Memo

To: Emily Thomson

From: Focus Resource Management Group

Date: 30th October 2012

Re: Technical background to coastal hazard management zones

This memorandum provides further technical details of the draft Coastal Hazard Management Zones outlined in Focus (2011). This is an updated version of a memo provided in August 2011, which outlines the data used to formulate the coastal hazard management zones recommended by Focus.

Coastal Hazard Science Base

The proposed Coastal Hazard Management Zones are based on the coastal hazard assessments undertaken by Coastal Systems Ltd (2008a; 2008b; 2012).

In 2007, KCDC commissioned Coastal Systems Ltd to undertake detailed assessment of coastal erosion hazard to enable revision and update of the coastal management setbacks. This work involved detailed assessment of the various components of coastal erosion hazard and the production of maps showing "future shorelines", based on several scenarios relating to human intervention (e.g. seawalls and entrance management).

Initial reports were prepared in 2008 (Coastal Systems Ltd, 2008a, 2008b, 2008c). Further work addressing a 100 year timeframe is was completed (Coastal Systems Ltd, 2012).

On the open coast, the various components of coastal erosion hazard identified by Coastal Systems Ltd are:

- **Long term trends for shoreline advance or erosion.** These rates were calculated from analysis of up to 135 years of historical aerial photograph and cadastral survey data. Long term erosion rates were calculated from earlier data (1870s to 1950s) to determine shoreline change prior to coastal management, and later data (1940s to 2007) to observe shoreline change as influenced by coastal structures and other management interventions.

- **Dynamic ("short term") shoreline fluctuations**, being those fluctuations in the shoreline induced by storms, climatic cycles and other environmental changes over timescales of several months to several years. This was also defined by using the historical shoreline record.
- **Potential shoreline retreat associated with sea level rise** over the next 50 and 100 years, based on 0.3 m and 0.9 m sea level rise scenarios respectively (as discussed in more detail below).
- **Retreat of the dune scarp** (i.e. dune face collapse to a stable slope following serious erosion).
- **Seawall related factors**, including:
    - "catch-up" factor identifying shoreline adjustment that would occur if existing seawalls were removed
    - an allowance for ongoing end effects on adjacent shorelines if seawalls are retained

The reports cover the open coast and river and other inlets. Erosion around each river entrance and inlet was based on the most eroded inlet shoreline recorded in available data, with an additional allowance for retreat associated with projected sea level rise.

On both the open coast and inlet shorelines, erosion hazard assessment also included a combined uncertainty term to provide for measurement error in the shoreline change data. This uncertainty factor was determined by mathematically combining the measurement error associated with each individual dataset (e.g. photograph, plan etc) into an overall potential error in the predicted shoreline location.

Various components of erosion were combined to identify potential "future shorelines", which were then mapped (Coastal Systems, 2008a; 2008b). The various scenarios mapped were:

- **Open Coast**:
    - seawall hold - assuming seawalls are successfully maintained to ensure integrity and remain fully functional;
    - seawall repair - where seawalls may fail locally, but are quickly repaired; and
    - seawall removal - where widespread failure occurs and the remnants are then removed.

- **Inlets**:
    - managed inlets - assuming continuance of present structures and inlet management practices;
    - unmanaged ("natural coast") inlets - assuming current inlet management structures and practices were removed and/or ceased.

The "seawall removal" and "unmanaged inlets" scenarios essentially identify the risk that would be present in the absence of human intervention, such as seawalls and entrance controls. Coastal Systems (2008a, 2008b) considered shoreline change over a 50 year

timeframe.

Coastal Systems Ltd (2012) included information from more recent targeted studies, and extended the scenarios to consider hazards over the next 100 years. The report associated with this most recent work was not available at the time of the Focus (2011) report and draft CHMZ zones. The latest data has now been included in the final Focus hazard zone recommendations (October 2012).

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Recommended Coastal Hazard Management Zones

The extensive work undertaken by Coastal Systems Ltd (2008a, 2008b, 2012) provided the coastal hazard data on which we have based the recommended zones for management of coastal hazards on the Kapiti Coast.

The Policy developed by Focus (2011) recommends the following three coastal hazard management zones for implementation through the District Plan:

- **50 Year Urban Coastal Hazard Management Zone (50 yr Urban CHMZ):** identifying the area potentially at risk from coastal erosion over the next 50 years.
- **100 Year Urban Coastal Hazard Management Zone (100 yr Urban CHMZ):** identifying the area potentially at risk from coastal erosion over the next 100 years, together with an allowance to ensure a small dune buffer remains after all likely erosion.
- **100 Year Rural Coastal Hazard Management Zone (100 yr Rural CHMZ):** identifying the area potentially at risk from coastal erosion over the next 100 years, together with an allowance to ensure a dune buffer remains.

