EVIDENCE OF CLIVE KENNETH ANDERSON

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Qualifications and Experience

1. I am the Team Leader for the Geotechnical and Mining Engineering Group of Golder Associates (NZ) Ltd.

2. I am qualified in civil and geotechnical engineering. I have an honours degree from the University of Canterbury in Civil Engineering (1980) and a Masters of Science in Soil Mechanics and Engineering Seismology with distinction from Imperial College, London University (1984).

3. Prior to entering university I worked for the former Christchurch Drainage Board as an Engineering Cadet (1975-79). I completed my Civil Engineering degree in 1979-80. I then worked for the former Ministry of Works as a graduate engineer in Haast and Greymouth (1980-82). I undertook my Masters in Soil Mechanics and Engineering Seismology in 1983-84. My dissertation was on liquefaction. After completing my masters studies in 1984 I worked for the Ministry of Works in Wellington as a Geotechnical Engineer (1984-1987), Construction Engineer for KRTA (1987-1988) then geotechnical engineer on the Clyde Dam Landslides (1988-92) with KRTA and Barrett Fuller and Partners Ltd. Following completion of the Clyde landslide work in 1992 I transferred to Auckland where I worked as a geotechnical engineer with Barrett Fuller and Partners Ltd and then Worley Consultants Ltd until 1996. I was then approached to work for Woodward-Clyde Ltd in Perth as leader of their geotechnical engineering group (1996-98). This company was purchased by URS Corporation and I returned to Christchurch in 1998 to take a position as a geotechnical engineer (1998-2009). In February 2010 I took up my current position with Golder Associates (NZ) Ltd.

4. I have worked on a wide variety of geotechnical projects within New Zealand and Asia including appearing as a technical witness at the International Court of Arbitration in London. These projects include assessment of natural hazards, land development, mining, roading, and tunnels. I have particular experience in engineering risk assessment of slope instability and liquefaction.

Brief for evidence

5. My brief for this evidence was to review the “Geotechnical Summary Report, Porters Expansion Project” dated 12 July 2010 (URS ref 42170087/03000/C) prepared by URS, which support the Porters plan change application, to comment on the adequacy of the assessment of geotechnical risks with respect to the proposed plan change and development. I visited the site to observe the location and proposed layout of the development.

6. The assessments of various geotechnical risks summarised in the geotechnical summary report have been undertaken by a range of suitably qualified and experienced scientists and engineers. The report is well written and clearly sets out an analysis of the geohazards, drawing on previous research. The issues are clearly presented and have been thoroughly researched.

Geotechnical hazards at Porters Ski Area

7. The Porters Ski Area is located within an area of recognised geotechnical hazards, including snow avalanche, flooding, slope instability, fault-induced ground rupture and dam break. The following paragraphs summarise my views on the risk associated with each of these hazards with respect to the proposed Porters Ski Area development.

Snow avalanche

8. Snow avalanche is a common phenomenon in the Canterbury mountains, that has the potential to cause fatalities and major infrastructure damage. Porters Ski Area has been recognised as having a significant snow avalanche hazard and this is reflected in the damage to infrastructure that has occurred since the existing ski field was developed. Section 6 of the geotechnical summary report describes the relatively high hazard and the associated history of avalanches affecting the existing ski field. The assessment indicates that the Village Base Area is well outside the run-out zone of observed avalanches and is inferred to have a low likelihood of being impacted.

9. However the full extent of the avalanche hazard in the Crystal Basin itself is not fully understood and data on avalanches in this area is still being collected. This should enable updating of the avalanche risk to skiers in this area. I believe this is an important action as I understand that the proponents of the plan change intend to attract large numbers of skiers to the upgraded and extended field. Therefore the potential injury or fatality consequences of an uncontrolled avalanche affecting the ski field could be much higher than currently exists for the Porters skifield.

10. The report indicates that snowmaking and an avalanche control system will be implemented as part of the proposed development, creating an artificial or modified avalanche environment.

11. The avalanche control programme should be designed to reduce the risk to people and infrastructure to an internationally accepted level. Where possible, vulnerable facilities and infrastructure, such as towers and locations where people will congregate should avoid known avalanche paths. Details of the proposed avalanche control programme and the assessed avalanche risk should be externally reviewed by a person with appropriate experience when it becomes available.

