[redacted]

19 December 2025

Riley Ref: 240065-T
Reissue of: 240065-R

Attention: [redacted]

Dear [redacted]

Geomorphic Impacts on Slope Stability
Delmore Residential Development
Russell Road, Orewa

1.0 Introduction

Further to the request from [redacted] acting on your behalf, we have prepared this letter summarising the required amendments to the stability enhancement measures to accommodate the recommended stream setbacks and long-term channel downcutting/alignment considerations. This letter is intended for use by Auckland Council to support Morphum Environmental's (Morphum) response to the feedback from Healthy Waters on the previous Resource Consent application. This letter is not intended to support a new Resource Consent application.

A geomorphic assessment has been completed by Morphum (Ref. Delmore Development Geomorphic Assessment – Final Memo, dated 20 November 2025) following feedback from Healthy Waters requiring an evaluation as to whether the proposed riparian setbacks are appropriate given existing stream conditions and expected future stream adjustments.

The assessment identified areas of the streams (reaches) where geomorphic processes are most relevant and further changes to the design, including geotechnical design, are required to be considered.

2.0 Design Considerations

Within their geomorphic assessment, Morphum identified reaches where further geotechnical assessment was required. The reaches were classified into red, orange and green to differentiate where the offset was acceptable or needed additional consideration. There is a 10m stream restriction set back to all reaches, except Reach 2 which requires a setback of 15m. Where the toe of the design is set back less than 10m, the gradient of the design profile has been steepened to accommodate the required set-back distance. The edges of the proposed building platforms remain unchanged.

The following requirements and design considerations were provided in an email from Morphum on 29 October 2025 (attached).

1. *Green Areas: We are comfortable with the setback distances along these reaches. However, there are some engineering structures alongside the stream, such as palisade walls, MSE walls or road bridges. Where the table indicates a check is required, we would like confirmation that the structures have been designed to take account of the potential for downcutting and widening. The current profiles of streams vary, so for simplicity, assume a stream depth of 2m with a width of 3m and vertical side banks.*
2. *Red and Orange Areas: There is concern that stream adjustment will impact on the Lots and/or structures along these reaches and the current set back distance may be inadequate. In some cases, this appears to be less than 10 m. The location of structures and Lot boundaries should be revised, and we recommend these be at least 10m (and 15 m for Reach 2). Structure design and slope stability should assume a stream depth of 2m with a width of 3m and vertical side banks. While 10 m is proposed as a minimum, there may be instances where other constraints mean this is difficult and we are happy to discuss these on a case-by-case basis.*

3.0 Slope Stability Analyses

We have carried out further slope stability analysis along the Reaches highlighted by Morphum using the cross-sections previously analysed as part of our Geotechnical Investigation Report (GIR, Ref. 240065-F, dated 14 February 2025). For locations where no suitable existing cross-sections were available, we have generated and analysed additional cross-sections (Cross-sections AE to AH).

For the Reaches identified by Morphum that needed further consideration, the stability analyses were updated to consider the long term downcutting and channel widening recommended by Morphum. They also considered amendments to the stability enhancement measures to provide the required riparian setbacks.

The slope stability analysis adopted the same parameters and methodology as presented in Section 5.1 of the GIR and subsequent updates to address scenarios specifically requested by Auckland Council. The finished surface profile used in the analysis was the same as that used in our GIR.

The outcome of the analysis is that some minor changes will be needed to the previously advised concept stability enhancement measures, but that in all cases, adequate Factor of Safety (FoS) were able to be achieved with the inclusion of the geomorphic considerations. A summary of the changes is presented in Table 1 attached. Stability analysis outputs are not attached. It should be noted that the changes included in the table are the minimum changes that were required to achieve the target FoS, and further amendments are likely during the detailed design process, and during any changes to the proposed design.

4.0 Conclusions

The stability analyses have been updated for the Reaches highlighted by Morphum. These give consideration to the potential impact of stream channel adjustments (downcutting/alignment) as recommended by Morphum. The analysis results have shown that some minor adjustments to the stability enhancement measures are required, but in all analysed cases, adequate FoS were able to be achieved.

