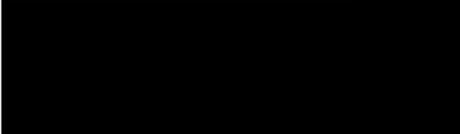


Date	10 February 2026
To	Jon Bright, Project Director – Waitaha Hydro Scheme Westpower Ltd
From	Murray Hicks (Earth Sciences New Zealand, formerly NIWA)
Project advice provided for	<i>Waitaha Hydro Scheme</i>
Qualifications	<i>BSc (Hons), BE (Hons, Civil), PhD, provided in Appendix 19: Sediment Report</i>
Code of Conduct	<i>Provided in Appendix 19: Sediment Report</i>
Documents referred to	<i>Waitaha Hydro Scheme Substantive Application Appendix 19: Sediment Report¹</i>
Signature	

1. I have read the peer review reports of Dr Jon Tunnicliffe and Mr Paul Morgan. I focus here on the Tunnicliffe report since that underpins the sediment-related issues raised in the Morgan report. Hence, I do not respond to any specific matters in the Morgan report as they follow my responses and conclusions to the Tunnicliffe report.

Executive summary

2. Having carefully considered Dr Tunnicliffe's review, overall, I am confident that:
 - (a) the effects of the Project on the river geomorphology and processes will not be as dire as Dr Tunnicliffe predicts, and
 - (b) my assessment that the sediment related effects of the Project on the river physical environment, after any mitigation triggered by monitoring, will be no more than minor.
 - (c) For the latter point, it is important that my effects gradings are interpreted with regard to their definitions given in Section 2.3.1 of the

¹ [Appendix-19-sediment-report.pdf](#)

Sediment Report²: “less than minor” is assigned to transient effects that would be difficult to discern and are well within the bounds of the natural variability observed to date in the Waitaha; “minor” is assigned to:

- (i) transient effects that are likely to be visible but still within the bounds of the natural variability observed to date in the Waitaha, or
- (ii) net morphological changes that might be measurable but are spatially limited and do not involve changes in channel form beyond that observed naturally from flood to flood.

Review of River Geomorphology (Jon Tunnicliffe report)

- 3. Dr Tunnicliffe’s review revolves around eight issues which led him to conclude that the scheme effects on the river geomorphology would be “moderate to more than minor”. I address his concerns in sequence below.

Issue 1: Bedload proportion and estimation methodology

- 4. In my Sediment Report³ I estimated that the long-term average bedload (which includes coarse sand, gravel, cobbles, and boulders) as 5-6% of the suspended load (which covers all finer material including finer sand and mud and has been reasonably well measured in the Waitaha). This estimate is based on the similarity of the of the Waitaha River and its catchment with the nearby Whataroa River and my experience working in the Whataroa River where I have estimated both its suspended load and bedload. Dr Tunnicliffe considers that this ratio is too low and that ratios several times higher (2-3+ times) should be considered.
- 5. I acknowledge the point Dr Tunnicliffe has raised but, of the two instances where estimated bedload transport rates are used in the Sediment Report, I undertook sensitivity analysis using higher ratios that fall within the 2-3+ factor proposed by Dr Tunnicliffe. Specifically, a 10X increase (equating to bedload being equivalent to 50% of suspended load) was used to assess deposition in the residual flow reach during extended periods of flow at 3.5 m³/s into that reach, while a 2X increase (equating to bedload being equivalent to 10% of the suspended load) was considered when assessing the downstream effects of gravel abstraction for access road building.

² [Appendix-19-sediment-report.pdf](#), page 17.

³ [Appendix-19-sediment-report.pdf](#), page 50.

Indeed, in the latter case the greater the bedload, the less the effect of the gravel abstraction.

