring (beds of rivers)" definition and consider also including a reference to "bed".

Definitions - "Earthworks" - seek amendment

Reasons:
While the PNRP says the more specific rule applies and while the definition of "Earthworks" refers to "soil", to avoid any potential for misunderstanding, it would be useful for the definition of "Earthworks" to exclude "Beach recontouring (beds of rivers)" and "Beach recontouring (coastal marine area)" as well as river and stream mouth cutting.

Decision sought:
Insert that the definition does not include Beach recontouring (beds of rivers) and Beach recontouring (coastal marine area) and does not include river (including stream) mouth cutting.

Definitions - "Functional need" and "Operational requirement" - seek amendment

Reasons:
The provisions use these terms in situations where use of the terms does not give effect to the NZCPS and does not enable appropriate hazard mitigation measures that might be able to be located elsewhere but are more efficiently, effectively or cost-effectively located in the particular location.

The focus on need in these terms is too narrow.

Decision sought:
Reconsider use of the terms "functional need" and "operational requirement" in the rules and either change the rules or the definitions to enable appropriate hazard mitigation measures that might be able to be located elsewhere but are more efficiently, effectively or cost-effectively located in the particular location.

Definitions - Hazard management strategy - seek amendment

Reasons:
The definition of "Hazard management strategy" is in practice little more than the application of the risk management approach. It is only referenced in Policy P28 and is required to allow hard engineering where the risks are unacceptable and the environmental effects are considered to be more than minor. A simpler definition using the definition of "risk management approach" should be used.

Decision sought:
Replace the current definition with:

"A hazard risk assessment along with a plan to manage any hazard risks, developed using the risk management approach and approved by the local authority."

Definitions – "High hazard areas" – oppose

Reasons:
"High hazard areas" are defined as "all areas in the coastal marine area and the beds of lakes and rivers". This definition cuts across Policy 24 of the NZCPS 2010 that lays down a process for identifying "areas at high risk of being affected [by coastal hazards]" and cuts across the management provisions of NZCPS Policies 25-27.

See the above discussion, and in particular under the heading "Whole plan - failure to address a range of matters relating to risk (including the definitions of "risk" and "risk-based approach (natural

hazards)"), risk assessment, and risk management, including in relation to climate change and coastal hazard mitigation issues."

Decision sought:
Delete the definition (and any reference to it throughout the plan) and align related passages of text to be compliant with NZCPS processes and provisions regarding areas at high risk of being affected by coastal hazards.

Definitions - "Risk" - seek amendment

Reasons:
The PNRP has its statutory basis in the RMA and NZCPS. The former under Section 32 requires the PNRP to explicitly address issues of risk in managing resources and in evaluating actions under it. Risk management is also central to the NZCPS in assessing and managing coastal hazards.

In 2009 new standards were adopted in Australia and New Zealand for risk management and these were incorporated in the NZCPS 2010 by reference (AS/NZS ISO 31000:2009 Risk management – Principles and guidelines, November 2009). Risk is defined as "the effect of uncertainty on objectives". Thus both positive and negative consequences need to be taken into account (not just losses), the full range of objectives need to be considered (and when it comes to matters of public policy the objectives of different interests) and the uncertainty in the assessments of both the event occurring and its impact are essential to properly assess and manage the risks.

The RPS definition of "risk" as carried through to the PNRP is based on the earlier standard[4]. It implicitly assumes only losses (a "hazard"), there is a single likelihood associated with the event (the "probability [sic] of a natural hazard") and that the consequences are inherent in the natural resource (the "vulnerability") rather than being a function of the various objectives the community has for those resources.

Given the references in the NZCPS 2010 to the AS/NZS ISO 31000:2009, and the history of relying on the then current standard, the PNRP needs to be updated to reflect this[5].

Decision sought:
Replace current definition with:

"Risks (hazards)"

"The effect of uncertainty in hazards on the objectives people and communities have to provide for their well-being through the sustainable use and development of the coastal environment. Ref. AS/NZS ISO 31000:2009 Risk management – Principles and guidelines, November 2009"

Definitions – "Risk-based approach" – oppose and seek amendment

Reasons:
The NZCPS 2010 sets out the process it requires to manage coastal hazard risks. First there is an objective identification and assessment (Policy 24) then based on that a range of management responses (Policies 25 – 27). The NZCPS 2010 is clear that the risk identification and assessments and the trade-offs between competing interests and objectives occur by persons

[4] In an explanation to Policy 29 (but not in the policy itself) the RPS refers (at page 110) to the superseded Standard, not the current Standard.
[5] The NZCPS 2010 requires local authorities to update plans to give effect to it "as soon as practical". P7. NZCPS 2010.

exercising functions and powers under the Act rather than others without this authority[6].

Any "risk-based approach" needs to maintain this separation between identification and assessment on the one hand and management on the other. It needs to follow processes set down in the relevant Policies in NZCPS 2010. The current definition mixes the two activities up (assessment and management) and misleads on the nature of the risk assessment.

The PNRP only uses the term "risk-based approach" twice, in Policies P27 and P28 and then in the narrow context of assessing risks. In practice "risk management" is appropriate in the PNRP wherever uncertain hazards impact on the objective of using the coastal environment to enhance the community's well-being (to paraphrase).

Decision sought:
Delete the existing definition (and reference to it elsewhere throughout the plan) and add a new definition "Risk management approach (natural hazards)" to replace it as follows:.

"Risk management approach (natural hazards)"

"Objective identification, assessment, and prioritization of risks and related uncertainties ("Risk assessment') followed by the coordinated and economical application of resources to minimize, monitor, and control the uncertainty of a hazard and its impact or to maximize the realization of opportunities ("Risk management"). Policy 24 and Policies 25-27 of the NZCPS respectively exemplify risk assessment and management. Ref. AS/NZS ISO 31000:2009 Risk management – Principles and guidelines, November 2009"

CHAPTER 3 - OBJECTIVES

Objectives - general

Reasons: Please also see the submissions and decisions sought under the heading "GENERAL AND WHOLE PLAN ISSUES", including the reasons relating to the objectives.

Decision sought: Please also see the submissions and decisions sought under the heading "GENERAL AND WHOLE PLAN ISSUES".

All of Chapter 3 - oppose and seek amendment

Reasons:
Except where support is expressed, all of Chapter 3 is opposed because it does not appropriately enable and address coastal hazard mitigation (including protection) activities, especially in areas of significant existing development.

Decision sought:
Revise Chapter 3 to appropriately enable and address coastal hazard mitigation (including protection) activities, especially in areas of significant existing development. All of the matters addressed below and any suggested changes to provisions are subject to this general decision sought.

[6] See "Application of this policy statement" P.7 NZCPS 2010.

Objectives – omissions – seek amendment

Reasons:
There is a need to assert an overarching objective of the plan in respect of use and development in the coastal environment to prevent it from inadvertently preventing activities that might otherwise be contemplated by the NZCPS.

A suggestion to remedy this deficiency is:

> *"Objective Oxx*
>
> *To enable people and communities to provide for their well-being through the sustainable use and development of the coastal environment."*

This objective could be associated with proposed Policy P7.

Furthermore, there is a need to deal with the specific issue of coastal hazard mitigation and protection.

A suggestion to remedy this deficiency is:

> *"Objective Oxx*
>
> *Coastal hazard mitigation and protection*
>
> *The importance of appropriate coastal hazard mitigation and protection measures, balancing benefits and costs to those affected is recognised."*

An associated policy will also need to be included in the Plan (a suggestion is covered under the heading, "CHAPTER 4 – POLICIES").

Decision sought:
Include an overarching objective in respect of use and development in the coastal environment to prevent the Plan from inadvertently preventing activities that might otherwise be contemplated by the NZCPS. Word the objective in a manner that enables people and communities to provide for their well-being through the sustainable use and development of the coastal environment.

Include an objective which deals with the specific issue of coastal hazard mitigation and protection. Word the objective in a manner that references the need to balance the benefits and costs of such measures on those affected.

Natural character, form and function - Objective O19, Objective O20, Objective O21, and Objective O22 – oppose and seek amendment

Reasons:
The objectives fail to comply with NZCPS 2010. See above discussion under section I. GENERAL AND WHOLE PLAN ISSUES, and in particular under the heading "Whole plan - failure to address a range of matters relating to risk (including the definitions of "risk" and "risk-based approach (natural hazards)"), risk assessment, and risk management, including in relation to climate change and coastal hazard mitigation issues".

Decision sought:
Delete Objectives O19-O22 and replace with a single Objective Oxx as follows:

> *"Ensure that natural hazard risks taking account of climate change, are managed by:*

- *locating new development away from areas prone to such risks;*
- *considering responses, including managed retreat, for existing development in this situation; and*
- *protecting or restoring natural defences to such hazards."*

Sites with significant values - Objectives 032 and 038 and all other relevant provisions that rely on proposed or operative district plans - seek amendment

By way of a general comment in respect of these objectives and the ones that follow, it is the attributes of a site that create the significant value that needs to be managed and potentially protected, not the site *per se*. The PNRP needs to focus on what constitutes inappropriate use of the site, not on protection regardless.

Reasons:
The PNRP is relying on proposed and operative district plans for identification of at least some outstanding natural landscapes and special amenity landscapes. In the fullness of time, these objectives run the real risk of being inconsistent with the actual proposed or operative district plan provisions and how the provisions are implemented in those plans by the rules. Given the link to various plans of various districts, the provisions need to be kept general in the PNRP.

Referring to "maintained or enhanced" in Objective 038 is too all encompassing and rigid. Special amenity landscapes run along most of the Kapiti coast.

Decision sought:
Reconsider the appropriateness of the provisions that rely on proposed and operative district plans and how they are best worded to ensure that, both now and in the fullness of time, there is no risk of the provisions being inconsistent with the relevant proposed or operative district plans.

A tentative suggestion is to reword Objective 038 to be more consistent with the wording in Objective 032 so that Objective 038 reads something along these lines: "Identified special amenity landscape values are protected from inappropriate subdivision, use and development" but it is probably preferable to make both objectives 032 and 038 more general where they are referring to areas within districts.

Sites with significant values - Objective 033 and Schedule C - seek amendment

Reasons:
The objective and Schedule C are too extreme.

Schedule C sets out an extensive list of areas with significant mana whenua values with resulting negative implications for hazard mitigation activities. Corresponding rules inappropriately make a wide range of activities, which would include soft and hard engineering hazard mitigation measures, in these areas non-complying activities. That is inappropriate.

In addition, regardless of the categorisation of coastal hazard mitigation activities, there needs to be appropriate policy support in the PNRP enabling such activities.

The wording of this objective is inappropriately different from Objective 034.

Decision sought:
Revise the objective to be less extreme and revise the objective and other relevant provisions in the PNRP to address the concerns expressed. An option is to revise the objective so that it reads "Sites with significant mana whenua values are protected from inappropriate use and development

and restored where appropriate" to be consistent with the wording of Objective 034 and to revise Schedule C.

Sites with significant values - Objective 035 and Schedule F - seek amendment

Reasons:
The objective and Schedule F are too extreme. Schedule F sets out an extensive list of areas with significant ecosystems and habitats with significant indigenous biodiversity values with resulting negative implications for hazard mitigation activities.

The wording of this objective is inappropriately different from Objective 034.

Decision sought:
Revise the objective to be less extreme. An option is to revise the objective so that it reads "Ecosystems and habitats with significant indigenous biodiversity values are protected from inappropriate use and development and restored where appropriate" to be consistent with the wording of Objective 034 and to revise Schedule F.

Sites with significant values - Objective 036 and Schedule J - seek amendment

Reasons:
The objective and Schedule J are too extreme. Schedule J sets out an extensive list of geological features in the coastal marine areas, with resulting negative implications for hazard mitigation activities.

The wording of this objective is inappropriately different from Objective 034.

Decision sought:
Revise the objective to be less extreme. An option is to revise the objective so that it reads "Significant geological features in the coastal marine areas are protected from inappropriate use and development" to be consistent with the wording of Objective 034 and to revise Schedule J.

Sites with significant values - Objectives 038 - seek amendment

Reasons:
Please see the reasons relating to Objectives 032 and 038, dealt with earlier.

Decision sought:
Please see the decision sought relating to Objectives 032 and 038, dealt with earlier.

Coastal management - Objective 053 - oppose and seek amendment

Reasons:
Objective 053 does not give effect to the NZCPS as the NZCPS does not require that use and development must have a functional need or operational requirement in order to be located in the coastal marine area.

Both the definitions of "functional need" and "operational requirement" convey the message of a need to be in a location.

Policy 6(2)(d) of the NZCPS states:

> "recognise that activities that do not have a functional need for location in the coastal marine area generally should not be located there". (Emphasis added)

Need is not required in all situations.

Policy 27 of the NZCPS specifically addresses a range of options for reducing coastal hazard risk in areas of significant existing development.

The objective fails to address the situation where there is not technically a need/requirement to be in the coastal marine area but the activity is e.g., more efficiently, effectively or cost-effectively located there. The NZCPS would not preclude such a situation and neither should the PNRP.

Decision sought:
Revise the objective to address the concerns expressed. Options include inserting "generally" after "area" and adding "or is more efficiently, effectively or cost-effectively located there" at the end of the objective or something along those lines.

Coastal management - Objective 056 - seek amendment

Reasons:
The objective should also recognise the purpose of the new development e.g., coastal protection works.

Decision sought:
Revise the objective to also recognise the purpose of the new development. An option is to add "and its purpose" at the end of the objective.

CHAPTER 4 - POLICIES

Policies - general - seek amendment

Reasons:
Please also see the submissions and decisions sought under the heading "GENERAL AND WHOLE PLAN ISSUES", including the reasons relating to policies.

Decision sought:
Please also see the submissions and decisions sought under "GENERAL AND WHOLE PLAN ISSUES".

All of Chapter 4 - oppose and seek amendment

Reasons:
Except where support is expressed, all of Chapter 4 is opposed because it does not appropriately enable and address coastal hazard mitigation (including protection) activities, especially in areas of significant existing development.

Decision sought:
Revise Chapter 4 to appropriately enable and address coastal hazard mitigation (including protection) activities, especially in areas of significant existing development. All of the matters addressed below and any suggested changes to provisions are subject to this general decision sought.

Policies – omissions – seek amendment

Reasons:

There is a need for an overarching policy that enables appropriate use and development in the coastal environment to ensure the Plan does not inadvertently prevent activities that might otherwise be contemplated by the NZCPS.

A suggestion for such a policy is:

> *"Policy Pxx: Community well-being through the use of the coastal environment*
>
> *The importance of enabling people and communities to provide for their social, economic, and cultural wellbeing and their health and safety, through appropriate subdivision, use, and development of the coastal environment is recognised."*

Additionally, a specific policy is needed to deal with the issue of coastal hazard mitigation and protection, particularly in areas of significant existing development.

A suggestion for the drafting of such a policy, modelled on proposed "Policy P16: New flood protection and erosion control" is:

> *"Policy Pxx: Coastal hazard mitigation and protection in areas of significant existing development*
>
> *The social, cultural, economic and environmental benefits and costs to those affected of existing and new coastal hazard mitigation and protection activities in areas of significant existing development are recognised."*

Furthermore, a policy is needed to provide for the use of a risk management framework in the consideration of use and development in the coastal environment.

A suggestion for the drafting of such a policy is:

> *"Policy Pxx: Risk management approach*
>
> *"Use and development shall be managed using a risk management approach, particularly when hazard risks impact upon the achievement of use and development objectives."*

Decision sought:
Include a policy that enables appropriate use and development in the coastal environment to ensure the Plan does not inadvertently prevent activities that might otherwise be contemplated by the NZCPS.

Include a specific policy to deal with issue of coastal hazard mitigation and protection, incorporating reference to "areas of significant existing development" and the "benefits and costs to those affected".

Include a policy that provides for a risk management framework to be used in the management of use and development in the coastal environment.

Ensure that such policies provide decision-makers with sufficient flexibility to make appropriate decisions, depending on all of the facts of a case. It is not appropriate to preclude that flexibility.

Policy P3: Precautionary approach - oppose and seek amendment

Reasons:

- A precautionary approach is not needed where the lack of information or uncertainty is not material or where the consequences are not significantly adverse (see Policy 3 NZCPS).

- The wording of the policy is unclear. It appears to be intended to bias decisions in favor of action or inaction where there is limited information. If this is the intention, then it is not in accordance with the RMA or the NZCPS.

- Risk management must balance the risks of taking costly action unnecessarily against the risks of incurring the cost of failing to take action. That is recognised in Policy 3 of the NZCPS 2010 where it refers to "avoidable social and economic loss and harm to communities does not occur". It is also recognised in section 32(2)(c) of the RMA that requires a balanced assessment of "the risk of acting or not acting". Being too precautionary results in avoidable social and economic harm, just as not being sufficiently precautionary does.

- The proposed policy is unbalanced in that it refers to adverse effects an activity might have on the environment but not to the contribution of that activity to the "social, economic and cultural well-being" of peoples and communities. Yet if a purpose is not to advance the wellbeing of people in their communities how can it be justified under section 32 of the RMA?

- The statement is unclear as to what recognition should be given to property owner's ability to manage risks to their well-being using risk acceptance and/or risk-pooling arrangements.

Relevant supporting material

Please read:

- *"The precautionary principle and its role in coastal risk management under the New Zealand Coastal Policy Statement and the Resource Management Act"* (attached) in conjunction with;

- *"NZCPS 2010 Guidance note Policy 3: Precautionary approach"*. The guidance note explains the origins of Policy 3 of the NZCPS, which GWRC should consider more carefully than is demonstrated in Policy P3 of the PNRP.

The Department of Conservation guidance note states:

> *"The application of the precautionary approach is a risk management approach rather than a risk assessment approach. It is when the risk of potential significant adverse or irreversible environmental effects cannot be adequately assessed (because of uncertainty about the nature and consequences of human activities or other processes) that a precautionary approach to risk management becomes appropriate."*

Application of the precautionary approach may or may not apply in relation to the coastal environment (noting again that a precautionary approach is not needed where the lack of information or uncertainty is not material). However, its application does not relate to and is not relevant with respect to the rest of the region.

The RPS, in explanations to Policies 29 and 51 (but not in the wording of the policies themselves), refers to precaution. The explanation to Policy 29 refers to a "precautionary, risk-based approach". The explanation to that policy states (at page 110):

"Guidance documents that could be used to assist in the process include:

- *Risk Management Standard AS/NZS 4360:2004 ..."* (emphasis added).

The Standard referred to in the RPS has been superseded by the joint Australian and New Zealand International Standard on risk management AS/NZS ISO 31000:2009 *"Risk management - Principles and guidelines"*.

This current Standard discards reference to a "precautionary approach" and instead addresses uncertainty.

As a result, while the references in the policies in the RPS that refer to a risk-based approach remain appropriate, references to precaution in the explanations should not be relied upon or given effect to. The Standard AS/NZS ISO 31000:2009 is what is now relevant to the PNRP provisions.

Outside the coastal environment, there is no justification for referring to a precautionary approach. The approach of the RMA is sufficient and appropriate.

Decision sought:
Revise the policy to deal with the concerns expressed including making it clear it doesn't apply where the lack of information or uncertainty is not material or where the consequences are not significantly adverse.

Include wording to acknowledge that being too precautionary is just as inappropriate (with inappropriate costs and consequences) as not being precautionary enough and redress its lack of balance with respect to the well-being of people in their communities.

Make it clear that the principle does not apply to risk assessment (see comments elsewhere in this submission about risk assessment, in particular under the headings, "Whole plan - failure to address a range of matters relating to risk (including the definitions of "risk" and "risk-based approach (natural hazards)"), risk assessment, and risk management, including in relation to climate change and coastal hazard mitigation issues" and "Whole plan – failure to incorporate the principles of AS/NZS ISO 31000:2009").

Policy P4: Minimising adverse effects - seek amendment

Reasons:
Given the extent of the areas referred to in P4(b), it will not always be possible or appropriate to avoid them. Further the test the RMA requires to be applied is that adverse effects only should be reduced to the extent that overall community well-being is being increased.

Decision sought:
Include appropriate qualification in P4(b) to deal with the fact that, given the extent of the areas referred to in (b), it will not always be possible or appropriate (particularly in terms of community well-being) to avoid them. An option would be to refer to "where reasonably practicable" (or whatever term is to be used consistently across the PNRP for conveying the concept of reasonable practicability) or something similar such as a community well-being test.

Policy P7: Uses of land and water - oppose and seek amendment

Reasons:
The list inappropriately "picks winners" (e.g., aquaculture, gravel extraction, transport). It deals in a lopsided way with many of the matters e.g.:

- referring to gravel extraction without recognising its effects in reducing the supply of materials to the coast, resulting for example, in slowing accretion in areas where continued accretion is needed to deal with ongoing sea level rise;

- referring to transport along, and access to, water bodies without recognising the problems that can be caused by vehicles and without recognising that Policy 19 of the NZCPS refers to walking access, not transport access (whereas Policy 20 of the NZCPS deals with vehicular access), and without recognising that the definition of water body in the RMA does not include the coastal marine area.

If the list remains, the considerable benefits of natural hazard mitigation measures should be referred to. The considerable benefits of natural hazard mitigation measures should be referred to and recognised. They are just as important as the other matters referred to with no worse effects than many of the activities referred to.

Decision sought:
Delete Policy P7.

If the policy is not deleted, then:

- reconsider the appropriateness of including each of the items and remove those that should not be there;

- delete (a) aquaculture;

- include reference to the benefits of river and stream mouth cutting and protecting against natural hazards by structures. An option is to revise (g) along the following lines "natural hazard mitigation measures including gravel extraction from rivers, river and stream mouth cutting, and structures [particularly in areas of significant existing development]". If that is not done, delete (g); and

- revise (k) to remove the word "transport" and reword the policy so it refers to something like "appropriate access to and along water bodies and the coastal marine area".

Policy P8(h): Beneficial activities (h) - support and seek amendment

Reasons:
Policy P8(h) dealing with existing structures is supported but, given the limited definition of "upgrade", upgrade should also be included.

Decision sought:
Include reference to "upgrade" in Policy 8(h).

Policy P9: Public access to and along the coastal marine area and the beds of lakes and rivers - oppose and seek amendment

Reasons:
The policy:

- is too uncertain in its reference to "extent or quality" of public access. Coastal hazard mitigation works might affect the extent or quality of public access but be an appropriate outcome and this policy should not preclude that. Indeed, they can also improve aspects of public access (as cycleways/walkways such as in New Plymouth) but that might not be in

accordance with this policy;

- is too extreme in referring to "shall be avoided" and "necessary";
- is too limited in (a) to (c) in that the purposes do not include reference to other beneficial activities e.g., natural hazard mitigation;
- does not distinguish between vehicular and walking access (Policy 19 of the NZCPS deals with walking access and Policy 20 of the NZCPS deals with vehicular access); and
- could interfere with attempts to limit inappropriate vehicular or pedestrian access (but changing the policy to refer only to walking access would limit appropriate vehicular access and that would be inappropriate).

Decision sought:
Revise the policy completely to address the concerns that it:

- is too uncertain in its reference to "extent or quality" of public access;
- too extreme in referring to "shall be avoided" and "necessary";
- too limited in (a) to (c) in that the purposes do not include reference to other beneficial activities, including in particular natural hazard mitigation measures; and
- fails to distinguish between walking and vehicular access and could interfere with attempts to limit inappropriate pedestrian or vehicular access.

Policies P15: Flood protection activities and P16: New flood protection and erosion control and the failure to include equivalent provisions for coastal locations - seek amendment

Reasons:
The definition of "Catchment based flood and erosion risk management activities" refers only to a river management scheme or a flood plain management plan so the policies are not sufficiently wide to cover coastal activities away from rivers. It is inappropriate to fail to recognise the benefits of coastal flood and erosion or other coastal hazard mitigation activities and they should be provided for.

There is no reason to recognise the benefits of river and flood plain protection and fail to recognise the benefits of dealing with flood and erosion matters and other coastal hazard mitigation matters for coastal properties. That is particularly the case as some of the river works have adversely affected the flow of gravel, sand, etc. to the coast and therefore benefits those affected by river flooding to the detriment of those potentially affected by reduced sediment supply to the coast.

Decision sought:
Either widen Policies P15 and P16 to include coastal hazard mitigation activities (using appropriate terminology) or create new policies to deal with those activities.

In addition, given the limited definition of "upgrade" and the importance of the existing activities, upgrade should be included.

Policy P20: Exercise of kaitiakitanga as well as all other relevant objectives, policies and rules and Schedule C - seek amendment

Reasons:
There are problems with the combination of:

- this policy (and possibly other relevant objectives and policies);
- the failure of the PNRP to include general objectives and policies supporting appropriate use to enhance community well-being and specifically enabling coastal hazard mitigation activities;
- the extensive areas identified in Schedule C; and
- the fact that the rules make many activities in those areas non-complying activities.

That combination is not appropriate and needs to be revised so that kaitiakitanga can be exercised but also so that appropriate activities do not become non-complying activities because they happen to be in areas identified in Schedule C. Because a non-complying activity can only be granted consent if the effects are minor or the activity is not contrary to the objectives and policies in the plan, the combination is particularly problematic.

Decision sought:
Reconsider the combination of Policy P20 (and other relevant objectives and policies), the failure of the PNRP to include objectives and policies enabling more general appropriate use and specifically coastal hazard mitigation (including protection) activities, the extensive areas identified in Schedule C, and the fact that the rules make many activities in those areas non-complying activities when discretionary activity status is appropriate.

Revise the provisions so that kaitiakitanga can be exercised but also so that appropriate activities, including coastal hazard mitigation activities, do not become non-complying activities because they happen to be in areas identified in Schedule C.

Policy P24: Outstanding natural character - oppose and seek amendment

Reasons:
The policy is too uncertain as the areas of outstanding natural character in the coastal marine area have not been identified in the PNRP.

The policy also does not give effect to the NZCPS in that the areas have not been mapped or otherwise identified in the PNRP (see Policy 13(1)(c) and (d) of the NZCPS).

The references to "preserved" and "avoiding" are too extreme and again do not give effect to the NZCPS as Policy 13 refers to protecting against inappropriate subdivision, use and development which conveys the meaning that appropriate subdivision, use and development can be acceptable. Omitting the reference to that part of the Policy conveys a different meaning from that in the NZCPS.

It is also not clear what is meant by "outside the area" in (e).

Decision sought:
Delete the policy or notify a variation to identify the areas of outstanding natural character in the coastal marine area.

If the policy is not deleted, revise the policy to address the concerns expressed, including by making it less extreme and by giving effect to the NZCPS.

Policy P25: Natural character - oppose and seek amendment

Reasons:
As with the previous policy, this policy is too uncertain as areas with high natural character in the coastal marine area have not been identified in the PNRP. This policy does not give effect to the NZCPS in that the areas have not been mapped or otherwise identified in the PNRP (see Policy 13(1)(c) and (d) of the NZCPS).

The reference to "avoid" is too extreme. It does not give effect to the NZCPS as Policy 13 refers to protecting against inappropriate subdivision, use and development which conveys the meaning that appropriate subdivision, use and development can be acceptable. Putting the reference to inappropriate subdivision, use and development in (d) rather than in the introductory words of the policy conveys a different meaning from the NZCPS.

In d(ii), referring only to functional need is not sufficient or appropriate and does not give effect to the NZCPS. Policy 6 of the NZCPS does not require that there be a functional need for an activity to be located in the coastal marine area (see the reference in Policy 6(2)(d) to "generally"). Reference should also be made to operational requirement and also to activities that are more efficiently, effectively or cost-effectively located there (using appropriate terminology).

Decision sought:
Delete the policy or notify a variation to identify the areas of natural character and high natural character.

If the policy is not deleted, revise the policy to address the concerns expressed, including by making it less extreme, by giving effect to the NZCPS, and by widening d(ii) as discussed above.

Policies P26-P30 – oppose and seek amendment

Reasons:
See explanation under I. GENERAL AND WHOLE PLAN ISSUES, and in particular under the heading, "Whole plan - failure to address a range of matters relating to risk (including the definitions of "risk" and "risk-based approach (natural hazards)"), risk assessment, and risk management, including in relation to climate change and coastal hazard mitigation issues."

Decision sought:
Delete Policies P26-P30 in their entirety, including headings.

Replace with policies that use risk management and reflect risk assessment and management policies (i.e., a risk management approach) as set out in the NZCPS and generalised to natural resources where appropriate.

Ensure that none of the replacement policies refer to "high hazard areas" and instead align any such needed language to Policy 24 of the NZCPS which identifies "areas at high risk of being affected [by coastal hazards]".

In the development of such replacement policies, have regard to Policies 25-27 of the NZCPS and ensure any proposed policies are aligned with the risk management provisions of the NZCPS.

Include a replacement policy using a "risk management approach" to enable appropriate use and development in the coastal environment (see drafting recommendation above).

If the policy is not deleted, revise the policy to address the concerns expressed, including by making it less extreme and by giving effect to the NZCPS.

Policy P25: Natural character - oppose and seek amendment

Reasons:
As with the previous policy, this policy is too uncertain as areas with high natural character in the coastal marine area have not been identified in the PNRP. This policy does not give effect to the NZCPS in that the areas have not been mapped or otherwise identified in the PNRP (see Policy 13(1)(c) and (d) of the NZCPS).

The reference to "avoid" is too extreme. It does not give effect to the NZCPS as Policy 13 refers to protecting against inappropriate subdivision, use and development which conveys the meaning that appropriate subdivision, use and development can be acceptable. Putting the reference to inappropriate subdivision, use and development in (d) rather than in the introductory words of the policy conveys a different meaning from the NZCPS.

In d(ii), referring only to functional need is not sufficient or appropriate and does not give effect to the NZCPS. Policy 6 of the NZCPS does not require that there be a functional need for an activity to be located in the coastal marine area (see the reference in Policy 6(2)(d) to "generally"). Reference should also be made to operational requirement and also to activities that are more efficiently, effectively or cost-effectively located there (using appropriate terminology).

Decision sought:
Delete the policy or notify a variation to identify the areas of natural character and high natural character.

If the policy is not deleted, revise the policy to address the concerns expressed, including by making it less extreme, by giving effect to the NZCPS, and by widening d(ii) as discussed above.

Policies P26-P30 – oppose and seek amendment

Reasons:
See explanation under I. GENERAL AND WHOLE PLAN ISSUES, and in particular under the heading, "Whole plan - failure to address a range of matters relating to risk (including the definitions of "risk" and "risk-based approach (natural hazards)"), risk assessment, and risk management, including in relation to climate change and coastal hazard mitigation issues."

Decision sought:
Delete Policies P26-P30 in their entirety, including headings.

Replace with policies that use risk management and reflect risk assessment and management policies (i.e., a risk management approach) as set out in the NZCPS and generalised to natural resources where appropriate.

Ensure that none of the replacement policies refer to "high hazard areas" and instead align any such needed language to Policy 24 of the NZCPS which identifies "areas at high risk of being affected [by coastal hazards]".

In the development of such replacement policies, have regard to Policies 25-27 of the NZCPS and ensure any proposed policies are aligned with the risk management provisions of the NZCPS.

Include a replacement policy using a "risk management approach" to enable appropriate use and development in the coastal environment (see drafting recommendation above).

Include a replacement policy to specifically deal with coastal hazard mitigation and protection in areas of significant existing development (see drafting recommendation above).

Ensure that such policies provide decision-makers with sufficient flexibility to make appropriate decisions, depending on all of the facts of a case. It is not appropriate to preclude that flexibility.

Policy P29: Climate change - oppose and seek amendment

<u>Reasons:</u>
This policy fails to give effect to the NZCPS, including Policies 3, 24, 25 and 27, and reflects a misinterpretation of the NZCPS.

In terms of the misinterpretation of the NZCPS, please see paragraphs 26-45 of the attached document prepared by Joan Allin, former Environment Court judge, *"Notes on the Kapiti coastal erosion fiasco and problems caused more generally by a number of NZ coastal scientists"*.

The policy as worded is also likely to result in unreasonable outcomes, as is happening in NZ in relation to problems being caused by inappropriate work being done and policy actions being taken in relation to climate change, including the failure to consider the uncertainties and the range of likely climate change outcomes, as explained in the same document by Joan Allin.

The word "guidance" in P29(d) is inappropriate and relative sea level rise is more important than absolute sea level rise so what is likely to occur in the particular areas in the region is what is relevant. A generic regional study should not be given prominence.

<u>Decision sought:</u>
Revise the policy so that it addresses the concerns expressed and the relevant issues dealt with in the document *"Notes on the Kapiti coastal erosion fiasco and problems caused more generally by a number of NZ coastal scientists"*.

Revise the policy so that it gives effect to the proper interpretation of the NZCPS. Suggestions include wording such as:

> *"In assessing hazard risks account should be had for the likely effects of climate change as provided for under Policy 24 of the NZCPS 2010"*

Include reference to the need to consider the uncertainties and the range of likely outcomes.

Policies P39, P40, P41, P42, P44, P45 and the areas identified in the relevant schedules, including Schedules A, C, F1, F2, F3, F4, F5 - oppose and seek amendment

<u>Reasons:</u>
It is relevant to protect and restore important areas. But it is equally relevant for the reasons discussed in respect of the corresponding Objectives not to include policies that effectively would prevent appropriate activities in those areas or make consent for those activities unreasonably difficult or impossible to obtain. The emphasis in the Policies should be on the attributes that create the significant values, not the areas *per se*.

Further the extent of the areas identified in the relevant schedules is extensive, therefore the schedules need to be less extensive and/or the policies need to be less extreme.

Reference to the precautionary approach in Policy P41 is not appropriate as the RMA provisions provide for an appropriate level of "precaution" and for the reasons expressed in relation to Policy P3.

Decision sought:
Limit the extent of the areas identified in the schedules or qualify the schedules (and any relevant defined terms) and revise the policies so that they are less extreme and focus on the attributes of the areas that create the value.

Remove the reference to a precautionary approach in Policy P41 as the RMA provides the appropriate approach.

Policy P48: Protection of outstanding natural features and landscapes – oppose

Reasons:
The heading of the policy does not match the text in that the text does not just deal with outstanding natural features and landscapes.

The policy is too uncertain as the location of the areas of outstanding and other natural features and landscapes (including seascapes) have not been identified in the PNRP.

If it includes areas identified in the schedules, it is too extreme. In fact, as worded, it seems that it is referring to, basically, all natural features and landscapes (including seascapes) of the coastal marine area, rivers, lakes and their margins and natural wetlands. That is too extreme.

If it is relying in the NZCPS (Policy 15) for the wording of the policy, it is inappropriate to apply that wording beyond the coastal environment and in relation to a wide range of unidentified areas.

In addition, the references to "protected" and "avoiding" are too extreme, again the focus needs to be on the attributes that create the values and balances other uses against these.

Decision sought:
Delete the policy or notify a variation to identify the outstanding and other areas of natural features and landscapes (including seascapes) being referred to.

Revise the policy to address the concerns expressed, including by making the policy less extreme, including in relation to the references to "protected" and "avoiding".

Policy P49: Use and development adjacent to outstanding natural features and landscapes and special amenity landscapes - oppose and seek amendment

Reasons:
There is a real risk of this policy being inconsistent with the policies of the various district plans and how the provisions are implemented in those plans by the rules both now and over time.

It would be inappropriate, for example for more stringent or inappropriately different considerations to occur for activities in the coastal marine area compared with what would be the case if the activity occurred in the actual area identified in the district plan, when relying on a district plan for identification of the area.

Given the link to district plans of various districts, the policy needs to be kept general in the PNRP.

Decision sought:
Revise Policy P49 to address the concerns expressed above. An option is to make the policy much more general in referring to district plan provisions

Policy P103: Management of gravel extraction and any related rules - oppose and seek amendment

Reasons:
The title of the policy does not reflect the wording of the policy as it extends beyond just gravel extraction.

The policy does not adequately address the flow of gravel, sand or rock to the coast and the need to protect coastal areas and properties against excessive and inappropriate extraction from rivers.

Just protecting against coastal erosion is inadequate as things should not be allowed to get to that stage.

In addition, the flow of gravel, sand or rock to the coast should not be reduced to the extent that it:

- limits the flow of gravel, sand and rock to coastal areas where that gravel, sand and rock protects against sea level rise adverse effects;
- changes a neutral coastline to an eroding one; or
- changes an accreting coastline to a neutral or eroding one.

Along the northern coast of Kapiti, accretion has protected against sea level rise but in some areas the rate of accretion is slowing. Where the flow of gravel, sand or rock to the coast is interrupted, coastal areas may be adversely affected and that is inappropriate.

See for information, discussion of sediment supply and resultant sediment deficit as it pertains to the Kapiti Coast in the attached article, *"Kapiti Coast coastal hazard assessment"* by Dr Willem de Lange.

In relation to (c), if something is needed to address aggradation, the gravel should be moved, not extracted at a rate that exceeds the natural rates of gravel deposition.

Decision sought:
Revise title of the policy to refer to gravel, sand or rock extraction.

Revise the policy so that it addresses the concerns expressed above, including about the flow of gravel, sand or rock to the coast. Suggestions are:

- at the end of (b), add ", changing a neutral coastline to an eroding one, changing an accreting coastline to a neutral or eroding coastline, or reducing ongoing accretion in areas where continued accretion protects against ongoing sea level rise adverse effects" or something similar after the word "erosion";
- in (c) refer to "material" as opposed to "gravel" and remove "unless this is required to manage aggradation" from (c) and replace it with something along the lines of "unless the material extracted is moved to another location in the river bed".