These management zones include the following parameters:

- **Existing trends for long term erosion** over 50 and 100 year timeframes (as relevant), but ignoring existing trends for shoreline advance (as applied by Coastal Systems Ltd, 2012).
- **Dynamic ("short term") shoreline fluctuations.**
- **Potential erosion associated with sea level rise** over the planning period (0.3 m over 50 years; 0.9 m over 100 years). Uncertainties around long term sea level rise are discussed further below.
- **Retreat of the dune scarp** (i.e. dune face collapse following serious erosion) to a stable slope.
- **"Catch-up" factor** to provide for shoreline adjustment that would occur if existing seawalls are removed or destroyed.
- **Measurement uncertainty.**

- **Shoreline fluctuations around river and estuary entrances**, assuming a "managed" scenario for the 50 year timeframes (i.e. ongoing entrance control works) and "unmanaged" scenario for the 100 year timeframe (i.e. removal or loss of all entrance control works).
- **Allowance for a natural dune buffer** in 100 year management zones.

We have defined these zones without regard to existing open coast seawalls so that the actual risk posed by coastal erosion is identified. This also reflects the planning review (Focus, 2011) which highlighted serious challenges associated with long term retention of existing seawalls, particularly with projected sea level rise over the next 50-100 years.

It should be noted that there is uncertainty around the most appropriate sea level rise scenarios to use for the definition of the management zones. Present national guidance (MfE, 2008), based on the most recent IPCC assessment and reports available to 2008, recommends consideration of a base level of 0.5 m by 2090-2099, along with consideration of the potential implications of higher sea level rise of "at least" 0.8 m to 2090-2099 and 0.1 m per decade thereafter. This suggests consideration of the implications of sea level rise of at least 0.9 m over the next century, as reflected in the assessment by Coastal Systems Ltd (2008a; 2008b; 2012.).

However, more recent science suggests sea level rise over the next century may be higher than anticipated at the time the MfE (2008)guidelines were prepared, with typical upper estimates of 1.0-1.5 m (RSNZ, 2011). Accordingly, sea level rise over the next century may exceed that allowed for in the assessment by Coastal Systems Ltd (2008a; 2012).

At this stage, we believe it is appropriate to follow the recommendations of the national guidelines (as per Coastal Systems Ltd, 2012), as this reflects the most recent IPCC assessment. As part of our consideration of this issue, we broadly assessed the significance of including a larger (1.2 m) sea level rise projection into our management zone recommendations. When compared with the 0.9 m projection, the difference in the width of the zones is typically in the order of 15 m. In our opinion, the dune buffer (of 15-30 m as discussed in more detail below) included in the recommended 100 year setbacks therefore contains sufficient conservatism to provide for these potentially higher levels of sea level rise should they occur over the next century.

Broadly speaking sea level rise is expected to drive long-term shoreline recession on sandy beaches such as those on the Kapiti Coast. However, where there is a long term trend for shoreline accretion (e.g. north of Paraparaumu), this may reduce or even cancel out sea level rise effects. Coastal Systems Ltd (2008a; 2012) did not include trends for long term shoreline accretion in calculations of future shoreline scenarios. It is widely accepted practice to remove accretion trends from hazard calculations to ensure conservatism. It could be argued, therefore that the Future Shorelines (Coastal Systems Ltd, 2012) and Coastal Hazard Management Zones (Focus, 2011) may overstate the potential coastal erosion hazard on the northern portion of the Kapiti Coast. This is a complex matter worthy of further ongoing consideration. The management zones and associated management implications are briefly summarised in the following sections.

50 year Urban Coastal Hazard Management Zone (50 yr Urban CHMZ)

The 50 yr Urban CHMZ recommendation includes allowance for long term shoreline trends, dynamic shoreline fluctuations, sea level rise and a stable frontal dune slope, based on the work by Coastal Systems Ltd (2012). The management zone therefore defines the worst likely risk that will apply at the end of the 50 year timeframe rather than the existing risk.

The area currently at risk from erosion is significantly less than the width shown by the 50 yr Urban CHMZ. The existing risk will however be exacerbated over the next 50 years and beyond by existing erosion trends (in some areas) and the impact of projected sea level rise (potentially in all areas). Accordingly it would be inappropriate to use only existing risk to guide the location of development and infrastructure.

The proposed 50 yr Urban CHMZ extends across significant areas of existing residential development, particularly from Paraparaumu southwards, as discussed in the following sections. This reflects the long term trend for erosion in these areas, as identified by Coastal Systems Ltd (2012) and the fact that revetments already hold much of the shoreline well seaward of its natural position.

The 50 yr Urban CHMZ is typically between 40 m and 70 m wide over the southern portion of the coast where the shoreline is experiencing long term erosion. The width varies largely due to seawall effects and the height of the dune. The 50 yr Urban CHMZ impacts most beachfront residential sections at Paekakariki severely, particularly south of Beach Road. North of Beach Road, the landward limit of the zone lies in a very similar position to the current relocatable zone requirement.

At Raumati South, beachfront sections are completely (or almost completely) within the recommended 50 yr Urban CHMZ. North of Wharemauku Inlet, the zone is narrower and runs through the middle of full depth sections, though completely encompasses smaller subdivided lots.

