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cc Emma Peters
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Geotechnical Assessment Lot 9, DP416455 Coombe Hay Lane, Toko Mouth

Dear Simon,

In accordance with our Agreement dated 26 May 2023 we have undertaken a geotechnical assessment at the above property, where a subdivision is proposed. In particular we have assessed the potential landslip hazard associated with the steep escarpment that lies adjacent some of the proposed residential lots.

This work has been undertaken to assist with your response to a S92 request raised by Clutha District Council regarding your resource consent application for subdivision, reference RM2893L Coastal Resource Area Subdivision – Lot 9, Coombe Hay Lane, Toko Mouth.



Figure 1: Proposed Subdivision location looking eastwards.

Site Description and Proposed Development

The proposed subdivision site is located on an ancient marine terrace, which is approximately 5-20 m in height above sea level from its lowest to highest point. The eastern side of the terrace comprises flat and gently eastwards sloping land with the western side comprising shallow sloping rolling slopes with some small gullies. The overall site topography slopes shallowly to the southeast.

A steep escarpment defines the edge of the terrace where Toko Mouth Domain Road is located.

We understand that the current proposal is to subdivide Lot 9 DP 516455 and Lot 3 DP 512557 to form 18 new residential lots (lots 1-18), one balance lot (Lot 19) and a new roadway which runs from the end of Coombe Hay Lane to Toko Mouth Road.

We note there are a number of current conditions attached to the individual lots on the subdivision, as outlined below:

- Lots 1-3 and Lots 8-13 must have a minimum setback from the edge of the escarpment of 15 m.
- Lots 1-3 and Lots 8-13, a 5 m wide strip along the escarpment boundaries is to be established.
- Lot 12 – no building footprint must be located above the 96 m contour.
- Lot 13 – the building footprint must be located within the designated platform on the subdivision scheme plan.

The eastern most lots outside the marked area shown in Figure 2 below are not included in this assessment as they have already been developed.

