

**BEFORE THE HEARINGS PANEL FOR THE QUEENSTOWN LAKES  
PROPOSED DISTRICT PLAN**

---

**IN THE MATTER** of the Resource Management Act 1991

**AND**

**IN THE MATTER** of Stage 3 of the Proposed District Plan, Chapter 30  
Variation

---

**EVIDENCE OF BEN MACKEY ON BEHALF OF OTAGO REGIONAL COUNCIL**

---

---

## EVIDENCE OF BEN MACKEY ON BEHALF OF OTAGO REGIONAL COUNCIL

---

### Statement of Professional Qualifications and Experience

1. My full name is Benjamin Hunter Mackey. I am a Natural Hazard Analyst at the Otago Regional Council based in Dunedin.
2. I hold an LLB(Hons) and BSc(Hons) from the University of Canterbury, and a PhD in Geology from the University of Oregon (USA). My PhD research focused on the long-term behaviour of slow-moving landslides.
3. I have been in my current role with the Otago Regional Council (ORC) for five years. This job involves assessing natural hazards across Otago, and working with local authorities and the public to manage risk from natural hazards. I have travelled extensively across the Queenstown Lakes District as part of my job with ORC, and have visited all the sites discussed in this submission multiple times.
4. I was not involved in the preparation of the Otago Regional Council submission or the further submissions. I have been asked by the Otago Regional Council to provide examples of existing and potential works in the Queenstown Lakes District aimed at mitigating the effects of natural hazards.

### Code of Conduct

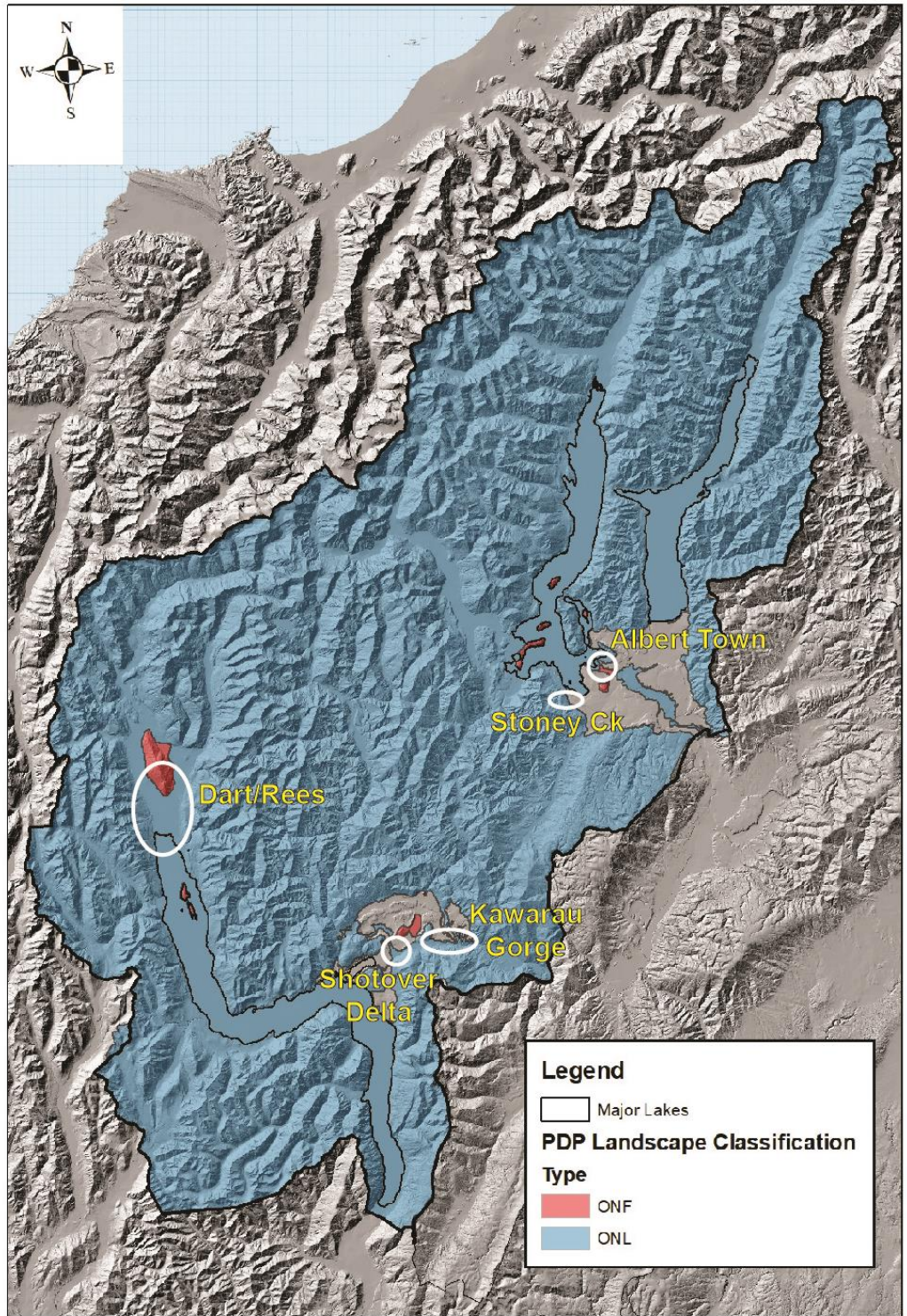
5. I confirm that I have read the Code of Conduct for Expert Witnesses as contained in the Environment Court's Practice Note of 2014 and agree to comply with it. I have complied with the Practice Note when preparing my written statement of evidence, and will do so when I give oral evidence.
6. The data, information, facts and assumptions I have considered in forming my opinions are set out in my evidence to follow. The reasons for the opinions expressed are also set out in the evidence to follow.
7. Unless I state otherwise, this evidence is within my sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