Flooding

12. Flood flows in the Porter River and tributaries can affect access roads and other areas of the proposed village. The geotechnical summary report describes the results of an assessment of flood flows and the areas affected by flooding for various flood events. The assessment defines an exclusion zone around Porter Stream defined as 0.5 m above the calculated 1 in 100 year flood flow. The 0.5 m buffer will accommodate some uncertainty about possible

bulking of the flow by debris eroded from the catchment. The report recommended that no critical infrastructure, including accommodation, be sited within the exclusion zone. This approach is considered appropriate. Non-critical infrastructure, including the access road, remain within the flood zone, however, road users will have ample warning to avoid being caught in the flood flows.

Slope instability

13. The steep mountainous environment of Porters Ski Area is affected by a variety of types of slope instability. These are described in the following paragraphs.

14. Rockfall from steep rock slopes, including slopes above the access road and on the slopes around Crystal Basin. The likelihood of rockfall is particularly high during strong earthquake shaking. No specific assessment of rockfall risk has been completed to date, and this should be undertaken as part of detailed design. Measures are available to reduce the likelihood of rockfall impacting on key infrastructure elements, including supporting rock outcrops with steel mesh and rock bolts and provision of catch fences to arrest rockfall. I believe that the risk of rockfall can be reduced to an acceptable level by use of conventional engineering measures, combined with rockfall trajectory analysis.

15. Debris flows induced by heavy rainfall or dam breach, are a slope instability phenomenon characterised by a fluid mixture of water, soil and rock material that moves with a high velocity. Debris flows can cause fatalities and infrastructure damage. The Village Base Area is relatively well protected from possible debris flows as its location is generally away from channel features. The risk of fatalities and infrastructure damage as a result of impact by debris flows has not been estimated, but I believe it is likely to be acceptably low.

16. Rock avalanches have been widely recognised throughout the mountains in Canterbury. The steep topography, underlying geology and high seismic hazard all indicate that this type of slope instability could occur in the Porters Ski Area, though no evidence of rock avalanche has been recognised in the last approximately 12,000 years. The likelihood of the Village Base Area and skifield being affected by rock avalanche is probably very low, but the potential consequences of these areas being impacted by a rock avalanche are severe. The associated risk is probably acceptable, but has not been estimated to date.

Seismic hazard and fault induced ground rupture

17. The area of the proposed development is subject to a significant seismic hazard as a result of close proximity to the plate boundary. Numerous faults capable of generating large earthquakes have been identified in western Canterbury that could cause severe ground shaking at Porters Ski Area. This is reflected in the loadings code NZS1170.5. Account will also need to be taken of potential topographic amplification effects on structures near to ridge crests.

18. Faults that could rupture during an earthquake have been recognised in the Porter River Valley. The geotechnical summary report includes an assessment of the presence of faults in the area, which could generate a ground rupturing earthquake. This assessment identifies several fault traces in the Porter River valley, including faults that cross the access road.

19. The report makes contrary statements about the activity of the Torlesse and Cheeseman Faults. In Section 3.1.1 it states that these faults are "*assessed as not having moved in the last 120,000 years.*" This is contradicted in Section 3.2.1 where it explicitly states that the Cheeseman Fault has an indicative recurrence interval of 2200 years and 3000 years for the Torlesse Fault which would deem them active. When coupled with the statements in Section 3.1.2 that sheared greywacke suggestive of a probable continuation of the Torlesse Fault "*in the vicinity of the Village Base Area*" is present in the Porter River Valley this low return period raises the possibility that the active fault requirements of the Ministry of Environment guidelines (Kerr et al 2003) may impact the Village design. I recommend that this important issue be clarified by the scheme proponent.

Dam break

20. Storage of water for snow-making on the upper slopes of the ski field presents a hazard to skiers, proposed infrastructure and the environment. Even though the stored volume of the proposed reservoir is relatively small, the effect of uncontrolled release of the stored water could be severe on people, the environment and infrastructure below the reservoir. Reservoir release could occur due to impact of an avalanche leading to overtopping, or failure of the embankment. The geotechnical summary report has evaluated the potential instability of the reservoir site in Chrystal Basin and concludes that it is suitable as a reservoir site. I agree that a reservoir could be built at this location and meet dam safety guidelines. I anticipate that a high degree of engineering design, construction supervision and peer review will be required to meet dam safety guidelines. The location of the proposed reservoir on a potentially mobile glacial feature will require special design consideration.

Reference

Kerr, J.; Nathan, S.; Van Dissen, R.; Webb, P.; Brunsdon, D.; and King, A.; 2003. Planning for Development of Land on or close to Active Faults: A guideline to assist resource management planners in New Zealand. Ministry for the Environment Project Number: 440W3301.

URS 2010, Geotechnical Summary Report, Porters Expansion Project, dated 12 July 2010 (URS ref 42170087/03000/C)