Revise any related rules that need revision to put these decisions sought into effect.

Policy P132: Functional need and efficient use (and other relevant policies) - oppose and seek amendment

Reasons:
Earlier, the issue of inappropriate inconsistencies in language in the PNRP was addressed and an example given that:

- in a number of places there is reference to what is "practicable" e.g., Policies P4 P25, P27, and Policy 132(g);
- in other places there is reference to what is "reasonably practicable" e.g., Policy P47;
- in other places there is reference to what is "reasonable or practicable" e.g., Policies P132(b) and (c), and P139).

Indeed, there is inconsistency within this policy between (b), (c) and (g).

In addition, this policy does not cater for the situation where appropriate natural hazard mitigation measures might be able to be located elsewhere but are more efficiently, effectively or cost-effectively located in the coastal marine area.

The reference in (f) to "redundant" is potentially problematic. Structures might be built, become covered in sand but might, in fullness of time, be useful again.

Decision sought:
Revise the policy to address the concerns expressed.

Revise the policy so that language that is currently problematically inconsistent across the PNRP is made consistent. A suggestion is to replace "practicable" and "reasonable or practicable" in this policy with "reasonably practicable" and to use that terminology throughout the PNRP.

Revise the policy to enable the situation where appropriate hazard mitigation measures might be able to be located elsewhere but are more efficiently, effectively or cost-effectively located in the coastal marine area.

Reconsider (f), the use of the word "redundant" and, if it remains, provide a definition of "Redundant" so that for example, structures that might be built, become covered in sand but might, in fullness of time, be useful again are not caught.

Policy P134: Public open space values and visual amenity – oppose and seek amendment

Reasons:
The coastal environment can be extensive and can include numerous buildings, residential areas, etc. extending well inland. In Kapiti, in both the Proposed District Plan and the Submitter Engagement Version, significant built areas are included in the coastal environment.

Decision sought:
Revise the policy to address the concerns expressed.

An option is to, in (b), add "built and/or" before "natural character" or refer to degree of naturalness or similar to reflect the fact that the coastal environment includes significant built areas.

Policy P138: Structures in sites with significant values - oppose and seek amendment

Reasons:
The policy is inappropriate and too extreme in that it covers extensive areas and the policy says structures are to be avoided except for very limited exceptions.

Hazard mitigation structures or indeed other structures may well be appropriate in these areas and should not be disadvantaged by this policy.

In addition, this policy does not cater for the situation where there may be "practicable alternative methods" (to use the language of the policy) but something in the area would be the best practicable option or the alternative methods are not as efficient, effective or cost-effective as something in the area proposed.

Decision sought:
Delete the policy or make it less extreme to deal with the concerns expressed. A possible solution is to simply refer to avoiding, remedying or mitigating the effects of structures in the areas and remove "and in respect of (a) to (d): (e) there are no practicable alternative methods of providing for the activity".

Policy P139: Seawalls - oppose and seek amendment

Reasons:
The policy inappropriately asserts that construction of a new seawall is inappropriate except in extremely limited circumstances. It fails to give effect to Policy 27 of the NZCPS and fails to recognise that Policy 27 acknowledges that seawalls may be appropriate for purposes beyond those set out in Policy P139.

Policy 27(1) of the NZCPS identifies that a range of options for reducing coastal hazard risk should be assessed for protecting areas of significant existing development from coastal hazard risk. Policy 27(4) specifically recognises (with conditions, and it is relevant to note that the definition of environment in the RMA includes people and communities) the possibility of hard protection structures on public land to protect private assets.

Whether a seawall is appropriate or not should be addressed in all the circumstances of a case including e.g., whether millions or billions of dollars of property would be protected by it, after considering the range of options, not as a policy inappropriately ruling out one option in advance.

Decision sought:
Delete Policy P139 and replace it with a policy that gives effect to Policy 27 of the NZCPS, including that seawalls may be appropriate to protect areas of significant existing development from natural hazards.

Policy P143: Deposition in a site of significance - oppose and seek amendment

Reasons:
Given the extent of the areas covered by the policy, the policy needs to allow the activities in (a) to (f) with reasonable efficiency. The need to demonstrate that there are "no practicable alternative methods of providing for the activity" is excessive, costly and unnecessary.

In addition, the reference to "sand, shingle or shell" is unclear in terms of what is meant by "shingle" for example, would rock rip rap be included?

In addition, the wording of (b) and (d) is potentially problematic as it might be taken to infer that in coastal areas only renourishment is permitted but not flood protection and/or erosion mitigation. If that is what is intended, that is inappropriate and the policy needs to be revised so there is no potential for dispute. Coastal areas should not be treated differently from other areas.

Decision sought:
Clarify what is meant by "shingle".

Delete "and in respect of (a) to (f): (g) there are no practicable alternative methods of providing for the activity".

Reconsider (b) and (d) and include reference to coastal hazard mitigation (including protection), using terminology consistent with that developed for the PNRP.

Policy P145: Reclamation, drainage and destruction - oppose and seek amendment

Reasons:
While the definition of "reclamation" excludes coastal or river mouth protection structures, this policy could prevent appropriate coastal hazard mitigation, including protection works.

What is meant by "destruction" and how it relates to reclamation, disturbance, or damage is not clear.

Decision sought:
Revise the policy so that appropriate coastal hazard mitigation activities are enabled (using appropriate language that is consistent with that used in the PNRP).

Include definitions of "destruction", "disturbance", and "damage" so that the differences in meaning of the terms is clear.

CHAPTER 5 - RULES

Rules - general

Reasons:
Please also see the submissions and decisions sought under the heading "GENERAL AND WHOLE PLAN ISSUES".

Decision sought:
Please also see the submissions and decisions sought under the heading "GENERAL AND WHOLE PLAN ISSUES".

All of Chapter 5 - oppose and seek amendment

Reasons:
Except where support is expressed, all of Chapter 5 is opposed, including the rules, general conditions etc.

The rules and conditions do not appropriately reflect risk management approaches nor do they enable and address coastal hazard mitigation (including protection) activities, especially for areas of significant existing development.

Decision sought:
Revise Chapter 5, including the rules, general conditions, etc. to appropriately reflect risk management approaches and to enable and address coastal hazard mitigation (including protection) activities, especially for areas of significant existing development.

All of the matters addressed below and any suggested changes to provisions are subject to this general decision sought.

Chapter 5 - Interpretation explanation about if an activity is covered by more than one rule - support and seek amendment

Reasons:
At the beginning of the sections containing rules there is an interpretation statement:

> "If an activity is covered by more than one rule, then the rule that applies is the rule that is more specific for the relevant activity, area or resource. This does not apply where a proposal includes a number of activities which trigger separate specific rules. In that case, all rules are considered when assessing the proposal."

It is helpful to identify what should occur if an activity is covered by more than one rule and helpful to limit it to the more specific rule. However, there seems to be room for dispute as to what rules would apply to an activity, especially if there is a specific rule about an activity but also a specific rule about another activity or an area or resource.

On a matter as important as what rule(s) apply, the PNRP needs to be clear and unambiguous.

Decision sought:
Reconsider the Interpretation statement that deals with the situation where an activity is covered by more than one rule and ascertain if its meaning is beyond dispute so that there is no potential for debate as to what rule(s) apply, especially where there are also specific rules about certain areas or resources.

If its meaning is not beyond dispute, revise it so that its meaning is clear and there will be no dispute about what rules apply to an activity, area or resource when various specific rules might apply. Include the revised statement everywhere that it should be included.

Revise any rules that need to be revised to ensure that there is no dispute about which rule trumps others.

Chapter 5 - all general conditions and all rules and definitions - seek amendment

Reasons:
There are issues about inconsistencies and inappropriate wording throughout Chapter 5 in relation to:

- inconsistencies in the references to discharges and the location of the discharge;
- inconsistencies in general conditions throughout the PNRP;
- general conditions or conditions within rules that inappropriately result in the activity not being a permitted activity;

- lack of clarity in the meaning of the general conditions;
- inconsistencies in associated activities referred to in rules in different sections of the PRNP;
- inconsistencies within rules between associated activities and conditions;
- internal inconsistencies within some rules; and
- lack of clarity in terms of the meaning of rules that refer to "disturb", "damage", "destroy" (or variations of those terms), what those words mean and the implications of those words being missing from a number of the rules.

In relation to inconsistencies in the references to discharges and the location of the discharge, and just by way of example:

- in section 5.5.2, Wetlands general condition (a), there is reference to "sediment and other materials inherent to the water or bed";
- Rule 104 refers to "discharge of sediment to water", without referring to the other materials referred to above;
- Rule 42 refers to "discharge of contaminants into water, or onto or into land where it may
- enter water";
- Rules R149 and R150 refer to "discharge of contaminants" with no mention of where the discharge can be to;
- in section 5.7.2, Coastal management general conditions (f) refers to "sediment" but, in contrast to Wetlands general condition (a) does not refer to "other materials inherent in the water or bed".

These differences are inappropriate and unacceptable.

In relation to inconsistencies in general conditions throughout the PNRP, there are other significant differences between what are equivalent general condition discharge provisions. For example:

- general condition (a) in section 5.5.2 for wetlands says:

  > "there shall be no discharge of contaminants (including but not limited to oil, petrol, diesel, paint, or solvent) to water or the bed, other than sediment and other materials inherent to the water or bed, but excluding any discharge of heavy metals or other toxicants"; but

- general condition (a) in section 5.5.4 for beds of lakes and rivers says:

  > "except where the discharge is expressly allowed by the activity description of a rule in this chapter there shall be no discharge of contaminants (including but not limited to oil, petrol, diesel, paint, or solvent) to water or the bed, other than sediment and other materials inherent to the water or bed, but excluding any discharge of heavy metals or other toxicants"; and, in contrast to those two different general conditions

- general condition (e) in section 5.7.2 (coastal management general conditions) uses different terminology again and says:

> "There shall be no discharge of contaminants (excluding sediment which is addressed by clause (f)) to water or the foreshore or seabed, except where the minor discharge is permitted by another rule in this plan."

It is not clear why there are such differences between these general conditions. The differences are inappropriate and need to be resolved and the wording made consistent throughout the PNRP, the meaning of the conditions needs to be clear, and the conditions need to be such that they do not effectively remove permitted activity status.

In many cases, the condition effectively turns the permitted activity into something that is no longer a permitted activity as some discharge of contaminants other than just sediment is likely to occur as a necessary consequence of some of the permitted activities.

In terms of a lack of clarity in the meaning of the general conditions, and just by way of example, the problems with general condition (a) in section 5.5.4 include:

- what is meant by "expressly allowed"?
- does reference to discharges in a rule mean that a discharge is expressly allowed?
- or does the rule need to actually expressly allow a particular type of discharge?
- when for example, painting of a structure is permitted, is sanding material from sanding the structure to prepare it for painting or the occasional paint drop permitted or not?
- is painting a structure even permitted in the rules about beds of rivers/streams? Rule R149 (coastal) includes a note that painting is permitted but the equivalent rule for the beds of rivers/streams doesn't;
- when a structure is repaired or built and there are discharges of, for example, some sawdust or discharge of whatever is incidental to actually being able to carry out the activity, are the discharges incidental to the activity permitted or not?

The meaning needs to be made clear.

All differences between conditions on the range of matters addressed in general conditions in different chapters of the PNRP, and in rules throughout the PNRP, should be identified and remedied in an appropriately consistent manner and in a manner that does not result in an activity not being a permitted activity because of unfortunate general or other wording.

In relation to inconsistences in associated activities referred to in rules in different sections of the PRNP, the rules relating to beds of lakes and rivers and also for wetlands refer only to the associated activity of:

> "discharge of sediment to water";

but the rules for the coastal marine area refer to the associated activity of:

> "discharge of contaminants".

Again, these inconsistencies are inappropriate and, again, the wetlands/beds of lakes and rivers wording can effectively turn a permitted activity into something else as some discharge of contaminants other than just sediment is likely to occur as a necessary consequence of some of the permitted activities.

For the wetland and beds of lakes and rivers wording, there is also no reference to discharge to land in circumstances where a contaminant may enter water, which seems to be a foreseeable possibility in relation to some of the permitted activities.

Furthermore, in terms of inconsistences in associated activities referred to in rules in different sections of the PRNP, there are also significant differences between equivalent rules. For example, in relation to beach recontouring of the bed of a river (a permitted activity), Rule R119 refers to:

> "discharge of sediment to water associated with the clearing of flood debris", with no mention of anything relating to beach contouring; but

Rule R192, which deals with beach recontouring for coastal restoration purposes in the coastal marine area (a controlled activity) refers to:

> "discharge of contaminants".

The reason for the difference in the wording of the associated activities is not apparent and neither is the reason for one being a permitted activity and the other being a controlled activity.

There are also inconsistencies in that some associated activities that are included in some rules are not included in others. By way of example, there are a number of rules where reference to diversion of water has not been included as an associated activity but where it would seem to be appropriate to include it e.g., Rules R178 and R192 and some rules dealing with the beds of rivers and lakes/coastal marine areas.

In relation to some rules being internally inconsistent, by way of example, Rule R105 (in relation to wetlands) in (e) only permits the "discharge of sediment to water" but condition (h) says that only agrichemicals approved by the EPA are to be used. But the activity does not permit discharge of contaminants so no agrichemicals are permitted to be discharged. There is a conflict between the activity and the conditions.

Another example is Rule R207. The rule does not include diversion of water as an associated activity but under matters of control, item 3. refers to the effects of diversion associated with the activity.

Finally, there is the issue of lack of clarity in terms of rules that refer to "disturbance", "damage", "destruction" (or variations of those terms), what those words mean, and the implications of those words being included in, or missing from, a number of the rules.

A number of rules refer to disturbance but not damage or destruction. There are also rules that refer to "disturbance or damage" (e.g. Rules R194 and R195) and rules that refer to "destruction, damage or disturbance" (e.g. Rules R204 and R205). The differences in meaning of those terms, and therefore what the rules cover or do not cover, is unclear. That lack of clarity is particularly problematic for permitted activity rules that only permit "disturbance" if someone could argue that the "disturbance" was also "damage" (whatever that means) or indeed "destruction" (again, whatever that means).

<u>Decision sought:</u>
Reconsider all the general conditions and rules in Chapter 5 to address the range of concerns expressed.

Resolve the following matters in all of the general conditions, rules and definitions by using appropriate, clear and consistent language across the PNRP:

- inconsistencies in the references to discharges and the location of the discharge;
- inconsistencies in general conditions and conditions throughout the PNRP;
- general conditions or conditions within rules that inappropriately result in the activity not being a permitted activity;
- lack of clarity in the meaning of conditions;
- inconsistencies in associated activities referred to in rules in different sections of the PRNP and other inconsistencies in equivalent rules;
- inconsistencies within rules between associated activities and conditions;
- internal inconsistencies within some rules; and
- the issue of lack of clarity in terms of rules that refer to "disturbance", "damage", "destruction" (or variations of those terms), what those words mean, and the implications of those words being included in, or missing from, a number of the rules.

Identify and remedy, in an appropriate and consistent manner, all differences between conditions on the range of matters addressed in general conditions in different chapters of the PNRP, and in rules throughout the PNRP and in a manner that does not result in an activity not being a permitted activity (or other type of activity) because of unfortunate general or other condition wording.

Reconsider all of the references to discharges of various items, make them consistent, appropriate to the circumstances, and complete and clarify to where the discharge can be (e.g., water or onto or into land where it may enter water) either in each rule or as a general interpretation statement(s) that apply to sets of rules.

Whatever wording is adopted should be used consistently across all of the provisions in the PNRP.

Reconsider all rules where there is no reference to diversion of water as an associated activity and add the reference where appropriate.

In all of the rules, reconsider use of the terms "disturbance", "damage", "destruction" and make the rules consistent so that there is, for example, no gap in permitted activity status and/or include definitions of those terms so that what is covered or not covered in each rule is clear.

All the rules relating to activities in beds of rivers (including streams) and all rules relating to the coastal marine area - seek amendment

Reasons:
At river and stream mouths, some activities will be occurring both in the coastal marine area and in beds of rivers (including streams) e.g., river and stream cutting.

Currently, there is a mismatch between rules dealing with the coastal marine area and rules dealing with beds of rivers (including streams). Where an activity is occurring in the coastal marine area and the beds of a river, the rules and any relevant definitions should be appropriate and consistent.

Currently, they are not. Consider, for example:

- the rules that apply to cutting river/stream mouths in the coastal marine area vs those for the beds of rivers/stream; and
- the beach recontouring definitions, and therefore the rules, that differ between the coastal marine area and beds of rivers.

Decision sought:
Reconsider all rules relating to beds of rivers (including streams) and all rules relating to the coastal marine area to address the concerns expressed.

Where an activity may be occurring in the bed of a river (including a stream) and in the coastal marine area for example, river (including stream) mouth cutting or beach recontouring or any other such activity, make the rules governing such activities, including any relevant definitions, appropriate and consistent both in the coastal marine area and in the bed of the river.

5.5.2 - Activities in wetlands general conditions and all relevant rules - seek amendment

Reasons:
Please see the reasons above under the heading "Chapter 5 - all general conditions and all rules and definitions - seek amendment".

The definition of "natural wetland" in the PNRP includes areas in the coastal marine area and in beds of lakes and rivers.

The rules provide for a range of activities as permitted activities. General condition (a) runs the risk of effectively precluding some permitted activities or making them unreasonably difficult to comply with by saying that there is no discharge of contaminants "other than sediment and other materials inherent to the water or bed".

In addition, that wording is not consistent with the wording of the actual rules, which refer only to "sediment" and make no mention of the ability to discharge "materials inherent to the water or bed".

General condition (a) would seem to be directly contrary to, for example, Rule R105(h) which refers to agrichemicals being used and therefore presumably permitting some discharge of agrichemicals i.e. a contaminant into the water. Furthermore, Rule R105(h) seems to be directly contrary to Rule R105(k).

Decision sought:
Please see the reasons above under the heading "Chapter 5 - all general conditions and all rules and definitions - seek amendment".

Revise (a) to that it does not effectively turn permitted activities into something else by the restrictions on the discharge of contaminants and so that its wording is consistent with the wording of the actual rules or vice versa and consistent with wording to be adopted across the PNRP.

Reconsider the wording of all of the rules relating to wetlands to ensure the above and to ensure that there are not inconsistencies between the rules and the general conditions or within the rules or inconsistencies with general conditions or rules in other sections of the PNRP.

Section 5.5.3 Activities in wetlands - Rules R104 to R111 - oppose and seek amendment

Reasons:
The definition of "natural wetland" in the PNRP includes areas in the coastal marine area and in beds of lakes and rivers, is widely defined and so it is not entirely clear what might be considered to be a wetland.

It seems that the intention is that river and stream cutting would override all of these rules. However, there are rules here about specific wetland areas that could potentially mean that cutting of river and stream mouths by GWRC would not be a permitted activity (e.g. Rule R108(b) or Rule R110(d)) if river or stream mouth cutting occurs in the relevant wetland areas.

The rules also potentially restrict or prohibit appropriate flood or erosion or other hazard mitigation measures.

In addition, there are some problematic drafting issues. Rule 104 and other rules in this section refer to "discharge of sediment to water" but Rules R149 and R150 refer to "discharge of contaminants" with no mention of water or where the discharge can be to. There should be consistency of terminology across the PNRP. Equivalent rules should be worded in equivalent, and appropriate, ways.

In relation to the wetlands rules, wetlands general conditions in 5.5.2(a) run the risk of overriding permitted activities by permitting no discharge of contaminants - rather Shylock-esque. Interestingly, that condition refers to sediment or other materials inherent to the water or bed, but Rule R104 does not include reference to "other materials inherent to the water or bed".

Decision sought:
Revise the rules or the definitions to ensure that cutting of river and stream mouths is a permitted activity and not restricted by any of these rules.

Revise the rules to ensure that appropriate hazard mitigation measures are not captured by the rules and ensure that hazard mitigation measures are not non-complying or prohibited activities.

Reconsider the wording of the rules to address apparent inconsistencies between the general conditions and conditions of some rules, apparent inconsistencies of conditions within rules, and apparent inconsistencies between general conditions and rules in this section and general conditions and rules in other sections.

Section 5.5.4 Activities in beds of lakes and rivers general conditions and all rules that relate to beds of lakes and rivers - seek amendment

Reasons:
Please see the reasons above under the heading "Chapter 5 - all general conditions and all rules and definitions - seek amendment".

As explained earlier, general condition (a) in section 5.5.4 for beds of lakes and rivers says:

> "except where the discharge is expressly allowed by the activity description of a rule in this chapter there shall be no discharge of contaminants (including but not limited to oil, petrol, diesel, paint, or solvent) to water or the bed, other than sediment and other materials inherent to the water or bed, but excluding any discharge of heavy metals or other toxicants".

In contrast, general condition (e) in section 5.7.2 (coastal management general conditions) says:

> "There shall be no discharge of contaminants (excluding sediment which is addressed by clause (f)) to water or the foreshore or seabed, except where the minor discharge is permitted by another rule in this Plan."

It is not clear why there are such differences between general condition (a) in section 5.5.4 and general condition (e) in section 5.7.2. These differences are inappropriate and need to be resolved and the wording made consistent throughout the PNRP, the meaning of the conditions needs to be clear, and the conditions need to be such that they do not effectively remove permitted activity status.

In terms of general condition (a) in section 5.5.4, problems include:

- what is meant by "expressly allowed"?
- does reference to discharges in a rule mean that a discharge is expressly allowed?
- or does the rule need to actually expressly allow a particular type of discharge?
- when for example, painting of a structure is permitted, is sanding material from sanding the structure to prepare it for painting or the occasional paint drop permitted or not?
- is painting a structure even permitted in the rules about beds of rivers/streams? Rule R149 (coastal) includes a note that painting is permitted but the equivalent rule for the beds of rivers/streams doesn't;
- when a structure is repaired or built and there are discharges of for example, sawdust or discharge of whatever is incidental to actually being able to carry out the activity, are the discharges incidental to the activity permitted or not?

The meaning needs to be made clear.

Any other differences between conditions on the range of matters addressed in general conditions in different chapters of the PNRP, and in rules throughout the PNRP, should be identified and remedied in an appropriately consistent manner and in a manner that does not result in an activity not being a permitted activity because of unfortunate general or other condition wording.

In addition, the rules relating to beds of lakes and rivers and also for wetlands (in contrast to rules in the coastal marine area), refer only to the associated activity of:

> "discharge of sediment to water".

In many cases, that condition effectively turns the permitted activity into something else as some discharge of contaminants other than just sediment is likely to occur as a necessary consequence of some of the permitted activities.

There are also significant differences between equivalent rules. For example, in relation to beach recontouring of the bed of a river (a permitted activity), Rule R119 refers to:

> "discharge of sediment to water associated with the clearing of flood debris", with no mention of anything relating to beach contouring; but

Rule R192, which deals with beach recontouring for coastal restoration purposes in the coastal marine area (a controlled activity) refers to:

> "discharge of contaminants".

The reason for the difference in the wording of the conditions is not apparent and neither is the reason for one being a permitted activity and the other being a controlled activity.

In addition, some rules are internally inconsistent. Just by way of example, Rule R105 (in relation to wetlands) in (e) only permits the "discharge of sediment to water" but condition (h) says that only agrichemicals approved by the EPA are to be used. But the activity does not permit discharge of contaminants so no agrichemicals are permitted to be discharged.

<u>Decision sought:</u>
Please see the reasons above under the heading "Chapter 5 - all general conditions and all rules and definitions - seek amendment".

Revise general condition (a) in section 5.5.4 and relevant rules to address the problems discussed above to satisfactorily resolve issues including:

- what is meant by "expressly allowed"?
- does reference to discharges in a rule mean that a discharge is expressly allowed?
- or does the rule need to actually expressly allow a particular type of discharge?
- when for example, painting of a structure is permitted, is sanding material from sanding the structure to prepare it for painting or the occasional paint drop permitted or not?
- is painting a structure even permitted in the rules about beds of rivers/streams? Rule R149 (coastal) includes a note that painting is permitted but the equivalent rule for the beds of rivers/streams doesn't;
- when a structure is repaired or built and there are discharges of for example, sawdust or discharge of whatever is incidental to actually being able to carry out the activity, are the discharges incidental to the activity permitted or not?

Rule R119: Clearing flood debris and beach recontouring - permitted activity and Rule R192: Beach recontouring for coastal restoration purposes - controlled activity - seek amendment

<u>Reasons:</u>
Please see the reasons above under the heading "Chapter 5 - all general conditions and all rules and definitions - seek amendment".

As noted earlier, there are significant differences between equivalent rules. In relation to beach recontouring of the bed of a river (a permitted activity), Rule R119 refers to:

> "discharge of sediment to water associated with the clearing of flood debris", with no mention of anything relating to beach contouring; but

Rule R192, which deals with beach recontouring for coastal restoration purposes in the coastal marine area (a controlled activity) refers to:

> "discharge of contaminants".

The reason for the difference in the wording of the associated activities is not apparent and neither is the reason for one being a permitted activity and the other being a controlled activity.

<u>Decision sought:</u>
Please see the reasons above under the heading "Chapter 5 - all general conditions and all rules and definitions - seek amendment".

Section 5.7 - use of the term "open coastal water" throughout this section (and anywhere else in the PNRP) - seek amendment

<u>Reasons:</u>
In various places, the term "open coastal water" is used. Given the definition of the term in the RMA, in a number of cases (if not all cases) "open coastal water" is not a correct term to use. By way of example, to use that term in the context of river mouth cutting is inappropriate. Many of the coastal management rules inappropriately refer to diversion of "open coastal water" being permitted when the permitted activity should preferably refer to diversion of "water".

<u>Decision sought:</u>
Reconsider all references to "open coastal water" throughout the PNRP and replace them with "water" or if there is a valid reason why "water" is not acceptable, then with "coastal water".

Section 5.7 - Coastal management general conditions and all of the rules that refer to them - seek amendment

<u>Reasons:</u>
Please see the reasons above under the heading "Chapter 5 - all general conditions and all rules and definitions - seek amendment".

There is a confusing interaction between the coastal management general conditions and the rules that refer to them, especially between:

- general condition (e) which says that there shall be no discharge of contaminants (excluding sediment which is addressed by clause (f)) to water or the foreshore or seabed, except where the minor discharge is permitted by another rule in this Plan; and

- the rules in this section that include discharge of contaminants but also refer to complying with the general conditions. Where the activity for example, painting, replacing a structure can result in the discharge of contaminants other than sediment, the interaction is confusing and potentially results in the activity not being a permitted activity.

<u>Decision sought:</u>
Please see the reasons above under the heading "Chapter 5 - all general conditions and all rules and definitions - seek amendment".

In the rules that permit discharge of contaminants, remove the confusing interaction between the coastal management general conditions and the rules that refer to them, preferably by indicating that general condition (e) does not apply.

All rules relating to structures and all rules relating to seawalls - seek amendment

<u>Reasons:</u>
The interaction between the rules about structures and the rules in section 5.7.6 about seawalls is potentially confusing.

In addition, some structures may have associated material deposition that is not part of the structure but that is there to help to protect the structure e.g., rocks.

It is not clear whether "any associated ... deposition ..." in the rules about structures and seawalls would include that protection material or not. It seems that it would not as loose material separate from the structure or seawall would not come within the definition of structure and presumably is not part of the seawall, but protecting the seawall.

There needs to be provision to allow activities in relation to the associated material e.g., disturbing the foreshore/seabed by moving the rocks, depositing new rocks, occupation of space by the rocks.

Decision sought:
Make it clear that the rules about structures apply to seawalls except for those explicitly different in section 5.7.6 or create new rules in the seawalls section that deals with matters that are missing in relation to the seawall rules e.g., maintenance and repair.

Include a note in the relevant general structure rule referring the reader to the different seawall provision.

For all rules about structures and seawalls (and any other relevant rules), the rules need to be expanded (or new rules created or definitions created) to address associated activities that are not structures e.g., materials to protect the structures but that are not attached to the land so do not come within the definition of structures e.g., disturbing the foreshore/seabed by moving the material, depositing new material, or the occupation of space by the material.

Rule R162: New structures, additions or alterations to structures inside sites of significance - non-complying activity and related rules - oppose and seek amendment

Reasons:
Given the extent of the areas covered by this rule, it is inappropriate for flooding and erosion mitigation structures or other coastal hazard mitigation activities to be non-complying activities.

The proposed rules relating to dredging for flood and erosion control purposes can be used as an appropriate guide. Rule R201 makes dredging for flood protection purposes or erosion mitigation inside sites of significance a discretionary activity, with dredging outside those sites a controlled activity.

Decision sought:
Revise the rule and related rules (or create new rules) to address the concerns expressed throughout this submission.

Make coastal hazard mitigation (including protection) structures outside sites of significance a permitted, controlled or restricted discretionary activity with structures inside sites of significance being a discretionary activity.

Rule R163: Replacement of structures or parts of structures - permitted activity - seek amendment

Reasons:
Replacement of structures is supported but the requirement in (f) of a functional need or operational requirement does not give effect to Policy 27 of the NZCPS. It may be more efficient, effective or cost-effective to replace the structure in the existing location and this should be permitted.

Decision sought:
Remove condition (f).

5.7.6 Rules about seawalls Rules R165 to R167 - oppose and seek amendment

Reasons:
Please see the reasons throughout this submission about the need for appropriate rules for coastal hazard mitigation (including protection) activities, especially for areas of significant existing development.

There is also a need to address the material that may be associated with a seawall but that is not attached to the land so is not a structure e.g., rip rap.

Given the extent of the areas covered by Rule 167 and the fact that seawalls would likely be built only to protect significant assets, it is inappropriate for it to be a non-complying activity.

One option (based on the approach to dredging for flood and erosion control purposes) could be to revise the rules to address the concerns expressed throughout this submission and also to move each of these rules down a category of activity for coastal hazard mitigation (including protection) activities.

Decision sought:
Amend the rules about seawalls to address the concerns expressed throughout this submission, especially in relation to areas of significant existing development.

Amend the rules or create new rules to address the material that may be associated with a seawall e.g., rip rap but that is not attached to the land so is not a structure and that includes occupation of space in the coastal marine area.

Make coastal hazard mitigation (including protection) structures outside sites of significance a permitted, controlled or restricted discretionary activity with structures inside sites of significance a discretionary activity.

Rule R192: Beach recontouring for coastal restoration purposes - controlled activity and Rule R119: Clearing flood debris and beach recontouring - permitted activity - seek amendment

Reasons:
Please see the reasons above under the heading "Chapter 5 - all general conditions and all rules and definitions - seek amendment".

As noted earlier, there are significant differences between equivalent rules. In relation to beach recontouring of the bed of a river (a permitted activity), Rule R119 refers to:

> "discharge of sediment to water associated with the clearing of flood debris", with no mention of anything relating to beach contouring; but

Rule R192, which deals with beach recontouring for coastal restoration purposes in the coastal marine area (a controlled activity) refers to:

> "discharge of contaminants".

The reason for the difference in the wording of the associated activities is not apparent and neither is the reason for one being a permitted activity and the other being a controlled activity.

Decision sought:
Please see the reasons above under the heading "Chapter 5 - all general conditions and all rules and definitions - seek amendment".

Reconsider why Rule R119 is a permitted activity but Rule R192 is a controlled activity and make them both either one way or the other.

Consider whether reference to diverting water should be included in all of these rules as moving material for the beach grooming could arguably result in diversion of water when the water reaches that area.

Rule 193: River and stream mouth cutting - permitted activity and the lack of an equivalent rule for rivers and streams outside the coastal marine area - seek amendment

Reasons:
It is appropriate to permit river and stream mouth cutting and that is supported. The river and stream mouth cutting is not only in the coastal marine area but also in the beds of the rivers and streams. It is inappropriate to have rules with different provisions for the same activity depending on whether it happens to be in the coastal marine area or not. There needs to be an equivalent rule to Rule R193 prepared to permit river and stream mouth cutting in beds of rivers and streams.

Reconsider the terminology "river and stream". The definition of river in the RMA includes stream.

The reference in (c) to "open coastal water" is inappropriate in light of its definition in the RMA.

The list of associated activities includes discharge of contaminants twice. As noted already, there are inconsistencies in the PNRP in terms of references to where the discharge is permitted to be.

Decision sought:
Change the references from "river and stream" to "river (including stream)" here and anywhere else such terminology occurs in the PNRP.

Change the reference in (c) from "open coastal water" to "water" and anywhere else inappropriate "open coastal water" terminology appears in the PNRP.

Check the list of associated activities, remove the duplicated reference to "discharge of contaminants", consider whether in this rule and in all other rules the location of the discharge of contaminants should be specified rather than being silent (or say, at the beginning of the rules, that where there is silence it means to e.g., to water, or onto or into land in circumstances where it may enter water, or any other appropriate provision), and make the list complete and consistent with equivalent lists in all other rules.

Create a new rule that is the equivalent of Rule 193 but that deals with river and stream mouth cutting in the beds of rivers (including streams) or otherwise ensure that appropriate provision is made for such activities in beds of rivers (including streams).

Rule R194: Disturbance or damage - discretionary activity and Rule R195: Disturbance or damage inside sites of significance - non-complying activity - seek amendment

Reasons:
Given the general nature of this rule, the extent of the areas covered by Rule R195, the reference to "damage" that is missing from most of the other rules, these general rules are potentially problematic.

The lack of reference to diversion of water seems problematic.

Decision sought:
Reconsider the relationship between these general rules and all of the other rules, including their reference to "damage" that is missing from most of the other rules.

Revise these and all other rules to address the concerns expressed throughout this submission.

Consider whether diversion of water should be added.

Ensure that any coastal hazard mitigation (including protection) activities, including soft and hard engineering activities, are no worse than discretionary activities.

Rule R196: Motor vehicles - permitted activity - oppose and seek amendment

Reasons:
Motor vehicle are not permitted by cities and districts in certain areas along the coast e.g., in front of some areas of housing for safety purposes.

The disturbance of the foreshore and seabed from motor vehicles in those areas should not be a permitted activity.

That would enhance the safety issues and enable any person to take enforcement action, both of which are benefits.

Decision sought:
Exclude from this rule the areas in districts where motor vehicles are not permitted (and areas seaward of those areas).

A suggestion is to create a new map, identify all of these areas and exclude these areas from Rule R196 and, with appropriate exceptions, make such an activity a discretionary activity.

Rule R197 - Motor vehicles for certain purposes - permitted activity - seek amendment

Reasons:
The reference to "local authority activities" is not sufficiently clear. The rule needs to cover not only work done by local authorities and but also work done by others (e.g. contractors) on behalf of local authorities. It also needs to cover activities done by or on behalf of local authorities that arguably might not come within the wording of "local authority activities" (whatever that actually means).

There should also be reference to coastal hazard mitigation (including protection) activities as these may not be done by or on behalf of local authorities. They could be done by virtue of a consent obtained by e.g., an organisation of affected residents rather than by the local authority.

Decision sought:
Change "local authority activities" here and anywhere else that term (or any similar term) is used in the PNRP to activities carried out "by or on behalf of local authorities" or similar wording (wording in Rule R207 is "by, or for, a local authority" but that is less desirable wording) to convey the message that the provision covers not only work done by local authorities and but also work done by others (e.g., contractors) on behalf of local authorities for a range of purposes.

Include coastal hazard mitigation (including protection) activities (using appropriate terminology) as one of the purposes so that motor vehicles (the PNRP definition includes heavy machinery) for that purpose are permitted activities.

Rules R200 and R201 - dredging - support and seek amendment

Reasons:
The general approach to dredging for flood protection or erosion mitigation measures is supported and should also be adopted for coastal hazard mitigation (including protection) measures generally i.e. no activity being a non-complying activity.

Please see the concerns expressed elsewhere in this submission.

Decision sought:
Please see the decisions sought elsewhere in this submission.

Rules R204 and R205 - Destruction, damage or disturbance and general concerns about terminology throughout the rules - seek amendment

Reasons:
It is not clear what activities these rules will deal with and how they relate to other rules. The references to destruction, damage and disturbance differ from some earlier rules which, for example, only refer to disturbance.

Destruction, damage or disturbance of what should be set out in the rule.

As expressed before, given the extent of the areas in Rule R205, it is not acceptable for activities in those areas to be non-complying activities.

Decision sought:
Reconsider the terminology used in all of the rules to ensure that it is consistent and appropriate.

Destruction, damage or disturbance of what needs to be set out.

How these rules relate to other rules, that do not refer to destruction or damage needs to be addressed and remedied.

The meaning of "damage" and "destruction" should be clarified, perhaps by a definition to clarify what exactly is damage or destruction of the foreshore or seabed and how those terms differ from, and relate to, "disturbance".

Make Rule R205 a discretionary activity or otherwise address the concerns expressed throughout this submission.

Rule R207: Deposition for beach renourishment - controlled activity - support and seek amendment

Reasons:
Subject to the reasons expressed, and decisions sought, elsewhere in this submission, making this a controlled activity is supported.

Reference is made in (d) to “by, or for, a local authority” but “by or on behalf of” is preferable.

