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**RISK MANAGEMENT Inc.**  
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We also thank our hosts for this event:  
Beca, KPMG Wellington, Christchurch City  
Council, Mighty River Power, 3R Group and  
Trust Power





# Rocks, risk and reality

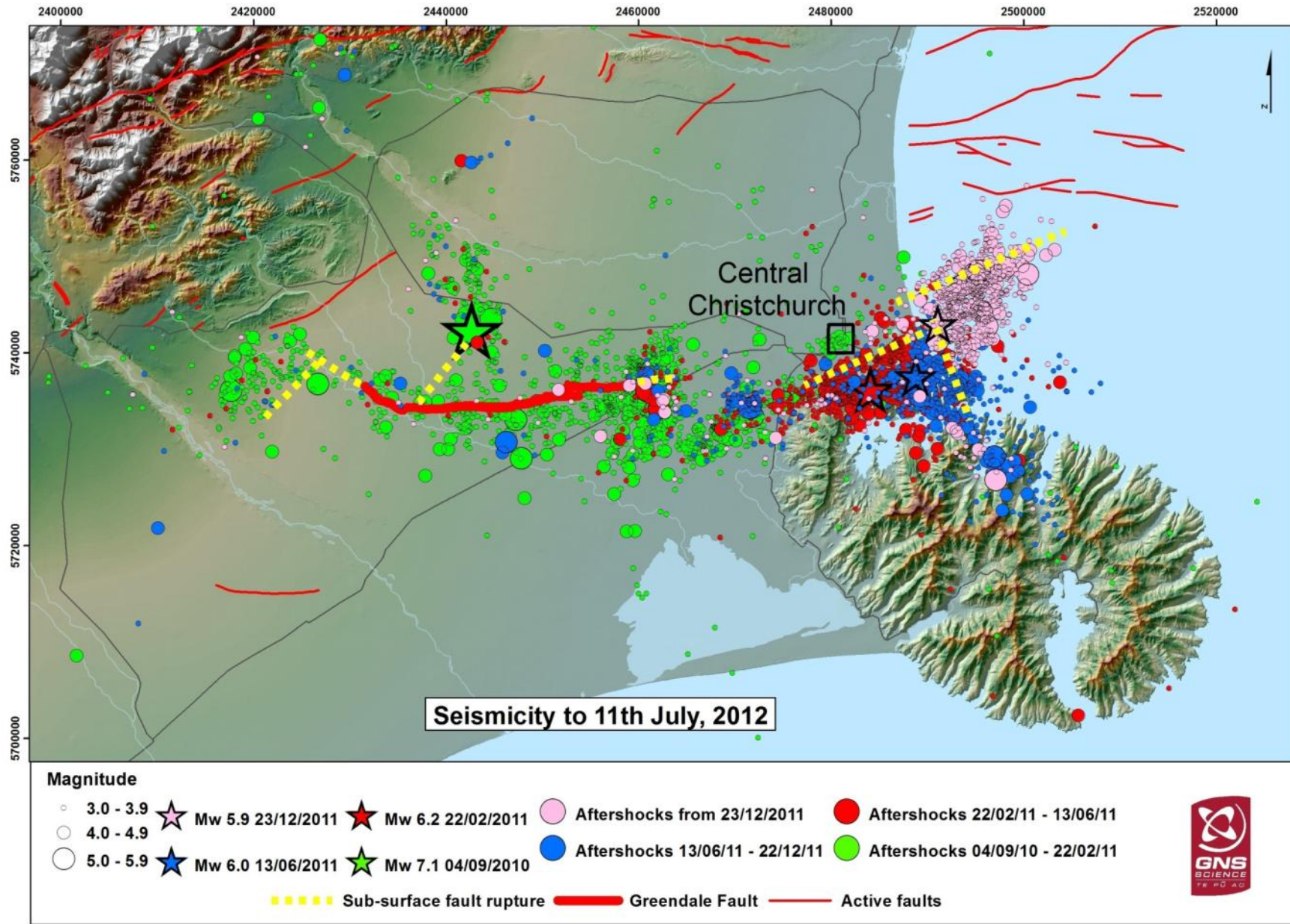
## Slope stability on the Port Hills, Christchurch



*“On an international scale this is an enormous project with very challenging technical and social complexities.”*