Where there is a long term trend for shoreline stability or accretion (i.e. north of Paraparaumu town centre), the 50 yr Urban CHMZ is typically between 35 m and 60 m wide. This zone nonetheless represents a significant increase in width when compared with the existing 20 m no-build zone at the southern beaches. At north Paraparaumu Beach, the recommended 50 year building setback will severely affect a small number of properties, on Manly Street in the vicinity of Ngapotiki Street and Watson Drive.

At Waikanae Beach, the 50 yr Urban CHMZ extends 10-15 m into many beachfront residential sections. This represents an increase in development controls when compared with the current 7.5 m coastal yard. Most sections will still remain useable in terms of accommodating a house. There are, however several properties near the entrance of the Waimeha Inlet that are severely affected by the 50 yr Urban CHMZ. North of the Waimeha Inlet (away from the influence of the inlet), beachfront properties are largely unaffected by this zone.

At Te Horo, the recommended 50 yr Urban CHMZ impacts properties north of Sea Road, and will increase development controls relative to the existing 7.5 m coastal yard. At the northernmost end, properties are severely impacted by the 50 yr CHMZ due to inlet effects.

At Peka Peka, the landward limit of the 50 yr Urban CHMZ lies 25-50 m seaward of the 70 m

setback currently in place.

In summary, there are many locations where the 50 yr Urban CHMZ can be adopted as a building exclusion zone while providing for reasonable use of existing properties. There are, however extensive areas where the 50 yr Urban CHMZ would preclude reasonable use of existing properties if implemented as a building setback. In these areas, adaptation strategies (see Focus, 2011) will be required to provide for reasonable use while also transitioning to a more sustainable long term outcome. At Peka Peka, the 50 yr Urban CHMZ is not as restrictive as the existing setbacks, and Council may choose to retain the existing 70 m setback to protect wider coastal values. Property owners may also desire this to avoid new buildings interfering with their lateral views (as identified in the Coastal Strategy).

100 year Rural and Urban Coastal Hazard Management Zones (CHMZ)

The 100 year development setback lies typically between 85 m and 140 m from the current shoreline, with only a few locations outside this range.

The 100 yr Urban CHMZ extends well landward into most existing residential areas, and highlights the longer term issues that may accompany projected climate change and sea level rise. It also includes significant infrastructure, including roads, sewers, water mains etc.

The 100 yr Rural CHMZ generally does not impact existing dwellings, with only isolated exceptions. In places, the 100 yr Rural CHMZ is less than the current 100 m building setback. This however, relates at least in part to queries about the existing science that will need to be addressed in the further work required, as noted below. Accordingly we recommend that any alterations to this zone are considered further at that time.

These 100 year management zones include an allowance for a dune buffer in addition to the assessed erosion hazard. This buffer zone provides for the long term management objective of the restoration of a natural dune along the length of the Kapiti Coast, as discussed further in Focus (2011). A dune buffer was not included in the 50 yr Urban CHMZ, as it was envisaged that the transition to a more sustainable outcome was sufficiently challenging in many areas to preclude this as a reasonable expectation over this shorter timeframe.

The recommended dune buffer is 15 m in residential and commercial zones and 30 m in the rural zone. The lesser width in areas of existing residential development recognises the greater constraints on managed retreat in these areas. It nonetheless provides sufficient allowance for a spinifex-dominated vegetation zone critical to natural dune functioning, including self-repair after storm erosion. The greater width in rural areas provides for a full width frontal dune and therefore some retention of natural values in back-dune areas. The widths adopted for the dune buffers were based on measurements of the current natural frontal dune widths on the Kapiti Coast using Google Earth.

The 2012 update of the Focus 100 yr CHMZ lines includes coverage of areas with Open Space zoning. Where large areas of Open Space zone exist in a rural setting, we have applied a 30 m buffer and the setback is the equivalent of the 100 yr Rural CHMZ. Where small areas of Open Space exist within an urban setting (e.g. Campbell Park), we have applied a 15 m buffer and the line is equivalent to the 100 yr Urban CHMZ.

GIS Data

The Focus CHMZ recommendations are based on the mapping data provided by Coastal Systems (2012). The data layers used to create each CHMZ are outlined below.

Focus 50 year Urban Coastal Hazard Management Zone (2012)

On the open coast south of Tikotu Inlet the 50 yr Urban CHMZ is equivalent to Coastal Systems Ltd *"2012 Update 50yr REMOVE-NATURAL 20-6-2012 UNCLASSIFIED LINE FEATURE"*, with small adjustments made at Wharemauku and Tikotu Inlets to connect the 50 year unmanaged open coast with the 50 year managed inlet scenario.