There should be reference to associated diversion of water, which is not mentioned, despite the point that matters of control, item 3.refers to the effects of diversion associated with the activity.

Decision sought:
Please see the decisions sought in the rest of the submission.

Add diversion of water to this rule and to all other relevant rules as deposition may divert water when the water reaches that area.

Change (d) “by, or for, a local authority” to “by, or on behalf of, a local authority” and use that terminology consistently throughout the PNRP when reference is made to things being done by a local authority or local authority activities so it is clear that the work can be done by others who are not part of the local authority.

Rules R208 and R209 - Deposition - seek amendment

Reasons:
Given the extent of the areas covered by this rule, it is inappropriate for deposition to be a non-complying activity for deposition that is for coastal hazard mitigation (including protection) activities.

In relation to structures or seawalls, it is not clear if the activities associated with those rules would cover deposition of e.g., rock to protect the structure or seawall or if these deposition rules would cover that.

Occupation of space of the material does not seem to have been addressed sufficiently.

The existing rules relating to dredging can perhaps be used as an appropriate a guide. Rule R201 makes dredging for flood protection purposes or erosion mitigation inside sites of significance a discretionary activity with dredging outside those sites a controlled activity.

Decision sought:
Revise the rule and related rules (or create new rules) to address the concerns expressed here and throughout this submission.

Clarify if the structures or seawalls rules cover the deposition of material to protect those structures (where the material is not attached to the land or the structure) or whether these rules apply.

Add reference to associated diversion of water.

Add reference to occupation of space in the coastal marine area for whatever rules do apply to the material used to protect any structures or seawalls or other materials deposited for coastal hazard mitigation (including protection) activities.

In terms of categorisation of the activities, a suggestion is that deposition outside sites of significance should be a permitted, controlled or restricted discretionary activity with deposition inside sites of significance being a discretionary activity.

CHAPTER 6 - OTHER METHODS

Other methods – general – seek amendment

Reasons:
Please also see the submissions and decisions sought under the heading "GENERAL AND WHOLE PLAN ISSUES".

Decision sought:
Please also see the submissions and decisions sought under the heading "GENERAL AND WHOLE PLAN ISSUES".

Other methods – omission – Coast care partnership projects and programmes - seek amendment

Reasons:
Beach and dune systems throughout the Wellington region are designated open space zones and esplanade reserves. Along with the foreshore and seabed, these natural environments are a part of the public domain, and as such, direct responsibility for the maintenance and enhancement of these natural environments lies with local regulators.

There is a requirement in the region for the coordinated, proactive management of the beach and dune resources in the same way as the regional parks and reserves are proactively managed by GWRC. Project and programme initiatives for the coastal environment need to be broad ranging, including the preparation of documented strategies and plans (with clearly assigned agency responsibilities) for pest plant management, native planting and erosion control, sand replenishment and dune reconstruction projects, public access projects, environmental monitoring programmes, and community education and awareness campaigns.

The present 'care group' community partnership programme model is woefully inadequate both in terms of funding as well as regulatory breadth, focus and management. It is a passive approach to (non)management of the coastal environment which relies on the public to approach the council with environmental maintenance and enhancement proposals and subsequently compete for the funding of their specific initiative. This manner of passive, ad hoc reserves management where the region's coastal assets are concerned is unacceptable.

A serious step-change in commitment from GWRC for the coordinated, proactive management of the region's beach and dune reserves is needed. Numerous provisions within the NZCPS require it.

Decision sought:
Include a method outlining GWRC's intention to take the lead role in the coordination of a partnership programme between Department of Conservation, city and district councils and their communities to proactively manage the beach and dune reserve environments and restore the form and function of the dune systems in the Wellington region.

Chapter 6 Other Methods – Method M3: Wellington regional hazards management strategy - seek amendment

Reasons:
Please see relevant comments throughout this submission.

It is unclear whether this is intended to cover all natural hazards or coastal hazards only.

The reference to "work in in partnership with ... stakeholders" lacks clarity in intention, both with respect to the type of participatory process envisioned as well as the determination of stakeholder groups. Natural hazard management strategies must be developed using a genuinely collaborative process, facilitated by regulators but led by local communities. In particular such a strategy development process must proactively seek participation by those property owners likely to be the most directly impacted by a particular natural hazard in order to achieve local support and buy-in for successful implementation.

Decision sought:
Revise the method to address the concerns above, in particular, when expanding on the intention refer to a "genuinely collaborative process" and "local communities of stakeholders, including affected property owners".

Clarify more specifically what natural hazards such a strategy is intended to address.

Chapter 6 Other Methods - Method M4: Sea level rise - seek amendment

Reasons:
Please see the relevant comments throughout this submission.

Given the poor-quality approach by local and central government authorities in New Zealand to dealing with sea level rise and coastal hazard risks as well as problems caused by some experts (see the attached paper *"Notes on the Kapiti coastal erosion fiasco and problems caused more generally by a number of NZ coastal scientists"*), GWRC should not be developing regional guidance on its own. It needs to do this in partnership with city and district councils and stakeholders, including affected property owners and any such guidance should be made available for public comment before it is produced. It is the affected property owners that will have to manage these risks in the first instance.

Proper statistical input should be obtained as statistical input was an important recommendation of the Kapiti international coastal panel.

There should be objective information on the uncertainties (see for example, the joint Australian and New Zealand International Standard on risk management is AS/NZS ISO 31000:2009 "Risk management - Principles and guidelines"), the range of likely sea level rise outcomes over what likely timeframes to enable submitters to participate effectively in any RMA processes.

That Standard has been discussed earlier under the heading "Whole plan - failure to address a range of matters relating to risk (including the definitions of "risk" and "risk-based approach (natural hazards)"), risk assessment, and risk management, including in relation to climate change and coastal hazard mitigation issues".

GWRC should be seeking contestable and broad based expert advice, should explicitly advise any professionals that what is provided should not be tainted by conservative or precautionary considerations, needs to be based on likely, not unlikely impacts of climate change and should not simply be producing a number and purporting to say that it is the sea level rise that should be

adopted for the Wellington Region. It should be made clear that the uncertainty needs to be quantified so it can be used in subsequent risk analysis and management.

Please see the attached paper *"Kapiti coastal hazard assessment"* by Dr Willem de Lange.

Decision sought:
Revise the method to address the concerns above, including the concerns in the attached paper *"Notes on the Kapiti coastal erosion fiasco and problems caused more generally by a number of NZ coastal scientists"* and the concerns expressed throughout this submission.

Revise the Method M4 to say "will work in partnership with city and district councils and stakeholders, including affected property owners, to develop..."

Add reference to using appropriate statistical input, information on the uncertainties, and the range of likely sea level rise outcomes over what likely timeframes.

Add that the purpose is to enable a "consistent, robust and high-quality approach..."

Add reference to draft guidance being provided for public comment.

CHAPTER 10 - KĀPITI COAST WHAITUA

Kāpiti Coast Whaitua – general – seek amendment

Reasons:
Please also see the submissions and decisions sought under the heading "GENERAL AND WHOLE PLAN ISSUES".

Decision sought:
Please also see the submissions and decisions sought under the heading "GENERAL AND WHOLE PLAN ISSUES".

Chapter 10 Kapiti Coast Whaitua all provisions relating to taking groundwater - seek amendment

Reasons:
The provisions in this chapter seem to conflict with Rule R136 that provides that taking groundwater in certain circumstances is a permitted activity. That rule also includes a note drawing the reader's attention to s 14(1)(b) of the RMA that provides, among other things, for taking water for an individual's reasonable domestic needs.

Decision sought:
State in Chapter 10 that Rule R136 and s 14(1)(b) of the RMA override all of the provisions and rules in Chapter 10.

SCHEDULES

All of the Schedules - oppose and seek amendment

Reasons:
All of the Schedules are opposed for reasons expressed elsewhere in this submission.

Decision sought:
Revise the schedules to appropriately address the concerns expressed.

MAPS

All of the maps - oppose and seek amendment

Reasons:
All of the maps are opposed for reasons expressed elsewhere in this submission.

Decision sought:
Revise the maps to appropriately address the concerns expressed.

III. ATTACHMENTS

All attachments are to be read in conjunction with reasons and decisions sought throughout this submission, and taken into account in relation to those submissions.

This supporting material is provided as attachments to this submission in the order of their first appearance/reference within this submission:

1. *"Notes on the Kapiti coastal erosion fiasco and problems caused more generally by a number of NZ coastal scientists*" by Joan Allin.

2. "*The precautionary principle and its role in coastal risk management under the New Zealand Coastal Policy Statement and the Resource Management Act*" by CRU Inc.

3. *"Kapiti Coast coastal hazard assessment"* by Dr Willem de Lange.

Notes on the Kapiti coastal erosion fiasco and problems caused more generally by a number of NZ coastal scientists

1. In these notes, I explain:

   a. what has happened in the Kapiti coastal erosion fiasco where the exact same results have morphed from:
      i. "likely"; to
      ii. "based on a worst case scenario" but worse than what and by how much were not explained; to
      iii. "very unlikely";

   b. my reactions to, and some opinions about, what has happened; and

   c. problems being caused more generally by a number of New Zealand coastal scientists who, in my opinion, are misinterpreting or ignoring the law and misunderstanding their role in the context of the Resource Management Act 1991 (RMA) and the New Zealand Coastal Policy Statement 2010 (NZCPS 2010 or in full).

2. I address:

   a. Kapiti long-term erosion/accretion;

   b. Kapiti reports/documents on coastal erosion;

   c. the problems that the independent panel of international and NZ coastal experts and a statistician (Coastal Panel)[1] engaged by Kapiti Coast District Council (KCDC) identified with the Coastal Systems Limited (CSL) reports;

   d. the practice of ignoring accretion, which is contrary to Policy 24(1)(b) of the NZCPS 2010;

   e. what KCDC has done in response to the Coastal Panel's report and an independent planning/legal report;

   f. the morphing information as to Kapiti results, where the exact same results have gone from:
      i. "likely"; to
      ii. "based on a worst case scenario" but worse than what and by how much were not explained; to
      iii. "very unlikely";

   g. some relevant statutory, and related, provisions;

   h. how some NZ coastal scientists interpret the law and approach their role;

   i. some hints to the contrary from the Environment Court;

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[1] Dr Paul Komar (USA), Mr James Carley (Australia), Dr Paul Kench (NZ) and Dr Robert Davies (NZ statistician).

j. the problems with providing only very unlikely results or overstating results;

k. risk management and uncertainty - AS/NZS ISO 31000:2009 *Risk management - Principles and guidelines*; and

l. in conclusion, NZCPS 2010 provisions, the recommendations of the Coastal Panel vs conventional practice of NZ coastal experts, and what, in my opinion, submitters and decision-makers are entitled to expect from scientific reports and coastal experts.

3. By way of background, our property was not affected by CSL's 50 year lines. The 100 year line touched the seaward side of our house. We were not concerned when we received the letter from KCDC advising us of this "likely" outcome. The concerns that I have are professional rather than personal.

4. During my career[2], I have encountered many well-meaning, but ultimately misguided, concerned citizens. I have read and evaluated many scientific and technical reports and dealt with expert evidence. I did not even intend to read the CSL reports as I assumed that the reports were validly prepared and that the residents were misguided. However, due to the ongoing controversy over the reports, I eventually felt that I should at least read CSL's 2012 Update to satisfy myself that it was valid. I was stunned (and not in a good way) by what I read and ultimately discovered.

5. It has been difficult to get to the bottom of the nature of the CSL results. It has taken me far too many hours, and several years, to uncover that the CSL results are not:

a. "likely" as initially described by KCDC; or

b. "precautionary" or "conservative", terms used in the 2008 and 2012 reports; or

c. "based on a worst case scenario" as later described by KCDC; but

d. "very unlikely" as described on CSL's own website in March 2015.

6. Over time, I have also developed concerns about what other NZ coastal experts are doing. It seems that a number of them consider that it is appropriate in the RMA/NZCPS 2010 context to provide only results that are very unlikely, or overstated. That does not accord with my view of the nature of scientific results that coastal experts should be providing. In my opinion, providing only very unlikely or overstated scientific results undermines (and in the Kapiti case sabotaged) the RMA/NZCPS 2010 process.

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[2] Senior lecturer in law at Victoria University, resource management partner at Chapman Tripp, independent hearings commissioner, Principal Environment Judge (ie the chief judge) and an alternate Environment Judge of the Environment Court. Now retired.

Kapiti long-term erosion/accretion

7. The southern part of the Kapiti coast has been affected by long-term erosion (although some predictions of erosion made in the past have not occurred).

8. The net effect of coastal processes (including the ongoing long-term sea level rise) on the central and northern parts of the Kapiti coast has not been erosion, but accretion.

9. A positive outcome of the CSL reports was demonstrating the areas of longer-term erosion and accretion, and that the trends are not linear.

Kapiti reports/documents on coastal erosion

10. The various reports/documents (including my comments on some of them) have been:

    a. 2003 Lumsden report on coastal erosion.

    b. 2005 Coastal Systems Limited (CSL[3]) review of Lumsden report which found it wanting.

    c. CSL 2008 (March 2008) Open Coast report[4] and Inlets report[5]:
        i. 50 years;
        ii. references to "precautionary" and "conservative";
        iii. KCDC puts process on hold pending updated New Zealand Coastal Policy Statement.

    d. CSL 2012 Update[6] (August 2012) to take account of the New Zealand Coastal Policy Statement 2010:
        i. 50 and 100 years;
        ii. accretion not included where report says progradation (accretion) is "expected" ie generally the central and northern parts of the Kapiti coast;
        iii. under Policy 24(1)(b) NZCPS 2010, the Council is to have regard to the "short-term and long-term natural dynamic fluctuations of erosion and accretion";
        iv. numerous references to "precautionary" and some to "conservative" strike me as unusual for a scientific report;
        v. precautionary assumption added to precautionary assumption added to precautionary assumption;
        vi. peer review of 2012 Update is 1 page "Overview comments" (Appendix H), which refers to results being "necessarily conservative (precautionary)", purportedly to comply with the 2008 MFE Guidance Manual;
        vii. flashing lights to me saying "investigate further";
        viii. and then I read the 2007 peer reviewer report.

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3 The author of all of the CSL reports that I refer to is Dr Roger Shand.

4 Available at http://www.kapiticoast.govt.nz/Documents/Downloads/District-Plan-Review/coastal-hazards/Kapiti_Coast-Erosion_Hazard_Assessment_Part1_Open_Coast.pdf.

5 Available at http://www.kapiticoast.govt.nz/Documents/Downloads/District-Plan-Review/coastal-hazards/Kapiti_Coast_Erosion_Hazard_Assessment_Part2_Inlets.pdf.

6 Available at http://www.kapiticoast.govt.nz/Documents/Downloads/District-Plan-Review/coastal-hazards/Kapiti_Coast_Erosion_Hazard_Assessment_2012_Update.pdf.

e. 2007 CSL "Summary of Peer Reviewer comments on the KCDC Open Coast Erosion Hazard Report"[7], February 2007 (2007 Compilation) - 50 years. The following quotes are from the author of the CSL reports:

> "Given the conservative manner in which all the components have been derived, coupled with the extrapolation uncertainty noted above, it is recommended that the 50 yr values be used be adopted [sic], with an understanding that they are [sic] can be applied to a 50 to 100 yr period if a hazard review is undertaken at 10 yr intervals." (page 20)
>
> "In an effort to simplify the computation method - thereby facilitating hazard update by future council staff, the method of combining hazard components has now been modified. All positive (acretionary) [sic] long-term rates of change have been set to 0. This practice is becoming more common in hazard assessment. The approach also remove [sic] the models [sic] reliance on trend continuity. This approach has effectively <u>doubled the hazard distances along the north coast</u>." (underlining is original, page 23)

So:

- the components are so conservative that the 50 year results could be used for 100 years, with reviews;
- with $1 billion+ of property affected, to simplify the computation method "thereby facilitating hazard update by future council staff", all accretionary long-term rates of change are set to 0; and
- the effect of putting accretion at 0 is to double the hazard distances along the north coast.

That's all rather startling.

This February 2007 compilation (over a year before the March 2008 reports were finished), the 3 page "Peer Review" of the 2008 Inlets report and the 1 page "Overview comments" in the 2012 Update are the only peer review documentation available and, in my opinion, demonstrate the superficiality of the peer review.

f. 29 November 2012 - KCDC Proposed District Plan notified under the RMA:
   i. will eventually replace the operative District Plan (does not just deal with coastal erosion);
   ii. CSL reports are used as the basis for no-build and relocatable zones.

[7] Not currently available on KCDC's website but I understand that KCDC may add it to the website.

g. September 2013 - CSL report on the northern shore of the Waimeha Inlet[8] produces different results:
   i. "The 1973 and 1988 aerial photo-based inlet shorelines used for the previous assessments were of poor quality so improved imagery was acquired, processed and shorelines abstracted." (page 6);
   ii. lines moved substantially seaward, if not completely off, the property of the landowner.

h. November 2013 - CSL draft (but not released[9]) report for the Mangaone Inlet produces different results:
   i. original reports - "it was not considered necessary to carry out a separate hazard assessment for a managed inlet scenario" (2008 Inlets report page 27, see also the 2012 Update page 36) for the Mangaone Inlet. That was despite the inlet being managed, the 2008 report identifying the management regime[10], the 2012 Update referring to the stream mouth cutting[11] and KCDC's terms of reference for CSL stating that managed and unmanaged scenarios should be done;
   ii. revised outcome (now providing a managed scenario) = 2 or 3 properties affected, not around 30[12].

i. January 2014 - CSL report for the Waikanae estuary in the vicinity of Kotuku Parks subdivision[13] produces different results:
   i. "Both the managed and unmanaged lines are now seaward of the Kotuku Parks boundary by about 40 m with the managed line adjustment increasing up to about 65 m in the northern sector" (page 7).

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8 Available at http://www.kapiticoast.govt.nz/Documents/Downloads/District-Plan-Review/coastal-hazards/reports/Erosion-Hazard-Reassessment-northern-shoreline-of-Waimeha-Inlet.pdf.

9 The version that KCDC has is labelled "DRAFT" and "NOTE this is a DRAFT assessment for professional review. This document is not to be forwarded without the authors [sic] permission." It is not on KCDC's website.

10 Page 27 of the 2008 Inlets report, section 3.4.1 states: "More recently, erosion and flood prevention management has been carried out when formal trigger conditions defined in the Wellington Regional Coastal Plan are exceeded. In particular, *stream mouth cutting is carried out when the channel outlet within the coastal marine area migrates either 100 m south or 300 m north of Te Horo Beach Road ....*, or when *the water level increases 300 mm or more above its normal level at Sims Road*." (emphasis original).

11 The 2012 Update records "... more recently, stream mouth cutting has been carried out to prevent lateral migration of the channel." (page 36).

12 In the draft managed scenario report, our property is not affected at all.

13 Not currently available on KCDC's website but I understand that KCDC may add it to the website.

j. mid 2013 - June 2014 - KCDC appoints independent Coastal Panel - 2 international coastal experts (USA[14] & Australia[15]), 1 New Zealand coastal expert[16] and 1 statistician[17] to review the CSL reports. The Coastal Panel's report[18]:
   i. identifies numerous problems with the CSL reports;
   ii. ironically, rejects CSL's approach to the short-term component in favour of Lumsden's, but subject to qualifications;
   iii. concludes "... the hazard lines recommended by CSL are not sufficiently robust to be incorporated into the Proposed District Plan ...". (section ES.1 Overview, see also page 51).

k. December 2013 - June 2014 - KCDC appoints Richard Fowler QC and senior planner Sylvia Allan to review the Proposed District Plan (PDP). Their report[19]:
   i. has significant recommendations regarding the PDP generally, but not that it be totally withdrawn;
   ii. recommends that all of the coastal hazard provisions be removed from the PDP.

Coastal Panel - problems with the CSL reports

11. The Coastal Panel identified a number of problems in the CSL reports, including:

   a. intentionally double-counting the recession caused by sea level rise - "Purposely double counting is a decidedly unconventional approach, and should not be followed ..." (page 34);

   b. concern that there may also be double counting when the "catch up" term is applied to some areas where a sea wall is lost or removed (page 29). "In the modelling of the "remove sea-walls" scenario the "catch-up" term in the 100-year projection appears to be incorrectly handled. It is doubled ... It should be left as is." (page 45);

   c. inappropriate approach to the short-term component - "the CSL assessments of the short-term hazards cannot be viewed as being robust ...". "It is the recommendation of this Panel that the analysis methodologies applied by Lumsden (2003) be adopted ...", subject to qualifications (section ES.4 see also pages 37-39);

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14 Dr Paul D Komar, Emeritus Professor of Oceanography, Oregon State University, USA.

15 Mr James T Carley, Principal Coastal Engineer, Water Research Laboratory, UNSW, Australia.

16 Dr Paul S Kench, Professor and Head of Department, School of Environment, University of Auckland.

17 Dr Robert B Davies, Statistician, Statistics Research Associates Limited, Wellington.

18 Available at http://www.kapiticoast.govt.nz/Documents/Downloads/District-Plan-Review/Proposed-District-Plan/Independent-review/Coastal_Erosion_Hazard_Assessment_Review_of_the_science_and_assessments_undertaken_for_the_PDP.pdf.

19 Available at http://www.kapiticoast.govt.nz/Documents/Downloads/District-Plan-Review/Proposed-District-Plan/Independent-review/Independent_Review_of_the_Kapiti_Coast_PDP.pdf.

d. failure to include accretion where it exists -

   i. "The Panel recognises that CSL is correct in this [setting accretion at 0 in accreting coasts] being a common practice ... although in the case of the [Kapiti] Coast it represents a rather extreme assumption that future rates of rising sea levels will overcome the positive balance provided by the sediment budget. The question of this being a valid assumption, that the cuspate foreland would soon disappear under rising sea levels, could be addressed by an evaluation of the sediment budget ..." (page 30). (CSL did not do a sediment budget).

   ii. "Along with revised open coast assessments, scenarios of change [for inlets] under accretionary coast conditions should be considered" (section ES.5, see also pages 44 and 53);

e. in relation to the dune stability component, "More elevated portions of the coast (south of about Raumati) are subject to more complex slope stability processes than the simple dune stability model used in CSL (2008a). Issues include (but may not be limited to) the sand grain size adopted and the assumption of dry sand. It is recommended that specialist geotechnical engineering advice be sought regarding slope stability in these areas" (page 40);

f. the inlets reports produced a "first approximation" of inlet erosion hazards (repeated several times on pages 43 and 44 of the Coastal Panel's report, although neither the CSL 2008 Inlets report nor the 2012 Update described the inlets approach as a "first approximation"). Weaknesses in the inlets approach include a number of matters (see pages 43, 53 and section ES.5) including:

   i. the approach masks the variability in the alongshore dynamics of inlet entrances;

   ii. the approach assumes that the lagoon shorelines will migrate landward, which ignores the likely primary control on such shorelines;

   iii. it assumed the coast will be erosional/recessionary, despite evidence that some parts of the coast and inlets have been in net accretion in the past; and

   iv. how the inlet and open coast hazard zones are merged should be reconsidered and a transparent procedure invoked;

g. a number of statistical technique issues (page 45):

   i. "It is recommended that studies such as these involve an experienced statistician, preferably one familiar with time-series analysis. There seems to have been only limited involvement of a statistician in the CSL analyses";

   ii. "...the simple regression analysis, linear or not, used in the CSL analyses is likely to be inappropriate for the data sets considered here.";

iii. "From a statistical perspective, it is recommended that "best estimates" rather than precautionary values be adopted, with margins of error or factors of safety kept separate from the estimates and added at the end if appropriate. Alternatively, one could give several scenarios based on best, worst and mid-way cases.";

iv. "An economic assessment of the consequences of planning restrictions needs to be undertaken before imposing them, since the restrictions may have been made on the basis of calculations which may be excessively precautionary. One needs to balance the cost to property owners of any restrictions with the actual risk (and its time scale) and one can't do this if there are hidden "precautionary" adjustments."

12. As already noted, the Coastal Panel concluded:

> "... the hazard lines recommended by CSL are not sufficiently robust to be incorporated into the Proposed District Plan ...". (section ES.1 Overview, see also page 51).

13. The Coastal Panel also said (page 47):

a. "Adaptive management provides a realistic alternative to excess speculation regarding definitive future coastal hazards."; and

b. "The assessment of coastal hazard zones should consider a range of plausible scenarios (e.g. low, mid, high, or best estimate and extremes)."

Practice of ignoring accretion is contrary to Policy 24(1)(b) of the NZCPS 2010

14. I return to the Coastal Panel's comment that:

> "The Panel recognises that CSL is correct in this [setting accretion at 0 in accreting coasts] being a common practice ... although in the case of the [Kapiti] Coast it represents a rather extreme assumption that future rates of rising sea levels will overcome the positive balance provided by the sediment budget."

15. It may be that a practice of ignoring accretion has developed over time among New Zealand and/or overseas coastal experts. However, such a practice cannot override the express provision introduced in New Zealand in Policy 24(1)(b) of the NZCPS 2010 that a Council is to assess hazard risks having regard to:

> "short-term and long-term natural dynamic fluctuations of erosion and accretion" (emphasis added).

16. If coastal scientists in New Zealand had developed a practice of ignoring accretion, such a practice should have stopped as of 3 December 2010 to enable Councils to fulfil their obligations under the NZCPS 2010.

What KCDC has done in response to the Coastal Panel and the Planning/Legal reports

17. KCDC has:

a. withdrawn the coastal hazard provisions of the PDP;

b. put a disclaimer, outlined in red, on the CSL reports on the KCDC website:

> "Disclaimer: before reading this report you need to be aware that an independent panel of coastal experts has found that the information contained in this report is not appropriate for planning purposes. A further independent planning report has subsequently recommended that the Council withdraw from the Proposed District Plan the coastal hazard management areas associated with this report and undertake further work in regard to the underlying methodologies for use in relation to future planning for the [Kapiti] District. The information contained in this report should not therefore be relied upon.";

c. removed the projected shorelines maps from KCDC's website;

d. withdrawn the information on the LIMs but included a general comment about coastal erosion;

e. stopped using the CSL reports as a basis for putting a notice on a property title under the Building Act if a building consent is granted for construction of a building, or major alterations to a building, on land that is subject or is likely to be subject to coastal erosion. KCDC's letter dated 19 December 2013 to property owners said that the endorsements that had been put on title would be reviewed and, where necessary, removed at no cost to the owner. Further building consents are being dealt with under the operative District Plan or on a case-by-case basis, not the PDP or CSL reports;

f. started reviewing all of the PDP and taking steps for further relevant coastal erosion work to be done;

g. written to CSL about misleading statements on the CSL website. The letter dated 12 February 2015 said:

> "... For the record the Council does not accept that the independent panel identified "very few issues" and that the CSL report is "fit for purpose"...
>
> It is therefore difficult to see how any reasonable person could conclude that the CSL report is "fit for purpose"... The Council will not hesitate to make its views known to any person making inquiries about the work CSL carried out for the Council on coastal hazards...
>
> The Council wishes to make it quite clear to you that it disassociates itself from the statements made on the CSL website regarding the Kapiti erosion assessments."

18. As of March 2015 (the website records that the page was updated 15 March 2015), the information in the Kapiti Erosion Hazard Assessments tab on the CSL website became more misleading further to KCDC's letter, not less. The CSL assertions are misleading, contain errors of law and fact, and should not be relied upon.

Morphing information as to Kapiti results

19. Over time, the CSL results have morphed from:

a. "likely" and "likely risk of significant erosion or inundation" (KCDC letter of 25 August 2012 to affected residents); to

b. "based on a worst case scenario" (KCDC letter of 18 January 2013 to affected residents) - worse than what and by how much were not explained; to

c. "Very unlikely" (CSL website March 2015).

20. 25 August 2012 letter to affected residents - the coastal hazard assessment:

> "... predicts where the shoreline is <u>likely to be</u> along [Kapiti] Coast within 50 and 100 years...
>
> Around 1,800 properties - including most beachfront properties in the district - are <u>at likely risk of significant erosion or inundation</u> (flooding) within 100 years. Up to 1,000 of these may be affected within 50 years." (emphases added)

21. 3 September 2012 - the then Mayor's column "A Moment with our Mayor" in the *Kapiti Observer*:

> "Around 1800 coastal properties in Kapiti are <u>likely to be at significant risk</u> of coastal erosion within the next 100 years and up to 1000 of these within the next 50 years.
>
> ...
>
> We have also been briefing a number of other significant stakeholders including local real estate agents, lawyers and valuers.
>
> At this point it is not known what effect this will have on property values, although an economic study in Whakatane District shows this information did not have a long term impact.
>
> Council's current policy is to maintain and protect roads and public health infrastructure (water supply, stormwater and sewerage) in the short term. However, we will progressively move public infrastructure away from areas of high risk.
>
> I completely empathise with residents who are anxious about this new direction and encourage you to visit our website ...
>
> Have a good week." (emphasis added)

22. KCDC was obviously under the impression that the CSL reports were providing information as to what was likely to occur. Busy telling real estate agents, lawyers and valuers. Considering what to do about infrastructure. Considering the effect on property values. Empathising with affected residents.

23. 5 months later, on 18 January 2013, - KCDC letter to affected residents - the assessment is:

> "based on a worst case scenario"

but worse than what and by how much were not identified.

24. March 2015 - CSL website's newly-created key to the Kapiti projected shorelines maps describes the results as:

> "Very unlikely".

25. So, between August 2012 and March 2015, the exact same results have morphed from likely to very unlikely. In my opinion, that is appalling.

Some relevant statutory, and related, provisions

26. The CSL reports were prepared for RMA purposes, including the NZPCS and district plans. Under s 75(3)(b) of the RMA, a district plan must give effect to the NZCPS 2010.

27. The NZCPS 2010 states:

> "This NZCPS is to be applied as required by the [RMA] by persons exercising functions and powers under the [RMA]." (page 7).

28. It is therefore the role of the Council (or the Environment Court) to apply the NZCPS 2010 as required by the RMA, not the role of coastal scientists.

29. Policy 24 states the functions of the Council in relation to the identification of coastal hazards:

> **"Policy 24 - Identification of coastal hazards**
>
> (1) Identify areas in the coastal environment that are potentially affected by coastal hazards (including tsunami), giving priority to the identification of areas at high risk of being affected. Hazard risks, over at least 100 years, are to be assessed having regard to:
> (a) physical drivers and processes that cause coastal change including sea level rise;
> (b) short-term and long-term natural dynamic fluctuations of erosion and accretion;
> (c) geomorphological character;
> (d) the potential for inundation of the coastal environment, taking into account potential sources, inundation pathways and overland extent;
> (e) cumulative effects of sea level rise, storm surge and wave height under storm conditions;
> (f) influences that humans have had or are having on the coast;
> (g) the extent and permanence of built development; and
> (h) the effects of climate change on:
> (i) matters (a) to (g) above;
> (ii) storm frequency, intensity and surges; and
> (iii) coastal sediment dynamics;
>
> taking into account national guidance and the best available information on the likely effects of climate change on the region or district." (emphases added)

30. I have often seen Policy 24 set out incorrectly. The mistake that people make is indenting the words at the end ie "taking into account ... the likely effects of climate change on the region or district" so it looks like those words are part of (h). But they are not part of (h). They form the ending of what is a long sentence that effectively reads:

> "Hazard risks, over at least 100 years, are to be assessed having regard to [(a) to (h)] taking into account ... the best available information on the likely effects of climate change on the region or district."

31. Setting out Policy 24 incorrectly affects its meaning.

32. Policy 24 effectively says that the Council's function is to:

> "(1) Identify areas in the coastal environment that are potentially affected by coastal hazards (including tsunami), giving priority to the identification of areas at high risk of being affected. Hazard risks, over at least 100 years, are to be assessed having regard to [(a) to (h)] taking into account national guidance and the best available information on the likely effects of climate change on the region or district." (emphases added)

33. Risk is defined in the NZCPS 2010 as:

> "Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence ...". (emphasis added)

34. So, to carry out its functions under Policy 24, a Council needs to:

   a. identify areas potentially affected by coastal hazards, with the hazard risks being assessed taking into account the likely effects of climate change;

   b. give priority to the identification of areas at high risk of being affected;

   c. in assessing risk (likelihood x consequences), consider the likelihood of coastal erosion occurring and the consequences.

35. Policy 25 of the NZCPS 2010 deals with "areas potentially affected by coastal hazards", so "potentially affected" is used on its own there. However, it is my view that it should be read in the context of Policy 24, which specifically deals with the "[identification of] areas ... potentially affected by coastal hazards" and also refers to the likely effects of climate change (and hazard risks), so that Policy 25 addresses areas identified by Policy 24.

36. Policy 27 of the NZCPS 2010 identifies the range of options the Council should assess for reducing coastal hazard risks in areas of significant existing development likely to be affected by coastal hazards. These areas should also have been identified by the Council during the Policy 24 process, as a subset of the other areas.

37. The first part of Policy 27 states:

> **"Strategies for protecting significant existing development from coastal hazard risk**
>
> (1) In areas of significant existing development likely to be affected by coastal hazards, the range of options for reducing coastal hazard risk that should be assessed includes: ..." (emphases added)

38. Affected Kapiti properties = $1 billion+.

39. Providing only "very unlikely" results, especially in Kapiti (or in other areas of significant existing development):

   a. does not provide KCDC (or any Council) with the appropriate scientific information that it needs to carry out its tasks;

   b. does not enable the community to participate in the RMA process with appropriate scientific information; and

   c. wastes resources as it does not enable the Council to focus attention on the areas where options for reducing coastal hazards are actually needed ie the areas likely to be affected.

40. Policy 3(2) of the NZCPS 2010 states:

> "In particular, adopt a precautionary approach to use and management of coastal resources potentially vulnerable to effects from climate change, so that:
> (a) avoidable social and economic loss and harm to communities does not occur;
> (b) natural adjustments for coastal processes, natural defences, ecosystems, habitat and species are allowed to occur; and
> (c) the natural character, public access, amenity and other values of the coastal environment meet the needs of future generations."

41. Some coastal scientists seem to have interpreted this provision as applying to them and therefore think that their scientific assessment of coastal hazards should be precautionary. Indeed, according to CSL's website as at March 2015, a number apparently consider that their results should be "very unlikely".

42. I have had a coastal expert (not any expert referred to on the CSL website) confidently tell me to my face that they need to provide precautionary results, and look at me like I was an idiot for thinking otherwise.

43. However:

    a. the provision is referring to what Councils are to do (not coastal scientists);

    b. it relates to "use and management of coastal resources" so, planning and resource consent matters, not identification of the hazards which is addressed in Policy 24;

    c. it uses different wording from Policies 24 to 27 ie "potentially vulnerable" so it is arguable whether it should be read in light of Policy 24 or not which makes it all the more important for coastal experts to prepare assessments based on objective science so that no matter what way the law is interpreted or what specific policies apply, the decision-maker has the relevant scientific basis for the decision;

    d. it refers to adopting a precautionary approach to use and management of coastal resources potentially vulnerable to effects from climate change, <u>so that avoidable social and economic loss and harm to communities does not occur</u>. In my view, that reads both ways. Too stringent provisions can cause avoidable social and economic loss and harm to communities as can too lenient provisions.

44. In short, Policy 3 does not direct that coastal hazard assessments should be precautionary.

45. Confirmation of that also comes from DOC's Guidance note on Policy 3 that says "The application of the precautionary approach is a risk management approach rather than a risk assessment approach." (page 6)

46. Other relevant statutes for different purposes:

a. Section 44A(2)(a) Local Government Official Information and Meetings Act 1987 different - matters to be included in a land information memorandum (LIM) are:

> "information identifying each (if any) special feature or characteristic of the land concerned, including but not limited to potential erosion, ... [that] ... is not apparent from ... a district plan under the [RMA]" (emphasis added).

Potential erosion is referred to on its own without qualifications. The provision ceases to apply when the district plan deals with the matter so limited effect. The reference to the district plan is relevant in that a Council would not normally expect to receive a report in the nature of CSL's reports, identifying only very unlikely results, for district plan purposes.

This is the provision the *Weir v KCDC* High Court judicial review case was about [2013] NZHC 3522 and [2015] NZHC 43.

b. Sections 71-74 Building Act 2004 - relevant to notices on title for building consents - s 71(1)(a) refers to land which:

> "is subject or is likely to be subject" (emphases added) to natural hazards.

If a person obtains a building consent for construction of a new building, or major alterations to a building, on land that is subject or is likely to be subject to a natural hazard, a notice goes on the property title about the hazard. A coastal hazard assessment that doesn't identify land that is subject or is likely to be subject to coastal erosion jeopardises Council's use of the Building Act, as has happened in Kapiti.

How some NZ coastal scientists interpret the law and approach their role

47. One wonders how the exact same results can morph from:

a. "likely"; to

b. "based on a worst case scenario" (but worse than what and by how much were not explained); to

c. "very unlikely".

48. It seems extraordinary for that to be able to occur. How could such a thing happen, with $1 billion+ of property affected?