6. His key concern, though, was that any underestimation of bedload delivery from Kiwi Flat would impact on the bedload-bypassing performance of the intake structure that has been designed. However, my understanding from the engineering team is that the intake structure design so far is largely conceptual and based on industry best practice (fully expecting a large, mountain regime bedload supply), and no bedload rates have been used in the intake engineering design to the stage that it has currently progressed. Rather, bedload transfer is to be included in Computational Fluid Dynamic (CFD) modelling at the next design stage should the approvals be granted (Dr Clunie Statement dated 10 February 2026) and that will require updated estimates of bedload delivery including extensive field measurements at Kiwi Flat including bed-material size – which may all lead to the current intake design being adjusted (within the parameters of the concept design). So, in that important regard, any underestimation of bedload proportions in the Sediment Report is moot.
7. Of a minor matter, my equation that increases the bedload/suspended load ratio as discharge increases is a purely empirical formulation derived from the Whataroa River by comparing its bedload and suspended load relationships with water discharge. It provides for a progressively increasing bedload/suspended-load ratio as discharge increases beyond the onset of bedload transport and provides a long-term average ratio of ~5% when integrated over the discharge record. It was applied to the Waitaha assuming physical similarity when discharge is normalised by mean discharge. Assuming a higher long-term average ratio of, say, 20% in the Waitaha would simply require multiplying the equation result by 4. It would not require assuming impossible values of the normalised discharge, as suggested by Dr Tunnicliffe in his paragraph 18.
8. Also inconsequential is Dr Tunnicliffe's comparison of suspended load estimates and cosmogenic ¹⁰Be-derived denudation rates in his paragraph 20. In that regard, when the uncertainty figures are considered, there is no significant difference between the Hicks et al. (2011)⁴ estimate of the Whataroa suspended load (3.8 ± 1.2 mm/y denudation) and the Larsen et al. figure (6.6 ± 1.7 mm/y denudation), even before considering the different

⁴ Hicks, D.M., Shankar U., McKerchar, A., Basher, L., Lynn I., Jessen, M. (2011) *Sediment yield from New Zealand rivers*, Journal of Hydrology (NZ) 50(1): 81-142.

temporal regimes (millennial for ^{10}Be denudation rates, decadal for the Hicks et al. 2011 data). So, the comparison is moot.

9. In summary, I accept that the bedload transport rates I estimated in my Sediment Report are likely underestimated. However, as explained above, I undertook sensitivity analyses using increased bedload rates when assessing bedload deposition in the abstraction reach during periods of steady flow at $3.5 \text{ m}^3/\text{s}$ and when assessing the downstream effects of gravel extraction for access road building. Moreover, my report's bedload estimates have not been utilised in the intake design to date (I note that Dr Clunie has used my suspended sediment loadings in his estimation of desander sediment rates). I am satisfied that the current concept design will allow bedload transfer into Morgan Gorge without the need for ongoing artificial bypassing by machine and that it will not promote extensive persistent aggradation of bedload over Kiwi Flat. Also, I consider that it retains flexibility to be modified as informed by the more detailed bedload investigations planned for the next design stage.

Issue 2: Sediment Connectivity at Morgan Gorge

Some misconceptions

10. Dr Tunnicliffe appears to have developed an opinion that the intake structure will stall sediment connectivity from Kiwi Flat into Morgan Gorge to the extent that persistent aggradation will occur upstream of the intake and continuous mechanical bypassing will be required to maintain bedload continuity. Hence his statement in his paragraph 13 that the scheme will result in a "more pulsed, intervention-dependent regime". His view appears to stem from some misconceptions about the Kiwi Flat river morphology and not appreciating the conceptual design of the intake structure including:
 - (a) the key transfer assistance provided by the sluice channel (explained further below and in the 10 February 2026 statements of Mr McCahon and Dr Clunie);
 - (b) some over-simplifications of the Kiwi Flat geomorphology (see below); and
 - (c) incorrectly assuming that bed material transfer connects into Morgan Gorge only during rising flood stages.
11. Specifically, in relation to Kiwi Flat:

- (a) A river gradient of 9 m/km along Kiwi Flat is not “low gradient”, nor is Kiwi Flat unconfined (its width is constrained by the valley walls which are simply set back further at the flat).
 - (b) The transition into Morgan Gorge is not abrupt. Morphologically, it begins some several hundred metres upstream of the gorge where the riverbed slope starts to progressively steepen along a convex profile (see Figure 3-3 in the Sediment Report⁵) and the channel narrows as the river funnels into the gorge. Refer also the statement of Mr Ian McCahon, dated 10 February 2026, for a description of this transition.
 - (c) Dr Tunnicliffe appears not to have appreciated the function and influence of the sediment sluicing/bypassing channel to be located towards the right side of the intake structure. While its primary purpose is to keep the intake clear of gravel, it also provides, when opened during floods and freshes, a low, steep passage for passing gravel through the headworks, in addition to gravel passing over the weir in such flows (explained further in the statements of Mr McCahon and Dr Clunie dated 10 February 2026). With the sluice in operation and while the intake structure is not drowned by the gorge choking, the “hard” geomorphic control, at least on the right side of the intake where the river thalweg and much of the flow will be focussed, will be the invert of the entrance to the sluicing channel. In particular, Figure 3 in Mr McCahon’s 10 February 2026 statement shows the weir crest (at 238 m RL) will sit at about the same level as the existing rock platform at the intake location (which naturally serves as a partial weir), and the sluice channel will provide some of the bedload conveyance that is presently provided by flow through the natural narrow “slot” carved in this bedrock platform (see also Figure C-6 from the Sediment Report⁶). In my opinion, with the Project and the sluice operating, there will be no significant change in the local geomorphic controls.
12. As described in Dr Clunie’s statement, the main purpose of mechanical intervention at the intake structure is to train the river flow

⁵ [Appendix-19-sediment-report.pdf](#), page 23.

⁶ [Appendix-19-sediment-report.pdf](#), page 42.

towards the sluice channel / intake as needed. It is not, and never has been, intended as a primary gravel bypassing mechanism.

Effect of hydraulic choking

13. Dr Tunncliffe has not, in my opinion, fully understood the role played by the hydraulic choking that occurs at the entry to Morgan Gorge during moderate-large floods. Naturally under such flow conditions, the primary hydraulic control on the flow into the gorge is exerted by the gorge walls rather than the bedrock level at its entrance. This causes water to “back-up” into the lower third of Kiwi Flat, flooding the normal river channel and lowering velocities through the backwater reach. Under choking, the bedload delivered from upper Kiwi Flat is deposited on lobes on a delta-front at the head of the backwater created (much like a river entering a reservoir deposits a delta), while the coarser suspended sand load carried into the lower velocity choked area settles-out on marginal banks. As flood flows and the choking wane, the channel bed profile at the gorge entrance resumes hydraulic control and the flows converge into the previous topography and the deposited sediment is reworked towards the gorge. Such reworking occurs both on a flood’s recession and on the rising stages of the next event.
14. This choking phenomena is naturally the main interrupter of coarse sediment transfer through into the gorge, and the upstream extent of the choking backwater (which varies depending on flood size) sets the geomorphic control on the upper 2/3 of Kiwi Flat. In my opinion, the natural hydraulic choking of Morgan Gorge will not be significantly influenced by the intake structure (which is why I do not expect the intake structure will affect all of Kiwi Flat).
15. Dr Tunncliffe has drawn some erroneous interpretations from his BASEMENT 2d hydraulic modelling on the effect of this choking (Figure A1 in his Appendix A).
 - (a) Firstly (and correctly in my opinion), the model shows that the “extensive slackwater conditions” (paragraph 25 in Tunncliffe review) only extend as far upstream as the Whirling Waters confluence, one-third of the way up the flat. Therefore, I do not agree with Dr Tunncliffe that it “dominates flow behaviour across Kiwi Flat”.