Fred Baynes









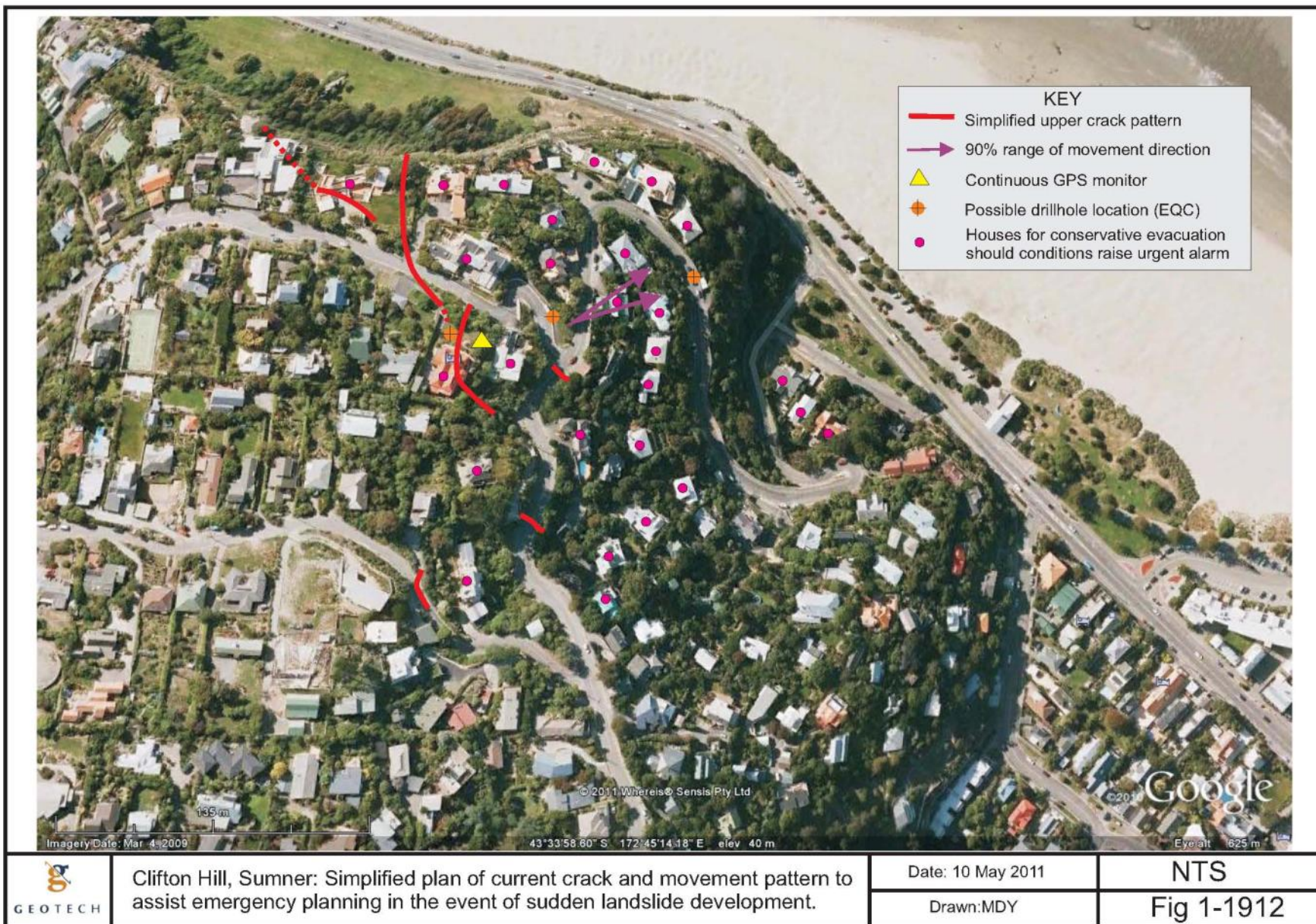




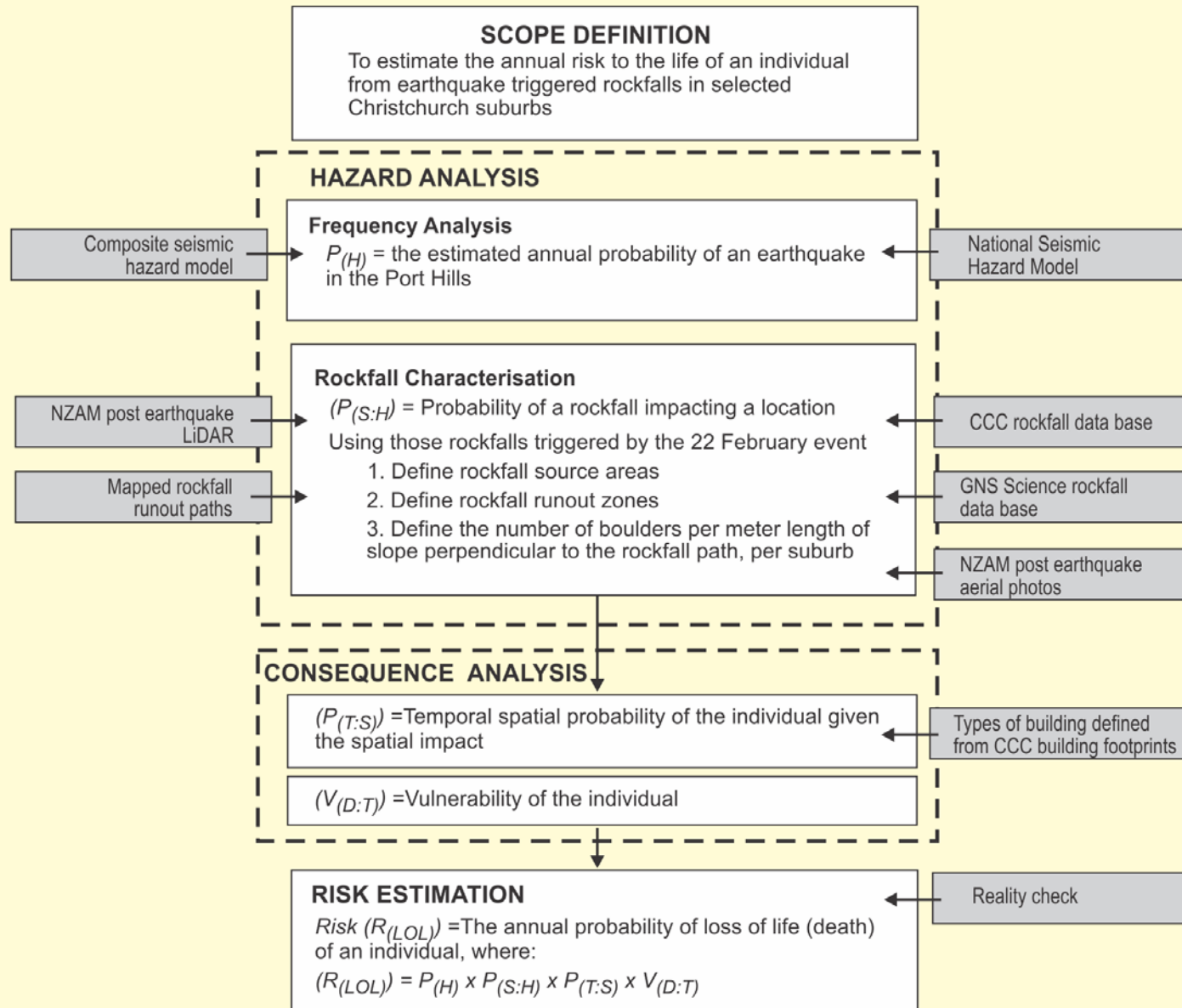




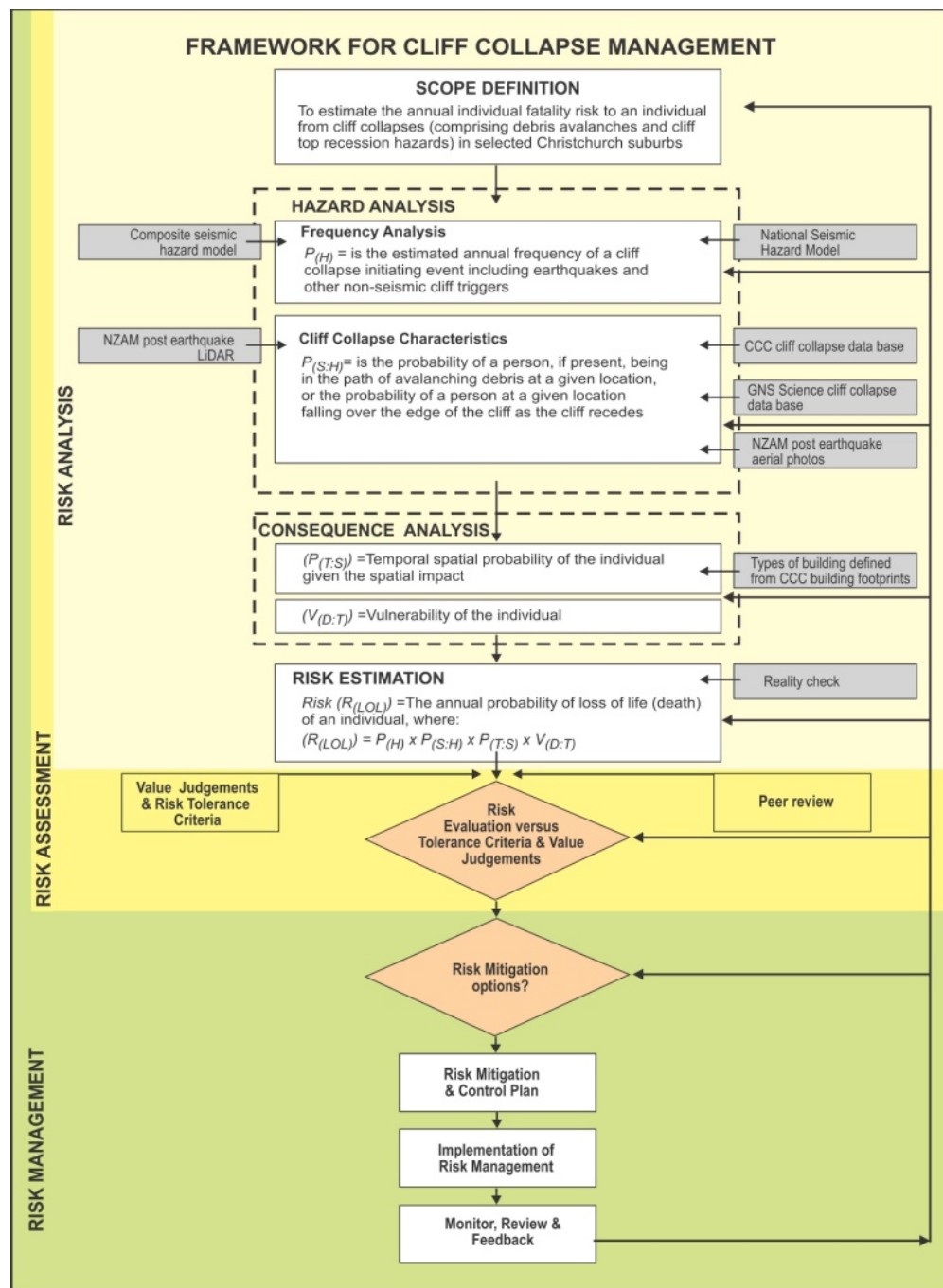




# FRAMEWORK FOR ROCKFALL RISK MANAGEMENT

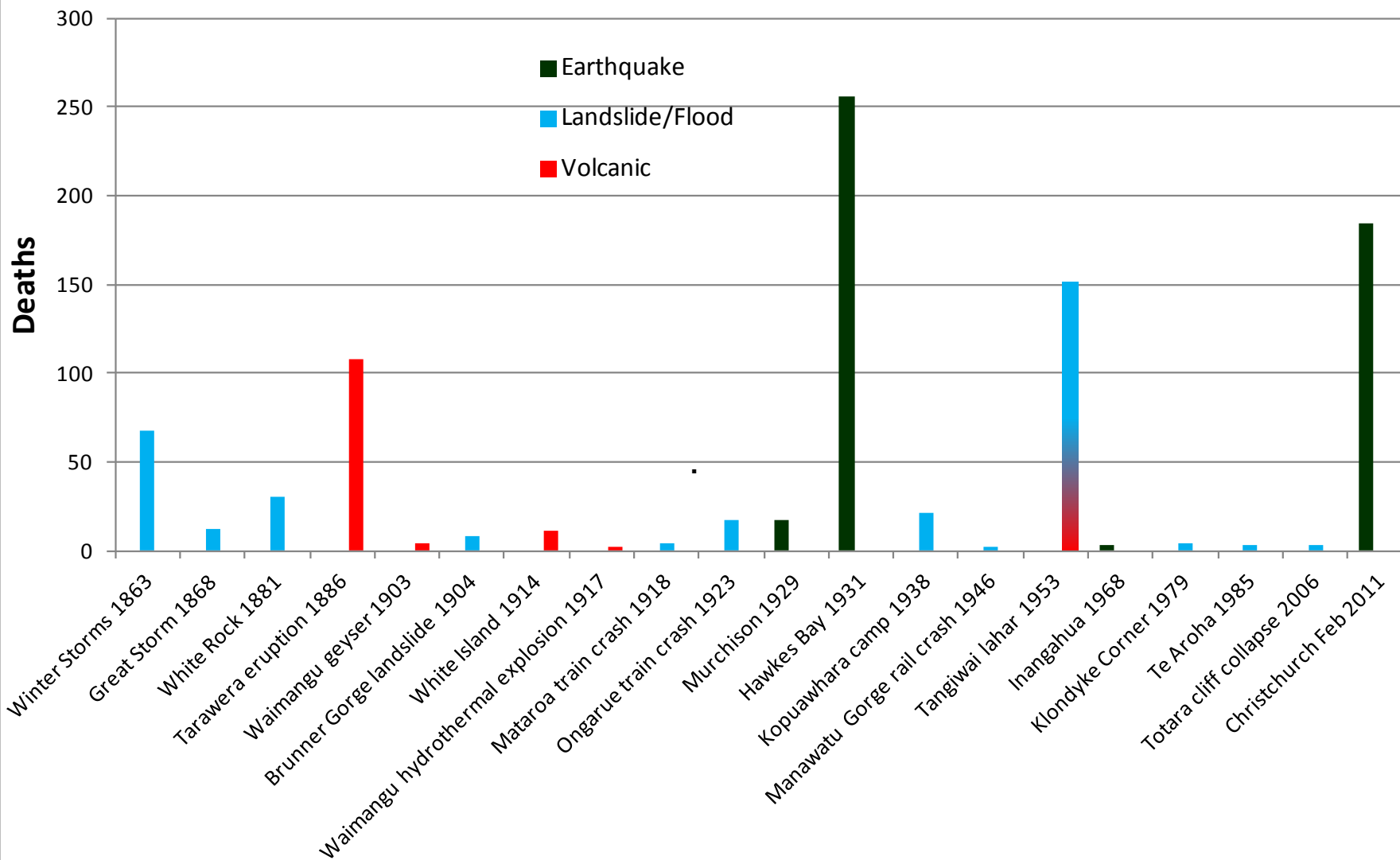




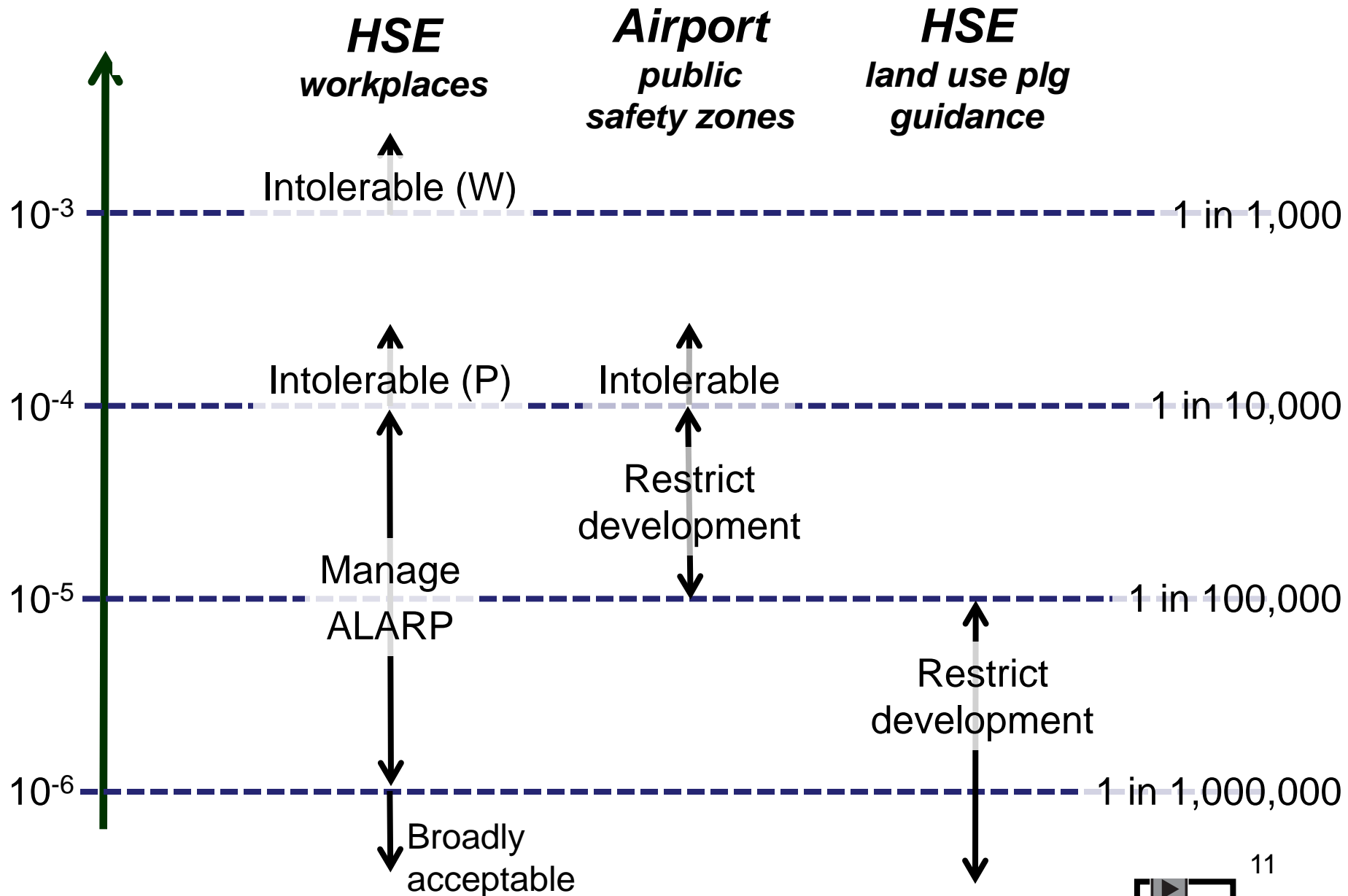


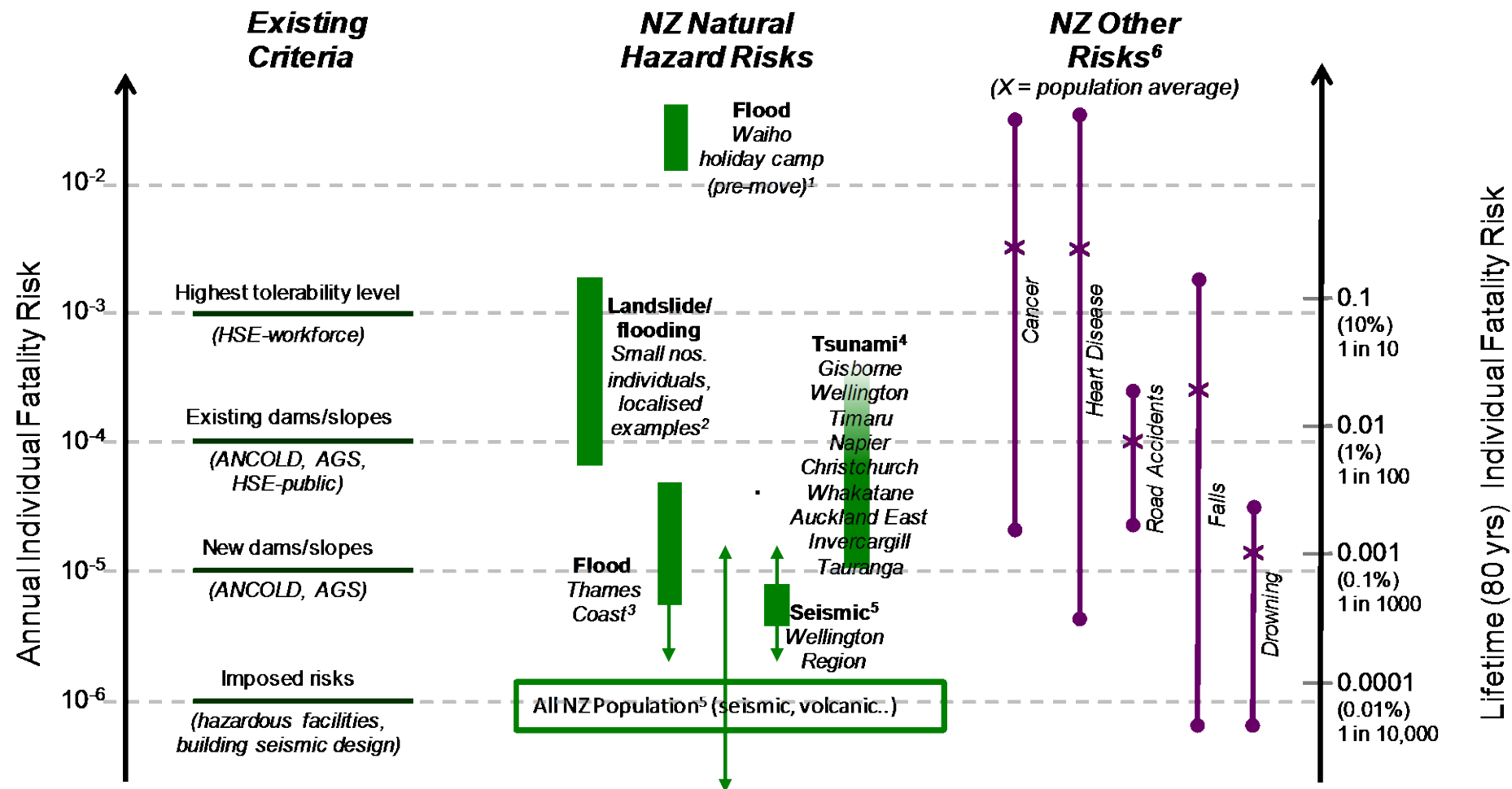


## Some Fatal Natural Hazard Events in New Zealand, 1858-2011



# Risk Tolerability – Assorted Guidance

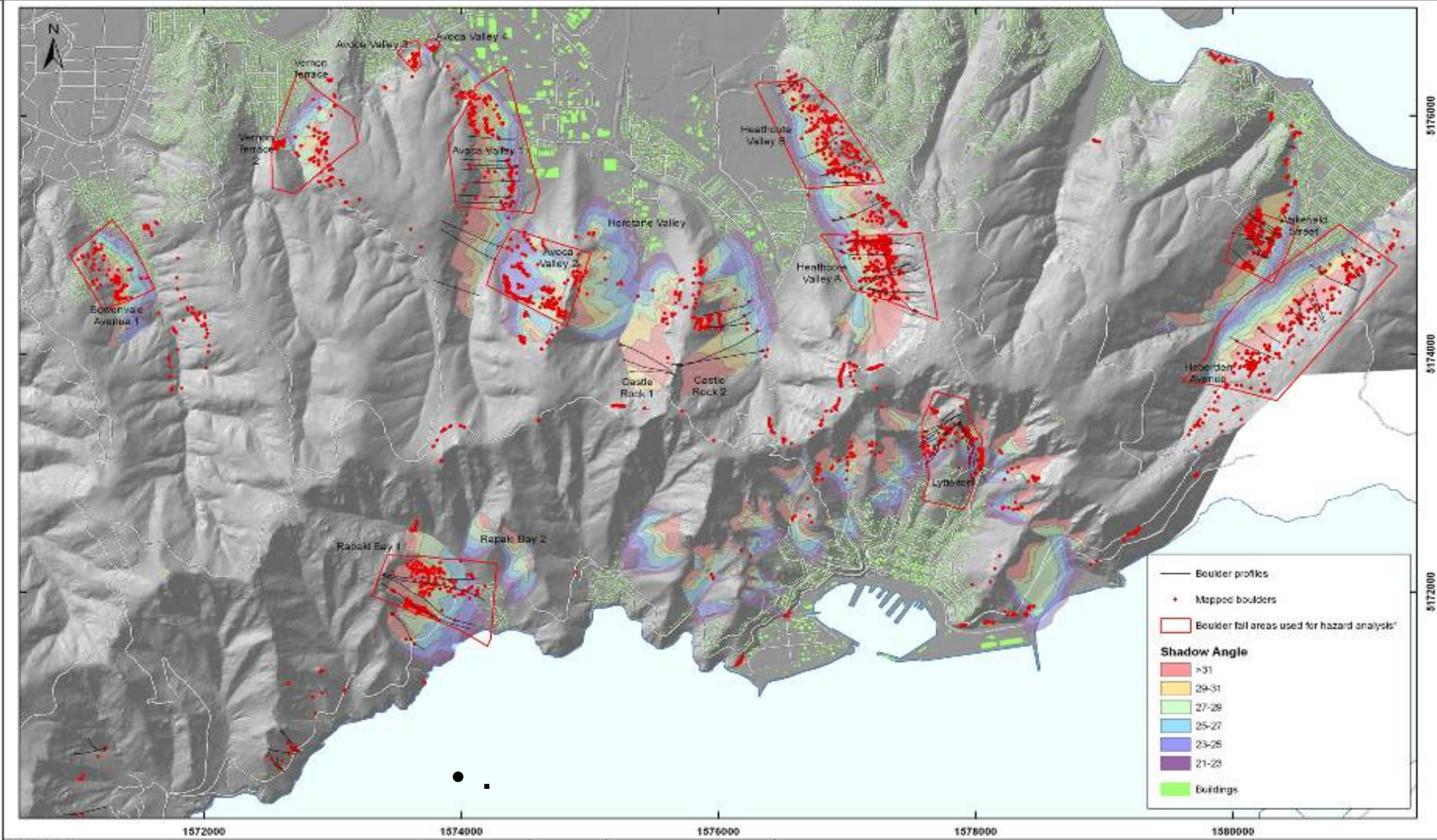




**Notes:**

1. Derived by the authors from results of MCDEM risk assessment (Optimx, 2002)
2. Estimated by the authors based on reasonable event return periods and likely consequences - see Report Section 4.1.2
3. Upper estimate for High Risk zones; arrow denotes wide range of risks downward (URS, 2003)
4. AIFR at 2-4m above sea level, no effectiveness assumed for warning (Webb, 2005)
5. Averages over large populations; arrows denote likelihood of substantial groups of people at higher/lower risk
6. Bars show range of values across age bands for men and women (Ministry of Health, 2008)





SCALE BAR: 0 1 2 Km

EXPLANATION:  
\*Areas used to define the number of boulders per metre passing each shadow line  
\*\*Distance measured perpendicular to boulder path  
Shade map derived from NZAM post earthquake LIDAR Survey (March 2011) resampled to a 3m ground resolution  
Building footprints provided by Christchurch City Council

DRW: BL DWH  
CHK: CM  
APP:



EARTHQUAKE-INDUCED BOULDER FALLS

Location Map

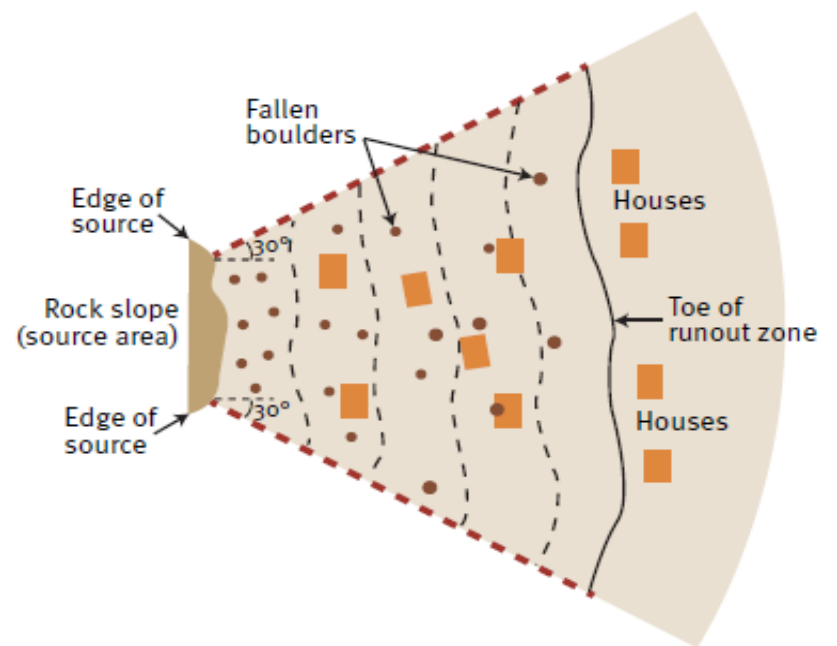
FIGURE

DWG DRAFT REV 8

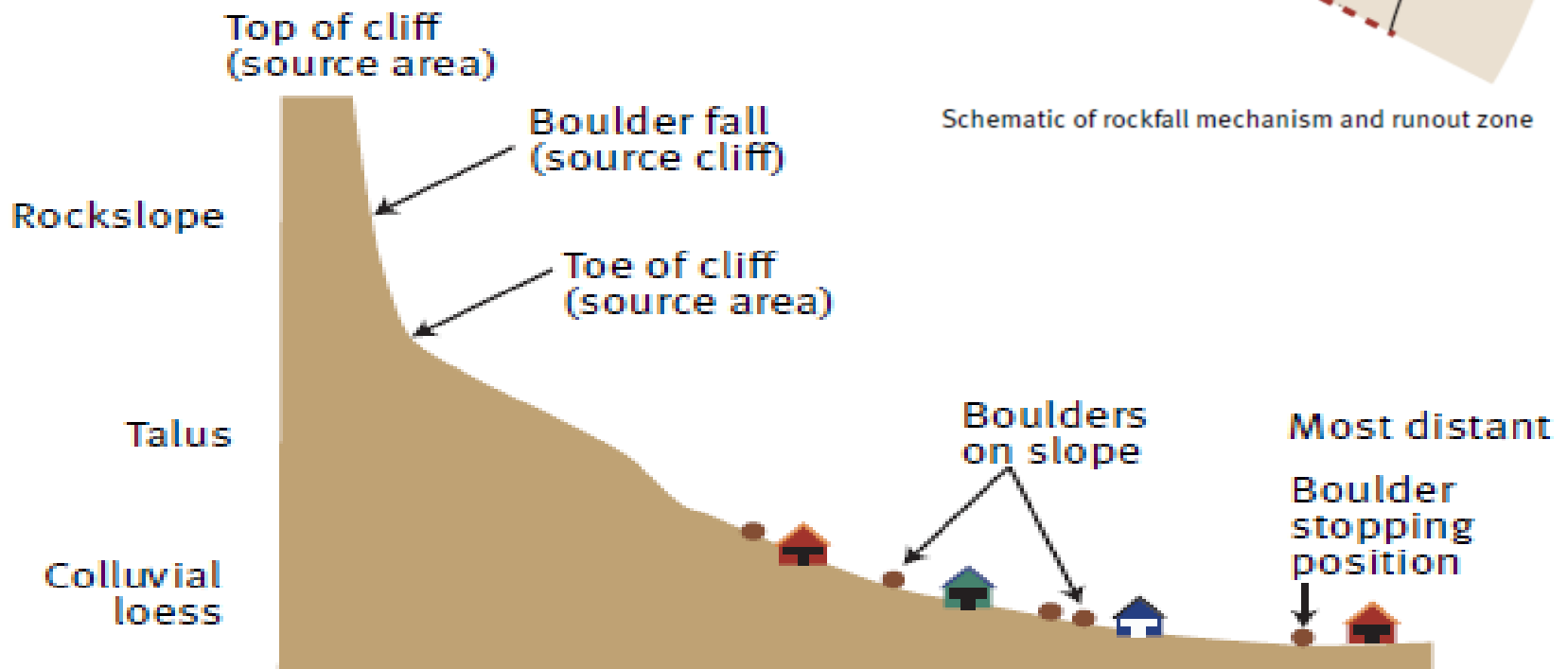
REV. SHEET: 1 of 1

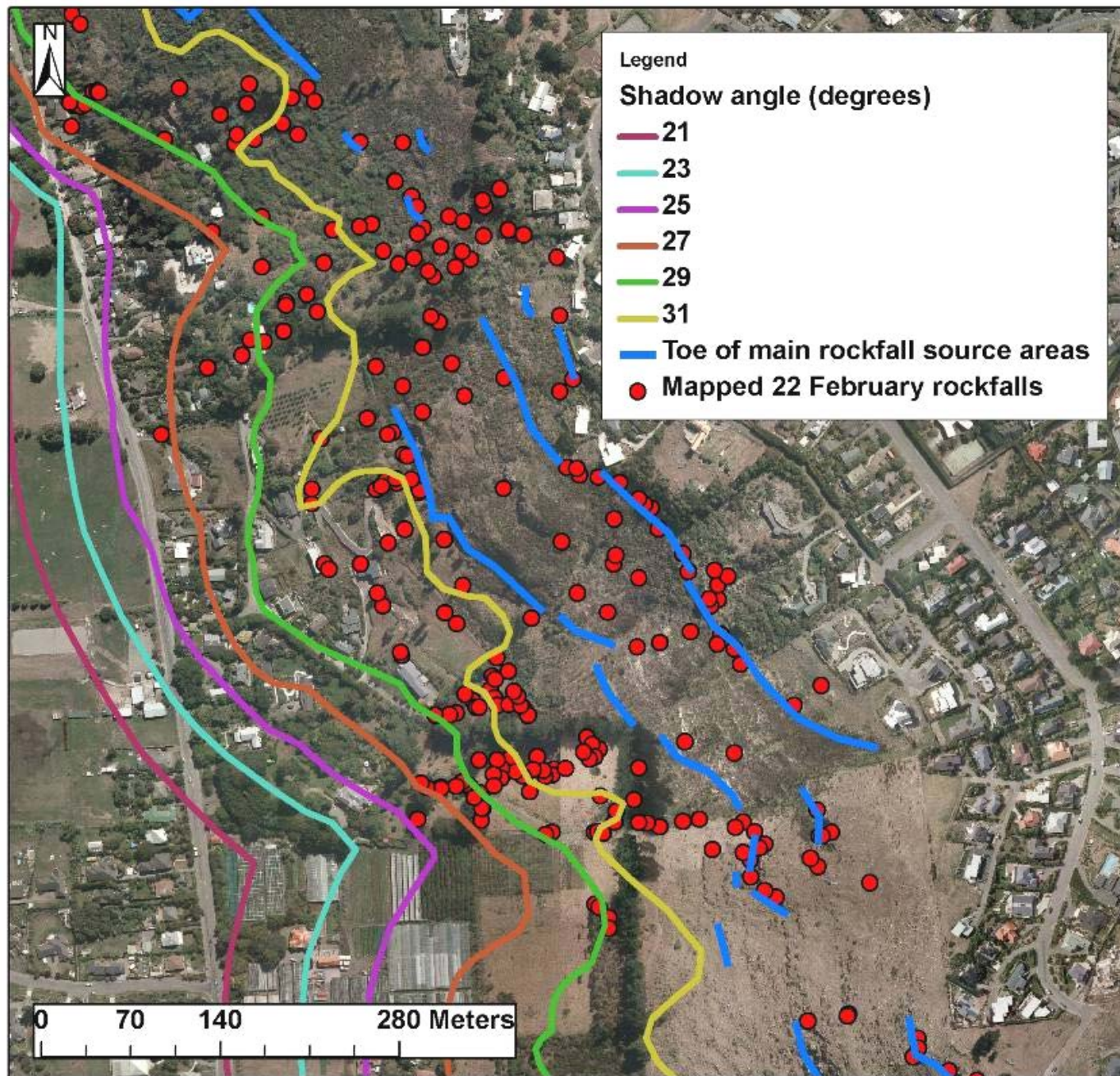
REPORT: DATE: Sept 2011



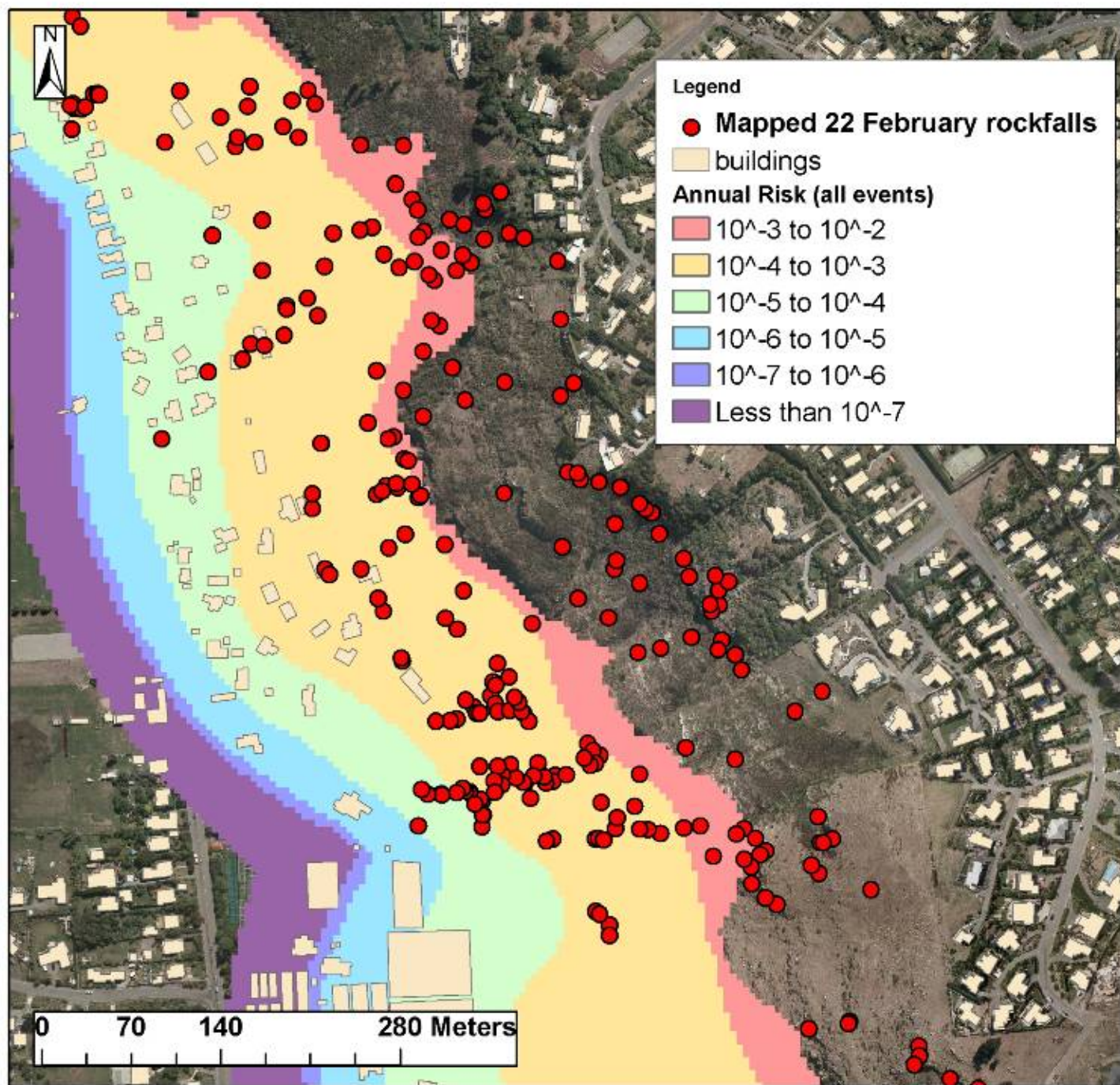


