Peer Review: Awatarariki debris-flow-fan risk to life and retreat-zone extent

M.J. McSaveney, T.R.H. Davies

We have reviewed the annual individual fatality risk calculations and map produced by Tonkin & Taylor dated September 2015. These have acknowledged uncertainties caused by the paucity of event records and the consequent difficulty in assigning return periods to event magnitudes. Nevertheless, we accept that this work is based on the best available information and is sufficiently fit for purpose.

I. The attached accompanying map shows the minimum retreat zone we recommend. This is based on the Tonkin & Taylor map of the distribution of annual individual fatality risk on the fan as calculated based on the RAMMS modelling, and also on the distribution of boulders and large woody debris deposited by the 2005 event. The distribution of boulders and large woody debris is matched closely by the area delineated by the 10^{-5} annual individual fatality risk, so we recommend using the latter to delineate the minimum retreat area.

II. The fatality risk map uses information calculated through a sophisticated numerical model which, although one of the best available, necessarily incorporates a number of simplifying assumptions (for example, that the behaviour of a debris flow carrying boulders and trees can be represented by a single homogeneous fluid). These assumptions result in uncertainties that are difficult to quantify. For this reason, we do not rely on the model results alone in choosing the extent of the area to be retreated from, and place much significance on the boulder distribution that occurred in the 2005 event. The individual fatality risk used in Christchurch for earthquake rockfall hazard zoning was 10^{-4} per year, but there, the zones were based primarily on observed boulder distributions which introduced much lower modelling uncertainty than is available at Awatarariki, and on a more robustly determinable event occurrence frequency. We recommend a conservative approach here, which is to use the estimated 10^{-5} per year fatality risk (as indicated by the Tonkin & Taylor risk calculations) as the minimum extent of the area to be retreated from. This is not to imply that we recommend adopting a limit of 10^{-5} per year fatality risk, but is to be more certain of having included the 10^{-4} per year limit.

III. Although there were no fatalities in the 2005 event, the presence of boulders and trees deposited by that event was a widely recognised serious threat to life. The lack of fatalities in 2005 may simply have been the result of luck, and/or the time of day when the event occurred. It may also be that the return period of the 2005 event has been overestimated: in addition to the tendency for boulders and large woody debris to travel further on the Awatarariki fan than models predict, there may also be a tendency for debris flows to increase in volume in the upper catchment more than we expect. Either or both of these could result in overestimation of the 2005-event return period, with consequent underestimation of the overall fatality risk.

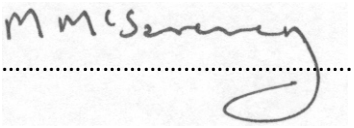
IV. We emphasise that the area outside this recommended minimum retreat zone is not free of risk to life from debris flows; a poorly quantified residual risk remains beyond the estimated 10^{-5} per year risk line. This residual fatality risk could be further reduced by extending the retreat zone, but this may be societally contentious.

V. The retreat zone will need on-going maintenance to ensure that changes within it over time due to further debris flows, other natural causes and alternative land uses do not further

increase the risk to life on or near the fan. We note that the fan area includes infrastructure overseen by other authorities, and there is a clear need for all stakeholders to coordinate their activities on the fan with risks to others in mind.

VI. Within the recommended zone for retreat, there is no physical mitigation of the high fatality risk that would be faced by a permanent resident who might chose to remain under "existing use" provisions, and there remains a substantial fatality risk even for visitors to the area. To provide for self-management of the risk to people in the retreat zone, we recommend that Council consider the viability of providing a debris-flow warning system that can alert people to an imminent danger of a debris flow in Awatarariki Stream, and may allow them to seek shelter or evacuate if they are able to do this safely and quickly. A variety of warning systems are in use in similar situations overseas with varying degrees of success (e.g. Hong Kong, Taiwan, Japan). We note that road users and rail traffic also are vulnerable to future debris flows irrespective of other users of the land. While risks to road and rail users have not been calculated herein or by Tonkin & Taylor, we suggest that an early-warning system should also be capable of reducing the fatality risks to road users and rail traffic from a debris flow on the Awatarariki fan.

VII. Last, the Tonkin & Taylor risk analysis was made for the area under residential use, and in our opinion the high fatality risk to residents there from debris flows makes such residential use unsafe. Future alternative uses of the land, which will be largely council land, are for Council to decide, with due consideration of the existing unmitigated hazards and the risks that they pose to potential users.