- (b) Secondly, his Figure A1 in his Appendix A highlights in my opinion an issue with his modelling which misleads on the timing and duration of bedload transfer along the lower part of Kiwi Flat. The issue is that the modelled flood is of un-naturally short duration. On his modelled hydrograph, flows rise between 250 m³/s and the 800 m³/s peak in only ~ 30 minutes and fall back again over the same time (~ 1 hour total duration). Figure 1 below (from data supplied by Mr Doyle) compares this modelled hydrograph with a real hydrograph from the Waitaha record with a similar peak discharge of 734 m³/s. The natural flood lasted ~ 14 hours above 250 m³/s.
16. On the rising limb of a flood it takes time (~ 15-20 minutes) for the inflow into the top of Kiwi Flat to translate down to Morgan Gorge. When the choking develops at the gorge it takes more time for the water to “bulk-up” in the backwater reach. Likewise, when the choking fades at the gorge on the flood recession it also takes time for the ponded water to drain. The duration of these response times for choking and unchoking depend on the “accommodation space” and the excess inflow over outflow but appear to be of the order of half to one hour (I provide evidence of this below). In the case of the Dr Tunnicliffe’s modelling, the flood is so short that I believe the backwater has not the time to fully develop until at or after the flood peak (Figures A1d and A1e in his Appendix A) and lingers down the recession while it drains (Figure A1f in his Appendix A).
17. In my opinion, Dr Tunnicliffe's assessment gives the false impression that bedload transport between upper Kiwi Flat and Morgan Gorge only connects during rising flood stages and does not connect on recessions. In contrast, natural Waitaha floods with peak discharges similar to the one modelled by Dr Tunnicliffe last some 10X longer, providing time for the backwater to develop on rising stages and to drain-away part-way down recessions – permitting bedload connection on both rising and falling hydrograph limbs. Moreover, the natural recessions are less steep than his modelled recession, providing a longer period of time for the unchoked recession flow to rework bedload down the lower flat into the gorge.

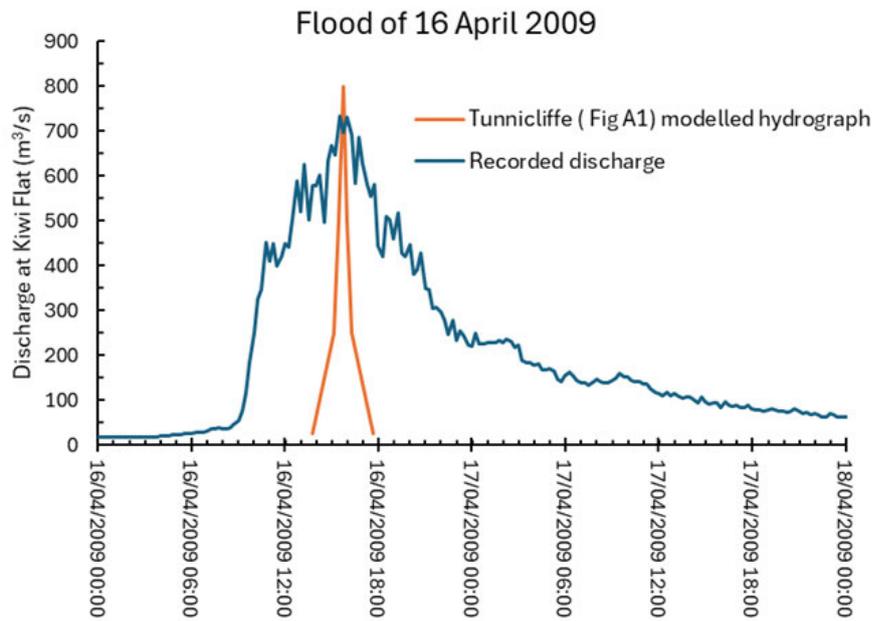


Figure 1: An example Waitaha flood peaking at 734 m³/s, with the reviewer’s modelled 800 m³/s flood superimposed (peaks aligned). The modelled flood spans only ~ 1 hour between passing 250 m³/s on the rising limb and passing it again on the falling limb – whereas the example real flood required 14 hours for this. This is a typical duration for floods of this size and larger at Kiwi Flat. Data supplied by Mr Doyle.

