

**From Mr Ben Mitchell, via email, 21 October 2014**

I am the owner of 56 Alison Ave and as a consequence I have a direct and immediate interest in the Terrace stability. I have an honours degree in Civil Engineering from Canterbury University with a focus on geotechnical engineering. While I am not a Chartered Professional Engineer, I was previously a Registered Engineer under the Engineers Registration Act that preceded the CPE framework. Additionally I worked for a time for the then Ministry of Works and assessed amongst other things the slope stability of the large Bakers Slip which became unstable with the filling of Lake Dunstan.

Craig has kindly passed on the Bryant engineering report and the following is my assessment of that, along with additional information that Mr Bryant was clearly unaware of.

**Bryant Report**

Mr Bryant's report is helpful, but he hasn't been briefed about the timing and cause of the slip and as a consequence the report addresses only part of the issue.

His assessment of the observed situation however is important. He has observed:

- First failure notified to QLDC in July 2013 and he has mentioned further movement was noted this winter.
- The location of the slip is on an oversteepened slope
- Movement appears to have continued by small amounts .... with ongoing downslope displacement and retrogression of the rear scarp.

The key point Mr Bryant wasn't apparently aware of is what triggered the slip failure in the first place. In January 2013 there were up to two weeks of very high river flows. The water level was 0.8m-1.0m above the bike track level during that time. (see attached photos) The extra buoyancy un-weighted the toe of the slope, which lead to the classic slip circle failure on the "oversteepened" slopes above. This failure was probably augmented and aided by the high river flow and the large poplar tree rocking on its root system loosening the slope toe due to wind and current action.

A significant scarp formed across the track as a consequence of the slip-circle failure. The QLDC knew of the damage as they placed a temporary closure on the track after the floods while they reshaped the track to smooth over the large scarp that formed on the track.

The other aspect of engineering risk that has not been picked up in the Bryant report relates to the scouring concentration risk just upstream of the rock armouring. This is located right in the centre of the slip failure. Scouring in a future flood will concentrate just upstream of the armouring and will scour out and likely un-weight the slope toe further, accelerating the extent of damage.

It is unfortunate that the rock armouring when placed back in 2003 stopped at the area of highest potential erosion action against the bank, rather than roughly 50m further upstream where the flood scour risk is much less.

Craig has noted that there is a puggy clay layer in the Terrace which was the cause of the major slip in 2003 that threatened the integrity of the bridge abutment just downstream of this site and hence lead to need for the rock armouring of the river bank. Importantly the Bryant report makes no mention of this. Hence it is likely that another contributing risk factor is at play that the Bryant report has not identified.

We are concerned that this puggy layer is an on-going risk right along the Terrace and believe that this needs further investigation, rather than just focussing on the first failure point. Local observations suggest that this is on the move in parts.

The survey attached to the Bryant report understates the extent of the observed slumping. There are multiple failure lines (scarps) within the area marked, which together undercut the toe of the slope above. Additionally there are more failure lines observable further up the slope, coming very close to the Terrace access track.

### **Key Issues:**

The key points that are relevant in future discussions with the Otago Regional Council and QLDC are:

- The slope has failed and is continuing to move.
- The Bryant report while helpful, only addresses part of the issues and risks.
- The wider Terrace stability is a major concern that has not been assessed.
- The next large flood will most certainly cause the failure to extend materially.
- The next slip-circle failure is likely to extend up the slope and take out the access track to the upper terrace.
- Work done now to prevent further failure will certainly be far cheaper than repairing a much larger subsequent failure.
- Any further slip action will affect property values all the way along the Terrace.
- While there is a slip, I agree with Mr Bryant in that there is probably no immediate danger to people using the lower track. The next chance of failure will be in the next major flood or through earthquake action.

### **Possible Repair Options:**

Based on my observations and experience I would suggest that a repair that will prevent future major failure and property value loss will be a combination of:

- Extending the rock armouring upstream past the scour risk area
- Removing the poplars that are destabilising the slope
- reducing the batter angle of the "oversteepened" slope.

The wider Terrace stability issue will need further investigation of the puggy layer to determine possible future failure mechanisms and likely mitigation options.

We appreciate the arrangement that you have made with Craig to redirect the walkers and cyclists along Alison Ave as the risk of large numbers of people using the unstable Terrace access track and walking along the wider Terrace that is also potentially unstable is not a risk any of us want to be party to.

I'd be happy to meet with you and your engineer on site to review this.