49. If I hadn't lived through it myself I would have found it difficult to believe that such a thing could happen.

50. My view is that it has occurred because some coastal scientists are:

a. misinterpreting or ignoring the law;

b. misunderstanding their proper role in the RMA process;

c. providing only very unlikely results (or results of that ilk);

d. failing to explain clearly the nature of such results (instead, referring to precautionary, conservative, potential) thereby camouflaging the very unlikely nature of the results;

e. failing to get proper statistical input;

f. failing to report the uncertainties;

g. providing false certainty of overstated results; and

h. unintentionally undermining, or indeed sabotaging, the RMA processes.

51. I have already noted that the district plan must give effect to the NZCPS 2010. I have set out some elements of Policies 3, 24, 25 and 27 and discussed the relevant wording. All of the provisions of the NZCPS 2010 are relevant, including the objectives and policies.

52. It is the Council's role (not coastal scientists) to give effect to the NZCPS 2010 in the district plan.

53. It is the role of the coastal scientist to provide appropriate objective, scientific information:

a. to enable submitters to participate in the RMA process; and

b. decision-makers to make appropriate decisions,

in an informed manner.

54. Some NZ coastal scientists seem to be usurping the decision-maker's role in deciding that only "precautionary" or "conservative" or "potential" results should be provided without clarifying how precautionary or conservative the results are or what the coastal scientist means by potential - and compared to what. Some are providing only results that are very unlikely.

55. The Supreme Court in *Sustain our Sounds Inc v The New Zealand King Salmon Company Ltd* [2014] NZSC 40 said:

> "[157] We accept that public participation is a key tenet of decision making under the RMA with many public participatory processes... As noted by Keith J in *Discount Brands Ltd v Westfield (New Zealand) Ltd*, the purpose of these processes is to recognise and protect the particular rights of those who are affected and to enhance the quality of the decision making."

56. The extract below is from the CSL website under the tab Kapiti Erosion Hazard Assessments (the website indicates that the page was updated on 15 March 2015). The extract is interesting (though troubling) in its failure to understand the difference between the High Court judicial review LIM statutory context and the NZCPS 2010/RMA context, and in what it says about how coastal practitioners interpret their role:

> "The 2008 assessment had been carried out conservatively enough to meet the "potential" hazard (risk) level specifically stipulated in the NZCPS 2010, along with additional requirements to allow for increased uncertainty associated with predicted climate change. It is noted that "potential erosion" is typically interpreted by practitioners as erosion occurring under an extreme set of circumstances and as such is "very unlikely" to occur. It is noted that the High Court has recently defined potential erosion as a "reasonably possible worst case scenario... i.e. a worst case scenario objectively determined and evidentially based" (CIV-2012-485-2577 [2015] NZHC 43). Such definitions are entirely appropriate as developers, prospective purchasers and insurers want to know that in the future their property of interest will be virtually free of erosion hazard." (emphasis added)

57. The newly-created key (as of March 2015) for the Kapiti projected shorelines maps on CSL's website identifies that CSL's Kapiti results are "Very unlikely".

58. So, the extract and the newly-created key are saying that, in the RMA context and according to the NZCPS 2010, coastal practitioners consider that their proper role is to provide only very unlikely results.

59. It becomes particularly problematic if coastal scientists consider it their role to provide only very unlikely results, but label them in ambiguous ways such as precautionary, conservative, or potential, thus camouflaging the fact that they are providing results that are, in fact, "very unlikely".

60. It is relevant to note that there is no reference in the CSL 2008 reports or the 2012 Update to the results being a worst case scenario, let alone a reasonably possible one. The language about a worst case scenario started with KCDC's letter to affected residents in January 2013.

61. Instead, the CSL 2008 and 2012 reports use the terms "precautionary" or "conservative", but just how precautionary or conservative, or precautionary or conservative compared to what, is not explained.

62. Kapiti has many areas of significant existing development. KCDC obviously considered that it was being given results that were likely, not very unlikely.

63. Using ambiguous language to describe "very unlikely" results is not helpful.

64. In addition, the idea that it is the role of coastal scientists to provide only "very unlikely" results in the RMA and NZCPS 2010 context:

   a. ignores the difference between s 44A of the Local Government Official Information and Meetings Act (where the word "potential" erosion is used on its own) and the RMA and Policies 24, 25 and 27 of the

NZCPS 2010 where it is not[20], as has already been discussed;

b. ignores the difference between judicial review of LIMs where there is a low threshold for assuming the validity of results and the RMA process where the "science and the reliability of his 50 and 100 year lines will be put to the test", as noted by the High Court in para [35] of the interim judgment;

c. fails to understand that it is the role of the coastal scientist to provide objective, scientific results to enable submitters to participate, and decision-maker to make decisions, based on results that are fit for purpose;

d. fails to understand that it is the role of the Council (or the Environment Court) to apply the Policy 3 precautionary approach, not the coastal scientist.

65. I refer to the point in b in the preceding paragraph about ignoring the difference between judicial review of LIMs where there is a low threshold for assuming the validity of results and the RMA process where the "science and the reliability of his 50 and 100 year lines will be put to the test". In the final judgment, the High Court said:

> "[7] The panel has since found, I am advised, that the Shand lines were not sufficiently robust to warrant their inclusion in the District Plan. With that finding in hand, the Council has now resolved to remove the lines from all LIMs because, according to Mr Stephens, they do not now meet the criteria for mandatory disclosure in s 44A(2). There remains on the LIMs some precautionary wording about coastal erosion, the terms of which have been agreed between the parties...
>
> [17] ... In truth, the review panel undertook its work in the context of the Council's consideration of the proposed District Plan. That is evidence that the system works as it was designed to work. As I said at [53] of the interim judgment:
>
>> I am satisfied that Mr [sic] Shand's science is sufficiently robust to satisfy that relatively low threshold requirement [i.e. a reasonable possibility of erosion]. Of course I say nothing at all about whether the Shand Report and the Shand lines should survive a more rigorous merit-based review through the District Plan Review process under the Resource Management Act 1991. That is not my arena. [the square brackets in the quote are the Court's]
>
> [18] The merits of the Shand lines were tested and found wanting...".

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20 As already noted, Policy 25 of the NZCPS 2010 deals with "areas potentially affected by coastal hazards", so "potentially affected" is used on its own there. However, it is my view that it should be read in the context of Policy 24, which specifically deals with the "[identification of] areas ... potentially affected by coastal hazards" and also refers to the likely effects of climate change (and hazard risks), so that Policy 25 addresses areas identified by Policy 24.

66. KCDC had affidavits from 4 coastal scientists in the *Weir v KCDC* case. The interim judgment includes statements that, in my view, demonstrate that coastal scientists are misunderstanding their role:

> "[47] It is also reflected, Mr Stephens argued, in the Ministry for the Environment's Coastal Hazards and Climate Change Guidelines ...:
>
> > Coastal erosion, on the other hand, at present tends not to be expressed probabilistically. As it is an ongoing process (a creeping hazard) it is usually defined as the expected position of the coast at a certain future point in time. [emphasis added]
>
> [48] The thrust of the evidence of scientists for KCDC was that the lines provide a sound worst case prediction over the assessment period using orthodox and up-to-date methods, together with an appropriately precautionary approach as required by the NZCPS." (emphases added)

67. The coastal scientists have apparently:

    a. failed to consider that the MFE Guidelines refer to the "expected position" of the coast, not the worst case or very unlikely position;

    b. failed to consider the reference in Policy 24 to the "likely effects" of climate change, the definition of risk which requires consideration of the likelihood of the event, and the reference in Policy 27 to areas of significant existing development "likely" to be affected;

    c. failed to realise that it is not the role of coastal scientists to apply a "precautionary approach" to hazard identification. As already noted, Policy 3(2) refers to use and management of coastal resources. Application of the precautionary approach is the role of the Council (or the Environment Court), not the coastal scientists.

68. In addition, the evidence demonstrates the misleading nature of the CSL reports. Nowhere do the reports identify that the results are a worst case. Instead, they are precautionary or conservative, conveying a different meaning. Indeed, we know now that the results are in fact very unlikely.

69. In summary, my view is that a number of coastal experts have the wrong end of the stick in terms of their interpretation of the relevant legal provisions and their appropriate role in the process. That is causing a lot of trouble and undermines both the RMA and the NZCPS 2010.

70. The recommendations of the independent Coastal Panel engaged by KCDC are instructive.

71. The Coastal Panel said:

> "It is recommended that studies such as these involve an experienced statistician, preferably one familiar with time-series analysis. There seems to have been only limited involvement of a statistician in the CSL analyses" (page 45);

> "From a statistical perspective, it is recommended that "best estimates" rather than precautionary values be adopted, with margins of error or factors of safety kept separate from the estimates and added at the end if appropriate. Alternatively, one could give several scenarios based on best, worst and mid-way cases." (page 45); and

> "An economic assessment of the consequences of planning restrictions needs to be undertaken before imposing them, since the restrictions may have been made on the basis of calculations which may be excessively precautionary. One needs to balance the cost to property owners of any restrictions with the actual risk (and its time scale) and one can't do this if there are hidden "precautionary" adjustments" (page 45).

72. From a legal perspective, I generally endorse what the Coastal Panel has said about these matters, but many coastal experts do not provide either:

    a. "best estimates" rather than precautionary values, with margins of error or factors of safety kept separate from the estimates and added at the end if appropriate; or

    b. several scenarios based on best, worst and mid-way cases.

73. Doing what the Coastal Panel recommends from a statistical perspective would enable everyone in the RMA process to participate effectively.

74. Risk management and effective decision-making requires an understanding of the uncertainties. Providing only very unlikely results (and/or describing them in ambiguous terms) does not assist submitters to participate effectively in the RMA process or enable Councils and the Environment Court to make informed decisions.

75. Interestingly, the Coastal Panel also said:

> "Where no factor of safety is adopted, conventional practice has been to adopt conservative/precautionary values. While it is appropriate to include a safety margin, this needs to be done in a transparent way and after taking account of the uncertainties involved in the estimates." (page 40)

76. So conventional practice developed among coastal experts, presumably without considering:

    a. the appropriateness of the "best estimates" statistical perspective; and

    b. the need for transparent information to be provided in the RMA legal process both for submitters and decision-makers

    may be a large part of the problem.

77. It is my view that variability in results should be reported and the uncertainties explicitly identified.

78. Just by way of example, if there is variability along a coast in relation to different components relevant to modelling, my view is that such variability

should also be reported rather than adopting precautionary/conservative values to each component as the "conventional practice" apparently supports.

79. The regrettable result of the "conventional practice" is that one ends up with precautionary assumption, added to precautionary assumption, added to precautionary assumption for each component of the model. The effect of those precautionary assumptions remains hidden and the cumulative effect can be significant.

80. As the Coastal Panel noted, from a statistical perspective "best estimates" are appropriate with margins of error or factors of safety kept separate from the estimates and added at the end if appropriate.

81. In my view, the same applies from a legal perspective. It enables properly-informed participation and decision-making in the RMA processes.

82. The approach of a number of New Zealand coastal scientists in providing only very unlikely results (and describing them in ambiguous terms) is, in my view, highly problematic.

83. It is particularly problematic as it is difficult to get to the bottom of what the coastal experts are actually doing. Over time, I have developed suspicions about what some might be doing. But it has taken me far too many hours, and several years, to uncover that the CSL results are not:

    a. "likely" as initially described by KCDC; or

    b. "precautionary" or "conservative", terms used in the 2008 and 2012 reports; or

    c. "based on a worst case scenario" as later described by KCDC; but

    d. "very unlikely" as described on CSL's own website in March 2015.

84. In the next section, I deal with some recent New Zealand cases that give an indication of what the Environment Court may be thinking in relation to these aspects as well.

Hints from the Environment Court

85. There may be some hints from the Environment Court about appropriate approaches, but I don't want to overstate what the Court may be inferring.

86. It is relevant to recall the Coastal Panel's comment about adopting "best estimates" rather than precautionary values, with margins of error or factors of safety kept separate from the estimates and added at the end if appropriate. Or several scenarios based on best, worst and mid-way cases.

87. *Gallagher v Tasman District Council* [2014] NZEnvC 245 was a plan change hearing mainly about inundation from sea level rise rather than coastal erosion.

88. At para [95], the Court said:

> "The coastal witnesses all agreed that a conservative approach should be adopted in assessing the hazard risk from coastal inundation induced flooding on the Gallagher property ... we have decided that [a specified overtopping rate] should be adopted as the *best fit* from all of the evidence which we heard. We consider that it is a realistic possibility." (emphasis is the Court's)

89. In the end, it was not determinative, but:

    a. it is interesting that all of the coastal witnesses agreed that a conservative - there's that word again - approach should be adopted; but

    b. the Court seems to be saying it is adopting the rate because it is the "best fit", rather than because it is a conservative approach.

90. It is also relevant to note the Court's reference to a "realistic" possibility.

91. At para [73], the Court said:

> "During the hearing there was extensive questioning of the witnesses on a number of key parameters ... for which there were significant differences of opinion... Despite this questioning, for the most part we were left little the wiser."

92. A problem if coastal experts are not careful, explicit and transparent about what they are doing is that it makes it unnecessarily difficult for the decision-maker.

93. *Mahanga E Tu Inc v Hawkes Bay Regional Council and Wairoa District Council* [2014] NZEnvC 83 is a case about a resource consent for a new subdivision in quite particular facts, not a case about provisions in a plan.

94. But it's interesting, and troubling, to see the differences in the predictions of the experts and interesting to see the comments of the Court.

95. The Environment Court identified that the property would be affected by erosion (at para [16]):

> "The Council submits, we think correctly, that the proposal cannot *avoid* the effects of coastal erosion over either 50 or 100 year periods. The best that can be done is to *mitigate* those effects through the process of managed retreat once the shoreline retracts to the chosen trigger point." (emphases are the Court's)

96. The Court said at para [35]:

> "It became evident from the different approaches by the coastal scientists dealing with essentially the same set of facts, that the preparation of accurate long term predictions for the behaviour of complex natural systems at a very small site is fraught with difficulty."

97. The erosion rates from the three experts, and the relevant paragraph references from the case, are:

- Mr Moynihan = - 0.14 m/yr (the long-term erosion rate will reduce or reach zero but some potential for no more than -0.14) (para [29]);
- Mr Reinen-Hamill = - 0.9 m/yr (para [30]); and
- Dr Roger Shand = - 1.2 m/yr (para [31]).

98. So after, say, 50 years, the differences in the predicted erosion at the site would be:

- Mr Moynihan = 7 m;
- Mr Reinen-Hamill = 45 m; and
- Dr Roger Shand = 60 m.

99. The Council in that case considered that 100 years was the appropriate planning period.

100. After 100 years, the differences would be even more dramatic:

- Mr Moynihan = 14 m;
- Mr Reinen-Hamill = 90 m; and
- Dr Roger Shand = 120 m.

101. So, what initially seem to be relatively small differences become enormous when multiplied by 50 or 100 years. In the special circumstances of that case, the Environment Court decided to use 20 years.

102. Both Dr Shand and Mr Reinen-Hamill had applied a 30% "factor of safety" to their predictions, a point that was criticised by Mr Moynihan (para [34]).

103. In relation to Dr Shand's prediction, the Court said:

> "[32] Dr Shand acknowledged that his analysis focused on the *potential* erosion hazard at the site over the 100 year planning period. He agreed that the *most likely* outcome was somewhat less than the potential hazard he identified, and would be around the predictions of Mr Reinen-Hamill." (emphases are the Court's)

104. The Environment Court did not accept the predictions of either Dr Shand or Mr Reinen-Hamill, referred to "a likely average rate of retreat of the shoreline at the site of around -0.4 m/yr", and decided to use 20 years as a relevant timeframe in the special circumstances of that case. The Court said:

> "[36] ... we are more inclined to the rather more pragmatic approach of Mr Moynihan. In simple terms, there is an observed rate of long-term erosion ... of less than -0.2 m/yr. If the influence of sea level rise in the future that is greater than that already observed in the long term rate is factored in, this could double the rate of long term erosion.
>
> [37] For the purpose of this decision, this would indicate a likely average rate of retreat of the shoreline at the site of around -0.4 m/yr ...

> [38] We have not found it necessary to determine a precise time frame based on erosion rate predictions beyond the *most likely* scenario described above in order to answer the core question..." [emphasis is the Court's]...
>
> [84] When the coastal issues are explored, and the proposed mitigation accepted, there really is no reason, on the evidence, to decline the necessary consents. The appeal is declined and the grant of subdivision and resource consents by both Councils is confirmed."

105. An additional interesting factor about overstating results is that the Court explained that Mr Moynihan based his erosion rate predictions for the earlier Commissioners' hearing on the 2005 and 2007 analyses by Dr Jeremy Gibb (since retired and not available to give evidence at the Environment Court hearing). Various factors involved Mr Moynihan revisiting the erosion predictions. The Court said (at para [28]):

> "... Mr Moynihan noted that the observed rate of erosion at the site was far less than predicted by Dr Gibb in his coastal hazard assessment. This led to the conclusion that other processes (not accounted for in the model used by Dr Gibb ...) were influencing the actual rate of erosion."

106. Again, without wishing to push things too far, interesting aspects of the *Mahanga E Tu Inc* case are:

   a. the vast difference in the experts' predictions for coastal erosion for 50 years (7 m vs 45 m and 60 m) and 100 years (14 m vs 90 m and 120 m);

   b. the Court not accepting the two more extreme predictions;

   c. Dr Shand apparently referring to his results as "potential";

   d. the difficulties the Court faced;

   e. the Court referring to the most likely scenario and basing its decision on that; and

   f. the Court indicating the difficulties of predictions at a small site.

107. From the opposite, and more general perspective, the vast difference in the predictions in this case (and the fact that observations had shown that earlier erosion predictions were in fact overstated) helps to demonstrate the potential perils of drawing lines on maps out 50 or 100 years, purporting to convey some measure of certainty, in what is an uncertain science, even when one is looking at specific facts at a specific site.

Problems with providing only very unlikely results or overstating results

108. A number of coastal experts apparently consider it their role to provide unlikely or very unlikely results, but label them in ambiguous ways such as precautionary, conservative, or potential.

109. A fundamental problem with providing only very unlikely results, or overstating results, is that it completely undermines the legal process that has been designed to enable informed participation and decision-making.

110. Proper expert information, including the uncertainties, is needed for informed participation and informed decision-making.

111. Decision-makers need to be able to consider all of the relevant factors that go into the mix and make their decisions based on informed judgement. Society ends up with sub-optimal decision-making when experts fail to provide the requisite information, including the uncertainties and any variability in any elements.

112. For as long as coastal scientists produce results that are not transparent and for as long as reports overstate the situation, conflicts between parties will continue and time and money will be wasted.

113. As already noted, to carry out its functions under Policy 24, the Council needs to:

    a. identify areas potentially affected by coastal hazards, with the hazard risks being assessed taking into account the likely effects of climate change;

    b. give priority to the identification of areas at high risk of being affected;

    c. in assessing risk (likelihood x consequences), consider the likelihood of coastal erosion occurring and the consequences.

114. In addition, Policy 24(1)(b) says that hazard risks are to be assessed having regard to "short-term and long-term natural dynamic fluctuations of erosion and accretion".

115. If coastal scientists in New Zealand had developed a practice of ignoring accretion, it should have stopped in New Zealand in December 2010 to enable Councils to fulfil their obligations under the NZCPS 2010.

116. Policy 27 sets out the range of options that KCDC (or any Council) should assess for reducing coastal hazard risk in areas of significant existing development likely to be affected by coastal hazards.

117. Providing only very unlikely results fails to recognise that for KCDC (or any Council) to consider a range of options for reducing coastal hazards in the areas of significant existing development that are very unlikely to be affected is:

    a. contrary to what Policy 27 says;

    b. a highly inefficient use of time and money; and

    c. perhaps most seriously, a distraction from the areas likely to be affected where the real focus, time and money should occur to identify options for reducing coastal erosion hazard risk.

118. Some of the troubling aspects about providing only very unlikely or overstated results, or not reporting the uncertainties, include:

a. coastal practitioners, rather than lawyers, purporting to interpret the law;

b. failing to realise the relevance and importance of the wording of the actual NZCPS 2010 provisions;

c. failing to appreciate that "developers, prospective purchasers and insurers [wanting] to know that in the future their property of interest will be virtually free of erosion hazard" is not an appropriate approach in the context of the RMA and the NZCPS 2010. Someone might well ask for such an assessment if that is what they want to achieve in a particular set of circumstances. But that is not what the wording (or the intent) of the NZCPS 2010 or the RMA contemplates and that is not what submitters and decision-makers in the RMA process need to participate effectively and to make informed decisions;

d. scientists providing policy results based on their own one-sided understanding of what they think people want rather than objective, scientific results based on the applicable law;

e. failing to realise that there are costs if restrictions are too precautionary, just as there are costs if restrictions are not sufficiently precautionary. It is for others ie the Council or the Environment Court to make the appropriate judgement, not coastal scientists;

f. failing to appreciate that the courts have said that the RMA is not a no-risk statute;

g. failing to appreciate that the role of a scientist is to provide the appropriate type of objective, scientific information, including the uncertainties, to enable KCDC (or any Council and, ultimately, the Environment Court) to make a decision on the basis of reliable and relevant scientific information and for submitters to participate effectively in the RMA process;

h. failing to understand that a coastal scientist should be providing objective, scientific results that are able to be used for the intended purpose. As the Coastal Panel said:

> "From a statistical perspective, it is recommended that "best estimates" rather than precautionary values be adopted, with margins of error or factors of safety kept separate from the estimates and added at the end if appropriate. Alternatively, one could give several scenarios based on best, worst and mid-way cases." (page 45)
>
> "The assessment of coastal hazard zones should consider a range of plausible scenarios (e.g. low, mid, high, or best estimate and extremes)." (ES.7 and page 47);

i. failing to appreciate that KCDC or any Council needs to assess the costs and benefits of any regulatory approaches (although it is required to give effect to the NZCPS 2010[21]). It is not for the coastal expert to decide to provide only results that show that properties will "in the future ... be virtually free of erosion hazard" based on very unlikely results or for the coastal scientist to apply their own idea of acceptable policy. As the Coastal Panel said;

> "An economic assessment of the consequences of planning restrictions needs to be undertaken before imposing them, since the restrictions may have been made on the basis of calculations which may be excessively precautionary. One needs to balance the cost to property owners of any restrictions with the actual risk (and its time scale) and one can't do this if there are hidden "precautionary" adjustments" (page 45);

j. failing to describe the results in the CSL reports (or other experts' reports) as "very unlikely", instead using words like "precautionary" or "conservative" (others also use such terms, as well as "potential"), not identifying what is meant by those terms, and masking the true nature of the results being provided;

k. failing to appreciate that providing only very unlikely results, and doing that without explicitly stating that the results are very unlikely (instead of using ambiguous terms like "precautionary", "conservative" or "potential"), sabotages the legal process. There is not proper, objective, scientific information, including the uncertainties, to enable submitters to participate in an informed manner and to enable KCDC or any Council to carry out its functions.

119. Many people assume:

a. that residents will react negatively if provided with good information about risks to their property;

b. that in Kapiti it is the residents who are unreasonably rejecting steps that the Council is trying to take; and

c. if only people would listen to the coastal scientists everything would work out well.

120. Some residents may react negatively, but many want to know if their properties are exposed to risk and over what timeframe.

121. What Kapiti residents objected to was:

a. no consultation;

b. misrepresentation of the results;

c. lack of compliance with the law; and

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21 *Environmental Defence Society Inc v The NZ King Salmon Co Ltd* [2014] NZSC 38.

d. precautionary assumption added to precautionary assumption added to precautionary assumption resulting in unreasonable, and now "very unlikely", results.

122. CSL's own subsequent reports for specific areas demonstrated that its own 2008 and 2012 reports considerably overstate the situation. In:

a. the northern part of the Waimeha inlet report, the lines were moved substantially seaward, if not completely off, the property of the landowner;

b. the Waikanae estuary in the vicinity of Kotuku Parks subdivision report, the lines were moved off the property. "Both the managed and unmanaged lines are now seaward of the Kotuku Parks boundary by about 40 m with the managed line adjustment increasing up to about 65 m in the northern sector" (page 7); and

c. the draft (but not released) managed scenario report for the Mangaone Inlet resulted in 2 or 3 properties being affected, not about 30.

123. Ultimately, it has been proven that the Kapiti residents were right. The results are not sufficiently robust to be used for the Proposed District Plan (Coastal Panel), should not be relied upon (KCDC's website), and are very unlikely (CSL's website).

124. But what a terrible waste of time, money, energy and emotion. And little or no progress in assessing the range of options for the areas that are truly at risk of erosion.

125. It is counterproductive to overstate the problem for many other reasons including:

a. it causes people to react negatively to the overstatements;

b. focusses attention on the overstatements rather than the main messages or solutions;

c. does not focus attention on areas truly at risk and assist in dealing with the issues faced by those in the areas at risk;

d. unfairly affects those not at risk;

e. wastes resources on areas not at risk;

f. does not enable the RMA process to proceed efficiently and effectively, with appropriate information for the submitters and the decision-maker.

Risk management and uncertainty - AS/NZS ISO 31000:2009 *Risk management - Principles and guidelines*

126. The definition of risk in the NZCPS 2010 refers to AS/NZS ISO 31000:2009 *Risk management - Principles and guidelines*. That Standard supersedes AS/NZS 4360:2004.

127. While the Standard may not legally be directly applicable, it is perhaps worth noting some of the principles from the Standard:

> "d) **Risk management explicitly addresses uncertainty.**
>
> Risk management explicitly takes account of uncertainty, the nature of that uncertainty, and how it can be addressed.
>
> ...
>
> f) **Risk management is based on the best available information.**
>
> The inputs to the process of managing risk are based on information sources such as historical data, experience, stakeholder feedback, observation, forecasts and expert judgement. However, decision makers should inform themselves of, and should take into account, any limitations of the data or modelling used or the possibility of divergence among experts.
>
> ...
>
> h) **Risk management takes human and cultural factors into account.**
>
> Risk management recognizes the capabilities, perceptions and intentions of external and internal people that can facilitate or hinder achievement of the organization's [organization is a wide-ranging term] objectives.
>
> i) **Risk management is transparent and inclusive.**
>
> Appropriate and timely involvement of stakeholders and, in particular, decision makers at all levels of the organization, ensures that risk management remains relevant and up-to-date. Involvement also allows stakeholders to be properly represented and to have their views taken into account in determining risk criteria."

128. Providing only very unlikely results, overstated results, or results with hidden (or difficult to untangle) precautionary adjustments:

   a. does not explicitly take account of uncertainty;

   b. does not provide the best available information;

   c. perhaps demonstrates that a human factor currently being ignored is the human factor of the coastal scientists. Everyone assumes that

property owners are being unreasonable and that the scientists are being objective and scientific. That was my view of the Kapiti situation for a long time, before I eventually read the scientific reports; and

d. is not transparent and does not enable appropriate involvement of stakeholders. There is not the appropriate range and type of transparent, objective information to enable informed participation by submitters, or decision-makers, in the RMA process.

NZCPS 2010 provisions, the recommendations of the Coastal Panel vs conventional practice of NZ coastal experts, and what submitters and decision-makers are entitled to expect from scientific reports and coastal experts

129. In conclusion, I:

a. repeat what I said earlier about the wording of Policies 24, 25 and 27;

b. repeat some of the recommendations of the Coastal Panel;

c. consider the apparent conventional practice of NZ coastal experts; and

d. set out what, in my opinion, submitters and decision-makers are entitled to expect from scientific reports and coastal experts.

130. Policy 24 effectively says that the Council's function is to:

> "(1) Identify areas in the coastal environment that are potentially affected by coastal hazards (including tsunami), giving priority to the identification of areas at high risk of being affected. Hazard risks, over at least 100 years, are to be assessed having regard to [(a) to (h)] taking into account national guidance and the best available information on the likely effects of climate change on the region or district." (emphases added)

131. Risk is defined in the NZCPS 2010 as:

> "Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence ...". (emphasis added)

132. So, to carry out its functions under Policy 24, a Council needs to:

a. identify areas potentially affected by coastal hazards, with the hazard risks being assessed taking into account the likely effects of climate change;

b. give priority to the identification of areas at high risk of being affected;

c. in assessing risk (likelihood x consequences), consider the likelihood of coastal erosion occurring and the consequences.

133. Policy 25 of the NZCPS 2010 deals with "areas potentially affected by coastal hazards", so "potentially affected" is used on its own there. However, it is my view that it should be read in the context of Policy 24, which specifically deals with the "[identification of] areas ... potentially affected by coastal hazards" and also refers to the likely effects of climate change (and hazard risks), so that Policy 25 addresses areas identified by Policy 24.

134. Policy 27 of the NZCPS 2010 identifies the range of options the Council should assess for reducing coastal hazard risk in areas of significant existing development likely to be affected by coastal hazards. These areas should also have been identified by the Council during the Policy 24 process, as a subset of the other areas.

135. So producing only very unlikely or overstated results is not helpful. Nor are results where there are hidden precautionary adjustments or precautionary assumptions that cannot be readily untangled.

136. I repeat some of the recommendations of the Coastal Panel:

> "It is recommended that studies such as these involve an experienced statistician, preferably one familiar with time-series analysis. There seems to have been only limited involvement of a statistician in the CSL analyses" (page 45);
>
> "From a statistical perspective, it is recommended that "best estimates" rather than precautionary values be adopted, with margins of error or factors of safety kept separate from the estimates and added at the end if appropriate. Alternatively, one could give several scenarios based on best, worst and mid-way cases." (page 45);
>
> "An economic assessment of the consequences of planning restrictions needs to be undertaken before imposing them, since the restrictions may have been made on the basis of calculations which may be excessively precautionary. One needs to balance the cost to property owners of any restrictions with the actual risk (and its time scale) and one can't do this if there are hidden "precautionary" adjustments." (page 45)
>
> "Adaptive management provides a realistic alternative to excess speculation regarding definitive future coastal hazards." (page 47)
>
> "The assessment of coastal hazard zones should consider a range of plausible scenarios (e.g. low, mid, high, or best estimate and extremes)." (page 47)

137. From a legal perspective, I particularly agree with the statement that:

> "From a statistical perspective, it is recommended that "best estimates" rather than precautionary values be adopted, with margins of error or factors of safety kept separate from the estimates and added at the end if appropriate."

138. That is generally what I would have expected coastal experts to be doing. Doing that enables submitters and decision-makers to have access to transparent information about the assessment. I certainly did not expect to

uncover results based on precautionary assumption added to precautionary assumption added to precautionary assumption.

139. However, it is apparent that at least some coastal experts consider it their role to provide only very unlikely or overstated results.

140. The Coastal Panel said:

> "Where no factor of safety is adopted, conventional practice has been to adopt conservative/precautionary values. While it is appropriate to include a safety margin, this needs to be done in a transparent way and after taking account of the uncertainties involved in the estimates." (page 40)

141. So part of the problem may be this "conventional practice" that has apparently developed, presumably without considering:

a. the appropriateness of the "best estimates" statistical approach; and

b. the need for transparent information to be provided in the RMA legal process to enable submitters to participate, and decision-makers to make well-informed decisions, based on appropriate scientific information.

142. As already noted, the Supreme Court in *Sustain our Sounds Inc v The New Zealand King Salmon Company Ltd* [2014] NZSC 40 said:

> "[157] We accept that public participation is a key tenet of decision making under the RMA with many public participatory processes... As noted by Keith J in *Discount Brands Ltd v Westfield (New Zealand) Ltd*, the purpose of these processes is to recognise and protect the particular rights of those who are affected and to enhance the quality of the decision making."

143. The Coastal Panel said "One needs to balance the cost to property owners of any restrictions with the actual risk (and its time scale) and one can't do this if there are hidden "precautionary" adjustments".

144. I would comment that one cannot make informed decisions of any type, or properly give effect to the NZCPS 2010, if there are hidden precautionary adjustments and/or if coastal experts are providing only very unlikely or overstated results.

145. It is made worse if the results are described ambiguously as precautionary, conservative or potential.

146. In my opinion, submitters and decision-makers are entitled to expect that scientific reports:

a. convey objective, scientific, transparent information;

b. are fit for purpose;

c. have regard to the "short-term and long-term natural dynamic fluctuations of erosion and accretion" as set out in Policy 24(1)(b) and

to other scientific matters referred to in Policy 24 to enable the Council to perform its functions;

d. are based on sound statistics, involving statisticians with appropriate statistical expertise;

e. state all assumptions, and state the implications of the assumptions (as far as possible), clearly;

f. not contain hidden precautionary adjustments (or precautionary adjustments that cannot readily be untangled from the results);

g. not add precautionary assumption, to precautionary assumption to precautionary assumption;

h. use, as the Coastal Panel recommends from a statistical perspective (and also recalling the *Gallagher* case, where the Environment Court selected the specified overtopping rate because it was the "best fit"), "best estimates" rather than precautionary values, with margins of error or factors of safety kept separate from the estimates and added at the end if appropriate;

i. not provide very unlikely results (unless for some reason they have been specifically told to do so and then the results will be described as very unlikely);

j. not describe results using ambiguous terms such as precautionary, conservative, or potential (or, if that is done, identify precautionary or conservative or potential compared to what, and by how much, so that submitters and decision-makers can understand what the coastal scientist actually means when they use those terms); and

k. identify the uncertainties eg by, as the Coastal Panel recommends, considering a range of plausible scenarios (e.g. low, mid, high, or best estimate and extremes).

147. From my perspective, if that is done (and especially in areas where there is significant existing development), some of the difficulties with the current RMA processes may at least diminish.

148. If the CSL results had been reasonable in the first place, I certainly would not have troubled myself with what has become the Kapiti coastal erosion fiasco. There are other things I would rather be doing with my life.

Joan Allin
April 2015

THE PRECAUTIONARY PRINCIPLE AND ITS ROLE IN COASTAL RISK MANAGEMENT

UNDER THE NEW ZEALAND COASTAL POLICY STATEMENT AND THE RESOURCE MANAGEMENT ACT

Coastal Ratepayers United Inc.
June 2015

Introduction

This paper sets out the understanding of Coastal Ratepayers United (CRU) of the precautionary principle (PP) and its applicability to the management of coastal hazard. It notes where and when the PP is to be used and by whom; and, because the PP is applied in the absence of adequate scientific information and evidence, it identifies the need for the PP to be subject to other checks and balances to avoid its misuse.

CRU sees the need for this clarification as a way of avoiding a repeat of the misguided application of the PP as in the investigations leading to the coastal management provisions in the Kapiti District's Proposed District Plan which had to be withdrawn.

Origin of the Term Precautionary Principle[1]

It is widely accepted that the precautionary principle originally emerged from Germany in the mid-1970s where it was known as the Vorsorgeprinzip[2]. The World Charter for Nature, which was adopted by the UN General Assembly in 1982[3], was the first international endorsement of the precautionary principle and by the late 1980s the principle was being incorporated into European environmental statements. It was subsequently reflected in a number of international conventions, but the most widely cited is the 1992 Rio Declaration on Environment and Development where, Principle 15 states: *In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation*[4].

More recently, the New Zealand Coastal Policy Statement (NZCPS)[5] reiterated this when it made the precautionary approach one of its key policies, *Policy 3: Precautionary Approach*, which requires local authorities[6] to –

(1) Adopt a precautionary approach towards proposed activities whose effects on the coastal environment are uncertain, unknown, or little understood, but potentially significantly adverse.
(2) In particular, adopt a precautionary approach to use and management of coastal resources potentially vulnerable to effects from climate change, so that:

> **(a) avoidable social and economic loss and harm to communities does not occur;**
> **(b) natural adjustments for coastal processes, natural defences, ecosystems, habitat and species are allowed to occur; and**
> **(c) the natural character, public access, amenity and other values of the coastal environment meet the needs of future generations.**

This requires the precautionary approach to be applied *inter alia* to the use and management of coastal resources so as to avoid social and economic loss and harm from the effects of climate change and in meeting the needs of future generations.

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1 For the purpose of this discussion paper, Precautionary Principle and Precautionary Approach are taken as synonymous. According to COMEST/UNESCO (2005) *The Precautionary Principle* - "in general, *principle* is employed as the philosophical basis of the precaution and *approach* as its practical application".
2 Stevens, Mary (2002) *The Precautionary Principle in the International Arena*. Sustainable Development Law and Policy, Volume 2, Issue 2, Article 7.
3 http://www.un.org/documents/ga/res/37/a37r007.htm
4 http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm
5 New Zealand Government (2010) *New Zealand Coastal Policy Statement 2010*. New Zealand Department of Conservation (DoC).
6 The NZCPS 2010 states: "This NZCPS is to be applied as required by the [RMA] by persons exercising functions and powers under the [RMA]" (page 7) and it is therefore the role of the local authority (or the Environment Court) not the role of coastal scientists to apply the NZCPS 2010 as required by the RMA.