18. The natural choking behaviour is well illustrated by a sequence of photographs taken at the Morgan Gorge entrance during a flood in December 2013 (data supplied by Mr Doyle). These are shown on Figure 2, along with the discharge and water level at the gorge inlet. This sequence shows the choking developing on the rising limb, evident by the flooded river channel and the disappearance of “white-water” waves on the flow surface (including the drowning of the flow over the bedrock platform in the bottom left corner) between images 4 and 5, spanning a period of 1 hour. It then shows the choking fading on the recession at flows of around 220 m³/s between images 6 and 7, spanning a period of about 2 hours. This event was a relatively small one (discharge peaked at 423 m³/s) and lasted only about 7 hours, but there was clearly ample opportunity for bedload connection on the recession as well as on the rising limb, before and after the choked phase.

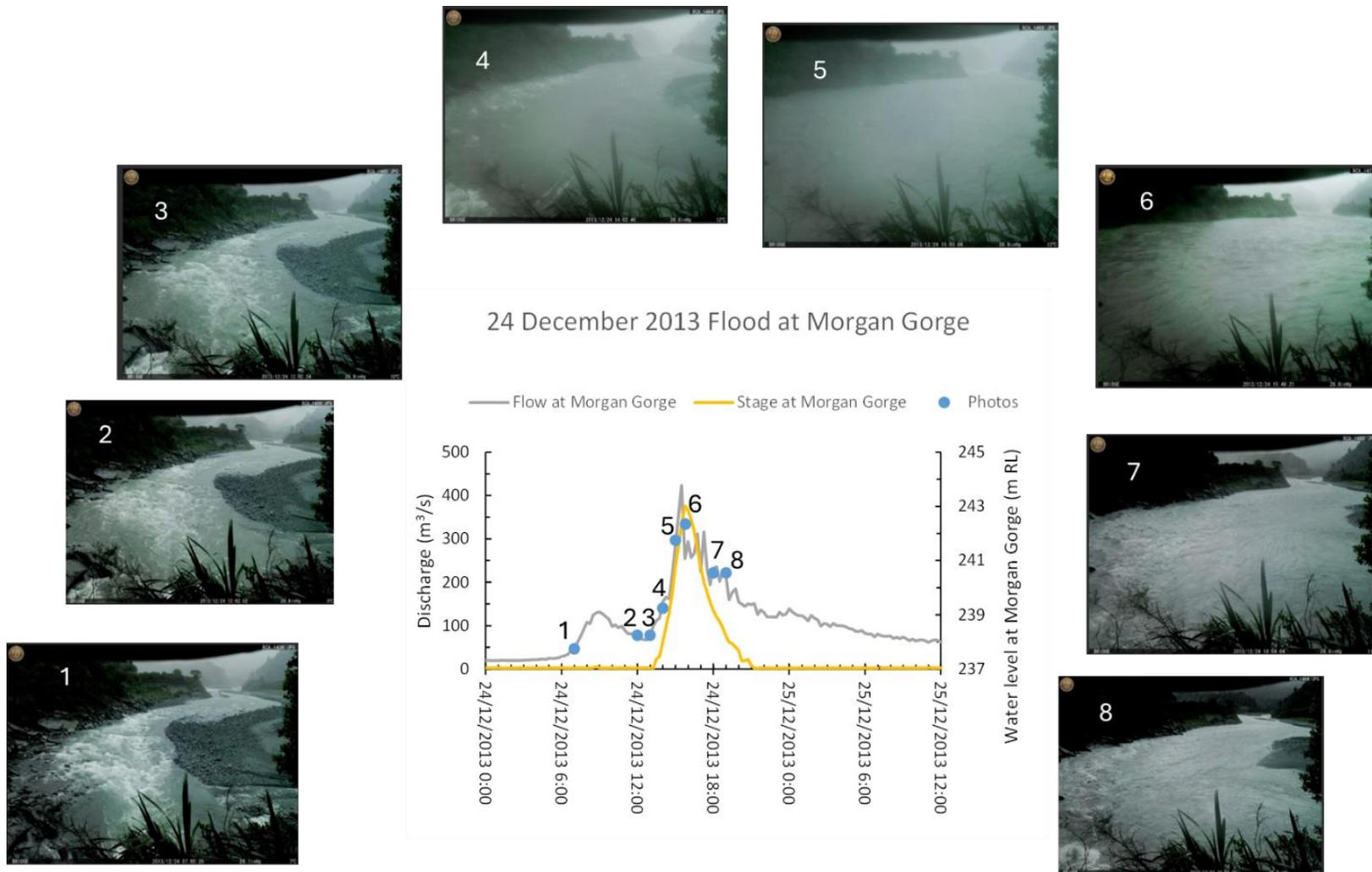


Figure 2: Photograph sequence looking upstream from Morgan Gorge entrance through a flood on 24-25 December 2013. The inset plot shows the photograph times overlaid on the discharge and water levels at the gorge entrance. To avoid damage, the water level sensor was located and began recording at a level 1.5 m above the gorge invert, hence the flat water-level trace at lower discharges.

