APPENDIX 6: A PROBABILISTIC METHODOLOGY FOR ESTIMATING HAZARD FROM TSUNAMI GENERATED BY SUBMARINE LANDSLIDES

Central New Zealand (the Cook Strait-Wellington area) was identified as a priority area to quantify landslide-generated tsunami hazard in the 2005 *Review of Tsunami Hazard and Risk in New Zealand* (IGNS client report 2005/104). Funding through the Natural Hazards Research Platform enabled preliminary work on this problem to be undertaken (Power et al., 2011), and has subsequently funded the second phase of the project with the objective of determining the probabilistic hazard from landslide tsunami to the Wellington region. This second phase of the project was initiated in mid-2012. The results of the first phase of work are summarised below.

Landslides are documented as widespread in the Cook Strait Canyon area (Mountjoy et al., 2009; Micallef et al., 2012). Analysis of landslide morphology demonstrates that the majority of landslides have some dependence on canyon incision. Several landslides are perched on the canyon walls and are likely to have resulted solely from the action of earthquake ground motion. It is inferred that the mapped population of landslides is representative of failures during earthquakes, with the majority of landslides affected by canyon erosion of the lower slope. This enables a model for landslide triggering to be developed based on return intervals for earthquake ground motion using the National Probabilistic Seismic Hazard Model (Stirling et al., 2012).

A model workflow has been developed in ArcGIS that uses pseudo-static slope-stability equations to determine the level of strong ground motion required to trigger failure, using data points on a 1 km grid across the canyon system. The result is compared with the time-varying levels of ground motion expected from the national Probabilistic Seismic Hazard Model to determine the time interval over which slopes within the canyon system can be expected to fail. The model is verified against commercial slope stability modelling software, and will underpin future probabilistic assessments of landslide-tsunami hazard.

The numerical hydrodynamic code Gerris has been adapted to model submarine landslides as tsunami sources (Popinet et al., 2011). The 2D vertical slice model has been validated against benchmark tests and demonstrates satisfactory performance with published laboratory-based benchmarks. Landslide scenarios have been modelled for Cook Strait Canyon based on evidence from previous slope failures of the canyon walls. These scenarios have been modelled in 2D and 3D using techniques from published code (TOPICS), as well as the newly developed code, to determine the most effective and realistic method of modelling landslide-tsunami sources. The effects of the generated waves on the coast have been modelled to assess whether a hazard exists from these landslide-generated tsunami. The results demonstrate the existence of a landslide-tsunami hazard to the Wellington/South Wairarapa coastal region. Modelling results indicate that initialisation of the tsunami over complex submarine topography (e.g., submarine canyons versus simple open slopes) can have significant influence on where tsunami energy is guided and focussed. The results demonstrate that the characteristics of the generated tsunami waves are not, however, particularly sensitive to incremental changes in the density or volume of the landslides.

Landslide-generated tsunami cannot be incorporated into the New Zealand hazard and risk model at this stage. However, development of a probabilistic tsunami hazard assessment is in progress and is planned for completion in 2014. The probabilistic landslide-tsunami model

will be based on a landslide-initiation model incorporating return times for varying levels of earthquake-generated ground motions. From this a synthetic catalogue of landslide-triggered tsunami events will be used to assess the probabilistic hazard from landslide tsunami to coastal areas of the Wellington region. This model is being developed as a workflow that can be applied to other regions of New Zealand to assess landslide-generated tsunami hazard. The model will be able to be incorporated with the tectonic-source tsunami model to assess the complete tsunami hazard to New Zealand coastal areas.

A6.1 REFERENCES

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