### Scope

8. The scope of this evidence relates to following matters:
  - 8.1. Current and potential sites within the Outstanding Natural Landscape and Outstanding Natural Feature areas where the ORC may need to undertake work to protect communities or infrastructure from natural hazards.

## **Outstanding Natural Landscape Extent**

9. The Outstanding Natural Landscape (ONL) and Outstanding Natural Feature (ONF) designations cover much of the Queenstown Lakes District, with the exception of the greater Queenstown and Wanaka areas (Figure 1).
10. The ORC undertakes work at sites across the district for the purpose of natural hazard mitigation. Given the extent of the ONL and ONF areas, it is likely that existing and future work will occur in areas designated as having an outstanding natural landscape or feature.
11. Some of the natural geomorphic processes which combine to generate outstanding landscapes, can also pose an ongoing hazard. There will frequently be an overlap between hazardous locations and high landscape value.



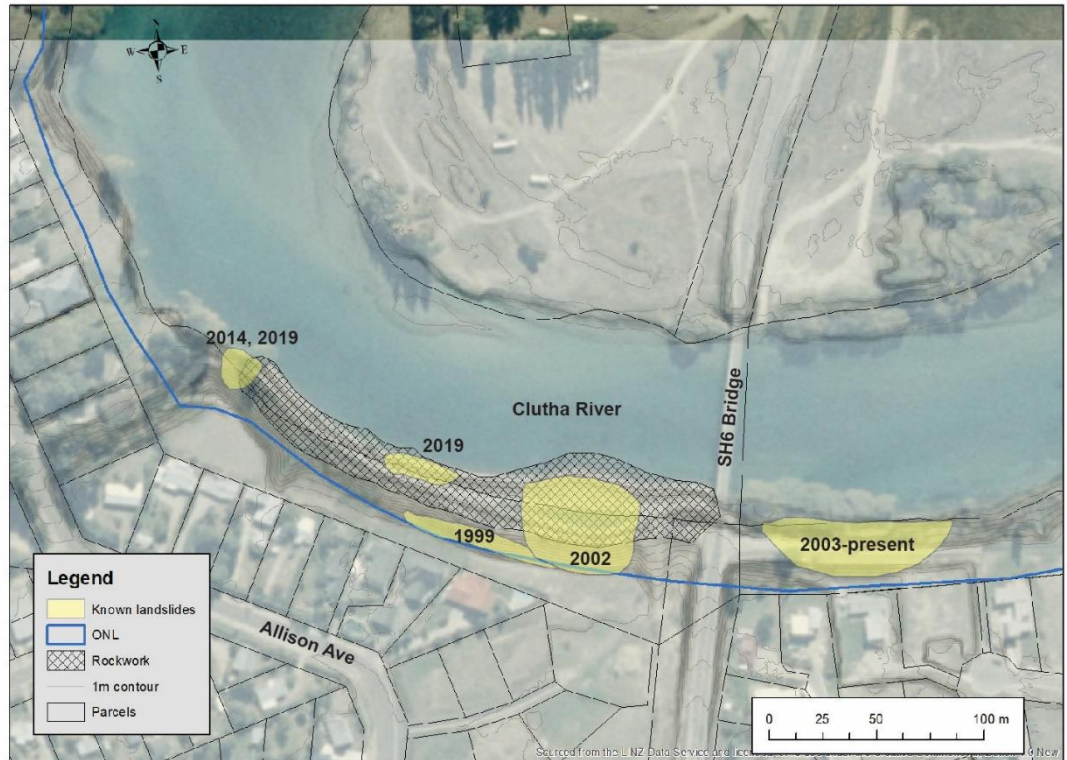
**Figure 1.** Map of the Queenstown Lakes District, and the extent of the ONF (red) and ONL (blue) layers. Sites mentioned in the text are circled white.