Application of the Precautionary Principle

COMEST/UNESCO[7] concluded that the precautionary principle is to be invoked where –

- **there exist considerable scientific uncertainties;**
- **there exist scenarios (or models) of possible harm that are scientifically reasonable (that is based on some scientifically plausible reasoning);**
- **uncertainties cannot be reduced in the short term without at the same time increasing ignorance of other relevant factors by higher levels of abstraction and idealization;**
- **the potential harm is sufficiently serious or even irreversible for present or future generations or otherwise morally unacceptable;**
- **there is a need to act now, since effective counteraction later will be made significantly more difficult or costly at any later time.**

It is debatable whether all these requirements are present in the management of coastal hazard arising from climate change. However, the two salient parameters for the application of the precautionary principle are still as in the original definition – (1) threats of serious or irreversible damage, and (2) lack of full scientific evidence or, as the European Commission[8] puts it, "*recourse to the precautionary principle presupposes that potentially dangerous effects deriving from a phenomenon, product or process have been identified, and that scientific evaluation does not allow the risk to be determined with sufficient certainty.*"

The European Commission[9] continues that, "*measures based on the precautionary principle should be, inter alia:*

- **proportional to the chosen level of protection,**
- **non-discriminatory in their application,**
- **consistent with similar measures already taken,**
- **based on an examination of the potential benefits and costs of action or lack of action (including, where appropriate and feasible, an economic cost/benefit analysis),**
- **subject to review, in the light of new scientific data, and**
- **capable of assigning responsibility for producing the scientific evidence necessary for a more comprehensive risk assessment."**

By definition, values and measures arrived at through the application of the precautionary approach are derived in the absence of scientific certainty and are not based on evidence. Such values and measures must therefore be subjected to other checks and balances and some of these are considered below.

Focus the Role of Science on Assessing the Risk and Not on Managing It

The precautionary approach is about risk and there are two key steps in dealing with risk –

- Risk assessment and analysis
- Risk management

Cameron[10] defines **risk assessment** as the process of converting uncertainty into risk, and it entails:

- analysing the initiating events and the routes (pathways) through which the effect occurs
- specifying the size and severity of the risk
- estimating probabilities and expected values

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[7] World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) (2005) *The Precautionary Principle.* UNESCO, Paris.
[8] European Commission (2000) *Communication from the Commission on the precautionary principle.* Brussels, 02.02.2000 COM(2000) 1
[9] *op. cit.*
[10] Cameron, Linda (2006) *Environmental Risk Management in New Zealand – Is There Scope to Apply A More Generic Framework?* New Zealand Treasury Policy Perspectives Paper 06/06.

Risk assessment/analysis is a process which can certainly benefit from scientific research and investigation and in the application of a robust scientific approach there is no role for the PP. Cameron[11] further recommends that risk assessment "*needs to be considered in the context of a more generic risk management framework, with clear guidelines that provide a systematic approach to setting the best course of action under uncertainty*".

However, the Biosecurity Council[12] recommends further caution - "*Scientists do not usually provide a unanimous body of opinion on a subject; there may be divergent scientific views on a subject. All relevant scientific opinion should be considered in a risk analysis and judged on the weight of available scientific evidence.*" Therefore regulatory measures (risk management) cannot be imposed simply on the basis of scientific opinion about perceived risks, even if arrived at through the application of a purely scientific approach. It is therefore essential that scientific advice is thoroughly questioned by other scientists (through peer review) as well as by the affected communities and that decisions reflect the spectrum of opinions that may exist[13].

The second step, **risk management** builds on the risk assessment/analysis and attempts to answer the questions: Does anything need to be done about the risk? If so, what can be done about it? What should be done about it? Who should it be done by? To these can be added the question – When?

One thing is certain – "*a zero-risk approach is untenable practically as well as conceptually* [and] *absolute safety cannot be a sensible regulatory goal*"[14] and risk must therefore be managed.

Risk management is the responsibility of private landowners, planners, managers and local authorities and not scientists. Different people have different attitudes to risk and different degrees of ability to manage given risks. In such circumstances, there is no such thing as an objectively-determinable "socially-acceptable" level or risk. The European Commission[15] observes that "*judging what is an "acceptable" level of risk for society is an eminently political responsibility ..... In some cases, the right answer may be not to act or at least not to introduce a binding legal measure. A wide range of initiatives is available in the case of action, going from a legally binding measure to a research project or a recommendation.*"

Risk management raises the question of who has the decision-making responsibility, particularly in regards to private property. Private property owners have rights and they are responsible for decision-making regarding their property. It is they who should apply the precautionary approach when they develop options for responding to changing risks, and assess the likely costs and benefits of those options. They will choose a decision that best reflects their risk preferences.

Planning and management decisions, while informed by the scientific assessment, must also take into account a broader spectrum of non-scientific parameters, influences and opinions and be based on conventional risk assessment tools, including but not limited to cost-benefit analysis as mentioned by the European Commission[16].

DoC's Guidance Note on NZCPS Policy 3[17] is quite clear that "*The application of the precautionary approach is a risk management approach rather than a risk assessment approach.*" Science is only involved in the first step (risk

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[11] *op. cit.*
[12] Hellstrom, J (2008) *Position Statement on the Application of Precaution in Managing Biosecurity Risks Associated with the Importation of Risk Goods.* NZ Biosecurity Council
[13] According to the European Commission (*op. cit*) The precautionary principle, which is essentially used by decision-makers in the management of risk, should not be confused with the element of caution that scientists apply in their assessment of scientific data.
[14] Majone, G (2010) *Strategic Issues in Risk Regulation and Risk Management*. Chapter 3 in Risk and Regulatory Policy: Improving the Governance of Risk. OECD Reviews of Regulatory Reform Series. OECD, Paris
[15] *op.cit.*
[16] *op.cit.*
[17] New Zealand Government (2010) *NZCPS 2010 Guidance Note Policy 3: Precautionary Approach.* New Zealand Department of Conservation (DoC)

assessment) and as there is no role for a precautionary approach in risk assessment/analysis, scientists should desist from applying a precautionary approach.

Provide for a Meaningful Participatory Process

Regardless of whether they are the result of a precautionary approach, but especially so if they are, decisions under the RMA must be made with the full participation of affected parties. As the Supreme Court[18] said: "*We accept that public participation is a key tenet of decision making under the RMA with many public participatory processes… As noted by Keith J in Discount Brands Ltd v Westfield (New Zealand) Ltd, the purpose of these processes is to recognise and protect the particular rights of those who are affected and to enhance the quality of the decision making.*"

Public participation must be meaningful and go beyond simply informing the public and must extend to actual decision-making. As COMEST/UNESCO[19] asserts, "*it is one of the ethical principles of modern democracies that parties affected by a decision should have their preferences taken into account when the decision is made.*" And the European Commission[20] adds, "*The decision-making procedure should be transparent and should involve as early as possible and to the extent reasonably possible all interested parties.*"

Among the parameters that need to be taken into account in reaching decisions on hazard and risk management in the coastal environment, is the risk tolerance of those directly affected by the decisions. It must also be remembered that "*benefits accrue decades later in the form of avoided climate change impacts. Even if the benefits in monetary terms outweigh the costs measured over a long period of time, such propositions are not very attractive or understandable for many people*[21]".

Many of those who have chosen to live on the coast are aware of the risks that come with the location and should be prepared to accept and manage these risks balanced as they are by the benefits of the location.

Assess the Comparative Costs and Benefits

Risk management options (including the do-nothing option) arrived at through a precautionary approach must be subject to a wider generic framework for decision-making under uncertainty, including an analysis of the comparative costs and benefits. The costs and benefits of acting now must be compared with the costs and benefits of acting sometime in the future. Unfortunately, the precautionary approach provides no guidance on how to evaluate the risk of taking costly action unnecessarily versus the opposite risk of failing to take action that should have been taken. In principle the standard utility maximising framework, and cost-benefit analysis go beyond monetary values and extend into quality of life and the impacts of stress. Inter-generational equity must also be considered, but if political processes dictate a greater cut in current consumption for the benefit of future consumption that some in the community are willing to contemplate, the burden of that imposed sacrifice should not be imposed disproportionately on a political minority.

Decision-makers must be careful to avoid imposing costs and losses on the community through premature or inappropriate action or by unduly delaying appropriate action.

According to the Kapiti Coastal Experts Panel[22], "*An economic assessment of the consequences of planning restrictions needs to be undertaken before imposing them, since the restrictions may have been made on the basis of calculations which may*

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[18] Supreme Court in *Sustain our Sounds Inc v The New Zealand King Salmon Company Ltd* [2014] NZSC 40
[19] *op.cit.*
[20] *op.cit.*
[21] European Environment Agency (2013) *Late Lessons from Early Warnings: Science, Precaution, Innovation.* Publications Office of the European Union, Luxembourg
[22] Carley, J T, P D Komar, P S Kench and R B Davies (2014) *Coastal Erosion Hazard Assessment for the Kāpiti Coast:*

be excessively precautionary. One needs to balance the cost to property owners of any restrictions with the actual risk (and its time scale) and one can't do this if there are hidden "precautionary" adjustments."

It is also current practice to make a distinction between existing use and greenfield development. For example, Bell[23] recommends "*an adaptive management approach for existing development which is periodically adjusted*" in response to monitoring of sea level and associated reviews. This is different from new developments which need to be considered within a longer term context[24].

Accept that the Position of the Coastline is Based on More than Sea Level

In assessing coastal hazard, the focus is usually on the position of the coastline, erosion and accretion; and, the emphasis in such an assessment/analysis is usually on sea level. However, according to the Ministry for the Environment[25], the position of the coastline is the result of the following drivers and interactions between them:

- **relative sea-level rise**
- **long-term sea-level fluctuations**
- **the frequeney and magnitude of storm surges**
- **tidal range (eoasts with relatively small tidal ranges eould be more vulnerable)**
- **storminess and wave and/or swell eonditions**
- **rainfall patterns and intensity, and their influence on river and eliff sediment supply**
- **Landforms and geology of the coast, and any modifieations that people have made (perhaps indirectly) to the eoast.**

To these can be added –

- distance from sources of sediment and littoral drift
- predominant wind direction and speed and impact on wave climate
- storm events and storm surge and frequency

All the above have an important influence on the position of the coastline and any attempt to assess the risk of sea incursion must consider them all. In a changing climate, some of these influences can have a positive outcome in terms of the position of the coastline and a precautionary approach needs to work both ways.

What the Precautionary Approach is Not

COMEST/UNESCO[26] has an excellent summary of what the precautionary approach is not. It states that,

"*To avoid misunderstandings and confusions, it is useful to elaborate on what the PP is not. The PP is not based on 'zero risks' but aims to achieve lower or more acceptable risks or hazards. It is not based on anxiety or emotion, but is a rational decision rule, based in ethics, that aims to use the best of the 'systems sciences' of complex processes to make wiser decisions. Finally, like any other principle, the PP in itself is not a decision algorithm and thus cannot guarantee consistency between cases. Just as in legal court cases, each case will be somewhat different, having its own facts, uncertainties, circumstances, and decision-makers, and the element of judgement cannot be eliminated.*"

Review of the Science and Assessments Undertaken for the Proposed Kāpiti Coast District Plan 2012. Kapiti Coast District Council.

[23] Bell, R.G. (2011) *Sea-Level rise synthesis for Auckland (2011).* Prepared for Auckland Council. NIWA

[24] However, there may not be any economic justification for discriminating against the new development.

[25] King, Julie (2009) *Preparing for Coastal Change – A guide for Local Government in New Zealand.* Ministry for the Environment

[26] *op. cit.*

Application of the precautionary approach should not be the default option; rather, it should be the last resort to be used only in the face of scientific uncertainty. As the Kapiti Coastal Experts Panel[27] noted, *"From a statistical perspective, it is recommended that "best estimates" rather than precautionary values be adopted, with margins of error or factors of safety kept separate from the estimates and added at the end if appropriate. Alternatively, one could give several scenarios based on best, worst and mid-way cases."*

Conclusion – Passing the Test for Precaution

The precautioniary approach is only evoked when the uncertainty is material to the management of significant risks. Just being uncertain about the likelihood of an event does not call for precaution unless it has serious (adverse) consequences. Similarly, being uncertain about the consequences of an event does not call for precaution if that event is not likely.

For example, while the range of the projected sea level rise from 1986-2005 to 2081-2100 (0.26 m to 0.82 m)[28] is large, it is reasonably quantified so any risks can be assessed and management strategies developed for them. A precautionary approach is not called for.

Even where the uncertainty is not constrained (*e.g.* collapse of marine-based sectors of the Antarctic ice sheet) the likelihood might still be assessed as being so low and distant that the risk can be put aside until further information can be gathered. This is a form of precaution.

Finally, the uncertainty may simply not encompass events with serious enough consequences. In Kapiti, coastal erosion in Queen Elizabeth Park has different consequences from erosion in built up areas, and the need for precaution in the face of uncertainty differs accordingly.

The decision on whether to apply caution requires the science to deliver untainted estimates of risk, consequences, probabilities and uncertainty across the full range of outcomes. It also requires information from diverse other experts about the likely consequences for each event and input from the community on their attitude to risk and on the weight they give to good and bad outcomes. The optimal decision will depend on both the nature of what is being managed and the attitudes of those involved.

[27] *op. cit.*
[28] Church, *et al* (2013) *Sea level change*. In IPCC AR5 WG1

Kapiti Coast coastal hazard assessment

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Executive summary

The Kapiti Coast consists of a coastal plain that merges with cuspate foreland that has been accreting in the lee of Kapiti Island since sea level reached a maximum between 7,000 and 8,000 BP. The current average rate of accretion varies between 0.4-0.6 $m.y^{-1}$, which is consistent with the long-term rate over the Holocene. Despite the overall trend for accretion, some areas have experienced coastal erosion that has affected coastal properties since 1900. The areas consistently affected by erosion are located south of the Tikotu Creek (Raumati and Paekakariki).

The sediments of the Kapiti coastal plain are primarily derived from the major rivers to the north (170 $kt.y^{-1}$) and local rivers (28 $kt.y^{-1}$). The supply of sediment appears to be affected by climatic oscillations influencing precipitation and windiness, potentially resulting in a cycle of longshore sediment transport of 50-60 years duration. This cycle appears to significantly affect the migration of inlet systems along the coast.

There is no compelling evidence of any relationship between prehistoric and historic shoreline movement and sea level and climatic changes for the Kapiti Coast. There is evidence that local earthquakes producing abrupt changes in relative sea level, and tsunamis have affected the shoreline stability.

The methodology adopted by Coastal Systems Ltd (CSL) was analysed, and this report discusses the various aspects that influence the Coastal Erosion Prediction Distance (CEPD) lines produced. The major concerns with the methodology are:

1. The methodology systematically maximises the CEPD at almost every step in the process in order to produce a conservative result. Consequently, the predicted CEPD lines greatly overestimate the risk of coastal erosion for the Kapiti Coast. Hence, it is unreasonable to assume that all of the properties seaward of the CEPD will experience erosion during the prediction periods of 50 or 100 years. The available data indicate that there is in fact a low risk that the majority of properties seaward of the CEPD will be affected by coastal erosion within this time period.
2. Components of the methodology used have been recognised as inappropriate for the purpose. The methodology also did not consider the morphodynamic differences along the coast associated with changing sediment type and foredune vegetation, which influence erosion processes and hence erosion hazard.
3. A risk assessment of coastal erosion hazard should include a probabilistic analysis of the drivers and impacts related to coastal erosion. This was not done, so there are no data to quantify risk, or permit a cost-benefit analysis of any proposed management responses.

Applying the CSL methodology as a hindcast for the interval 1950-2007 demonstrated that the methodology is a very poor predictor of past coastal erosion (4% success compared to 87% assuming past trends). This does not provide confidence in the reliability of the methodology for predicting future coastal erosion. Given the identified problems, the CSL methodology cannot be used to make an assessment of the risks of coastal erosion at any point on the Kapiti Coast, and an alternative probabilistic approach should be utilised.

One alternative approach is to evaluate the sediment budget the Kapiti Coast, in order to identify areas unlikely to stop accreting, those that may start eroding in the future, and those that are in sediment deficit. At present the average accretion rate for the Kapiti Coast is of the order 1.2 $kt.y^{-1}$, which is 2 orders of magnitude smaller than the available sediment supply (~200 $kt.y^{-1}$). Therefore, it is unlikely that most of the shoreline will change to a long-term sediment deficit.

The determination of the CEPD lines should differ to account for the availability of sediment. Areas with a sediment surplus, and hence accreting, should require a CEPD primarily based on the short-term storm event erosion. This is best determined from shore profile data, which would provide the probability distribution for shoreline recession caused by storms.

Areas with an existing or potential sediment deficit should be subject to a process-based probabilistic analysis of the CEPD. An example for the Kapiti Coast based on the methodology of Ranasinghe *et al* (2012) is given in the report.

Structure of Report

This Report is structured as follows:

- Executive summary
- Introduction
- Kapiti Coast background
  - Geomorphology
    - Cuspate foreland
  - Holocene development
    - Sources of sediment
    - Dune sequences
    - Influence of dune vegetation
  - Inlets
  - Relative land movements, sea level and climate effects
    - Shoreline response to eustatic sea level rise
    - Shoreline response to abrupt relative sea level rise
    - Impacts of storm activity on sediment supply
    - Impacts of climate on storm activity
    - Conceptual model of sediment pathways
  - Implications for managing coastal erosion hazard
- Coastal Systems Ltd Methodology
  - Open coast erosion
  - *LT* – Longer-term trend derivation and uncertainty
  - *ST* – Shorter-term shoreline fluctuation and uncertainty
  - *SLR* – Impact of sea level rise determination and uncertainty
  - *DS* – Dune stability factor determination and uncertainty
  - *CU* – Combined uncertainty determination
  - Removal of structures
  - Inlet Methodology
  - Summary of methodological concerns
- Alternative approach

Introduction

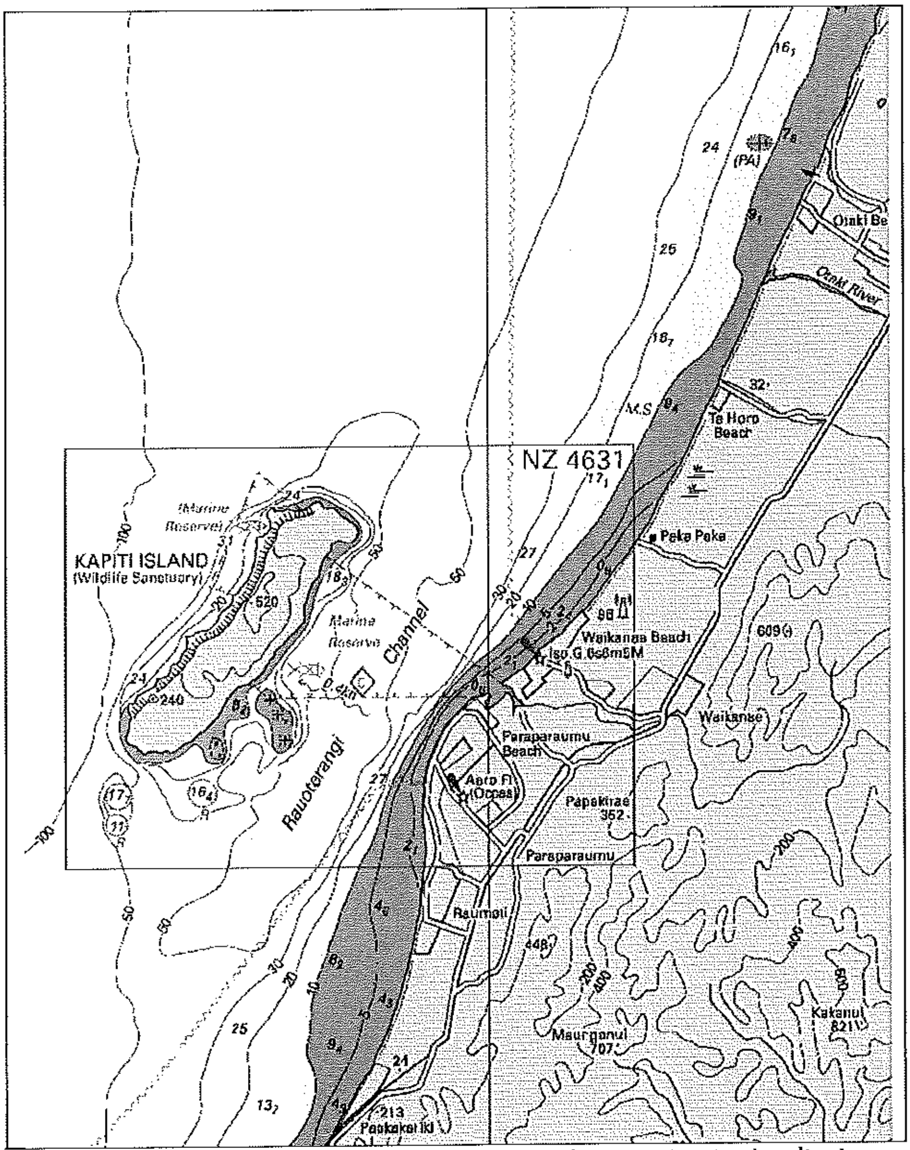


Figure 1. Section of hydrographic chart NZ 46 showing the Kapiti District shoreline between Otaki Beach and Fisherman's Table Restaurant, Paekakariki. Note the cuspate foreland associated with Kapiti Island, and the varying nearshore gradient between the shoreline and 10 m depth contour

The Kapiti Coast District Council contracted Coastal Systems Limited to provide coastal erosion hazard assessments for the Kapiti Coast (generally shown in Figure 1), and in particular to define coastal erosion hazard distance (CEHD) lines corresponding to predicted coastal erosion over 50 years (CSL, 2008a & b), and subsequently 100 years (CSL, 2012). Potential coastal hazards other than erosion were excluded from the analysis.

In general, the approach used to define the CEHDs, which were renamed coastal erosion prediction distance (CEPD) lines in the 2012 report, follows what has been best practice for determining coastal setback lines in terms of the individual components that should be considered: long-term trends; short-term fluctuations; changes in forcing processes; and characteristics or stability of coastal sediments (*viz.* Gibb, 1983; Healy and Dean, 2000; Ramsay *et al.*, 2012). However, this methodology does not consider the probabilities associated with the components, and hence does not provide a probabilistic assessment of risk, which is a requirement of risk management coastal planning frameworks (Ranasinghe *et al.*, 2012).

Further, CSL (2008a) modified the methodology used to determine the individual components of the CEPD lines, and made assumptions that appear to reflect planning interpretations and not objective science, that in combination indicate that the results are unfit for their intended purpose.

Comparison between predicted shoreline trends using standard methodology and the observed shoreline trends indicates that the standard methodology is not appropriate (*viz.* List et al, 1997; Cooper & Pilkey, 2004; FitzGerald *et al.*, 2008), and assumed changes of forcing processes do not agree with observations (de Lange and

Carter, 2013). It has also been recognised that better methods for assessing coastal hazards are required that do incorporate a probabilistic estimate of coastal response to sea level (*viz.* Ranasinghe *et al*, 2012). Therefore, an alternative approach should be used.

This report considers the Holocene evolution of the Kapiti Coast and resulting beach characteristics, evaluates the Coastal Systems Limited methodology and assumptions, and suggests an alternative approach to assessing the risk of coastal erosion.

Kapiti Coast background

Geomorphology

The Kapiti Coast between just north of the Waiorongomai Stream in the north, and the Fisherman's Table Restaurant, Paekakariki, in the south, is largely an extension of the sand country that forms the coastal plains of the Manawatu (Wright, 1988). The Holocene coastal plain consists mostly of dune sequences enclosing peat swamps that lie seaward of an assumed interglacial highstand seacliff formed after sea level reached approximately the present level 7,000-7,500 years ago (Hawke and McConchie, 2006; Gibb, 2012). The width of the Holocene coastal plain varies along the coast, being around 3 km wide at Te Horo, reaching a maximum width of 4.2 km at Paraparaumu Beach, and decreasing to zero at Fisherman's Table Restaurant (Figures 1 & 2).

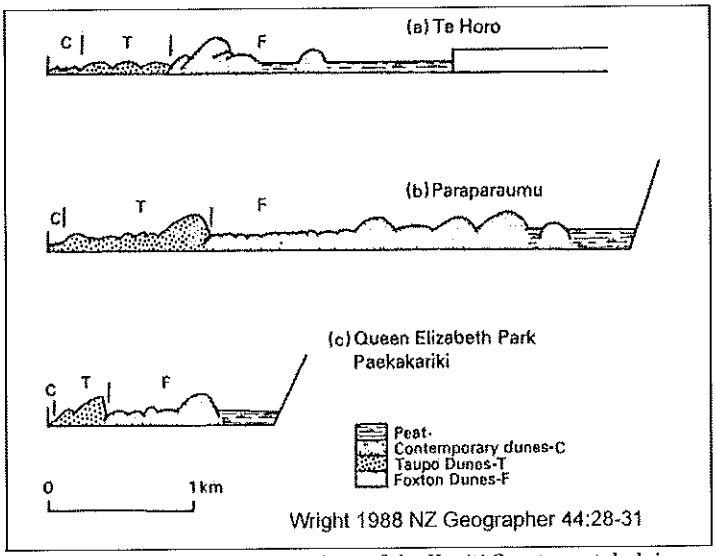


Figure 2. Schematic cross-sections of the Kapiti Coast coastal plain showing the main units identified by Wright (1988) and the varying width.

Cuspate foreland

The longshore variation in shoreline position is referred to as a cuspate foreland, being generally triangular in shape and comprising of a series of shore parallel beach ridges and dunes, indicating overall offshore progradation (Craig-Smith, 2005). Although it was suggested by Wright (1988) that the cuspate foreland formed in response to wave refraction, Black and Andrews (2001) argue that due to the deep waters of the Rauoterangi Channel, the primary mechanism is wave sheltering in the lee of Kapiti Island, and hence a reduced transport capacity. The maximum coastal plain width corresponds with the apex of the cuspate foreland (Figure 1). There is a significant longshore variation in nearshore gradient as indicated by the separation between the shoreline and the 10 m depth contour. The steepest gradient occurs between the Otaki River and Te Horo Beach, in association with mixed sand-gravel beaches, and the flattest gradient occurs between Raumati and Paekakariki (Figure 1).

The nearshore zone narrows significantly at the apex of the cuspate foreland, with a rapid increase in water depth from 0 m to 30 m close to the shoreline (Figure 1). It is suggested that the steep slope and strong currents in the Rauoterangi Channel limit further progradation towards Kapiti Island, and hence preclude further progradation towards Kapiti Island, and hence development of a tombolo (Wright, 1988).

It has also been suggested that the proximity of deep water to the apex of the cuspate foreland results in the loss of sediment into the Rauoterangi Channel, where strong currents disperse it (Wright, 1988). However, Chiswell and Stevens (2010) demonstrate that the residual current is towards the southwest so the ridge connecting Kapiti Island to the mainland would trap sediment (Figure 1), and the maximum near bed velocities in the channel are 0.1-0.2 $m.s^{-1}$, which are too low to transport sandy sediment. Further, the seabed in the channel consists primarily of rock, cobbles, and gravel with broken shell, with minor areas of mud and broken shell (Chart NZ 4631). Therefore, the Rauoterangi Channel is unlikely to be a major sediment sink for the sands transported south along the coast. It is more likely that sediment is accumulating on the inner shelf between Raumati and Pukerua Bay, south of Paekakariki (Figure 1), following the sediment transport pathway proposed by Gibb (1978) (Figure 10 below).

Holocene development

Sources of sediment

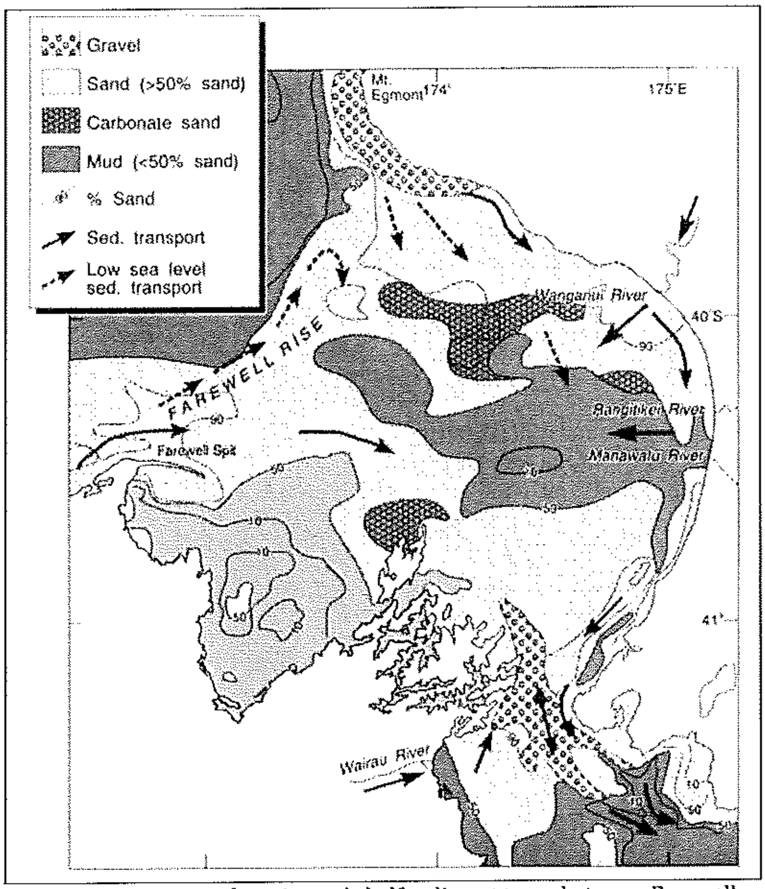


Figure 3. Summary of continental shelf sediment types between Farewell Rise and Cook Strait. (Lewis et al., 1994). Also shown are inferred sediment pathways for interglacial (solid arrows) and glacial (low sea level) conditions (dashed arrows).

Multiple sources of sediment for the Kapiti coastline have been identified. Gibb (1978) suggested that the sediment was derived from three main source regions (Figure 3) summarised below, with estimates of the present day bedload sediment discharge from Griffiths and Glasby (1985):

1. From the catchments of the Wanganui (70 $kt.y^{-1}$) and Rangitikei (40 $kt.y^{-1}$), and Manawatu (60 $kt.y^{-1}$) Rivers;
2. Smaller rivers draining the Tararua Ranges, including the Otaki River (20 $kt.y^{-1}$) and Waikanae River (8 $kt.y^{-1}$); and
3. Erosion of volcaniclastic deposits around Mt Taranaki/Egmont (*viz.* Cowie *et al.*, 2009).

It is also evident that small volumes of sediment are derived from the Te Paripari cliffs south of Paekakariki (Adkin, 1951), although this source may have been restricted by the construction of State Highway 1 (Gibb and Depledge, 1980).

Beaches around the northern and eastern North Island coast also have derived a significant proportion of their total sediment volume from onshore movement of sand during sea level rise (*viz.* Schofield, 1970), and this process appears to be ongoing (*viz.* Bear *et al.*, 2009). Wright (1988) suggests that some of the sands along the Kapiti

Coast represent sediment deposited on the continental shelf during previous glacials and moved onshore in response to sea level rise (marine *bulldozing* effect).

However, analysis of the sediment textural characteristics suggests the contribution from offshore is relatively small. Firstly the longshore distributions of grain size and sorting indicate a predominantly southwards movement along the shoreline from Taranaki to Paraparaumu Beach. Textural and compositional characteristics also suggest that there is a weak northwards movement from Paekakariki to Paraparaumu Beach (Gibb, 1978; Gibb and Depledge, 1980; Wright, 1989; Kasper-Zubillaga, *et al.*, 2007). Secondly, the compositional characteristics of the sands between Otaki and Raumati indicate that the sediment is immature, reflecting a strong fluvial component with little modification by marine processes, and closely linked to sands found between Foxton and Wanganui predominantly derived from the Whanganui, Whangaehu, Rangitikei and Manawatu Rivers, and Kaikakokopu Stream (Kasper-Zubillaga *et al.*, 2007). There is some evidence that the same sediment sources contributed to Farewell Spit, and some sediment derived from the South Island is present. This observation is inconsistent with the interpretation of glacial and interglacial sediment pathways of Lewis *et al* (1994) shown in Figure 3. Finally, the offshore sediment characteristics (Figure 3 and LINZ Chart NZ 4631) indicate that there is a zone of mud dominated seabed along the coast, so there are limited sand resources directly offshore from most of the Kapiti Coast, except for the shallow area between Kapiti Island and the coast between Paraparaumu Beach and Paekakariki.

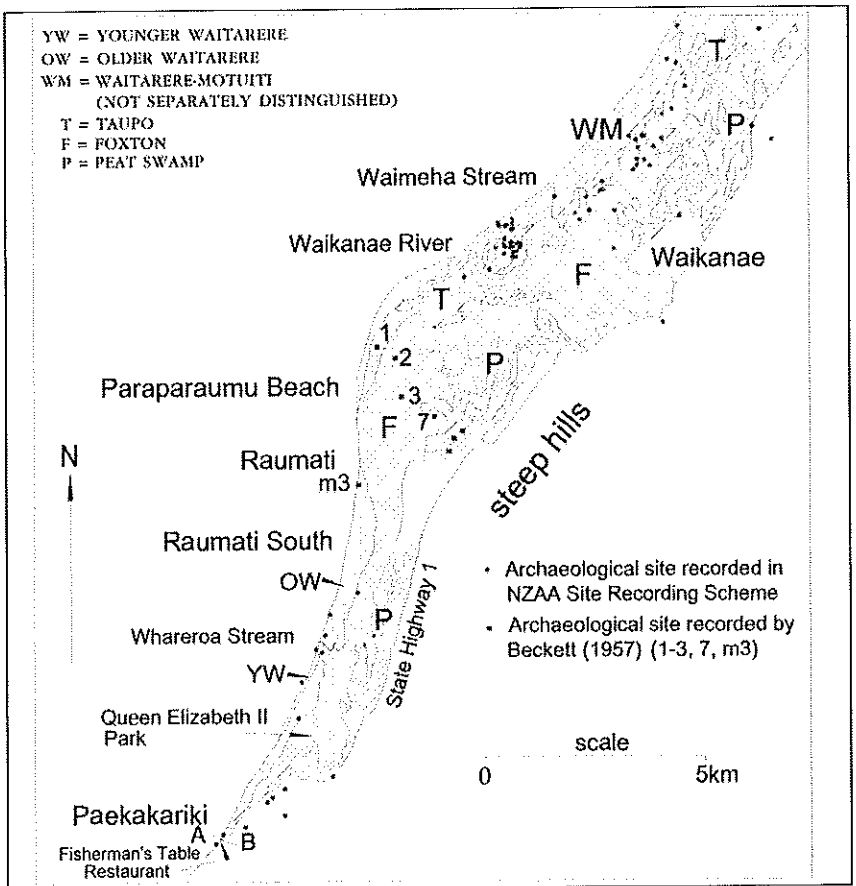


Figure 4. Sketch map of the cuspate foreland showing the main Holocene dune deposits and peat identified by McFadgen (1997). State Highway 1 approximately follows the position of the interglacial highstand seacliff.

Based on 14 months of visual observations of wave conditions and the estimated volume of longshore sediment transport from Williams (1988), the present day gross mass longshore transport is of the order 80-240 kt.y^{-1}. This is comparable to the estimated net total mass bedload discharge from the major rivers identified as sediment sources above. It is likely that the main sediment sink is progradation of the cuspate foreland, both seaward and vertically due to inland movement of sand dunes.

Dune sequences

Various studies have investigated the dune sequences of the Kapiti Coast, with McFadgen (1997) providing a useful summary (Figure 4). Key dune sequences have been identified, initially based on geomorphology and soil development and subsequently by dating using ^{14}C,

optically stimulated luminescence (OSL), and tephrochronology (Muckersie and Shepherd, 1995; McFadgen, 1997; Hesp, 2001; Hawke and McConchie, 2006; Clement *et al.*, 2010), and these include (Figure 4):

1. *Koputaroa dunes* generally located landward of the interglacial highstand seacliff and dated at 9,000-12,700 BP. They are attributed to deposition of sand blown from braided riverbeds. Further north, an older sequence of Koputaroa dunes has also been linked to a marine source when sea level was 40-50 m below present.
2. *Swamp Road dunes* that appear restricted to the Otaki-Te Horo area, and do not appear in Figure 4. These are the most landward dunes formed after sea level reached approximately the present level around 7,500 BP. These dunes are dated at 2,390-5,460 BP, and stratigraphically are considered to have formed between 4,000-4,400 8P from a marine source (as are all the younger dunes), with a fluvial input from the Otaki River.
3. *Foxton dunes* are a part of an extensive region of dunes associated with a rapid progradation of the Manawatu coastal plain between 6,500 BP and 1,600 BP. Their formation has been attributed to the onshore movement of sediment from the continental shelf associated with sea level rise. Two phases of Foxton dune development in the Manawatu can be recognised, an initial phase contemporaneous with the Swamp Road dunes, and a younger phase contemporaneous with the Foxton dunes of the Kapiti Coast dating around 2,100-3,200 BP. The onset of the younger phase coincides with 1.5-3 m of uplift at Kapiti Island and a regional tsunami associated with a local earthquake, probably on the Wairau Fault, at 3,360±40 BP (Goff *et al.*, 2000), suggesting this event may have destabilised the coastal dunes as is evident at Raumati South (Figure 5) in response to a 15th Century tsunami (Goff *et al.*, 2007).
4. *Taupo Pumice*, while not directly forming sand dunes, is an important stratigraphic marker. During the Taupo Eruption of 1717 cal BP (Lowe *et al.*, 2008), airfall lapilli and ash (tephra) covered the dunes, and larger sea rafted clasts were deposited on the beaches. In some areas of the Kapiti Coast, the deposits of sea rafted pumice are extensive (Figure 4). These have been interpreted as marking the location of the shoreline at the time of the eruption (*viz.* Gibb, 1978). However, pumice clasts are easily broken down in the swash zone of a beach, so preservation requires that they are buried or transported inland (de Lange and Moon, 2007). Hence, the Taupo Pumice deposits identified in Figure 4 are mostly tsunami washover deposits formed in swales between existing dunes, similar to the Taupo Pumice

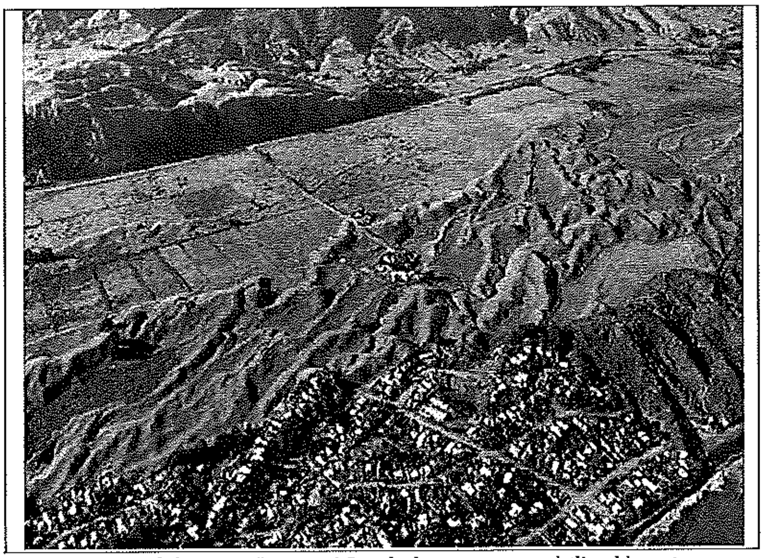


Figure 5. Sand dunes at Raumati South that were remobilised by a tsunami in the 15th Century and then stabilised by vegetation (Goff *et al.*, 2007).

deposit located in the Okupe Lagoon on Kapiti Island (Goff *et al.*, 2000). Thus, the Taupo Pumice cannot be considered a reliable shoreline marker as assumed by Gibb (1978).

