RIVER & FISH
ENGINEERING SOLUTIONS LTD

Memo

To:	Otago Regional Council Attention: Andrew Maclennan	From:	Paul Morgan River and Fish Engineering Solutions
		Date:	23 March 2026

The following is the second Memo sent related to review of the engineering and fish passage issues at the proposed Extension to Mahinerangi Wind Farm. The first Memo was dated 20 January 2026 following the first site visit on 15 January 2026. The main issues from that review related to the proposed culvert in Lees Stream.

A second site visit was undertaken on 4 February 2026. During the site visit to the location of the proposed culvert, we observed hundreds of fish within the stream and given eDNA has shown that only Eldon's Galaxias are at this location this confirmed the presence of these fish. They fish observed were from small juveniles of approximately 20mm and less as well as adults estimated to be approximately 80mm to 100mm in length which also is an indicator of a healthy population given the variety of life stages present.

At the site I discussed the design of the culvert with Vaughan Martin from RILEY and the changes they are proposing to address the issues I raised in the 20 January Memo. The changes they were proposing were addressing a number of the concerns raised in the earlier review.

1 Summary of review

RILEY sent an email dated 25th January with some proposed changes to the design and an email dated 28 January 2026 with responses to issues raised in the review. I responded on 7 February 2026, and the Section 2 below includes the correspondence and information sent.

Updated reports from the application were provided on 17 March 2026. The main issue from the earlier review was the design of the culvert at Lees Stream. In the memo dated 20 January several issues were highlighted, and Section 2 shows some of the responses to those issues presented by RILEY. I recommend that rather than spending time in detailed responses and counter arguments a better approach is to review the proposed design and consider what has been presented and how the changes to the design have accounted for the issues previously raised. This is also because some of the responses to issues raised RILEY have provided a reason why they do not agree with the review comments but have still then made the suggested changes to the design to address anyway.

Review of current design presented in drawings (Drawings 240034-285 to 240034-288)

A key element in the proposed design is using a very large box culvert of 2.5m wide and 2.5m high as this significantly reduces the impact of the culvert and provides for opportunity to make it more like the natural stream bed.

The combination of the baffles and use of natural materials (rock and gravels) will provide the complexity of flow conditions and resting areas required to enable fish passage across a range of flow conditions. There is still a symmetry to the shapes in general but there is opportunity to impact on that through the placement of larger rock and RILEY have also included a central baffle block at every sixth baffle.

As I noted in earlier review the 2024 Fish Passage Guidelines should be considered in combination with the 2018 Guidelines and this is especially important for the fish species present which are Eldons's Galaxias as they are non-migratory and some of the elements of the guidelines relate directly to behaviour of migratory fish. For this site following the "Stream Simulation" approach in the design of a culvert from the 2018 guidelines is more appropriate and that is also international best practice. In summary that approach aims to copy the hydraulic conditions within the natural stream and use that as basis for the culvert. The features within the proposed design have introduced that approach in response to earlier comments and this should provide favourable conditions to reduce any impacts on fish passage at the site.

The management plan has included the recommended approach of monitoring during initial flow conditions and following any higher flow events with the opportunity to move around some of the rock within the culvert where there are any areas of concern for fish passage observed.

The following are the two issues that still remain for the proposed design from previous review comments raised:

1. The culvert and apron material proposed has a gradation table on Drawing 240034-286. The percentage of finer materials appears to be quite low and may need to be higher to ensure suitable filling of voids.

2. Given the fish present are non-migratory and therefore do not follow any patterns of upstream and downstream movement the recommended design approach is to ensure velocities in general are suitable for fish passage over as wide a range of flow conditions as possible and it is suggested based on the flow duration curve for the stream a range between the 10th to the 90th percentile should be met. Therefore, there still needs to be confirmation of the general velocity profile through the culvert and the aprons for these flow conditions to show how the proposed design meets this through comparison of modelled velocity with fish swimming speeds. As the proposed design provides for complexity of flow these variations within the culvert are part of this comparison. The RILEY email dated 28 January 2026 stated that they *"would undertake the work to show the relationship between different flow conditions and fish swim speeds to confirm the design meets this"* but this information has not been presented.