## Existing natural hazard mitigation infrastructure and work/projects

### *Rock protection at Albert Town*



12. The ORC owns a 230m long rock protection structure along the right bank of the Clutha River at Albert Town, designed to limit riverbank erosion, and protect property along the top of the terrace and the SH6 Bridge (Figure 2).



**Figure 2.** Location map of Albert Town rockwork. Boundary of ONL is shown by blue line and extent continues to the north. Known landslides along this reach shown in yellow, with the year of movement indicated. Background image from 2006.

13. The rock armouring in this location was first placed by the ORC in 2000 following bank erosion during the historic 1999 floods. The current structure was constructed in 2003 following further slumping of the bank in 2002. Approximately 12,500 m<sup>3</sup> of rock was imported to the site, and extensive earthworks were undertaken along the terrace face to increase terrace stability. This structure is within the ONL layer (Fig. 2).
14. The rockwork requires ongoing maintenance in response to continued river erosion at the site. The site is the outside bend of the Clutha River, and is subject to continual erosive forces, especially during floods. This area is inherently susceptible to slumping and bank erosion, as weak bank materials (predominantly gravels and lake silts) are exposed to high velocity flows. In the absence of the rockwork, the river would naturally erode the terrace face.
15. A slump at the upstream end of the rockwork occurred in 2014, and has been monitored for the ORC.
16. During flooding in December 2019 (highest flow since 1999) a 40m section of the rockwork was damaged (Figure 3), and the 2014 upstream slump was reactivated due to significant scour along the channel wall. The rockwork requires repair and modification to re-establish the pre-existing level of bank protection. This will likely

involve the importation of a significant quantity of rock and fill, and potentially modification of the river edge and terrace face.



**Figure 3.** Slumping of rockwork protecting the right bank of the Clutha River at Albert Town. Damage occurred due to scour of the channel bank and bed during high flows in December 2019. SH6 bridge visible in top of image.

17. The one-time placement of a river protection structure does not fix or solve the issue. Engineered structures in dynamic environments, such as the Clutha River bank at Albert Town, require maintenance and when necessary repair, particularly when they are stressed or damaged during sustained high flows.
18. An ONL or ONF layer extends over the Clutha River and surrounds from the source at Lake Wanaka, to the district boundary approximately 5km downstream of Luggate. Along this reach, there are other sites that may require erosion prevention in the future, either to stabilise banks, or maintain channel capacity. Examples where work may be considered necessary include known landslides downstream of Albert Town near Halliday's Bluff, or recent gully erosion at Reko's Point.