For future Resource Consent applications, the slope stability analyses will need to be updated for the new design profile and an updated corresponding GIR will be required. Any future slope stability analyses will need to consider the geomorphic design requirements identified by Morphum along the high-risk reaches.

5.0 Limitation

This Letter report has been prepared solely for the benefit of Vineway Ltd as our client with respect to the brief and Auckland Council. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such parties' sole risk.

Recommendations and opinions in this letter are based on data from limited test positions. The nature and continuity of subsoil conditions away from the test positions are inferred, and it must be appreciated that actual conditions could vary considerably from the assumed model.

Yours faithfully
Riley Consultants Ltd

Prepared by:	Reviewed by:	Approved for issue by:
[redacted]	[redacted]	[redacted]
Engineering Geologist	**Principal Geotechnical Engineer, CPEng**	**Project Director, CPEng**

Enc: Table 1
Table 2
Email from Morphum, dated 29 October 2025

cc: [redacted] Barker & Associates Ltd
[redacted] Barker & Associates Ltd
[redacted] Mills Lane Chambers
[redacted]

Table 1: Summary of Updated Slide Analysis Results for Geomorphic Considerations

Critical Level[1]	Reach[1]	Cross Section[2]	Previous Design[2]	Previous Set-Back Distance	Updated Design After Geomorphic Consideration[3]
Red	2	B	REB slope with geogrid and shear pile. NOTE: Cross Section B is at the southern extent of Reach 2. Additional section (AG) has been cut and analysed further north along the reach where distances decrease.	Approx. 15m	No change to remedial design required to meet minimum FoS.
		AG (NEW)	Assumed to be REB slope with geogrid and shear pile (as per proposed remedial concept design in this area).	Approx. 11m	Proposed design meets minimum FoS. REB slope is steepened from 45° to 55° to create 15m set-back distance. Shear pile to 9m depth at 1.5m spacing with shear capacity of 640kN. Geogrids 9.5m lengths at 0.6m vertical intervals, except within 1.2m of surface under a building platform which is limited to 2m long. NOTE: Additional detail and detailed design consideration will be required at the bend and tie in detail with the REB wall between Sections AG and J (i.e. where the building platforms join the proposed road/road crossing).
Red	36	AH (NEW)	Assumed REB slope, geogrid, shear key and counterfort drains (as per proposed remedial concept design in this area).	Approx. 4m	Proposed design meets minimum FoS. REB slope is steepened from 45° to 57° to create 10m setback distance. Shear key is 4m deep and 11m wide. Counterfort drains extending approx. 13m upslope. Geogrid is 10m long, except within 1.2m of surface under a building platform which is limited to 2m long.