North of Tikotu Inlet the 50 yr CHMZ has been constructed from several of Coastal Systems Ltd 2012 updated lines:

- *2012 Update 50yr CEHL REMOVE-NATURAL 20-6-2012 NATURAL_OPEN_COAST.nztm*
- *2012 Update 50yr CEHL REPAIR MANAGED Sections only 20-6-2012 MANAGED INLET.nztm*
- *2012 Update 50yr CEHL REPAIR MANAGED Sections only 20-6-2012 NATURAL OPEN COAST.nztm*
- *2012 Update 50yr CEHL REMOVE NATURAL20-6-2012 NATURAL INLET.nztm*

100 Year Urban Coastal Hazard Management Zone

This line follows the same shape as Coastal Systems (2012) 100 year natural inlet line ("2012 Update 100yr CEHL REMOVE NATURAL 20-6-2012 UNCLASSIFIED LINE FEATURE.nztm") in urban areas, with the addition of a 15 m dune buffer to landward.

100 Year Rural Coastal Hazard Management Zone:

This line follows the same shape as Coastal Systems (2012) 100 year natural inlet line ("2012 Update 100yr CEHL REMOVE NATURAL 20-6-2012 UNCLASSIFIED LINE FEATURE.nztm") in rural areas, with the addition of a 30 m dune buffer to landward.

Further Work Required for Detailed CHMZ Mapping

The management zones outlined in Focus (2011) and the draft indicative maps provided in 2011 required further discussion and detailed work before they could be fully mapped. This work needed to address:

- **Clarification of various matters related to the present science.** The data provided for this project by Coastal Systems Ltd in 2011was preliminary, as the relevant reporting was not yet complete. Since that time, the Coastal Systems (2012) report has been completed and the associated data further refined. The latest version of Focus CHMZs

reflects this latest data. **The indicative mapping highlighted various matters that** were discussed with Dr Shand. These matters included considerations related to the "catch up" factor, allowance for three dimensional (alongshore) effects, adjustment of inlet shorelines, factor of safety in inlet erosion zones and the possible inclusion of progradation rates into setback calculations. Dr Shand has considered these matters and included comment within the 2012 report.

While the 2012 report is now available and these issues have been considered by Dr Shand, some further refinement may be required following the planned peer review of Coastal Systems (2012) final data and reporting.

- **Management of end effects** associated with existing coastal structures, bearing in mind that while these are not included in the existing management zones, they will be relevant for the transitional period that the structures remain in place. This will need to be considered as part of site specific management strategies.

As noted in 2011, it may be useful to provide some indication of the extent of existing (current) risk in future communication of the hazard information and management recommendations. Such information is helpful for property owners to understand the extent of immediate risk, compared with the risk in 50 years time. This information may be also of value to insurance providers. Without this information, existing risk and short-term management problems may be over-estimated. It is our opinion that consideration of existing risk and the nature of the various erosion hazard components will be significant factors in the adaptation strategies that are required to move management of coastal hazards from the present situation to a more sustainable position in difficult areas.

Monitoring and Review

As discussed by Focus (2011), the proposed CHMZs will need to be periodically reviewed and updated to reflect the most recent available science. This review will be linked to ongoing monitoring of coastal change along the Kapiti Coast (discussed in the reports by Coastal Systems Ltd) and to future IPCC assessments and other work relevant to projected sea level rise.

We recommend that this review normally be conducted every 10 years and be timed to coincide with IPCC assessments and revised national guidance.

Memo

To: Emily Thomson

From: Focus Resource Management Group

Date: 25th August 2011

Re: Technical background to coastal hazard management zones

This memorandum provides further technical details of the draft Coastal Hazard Management Zones outlined in Focus (2011).

Coastal Hazard Science Base

The proposed Coastal Hazard Management Zones are based on the coastal hazard assessments undertaken by Coastal Systems Ltd (2008a; 2008b; 2011 *in prep.*).

In 2007, KCDC commissioned Coastal Systems Ltd to undertake detailed assessment of coastal erosion hazard to enable revision and update of the coastal management setbacks. This work involved detailed assessment of the various components of coastal erosion hazard and the production of maps showing "future shorelines", based on several scenarios relating to human intervention (e.g. seawalls and entrance management).

Initial reports were prepared in 2008 (Coastal Systems Ltd, 2008a, 2008b, 2008c). Further work addressing a 100 year timeframe is currently being completed (Coastal Systems Ltd, 2011 *in prep.*). Preliminary results from this further analysis were provided by Coastal Systems Ltd in June 2011 to enable progress of the management recommendations.

On the open coast, the various components of coastal erosion hazard identified by Coastal Systems Ltd are:

- **Long term trends for shoreline advance or erosion.** These rates were calculated from analysis of up to 135 years of historical aerial photograph and cadastral survey data. Long term erosion rates were calculated from earlier data (1870s to 1950s) to determine shoreline change prior to coastal management, and later data (1940s to 2007) to observe shoreline change as influenced by coastal structures and other management interventions.