#### *Shotover Delta Training Line*

19. The ORC constructed a rock revetment and 400m long training line on the Shotover River delta in 2011. Much of the Shotover River Delta, including the training line, is classified as ONL.
20. The training line structure is designed to 'train' the Shotover River to join the Kawarau River at an oblique angle, rather than at right angles as governed by the geometry of the Shotover/Kawarau confluence (Fig. 4). In training the Shotover



River to occupy the left hand (east) side of the delta, it is intended to minimise the potential for the Shotover River to constrict the flow of the Kawarau River, the only outlet from Lake Wakatipu. In previous floods, the Shotover River has met the Kawarau River orthogonally. Water and sediment from the Shotover River obstructs the flow of the Kawarau River, causing water to back up into Lake Wakatipu, directly increasing both the level of the lake and the potential of flooding in Queenstown.



**Figure 4.** View up the Shotover Delta during high flows in 2013. The training line visible on lower left of image directs the turbid water of the Shotover River to the right to meet the clear water of the Kawarau River at an oblique angle. Kawarau River flows left to right.

21. The Shotover training line is complemented by management of vegetation and gravel extraction on the Shotover Delta (downstream of SH6 bridge). An important objective of this work is maintaining a target river bed profile across the delta. This encourages the preferred flow path of the Shotover River, and ensures there is space for sediment deposition and storage across the delta during high flows in the Shotover River.

#### **Potential natural hazard mitigation infrastructure and work/projects**

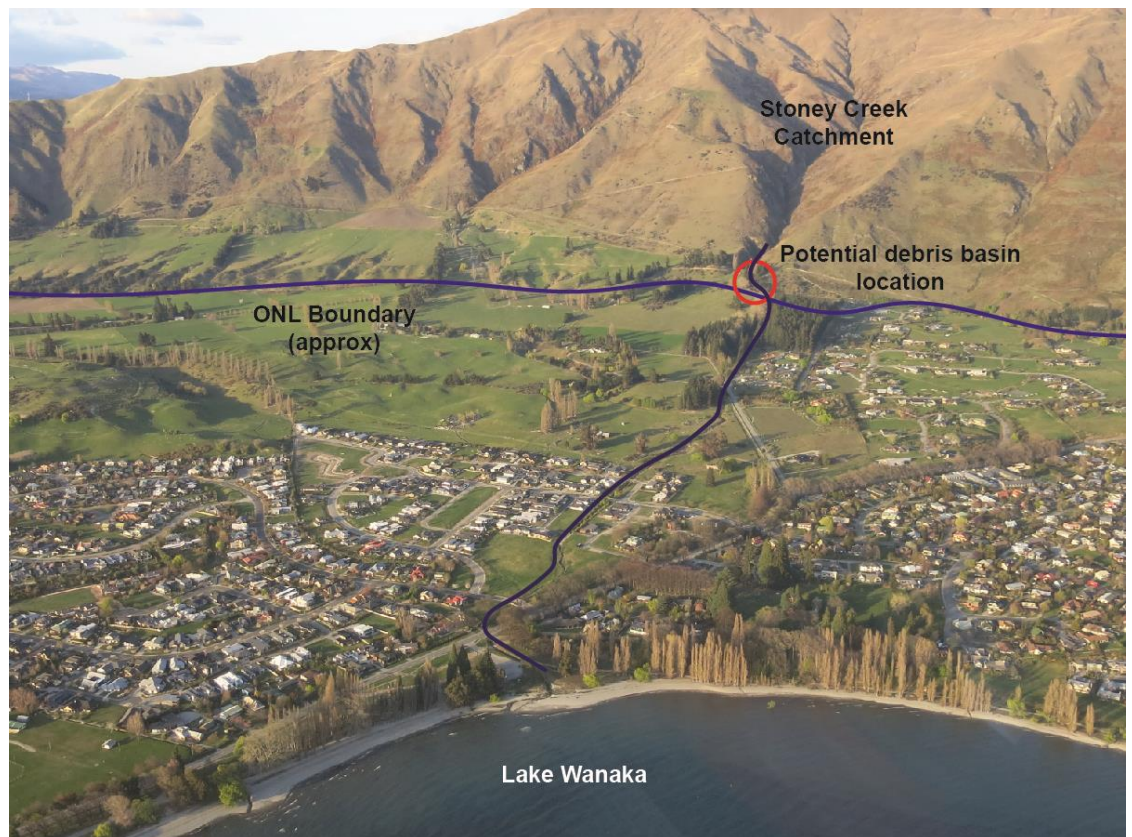
22. The ORC is aware of a number of sites in the Queenstown Lakes District where natural hazards present a current or potential risk to property or infrastructure. The following section identifies some of these locations where work may be considered necessary in the future; it is not an exhaustive list. These are given for illustrative purposes and should not be interpreted to suggest ORC is planning or committed to undertaking the potential projects.