5. *Motuiti dunes* (labelled as WM in Figure 4) are generally located seaward of sea rafted Taupo Pumice deposits, and contain significant quantities of Taupo Tephra. This suggests that they had formed around the time of the Taupo Eruption, and may have been destabilised by the tsunami that was associated with the eruption (Lowe and de Lange, 2000; Goff *et al.*, 2000). They advanced over the top of Foxton dunes, and bury archaeological remains along their inland edge (McFadgen, 1997). Therefore, it is suggested that human activities associated with Polynesian colonisation may also have destabilised the dunes (Clement *et al.*, 2010). This dune sequence is dated between 150 and 1000 BP.
6. *Waitarere dunes* are the most recent sand dunes, being generally less than 120 years old. McFadgen (1997) separates them into Old and Young Waitarere dunes (OW and YW respectively in Figure 4) based on buried artefacts and vegetation types. The youngest dunes overlie European-introduced artefacts and plants, and are attributed to destabilisation of the foredunes by grazing and human activities (Cockayne, 1911).
7. Mixed-sediment beaches are associated with the discharge of gravel-sized sediment to the coast. The major zone of mixed sediment beaches is the *Te Horo Gravel Beach* between the Otaki River and southern Te Horo Beach, which is of particular importance as a region of ecological significance (Forsyth and Beadel, 2012). Further, this coastal unit indicates that the Otaki River may disrupt the southwards longshore transport of sediment from the large rivers to the north (Hawke and McConchie, 2006). Following the classification of Jennings and Schulmeister (2002), the type of beach progressively changes from a composite beach just south of Otaki River, to mixed sand and gravel beach near Sims Rd, to predominantly sandy beach just south of Te Horo. Between Otaki River and Te Horo, gravel storm ridges form the coastal plain immediately inland from the beach. The ridges do not appear to have been dated, but stratigraphically correlate to the Motuiti and Waitarere dunes. The gravel storm ridges result in a significantly lower elevation of the coast plain than found for the rest of the Kapiti Coast. A smaller extent of mixed-sediment beach occurs at the southern end of the coast at Paekakariki. This area is highly variable depending on sediment availability.

The extent of dune sequences varies along the coast (Figure 4), with each unit becoming less extensive, and fewer dunes ridges being evident progressing from north to south. There is also some evidence to suggest that the southern dunes have been more disturbed by tectonic events than the northern dunes. Gibb and Depledge (1980) discuss evidence that the dunes around Paekakariki have undergone ~3 m of uplift, while the area around Raumati has undergone subsidence. Wright (1988) also suggests that the southern dunes were never as well developed as further north, primarily due to limited sediment supply.

Overall, the evidence suggests that the cuspate foreland formed some time (100s to 2000 years) after the initial onshore flux of sand associated with the Holocene marine transgression. Further the growth of the foreland was primarily controlled by southwards sediment transport from the major river catchments to the north, leading to asymmetrical dune development (Figure 4).

Influence of dune vegetation

The main dune sequences are associated with phases of inland migration of sand from the coast (Hawke and McConchie, 2006), which may be initiated by either an influx of sediment to the coast (oldest Foxton dunes, and Taupo Pumice) or renewed wind erosion of previously stable dunes or other sand deposits (Koputaroa dunes,

Swamp Road dunes, Motuiti dunes, and Waitarere dunes). The most recent phases are attributed to anthropic disturbance of dune vegetation (Hawke and McConchie, 2006), although the Motuiti dune phase also coincided with at least 3 tsunami events (Goff *et al.*, 2000; Goff *et al.*, 2008) as is evident at Raumati South (Figure 5).

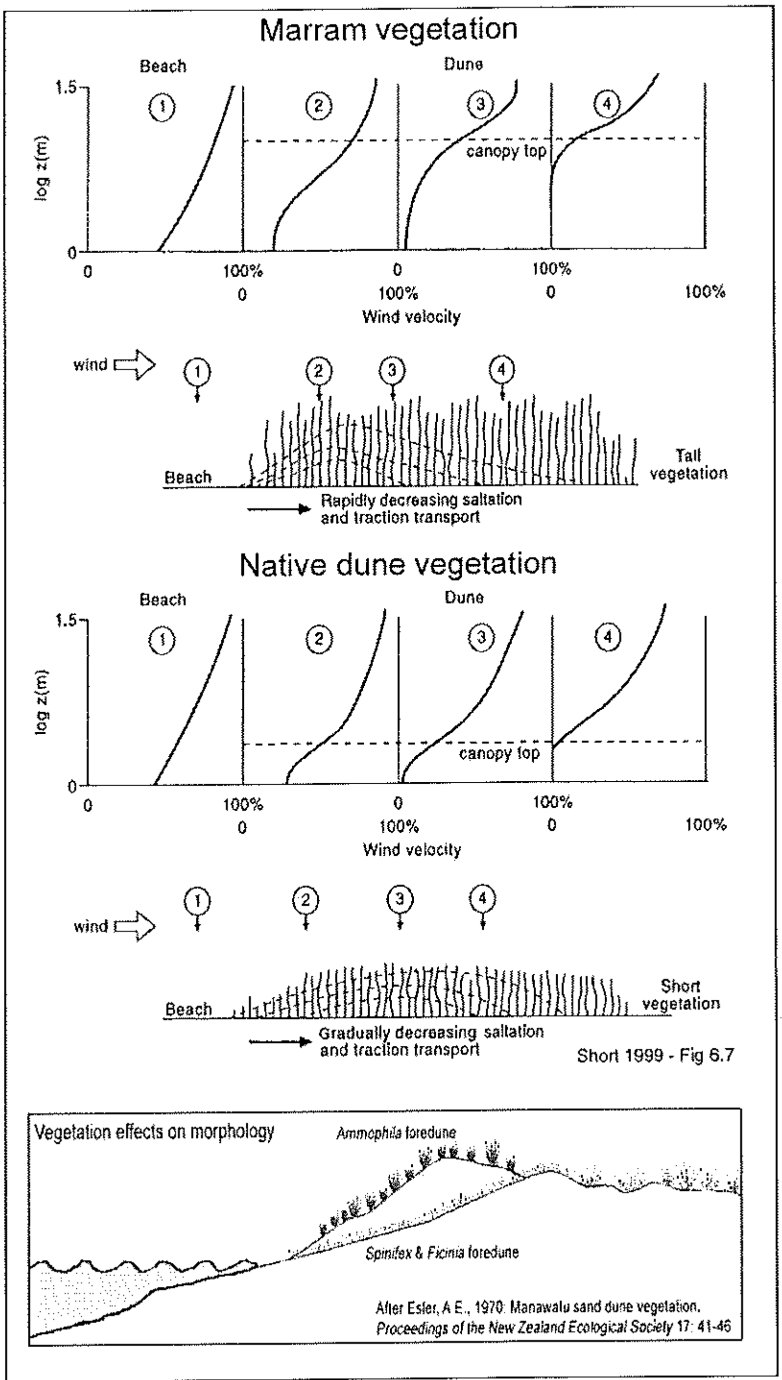


Figure 6. Effects of vegetation characteristics on foredune morphology (After Hesp, 1999).

The Waitarere dunes are linked to anthropic disruption of dune vegetation, primarily due to grazing, burning and the introduction of new flora (Cockayne, 1909, 1911; Hesp, 2001; Hilton, 2006). Cockayne (1909) reported when he surveyed the dune vegetation of the Kapiti District "*it is not easy to say what was the typical vegetation of a fixed inland dune. The pasturing of stock, frequent burning of the vegetation, and the spread of introduced plants has, in most places, called into existence a plant-association quite foreign to primitive New Zealand*". Subsequently, Cockayne (1911) proposed the use of introduced Marram Grass (*Ammophila arenaria*) as part of a strategy to stabilise the coastal dune fields around New Zealand. This was followed by the establishment of *Pinus radiata* plantations, and then extensive pastoral farming (Hilton, 2006).

The substitution of native dune species with Marram Grass and other introduced flora resulted in a significant change in the morphology of coastal dunes (Figure 6). Coastal dune morphological development depends primarily on: vegetation density, height and cover; wind velocity; and sediment supply (Hesp, 1999). Different plant species produce variations in density, height and cover. In particular, *Ammophila arenaria* produce tall dense vegetation that covers most of the surface, while the native species *Spinifex sericeus, Ficinia spiralis,* and *Asutrofestuca littoralis* produce sparse, lower vegetation with less ground coverage. These differences result in distinctly different morphologies (Figure 6).

Ammophila and associated introduced flora produced narrow high steep-faced coastal dunes to replace the lower and broader dunes that existed previously. In areas of limited sediment supply, this was associated with

shoreline retreat as any given volume will occupy less horizontal space as a high steep dune. Further, during the transition from native dunes to *Ammophila* dunes, sand was lost inland as transgressive sand sheets and parabolic dunes (Hilton *et al.*, 2005). This process likely contributed to the phase of erosion between Raumati and Paekakariki reported by Gibb and Depledge (1980).

More importantly, there is growing evidence that the response of the beach to storm events differs with the morphology of the foredune. In particular, steep *Ammophila* foredunes are more prone to scarping and collapse, while lower *Spinifex-Ficinia* foredunes are more prone to overwash that can result in accretion during storms (*Pers. Obs.*).

Dune restoration activities are now increasingly common around the New Zealand coastline, including within Kapiti District. These commonly include replanting native species to encourage the growth of foredunes, and may also involve the removal of introduced species, particularly *Ammophila*. This is resulting in the reversion of coastal morphology to pre-marram invasion conditions (Hilton *et al.*, 2009).

Inlets

There are 12 inlets of varying size along the Kapiti District coastline from the Waikakariki Stream in the south, to the Waiorongomai Stream in the north, with the largest in terms of freshwater and sediment discharge being the Otaki and Waikanae Rivers. Most of the inlets are associated with a coastal lagoon. However, these lagoons differ from the traditional concept of coastal lagoons, which are generally tidally dominated water bodies formed as a consequence of inundation following sea level rise (Oertel, 2005). Depending on the freshwater discharge, the lagoons on the Kapiti Coast are either wave or fluvially dominated, and hence behave like *hapua*, or river-mouth non-estuarine lagoons, found on the mixed sand-gravel coasts of the South Island (Hart, 2007, 2009a & b). For these systems the lagoon inlet varies in response to the freshwater discharge and volume of longshore sediment transport, with several distinct phases being recognised (Hart, 2009a):

1. When the discharge is sufficiently low, the lagoons inlets become blocked and drainage occurs through the barrier as a ground water flow.
2. At intermediate discharges, the inlet tends to migrate in the direction of longshore transport (generally southwards for inlets from Tikotu Creek northwards, and northwards for inlets south of Tikotu Creek – CSL (2008b)).
3. Finally at high discharges the barrier tends to be breached close to the freshwater channel entering the lagoon, forming a new inlet.

The shoreline changes mapped by CSL (2008b), indicate that this pattern of behaviour occurs at inlets on the Kapiti Coast. There is also evidence that as the shoreline has accreted, lagoons have progressively been stranded inland, forming lakes that eventually infilled with peat (Figure 4). It is possible that this has been associated with pulses of sediment transported southwards along the coast. CSL (2008b) discusses the possibility of such a sediment pulse in the late 1940s leading to extensive development of new control measures for the inlets during the 1950s.

The available evidence indicates that the natural inlets along the Kapiti Coast tended to migrate over time, and also became blocked, impeding drainage and contributing to an extensive area of swampy land between the coastal dunes and the hills (Figure 4). In order to develop the coastal plains, the swamp areas were drained, additional inlets were dug, and existing inlets were progressively modified. Since the 1920s, a range of stopbanks

and training walls have been constructed around some of the inlets, and sediment barriers blocking the inlets have been routinely breached (Greater Wellington Regional Council, 2003; CSL, 2008b), with provision for this activity in the Regional Coastal Plan. Therefore, the present day inlets are highly modified, and limited in their ability to respond to variations in discharge and longshore sediment transport.

Relative land movements, sea level and climate effects

South of Paekakariki, three main fault zones are identified on land: Pukerua Fault, Ohariu Fault and Moonshine Fault (Gibb, 2012). The Ohariu Fault has been mapped through Kapiti District (Van Dissen and Heron, 2003), and generally follows the base of the hills flanking the coastal plains. The Pukerua Fault extends offshore at Pukerua Bay and probably links with the submarine fault systems running northwards through the Rauoterangi Channel (Nodder *et al.*, 2007) on the seaward margin of the coastal plain. Further offshore, the major Wairau Fault system from the South Island is thought to continue northwards to the west of Kapiti Island. Borehole data also indicate that multiple faults disrupt the basement rock underneath the coastal plain (van Dissen and Heron, 2003).

In the Manawatu, the older deeper faults are associated with a series of anticlines that deform the surface. However, these are not evident in the Kapiti District (van Dissen and Heron, 2003). Instead, it is more likely that there is broad tilting of the blocks between the major fault zones (Gibb, 2012), down in the west and up in the east, which is consistent with the observed vertical displacements of sand dunes south of Paraparaumu Beach (Gibb and Depledge, 1980). The last identified major seismic event involved 3-4 m of vertical displacement on the Ohariu Fault around 1000-1050 cal BP. This is consistent with estimates of the onset of erosion at Paekakariki to Raumati (Gibb, 1978; Gibb and Depledge, 1980), and a tsunami event recorded at Kapiti Island (Goff *et al.*, 2000).

Beavan and Litchfield (2012) reviewed long-term geological indicators and short-term continuous GPS (CPS) measurements of subsidence/uplift. For the Kapiti District they found that the geological data indicate long-term uplift of 0-1 mm.y^{-1}, that numerical models predict an upwards glacio-isostatic adjustment of 0.34 mm.y^{-1}, and that CGPS measured subsidence at 0.7-2 mm.y^{-1} (with >1 mm uncertainty).

Although there are no reliable analyses of relative sea level changes during the Holocene for the Kapiti District, Clement *et al* (2010) summarise Holocene sea level for the Manawatu region to the north, and Gibb (2012) similarly examines the evidence for the Porirua Harbour area to the south. Gibb (2012) assumes a eustatic sea level curve based on his earlier 1986 published data (Gibb, 1986), but with adjusted ^{14}C ages. Clement *et al* (2010) combines the Gibb (1986) data with additional data, primarily from northern New Zealand, to produce a revised curve (Figure 7).

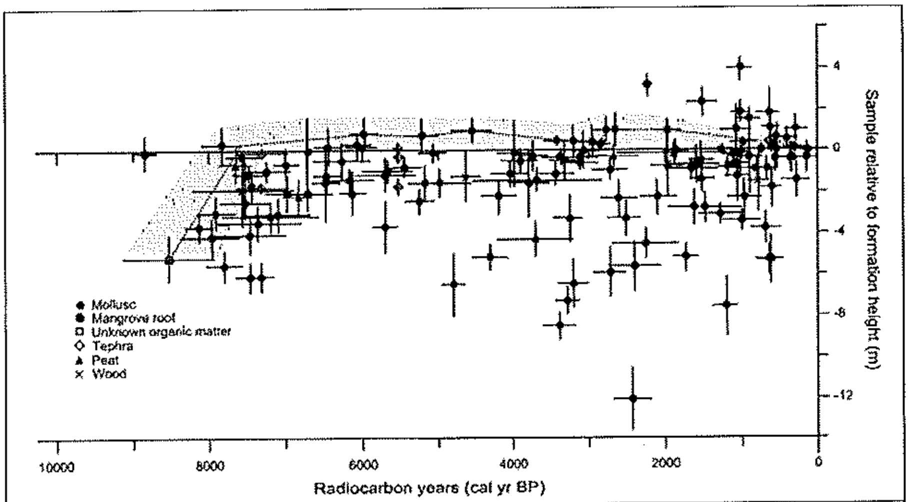


Figure 7. Revised New Zealand Holocene sea level curve (Clement *et al.*, 2010).

The Gibb (2012) and Clement *et al* (2010) eustatic curves are broadly similar, but the revised curve (Figure 7) indicates sea level may have reached approximately the present position up to 1000 years earlier. Clement *et al* (2010) also indicate that the eustatic sea level was likely 0.3 m higher than indicated in Figure 7 around 7500 BP. This would make the New Zealand curve consistent with the Zone V (most of Southern Hemisphere) eustatic sea level curve of Clark and Lingle (1979), the recent assessment of the Australasian eustatic sea level curve (Lewis *et al*, 2013), and the thermosteric sea level behaviour implied by recent reconstructions of Holocene Australasian ocean heat content (Rosenthal *et al.*, 2013).

Clark and Lingle (1979), and more recently Gehrels (2010), demonstrated that the concept of a single global eustatic sea level curve is misleading, and a better approach is to focus on regional sea level curves, particularly for regional planning. The key features of the regional sea level curve for the Southwest Pacific Ocean are that: the maximum sea level occurred between 7-8,000 BP; the overall trend for the last 7,000 years has been falling sea levels, consistent with the reported ocean cooling trend for this region over this time period (Rosenthal *et al.*, 2013); and there have been fluctuations about the trend of the order ±0.5 m, also consistent with the fluctuations in the ocean heat content record. The sea level rise observed at the Kapiti Coast at present is consistent with the pattern over the last 7,500 years.

Shoreline response to eustatic sea level rise

Therefore, it is likely that the development of the Kapiti District coastal plain and cuspate foreland occurred during a period of fluctuating sea levels, including intervals with higher sea levels than at present. There is no clear relationship between regional sea level variations and the shoreline response along the Kapiti Coast; accretion has occurred regardless of whether sea level rose or fell.

Shoreline response to abrupt relative sea level rise

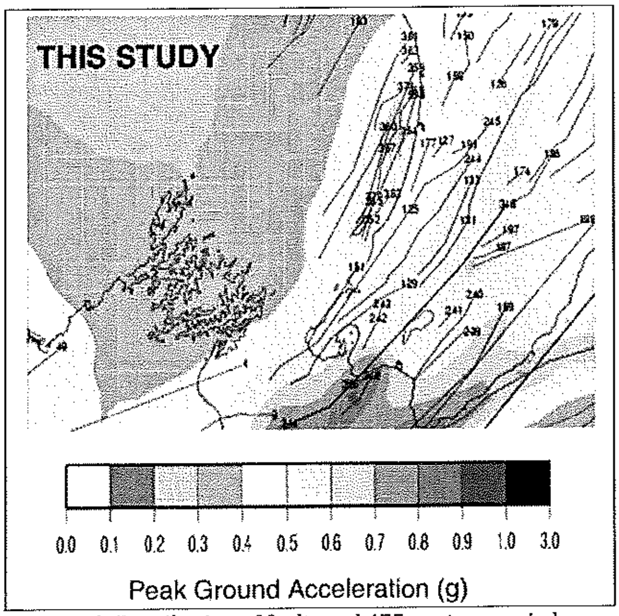


Figure 8. Distribution of faults and 475 y return period peak ground accelerations showing the influence of off-shore faults along the Kapiti-Manawatu coast (Nodder *et al.*, 2007).

Gibb (2012) also provides evidence for abrupt relative sea level changes associated with seismic events on the major faults along the west coast of the lower North Island. The mean vertical displacement during a seismic event is reported as 3.7 m, consistent with the estimated mean magnitude of M_w=6.9±0.3 for the Kapiti-Manawatu Fault System (Nodder *et al.*, 2007). The average return intervals for individual fault systems are estimated as ranging from 2,000 to >5,000 years. However, the number of fault systems present in the region results in a relatively high probability of a significant event (Figure 8).

Considering the locations of the faults in Figure 8, a seismic event causing several metres of relative sea level change is a low probability event of the order 0.02-0.05% annual probability. However, the probability of a local tsunami is higher, with annual probabilities of 0.2% for tsunami larger than 1 m based on the National Seismic Hazard Model 2010 update (Stirling *et al.*, 2012), and 0.1% for tsunami larger than 5 m based on the Goff *et al* (2000) tsunami record from Kapiti Island. The geological and geomorphic evidence indicate that

either an abrupt relative sea level change, or a tsunami, can destabilise the foredunes along the Kapiti Coast, leading to parabolic dunes and transgressive sand sheets, or landward roll-over of gravel ridges. Hence, there is likely to be consequential erosion of the shoreline.

Impacts of storm activity on sediment supply

Although there is evidence for seismic events and/or tsunami triggering inland sand movement (Goff *et al*, 2008), major phases of dune migration are mostly attributed to climatic factors influencing the stability of the coastal dunes, and possibly more importantly the sediment supply (Muckersie and Shepherd, 1995; Hesp, 2001; Clement *et al.*, 2010). Allowing for variations in the underlying geology, there is a strong correlation between precipitation and sediment discharge for New Zealand catchments (Hicks *et al.*, 2011). Further, New Zealand steepland catchments appear to be particularly sensitive to environmental change at a range of time scales (Upton *et al.*, 2013). This suggests that there is likely to be a relationship between the supply of sediment to the Kapiti Coast and environmental changes in the catchments draining to the coast between Cape Egmont and Paekakariki.

Grant (1981) proposed that coastal erosion around the North Island was associated with precipitation regime shifts linked to fluctuations in tropical cyclone activity. In particular, he identified an increase in storm activity that started in 1954 and continued to around 1978. Prior to the increase, there appeared to be widespread accretion around the coast, which was followed by phases of severe erosion. Increased storm activity was also associated with an increased frequency of severe floods. de Lange (2001) showed that the fluctuations in storm activity were linked to the phases of the Interdecadal Pacific Oscillation (IPO – also known as Pacific Decadal Oscillation, or PDO, in the northern hemisphere), and they produced changes in the dominant coastal wind direction and available wave energy, which favoured periods of erosion or accretion. Proxy indicators of storm activity indicated that the fluctuations between increased and decreased storm activity had occurred for at least 5,000 years.

Although an increased frequency of severe floods results in a higher discharge in sediment to the coast, there is a lag in the response so this effect is not contemporaneous with the flood events. Grant (1991) assessed forest disturbance within the Ruahine Range (part of the headwaters of the Manawatu River). He found that the stormy phases resulted in increased forest disturbance and mass movement, with a 2% reduction in vegetation cover and average denudation rates of 7 ± 2 $mm.y^{-1}$ (2-6 times the rate of tectonic uplift). The sediment that entered the channels took several decades to be transported to the coast. Grant (1991) also concluded that the fluctuations in precipitation and windiness were more significant than anthropic effects in terms of sediment discharge.

Impacts of climate on storm activity

Lake Tutira, Hawkes Bay, provides a record of North Island storm activity for the last 7200 years (Page *et al.*, 2010), which was found to be a useful proxy for the discharge of sediment from the Waipaoa River catchment into Poverty Bay (Upton *et al.*, 2013). The sediment discharge from the Waipaoa River was simulated over the last 5,500 years, and found to correlate well with continental shelf sedimentation, and indicated that centennial to millennial scale precipitation fluctuations were the primary driver of changes in sedimentation rates.

Figure 9 shows the Lake Tutira storm activity measured as years between storm event deposits within the lake, climate proxy data derived from carbon (precipitation) and oxygen (temperature) isotopic ratios in speleothems from Waitomo, the dune phases preserved at Te Horo (discussed above), and the ages of palaeotsunami deposits found on Kapiti Island by Goff *et al* (2000). Page *et al* (2010) identified 25 periods of increased frequency of ma-

jor storms over the last 7,200 years, of which 9 were of at least 100 years duration (shaded bands in Figure 9). They found no relationship between storm activity and ENSO (3-7 year) climatic variations, and speculated that storm behaviour may be influenced by the interaction of ENSO, IPO (50-60 year fluctuations) and the Southern Annular Mode (SAM). They also noted that, as is evident in Figure 9, Holocene climate for New Zealand has involved multiple periods of rapid change, particularly in terms of storm activity.

Gomez *et al* (2011) examined the Lake Tutira data in conjunction with climate proxy data from Ecuador, the Western Pacific Warm Pool, and Central Antarctica, in order to assess the combined role of ENSO and SAM climatic variations. They argue that La Niña (positive) conditions and a positive SAM both enhance rainfall and the incidence of extratropical storms and strong easterly to northeasterly winds for the eastern North Island. Hence, the storm activity record from Lake Tutira represents the relative phase of ENSO and SAM, with maximum storm activity occurring when both are positive. Although the data showed some support for this interpretation, it was also evident that the strength of the coupling between ENSO and SAM varied throughout the last 7,200 years. The variation in coupling was linked to the seasonal contrast in solar insolation, and therefore the precession component of Milankovitch Cycles, resulting in amplified responses around 5000 and 2000 BP.

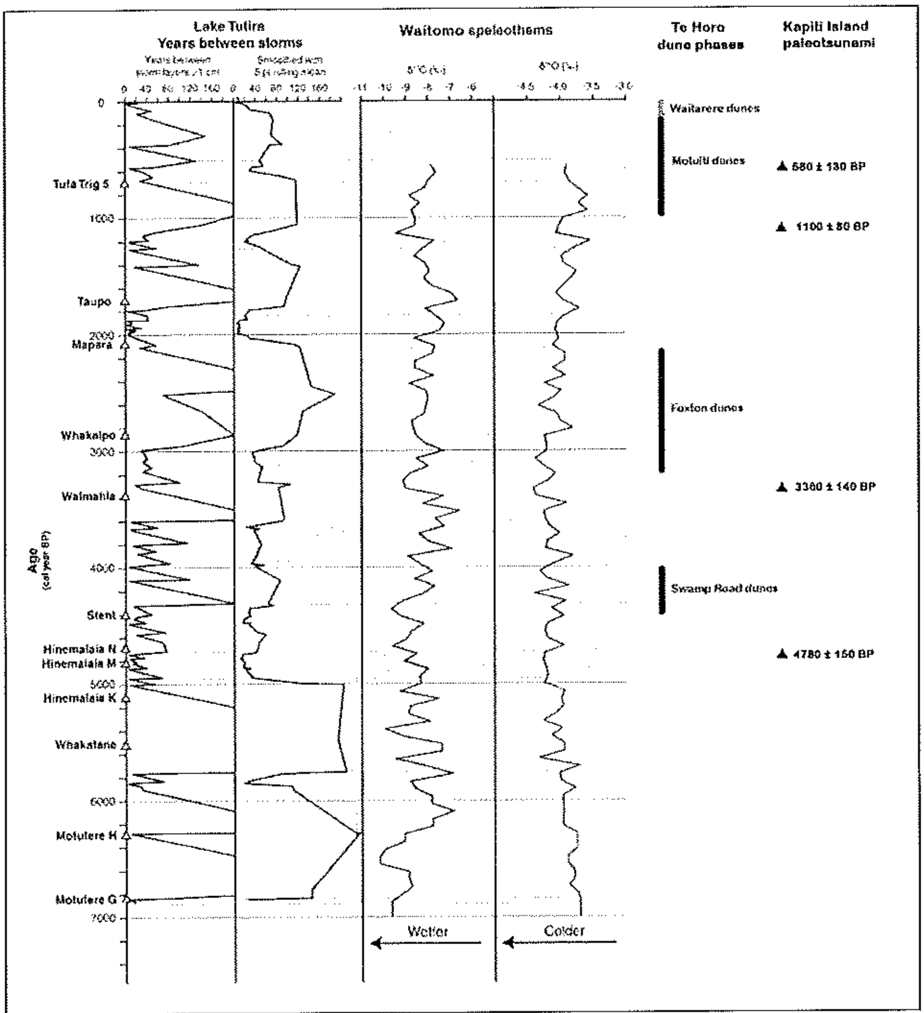


Figure 9. Comparison between storm intensity at Lake Tutira (indicated by years between storms), precipitation and temperature proxy data from Waitomo, the dune phases at Te Horo, and palaeotsunami deposits on Kapiti Island. Open triangles on the vertical axis summarise key tephra markers (After Page *et al.*, 2010; Hawke and McConchie, 2006; and Goff *et al*, 2000).

Although the Kapiti District is on the west coast of the North Island, the main catchments supplying sediment to the coast (Wanganui, Rangitikei and Manawatu Rivers) all have headwaters in ranges that are affected by the same weather systems as Lake Tutira. Therefore, a similar pattern of storm activity related sediment discharge can be expected for the Kapiti District. Comparison between the Lake Tutira storm activity data and the dune phases at Te Horo (Figure 9) show that the periods of dune instability all follow periods of increased storm activity. However, not all periods of increased storm activity are associated with dune migration, and the climate proxy data (Waitomo speleothems) does not show any systematic relationship with the dune phases.

In contrast, the onset of every dune phase occurs around the same time as a major local tsunami event recorded at Kapiti Island (Figure 9). Therefore, it appears more probable that the destabilisation of coastal dunes was associated with tsunami inundation as suggested by Goff *et al* (2008), than as a direct consequence of climatic variations.

There are no published records of geological indicators of the movement of the shoreline over the last 7,000 to 8,000 years. Although the seaward margin of the dune phases and sea rafted Taupo Pumice have been suggested as shoreline indicators, these cannot be considered reliable particularly the Taupo Pumice, which probably represents an overwash deposit and not a beach deposit. Based on the available survey data (Gibb, 1978; CSL, 2008a and b), there is evidence of decadal scale pulses of sediment arriving from the river catchments. The pulses of sediment are most likely related to precipitation and windiness variations at decadal or longer scales (*viz.* Grant, 1981). Therefore, the rate of sediment supply to the Kapiti District is probably affected by variations in storm activity. However, the available evidence indicates that storm activity over the Holocene is not systematically correlated with climatic forcing. Hence, climate change is not a direct driver of sediment supply for the Kapiti Coast.

Conceptual model of sediment pathways

Gibb (1978) proposed sediment transport pathways affecting the stability of the coast between Paekakariki and Paraparaumu Beach (Figure 10). The key features are a southward movement of sediment from major sources in the north, which is deflected offshore near the apex of the cuspate foreland, and a northward movement of sediment from sources south of Paekakariki. Longshore sediment transport converges between the Wharemauku Stream and Tikotu Creek, and the offshore deflection of sediment transport leads to deposition on the inner shelf between Paekakariki and Raumati.

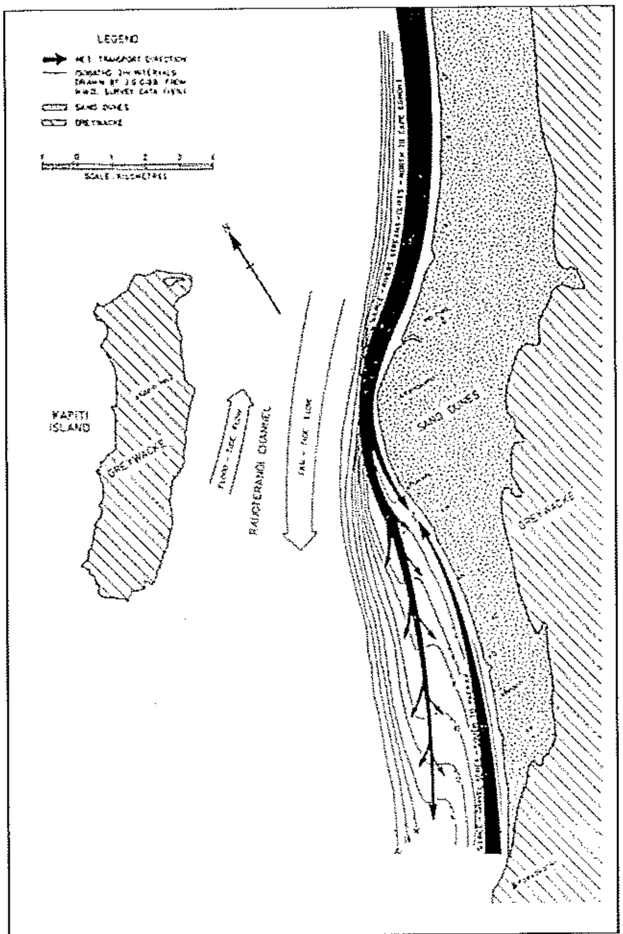


Figure 10. Proposed sediment transport pathways for the southern section of the Kapiti Coast from Te Hapua to Paekakariki (Figure 8 from Gibb, 1978).

The evidence discussed above indicates that the behaviour suggested by Gibb (1978) is broadly correct. However, there is little contribution of sediment from the south. It is more likely that sediment moves onshore during relatively calm low amplitude swell conditions. Hence, the sediment supply for the southern flank of the cuspate foreland is primarily driven by recirculation of sediment ultimately derived from the north. Since the northwards movement of sediment along the coast of the southern flank of the cuspate foreland is predominantly associated with storm waves, it tends to

occur episodically at high rates. The replacement of lost sediment will occur at slow rates over longer time periods. Therefore, this section of coast is likely to show a strong decadal cycle of severe erosion followed by prolonged recovery.

Implications for managing coastal erosion hazard

The Kapiti Coast can be subdivided into 4 regions based on geomorphology, sediment supply, and the key processes determining coastal erosion hazard. These regions are:

1. The sandy northern flank of the cuspate foreland and northern sandy beaches between Paraparaumu Beach and just south of Waikawa. The sediment budget is positive, resulting in accretion throughout the Holocene at an average rate of 0.4-0.6 $m.y^{-1}$. Accretion is continuing at present (CSL, 2008a), most likely due to bedload sediment discharge from the major river catchments to the north. However, there is some coastal erosion occurring as decadal scale cut and fill (Gibb, 1978), and possible pulses of sediment moving along the coast (CSL, 2008a). The beach systems display predominantly dissipative to rhythmic bar and trough intermediate beach states.
2. The mixed-sand gravel coast between the Otaki River and Te Horo, with associated gravel storm ridges and limited sand dune development. The sediment budget is positive and appears to be primarily derived from the Otaki River, with the finer sand from further north largely bypassing (Hawke and McConchie, 2006). This area has accreted at ~0.5 $m.y^{-1}$ over the Holocene, and is still accreting (CSL 2008a). The beach becomes progressively sandier towards the south, changing from a composite beach at Otaki River to a mixed sand gravel beach by Te Horo.
3. The sandy southern flank of the cuspate foreland between Raumati and Paekakariki. Although this region has accreted over the Holocene, including since the Taupo Eruption according to Gibb (1978), the rate decreases to essentially zero at Fisherman's Table Restaurant. Gibb (1978) identified two regions of long-term erosion that primarily correspond to areas of urban development, particularly the construction of dwellings on the early 1900s foredune. The first subdivisions occurred in 1906 around Raumati and 1907 at Paekakariki, coincident with the establishment of *Ammophila* for dune stabilisation. Gibb (1978) also indicated that accretion had occurred in the central region occupied by Queen Elizabeth II Park. CSL (2008a) identifies this entire zone as undergoing erosion, and suggests that the 1880 and 1958 shorelines determined by Gibb (1978) were incorrect. The beaches are predominantly dissipative to longshore bar and trough beach states.
4. The inlets along the coast are strongly affected by freshwater discharge, and therefore are considered as a separate coastal type. Although there is some tidal influence for most of the inlets, overall they behave more like non-estuarine river mouth lagoons than estuarine lagoons. The frequency and magnitude of flood events, the volume of bedload sediment transport, and the magnitude of longshore sediment transport affect their behaviour. Some of the inlets were created to facilitate drainage of the coastal swamps, most have been modified for at least 80 years as part of flood management works, and the Otaki and Waikanae Rivers have been used as sediment sources, particularly for gravel (Williams, 2011).

