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Dear Louise

Riverstone Holdings, Fiordland Link Experience, Civil & Structural Engineering Response to Two Concession Submissions

Further to our recent discussions, this letter outlines our response (including input from our geotechnical team) to the submissions from Ian Turnbull and David Boniface as they relate to our report in the concession application. Paragraphs have been extracted from their submissions and shown in italics so there is clarity around the context of our response.

Ian Turnbull

9.*"… should not be used for building site assessment, land use planning, engineering projects, quarrying operations, or other work for which detailed site-specific investigations are required"*

The limitation on the geological map is noted and is consistent with other sources of information typically used in preliminary engineering investigations. It is clear from our work that further investigation is intended.

11. *It is my submission that use of the 1:250 000 scale Wakatipu geological map as the basis of the geotechnical assessment of the proposal is inappropriate, and it hampers a full appreciation of the potential effects on this project. In my opinion, a better geotechnical assessment may have been made if the 1:50 000 sale maps, which cover the Monorail route at a scale five times more detailed, had been used.*

We have reviewed the 1:50,000 scale maps.

12. *Specifically, a comparison of the detail available on the 1:250 000 and 1:50 000 scale maps (see PPT slides 1, 2) suggests that the significance of large-scale landsliding in this region has been downplayed. The OPUS report states "An initial desk top review of slope stability in the area has shown that the route is generally not subject to instability. Figure 36 from the IGNS document Geology of the Wakotipu Area is included in appendix C." Use of a 1:l million scale diagram as a basis for assessing slope stability is rather dubious, and while this statement may be true of the route itself, the presence of six large landslides within a distance of 12 km of the route is at odds with the statement in the RHL application (p. 22) that "..."The route passes through an area that does not seem particularly prone to landslides." (PPT slides 4, 5)*

Comment for 11 applies, and we note that Ian concurs with our comment re instability on the route.

13. *While the OPUS report (p. 15 and Appendix C therein) draw attention to a landslide in the "Ascension Creek" sector of the monorail route along the western slopes of Mt Snowdon (PPT slide 6), this landslide is dismissed with the statement (p. 15) that "... this area is notsteep andis well vegetated with moture beech forest" and it is not shown in their Fig 6. The upper part of this landslide is devegetated and is considered active; it is visible in Fig. 8 of the OPUS report (Fig. 2.11 of the RHL application). Although the lower part has not moved since the establishment of the*

mature forest cover (see above), reactivation under prolonged heavy rain or/and large earthquake shaking is possible. The landslide could be avoided by moving the route outside the 200m corridor to the true left of "Ascension Creek" (PPT slide 6), although this would involve steeper sidling and higher impact (PPTslide 7).

The 200m wide corridor enables the monorail to remain on the True Left of Ascension Creek so that it avoids the toe of the instability we have identified on the True Right of Ascension Creek. We have overlaid the 1:50,000 geological map on the route drawing to confirm this.

16 *While none of the large landslides referred to directly affect the route, any significant reactivation of any of these landslides is likely to dump a very large amount of debris into' the Upukerora River, with significant effects on the monorail. The minor landslide mentioned by NIWA (p. 33 and Fig. 36) (a "large historic landslide" on p. 22 of the RHL application) wouldn't even be noticed. This landslide, and its significance, has vanished from the final application and hence has not been addressed in the DOC report or the MWH audit. Note that this landslide was considered too small to show at 150 000.*

In terms of sediment from the large landslides up-river in the Upukerora, we have anticipated this in our work to date. Our approach to this has been to take a 'tried and tested' approach to the foundation construction in the river valleys, similar to that used in road and bridge construction. This approach uses shallow footings while on stable higher river terraces and deep piled foundations in the active flood channel to guard against scour with sufficient clearance to allow for aggradation. (Opus report section 4.8, para 1).

17 *'An area of instability known as "Bluff Slip" has been identified (e.g. OPUS report . . Section 4.3.3; NIWA report pp. 32-33 and Fig. 35) and the monorail has been re-routed to higher ground above. I certainly agree that this sector of the route has potential problems and shifting the route above the upper bounds of any potential failure - or across the river - would be good practice. Note that this area of instability up from the river-bank was also considered too insignificant to show at 1:50 000 during mapping in 1985, and it may still be expanding (see Fig. 11 in OPUS report) so further geotechnical investigation would be essential.*

Ian notes that the approach we have taken at 'Bluff Slip' would be 'good practice'. As noted in our report, further geotechnical investigation will be carried out in subsequent stages.