#### *Stoney Creek Alluvial Fan, Wanaka*

23. Stoney Creek is one of a series of creeks emanating from hills south of Wanaka Township (Fig. 5). These catchments have alluvial fans at their base, and have generated debris flows and sediment laden floods in the past which can endanger

lives and damage property. Following debris flows and damage to houses during heavy rainfall in 1999 and 2004, work was undertaken to provide a level of protection against debris flows along Stoney Creek. This involved channel enlargement, overflow paths, and creation of a debris trap on the lower alluvial fan – this existing debris flow protection scheme is outside the ONL.

24. Original plans included the creation of an upper debris trap basin at the head of the alluvial fan, a site which is partly covered by the ONL layer (Fig. 5). With increased urban development on the lower slopes of the Stoney Creek alluvial fan, additional protection from debris flows, such as creation of a debris trap structure, may be considered in the future. This would require significant earthworks and potentially the installation of rock or concrete elements.



**Figure 5.** Oblique view of the Stoney Creek alluvial fan, Wanaka. The approximate ONL boundary is shown in blue, with the ONL extent continuing upslope. A proposed site of a debris retention basin is shown in red. Photo taken in 2015.

25. There are other locations where debris flow protection work may be required on developed alluvial fans in the district. These sites include Makarora, Gibbston, Gorge Road (Queenstown), and Glenorchy, and are all partly or wholly within the ONL layer. Protection measures could include the creation of bunds, debris trap basins, channel enlargement, or sediment retention structures such as catch fences or walls.

#### *Dart and Rees Rivers*

26. The Dart and Rees Rivers at the head of Lake Wakatipu are active braided rivers in close proximity to the townships of Glenorchy, Kinloch, and key local roads. In



recent years the rivers have changed course during high flows, and damaged roads and property (Figs. 6-7). Future river avulsions could pose a hazard to the settlements of Kinloch and Glenorchy.



**Figure 6.** View southwest across the Dart River delta towards Kinloch during  $>1700 \text{ m}^3\text{s}^{-1}$  flood in March 2019. Clear water in top left is Lake Wakatipu. The inundated Kinloch Road follows the tree line in centre-right of view.

27. The ORC and associated organisations may look to establish bunds or armoured banks to attempt to constrain river migration or protect key sites. These could involve significant river training structures, potentially hundreds of meters long, in an area that is covered by an ONL.



**Figure 7.** Dart River erosion causing damage to Kinloch Road (Feb 2020).

### *Kawarau Gorge Landslides*

28. The Kawarau River which drains Lake Wakatipu has a relatively low gradient, until approximately the bungy bridge where it steepens through the Kawarau Gorge. This reach is within the ONL layer (Figure 1). A longstanding concern has been the potential for landslides to deposit rock and debris into the river and potentially form a landslide dam (Fig. 8). By impeding flow down the Kawarau River in this section, a landslide dam could decrease the efficiency of outflow from Lake Wakatipu, or in an adverse scenario, block and back up the river and cause lake level to rise. This could cause flooding issues in Queenstown and other lakeside communities.





**Figure 8.** Incipient bedrock landslide above the Kawarau River approximately 1.6km upstream of the Arrow River confluence. This landslide has sufficient volume to dam the river if it failed as one mass. The landslide is monitored by ORC.

29. Were a landslide identified with potential to block the Kawarau River it may require preventative measures, including extensive earthworks, to stabilise it. If this scenario eventuated and the river was partially or fully blocked by landslide debris, then it may be necessary to modify or excavate the landslide deposit to re-establish efficient flow down the Kawarau River.



*B. Mackey*

Benjamin Hunter Mackey  
29 May 2020