2 Correspondence and notes between 20 January 2026 review memo and consent documents provided this week

These notes are background information in the processes over the last two months.

The following is my email notes I sent to RILEY on 7 February 2026 as they were working through design of the culvert:

Just had some general comments on what is proposed below regarding modifications and from discussions at the site visit.

- *The combination of baffles and use of natural materials (rock/gravel) will improve the issues raised regarding fish passage particularly in providing for the complexity of flow including rest areas for the fish which is required for the length of the culvert as is also indicated below. There still needs to be some analysis of the proposed design to indicate expected hydraulics for a range of flows and ideally as large as possible (from flow duration curve something from 10th - 90th percentile).*
- *It would be better if the design was not symmetrical throughout the culvert length so variations in baffle spacing and lengths in addition to the introduction of rock would be useful as this then helps with the changes that occur with different flow rates and will improve the range of flows over which fish passage will be possible.*
- *We discussed having conditions (management plan) relating to monitoring after construction to check it is achieving suitable hydraulic conditions within the culvert and aprons are particularly related to rock placed to ensure at different flow rates and following any significant storm events that it is operating as expected.*

Other Issues possibly raised by Andrew Rossaak

- *Consideration of any potential issues with the darkness within the culvert given its length and whether that has any implications for fish passage.*
- *Site visit again highlighted that habitat values in the area of the culvert and upstream could be significantly enhanced by keeping stock out the stream in that area, potentially some clearing of vegetation that is within channel that is almost completely blocking especially on the upstream section we did not observe any fish as very little open sections of water present and targeting vegetation planting to provide some more cover.*

The following is summary of email notes Sent by RILEY on 28 January 2026 which my above notes responded to. I have also added a third column with direct comments in response to their email based on proposed design.

Reviewer Comments (20January 2026 Memo)	Riley Response 28 January 2026	Comments on RILEY response
1. The velocities in the culvert show that the proposed "meandering low flow channel" has all velocities above 0.8m/s, whereas the natural channel has continuous pathways of flow down to 0.2m/s.	velocities through low flow channel in high fish flow scenario is less relevant - the fish passage path is along the sides of the culvert in the high flow scenario - this provides a corridor (meeting the fish passage guidelines requirement of min 150mm wide and 150mm deep) with velocities equivalent to the existing stream bank sides, therefore we consider this design criteria of the fish passage guidelines is met	This is the approach from the 2024 guidelines and several experts within industry have questioned this approach and whether it is a suitable basis for culvert design for fish passage. Given the fish present are non-migratory they do not move because of any triggers from higher flows within the stream. The approach in the 2018 guidelines based on design for a large percentage of the flow conditions within the stream is considered much more suitable than using the 2024 guidelines which are based on higher flows that only occur for a few percent of the time.
2. The velocity profiles above show that the complex velocity environment in the natural channel is not present in the culvert.	Neither the Regulations nor the NZ Fish Passage Guidelines require the culvert design to fully replicate complex velocity environments observed within the existing natural channel. However, during the culvert commissioning process, larger rocks can be selectively positioned to provide further velocity variation	The 2018 Guidelines were based upon international best practice of using the approach of stream simulation with the aim to match the stream conditions as much as possible within the culvert. This is especially relevant for non-migratory fish. The proposed design is a very good example of applying stream simulation even if that has not been the basis for the design.
3. The modelling of the velocity is a good indication of what the velocities are, but it is important to note that this is a 2d model and therefore does not account for the vertical variations that occur within a channel.	Noted, although we also consider the modelling undertaken to date follows best practice noting that 3D modelling is not discussed with the NZ Fish Passage Guidelines. Specifically, the NZ Fish Passage Guidelines discuss depth-averaged velocity (i.e. 2D).	The proposed design is providing for an approach that is providing complexity of flow which indirectly is consistent with the issue highlighted.

