NATURAL HAZARD RISK TOLERANCE POLICY

Applicability: All CVRD

Effective Date: September 11, 2019

PURPOSE:

To establish life-loss risk tolerance criteria for decisions made by the Cowichan Valley Regional District (CVRD) related to natural hazard risk management.

DEFINITIONS:

ALARP

As low as reasonably practicable is currently not well defined and will evolve over time, based on specific situations and case law, to increasing natural hazards that cause fatalities. Input from both Qualified Professionals and legal counsel should be sought for decisions in this area.

Individual Risk

1. Individual Risk considers the probability that a hazard scenario results in loss of life for a particular individual, referred to as Probability of Death of an Individual (PDI).

   When considering a single hazard scenario, PDI is the product of the following factors:

   a. The annual probability of the hazard scenario occurring;

   b. The probability that the hazard reaches the exposed individual;

   c. The probability that the exposed individual would be in the impact zone at the time of impact; and

   d. The probability of fatality given impact occurs with a certain severity.

2. PDI is often estimated for the smallest spatial unit possible within a potentially impacted zone, such as per building or land parcel.

   Given several individuals could be impacted in a spatial unit, PDI considers the individual judged to be most at risk, such as a young child, stay-at-home person, or an elderly person. Numerically, this is usually accounted for by using a higher temporal probability in calculations of individual risk.

3. Individual risk can be evaluated using numerical thresholds that define unacceptable risk.

   To put a 1:10,000 PDI into perspective, an individual's annual risk of loss of life depends on several factors including his/her age, occupation, general state of health and other environmental factors. Statistics Canada[1] reports the average Canadian mortality rates by cause. Between 2000 and 2005, the age-standardized risk of loss of life by all causes was approximately 1:175 per annum, the average risk from accidental causes was about

[1] Statistics Canada. (2005). Mortality, Summary List of Causes. Government of Canada, Catalogue no. 84F0209X.

1:2,500 per annum, and the average risk from automobile accidents was about 1:10,000 per annum.

Group Risk

1. Group Risk considers the total expected number of fatalities that could result from a single hazard scenario.

   It is estimated by considering the same factors as Individual Risk, as well as the total exposed population within the impacted hazard zone.

2. Multiple hazard scenarios are often compared by considering the probability of each event occurring and resulting in the estimated number of fatalities.

   Given Group Risk reflects total losses from an event, it is possible to have a situation where Individual Risk is considered tolerable, but Group Risk is not tolerable due to the large number of people affected.

3. Because Group Risk is proportional to the number of people exposed to hazard, it is typically estimated for a standard geographic area referred to as the Consultation Zone (CZ).

   The CZ is defined by Porter et al. as "all proposed and existing development in a geographic zone defined by the approving authority that contains the largest credible area affected by specified geohazards, and where damage or loss arising from one or more simultaneously occurring specific geohazards would be viewed as a single catastrophic loss"[2].

4. It is not typically appropriate to estimate Group Risk for individual elements at risk within a hazard area. For example, if a single building is proposed for development in a hazard area, group risk estimates would need to consider all buildings in the CZ, not just the proposed building.

   Group Risk tolerance can be evaluated graphically on an F-N curve, as shown in Figure 1. The F-N curve defines three zones of risk: unacceptable, ALARP, and intense scrutiny. The zones are defined by the expected number of fatalities, N, and the annual frequency of an event causing N or more fatalities. Similar plots often also show a broadly acceptable zone below ALARP.

POLICY:

The CVRD recognizes the wide range of natural hazards across the region, the historic development patterns which may put some communities at risk, as well as the growing level of risk due to both climate change and continued growth. Therefore, the CVRD will utilize the following criteria[3] to inform planning, land use and infrastructure decisions related to subdivision; construction of, addition to or alteration of a building or other structure; or land alteration:

[2] Porter, M., Jakob, M., and Holm, K. (2009). Proposed Landslide Risk Tolerance Criteria. Proceedings of the 2009 Canadian Geotechnical Conference, Halifax, Canada. September 20 – 24, 2009.