It is evident that a single methodological approach to assessing coastal erosion hazard is inappropriate. CSL (2008a & b) accordingly used separate analyses for the open coast and inlets. However, given the differences in prehistoric and historic behaviour for the 4 zones identified, the open coast should not be treated as one type of

morphodynamic system. The inlets have had a long history of modifications that vary significantly between inlets, and there are differences between them in terms of the predominant sediment texture and ranges of discharges. Therefore, the inlets should also not be treated as one type of system.

Coastal Systems Ltd methodology

The CSL (2008a & b) reports distinguished between coastal areas directly affected by stream and river discharge to the coast (Part 2: Inlets) and the rest (Part 1: Open coast). Different methodologies were used to determine the CEPD for the two types of coastal areas, and these are discussed separately below.

Open coast erosion

The basic equation used includes the key components suggested by various reviews of Coastal Hazard Zonation methodology (Komar *et al*, 1999; Healy and Dean, 2000; Ramsay *et al.*, 2012), with no weighting factors for the different components evident in the relationship as expressed in Equation 1 (page 11, CSL, 2008a). An additional combined uncertainty term has been included to give

$$CEPD = LT + ST + SLR + DS + CU$$

where these were defined by CSL (2008a, 2012) as:

1. *CEPD* = Coastal erosion prediction distance (changed from CEHD = coastal erosion hazard distance terminology between the 2008 and 2012 reports).
2. *LT* = *Longer*-term historic change based on cadastral maps and aerial photographs. Strictly, the long-term change should be over a minimum of 60 years to allow for the fluctuations due to climatic oscillations such as IPO and SAM. However, as discussed below, the time interval used was variable, which is presumably why the *LT* term is referred to as *longer*-term relative to the *shorter*-term fluctuations;
3. *ST* = *Shorter*-term historic fluctuation. From the discussion in CSL (2008a) this was to be derived from statistical analysis of historical data, but in practice it was estimated from the residuals of an Ordinary Least Squares (OLS) fit to the longer-term trend. For assessing coastal erosion, this is probably the most important term as arguably sea level rise does not directly cause erosion for sandy coasts, but acts to increase the elevation to which storm processes affect the beach;
4. *SLR* = Shoreline retreat associated with sea-level rise induced by global warming. CSL (2012) renamed the term *RSLR* to represent the shoreline retreat associated with sea level rise. This terminology assumes that future sea level rise can only cause erosion, and therefore *SLR* will be retained for this discussion. Strictly the *SLR* term should be due to the effect of a change in the rate of sea level rise, as historic sea level rise is already incorporated into the *LT* term;
5. *DS* = Dune stability. This accounts for the scarp retreat to a stable slope after an erosion event. This term is required if the previous terms are predicting the location of the base of the slope and infrastructure of concern is located at the top of the slope;
6. *CU* = Combined uncertainty. CSL (2008a) defines this as the error associated with the previous four terms in the equation, and any other precautionary measures that result from assumptions made in the analysis.

The methodology used by CSL (2008a; 2012) to determine each of these terms is considered in more detail below:

LT – Longer-term trend derivation and uncertainty

The longer-term trends were derived from aerial photographs, and pre-digitised shorelines determined by the National Water and Soil Conservation Organisation (NWASCO) predominantly from aerial photographs and un-specified cadastral maps. It was noted that a systematic error resulting from using vegetation lines as shoreline indicators in aerial photographs, and reported high tide shoreline at the time of the survey on the cadastral maps produced an over-estimate of shoreline erosion rates. The two different shoreline indicators may be several to tens of metres apart at any one time, depending on beach state.

According to CSL (2008a) landward reference points were used to define 68 locations, and the distance between the shoreline and reference point measured in GIS (presumably, as it was not stated) from the geo-rectified aerial photographs and NWASCO plotted shorelines.

CSL (2008a) assumed that the geo-rectification results in a location error of ±3 m, with a further error in estimating the shoreline position of ±3 m. It is not clear if this was determined separately for aerial photos and NWASCO shoreline cadastral data. For each location about 9 measurements were made from aerial photographs, and 1-2 from cadastral map shorelines. These should have different uncertainties, as generally the error would be expected to differ with the scale of the aerial photograph and the technique used.

The longer-term trend was determined by Ordinary Least Squares (OLS) regression analysis. Three different trends were determined:

1. Entire record – 1870s to 2007
2. Earlier period – 1870s to early 1950s
3. Later period – 1940s to 2007

These dates are not exact because the survey coverage varies along the coast, so the dates varied with location. The earlier period was assumed to be unaffected by coastal management, but there is clear evidence that the dunes were affected by grazing and burning resulting in extensive vegetation loss and destabilisation (Hesp, 2001; Hilton, 2006). Following the Sand Drift Act (Introduced 1903, enacted 1908) the dunes were planted in *Ammophila* (marram grass), which significantly altered their shape and behaviour (Hilton, 2006).

It can also be argued that land-use changes and flood protection works in the catchments have affected sediment yield over the entire record (Grant, 1991). Development of infrastructure of the dunes also began in the early 1900s. However, coastal protection and flood control structures mostly were first installed in the early 1950s.

NZ studies have identified decadal-scale patterns of shoreline fluctuations (de Lange, 2001), and Grant (1981) identified these patterns for the Kapiti Coast. This means that it is necessary to ensure that the influences of decadal-scale fluctuations are removed from long-term trends, and also the probabilities of coastal hazard extremes (de Lange and Gibb, 2000a & b). CSL (2008a) treated "non-linear" trends using break-point analysis without any constraints on the minimum trend duration that would allow discrimination between trends and fluctuations (Figure 3 CSL, 2008a). This approach has a significant effect on the *LT* term required for the analysis. In particular, CSL (2008a) uses this approach to replace long-term (~100 year) trends with trends over only a few decades (*longer*-term). This is demonstrated in Figure 3 of CSL (2008a). In figures 3A and 3C an accretionary trend is transformed into long-term erosion, which is misleading. In Figures 3B and 3D, the magnitude of the trend is altered significantly.

It is claimed by CSL that, apart from the sites in Figure 3 (CSL, 2008a), the later period trend was *qualitatively* similar to the trend over the entire record. No summaries of the longer-term trends were provided. However, summaries of the trends for the earlier and later periods were available in the database. If the later period trend is *quantitatively* similar to the entire trend, then the trends for the two sections should also be similar. Using the data supplied for 47 sites, the ratio of the later period trend to the earlier period trend was calculated, and found to vary from -32 to 815 (Note that a negative sign indicates a switch in trend between periods). This is a very large variation, which is largely due to the effects of 5 sites that have absolute ratios >30. Three sites are at the foreland apex (C13.04 ratio 814, C13.24 ratio 77, C13.44 ratio -32) , one on the southern flank (C3.93 ratio 53), and one on the northern flank (C22.06 ratio 32). One of these sites – C13.44 - was identified in Figure 3B of CSL (2008a).

Six sites (Table 1) appear to have a change in the direction of trend between the earlier and later periods (either from accretion to erosion, or vice versa). Three sites located between the end of the northern Raumati seawall and Tikotu Creek (C10.29, C10.61, and C11.17) and one closer to the Waikanae River (C14.20) show a switch from accretion to erosion. Sites C11.17 and C14.20 are shown in Figures 3A and 3C of CSL (2008a). Two sites located further north show a switch from erosion to accretion (C13.44 and C17.88), and Site 13.44 is shown as Figure 3B of CSL (2008a).

Table 1. Summary of the changes in trends between the earlier and later periods reported by CSL (2008a) for 47 sites assumed to be unaffected by coastal structures along the Kapiti District coastline.

	Accretion to erosion	Erosion to accretion	Consistent accretion	Consistent erosion	Total
Decelerating	3	0	11	2	16
Accelerating	1	2	17	11	31
Total	4	2	28	13	47

The remaining 41 sites retain the same direction of trend, but either they display deceleration (ratio <1) or acceleration (ratio >1). Ignoring the 5 sites with absolute ratios >30, the mean absolute ratio is 2.34 ± 2.43 for the remaining 42 sites. This indicates that the later period overall has increased trends, as reflected by the values in Table 1. However, the earlier period analysis typically combines 1-3 cadastral survey data points with 1-2 aerial photo points, while the later period analysis is entirely based on aerial photo data. Since there is a difference in the shoreline definition between the two types of data that biases the trend, the inferred trends may be erroneous, and it is not clear if the difference in trends between the two periods reflects a real change in rate or an error.

Not evident in Table 1 is that only one site (C32.54 at the Otaki River mouth) has a ratio that lies in the range 0.8-1.2. The implication of these results is that if the *LT* term was determined in the early 1950s and the same methodology applied to estimate the long-term average shoreline position at the end of the late period, only one site out of 47 would be within ~20% of the actual location. This implication will be examined further in conjunction with the effects of sea level rise below.

Overall, there are significant differences in trends between the two periods analysed, and it is not appropriate to assume that the later period trend is representative of the long-term trend. This is of particular concern because the *LT* trend is extrapolated into the future by 50 and 100 years, and so small variations in the trend will produce large variations in the CEPD.

CSL (2008a) used a comparison of the earlier period trend with the later period trend to assess the impact of coastal structures, in order to predict shoreline response for scenarios where the structures are removed or fail. It was acknowledged that this approach was problematic, as "*Given that these rates may be exaggerated by the inclusion of tide-based shorelines from cadastral maps, and affected by lack of intermediate data-points, the pre-urban shoreline appears to have been relatively stable.*" (page 20 CSL, 2008a). Therefore, it was assumed that in the critical area where structures now exist, the longer-term rate prior to construction was "*stable*". However, this assertion is unsupported by data provided. Instead, Table 1 indicates that few sites were *stable*, and for most the rates of change are different between the two periods.

CSL derives its' longer-term trend from the later period trend, except for those sites with seawalls or a "recent trend change" (Figure 4B CSL, 2008a). Those sites with a recent trend change use a short-term trend determined by the weighted linear model (strictly appears to be a truncated linear model using selected recent data points). Sites with seawalls are assumed to have no longer-term trend while seawalls are present. However, the report notes that there has been accretion at some seawall sites (in one case the seawall is completely buried now - site C12.50).

Hence, there is no consistent approach by CSL in determining the long-term trends for the Kapiti Coast. The main approaches for the calculated rates of shoreline movement in CSL (2008a) are:

1. Trends determined by OLS for the 1940s to 2007 (late period) – a trend over a maximum period of 67 years, which is barely long enough to span the 50-70 year fluctuations in NZ shorelines identified by other studies and probably present along the Kapiti Coast (Grant, 1981; Shepherd in CSL, 2008a).
2. Trends determined by "weighted" OLS for the 1990s to 2007 (non-linear sites) – which is really a short-term trend.
3. "Stable" areas assumed to have no trend due to the presence of seawalls.

Then, if the later period trend is positive (coast is accreting) it is set to zero, unless the weighted OLS trend indicates a recent change to erosion, in which case the recent trend is substituted for the longer-term trend. Hence, a coast that the data and geomorphic evidence shows to be predominantly accreting north of Tikotu Creek is transformed into an erosional coast to assess future risk of erosion.

The uncertainty in the *LT* factor is determined as follows:

1. The assumed geo-rectification (±3 m) and shoreline detection errors (±3 m) are combined to give an assumed error of ±4.2 m.
2. The longshore variation of the "error" in the OLS regression for the later period data was assessed and an estimated 95% upper percentile was used to represent the entire coast. It is not clear exactly which error is referred to, but it appears to have been the Standard Error of Estimate (SEE), which is the standard deviation of the residuals.
3. Other factors that affect the uncertainty are discussed but then ignored.

CSL (2012) states that "*alongshore smoothing was carried out to derive the 95% confidence band over adjacent transects where similar cross-shore shoreline behaviour was apparent, thus preserving alongshore trends*" (Page 16). This procedure was carried also out for other components in the analysis. It is unclear what was actually done, as the smoothing methodology and derivation of 95% confidence bands is not explained. Further, CSL gives conflicting explanations of the same procedure: CSL (2008a) states "*The maximum (95%) value over several transects with similar characteristics was selected to represent that reach*" (Page 28); and CSL (2012) states "*the*

approach used in the present assessment of applying the upper 95% value for longer-term rates and shorter-term variation derived from several adjacent sectors to all those sectors" (Page 63).

The different procedures defined all exaggerate the magnitude of the components being considered, as indicated by CSL (2012), which states that the approach used "*may have resulted in an overly large component value being applied to some locations. While general precautionary approaches such as these help to minimize uncertainty and increase the safety margin, they may also result in some hazard distances derived in this report being overly cautious*" (Page 63). The assertion made in this statement that a precautionary approach minimises uncertainty is in direct contradiction with an overly cautious CEPD, and is not substantiated by objective analysis.

The error that should be relevant to the *LT* factor when extrapolating the trend into the future is the uncertainty in the OLS gradient (ie. the uncertainty of *b* in Equation 2 of CSL, 2008a). This indicates how much faster or slower the shoreline could be moving relative to the estimated average rate (ie. the confidence limits for the extrapolation at some specified probability). The report states that this was ignored because "*the weighting procedure, together with the variance reduction measures of setting positive rates to zero and the selection of the maximum longshore rate, were found to be adequate*" (page 26 CSL 2008a). No evidence is presented to support this assertion, but it is clear that for accreting coasts, the methodology produces a rate that bears no resemblance to the measured rate, and appears to be inappropriate.

The report also states that the ±3 m shoreline detection error was found empirically to produce a ±3.7 m error in the actual "rates of change" over a 50-year prediction period. Apart from the inconsistent units, it is not evident how this was calculated and why? However, this number is taken to be the *LT* uncertainty for the entire coast. Further, it is assumed that a one-tailed uncertainty distribution is appropriate and hence the only uncertainty to take into consideration is -3.7 m.

Therefore, setting all accreting coastal sites to zero, and then applying an LT uncertainty of -3.7 m over 50 years transformed the entire Kapiti coastline into an erosional zone (-0.074 $m.y^{-1}$ *cf.* an observed long-term trend of 0.4-0.6 $m.y^{-1}$ for most of the coastline). The results do not reflect the true probability of long-term coastal erosion, or the variation of risk along the coast that is evident from historical shoreline changes.

To summarise, the derivation of the *LT* term for the open coast (CSL, 2008a, 2012), is unreliable for the following reasons:

1. The analysis does not assess a long enough record to determine the long-term trend for the Kapiti Coast. Instead, a *longer*-term trend is based on a maximum of 67 years, and arbitrarily uses shorter intervals if they indicate an erosion trend.
2. The assumption that the later period trend is representative of the longer-term trend is invalid. A comparison of earlier and later period trends indicate that 46 out of 47 sites analysed experienced a different rate of change, and 6 of those also involved a changed direction of change (Table 1). It is not clear if the changed rates of shoreline movement between the earlier and later periods represent a systematic bias in the methodology, a consequence of too short a record to remove 50-60 climatic oscillations, a real change in migration rates, or a combination of all these factors. This indicates that the extrapolation of the derived longer-term trend up to 100 year into the future is very uncertain.
3. By separating the uncertainty from the *LT* term, the analysis incorrectly incorporates components into the *CU* term. In particular, when the accretion rate is set to zero the use of a non-zero uncer-

tainty transforms accreting coasts to an erosional trend. There should be no uncertainty for the application of a constant.

4. The uncertainty for the *LT* term is solely based on the estimated measurement errors for shoreline locations. There is no consideration of the goodness of fit of the OLS trend lines in terms of uncertainties. However, the residual standard deviations are used to estimate the *ST* term as discussed below.
5. Although there is discussion of the use of a 95% confidence band for selection of single values to represent a section of coast (referred to as a *reach*), there is no analysis of the confidence limits of the trends, or the confidence limits of the extrapolated trends.

In conclusion, the *LT* term in CSL (2008a and 2012) does not represent a probabilistic analysis of long-term coastal erosion trends as defined by Ranasinghe *et al* (20120), and hence is not suitable for an appraisal of the risk of coastal erosion.

ST – Shorter-term shoreline fluctuation and uncertainty

The short-term shoreline fluctuation in most coastal erosion hazard assessments accounts for the cut and fill associated with storm events occurring over decadal scales or less. It is generally the most important factor for predicting coastal erosion risk, as it defines the limits of the active beach over decadal time scales. Any structures falling within the shoreline envelope defined by cut and fill cycles can end up within the active beach at some point. If the coast is eroding, the probability of this occurring will increase over time, while the probability will decrease if the coast is accreting. For most of the Kapiti Coast, the probability of being affected by storm cut and fill is likely to decrease in the future due to ongoing accretion.

Analysis of short-term fluctuations can be complicated for several reasons:

1. The erosion phase (cut) is considerably faster than the recovery phase (fill); typically being hours compared to days to decades for the complete return of eroded sediment volume. Usually, up to 80% of the recovery occurs within days to a few weeks if most of the eroded sediment is transported offshore into the offshore bar;
2. If sediment is transported onshore by wave overwash, there may not be a significant recovery phase. This is particularly important for coarser sediments (mixed sand-gravel, and gravel beaches), such as those that occur between the Otaki River and Te Horo. The recovery phase may also be incomplete if the coastal dune vegetation is disrupted, allowing the beach sediment to migrate inland, as has occurred previously along the Kapiti Coast. Without complete recovery, there will be a net loss from the beach sediment budget, resulting in a longer term erosion trend if there is insufficient longshore sediment transport to replace the loss;
3. Storms may occur in clusters, so that the beach may not fully recover before a subsequent erosive event occurs. Studies around the NZ coast have identified that there have been decadal-scale fluctuations in storm frequency and magnitude, which means that a coast can show an erosive trend for several years to decades, followed by an accretionary phase. Coco *et al* (in press) observed the impacts of a cluster of storms on the French coast, and concluded that it is not possible to scale up the effects of individual storms to predict the effects of a cluster of storms. The corollary is that it will be difficult to untangle the cut and fill effects of individual storms during a cluster of storms.
4. The impact of storms along a coast is generally not uniform. Depending on the pre-existing geomorphology, some areas can be severely eroded while other areas accrete. Key elements of the geomor-

phology that have been associated with longshore variations in storm erosion are variations in beach state (Amaroli et al., 2013), variations in offshore bar/shoal locations and presence of major rip systems (Komar *et al*, 1991; Stephens et al., 1999, Anthony, 2013), and the continuity and elevation of the foredune system (Houser, 2013).

Analysis of the short-term fluctuations requires a time-series data-set that captures the short duration erosion events, as well as the longer duration recovery phases and the decadal-scale effects of storm clustering. It is evident that the aerial photograph and cadastral survey records used for the 2008 study were not suitable for characterising the short-term trend.

CSL (2008a) refers to *shorter*-term fluctuations, which appears to indicate a different approach to the analysis of cut and fill cycles. Some beach profile data were available, but were not utilised (footnote page 27 CSL, 2008a). CSL (2008a) provided a range of reasons for rejecting the profile data sets, largely due to difficulties with locating the profiles in relation to the shorelines derived from vegetation cover.

However, after examining the profile data provided by Kapiti Coast District Council, the profiles do appear to be suitable for characterising the short-term fluctuation. The purpose of the *ST* term is to provide an estimate of the variability of the shoreline location about the longer-term trend resulting from cut and fill. Therefore, provided the profiles are sampled sufficiently frequently at specific locations, it should be possible to determine the variation about an average profile. Commonly, the short-term fluctuations are expressed as multiples of the standard deviation (typically 3 to approximate 99% confidence limits assuming a Gaussian distribution) of the profile change at selected elevations. This type of analysis appears to be feasible for the Kapiti coastline.

Instead CSL (2008a) assumed that the shorter-term fluctuations are represented by the residuals between the measured shoreline location and the trend line. Hence, the *ST* term was based on the standard error of the estimates (SEE) for the OLS best-fit line by assuming it is equivalent to the standard deviation of the measured profiles, giving $ST = \pm 3 \times \text{SEE}$. However, this is not a reasonable interpretation for several reasons:

1. The shoreline position was recorded using two different approaches: cadastral survey of high water mark or toe of the foredune; and vegetation line determined from aerial photographs. These would correspond to different shoreline positions, even if taken at the same time, and would appear as residuals from the trend. Although the later period trends determined by CSL (2008a) involve only one type of measurement, there is still a measurement error that is incorporated in the residuals. In particular, the errors in geo-rectification and shoreline position determination appear to be of a similar magnitude to the calculated standard error of estimates (Figure 6A CSL, 2008a; Table 3.1 CSL, 2012);
2. The vegetation lines are not likely to represent the average shoreline position (assumed by the CSL methodology). As noted in CSL (2008a), the vegetation line retreats during erosion, and takes time to return to the original position after shoreline recovery. Therefore, the vegetation line is biased towards an eroded shoreline, and there may be a seasonal effect on vegetation extent. Shore profile data may also be biased towards an eroded shoreline, as there is often a tendency to undertake more frequent surveys following a storm, and less when the beach is considered stable or accreting; and
3. The residual approach assumes that the rate of erosion/accretion is constant over time (linear trend). It is likely that this is not the case, as the sediment supply and driving processes are not constant as discussed above, so a proportion of the residuals represents fluctuations in the long-term rate.

Therefore, the variations represented by the residuals probably do not represent the short-term cut and fill fluctuations. It is also of concern that the standard deviation of the residuals appears to be the error term considered for the uncertainty of the *LT* factor, and therefore this has been incorporated into the CEPD more than once.

Appendix C of CSL (2008a) compares the estimated *ST* term with the reported cut and fill shoreline changes of Gibb (1978), focussing on his long-term trend data. CSL (2008a) argues convincingly that the large fluctuations in Appendix 1 of Gibb (1978) are due to errors in the shoreline location on early cadastral maps, and therefore the Gibb (1978) short-term values should be ignored. However, the main body of Gibb (1978) bases short-term fluctuations on measured changes during storm events in the 1970s, particularly the 11-13 September 1976 storm, which occurred at the end of a cluster of storms, that produced a maximum of 15 m erosion at the Raumati seawall, and an average of 6 m elsewhere along the coast. This compares to *ST* values from CSL (2008a) ranging from 10 to 36 m, with the lowest values occurring along the southern flank of the foreland, which Gibb reported as having the largest storm cut that he attributed to the influence of seawalls that failed during the storms, and the highest values occurring near the Waikanae River, which experienced much lower storm cut in the 1970s. Overall, the estimated *ST* values of CSL (2008a) appear inconsistent with observed storm cut.

Gibb and Depledge (1980) provide further data on cut and fill for the Paekakariki area for storms that occurred from December 1978 to January 1980, producing maximum storm cut of 7-12 m. Based on the calculated long-term erosion and storm cut, Gibb and Depledge (1980) recommended the immediate removal of 13 NZ Railway houses on the seaward side of the southern end of Ames St, Paekakariki, to be followed by the removal of the next 20 houses further north over 5 years. The first 13 houses were removed from the coast between sites C0.40 and C0.73, while the other properties are still occupied (Appendix A CSL, 2008a). The evacuated properties do not have any seawalls or other coastal protection. Appendix A, and the database provided indicate that there has been a reduction in erosion over the later period analysed by CSL (2008a). However, this includes the erosion from the 1970s that resulted in the house removals. Since the houses were removed, the data indicate stability to slight accretion, contrary to the predictions of Gibb and Depledge (1980).

The uncertainty for the predicted *ST* was derived from the measurement errors related to the OLS determination using an undefined empirical method. This gave an uncertainty of ±2.6 m. For the CEPD summation, only negative values for *ST* and the uncertainty were considered. Again, for the accreting areas of the Kapiti Coast, this approach will exaggerate erosional hazard in the future.

There was also an assumption of a 5 m erosional uncertainty if the existing seawalls are maintained, due to vertical scour in front of the structure. It is not clear how the vertical scour translates into horizontal erosion in the presence of a stabilised shoreline.

In conclusion, the derivation of the shorter-term trend by CSL (2008a, 2012) uses a method that differs from standard practice, does not appear to be a valid approach, and does not provide a probabilistic assessment of the cut and fill extent. The predicted values appear to be inconsistent with observed storm events.

SLR – Impact of sea level rise determination and uncertainty

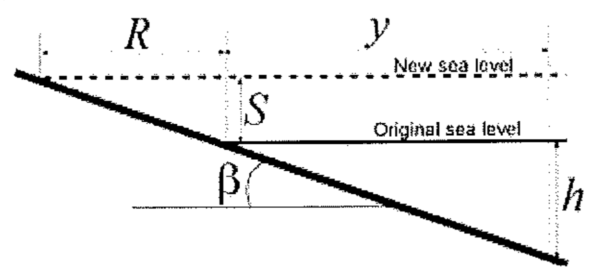
This factor is included to account for accelerating sea level rise anticipated as a consequence of global warming, and CSL (2012) renamed the term *RSLR* to represent the shoreline retreat associated with sea level rise. Since the available evidence shows no relationship between sea level and shoreline retreat along the Kapiti Coast, this

relabelling is inappropriate and reflects an assumption that future sea level rise can only cause erosion. Therefore, the symbol *SLR* will continue to be used in this discussion.

The *LT* factor discussed above already includes the effects of historic relative sea level changes and is extrapolated into the future. Therefore, the *SLR* factor should strictly be based on the additional rates of sea level rise or fall over the period of interest. This was not done, so the *SLR* factors calculated will be biased too high.

For stabilised parts of the Kapiti Coast (with seawalls), it was assumed that sea level rise would not cause erosion while the structures were maintained for up to 50 years (CSL, 2012), while the 100 year predictions assumed all structures were immediately removed. Without a maintained structure, it was assumed that sea level rise would automatically lead to coastal erosion. This assumption is commonly made for the effects of future sea level rise (FitzGerald *et al*, 2008; Ranasinghe and Stive, 2009; Jackson *et al*, 2013). For example Zhang *et al* (2004) suggested that the underlying rate of erosion of sandy coasts is "*two orders of magnitude greater* than the rate of rise of sea level" (italicised in the original). There are some difficulties with this assumption. Firstly it is clear from observations that past sea level rise is not consistently associated with erosion of sandy coasts (FitzGerald *et al*, 2008; Anthony, 2013), and this is currently the case for most of the Kapiti Coast. Secondly the assumption of future coastal erosion is largely based on numerical predictions derived from the *Bruun Rule* (BR) and/or *Equilibrium Beach Profile* (EBP) concepts (SCOR Working Group 89, 1991; Thieler *et al*, 2000; Ranasinghe *et al*, 2012).

Both conceptual models can only predict erosion due to their inherent assumptions about the response of a beach system to rising water levels (Figure 11), which is primarily that there is an upward and landward adjustment of an idealised beach profile (SCOR Working Group 89, 1991; FitzGerald *et al*, 2008). Note that this approach should also predict accretion for falling water levels as occurs on the Kapiti Coast in response to climatic oscillations, such as ENSO and the IPO (Bell and Hannah, 2012), which has not been observed.



$$R = \frac{S}{\tan \beta} = \frac{yS}{h}$$

Figure 11. Definition sketch for the mathematical formulation of the Bruun Rule for the shoreline retreat due to sea level rise initially proposed by Bruun (1962).

It should be obvious that the rapid influx of sediment onto the coast of the Manawatu that started around 7,000 BP could not have occurred if the assumptions of the BR or EPB models were valid. Although some aspects of the BR and EBP conceptual models have been demonstrated under controlled laboratory conditions, field tests show that these methods have no predictive value. For example, List et al (1997) used the BR and measured relative sea level changes to hindcast the shoreline erosion for Louisiana barrier islands in the USA, and they found no significant correlation. Hence, they concluded that the BR approach has no power for hindcasting or forecasting the effects of sea level rise. Following a series of reviews of the factors driving coastal change for the entire USA and Hawaiian coast, Hapke *et al* (2013) found that geomorphology and human activities were the primary controls on coastal erosion, probably through their effects on the sediment budget. Anthony (2012) found the same for the southern North Sea. Pickett (2004) assessed the use of

EPB models for predicting coastal hazards in the 8ay of Plenty, New Zealand. He found no significant correlation between relative sea level rise and EBP predicted shoreline response.

Consequently it is evident that the BR and EBP approaches are unsuitable for predicting shoreline response to sea level rise (SCOR Working Group 89, 1991; Thieler *et al*, 2000; Cooper and Pilkey, 2004; Davidson-Arnott, 2005; FitzGerald *et al*, 2008). CSL (page 32 2008a) agrees that the BR approach is not appropriate and indicates that it shouldn't be used.

Appendix D (CSL, 2008a) discusses models for predicting shoreline response to sea level rise. It confuses the original 8R (Bruun, 263; 1983; 1988) with later variations of it, particularly the Weggel (1979) modification, and mostly discusses estimates of the closure depth. This is largely irrelevant, as most studies have found that the most effective estimate of nearshore slope is based on the surf zone gradient (Weggel, 1979), or the steeper slope of the offshore bar (Dubois, 1977), neither of which are dependent on the closure depth. Essentially, the Bruun Rule states that the shoreline retreat is equal to the ratio of the sea level rise to the slope of the shoreline (Figure 11). The BR method discussed in the report (Equation D1 CSL, 2008a) attempts to approximate this by including the height of the sub-aerial berm or foredune, which is the Weggel (1979) formulation, and a common modification of the BR (Rosati *et al*, 2013).

CSL (2008a) suggests that the Komar *et al* (1999) equation is a better alternative. This relationship was developed to predict the extent of storm cut during a single event, albeit for the largest expected storm over a specified time period. It was developed for the Oregon coast, and Komar *et al* (1999) note that due to tectonic effects parts of the coast are experiencing relative sea level fall, while other areas have a relative sea level rise. They also observed that sea level rise is not a significant factor. Equation (2) in Komar *et al* (1999), which defines the coastal hazard zone, makes it clear that the method is not a function of sea level rise, as a separate term is included for projected sea level rise effects. Equation (3) in Komar *et al* (1999) defines the maximum dune erosion, and can be expressed as (see Figure 12 for definition of parameters):

$$R_{\max} = \frac{(\eta_{\max} - z_{toe}) + \Delta BL}{\tan\beta}$$

This equation predicts the maximum expected dune erosion by assuming that the saturated beach face can be projected inland until it intersects the extreme water level, and all the sediment above that surface is removed by erosion if the extreme water level is above the dune toe elevation (Figure 12). The method also allows for the beach surface to be adjusted for any erosion that occurs during the storm.

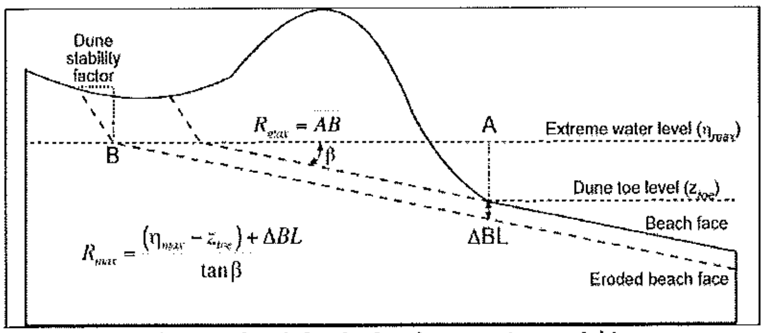


Figure 12. Definition sketch for the foredune erosion model in response to storm events proposed by Komar *et al* (1999)

The method was tested against available data for dune erosion along the Oregon coast, which seems to have involved dissipative beaches. Further, *Ammophila arenaria* (known as European beach grass in Oregon) was introduced to the Oregon coast in the late 1930s to stabilise drifting sand (Reckendorf *et al*, 1985). It has progressively invaded the coastal dunes, leading to artificially high and continuous foredunes that didn't previously exist (Wiedemann, 1996), similar to *Ammophila* dunes in New Zealand (Hilton, 2006). This suggests that the Komar *et al* (1999) method would be an

appropriate approach for assessing the short-term cut (*ST* term) for the *Ammophila* dunes of the Kapiti Coast in conjunction with the extreme wave and water level probability distributions reported by MetOcean Solutions Ltd (2010).

It appears CSL (2008a) modified Equation (3) of Komar *et al* (1991) by replacing the numerator term with sea level rise, indicating that the *SLR* term is equal to the ratio of sea level rise to the slope of the beach (Equation 3 CSL, 2008a). This is the functional form of the BR, particularly the Weggel (1979) modification. Therefore, for all practical purposes $\tan\beta = L/[B+d]$, so there is no real difference between Equation D1 that CSL (2008a) correctly argues should not be used, and Equation 3 that CSL (2008a) did use.

The method used by CSL (2008a) depends on the nearshore slope, which was taken to be the inter-tidal beach slope, and the predicted change in sea level. For the Kapiti Coast, nearshore slope was estimated for 22 sites where repeated profile measurements were available. It seems that the available profile slopes were averaged, but it is not explained how it was done or what the variation about the averages were. The calculated slopes were rounded down in order to increase the predicted shoreline retreat. The profile sites did not coincide with the coastal hazard calculation sites, and so slopes were interpolated. No errors were defined for the interpolated slopes.

The nearshore slopes estimated varied between 0.8° and 6°, although most were around 1-2°. Using Equation 3, the predicted sea level rise is multiplied by 9.5 to 71.6, with most locations having a multiplier of 28.6-57.2. These relatively high multipliers reflect the generally dissipative to intermediate beach state along the Kapiti Coast. Note that based on the measured shoreline response to the historic sea level rise of the order of 17 cm/century assumed in the report, the multipliers should be predominantly negative (-247 for the average accretion rate of 0.42 m/y).

The other component is the predicted sea level change. Both the 2008 and 2012 reports are based on various projections of future sea level derived from economic scenarios used to estimate future radiative forcing, and hence future temperatures. The projections then assume that sea level responds in a predictable manner to global temperatures. So far this has not been the case (Gregory *et al.*, 2012), and more than 40 years of sea level projections have not successfully predicted the actual global sea level response (Gehrels 2010; de Lange and Carter, 2013, Houston, 2013). Most studies have found that the global rate of sea level rise determined by long-term tide gauge records has been decelerating for at least the last 50 years (de Lange and Carter, 2013), and this is also evident in the shorter, more recent satellite record (Chen *et al.*, in press).

At a regional scale, the projections for the Tasman Sea significantly overpredict the observed sea level rise (Boretti, 2012). Finally for the local Kapiti Coast, the measured relative sea level rise of 2.03 $mm.y^{-1}$, which includes the effects of tectonic subsidence (Bell and Hannah, 2012), is lower than the 3.7 $mm.y^{-1}$ sea level projections assume the rate has accelerated to by 2013 (IPCC WGI Fifth Assessment Report – Chapter 13). Assuming that the difference between the observed and assumed rates for the Kapiti Coast remains constant for the next 50 years, it would equate to a difference of 0.8 to 6.0 m for predicted *SLR* term. If the observed sea level rise accelerates at a lower rate than assumed for the projections, the difference will be larger, and if the observed deceleration in the rate of sea level rise continues, the difference will increase still further.

Figure 13 compares the average shoreline response (ignoring the *ST* and *DS* terms) for the period 1950-2007 assuming the observed rate of relative sea level rise for Wellington of 2.03 $mm.y^{-1}$ (Bell and Hannah, 2012). This

value is higher than the 1.7 $mm.y^{-1}$ reported by CSL (2008a) due to subsidence of the Wellington region associated with slow slip earthquakes (Beavan and Litchfield, 2012). Since it is the observed rate at Wellington, it may be a little too high as the effect of the observed subsidence is smaller for Kapiti than Wellington (Beavan and Litchfield, 2012).

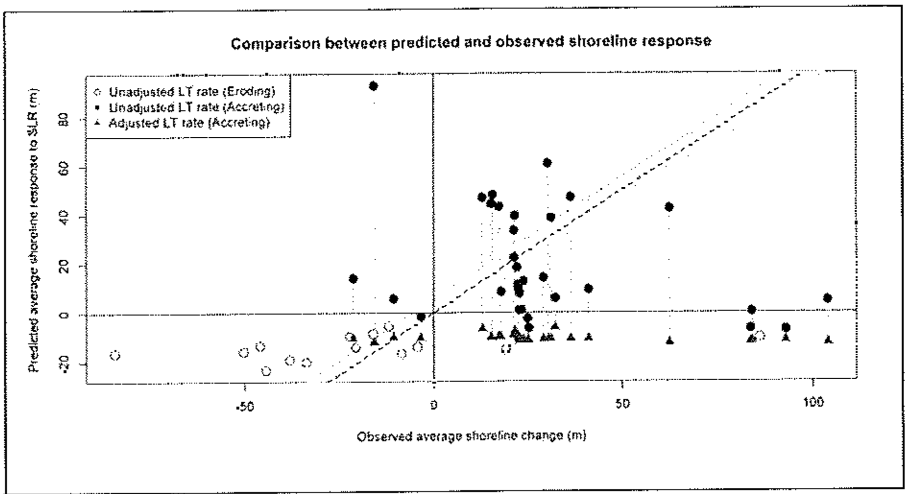


Figure 13. Comparison between the predicted and observed average shoreline change between 1950 and 2007 using the early period *LT* erosion/accretion and the *SLR* erosion determined by the BR method for a rate of sea level rise since 1950 of 2.03 $mm.y^{-1}$ (Bell and Hannah, 2012). The adjustment for accreting coasts used by CSL (2008a) was also applied to locations accreting during the early period (red triangles connected to unadjusted predictions by vertical dotted lines). The shaded grey zone indicates agreement between predicted and observed shoreline response allowing for a *CU* term of ±6 m.