20 *The Snowdon geological map suggests that there is potential for the route to encounter mudstone (PPT slide 8) on the slopes between the Dunton Swamp and the head of Dunton Creek (e.g. OPUS report, Fig.7). Given the uncertainty in mapping areas of mudstone under forest cover with no outcrop, there may be sections of the proposed route above the Bluff Slip that are on mudstone, and the bedrock referred to at Bluff Slip (OPUS report, Section 4.3.3, p. 10) is very likely mudstone. This mudstone is unstable (e.g. Horsehoe Bend on the Milford Road; Gorge Hill west of Mossburn; beside the monorail route in upper Henry Creek) and if it is encountered could require imaginative engineering solutions. This potential problem is nowhere acknowledged, and could readily be avoided by taking the route along the true left bank of the Upukerora River to opposite Takaro Lodge (as suggested by NIWA, p. 35).*

If the mudstone is found to be unstable, there is scope to alter the route within the 300m wide corridor in this area. Alternative foundation designs are also possible and have been mentioned in outline from in Opus report section 4.3.3.

21. *Although seismotectonic hazard assessment is not my speciality, I have contributed to numerous reprts on this topic and am familiar with the concepts. Nowhere in any of the documents I have read is there any serious discussion of seismotectonic hazard, or of associated hazards such as ground shaking amplification or liquefaction. For a major engineering project in the Te Anau basin, close to the Alpine Fault and surrounded by active fault traces, and in the light of recent events in Christchurch, this omission is both surprising and worrying.*

We are familiar with ‘basin effects’, amplification and liquefaction. We have proposed a range of foundation types which will enable selection to mitigate the effects of liquefaction. In terms of levels of shaking, we have designed civil and bridge structures in high seismicity areas including those in areas very close to major faults, and for this project we have proposed a conventional, similar form of construction.

23. From the RHL application (p. 21): "The route also crosses two concealed seismic fault traces which are not considered to be active. One of these is the Hollyford Fault, to the immediate west of Dunton Range and running north/south through Dunton Swamp, the other is the Moonlight Fault which runs along the Mararoa River valley past the proposed Kiwi Burn terminus site." With respect, this under-estimates the number of faults in the region (see PPT slide 9). There are eight faults crossing the route which are large enough to map at 1:50 000, and neither the Hollyford nor the Moonlight faults are among them.

25. These active faults, together with the Alpine Fault off Fiordland and others in the southern South Island, have been used by Stirling et al. (2010) to model the likely peak ground acceleration (PGA) and intensity (MM) from earthquakes over certain time periods (PPT slide). PGA refers to the strength of the "kick" given by an earthquake; the MM scale describes what is felt and seen (see PPT slides 10 11 For the Te Anau Basin, there is a 35% chance over the next 50 years of intensities of MM 6 to 7 effects being caused by an Alpine Fault earthquake (see PPT slide 12). (MM 7 effects include some damage to built structures, shallow landslides, and common rockfalls on steep slopes and cuttings; PPT slide 13.) MM 8 may be experienced if an earthquake occurs on any of the nearer faults, although the chances of this are less (10% probability in 50 yrs). (MM 8 effects include numerous small to moderate landslides and some large landslides, and instances of liquefaction.) Ground shaking is amplified in areas of loose ground (such as outwash gravels and peat swamps).

26. Nowhere is there any acknowledgment of the seismic risks to a monorail elevated up to 6m above unconsolidated ground. Earthquakes are mentioned in Section 6.2.6 (Climate) (p. 62), but only in the sense of responding to a seismic event. I submit that the "preliminary seismic assessment" by OPUS, unless accompanied by further documentation and methodology, is insufficient to allow an informed judgment of this aspect of the project, and that the proposal should be put on hold until this has been addressed.

We note the presence of several faults near the route and we have carried out a preliminary assessment of seismicity, sufficient to assess that the effect of the alpine fault on ground shaking is greater than the local faults. This appears to be consistent with Ian’s assessment in paragraph 25. As noted in 21 above, the approach to design and construction of the superstructure and foundations is conventional and consistent with the approach taken to other infrastructure projects. Design and detailing will include design for both the level of shaking and to accommodate reasonable allowance for ground displacement.

28. *However, the outcomes of this "further work" may well result in deviations outside the current route corridor.. For instance, deviating to the south side of the Upukerora to avoid both the "Bluff Slip" and potentially unstable mudstone above it (or under it) would place the revised route outside the present 300m corridor. If the project was consented at this stage, there is the potential for a larger or different environmental footprint, that could not be considered by this hearing.*

The 200m wide corridor has been established to accommodate ‘deviations’ both necessary and advantageous to optimise the geometric alignment, avoid more difficult foundation conditions and minimise environmental impact. The corridor in the area of ‘Bluff Slip’ has been increased to 300m so that an alternative route below bluff slip can be accommodated within the corridor.