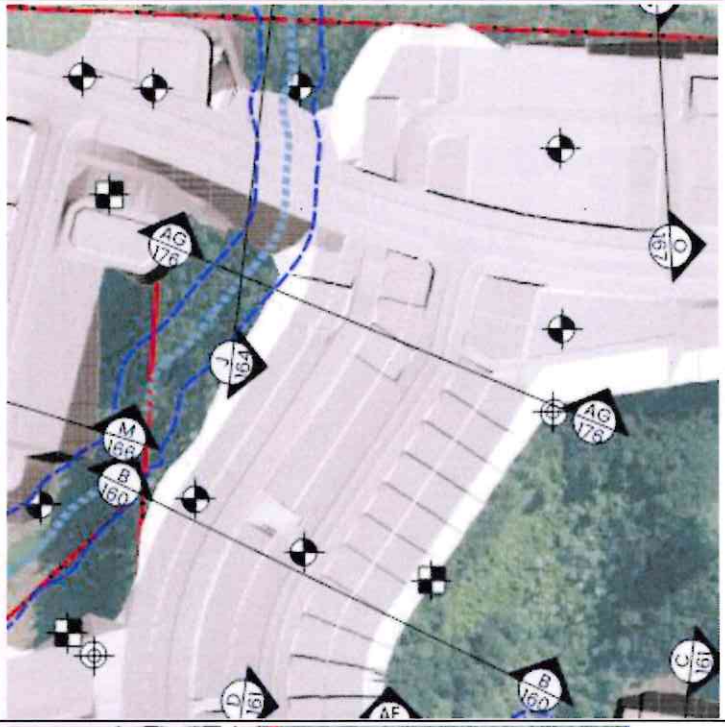
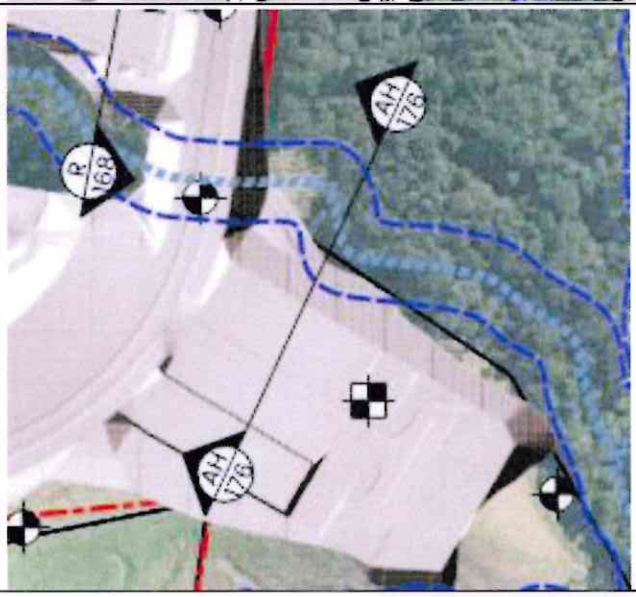
Critical Level[1]	Reach[1]	Cross Section[2]	Previous Design[2]	Previous Set-Back Distance	Updated Design After Geomorphic Consideration[3]
Red	23	R	REB slope with geogrid, shear pile and shear key.	Approx. 7m	REB slope is steepened from 40° to 54° to create 10m set-back distance. Shear pile deepened by 0.5m (3.5m to 4m length) to meet the same assumed rock boundary at this location. Shear key deepened from 1.3m to 2.3m but reduced width from 6.4m to 5.1m. Geogrid increased in length from 5m to 6m.
		AA	REB slope with geogrid and shear key.	Approx. 7.5m	REB slope is steepened from 45° to 51° to create 10m set-back distance. Shear key deepened from 5.4m to 5.7m. Geogrid increased in length from 10-13m to 13.5-14m.
		AB	REB slope with geogrid and shear key.	Approx. 8m	REB slope is steepened from 37° to 39° to create 10m set-back distance. Shear key deepened from 4.2m to 5.3m and widened from 10m to 11m. Geogrid increased in length from 10.5m to between 10.5m and 15.5m.
Red	24	Z	Palisade wall.	>10m	Palisade wall shear capacity increase from 200kN to 250kN. No change required to pile spacing or pile length.
		AA	Refer Reach 23 above.		
Orange	10	L	Retaining wall separating lots.	Approx. 14m	No change to remedial design required to meet minimum FoS.
Orange	29	V (R-L)	REB slope with geogrid, shear pile and counterfort drains.	Approx. 3m	REB slope is steepened from 45° to 63° to create 10m set-back distance. Geogrid length does not need to increase due to change in failure model from increase in gradient of REB slope.