- **Dynamic ("short term") shoreline fluctuations**, being those fluctuations in the shoreline induced by storms, climatic cycles and other environmental changes over timescales of several months to several years. This was also defined by using the historical shoreline record.
- **Potential shoreline retreat associated with sea level rise** over the next 50 and 100 years, based on 0.3 m and 0.9 m sea level rise scenarios respectively (as discussed in more detail below).
- **Retreat of the dune scarp** (i.e. dune face collapse to a stable slope following serious erosion).
- **Seawall related factors**, including:
    - "catch-up" factor identifying shoreline adjustment that would occur if existing seawalls were removed.
    - an allowance for ongoing end effects on adjacent shorelines if seawalls are retained.

The reports covered the open coast (Coastal Systems Ltd, 2008a) and river and other inlets (Coastal Systems Ltd, 2008b) separately. Erosion around each river entrance and inlet was based on the most eroded inlet shoreline recorded in available data, with an additional allowance for retreat associated with projected sea level rise.

On both the open coast and inlet shorelines, erosion hazard assessment also included a combined uncertainty term to provide for measurement error in the shoreline change data. This uncertainty factor was determined by mathematically combining the measurement error associated with each individual dataset (e.g. photograph, plan etc) into an overall potential error in the predicted shoreline location.

In the 2008 reports, various components of erosion were combined to identify potential "future shorelines", which were then mapped. The various scenarios mapped were:

- **Open Coast**:
    - seawall hold - assuming seawalls are successfully maintained to ensure integrity and remain fully functional;
    - seawall repair - where seawalls may fail locally, but are quickly repaired; and
    - seawall removal - where widespread failure occurs and the remnants are then removed.

- **Inlets**:
    - managed inlets - assuming continuance of present structures and inlet management practices;
    - unmanaged ("natural coast") inlets - assuming current inlet management structures and practices were removed and/or ceased.

The "seawall removal" and "unmanaged inlets" scenarios essentially identify the risk that would be present in the absence of human intervention, such as seawalls and entrance

controls.

Coastal Systems Ltd (2011 *in prep.*) is currently producing further "future shorelines" scenarios as follows:

- **50 Year Future Shoreline** - based on the retention of existing seawalls ("seawall repair" scenario) and the ongoing management of inlet entrances ("managed inlet" scenario). This potential "future shoreline" includes allowance for 0.3 m of sea level rise over the next 50 years.
- **100 Year Future Shoreline** - assuming removal of existing seawalls ("seawall removal" scenario), and ongoing management of inlet entrances. This potential "future shoreline" includes allowance for 0.9 m of sea level rise over the next 100 years.

The report associated with this most recent work was not available at the time of the Focus (2011) report, but Coastal Systems Ltd provided updated erosion component values, and shape files of the 2011 (draft) future shorelines described above.

Recommended Coastal Hazard Management Zones

The extensive work undertaken by Coastal Systems Ltd (2008a, 2008b, 2011 *in prep.*) provided the coastal hazard data on which we have based the recommended zones for management of coastal hazards on the Kapiti Coast.

The Policy developed by Focus (2011) recommends the following three coastal hazard management zones for implementation through the District Plan:

- **50 Year Urban Coastal Hazard Management Zone (50 yr Urban CHMZ):** identifying the area potentially at risk from coastal erosion over the next 50 years.
- **100 Year Urban Coastal Hazard Management Zone (100 yr Urban CHMZ):** identifying the area potentially at risk from coastal erosion over the next 100 years, together with an allowance to ensure a small dune buffer remains.
- **100 Year Rural Coastal Hazard Management Zone (100 yr Rural CHMZ):** identifying the area potentially at risk from coastal erosion over the next 100 years, together with an allowance to ensure a dune buffer remains.

These management zones include the following parameters:

- **Existing trends for long term erosion** over 50 and 100 year timeframes (as relevant), but ignoring existing trends for shoreline advance (as applied by Coastal Systems Ltd).
- **Dynamic ("short term") shoreline fluctuations**.
- **Potential erosion associated with sea level rise** over the planning period (0.3 m over 50 years; 0.9 m over 100 years). Uncertainties around long term sea level rise are discussed further below.
- **Retreat of the dune scarp** (i.e. dune face collapse following serious erosion) to a

stable slope.

- **"Catch-up" factor** to provide for shoreline adjustment that would occur if existing seawalls are removed or destroyed.
- **Measurement uncertainty**.
- **Shoreline fluctuations around river and estuary entrances**, assuming a "managed scenario" for the 50 and 100 year timeframes (i.e. ongoing entrance control works).
- **Allowance for a natural dune buffer** in 100 year management zones.

We have defined these zones without regard to existing seawalls so that the actual risk posed by coastal erosion is identified. This also reflects the planning review (Focus, 2011) which highlighted serious challenges associated with long term retention of existing seawalls - particularly with projected sea level rise over the next 50-100 years.

It should be noted that there is uncertainty around the most appropriate sea level rise scenarios to use for the definition of the management zones. Present national guidance (MfE, 2008), based on the most recent IPCC assessment and reports available to 2008, recommends consideration of a base level of 0.5 m by 2090-2099, along with consideration of the potential implications of higher sea level rise of "at least" 0.8 m to 2090-2099 and 0.1 m per decade thereafter. This suggests consideration of the implications of sea level rise of at least 0.9 m over the next century, as reflected in the assessment by Coastal Systems Ltd (2008a; 2008b; 2011 *in prep.*).

