Summary points for the panel to consider
(with special reference to the 100 year lines mapped in Raumati south, especially behind the KCDC seawall fronting The Esplanade:

Submission by Peter King

Some science questions or comments

1. The 2012 Coastal Systems Ltd report, repeated in KCDC documents, states that the hazard assessment is "empirically-based". **However, the calculations include predictions, so in fact are not entirely empirical.**

2. The report states that the assessment incorporates hazard magnitude and probability, **yet there are no values supplied on the probability of such hazards occurring.**

3. There are several ambiguities in the Coastal Systems Ltd 2012 report, with respect to definitions and predicted managed and unmanaged 50 year erosion distances (page 3). The term "managed" is defined as maintenance and repair of community seawalls. However, areas with seawalls are modelled as "managed" and 'unmanaged", the latter apparently to simulate "a natural state". Conversely, localities that don't have seawalls are cited (e.g. QEII coast, Te Horo Beach etc) for the 50 year managed scenario. Perhaps the managed scenarios are hypothetical, but this is odd given the councils preference not to create new sea walls. Moreover, **the highest erosion distance in the 50 year managed (120 m) is much higher than the maximum for unmanaged (72.2 m).The mean erosion distances for each of the two scenarios are only 1.4 m different, which also seems very odd.**

4. The Coastal Systems Ltd calculations for the 100 year scenario are not consistent. **The 100 year calculation adopts values at the high end (worst case) of the possible range (the precautionary principle), whereas the 50 year does not.** One example was the use of the lowest 2008 guidance value (rounded) for sea level rise for 50 years, but using an additional increment to the lowest guidance value for 100 years. They should be done the same way. Moreover, the range of possibilities is not expressed in terms of probabilities (or likelihoods). Thus the stated calculations run the risk of being interpreted as an absolute fait accompli, which they are not.

5. There are a host of other variables used to amplify the precautionary principle (page 19 of 2012 report). One example is a weighting factor in the long-term shoreline analysis to emphasise more recent erosion. **This should only be done if that erosion is significantly greater than the long-run range of short-term erosion fluctuations, which are otherwise already accounted for.**

6. At face value, the calculation for predicted erosion distance seems flawed. It is additive, and **appears to double count some factors**. The 2012 Coastal Systems Ltd report says the variables are independent, yet the long-term historical rate is the net outcome of the various physical parameters in combination in the past, and intrinsically incorporates factors such as short-term variations, dune stability and past sea level rise. Therefore, one could simply project the long-term trend forwards, with perhaps an upwards modifier to cater for the assumption that the rate of sea level rise will increase over time. Perhaps the results will be similar. However, **the addition of "combined uncertainty" for the future predictions should also be balanced by a subtraction of "combined uncertainty"** (to allow for the

possibility that the projected rates of change and/or their impacts are less than those used in calculation).

7. Is it reasonable to take the "worst-case" assumptions for each calculation input parameter, without considering end-member ranges? The additive result greatly exaggerates the amount of predicted future erosion and shoreline retreat, or at least it create a significant bias towards extreme (high) amounts, without tempering it with scenarios for other physically feasible lesser amounts. Is it reasonable to include a sea level rise term as well as a long-term factor (which already incorporates historical sea level rise)?

8. The combined uncertainty values (section 3.2.5, page 23, 2012 Coastal Systems Ltd report) are again themselves additive, which creates a worst-case calculation. There is no attempt to balance this with "subtractive" errors. **Overall, the uncertainty values are much higher than the individual components, and therefore add a significant bias to the end result** (i.e. predicted erosion distances).

9. **Predicted sea level (SL) rise is well within the current daily tide cycle of 1.9 m** (max. high at 1.9m, min. low at 0m, mean sea level at 0.9 m). It is considerably less than the maximum tidal fluctuation (spring tides often 3m+, max. 3.6m at Paraparaumu). There is no catastrophic calamity every time it is windy and the tide is high. Even with tide cycles superimposed upon a raised SL, the coincidence of extreme storm events with spring high tides must be rare. What is this periodicity? What are the probabilities for such events over the modelled period?

10. According to the PDP, the **current long term shoreline retreat in areas some distance south of the cuspate foreland is 0.25m/yr (or 25 m in 100 years** (PDP, Chpt.4 page 9). This distance barely encroaches about one third into the width of the proposed CHMA no-build zone (Map 14C hazard lines). Given that projected sea level rise is within the existing range of semi-diurnal tide heights, **why is the 100 year line on the hazard map(s) approximately three times further inland than the current long-term retreat?** Moreover, after considering sea level rise, the 100 year projection for retreat is 40-60 m (PDP, Chpt.4 page 9). **Again, why are the 100 year hazard lines on the maps so much further inland than these estimates?**

11. It seems counter-intuitive for there to be any uncertainty value where shore-parallel protection structures are present (page 23, 2012 report). Surely if the rate of sea level rise is 0, the advance is 0? And it is special pleading to argue for an additional 5 m of uncertainty to allow for scour ahead of the structures, **especially as this means the uncertainty value ends up being greater than for natural coasts!**

12. The literature refers to a major storm in September 1976. This was 37 years ago, or over one third of the modelled period. Do the calculations consider only 3 such events for the next 100 years?

13. Any argument that climate change will cause greater storminess is moot. NIWA's own website is highly equivocal on this with respect to their modelled predictions. Even if there was greater storminess, with more high rainfall events, this should lead to greater sediment supply from rivers and a higher sediment budget for beach replenishment.