19. With the Project, during the lower limbs of flood events when the gorge is not choked, gravel will pass the intake by weir-overtopping flows and flows through the sluice channel, and the only longer transfer interruption will involve the extraction of gravel from the intake area on the right side of the channel should the sluice channel become jammed with debris.
20. Therefore, in my opinion, Dr Tunncliffe's notion of the Project "shifting sediment delivery from a semi-continuous, event-driven process to a more pulsed, intervention-dependent regime"⁷ is not correct for multiple reasons.
21. I also have concerns as to how Dr Tunncliffe has interpreted his stream power long-profile on his Figure 1, which is reproduced here as my **Figure 3**.

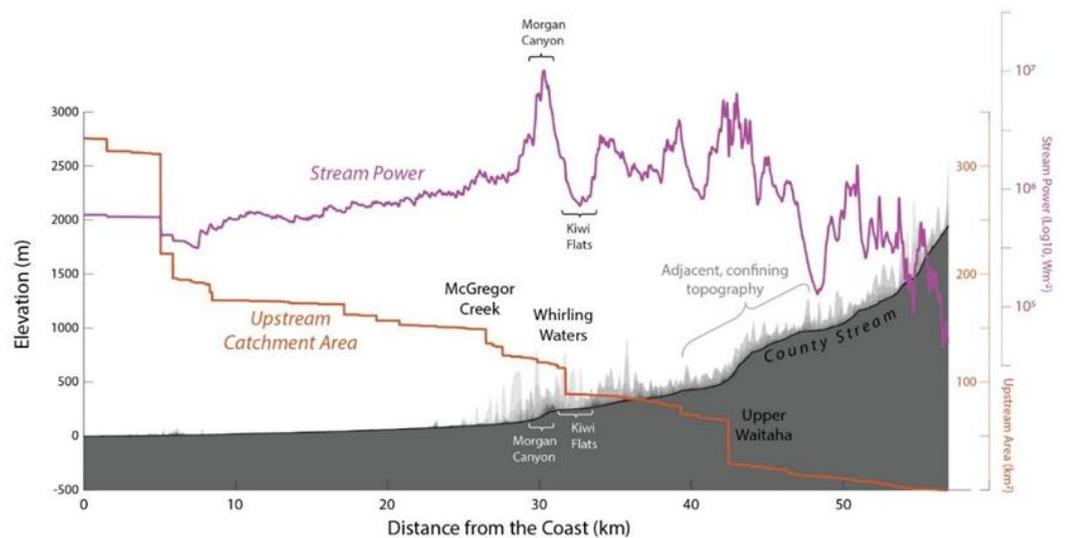


Figure 1 - Longitudinal profile of the Waitaha River from the upper end of County Stream to the coast. The bed elevation, upstream catchment area, and stream power have been assessed using LINZ regional LiDAR (2020-2025). The stream power (scaled logarithmically) emphasizes that the peak of transporting capacity is found within Morgan Gorge (note that capacity is seldom fully satisfied).

Figure 3: Dr Tunncliffe's Figure 1.