David Boniface

Our comments relate to David’s section d) Proposed Details

Track Construction

The physical track footprint will be significantly wider than 3m although the carriageway may be able to be contained within that width. There seems to be no consideration for vehicles passing. Additional width beyond 3 metres will be required for up slope and down slope batters and water tables. Typically batters will need to be 45 degrees (1:1) in this country.

The footprint calculation is not based on a 3m width. Cuts and fills have been considered and calculations of footprint are based on the cuts and fills as indicated on drawing sheet 3, which include water tables. Batter slopes proposed range from 2V:1H for cuts to 1V:1.5H for fills.

A huge influence also will be the need to contain gradients of the track to limits able to be negotiated by construction traffic. Typically gradients of 1 in 6 (15 degrees) is about the maximum you would contemplate. In undulating country such as through the Snowden Forest cuts and fills may be substantial.

There should be no requirement for track gradients to be as steep as 1 in 6 as the maximum grade on the monorail alignment will only be in the order of 6%. In some locations the spur tracks will need to be steeper than the overall grade on the track, but these are short and can take advantage of suitable topography and can sidle where necessary to gain the height required.

I personally think that that a track within the 10 metre (or wider as may be necessary) monorail footprint would present a least impact solution. This would compromise the bike trail experience I guess.

We have carried out considerable work on the construction track, considering the monorail with the co-located construction track and the separate construction track as proposed, in conjunction with the ecology team. The decision to progress with the separate track is based on minimising overall impact in terms of footprint area and effect on canopy. This is substantially due to the construction track being much less constrained than the monorail alignment. This means it can be routed to minimise impact by avoiding steep slopes and earthworks, trees, streams etc.(refer section 6.2 of Opus report)

Providing spur tracks every 200 - 300m will be hideous. Turning circles would have to be around 20 - 30m radius for cranes and beam carriers. The impact at intersections will be large.

The turning circles will not need to be more than about 3m, because no beam transporters or cranes are required on the track. The beams will be transported along the completed monorail track and erected using the launching gantries operating from the completed monorail beams.

The track will need to be metalled. Gravel will need to be won. It is not clear if this would be allowed from local pits or rivers but no doubt the contractor will want to minimise cartage and production costs. For say 30 km of track some 45,000 cubic metres of gravel will be required - some quantity and a significant impact.

Imported gravel will be required. This can be brought in using road transport from existing sources of aggregate, or possibly from sources on private land which are already in use much closer to the route.

The construction equipment appears relevant although I would want to use 20t excavators rather than 12t given the extent and size of vegetation to be removed and the earthworks.

The use of a 12t excavator is based on advice from HEB Construction.

River Access

The extent of pier depth can not be ascertained until the specific hydraulic / waterway design is completed for each structure. The MWH report recommends this and I agree this should be completed ahead of any consent.

As noted in our report, further geotechnical investigation is required, and consideration of flooding, scour, aggradation and therefore waterway will be undertaken. The approach we have taken at this stage is using a construction approach consistent with bridge construction in river valleys, as noted in 16 above.

I imagine the track width may have to be two lane (perhaps) in places to accommodate the haulage of large / long precast units such as bridge pier units.

As noted in 'track construction para 6, the track is not required for transporting beams.

There will be bridging requirement for the maintenance track / road also. Where are the details? What are the impacts? What river protection works to safeguard the structures? Fiordland has very high intensity rainfalls and significant flooding potential.

The track construction standard is generally to be in accordance with DOC standard VC 1672. This document contains guidelines on management of water, scour protection etc.

Tree Clearance Area/Footprint

I think the area claimed is Riverstones best minimum guess. They will not know precisely until specific design of the monorail and track is completed.

The clearance area calculation is based on the route and terrain type drawings and the relevant cross sections for the respective terrain types.

Monorail - you would want your initial clearing to be sufficient to take care of potential tree falls. I am not sure of the average forest height but if 8m you would want. Up to 10m each side of the monorail, perhaps a 20 m cleared corridor. = 40ha of clearing alone.

The tree clearance is intended to be sufficient to provide a safe operating corridor while minimising tree removal. Section 4.4 covers this issue in more detail and it is also discussed in the ecological report. The draft Operations and Environmental management Plan outlines an ongoing approach to tree management.

Track - av footprint say 10m x 30k = 30ha plus some 2 laneing plus turning circles.

I can envisage total clearing being in excess of 80 ha.

Footprint calculation as in paragraph 1 above

Please don't hesitate to call to discuss any aspect.

Yours sincerely

Will Parker
Principal Civil & Structural Engineer