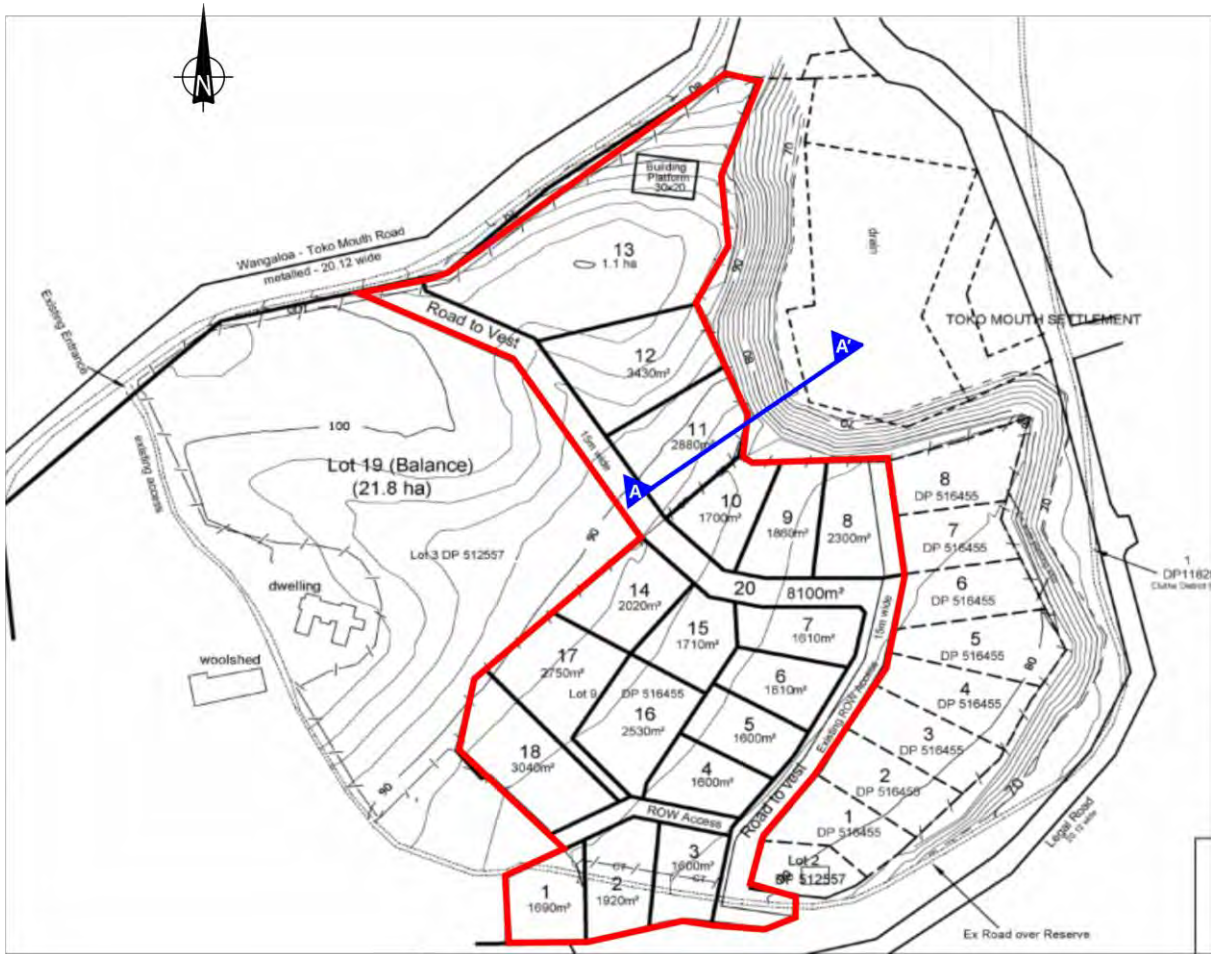


Figure 2: Proposed subdivision layout outlined in red. Snip taken from Craig Horne registered surveyor (reference Davies P67). Cross Section location is also shown.

Development Background and Desktop Information Review

We have been supplied request for further information from Clutha District Council which seeks further information about the stability of the escarpment on which the proposed subdivision is located. We note they require specific comment on the proposed stormwater and wastewater disposal to confirm that the proposed design is sufficient to ensure that the instability risk of the escarpment is acceptable. The full request is shown in Figure 3 below.

2. Hazards

The proposal relies on a 2005 geotechnical report prepared for a subdivision on the same landform as the current proposal that was not implemented. This geotechnical report was also relied on for the subdivision RM2229.

It is accepted that the terrace landform due to its elevation is not prone to coastal or flood hazards hazard, but it is a terrace with steep escarpment edges. Recent storm event across New Zealand have demonstrated that heavy rainfall events can lead to landslips at escarpment edges. The 2005 geotechnical report identifies that discharges to the escarpment edges should be avoided and I note that cut off drain 2 is identified in the Wai 36 report as discharging to the escarpment edge. The proposed development may result in an increased stormwater discharge to the slope from this drain.

I also note that an edge setback of 15m and planting within the setback is proposed in line with the 2005 report, but I am not confident given the age of the report that increasing risk of escarpment edge slippage associated with climate change influenced heavy rain events have been fully considered.

Please provide an expert assessment of the potential landslip hazard risk at escarpment edges including the risks associated with stormwater and onsite wastewater disposal to confirm that the hazard mitigation proposed in the application is sufficient to ensure that the risk from landslip hazards at escapement edges is at an acceptable level.

Figure 3: Clutha District Council request for further Information

Proposed Stormwater and Wastewater Disposal

We are in receipt of an Onsite Wastewater feasibility assessment and Stormwater Management Plan prepared by Wai360 Engineering Limited (reference W000002, dated 6 May 2022)) which outlines stormwater mitigation and onsite wastewater disposal feasibility assessment.