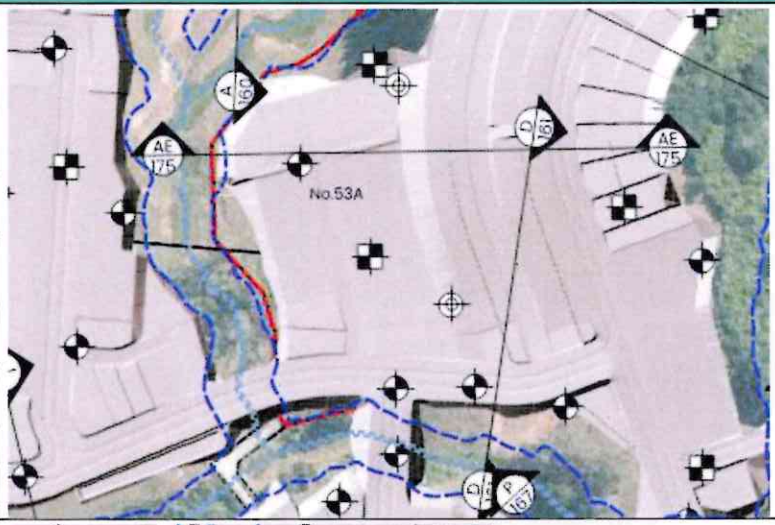
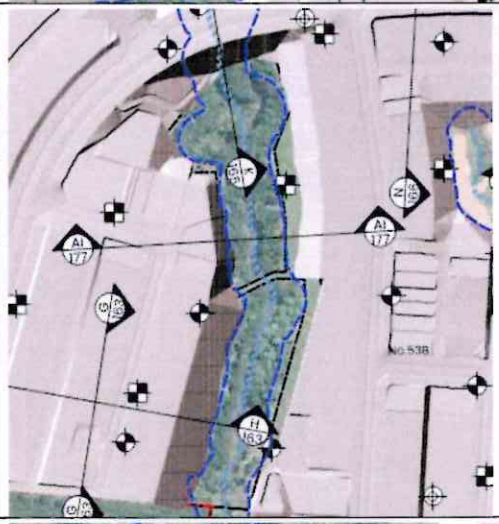
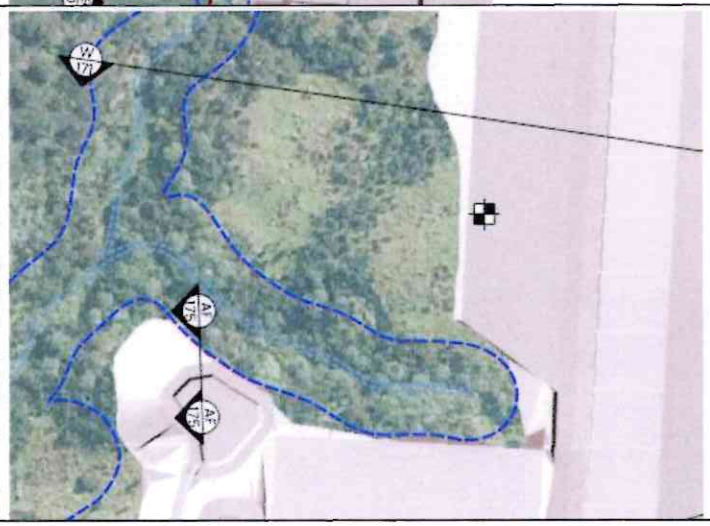
Critical Level[1]	Reach[1]	Cross Section[2]	Previous Design[2]	Previous Set-Back Distance	Updated Design After Geomorphic Consideration[3]
					Shear pile increased from 300kN to 400kN.
Green	7	E (reach 8)	REB slope with geogrid and shear pile.	Approx. 13m	No change to remedial design required to meet minimum FoS.
		F (reach 8)	None.	Approx. 25m	No change to remedial design required to meet minimum FoS.
Green	4	AE (NEW)	Assumed REB slope, geogrid and shear pile.	Approx. 11m	Proposed design meets minimum FoS. REB slope is at 45°. Shear pile to 6m depth at 1.5m spacing with shear capacity of 280kN. Geogrids 4m long, except within 1.2m of the surface under a building platform which is limited to 2m long.
Green	13 - 14	H	REB slope with geogrid and shear pile.	Approx. 8m	REB slope is steepened from 30° to 33° to create 10m set-back distance. Increase in cut to enable placement of engineered fill extending 11m into the slope (previous 9.2m). Geogrid increased in length from alternating 2m and 8.5m to 10m.
		AI (NEW)	Assumed REB slope, geogrid and shear pile.	East – Approx. 22m West – Approx. 12m	Eastern slope: REB slope is 45°. Geogrids 6m long, except within 1.2m of the surface under a building platform which is limited to 2m long. Western slope: REB slope is 55°. Geogrids 7m long, except within 1.2m of the surface under a building platform which is limited to 2m long. Shear pile to 6m depth at 1.5m spacing with shear capacity of 240kN.