22. First, close examination of this plot shows that in fact the stream power is lowest upstream of the Whirling Waters confluence (which is

⁷ Paragraph 13 in Dr Tunncliffe's review.

located at the sudden jump on the underlying catchment area graph), it receives a sharp boost as the Whirling Waters flow is added, and it rapidly increases downstream from there towards the gorge. This confirms that the geomorphic “node” transcends a zone rather than being a single point.

23. Second, the stream power values appear to be too large. For example, on Dr Tunnicliffe’s Figure 1 the stream power minimum at Upper Kiwi Flat is approximately $7 \times 10^5 \text{ W/m}^2$. Using the field-measured slope (S) of ~ 0.009 , using $\sim 30 \text{ m}^3/\text{s}$ for the mean discharge (Q), and with water density (ρ) = 1000 kg/m^3 and the gravitational acceleration (g) = 9.81 m/s^2 , then stream power = $2.7 \times 10^3 \text{ W/m}^2$ – a factor of X260 smaller than the reviewer’s value. Even using a higher discharge (say $812 \text{ m}^3/\text{s}$ to match the mean annual flood at Morgan Gorge), the discrepancy would still be a factor of X10. Therefore, I am unclear where the reviewer’s numbers come from.
24. Setting these matters aside, however, and accepting the longitudinal pattern illustrated by Dr Tunnicliffe’s stream power profile, converting back from the plot’s log-scale shows that the stream power in the vicinity of the proposed power station (at $\sim 28 \text{ km}$ from the coast) is $\sim 2\text{X}$ higher than the low value at upper Kiwi Flat (at $\sim 32 \text{ km}$ on the plot) and increases upstream from the power station to $\sim 13\text{X}$ higher at the steepest part of Morgan Gorge. Allowing that the river along Kiwi Flat upstream of Whirling Waters, where the stream power is at its minimum, is in a state of dynamic equilibrium between bedload supply and transport capacity (as indexed by stream power), then the much higher stream power values between there and the power station site indicate that the river has excess transport capacity all along the abstraction reach. In my opinion, that is confirmed by the predominantly boulder-armoured channel along the abstraction reach in contrast to the more abundant proportions of gravel and coarse sand (which dominate the bedload) in the upper Kiwi Flat channel (compare Figures C-4 and C-9 in the Sediment Report)⁸. This illustrates to me the resilience of the abstraction reach channel to quickly pass any transient accumulation of gravel and sand stemming from the Project operations. Indeed, the bracketed note at the end of

⁸ [Appendix-19-sediment-report.pdf](#), pages 41 and 44.

Dr Tunnycliffe's Figure 1 caption acknowledges "that capacity is seldom fully satisfied".

25. Setting these matters aside, however, and accepting the longitudinal pattern illustrated by Dr Tunnicliffe's stream power profile, converting back from the plot's log-scale shows that the stream power in the vicinity of the proposed power station (at ~ 28 km from the coast) is ~ 2X higher than the low value at upper Kiwi Flat (at ~ 32 km on the plot) and increases upstream from the power station to ~ 13X higher at the steepest part of Morgan Gorge. Allowing that the river along Kiwi Flat upstream of Whirling Waters, where the stream power is at its minimum, is in a state of dynamic equilibrium between bedload supply and transport capacity (as indexed by stream power), then the much higher stream power values between there and the power station site indicate that the river has excess transport capacity all along the abstraction reach. In my opinion, that is confirmed by the predominantly boulder-armoured channel along the abstraction reach in contrast to the more abundant proportions of gravel and coarse sand (which dominate the bedload) in the upper Kiwi Flat channel (compare Figures C-4 and C-9 in the Sediment Report)⁹. This illustrates to me the resilience of the abstraction reach channel to quickly pass any transient accumulation of gravel and sand stemming from the Project operations. Indeed, the bracketed note at the end of Dr Tunnycliffe's Figure 1 caption acknowledges "that capacity is seldom fully satisfied".
26. On the same basis, I expect minimal impact on the bedload budget and channel geomorphology downstream of the power station because the intervening (residual flow) reach has excess transport capacity for the finer bedload phases (coarse sand and gravel) that dominate the bedload at moderate flows, and the frequent flood regime will "shunt on" what deposits in this reach at times when it is at significantly reduced flows. The cobble and boulder armour of the downstream reach will prevent any degradation due to any temporary stalling of the fine bedload phase in the residual flow channel above the powerhouse.