The effect of setting the *LT* term to zero for accreting coasts and applying a non-zero uncertainty was also assessed for locations that were accreting during the early period considered by CSL (2008a). Vertical dotted lines connect the predicted shoreline locations without (red triangles) and with (solid circles) an accreting shoreline. The sloping dashed line indicates perfect agreement between predicted and observed coastal erosion, with the grey shading indicating the *CU* uncertainty adopted by CSL (2008a) of ±6 m. It is evident that, using historical data for sea level rise, there is poor agreement between predictions and observations. Further, the adoption of a zero trend for accreting coasts does not improve the agreement, as there were 3 sites within the grey zone before adjustment, and 2 different sites after adjustment. Overall, the methodology of CSL (2008a) provided hindcast predictions within the specified uncertainty for 4-6% of the cases, which does not provide confidence in the predictions for the future.

The hindcast analysis used a known sea level rise, but this is not known for the predictions of the future. Therefore, for an assessment of risk it is of concern that there are no probabilities associated with the sea level projections. Although terminology such as *most likely value* is often applied to sea level projections, this is a qualitative judgement and not a statistical interpretation. CSL (2008a) is based on a value of 0.6 $m.Century^{-1}$, which is three times the observed rate of relative sea level rise for Wellington since 1944, while CSL (2012) used 0.6 $m.Century^{-1}$ for the 50-year projection (0.3 m total) and 0.9 $m.Century^{-1}$ for the 100 year projection. The assumed sea level rise was described as conservative (page 34 CSL, 2008a).

There is no indication of the probability of occurrence for the assumed sea level rise, which is required for risk assessment. Considering the IPCC AR4 projections (IPCC, 2007), used to develop the Ministry for the Environment guidelines for New Zealand, and the more recent IPCC AR5 projections[1], the worst case, and hence least likely, scenarios are suggesting maximum sea level rises of 0.6-0.8 $m.Century^{-1}$ with mid-point sea level rises of 0.4-0.6 $m.Century^{-1}$. Hence, the sea level rises used by CSL (2012) are higher than those summarised by the IPCC

[1] The IPCC AR5 projections are currently only available in draft form and may be changed to align with the published Summary for Policy Makers before being published in 2014.

(2007, in press), and involve rates of sea level rise that have previously only occurred for short durations during meltwater pulses following the Last Glacial Maximum (Standford *et al.*, 2011). Therefore, the probability of the assumed sea levels occurring is likely to be extremely low.

The *SLR* uncertainty is based solely on the estimated error in the measurement of the nearshore slope, and was determined to be ±1.6 m. It is unclear why the slope measurement was converted to an angle for this determination. The slope error was originally ±0.001 grad, and, since this calculation effectively takes the reciprocal of the slope, the error analysis should have been based on percentage error. The uncertainty should also consider the variability of the nearshore slope, particularly since the method is based on the most variable part of nearshore geomorphology. The *SLR* uncertainty should consider the uncertainty of the sea level projections as well as the slope measurements.

In conclusion, the *SLR* term was determined by an inappropriate methodology that incorrectly determines the response to sea level as demonstrated by hindcasting 57 years of shoreline change for the Kapiti Coast (Figure 13). No analysis of the probability distributions of the key parameters used was undertaken, and therefore, the results cannot be used in a risk assessment.

DS – Dune stability factor determination and uncertainty

The *DS* factor takes into account the slope adjustments that occur after an erosion event, particularly the scarp retreat that results in an additional landward migration of the upper dune face, assuming that the erosion has scarped the frontal dunes. In relation to the Kapiti Coast assessment, this scarp adjust has already been accounted for because the shoreline is based on the vegetation line (ie. landward of any scarp, after a period of time during which it is likely that the face has adjusted to a stable angle). As discussed above, the *LT* and *ST* factors are both based on the vegetation line and will already include any *DS* adjustment. Therefore, for the CEPD the *DS* term is double dipping.

The methodology used to assess *DS* is quite common, and assumes that the material falling from the top of the slope accumulates at the toe until a stable slope is achieved. CSL (2008a) assumes that half of the stable slope occurs landward of the dune toe at the end of the storm, and the other half occurs seaward. Hence, the *DS* term is half of that often applied by assuming the stable slope is located entirely landward of the storm dune toe. The result depends on the assumed stable slope angle and the height of the scarp. CSL (2008a) assumed a stable angle of 34° for the Kapiti Coast dunes, while noting that some stable dune scarps around Paekakariki have angles of 41°. In contrast, Gibb and Depledge (1980) assumed a stable angle of 40° based on measurements after storm scarping of the dunes at Paekakariki that ranged from 35° for loose dry sand to 45° for vegetated damp dunes. Therefore, the *DS* term is likely to overestimate the retreat required to produce a stable slope.

CSL (2008a) assumed that the scarp height resulting from future erosion equated to the maximum dune height along sections of similar coast including each location for sites south of Otaki, and equal to the maximum for the entire Kapiti Coast for sites north of Otaki. This is only valid if the final future erosion event termination is coincident with the maximum dune height. Overall, the approach used will over-estimate *DS*, as noted in the report (page 36 CSL, 2008a).

The uncertainty is based on the root mean square (RMS) measurement error for the estimated maximum dune height, and was calculated as ±2.3 m. It does not include any consideration of the uncertainty in the assumed

stable slope angle, which is likely to underestimate the steepness of the dune scarp as observed by Gibb and Depledge (1980).

In conclusion, the *DS* term should not have been included in the CEPD assessment. Further the methodology used over-estimates the *DS* term, although this is offset by assuming that only half the *DS* term occurs landward of the dune toe at the end of the storm.

CU – Combined uncertainty determination

There are some issues with the approach to the uncertainty as expressed in the definition of Equation 1 in the original report:

1. Some factors are time dependent (*LT* and *SLR*, which involve multiplying a factor by the time interval being considered) while others are not (*ST*, which is a fluctuation about zero, and *DS*, which is a one-off adjustment). Strictly the uncertainties of the time dependent factors will increase with time, and the others will not.
2. It is not clear why there should be additional uncertainty factors beyond those that are already incorporated into the uncertainties of *LT, ST, SLR* and *DS*. However, there do not appear to be any such factors actually included in the *CU* term.
3. The methodology repeatedly selects values that maximise the possible erosion as a conservative or precautionary approach. There is no analysis of the extent to which this increases the final CEPD, or what the CEPD would be if alternatives that minimise coastal erosion were used.

The uncertainties derived for the LT, ST, SLR and DS factor were combined using the Root Sum Squares (RSS) approach. The report states that the *CU* factor was also included in the RSS summation (Page 38 CSL 2008a), but it shouldn't be included and it does not appear to have been. It was also stated that the 5 factors are independent. However, the LT and ST factors are highly correlated and their uncertainties were derived from the same measurement errors by unspecified empirical methods, and Equation 5 indicates *CU* is a function of the other terms.

The calculated *CU* factor was ±5.3 m, which was rounded up to ±6 m for the 50 year CEPD (CSL, 2008a). It is clear from Figure 13 that this underestimates the errors in the predicted shoreline changes. CSL (2012) recalculated the *CU* factor for the 100 year CP, and obtained ±9.5 m, which was rounded up to ±10 m suggesting an increased confidence in the results for the second half of the century.

CSL (2012) also lists a number of contributions to uncertainty that were considered unnecessary to be included because the conservative and precautionary methodology already over-estimated the erosion, and that this compensated for the uncertainty of the projections of future climate. This is an unusual approach to quantifying uncertainty, and seems to advocate a particular planning position on acceptable risk rather being an objective approach to risk assessment.

It is evident that at each step of the determination of the CEPD, the analysis maximises the estimated future shoreline erosion, and the effect it had on the resulting CEPD has not been quantified. Of particular concern is that this approach ignores any mitigating factors, except for the presence of some seawalls. Overall, it has the effect of exaggerating the future hazard and almost certainly has identified areas as being hazardous that are unlikely to experience any coastal erosion. Therefore, it represents an unrealistic assessment of the potential risk associated with coastal erosion.

Removal of structures

CSL (2008a, 2012) also has predicted the CEPD for locations currently protected by seawalls based on three scenarios:

1. The seawalls maintain their current level of protection for the duration of the prediction period (*Seawalls hold*);
2. The seawalls occasionally fail, but are quickly repaired or replaced (*Seawalls repaired*); and
3. The seawalls fail and are removed at some stage during the prediction period (*Seawalls removed*). This scenario was omitted from the 2012 update (CSL, 2012).

Somewhat confusingly, the three scenarios were also applied to regions with no seawalls, but using a different methodology. Only the coast south of Marine Parade, Paraparaumu Beach (site C11.17) appears to have sites where the three scenarios have some relevance. CSL (2008a) also distinguishes between *official* and *private* seawalls, where official seawalls were built and/or maintained by the Kapiti Coast District Council and protect multiple properties and public land. Private seawalls are built and maintained by private individuals, and it is assumed that they only provide partial protection. It is not clear if the distinction resulted in a different methodological approach.

CSL (2008a) does not clearly explain the methodology for the different scenarios, stating that the methodology was defined in the database. The approach appears to have been:

1. *Seawalls hold* methodology set all the terms to zero, so the CEPD is zero;
2. *Seawalls repair* methodology assumes that there is some coastal erosion before the seawall is repaired, and this erosion consists of *ST*, *DS*, and *CU* terms. The *ST* term was interpolated from adjacent non-seawalled sites and seems to be 15 m for most sites. The *DS* term was calculated from the local maximum dune height, and the *CU* term was increased to ±9 m to account for scour in front of the damaged seawall. It is assumed that the maximum possible erosion occurs regardless of the extent of damage, or the duration of the repair.
3. *Seawalls removed* methodology includes all the same terms as used for an unprotected shoreline. The only difference is the calculation of the longer-term rate, which represented the sum of an estimated rate of shoreline change if the seawall had not been constructed (LT_{50}) and a catch-up allowance for the amount of erosion that may have occurred over the past 50 years if the seawall was not present (LT_{cu}). For a 50 year prediction period, the two components are equal ($LT_{50} = LT_{cu}$) so (CSL, 2008a) effectively replaced LT with $2 \times LT_{50}$. This approach implies that for a 100 year prediction the LT would be $3 \times LT_{50}$ (100 years of the long term trend plus the 50 years of catch-up). However, the values given in Appendix D (CSL, 2012) correspond to $4 \times LT_{50}$. The longer-term rate used to calculate LT_{50} was based on the calculated earlier period trends. The calculated trends for adjacent sections of coast were smoothed and the 95% maximum erosion rate estimated (Accreting trends were set to zero). The erosion rate was then rounded to the nearest 0.05 $m.y^{-1}$ to allow for the less reliable cadastral-based data for the earlier period rate. CSL (2012) discusses an alternative approach based on the behaviour of the unprotected coast between Paekakariki and Raumati South, and concluded that the CSL (2008a) methodology was appropriate.

Overall, the methodology used is likely to over-estimate the shoreline erosion, particularly in the case of the *seawalls removed* scenario. This arises due to over-estimation of the erosion rates, and also because of the assump-

tion that the erosion occurs for the full duration of the prediction period (no consideration of when the seawalls are removed), or to the maximum possible extent during a seawall repair with no mitigation measures to minimise erosion, to repair the effects of erosion.

Inlet methodology

Where a stream or river discharges at the coast a tidal inlet typically forms. Different types of inlets can form depending on the balance between freshwater discharge, tidal flows and longshore sediment transport (Hart, 2009a & b). The type of inlet is not too important for a hazard zone assessment, but the amount of inlet migration is a factor. Over time the inlet position can move along the coast, generally in the direction of longshore sediment transport, with erosion on the downdrift side and accretion on the updrift side of the inlet forming a longshore spit and tidal lagoon. There tends to be a maximum amount of lateral movement, as flood events tend to breach the longshore spit and effectively straighten the inlet. The spit may also be artificially breached to achieve the same effect.

CSL (2008b) argues that for the Kapiti Coast, the hazards associated with tidal inlets are significantly different to those experienced on the intervening open coasts. This is reasonable in that inlet migration only occurs at inlets, and requires that the future behaviour of the inlet be reliably predicted. The open coast CEPD equation was modified by replacing the short-term fluctuation with an inlet migration factor (*IM*) to account for inlet migration (CSL, 2008b, 2012). Note that the subtraction operation in the equations defining the *IEPD* (Equation 2 CSL, 2008b; Equation 6 CSL, 2012) is incorrect, as the terms are all added together to define the landward movement of the shoreline. The *IEPD* merely replaces the short-term fluctuations due to wave process (*ST*) with the short-term fluctuations associated with channel migration. It does not take into account any of the other hazards, such as flood inundation, that may be associated with inlets.

To determine the inlet migration CSL (2008b) selected points that represented the maximum landward excursions evident in aerial photographs since 1939 based on the location of vegetation regardless of longshore position. This doesn't really correspond with accepted interpretations of inlet migration that relate to the longshore stability of the main channel (viz. Hayes, 1980; Komar, 1996; Hart, 2009b). It is difficult to envisage how the CSL (2008b) approach will provide suitable data for a probabilistic analysis of coastal erosion risk.

Further, by using vegetation to indicate shorelines, there is likely to be a significant lag between the migration of the shoreline and establishment of vegetation, particularly if grazing and other anthropic factors are present. Earlier cadastral surveys, which were based on the position of the high tide mark, were only used to estimate the location of the main inlet channel(s).

The maximum landward excursions from the entire set of inlet shorelines measured were then combined to produce a *composite shoreline*, which represents the maximum landward extent of the envelope of all inlet shoreline positions. Note that at no time during the period of analysis did the inlet shoreline simultaneously occupy all positions along the composite shoreline. The composite shoreline is then transformed into the *inlet migration curve* (*IMC*) by fitting a curve that was *"consistent with the general shape"* (page 15 CSL, 2008b) of the local maximum landward inflexion points along the composite shoreline. Finally the *LT*, *SLR* and *DS* terms from the nearest open coast site were used to calculate an offset that was combined with the inlet *CU* term (*LT+SLR+DS+CU*) to shift the inlet migration curve inland to become the *IEPD*.

The uncertainty term *CU* for the inlets used by CSL (2008b) should differ from the open coast *CU* term (CSL, 2008a) due to the substitution of the *ST* term with the *IMC*. CSL (2008b) calculated the *IMC* uncertainty solely from the measurement error of the digitised inlet shorelines, and determined a total *CU* over 50 years of ±5.9 m (*cf.* ±5.4 m for the open coast), which was then rounded up to ±6 m, matching the open coast *CU* value adopted by CSL (2008a). Similarly CSL (2012), derived an inlet *CU* term of ±10 m over 100 years that matched the open coast value. There was no quantification of the uncertainties involved in the conversion from measured shorelines to the inlet migration curve. In particular, the fitting a curve to approximate the general shape introduces additional errors not account for by the *CU* term. Therefore, the uncertainty is likely to be larger than indicated by the *CU* term.

CSL (2008b) distinguished between *unmanaged*, *transitional*, and *managed* in analysis periods (summarised in Table 2 below). The distinction between unmanaged and managed inlets was on the basis of the inferred effectiveness of any inlet management structures and/or procedures such as the deliberate breaching of any berm blocking the inlet as permitted for many of the inlets by the Greater Wellington Regional Council. Transitional inlets represented time periods where the effectiveness of management was uncertain. Data for transitional periods were excluded from the derivation of inlet migration curves. CSL (2008b) further distinguished between the northern and southern sides of inlets primarily on the basis of the interpreted behaviour of the open coast, the presence or absence of open coast structures, or the potential influence of structures or inlets updrift of the inlet.

It is evident that the application of the methodology varied between inlets by considering different time periods, and the interpretation of the influence of structures, management regimes such as barrier breaching, and the influence of coastal processes. The methodology for determining the inlet migration curve was modified at Mangaone Stream to account for an assumed change in beach morphology. Finally the methodology was also altered for Whareroa and Wainui Streams to incorporate the effect of open coast seawalls not specifically part of the inlet system.

Table 2. Summary of the analysis periods used by CSL (2008b) for the inlets along the Kapiti Coast.

Inlet	Unmanaged period	Transitional period	Managed period
Waiorongomai Stream - North	1942 - 1965	1965 - 1972	1972 - 2007
Waiorongomai Stream - South	1942 - 2007		
Waitohu Stream	1942 - 1966	1966 - 1973	1973 - 2007
Otaki River	1939 - 1946	1946 - 1957	1957 - 2007
Mangaone Stream	1948 - 2007		
Hadfield Stream	1948 - 2007		
Waimeha Stream	1942 - 1966	1966 - 1973	1973 - 2007
Waikanae River	1942 - 1966	1966 - 1980	1980 - 2007
Tikotu Creek	1942 - 1965	1965 - 1972	1972 - 2007
Wharemauku Stream - North			1952 - 2007
Wharemauku Stream - South	1942 - 1966	1966 - 1973	1973 - 2007
Whareroa Stream	1942 - 2007		
Wainui Stream	1942 - 2007		
Waikakariki Stream	1942 - 1956	1956 - 1979	1979 - 2007

An interesting aspect evident from the discussions of the historical development of the inlets in CSL (2008b) is the progressive southward appearance of a pulse of sediment affecting the inlet morphology. This is reported for the northern-most inlets as starting in the 1940s, affecting the Waikanae River in the 1950s and 1960s and finishing at the southern-most inlets in the 1970s. Further, it is suggested that it represents a 50-60 year quasi-cyclic process, which is consistent with the findings of Grant (1981) and corresponds to the IPO oscillation

modulation of precipitation and wind climate, with a lagged influence along the coastline associated with the rate of longshore sediment transport. The data presented also suggest that another pulse of sediment has been affecting the northern-most inlets for at least the last decade.

The methodology has several problems:

1. The aggregating of multiple inlet shorelines into a shoreline envelope to define the composite shoreline ignores the behaviour of the inlet over time, which means that there are no probabilities associated with shoreline locations. This makes it impossible to assess the risk of erosion. It also obscures any systematic patterns of behaviour that could be used to predict the future pattern of inlet migration.
2. The composite shorelines, and more importantly the IMCs derived from them, do not appear to consider the geomorphology consistently. For example, CSL (2008b) adjusted the IMC for the southern side of the Mangaone after assuming that the 1948 shoreline was in response to a lowered beach berm height. However, there is no allowance for the dunes formed since 1948, which would restrict shoreline erosion.
3. The analysis depends on the determination of what constitutes a managed or unmanaged inlet. The historical summaries presented (CSL, 2008b, 2012) indicate that all of the inlets have been modified in various ways and extents throughout the entire analysis period, particularly the period of aerial photography. It seems that the distinction is based mostly on an arbitrary assessment of the type of structures built within the inlet, presumably to fit with the seawall scenarios on the open coast. There is no analysis of the impacts the structures have on the probability of inlet erosion, apart from recognition that they may restrict inlet migration.
4. Although the data show that most of the inlets occur on accreting coasts, it is assumed that the inlet migration curve can shift landwards in the future.
5. The overall analysis appears to be sensitive to the availability and quality of the data, and the choices made by the analyst.

The Waimeha Inlet (Figure 14) demonstrates the last issue. CSL (2013) undertook a reassessment of the northern side of Waimeha Inlet. This reassessment included aerial photographs taken in 2010 and 2013, higher quality aerial photographs for 1973 and 1988, and additional historical data on inlet modifications. The reanalysis considered two different time periods for the transition between managed and unmanaged inlet conditions – the original from CSL (2008a, 2012) given in Table 2, and an alternative transition period of 1980-1988. This corresponds to 3 different

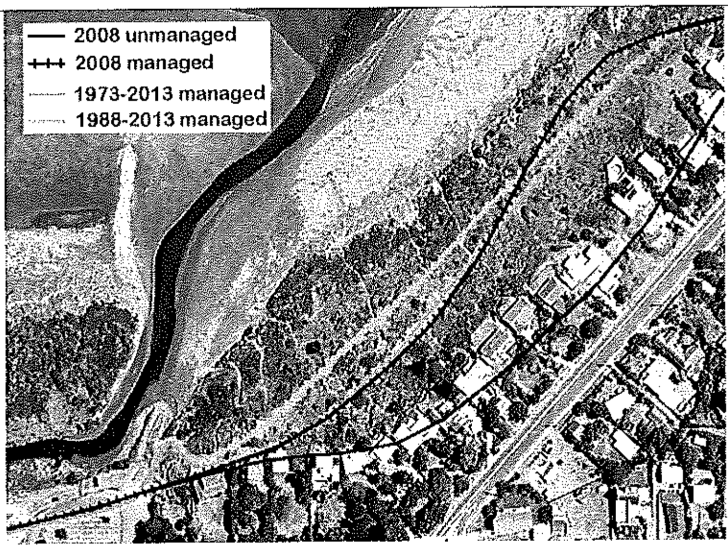


Figure 14. Comparison between the original CSL (2008a) predictions (unchanged in CSL, 2012), and the revised CSL (2013) predictions for 50-year CEPD lines of the northern side of Waimeha inlet. See text for discussion of the revisions.

predictions of the 50 year managed shoreline based on different time periods: 1973-2007; 1973-2013; and 1988-2013.

Figure 14 shows the changes between the managed CEPD lines derived from the three different time periods considered to be affected by inlet management (2008 managed CEPD was based on the 1973-2007 time period). It is evident that the combination of shorelines used to create the inlet migration curve significantly affects the outcome. In particular, the exclusion of the 1980 and 1988 shorelines appears to be the sole factor causing the difference between 50-year managed shorelines based on the 1973-2013 and 1988-2013 periods (Figures 14 & 15)

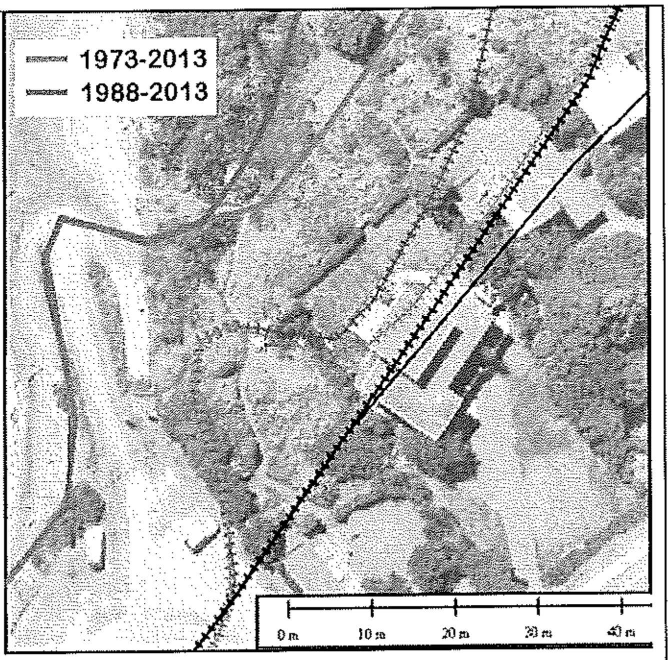


Figure 15. Close-up of northern side of Waimeha inlet showing the CEPD lines (black solid line and hatched lines), with the *IMC*s and managed shorelines from Figure 2 of CSL superimposed (red/green solid and hatched lines respectively).

It is also evident that the interpretation of the influence of structures, as the groyne and stormwater outlet located to the right of the sharp bend in the Waimeha Stream as it exits onto the beach was ignored in the earlier assessments due to the poor quality of the aerial photographs and not being noticed during the site visit (CSL, 2013). The inclusion of these structures produces the bulge on the seaward side of the property at 21 Field Way.

Comparing Figures 1 and 2 from CSL (2013) also suggests that there is an issue with the implementation of the methodology using GIS (Figure 15). The methodology states that the CEPD is a landward translation of the *IMC* by a distance determined by the sum of the other terms, but doesn't explicitly state the orientation of this displacement. For the example in Figure 15, the CEPD is offset in the longshore direction. It would also be legitimate to question why the CEPD doesn't coincide with *IMC* for the region that is protected by a hard structure. Finally, Figures 14 and 15 also demonstrate how the choice of data and how it is included has different impacts on properties in the affected region.

Summary of methodological concerns

The preceding sections outlined concerns with various aspects of the methodology used by CSL (2008a, 2008b, 2012 and 2013), ranging from serious to minor. It should be self-evident that the CEPD lines produced are the consequence of a series of assumptions made and the specific methodology used to derive them. There are three main aspects that invalidate the CEPD lines for the purpose of providing an assessment of the coastal erosion hazard for the Kapiti Coast:

1. At almost every step of the analysis, a procedure was followed that maximised the predicted erosion, which was justified as being a precautionary or conservative approach. The only exception was the choice to distribute the effect of the dune stability factor on either side of the predicted storm erosion extent. However, the dune stability factor was also inflated by the choice of dune scarp height, stable

angle and the inclusion of an estimated scour factor for the seawall repair scenario (dropped for CSL 2012). Since the shorelines were derived from vegetation lines at the top of the dune scarps, the dune stability factor should have been omitted. Consequently, the CEPD represents an extremely unlikely worst-case scenario. Hence, while it may be reasonable to assume that areas landward of the CEPD will not be affected by coastal erosion, it is unreasonable to assume that all areas seaward of the CEPD will be affected. Also, this procedure means that the analyst is deciding what is an acceptable level of risk at each stage of the procedure, rather than those responsible for coastal management.

2. The methods used are inappropriate for the purpose. Aspects of particular concern are:
   a. The *longer*-term trend (*LT*) is based on too short a time period to separate the long-term trend from fluctuations associated with the IPO. Further, the assertion that the later period trend is qualitatively consistent with the overall trend is demonstrably incorrect.
   b. By separating the uncertainty from the *LT* term, the analysis incorrectly transforms accreting coasts to an erosional trend. The use of very short sequences of data to represent the long-term trend is not justified. There is no basis for expecting a sudden reversal of the observed long-term accretion trends.
   c. The derivation of the shorter-term trend from the standard deviation of the residuals from the OLS fit for the longer-term trend differs from standard practice. It does not appear to be a valid approach, and the predicted values appear to be inconsistent with observed storm events.
   d. Available shore profile data would provide a better estimate of the likely cut and fill response for the Kapiti Coast.
   e. The *SLR* term is derived using a common variant of the Bruun Rule, despite it being recognised that the Bruun Rule should not be applied.
   f. The *DS* term should not have been included because the shorelines used in the analysis were based on vegetation lines, and therefore already incorporate the effects of slope instability.
   g. Using the methodology to hindcast the shoreline response over 57 years indicates that the method is a very poor predictor of the ohserved response. A simpler and more effective method is to extrapolate the long-term trend covering all available data.
   h. The inlet IEPD is based on an assumed landward inlet migration, and not the longshore migration of the inlet that would normally be used to assess inlet stability.
   i. The landward inlet migration is derived from an envelope of shoreline positions. The methodology used is very sensitive to the selection of which shorelines are included, and the assessment of the effects of any structures present. Overall the method for inlets does not seem robust or reliable.
   j. The uncertainty terms are largely based on measurement errors and do not consider errors introduced by the methodology followed. The terms used are not strictly independent, there are unexplained empirical derivations, and values are arbitrarily inflated to account for unspecified uncertainties. Only single-sided *CU* terms are applied to the final CEPD and IEPD lines.
   k. The analysis does not include a probabilistic analysis of the components of the CEPD or IEPD, and hence cannot form the basis of a coastal erosion risk assessment.

3. Apart from the distinction between the open coast and inlets, the methodology is assumed to apply to the entire coast. There is good evidence to show that the behaviour of mixed-sediment beaches is significantly different to that assumed for sandy beaches. This affects the coast between the Otaki River and Te Horo Beach, and the southern area of Paekakariki to a lesser extent. There is a growing body of evidence that dunes with established native vegetation respond differently to storm events than those stabilised by introduced *Ammophila*. Further, *Ammophila* affects the inland loss of sediment from the coast. As community initiatives are replacing *Ammophila* with native dune species along the Kapiti Coast, the response to coastal forcing is changing and should be accounted for with more suitable methods. Overall, it is evident that a single methodology for the entire open coast is not appropriate.
4. A risk assessment of coastal erosion should include a probabilistic analysis of the drivers and responses for the coast. In terms of drivers for coastal erosion, the analysis adopts values for sea level rise that are suggested for consideration by the Ministry for Environment 2008 guidelines, but does not consider their applicability or probability of occurrence. The analysis assumes that the future climate will adversely affect sediment supply to the Kapiti Coast, but does not quantify the probability of this occurring. It should be noted that the NIWA climate projections (http://www.niwa.co.nz/our-science/climate) do not show any significant change in the coastal drivers other than sea level before 2050, and there is low to moderate confidence in some change by 2090, but the regional effects are very uncertain. Having assessed the probability of changes to the processes driving coastal erosion, the analysis should also have quantified the risk of coastal erosion, allowing for existing mitigating factors. This would provide the necessary data to assess the risk to coastal areas, and also permit a cost-benefit analysis for any proposed management responses.

CSL (2012) recognised that some of the CEPD and IEPD lines were "*overly cautious*" (Page 63). However, it is evident that, due to the methodology followed, all the CEPD and IEPD lines represent an extremely unlikely worst-case scenario. Further, the available data for the evolution of the Kapiti Coast indicate that the shoreline migration is largely determined by the sediment budget, and this budget has been influenced by decadal scale variations in storm activity and not by changing sea level. Climate projections for the next century do not indicate any major changes in storm activity for the Kapiti Coast. Therefore, it is unlikely that significant changes in sediment budget, and thus shoreline migration, will occur in the next century. Hence, the observed changes over the past century, allowing for the effects of structures and management practices, will be a good indicator of coastal erosion hazard (as demonstrated by comparing earlier and later period shoreline trends).

Based on this reasoning, areas experiencing historic shoreline accretion are unlikely to experience an erosion trend in the future, and hence are low risk. In contrast, areas experiencing historic erosion are not likely to experience significant accretion trends in the future, which would make them high risk. However, as noted in CSL (2008a, 2008b, 2012) those areas where historic erosion has affected properties have been modified to mitigate the risk, either by the construction of structures, or the removal of affected infrastructure. Therefore, unless it is policy to remove structures, the future risk is low. Examination of the CEPD and IEPD lines indicate that the majority of properties seaward of the lines occur in areas of accretion, or have protective structures. Hence, it can be concluded that the majority of properties are low risk.

In order to better quantify the actual level of risk, a probabilistic approach should be applied, as discussed below.

Alternative approach

From the available evidence of the Holocene evolution of the cuspate foreland summarised above, and historical shoreline changes for the Kapiti Coast (Gibb, 1978; CSL, 2008a & b), the primary driver of shoreline accretion or erosion is the available sediment (*net sediment budget*). The sediment budget is affected by variations in sediment supply, primarily in response to climatic fluctuations in rainfall and windiness, and to a lesser degree by anthropic factors such as land-use changes and sediment extraction (*viz.* Grant, 1981, 1991). Local sea level variations due to eustatic sea level changes do not have any identifiable impact on shoreline location. Abrupt, large relative sea level changes due to local earthquakes appear to have relatively minor effects on open coast shoreline position, but may affect inlets and can alter the accommodation space for sediment deposition. Local earthquakes can be associated with large increases in sediment supply (Goff *et al*, 2008) and local tsunami, which have probably caused significant changes to the coastal geomorphology of the Kapiti District in the past (Goff *et al.*, 2007).

Given the importance of the coastal sediment budget, an alternative approach would be to first determine the sediment budgets for sections of the Kapiti Coast corresponding to the major geomorphological units. Walton Jr *et al* (2012) review sediment budget methodologies and propose a simplified approach for inlets that can also be utilised for the open coast, although the purpose of their analysis is to identify what can be achieved with a sediment budget.

Table 3 below summarises the data available for assessing the overall sediment budget for the Kapiti Coast. The main sources and sinks of sediments were discussed above in relation to the Holocene evolution of the coastline. Gibb (1978) estimated the volume of sediment required to renourish the Paekakariki and Raumati coast in response to the observed erosion. His estimates correspond to 64 t/m/m of sediment (mass of sediment per metre of beach width per metre of shoreline advance or retreat). This is an under-estimate as it didn't consider the sand volume in the dunes, but gives a reasonable indication of the magnitude. However, taking this value over the entire Kapiti Coast, the observed rate of accretion represents 1.2 kt.y^{-1}. Hence, it is likely that the observed shoreline changes involve mass transport at least an order of magnitude smaller than the potential sediment input to the system.

Table 3. Possible components of a sediment budget for the Kapiti Coast.

Sediment inputs		Sediment outputs
Longshore drift — 80-240 kt.y^{-1}		
Regional	Local	Local
Rivers — 170 kt.y^{-1}	Rivers — 28 kt.y^{-1}	Shoreline advance — 1.2 kt.y^{-1}
Coastal erosion — unknown	Coastal erosion — unknown	Inland — unknown
Inner shelf — unknown	Inner shelf — 0 kt.y^{-1}	Offshore — unknown

Although there are components of the sediment budget missing from Table 3 because they could not be estimated from the literature assessed for this report, they are either relatively easy to assess, such as from comparisons of hydrographic charts for the offshore sediment outputs, or likely to be smaller than the uncertainties in the river sediment inputs. The available data do indicate that a substantial change in the sediment hudget would be required to transform the entire Kapiti Coast to an erosional coast.

The sediment budget can be refined by considering smaller sections of the Kapiti Coast, particularly to assess the effects of the 12 inlets along the coast. This would clearly identify areas that have sufficient input of sediment to offset any potential future tendency towards long-term erosion. It would also be useful to assess the effects of

sediment pulses moving along the coast. It is expected that such an analysis would replicate the existing pattern of erosion and accretion reported by CSL (2008a), rather than the predicted patterns of coastal erosion implied by the CEPD and IEPD lines.

For areas that are accreting and have a significant surplus of sediment, the CEPD should be predominantly a function of the short-term fluctuations associated with storm events. The extent of erosion can be determined from profile measurements, which is preferred because it would permit a probabilistic analysis, or by the application of analytical models such as Komar *et al* (1991) or Larson *et al* (2004), or numerical models such as XBeach (Roelvink *et al.*, 2009). The long-term trends would only need to be considered if there is an intention to continue development seaward of existing property boundaries.

For areas that are eroding, or are identified as likely to experience a sediment deficit in the future, there should be a probabilistic analysis of the CEPD using a process-based model. Ranasinghe *et al* (2012) provide an example of such an approach for Narrabeen Beach, Sydney, Australia, that would be applicable to the Kapiti Coast. The key steps of such an analysis for the Kapiti Coast, assuming the shoreline corresponds to the dune toe, are:

1. Use a Monte Carlo simulation to generate a time series of storms for the future interval of interest using observation based joint probability distributions of the storm characteristics. MetOcean Solutions Ltd (2010) has already evaluated the necessary data for the Kapiti Coast.
2. Estimate the range of mean sea level elevations for the time each storm occurs. Generally, the most recent IPCC projections are used, as they should represent a complete review of the available projections. Note that it is not appropriate to select either the worst case, or best case, scenarios.
3. For each storm estimate the amount of coastal erosion. This is best based on historical observations, but can be estimated by model predictions. There must be allowance for shoreline recovery between storm events, which is best determined from historical observations. Note that this model can be applied to an accreting coast by adjusting the recovery phase to incorporate the long-term trend.
4. Estimate the final shoreline position at the end of the prediction period by temporally averaging the last 2 years (this reduces the influence of any storms that occur in the last 2 years, and therefore haven't had sufficient time for the recovery phase).
5. Subtract the initial position from the final position to estimate the shoreline change (negative values correspond to erosion).
6. Repeat steps 1-5 until the exceedance probabilities > 0.01% converge (bootstrapping).

Ranasinghe *et al* (2012) found that using this approach, with the numerical SBEACH estimating the coastal erosion, and an assumed sea level rise of 0.92 m relative to 1990 by 2100, the BR method (used by CSL, 2008a, 2012) estimates corresponded to probabilities of exceedance between 8% and <1% depending on the shoreline slope used (higher probabilities associated with steeper slopes). They used BR sea level multipliers of 34-68 *cf.* 28-57 for most of the sites analysed by CSL (2008a). However, they didn't use the technique to hindcast the observed shoreline response to historic sea level rise, so it is difficult to assess how reliable the method is for forecasting.

An important aspect of the methodology suggested by Ranasinghe *et al* (2012) is recognition of shoreline recovery following storm events. This would facilitate consideration of the impacts of coastal management. de Lange *et al* (1997) developed a similar methodology to assess the overall impact of climate change on the New Zealand coast. This was extended to islands in the Pacific (Kench and Cowell, 1996), and is incorporated into the Sim-

CLIM climate impact modelling software. Based on this approach, Warrick (2006) determined that for the IPCC 2001 worst-case scenario, an annual accretion rate of 0.015 tm^{-1} of beach length would be sufficient to offset the predicted erosion. This is several orders of magnitude smaller than the observed rate of accretion for the Kapiti Coast, and suggests that the proposal of Gibb (1978) to utilise the offshore sand resource to renourish the Paekakariki to Raumati shoreline would be a successful strategy.

There does not appear to be an existing probabilistic model for predicting future inlet response. Development of a model for the Kapiti Coast will be complicated by the long history of inlet modification.

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