Critical Level[1]	Reach[1]	Cross Section[2]	Previous Design[2]	Previous Set-Back Distance	Updated Design After Geomorphic Consideration[3]
Green	32	AF (NEW)	None assigned.	<10m	Cut section: The alignment of the stormwater retention pond would need to be moved in the design to provide the 10m set-back distance. Palisade wall to 4m depth at 1.5m spacing with shear capacity of 280kN (approximately 310UC97 or steel reinforced 600mm-750mm steel reinforced concrete piles) Fill section: REB slope can be steepened from 27° to 33° to create 10m set-back distance. Geogrids to be a minimum of 2m length. Further detailing is required to ensure topsoil stays in place on the steepened batter.

[1] As defined in Delmore Development Geomorphic Assessment - Field Investigation Memo, dated 20 November 2025.
[2] Refer to 250065-F, dated 14 February 2025.
[3] Stability run to include 3m wide x 2m deep stream.

Table 2: Figures Showing Relative Locations of New Cross Sections

Critical Level[1]	Reach[1]	Cross Section	Cross Section Location[2]
Red	2	AG (NEW)	
Red	36	AH (NEW)	

Critical Level[1]	Reach[1]	Cross Section	Cross Section Location[2]
Green	4	AE (NEW)	
Green	13-14	AI (NEW)	
Green	32	AF (NEW)	

[1] As defined in Delmore Development Geomorphic Assessment - Field Investigation Memo, dated 20 November 2025.

[redacted]

From: [redacted]
Sent: Wednesday, 29 October 2025 4:29 pm
To: [redacted]
Subject: Re: Delmore - Geomorphic Risk Assessment

Hi [redacted]

Thanks for your time earlier. Below is a summary of our discussion, including input from [redacted] from Morphum:

1. Green Areas: We are comfortable with the setback distances along these reaches. However, there are some engineering structures alongside the stream, such as palisade walls, MSE walls or road bridges. Where the table indicates a check is required, we would like confirmation that the structures have been designed to take account of the potential for downcutting and widening. The current profiles of streams vary, so for simplicity, assume a stream depth of 2m with a width of 3m and vertical side banks.
2. Red and Orange Areas: There is concern that stream adjustment will impact on the Lots and/or structures along these reaches and the current set back distance may be inadequate. In some cases, this appears to be less than 10 m. The location of structures and Lot boundaries should be revised and we recommend these be at least 10 m (and 15 m for Reach 2). Structure design and slope stability should assume a stream depth of 2m with a width of 3m and vertical side banks. While 10 m is proposed as a minimum, there may be instances where other constraints mean this is difficult and we are happy to discuss these on a case-by-case basis.
3. There are some areas, i.e., the wetlands, which are at risk of being channelised if the hydrology changes. For these, we are seeking clarification that stormwater controls are being put in place to minimise the change to the current flow hydrograph, i.e., through retention and detention. In general, we don't have concerns about T-Bars from a geomorphic perspective, as these will spread the flow over the slopes rather than create a concentrate discharge point to the stream. We recommend that the slopes around T-bars be vegetated to improve evapotranspiration, enhance bank stability, and slow the flow of the discharge downslope which will reduce the risk of surface scouring.

If you're unsure of what is required for any of the reaches, let us know and we can clarify them for you.

Ngā mihi | Kind Regards

[redacted]
ENVIRONMENTAL ENGINEER
[redacted] www.morphum.com

MORPHUM ENVIRONMENTAL

From: [redacted]
Sent: Wednesday, 29 October 2025 3:15 pm
To: [redacted]
Subject: RE: [External] Re: Delmore - Geomorphic Risk Assessment

Hi all

Thanks for the meeting just now. That was very helpful. Actions below:

1. [redacted]: to come back on [redacted] email and correct understanding about scope of work required (see below first bullet).
2. [redacted]: to address the t-bar in final report explaining why best option from geomorphic perspective.
3. [redacted]: to provide responses on Morphum table regarding how green and orange by end of week, and to advise on estimated timing for reds then too.