14. Exxonian sequence stratigraphic models predict that sand will be trapped in the inshore area during sea level rise. Thus, any erosion that might occur from storms could be expected to be healed during fair weather interludes. This might especially be true in the Raumati south area, where bathymetry is already shallow, the shelf broad, and sand is currently being trapped by longshore drift (primarily from the north). An end member denouement of Exxon's highstand model is aggradation and progradation, as sediment occupies the available accommodation space (assuming adequate sediment supply).

15. The erosion prediction lines appear to be predicated on a calculation that factors in the need to flatten high dunes to an equilibrium elevation profile, which has the effect of translating the hazard line tens of metres inland. It again seems counter-intuitive that the greatest shoreline advance will be where the dunes are highest (dune scarp adjustment, page 23, Coastal Systems Ltd report 2012). Is it reasonable to calculate erosion based on the highest dune elevations, resulting in greatest inland retreat of the dune profile? I would have thought that such dunes would be the ones most likely to remain at least partially intact, and that inundation would preferentially exploit intervening low topography between dunes? Moreover, even where dunes are scarped (e.g. at Queen Elizabeth Park) their faces remain relatively steep (i.e., they do not necessarily retreat far).

16. The Shand report 2012 appears to just "clip on" the 100 year scenarios to the previous 2008 report for 50 year scenarios, with assumptions of escalating change that may be disproportionately high.

17. There are many typographical and other errors throughout the 2012 report, leading to the possible conclusion that the report was done in haste, leading to the subsequent conclusion that some aspects were not well considered.

18. It is extremely difficult to follow the calculations, explanations, figures and figure annotations in Appendix C, Profile Extrapolation analysis (Coastal Systems Ltd report 2012).

19. There was no external peer review. The internal reviewer "rubber stamps" the methodology by regurgitating what the author has written, but with no critique.

I note that assessing the community's ability to manage hazard risks is beyond the scope of the TOR for the Expert Panel. However, I also note that consideration of fitness for purpose and appropriateness of the hazard risk conclusions is within scope. In the latter two regards, I have some questions or comments relating to practical aspects of sea level rise mitigation:

1. There are significant uncertainties with respect to projected sea level rise. But even if the sea level rise of 0.9 cm a year used in Dr Shand's modelling does eventuate, this annual rise equates to the width of a ballpoint pen. Is it reasonable to assume that we cannot protect against this (by implying on LIM reports that erosion will occur up to the mapped lines within 100 years)?

2. The 100 year lines purport to be "unmanaged" lines. Intuitively, "unmanaged' means just that. The fact is, at The Esplanade in Raumati south there is a sea wall (which is now newly re-constructed). It seems that the 100 year line is based on an assumption that after 50 years, the seawall at The Esplanade will be abandoned? Is this reasonable? What if the sea wall were to be abandoned at some time well beyond 50 years from now? Will it even need to be abandoned? Will one-off storms (say 20-30 year storm events) wreak such havoc that it will

be irreparable (prior to the next such storm event)? Will it be undermined (especially given the premise that sand supply will be plentiful as argued above)? Are there complementary engineering solutions that will ensure the longevity of the wall beyond 50 years?

3. The rate of projected rise is 5 times greater than the rate of c. 1.8 mm/yr over the past 120 years (http://www.kapiticoast.govt.nz/Documents/Downloads/District-Plan-Review/coastal-hazards/reports/Sea-level-rise.pdf), but is still only a mere 9 mm a year. On a comparative basis, the maximum high tide in 100 years would be only 1.8 m above present mean sea level. This is hardly a cause for concern with respect to the height of the sea wall at The Esplanade which is several metres higher still. The wall should also cater to "the perfect storm", in which high tides, low atmospheric pressure and strong winds combine to give powerful sea height surges. Even if some minor damage was inflicted, such storms are sufficiently infrequent that any remediation required should be quickly dealt with. Theoretically the seawall should have already been engineered to withstand "the 100 year" storm, or a series of lesser storms, in which case there is no need to attempt to predict 100 years of erosion opposite it.

4. Do the panel believe in all practicality that erosion will encroach as far as the 100 year lines that are mapped? For planning purposes, wouldn't it be more sensible and reasonable to only adopt 50 year hazard lines as the practical duration of building and infrastructure management (which is what this is all about)? Consideration of longer-term scenarios could be made every ten years, during incremental reviews of the District Plan, so that empirical data and evidence from the preceding ten years could better inform future planning. This means that management practices will be more contemporary, in keeping with the physical realities of the time, rather than placing a vastly premature impost on current residents and homeowners.
5. I have lived in Raumati South for 8 years. In that time I have seen only one storm that caused damage (north of the area protected by a rock wall). I can see no reason to abandon the rock wall adjacent to The Esplanade, I can see no evidence of escalating natural disasters, and I have no sense that I, my neighbours, nor the suburban inhabitants in general will need to head for the hills within the modelled period.

Concluding remarks

Overall, there are a great number of uncertainties in the erosion predictive modelling, and the outcomes of the various assumptions and input parameters could in reality be highly variable. Yet the way the results have been manifested, as single "one size fits all" lines drawn on maps for each of the 50 and 100 year calculations, implies a high degree of certainty. This in turn will create the perception of a physical reality that is in virtually all cases spurious and for all practical purposes highly unlikely. By promulgating the "hazard" lines onto LIM reports, without appropriate caveats and technical explanations, these misperceptions will be translated through to homeowners and potential home purchasers and will adversely and unduly affect the marketplace, including the home improvement and construction sectors.