- Persons in vehicles are less vulnerable than those in the open. Their vulnerability depends on the volume and velocity of the landslide. Experience in Hong Kong (Finlay *et al.,* 1999) indicates that rapid landslides of only a few hundred cubic metres are likely to result in death of the occupants of the vehicle.

It should be noted that whether a person will evacuate from the path of the landslide is covered in temporal spatial probability, not in vulnerability.

C7 RISK ESTIMATION

Standards Australia (2004) HB436:2004 discusses the types of risk analysis which may be summarized as:

- *Qualitative analysis*: "uses words to describe the magnitude of potential consequences and the likelihood that those consequences will occur. These scales can be adapted or adjusted to suit the circumstances, and different descriptions may be used for different risks"
- *Semi-quantitative analysis*: "qualitative scales, such as those described above are given values. The objective is to produce a more expanded ranking scale than is usually achieved in qualitative analysis, not to suggest realistic values for risk such as is attempted in quantitative analysis."
- *Quantitative analysis*: "uses numerical values (rather than descriptive scales used in qualitative and semi-quantitative analysis) for both consequences and likelihood using data from a variety of sources. The quality of the analysis depends on the accuracy and completeness of the numerical values and the validity of the models used."

Appendix G of AGS (2000) presented an example of qualitative terminology and risk matrix that was considered to be suitable for use in landslide risk assessment for property. AGS (2000) recognized that alternative schemes may be used, provided they are defined. As previously noted, AGS (2000) has now been superseded by the Practice Note.

C7.1 QUANTITATIVE RISK ESTIMATION

Reference should be made to Lee and Jones (2004) for a number of examples of risk calculations for a variety of scenarios. Some examples are also given in Roberds (2005) and other invited papers in the same volume. Such examples may be useful for deriving an appropriate model to enable suitable risk estimates.

C7.2 SEMI-QUANTITATIVE AND QUALITATIVE RISK ESTIMATION FOR RISK TO PROPERTY

In the context of risk assessments for residential development with submission to a regulator, adoption of a common preferred qualitative terminology should be mandatory as stipulated in the regulator's policy. If the practitioner considers an alternative scheme to be preferable for a particular hazard/situation, then adoption of this alternative must be justified by detailed documentation of the reasons.

There is considerable benefit to the regulator and the practitioner to use a common terminology. Comparison between different sites and between different practitioners is facilitated. Whilst there may be an inherent difference in assessment between practitioners (for example as shown by Baynes *et al.*, 2002), adoption of a common terminology will facilitate understanding and calibration between practitioners. Use of a scheme developed for a specific site or case makes cross comparisons difficult or confusing.

Although the Practice Note Appendix C scheme uses qualitative terminology to communicate and/or summarise the assessment of risk to property, it is in essence a quantitative scheme since it relies on the best estimates of the likelihood and consequence for the analysis. Risk to life should only be considered quantitatively and the adoption of semi-quantitative methods is considered to be inappropriate.

C7.3 RISK MATRIX FOR PROPERTY LOSS

The preferred Risk Matrix for Property presented in the Practice Note Appendix C has been derived primarily for residential development. It may also be appropriate to apply the scheme to other development,or situations/consequences. If the scheme is modified, or an alternative adopted, then full discussion of the justification and basis for the alternative scheme should be given.

A number of alternative qualitative scales for Likelihood, Consequences and resulting risk matrices and assigned risk levels were examined before deriving the final scheme in the Practice Note. Further discussion is given in Appendix CC of the considerations involved.

The main considerations were:

- The use of the annualised cost of damage to help allocate the risk categories.