However, more recent science suggests sea level rise over the next century may be higher than anticipated at the time the MfE (2008)guidelines were prepared, with typical upper estimates of 1.0-1.5 m (RSNZ, 2011). Accordingly, sea level rise over the next century may exceed that allowed for in the assessment by Coastal Systems Ltd (2008a; 2011 *in prep.*).

At this stage, we believe it is appropriate to follow the recommendations of the national guidelines (as per Coastal Systems Ltd, 2011 *in prep.*), as this reflects the most recent IPCC assessment. As part of our consideration of this issue, we broadly assessed the significance of including a larger (1.2 m) sea level rise projection into our management zone recommendations. When compared with the 0.9 m projection, the difference in the width of the zones is typically in the order of 15 m. In our opinion, the dune buffer (of 15-30 m as discussed in more detail below) included in the recommended 100 year setbacks therefore contains sufficient conservatism to provide for these potentially higher levels of sea level rise should they occur over the next century. Nonetheless, we recommend that uncertainties around sea level rise and associated issues (e.g. residual risk) be reviewed in the detailed mapping project discussed further below. Any agreed changes to the sea level rise scenarios adopted need to be reflected in the final report by Coastal Systems Ltd as well as the mapped management zones.

Broadly speaking sea level rise is expected to drive long-term shoreline recession on sandy beaches such as those on the Kapiti Coast. However, where there is a long term trend for shoreline accretion (e.g. north of Paraparaumu), this may reduce or even cancel out sea level rise effects. Coastal Systems Ltd (2008a; 2011 in prep.) did not include trends for long term shoreline accretion in calculations of future shoreline scenarios. It is widely accepted practice to remove accretion trends from hazard calculations to ensure conservatism. It could be argued, therefore that the Future Shorelines (Coastal Systems Ltd, 2011 in

prep.) and Coastal Hazard Management Zones (Focus, 2011) may overstate the potential coastal erosion hazard on the northern portion of the Kapiti Coast. This is a complex matter worthy of further consideration during the detailed mapping project.

The indicative location of the management zones is shown on draft maps supplied to KCDC in August 2011, though accurate mapping cannot be undertaken until completion of the detailed mapping work outlined further below. The management zones and associated management implications are briefly summarised in the following sections.

50 year Urban Coastal Hazard Management Zone (50 yr Urban CHMZ)

The 50 yr Urban CHMZ recommendation includes allowance for long term shoreline trends, dynamic shoreline fluctuations, sea level rise and a stable frontal dune slope, based on the work by Coastal Systems Ltd (2011 *in prep.*). The management zone therefore defines the worst likely risk that will apply at the end of the 50 year timeframe rather than the existing risk.

The area currently at risk from erosion is significantly less than the width shown by the 50 yr Urban CHMZ. The existing risk will however be exacerbated over the next 50 years and beyond by existing erosion trends (in some areas) and the impact of projected sea level rise (potentially in all areas). Accordingly it would be inappropriate to use only existing risk to guide the location of development and infrastructure.

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sections. This represents an increase in development controls when compared with the current 7.5 m coastal yard. Most sections will still remain useable in terms of accommodating a house. There are, however several properties near the entrance of the Waimeha Inlet that are severely affected by the 50 yr Urban CHMZ. North of the Waimeha Inlet (away from the influence of the inlet), beachfront properties are largely unaffected by this zone.

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These 100 year management zones include an allowance for a dune buffer in addition to the assessed erosion hazard. This buffer zone provides for the long term management objective of the restoration of a natural dune along the length of the Kapiti Coast, as discussed further in Focus (2011). A dune buffer was not included in the 50 yr Urban CHMZ, as it was envisaged that the transition to a more sustainable outcome was sufficiently challenging in many areas to preclude this as a reasonable expectation over this shorter timeframe.

The recommended dune buffer is 15 m in residential and commercial zones and 30 m in the rural zone. The lesser width in areas of existing residential development recognises the greater constraints on managed retreat in these areas. It nonetheless provides sufficient allowance for a spinifex-dominated vegetation zone critical to natural dune functioning, including self-repair

after storm erosion. The greater width in rural areas provides for a full width frontal dune and therefore some retention of natural values in back-dune areas. The widths adopted for the dune buffers were based on measurements of the current natural frontal dune widths on the Kapiti Coast using Google Earth.

Further Work Required for Detailed CHMZ Mapping

The management zones outlined in Focus (2011) and the draft indicative maps provided will require further discussion and detailed work before they can be mapped accurately. This work will need to address:

- **Clarification of various matters related to the present science.** The data provided for this project by Coastal Systems Ltd was preliminary, as the relevant reporting was not yet complete. Further refinement may be required upon consideration of Coastal Systems (2011) final data and reporting, and associated discussions with Dr Shand. The indicative mapping has highlighted various matters that need to be discussed with Dr Shand including: considerations related to the "catch up" factor, allowance for three dimensional (alongshore) effects, adjustment of inlet shorelines, factor of safety in inlet erosion zones and the possible inclusion of progradation rates into setback calculations.