4. For the culvert aprons a meaner channel constructed for low flow has some merit as the issue with the aprons can be they spread flow across a very wide width and in low flows that becomes an issue with depth of flow. However, the sudden change in profile is a concern when flows exceed the meander channel capacity as they then are onto a flat surface and will have shallow depths (so an issue for both upstream but also downstream fish passage). It is better to have an apron that slopes towards a central low flow channel so there are no sudden changes and for the use of rocks embedded to provide for the variability in flows and velocity needed.	We agree with these comments, and we can update the design/drawings to address this	No comments to add as addressed in proposed design
5. The proposed culvert design does not provide for a solution that will ensure fish passage upstream through the culvert is possible. Regulation 70 (2)(a) is not met by this proposed design and highlights that simply meeting specified criteria about average velocity, embedment, widths on their own are not sufficient to achieve this regulation. The assessment presented had not compared modelled velocities with fish swimming speeds and culvert length to prove this design works for both low and high design flows.	We acknowledge the reviewer's comments and have taken them into account. We believe the principles of Regulation 70 (2) (a) can be met through minor modifications to the existing design - namely, by shaping the stream bed infill profile to create fish resting areas at the proposed concrete baffle locations, as illustrated below. We believe this will go a long way to address concerns re. fish swimming speeds vs flow velocities for low flow conditions. We will seek to remodel (or demonstrate by some other means) that the updated design meets the intent of the regulations and include comparisons with fish swimming speeds and existing stream flow environment (for low and high fish flow scenarios).	The proposed design has addressed this issue. All that remains is some analysis of the proposed design to show what velocities are for range of flow conditions (which RILEY indicated in email correspondence that they would undertake.)

6. The current culvert design does not ensure fish passage is possible and some of this relates to the long length of the culvert as well as lack of any significant means to provide velocity variance. As shown in the Tables from both 2018 and 2024 guidelines small native fish can only sustain very low velocities which means a 35m culvert will not provide suitable conditions for fish passage unless there are means to provide a wide variety of velocities and resting areas. The proposed meander in the channel does not provide that as indicated by the velocity modelling results presented.	See response to 5.	Addressed with proposed design
7. If a culvert option remains the approach the design needs to include proven techniques for addressing fish passage needs and accounting for as wide a variety of flow conditions as possible to maintain fish passage. The very low swimming speeds of the size of the fish present at this site highlights the importance of an understanding of the variability in flow conditions required to ensure upstream passage is feasible for a 35m long culvert.	See response to 5.	Addressed with proposed design
8. Given the large size of the culvert proposed it should be possible to create a bed level with rock features and other more natural conditions that will create the complexity of flow and velocity conditions to enable fish passage. This needs to be robust so that it is not washed out in a flood and therefore just placing rock will not be sufficient on a concrete base so would need to be	The proposed low flow meandering channel (which will be structurally supported by the positioning of the concrete baffles) will add flow length and thus replicate the slope/gradient of the adjacent stream bed which the culvert will replace (the culvert is shorter than the section of stream it replaces) -	Addressed with proposed design

some constructed baffles combined with rock and other material placed in the invert.	which is preferred and in line with design principles of the guidelines. Secondly, the low flow channel is designed to maintain connectivity (min 150mm water depth) between upstream and downstream habitats in the low fish passage flow scenario - another design principle of the guidelines. The low flow depth through the culvert is an increase/improvement on depth of flow through the connecting reaches of the stream - as shown by figure below. With respect to a rock / baffle matrix solution suggested by the reviewer, it would be difficult to achieve and/or demonstrate compliance with the above fundamental design principles. However, during the commissioning process, larger rocks can be selectively positioned within the culvert to provide further flow velocity variation as mentioned above.	