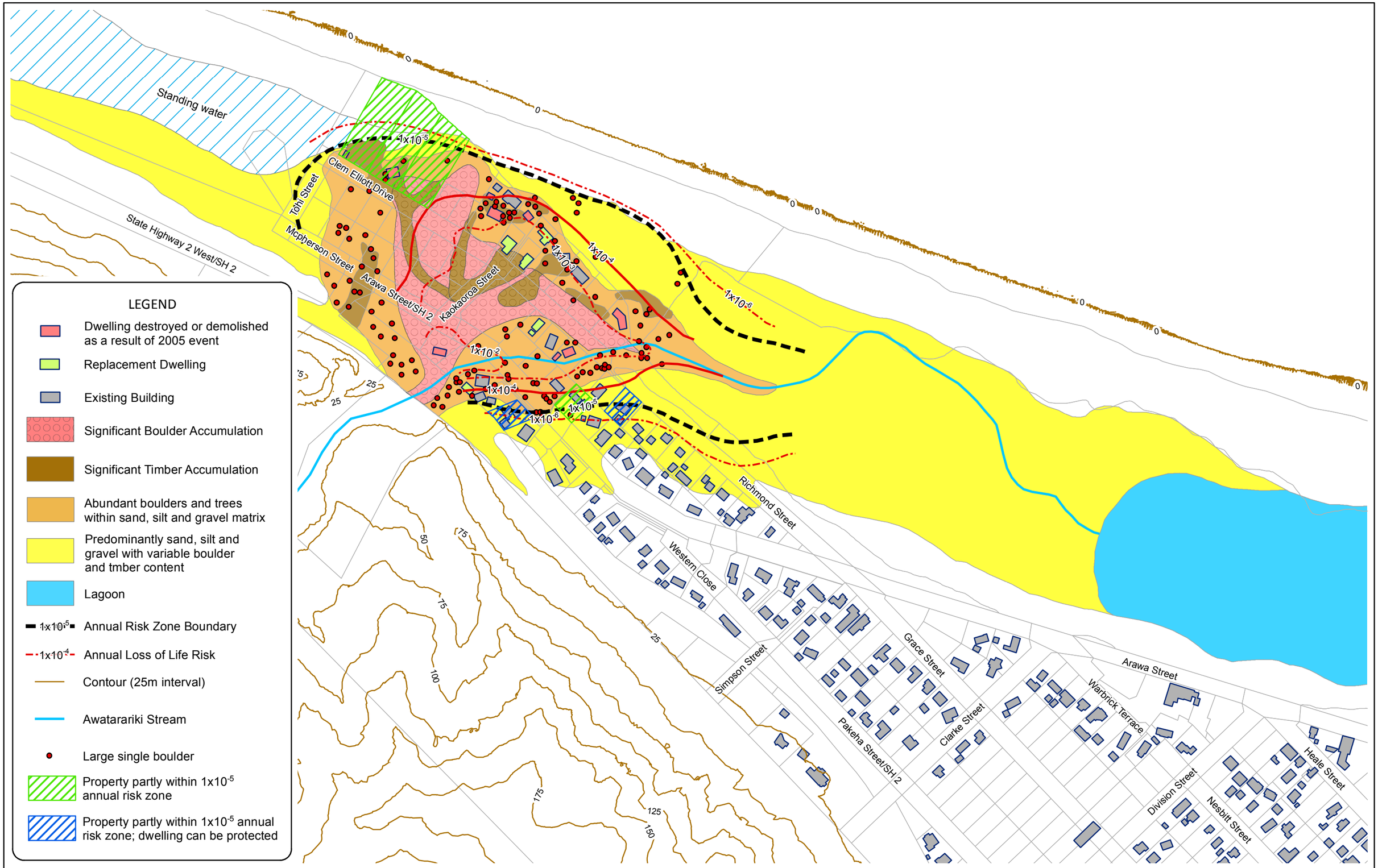
……M.J. McSaveney
Scientist Emeritus
GNS Science

……T.R.H. Davies
Professor
Department of Geological Sciences
University of Canterbury

17 November 2015

One attachment:

Awatarariki Fan risk distribution and suggested retreat zone boundary.
The outline of the recommended minimum retreat zone is marked by the heavy dashed line (**----**).



A3 SCALE 1:4,000

0 0.05 0.1 0.15 0.2 (km)

N

Location Plan

Tonkin+Taylor

105 Carlton Gore Road, Newmarket, Auckland
www.tonkintaylor.co.nz

DRAWN	JC	Oct.15
CHECKED		
APPROVED		

ARCFILE 29115.3000-F1(10.2).mxd

SCALE (AT A3 SIZE) 1:4,000

PROJECT No. 29115.3000

WHAKATANE DISTRICT COUNCIL

MATATA QLRA

Debris distribution from 2005 event and predicted annual loss of life risk

FIGURE No. Figure 1.

Rev. 0

Path: L:\29115\29115.3000\WorkingMaterial\GIS\29115.3000-F1(10.2).mxd Date: 23/10/2015 Time: 10:10:14 a.m.