[3] BGC Engineering Inc. (2019). CVRD Natural Hazards Disaster Risk Reduction Strategy, Phase 1: Risk Tolerance Policy Recommendations. Prepared by BGC Engineering Inc. for Cowichan Valley Regional District.

Level 1 - Minor

1. Building permit for structural alterations where less than 25% of the value of the building or structure is altered, as determined by the CVRD Building Inspector; and
2. Building permit for additions of less than 25% of the original gross floor area.

Level 1 - Minor Criteria

1. Engineered slopes and retaining structures:
    a. Slope stability factor of safety >1.3 under static conditions, and slope stability factor of safety >1.0 under earthquake ground motions with a 1:475 annual probability of exceedance, or <15 cm of displacement predicted under earthquake ground motions with a 1:475 annual probability of exceedance.
2. For coastal slopes subject to sea-level rise:
    a. A setback distance from the expected slope crest associated with 100 years of predicted shoreline erosion accounting for projected sea level rise over a period of 100 years. The setback distance from the crest of the slope is to be determined through a slope stability factor of safety calculation with a minimum factor of safety of 1.3 at the setback location, and >1.0 under earthquake ground motions with a 1:475 annual probability of exceedance, or <15 cm of displacement predicted under earthquake ground motions with a 1:475 annual probability of exceedance.
3. For all other natural hazard scenarios with potential to cause loss of life:
    a. Individual Risk (PDI) not to exceed 1:10,000 per year for individuals most at risk.
4. For all other natural hazard scenarios with potential to cause loss of life:
    a. Group Risk to plot in the ALARP Zone on an F-N plot as illustrated in Figure 1.

Level 2 – Major

1. Development (including subdivision, building/structural alteration, and land alteration) within a Development Permit Area[4] (DPA) unless listed as a DPA exemption;
2. Building permit (not eligible under Level 1).
3. Rezoning, development variance permit or temporary use permit application within a DPA or area identified as hazardous by the CVRD;
4. Infrastructure/works undertaken by the CVRD or contractor in a DPA or area identified as hazardous by the CVRD.

[4] A DPA would need to be designated under s. 488(1)(b) of the *Local Government Act* for the purposes of protecting development from hazardous conditions.