Schematic of rockfall mechanism and runout zone

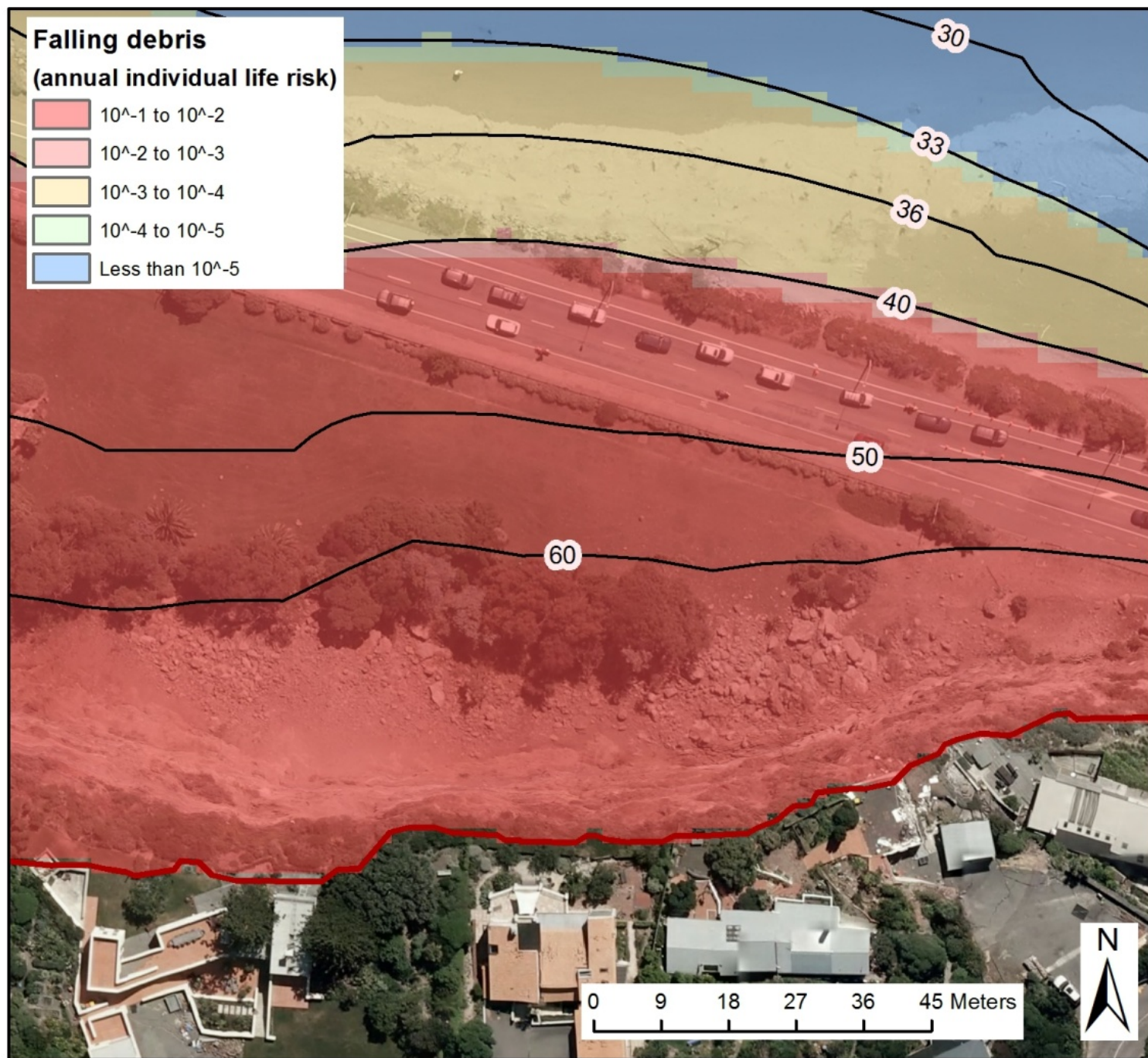










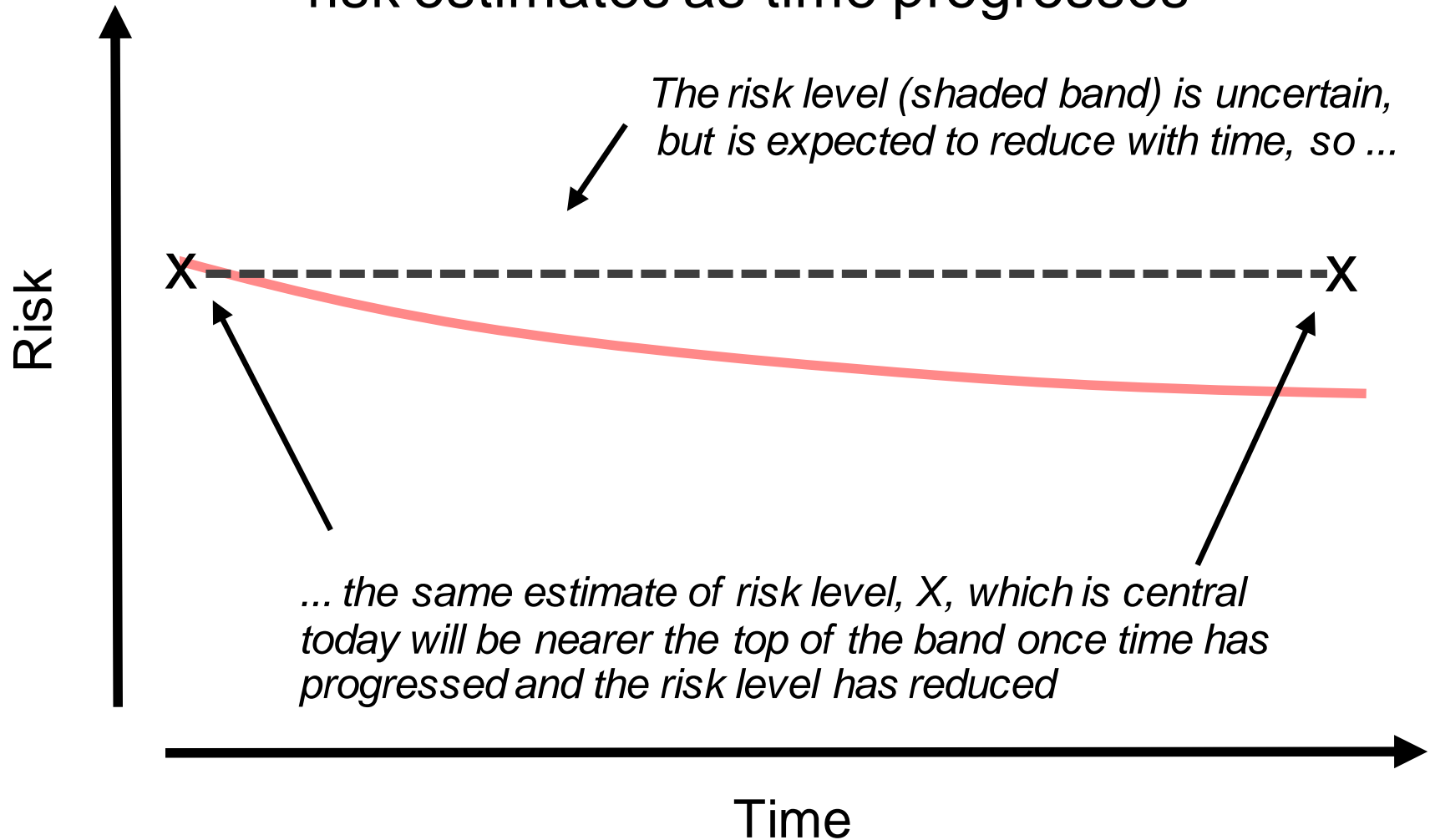




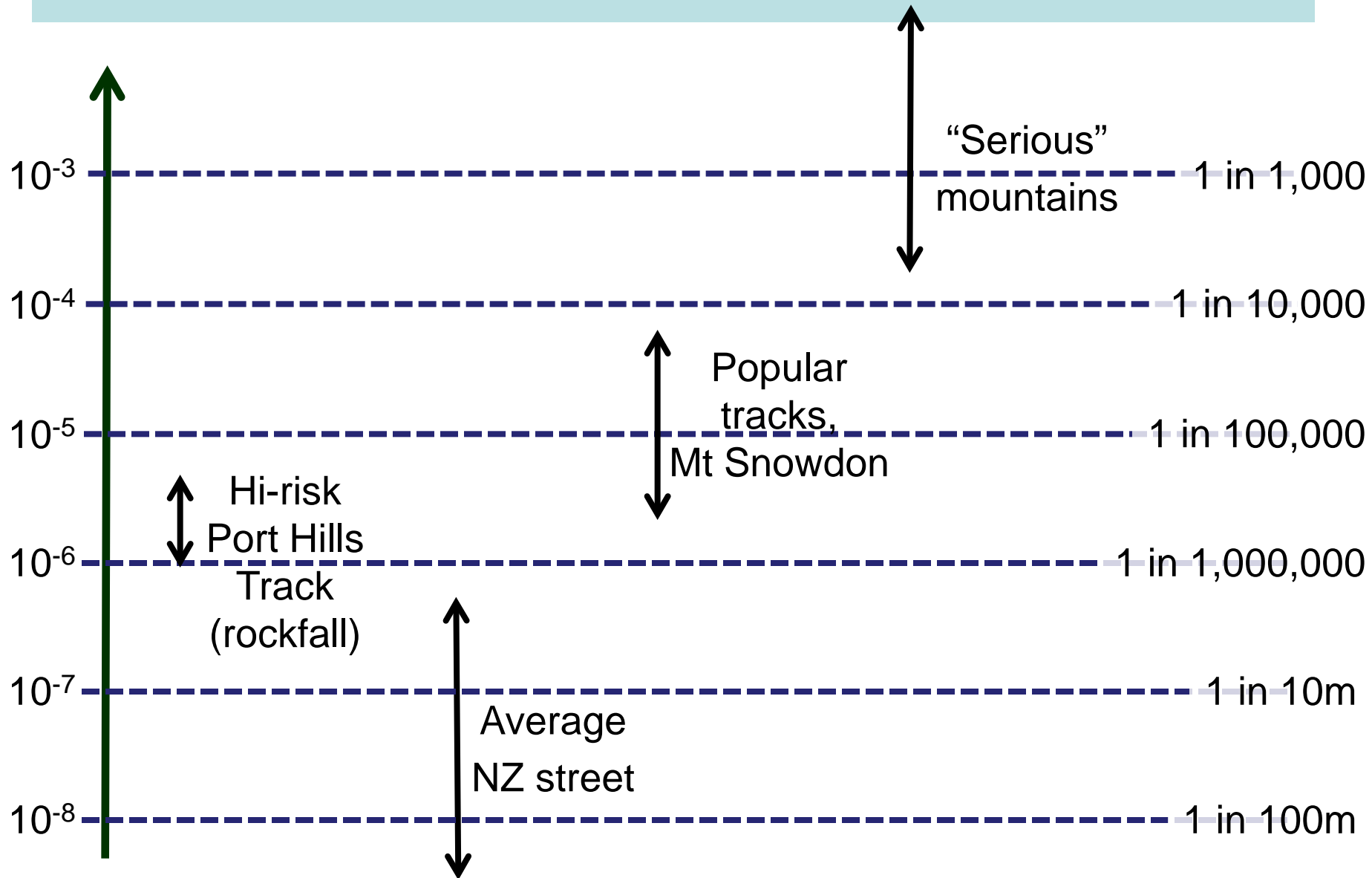




# What happens to today's rockfall-related risk estimates as time progresses



# Individual Fatality Risk per walk





A