Based on the modelled stormwater runoff and site observations, there are three existing stormwater discharge paths from the current site, as outlined below:

- A 450 mm culvert on the south side of the proposed subdivision running under Coombe Hay Lane which we understand discharges onto the slopes, however a roadside drain captures this and discharges it into Rocky Valley Creek.
- An existing roadside drain runs along Coombe Hay Road and along the Davies Access Road.
- An existing farm creek which discharges down the cliff into Toko Mouth Domain, then into the Toko River.

We understand that based on a review of existing documents, the proposed design indicates that excess stormwater from roof surfaces will be diverted into swale drains while stormwater from hard surfaces will be directed into sumps.

We understand that the stormwater design proposed by Wai360 ensures that the modelled post development stormwater flows are no more than current development flows, with the existing flow paths as noted above remaining in place.

The above 3 discharge points and likely stormwater flow paths are shown in Figure 4 below. This figure also shows likely water flow paths based on a site walkover and mapping exercise undertaken.

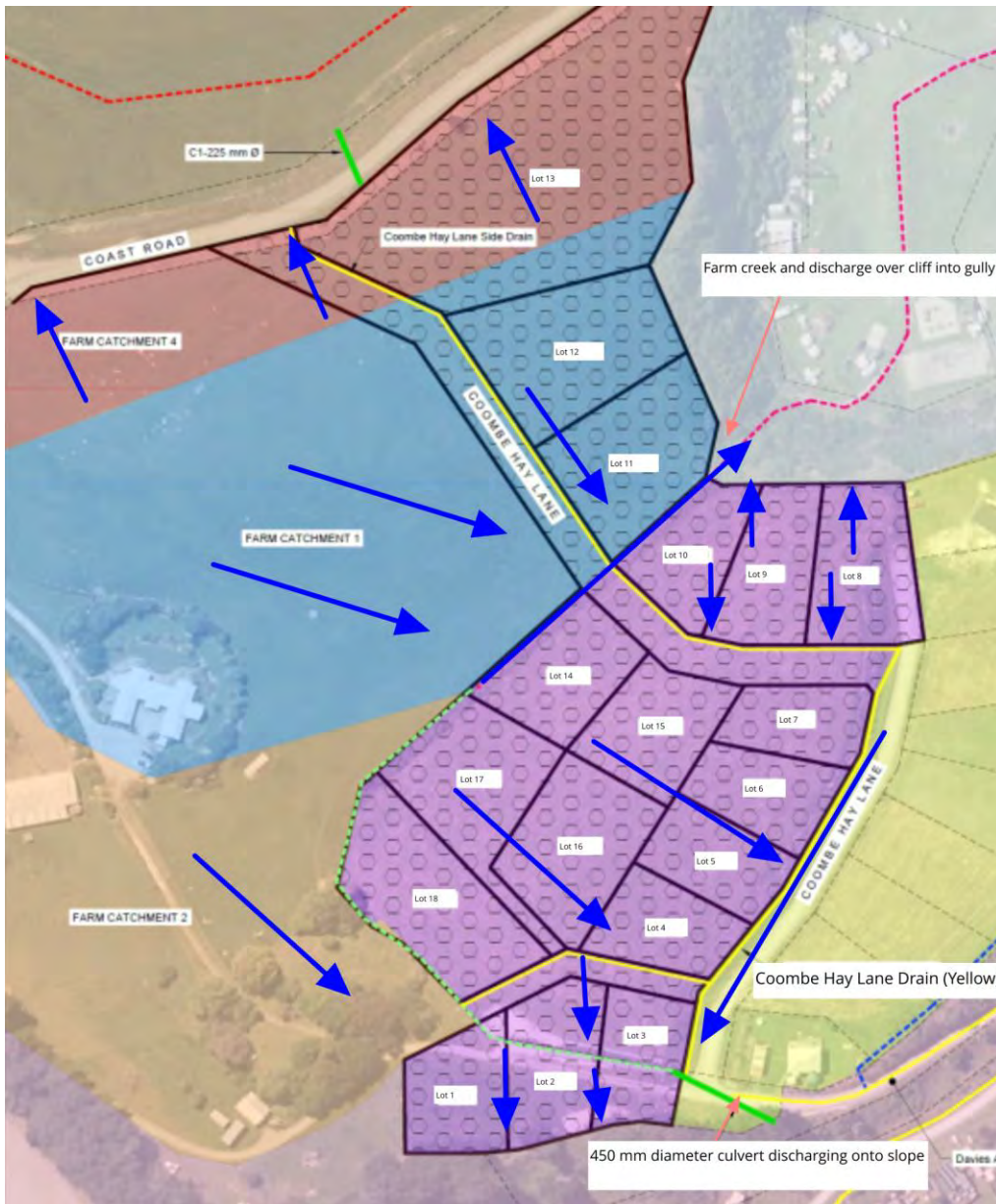


Figure 4: Mapped catchments with likely surface water drainage paths (shown as blue arrows) based on site walkover observations.

Wastewater Drainage

We understand that wastewater will be disposed of on-site via a self-contained wastewater treatment system which (for each lot) does not exceed 2000 litres per day (weekly average).

Slope Stability and Erosion

As discussed above, the proposed subdivision is located on an elevated marine terrace, with an escarpment surrounding it up to 10-30 m in height. The underlying geology of the

terrace comprises fine grained sandstone with quartz gravel layers. There is a surficial layer (approximately 1-2 m) of loess overlying the sandstone. The steep slopes have overall angles of between 30-50 degrees with some steeper areas.

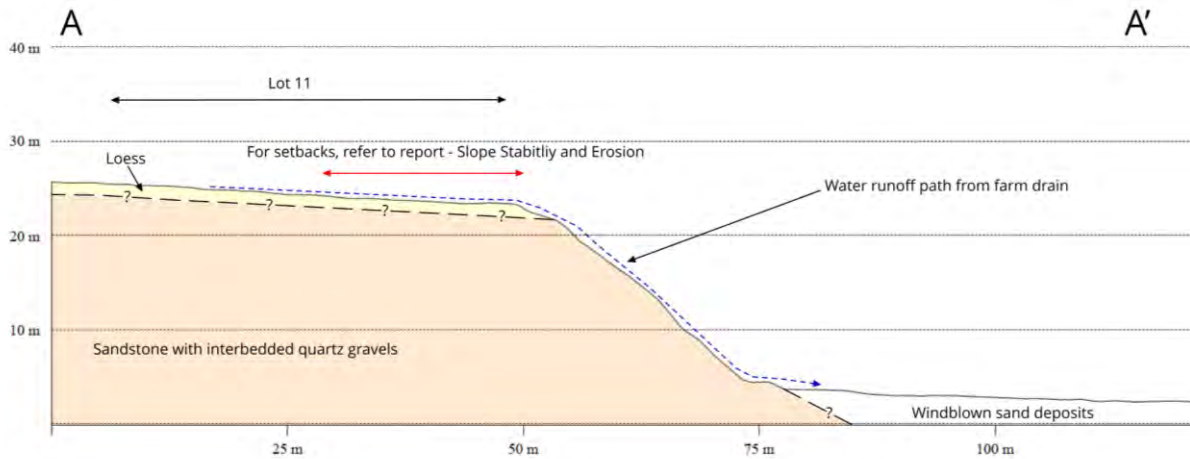


Figure 5: Schematic Section of the marine terrace escarpment.

We have reviewed aerial imagery from Retrolens¹ of the site, focusing on the areas where stormwater is proposed to overflow down the cliff.

These show that the gully feature where a farm drain flows into the Toko Domain below the raised terrace appears to have widened and likely deepened in the period between 1962 and present day.