  Once these matters have been discussed, any agreed changes can be incorporated in the scientific reporting as well as the mapping. This will ensure the reporting and the mapping are well aligned.

- **Sea level rise scenarios** (as discussed above) and management of residual risk.

- **Management of end effects** associated with existing coastal structures, bearing in mind that while these are not included in the existing management zones, they will be relevant for the transitional period that the structures remain in place.

- **Discussion of immediate risk versus the longer term risk** defined in the management zones. It may be useful to include some indication of the extent of existing risk in the communication of the management recommendations. Otherwise, short-term management problems may be over-estimated by parties who do not appreciate the difference. It is our opinion that consideration of existing risk and the nature of the various erosion hazard components will be significant factors in the adaptation strategies that are required to move management of coastal hazards from the present situation to a more sustainable position.

Monitoring and Review

As discussed by Focus (2011), the proposed CHMZs will need to be periodically reviewed and

updated to reflect the most recent available science. This review will be linked to ongoing monitoring of coastal change along the Kapiti Coast (discussed in the reports by Coastal Systems Ltd) and to future IPCC assessments and other work relevant to projected sea level rise.

We recommend that this review normally be conducted every 10 years and be timed to coincide with IPCC assessments. However, in view of the significant change in sea level rise projections since the last IPCC assessment, it is important to adequately "future proof" the most recent hazard assessment. Accordingly, we have also recommended further discussion of sea level rise in the detailed mapping project as noted above.

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ECONOMOS

Sustainable Solutions in Coastal Science and Management

12 March 2012

Ms Emily Thomson

Kapiti Coast District Council

PO Box

Paraparaumu

Dear Emily

Meeting with Dr Shand to Agree Work Required to Finalise Setbacks

As per your instructions, we (Bronwen Gibberd and Jim Dahm of Focus Resource Management Group) have completed a meeting with Dr. Roger Shand to:

- Discuss queries relating to the scientific work that arose during our work, and
- Confirm any additional work required to complete the scientific and planning reports and mapping, to ensure consistency between the scientific and planning recommendations.

This letter summarises the key matters discussed.

The further work recommended to finalise the scientific report and the setback maps is also outlined (bolded in text for easy reference).

1 Alongshore Smoothing of Coastal Hazard Parameters

Dr Shand calculated coastal hazard parameters at a number of representative points along the coast. We discussed whether the parameter values so determined have been adequately smoothed alongshore to avoid unrealistic variations in the proposed setbacks.

Roger confirmed that he included appropriate alongshore smoothing of the main parameters used within his setback calculations.

He is of the view that remaining alongshore variations in these parameters (e.g. beach gradients) are genuine. He did note though that the representative dune height values

adopted were necessary high to ensure a conservative approach.

2 Should Existing Accretion Rates be included in Setback Calculations?

There is an existing long term trend for shoreline advance north of Paraparaumu. This trend may wholly or partly offset the impact of projected future sea level rise over some timeframes - if one could be sure that the trends will continue in the medium to long term.

At present, Roger has not included long term shoreline advance in assessing the future shoreline response to sea level rise. This is consistent with best practice in erosion hazard assessment and ensures a precautionary approach.

It could be argued that this approach may result in the setbacks being rather conservative, or overstating the risk in these areas; at least in the short to medium term. This is most relevant where the proposed 50 year no build management zone impacts on existing beachfront properties or dwellings. The only area where this occurs is north Paraparaumu.

It was agreed that excluding existing trends for shoreline advance remains the best approach in regard to the proposed 50 and 100 year hazard management zones. This ensures these are adequately precautionary. Roger has noted that he is currently conducting more detailed scientific work in this area, which should help better define shoreline change trends and may aid in refining future setback lines.

3 Is the "Catch-Up" Factor Adequate?

Where seawalls have been in place for long periods of time on an eroding coast, the shoreline is often held well seaward of its natural position. The removal or failure of the seawall would therefore result in rapid shoreline adjustment (erosion) toward a more "natural" location. The "catch up" factor identifies this additional erosion. It is important not to under-estimate this factor as this erosion would be severe in some locations along the Kapiti coast.

Roger has estimated the likely "catch-up" erosion associated with seawall removal or failure, by assessing shoreline erosion rates prior to installation of the sea walls and multiplying these rates by the length of time the seawalls have been in place.

We discussed other approaches that could be used to provide a second check on the "catch-up" factor. The use of surveyed profiles appeared to us to offer the best promise. This method utilises beach profile data from adjacent natural areas of the beach to assess how much further landward the natural shoreline (e.g. dune toe) might lie were the sea wall not present, based on the beach elevation in front of the seawall.