B





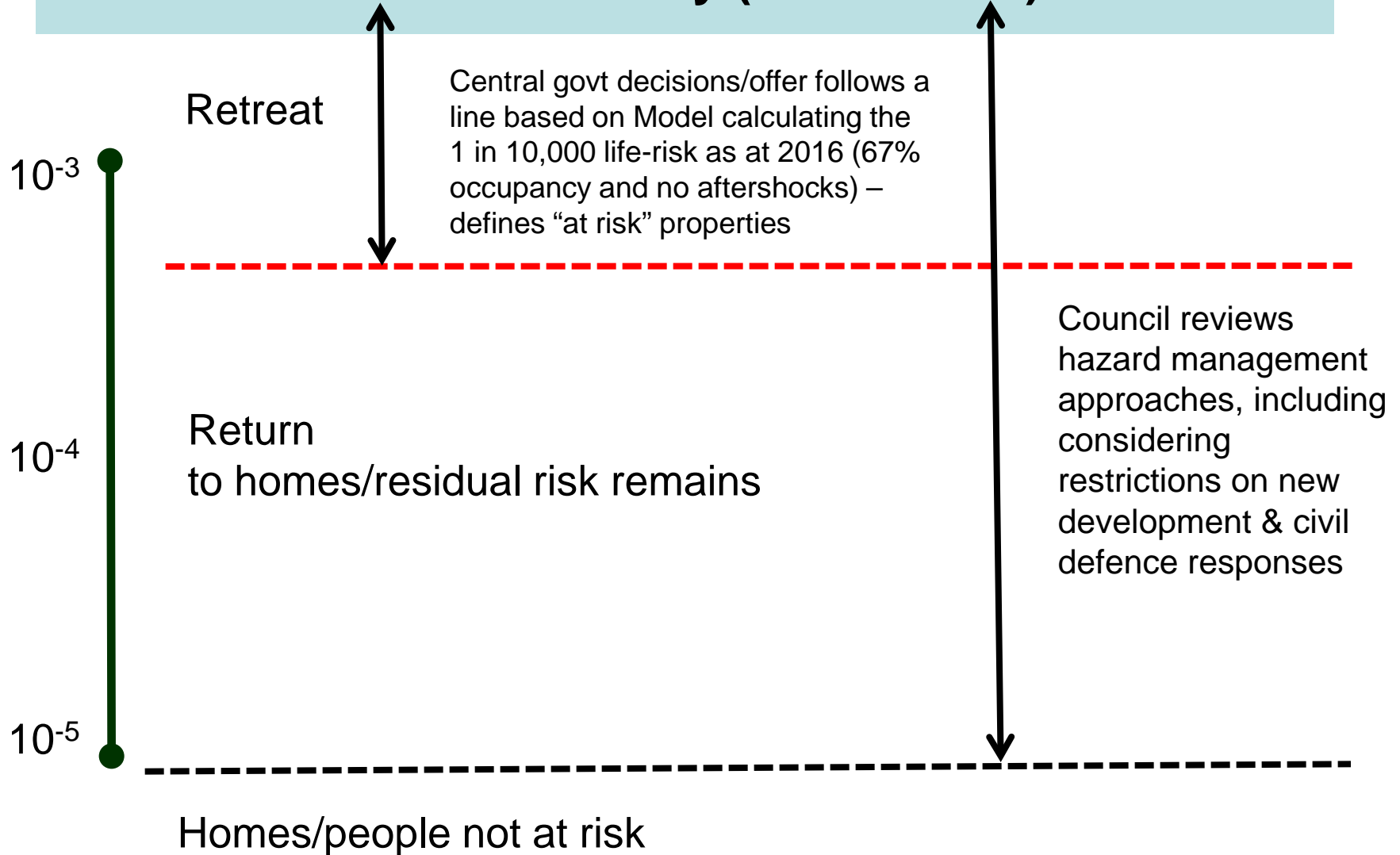




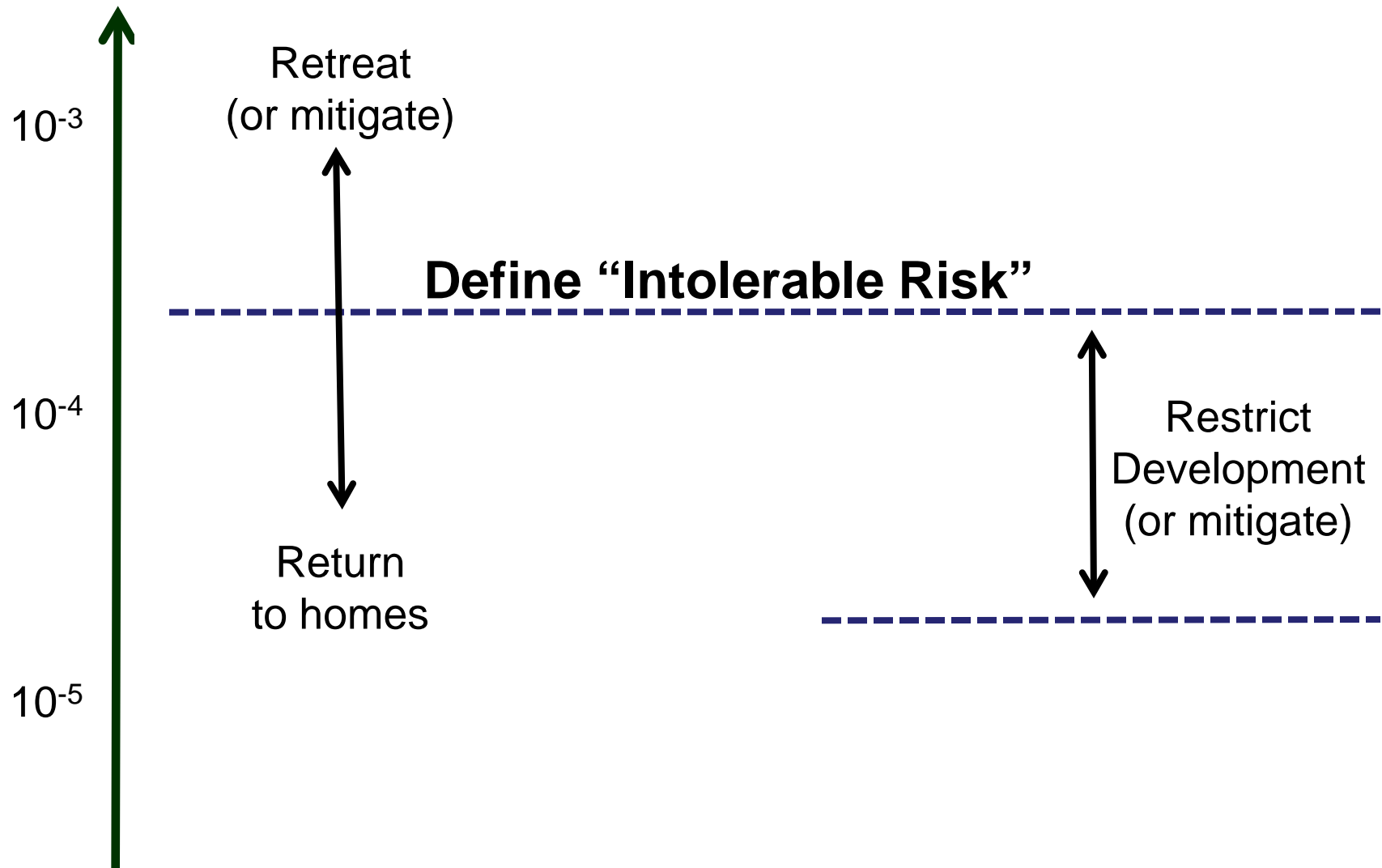




# Risk Tolerability (2012 Model)



# Risk Tolerability – CCC Policy/Practice



# Planning considerations

- risk management approach - context, risk analysis, risk assessment, risk treatment
- people away from rocks c.f. rocks away from people
- structural mitigation v. non-structural
- willingness and ability of communities to pay
- existing controls - district plan zoning approach
- viable, economically acceptable, socially appropriate and balanced set of measures





# QUESTIONS