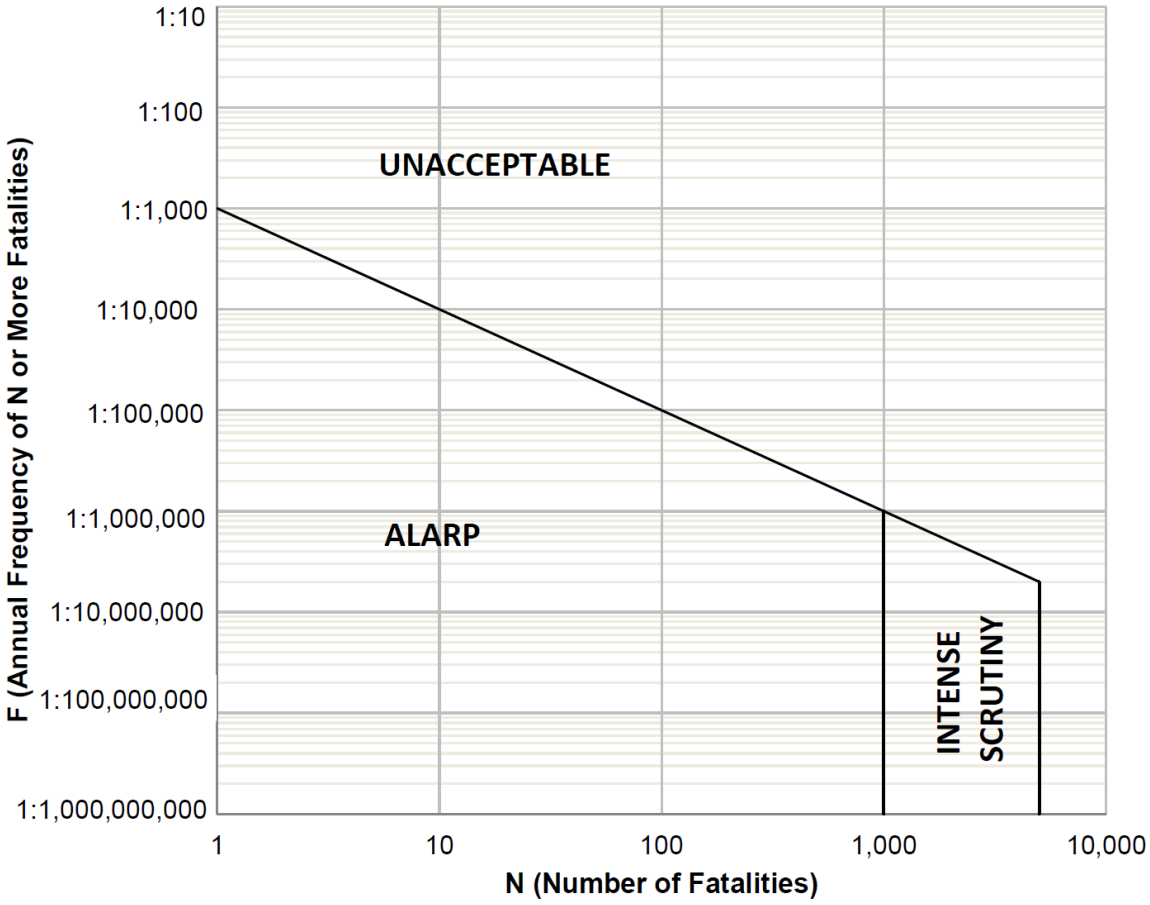
Level 2 – Major Criteria

1. Engineered slopes and retaining structures:
    a. Slope stability factor of safety >1.5 under static conditions, and >1.0 under earthquake ground motions with a 1:2,475 annual probability of exceedance, or <15 cm of displacement predicted under earthquake ground motions with a 1:2,475 annual probability of exceedance.
2. Coastal slopes subject to sea-level rise:
    a. A setback distance from the expected slope crest associated with 100 years of predicted shoreline erosion accounting for projected sea level rise over a period of 100 years.
    b. The setback distance from the crest of the slope is to be determined through a slope stability factor of safety calculation with a minimum factor of safety of 1.5 at the setback location, and >1.0 under earthquake ground motions with a 1:2,475 annual probability of exceedance, or <15 cm of displacement predicted under earthquake ground motions with a 1:2,475 annual probability of exceedance.
3. For all other natural hazard scenarios with potential to cause loss of life:
    a. Individual Risk (PDI) not to exceed 1:10,000 per year for individuals most at risk, and to be reduced to as low as reasonably practicable (ALARP principle).
4. For all other natural hazard scenarios with potential to cause loss of life:
    a. Group Risk to plot in the ALARP or Acceptable Zones on an F-N plot as illustrated in Figure 1.

This policy should be reviewed within three years of its adoption to take into consideration issues related to implementation and the evolution of the CVRD Natural Hazard Risk Tolerance Strategy. In particular, this will allow for adjustments if necessary and provide time for stakeholder engagement, particularly with the definition of ALARP.

Approved by: Board
Approval date: September 11, 2019

Figure 1. Proposed frequency/fatality group risk evaluation grid[5]



[5] BGC Engineering Inc. (2019). CVRD Natural Hazards Disaster Risk Reduction Strategy, Phase 1: Risk Tolerance Policy Recommendations. Prepared by BGC Engineering Inc. for Cowichan Valley Regional District.