Some areas of instability were noted in the area of this feature during engineering geological mapping, including subvertical faces up to 1.5-2 m high with minor overhangs. However, evidence of surficial soil instability were noted no further than approximately 0.5 m from the crest of these slopes and this area is currently well fenced off.

Some evidence of slopewash/fan sediment is visible from aerial imagery taken from 1946 in the area of the gully feature on the northern side of the proposed subdivision downslope from lots 11-13 (Toko Domain). We note slopes are not vegetated at this time. Subsequent images taken between 1962 and 1982 show no further evidence of slopewash/fan sediment deposits and show the escarpment slopes covered in vegetation, which will make the slopes more resilient to erosion.

The aerial imagery review also shows the slopes on the southern side of the terrace have exhibited minor signs of regression since 1962 however these are obscured by large trees making an assessment difficult. Due to recent tree removal and significant debris, steep slopes and vegetation the slopes in the area was unable to be accessed and visual assessment of the slopes was difficult. It was also not possible to identify the outfall of the 450 mm culvert located at the southern end of the site which drains under Davies Accessway (see figure 4). As part of the development, we recommend identifying its

¹ <https://retrolens.co.nz/>

location and confirming it is still suitable for stormwater discharge and that there are no obvious areas of additional instability.

As stormwater is being discharged directly onto the slopes, some further regression and erosion is expected to continue along these flowpaths in line with previous relatively minor rates.

During one off heavy rainfall events (due to climate change), some additional localised instability is possible.

We note that aside from some erosion and surficial instability near the crests of where waste is discharged, there is no evidence of recent landslide activity on the escarpment.

Based on this assessment, we consider the areas where stormwater is being discharged to have a low to moderate risk of instability, and areas where stormwater is not being discharged to have a low risk of instability in its current configuration.

It is generally not considered to be good practice to discharge stormwater to slopes as this promotes instability. However, in this instance, given that existing flowpaths are being utilised, flow volumes are not changing and that shallow rock is present this is considered acceptable. The proposed subdivision will not increase the slope stability hazard.

With regard to wastewater disposal, as the majority of the lots are away from the crest of the slopes, placement of any dispersal field is not likely to affect slope stability provided the setbacks below are adopted for the disposal fields.

Based on this assessment we consider the following setbacks are appropriate for residential dwelling construction with a design life of 50 years based on a 2(horizontal):1(vertical) line from the base of the cliffs:

- A set back of 20 m from the crest of the slopes on Lot 13;
- A setback of 15 m from the crest of the slope for the remainder of the subdivision;
- Setbacks on lots 10 and 11 should be taken from the crest of the V shaped water runoff channel.

Conclusions and Recommendations

We recommend that the proposed stormwater and wastewater discharge plan proposed and outlined in the Wai360 report be implemented to restrict post development flow rate to less than peak pre-development flow rate utilising exiting flow paths.

Other recommendations are:

- Residential development including wastewater disposal fields should be setback as defined above.
- We recommend identifying the southern 450 mm diameter culvert outlet (adjacent to Lot 3 – shown in Figure 6) and confirming it is still suitable for stormwater discharge. If there is erosion at the outlet then rock riprap should be placed.
- A stormwater management plan will be required as per Wai360 Engineering Limited's report. This will need to be agreed upon by individual lot owners.

- We do not recommend that any additional stormwater discharge points directly discharged onto the escarpments. If additional stormwater points are required, these should be piped down the escarpments to approved stormwater outlets.

In our opinion, if the setbacks recommended in this report and the recommendations in the Wai360 report are followed there will be a very low risk of slope instability affecting residential development even during climate change influenced heavy rainfall events. Closer setbacks may be possible but would require geotechnical investigations and slope stability assessments.

Applicability

This report has been prepared for the sole use of our client, Toko Developments Limited, with respect to the particular brief and on the terms and conditions agreed with our client. It may not be used or relied on (in whole or part) by anyone else, or for any other purpose or in any other contexts, without our prior review and written agreement.

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