It was agreed that while there are a variety of difficulties with this approach, it could (with suitable data and care) provide a useful cross-check on catch-up rates. It was agreed that it would be useful for Roger to investigate the potential use of this approach when he finalises his report.

4 Possible Future Need to include "End Effects" in Setbacks

Roger has calculated end effects in his 2011 report using equations developed with Kapiti Coast data. These equations predict the maximum alongshore length and cross shore depth of erosion associated with a given seawall.

The 50-year CHMZ we have recommended does not include end effects, as it uses the "sea walls removed" data. While was agreed that this is appropriate and no change to the setback is warranted at this time, we also agreed that further thought will need to be given to this matter if existing sea walls are to remain in place for a lengthy period of time. In these cases, future erosion of areas adjacent to seawalls may be underestimated by the current hazard zone recommendation. This matter would be best addressed in the site-specific strategies we recommended be developed.

5 Matching our Setbacks with Dr Shand's

In terms of inlet areas, Dr Shand's 2008 report included natural and managed inlet scenarios. The 2011 review which revised and updated this work did not include a 100 year natural inlet - as this was not within his terms of reference.

Our draft 100 year CHMZ maps were compiled by translating Roger's 50 year natural inlet lines (from the 2008 report) inland - by adding sea level rise related erosion for the additional 50 years and our buffer zones. However, this does not accurately reflect Roger's 100 year natural inlet line because of complexities in the mapping around inlets.

Accordingly, we need Roger to map 100 year natural inlet lines in the final draft of his 2011 report for use in our recommended 100 year CHMZ; so that the science and management lines are based on the same data.

In terms of open coast areas over a 50-year timeframe, Roger's 2011 report was also limited to a managed ("seawall hold") open coast shoreline.

The Focus CHMZ recommendations made use of Roger's 2008 "seawall remove" data but there are subtle variations and complications that mean this draft setback may not exactly match the updated 2011 report.

It is therefore recommended that the final 2011 "Erosion Hazard Assessment Update" report being completed by Roger include 50 yr unmanaged open coast shoreline data.

These additions to Roger's 2011 repoprt will ensure that the management setbacks directly utilise data presented in the most recent scientific report.

This will also simplify finalising the CHZM setbacks as they will then simply require the addition of the proposed 15 m and 30 m buffer zones.

6 Are the Unmanaged Inlet Lines Mapped with Sufficient Precaution?

Roger predicted natural inlet erosion based largely on the worst measured shoreline change. We discussed the fact that available records may or may not record the worst erosion that has occurred or may occur.

We agreed that, subject to KCDC approval, it would be useful for Roger extend his 2011 report by examining the oldest (usually 1940s) aerial photographs (stereo pairs) to see if

there is any evidence of erosion scarps or other geomorphologic features that indicate the potential for worse erosion than presently assessed.

The work is relatively minor in scope but would be a useful additional check in these dynamic entrance areas.

Roger indicates that this additional work can be done within the scope of work he is presently completing for Matt.

7 Do we Need to Consider Higher Sea Level Rise Values?

There is some uncertainty around the most appropriate sea level rise scenarios to use for the definition of the management zones. Present national guidance (MfE, 2008), based on the most recent IPCC assessment and reports available to 2008, recommends consideration of the implications of sea level rise of at least 0.9 m over the next century, and this is reflected in the assessment by Coastal Systems Ltd (2011).

More recent science suggests sea level rise may be higher than anticipated at the time the MfE (2008) guidelines were prepared, with typical upper estimates of 1.0-1.5 m and even as high as 2 m (e.g. review by Royal Society of New Zealand in 2011).

These matters were discussed and we all agree that it is appropriate to continue to follow the recommendations of the national guidelines at this point in time (as per Coastal Systems Ltd, 2011). The matter can be reviewed after future IPCC assessments.

We are comfortable that the 15 m and 30 m dune buffers included in our 100-year urban and rural setbacks, respectively, provide sufficient 'fat' to accommodate possible higher sea level rise.

8 Summary and Further Work Required to Finalise Setbacks

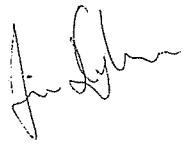
The following additional work is recommended for inclusion in the final "Erosion Hazard Assessment Update (2011)" being prepared by Roger:

- **Profile extrapolation to check present estimates of "catch-up" erosion.**
- **Mapping of a 100 yr natural inlet curve for the Kapiti coast entrance areas.**
- **Inclusion of data for a 50 yr unmanaged ("seawall remove") open coast shoreline when finalizing the 2011 Erosion Hazard Assessment report.**
- **Stereo analysis of earliest aerial photos in inlet areas to check for any erosion scarps or other data that could indicate the potential for more severe erosion than estimated from existing measured data.**

Once the scientific work is finished, the update of the CHZM setbacks can be completed fairly readily by Focus GIS personnel.

I will ring to discuss the above matters.

Regards



Jim Dahm

Senior Coastal Scientist

Focus Resource Management Group

cc: Above letter was compiled jointly with Dr. Shand and Ms. Gibberd