Kind regards

[redacted]

[redacted]
MILLS LANE CHAMBERS
[redacted]
Level 27, 125 Queen Street, Auckland, 1010
PO Box 537, Shortland Street, Auckland 1140

[redacted]
MILLS LANE CHAMBERS
[redacted]
Level 27, 125 Queen Street, Auckland, 1010
PO Box 537, Shortland Street, Auckland 1140

From: [redacted]
Sent: Wednesday, 29 October 2025 9:56 AM
To: [redacted]
Subject: RE: [External] Re: Delmore - Geomorphic Risk Assessment

Hi [redacted]

Thanks for your time to discuss the implications of your geomorphic assessment for the geotechnical stability enhancement measures.

To summarise our conversation I understand the following:

- That 1-2m of downcutting and 1-2m of channel migration/widening needs to be considered at all locations regardless of whether the reaches are classified as green, yellow or red, and that both need to be considered at each location.
- For the red zone, stability enhancement measures need to be located at least 15m from the stream (where noted, eg Reach 2).
- As discussed the depth to bedrock is variable across the site and at 4-5m depth at a number of locations near the streams. As discussed I understand that a downcutting allowance of only 1-2m needs to be made even where bedrock is at these depths.

- That the 1-2m downcutting and channel migration/widening is estimated to typically occur over a 50yr period.

Can you please confirm that I have captured that correctly. Also I think it would be helpful for those who have to use this and also for the Commissioners/Council if these elements could be explicitly stated so that they can easily understand what the recommended technical response to your assessment is. Perhaps that could be included as a separate section in the text after the summary.

I realise that we have only discussed the matters that have implications for the geotechnical aspects of the development. [redacted] might also have some questions/comments regarding stormwater/hydrology matters.

Please feel free to call if you have any questions.

Regards

[redacted]
RILEY
[redacted]

From: [redacted]
Sent: Tuesday, 28 October 2025 9:02 am
To: [redacted]
Subject: [External] Re: Delmore - Geomorphic Risk Assessment

CAUTION: This email originated from outside of Riley. Do not open links or attachments unless you know the content is safe.

Hi [redacted]

Have you reviewed this and made any assessment on the areas?

Regards,

myland
PARTNERS

[redacted]

From: [redacted]
Date: Wednesday, 22 October 2025 at 10:51 AM
To: [redacted]
Cc:

[redacted]

Subject: RE: Delmore - Geomorphic Risk Assessment

Hi [redacted]

Please find attached the memo with the preliminary findings from our field investigation.
Please let me know if you have any questions.

Ngā mihi | Kind Regards

[redacted]
ENVIRONMENTAL ENGINEER
m. +64 29 124 54570 www.morphum.com

MORPHUM ENVIRONMENTAL

From: [redacted]
Sent: Tuesday, 21 October 2025 8:36 am
To: [redacted]
Subject: RE: Delmore - Geomorphic Risk Assessment

Hi [redacted]

Our draft memo, including the tables and maps, is now under QA review. I'll send it through shortly.

Ngā mihi | Kind Regards

[redacted]
ENVIRONMENTAL ENGINEER
m. +64 29 124 54570 www.morphum.com

MORPHUM ENVIRONMENTAL

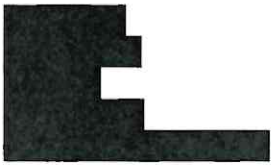
From: [redacted]
Sent: Monday, 20 October 2025 4:45 pm
To: [redacted]
Subject: Delmore - Geomorphic Risk Assessment

Hi all,

Thanks for the catch-up last week to discuss your findings on the geomorphic risk assessment.

I have cc'd in [redacted] (McKenzie & Co – civil engineer) and [redacted] (Riley – geotechnical engineer). Can you please touch base to work through the engineering solutions for the high-risk areas as discussed during the meeting.

Nga mihi | Kind regards,



B&A
Urban & Environmental

100 First Avenue,
Tauranga 3110

barker.co.nz

Kerikeri | Whangarei | Warkworth | Auckland | Hamilton | Cambridge | **Tauranga** | Havelock North | Wellington | Christchurch | Wanaka & Queenstown