⁹ [Appendix-19-sediment-report.pdf](#), pages 41 and 44.

27. Therefore, while I broadly agree with Dr Tunnicliffe's statement that the river naturally maintains an equilibrium where there is a quasi-balance between bedload supply and transport capacity, in my view this only applies to the upper part of Kiwi Flat, above Whirling Waters. From there to the gorge the dynamics and bedload transfers are dominated by the gorge-choking phenomenon, while through the gorge and past the power station site the steeper river has excess transport capacity. If it did not, it would be mainly gravel- and sand-bedded, not boulder-armoured as it is.
28. Based on the above, I strongly dispute Dr Tunnicliffe's suggestion that the weir will alter the "balance" of bedload transfer down and out of Kiwi Flat, shifting the reach from transient sediment storage to ongoing aggradation.
29. I accept that 5-10 years would be a long time to wait to verify the geomorphic response of Kiwi Flat, so propose annual LiDAR or ground surveys of the reach between the gorge and the Whirling Waters confluence for the first 5 years after the intake structure is built. I would expect any net changes to develop over that time span.
30. Overall, in relation to sediment connectivity at Morgan Gorge, I:
 - (a) disagree with Dr Tunnicliffe's consideration of the geomorphology of Kiwi Flat and its transition into Morgan Gorge;
 - (b) consider that Dr Tunnicliffe has not:
 - (i) appreciated the function and influence of the sediment sluicing/bypassing channel;
 - (ii) fully understood the role played by the hydraulic choking that occurs at the entry to Morgan Gorge during moderate-large floods;
 - (iii) appreciated that bedload transport between upper Kiwi Flat and Morgan Gorge connects on recessions as well as during rising flood stages; and
 - (iv) appropriately interpreted his stream power long-profile on his Figure 1, such that while I agree the river naturally maintains a dynamic equilibrium between bedload supply and transport

capacity at the upper part of Kiwi Flat, above Whirling Waters, from there to the gorge the dynamics and bedload transfers are dominated by the gorge-choking phenomenon, while through the gorge and past the power station site the river has excess transport capacity; and

- (c) based on the above, disagree with Dr Tunnicliffe's conclusion that the scheme will induce a systemic shift in sediment delivery out of Kiwi Flat from a semi-continuous, event-driven process to a more pulsed, intervention-dependent regime.

Issue 3: Altered Flow Regime and Geomorphic Effectiveness

31. Dr Tunnicliffe develops the argument that the geomorphic effectiveness of the river at transporting sediment and delivering ecological functions (such as maintaining substrate) along the residual flow reach will be impaired by the diversion of flows when the natural river flow is under 250 m³/s. While some transient fine sediment deposition is acknowledged (and will be addressed by monitoring and mitigation), the severity of this is in my opinion overstated by Dr Tunnicliffe in two ways:

- (a) First, regarding "effective discharges" (paragraph 29 of Dr Tunnicliffe's review). I agree that in the geomorphic literature, "effective discharges" are mid-range discharges - by dint of the sediment transport "work rate" they do and the period of time that they occur. In the Waitaha, the effective discharge range for the suspended load is 300-400 m³/s (the steepest part of the cumulative load curve on Figure D-6 of the Sediment Report¹⁰). But such flows occur during all flood events that pass through and beyond that flow range, and the most effective floods (indexed by their peak flows) are typically held in the literature to align with the mean annual flood, which is 812 m³/s at Morgan Gorge (Appendix 18: Hydrology Report¹¹). This has an annual recurrence interval averaging 2.33 years and would not be regarded as an "extreme, catastrophic" flood (Dr Tunnicliffe's paragraph 29).
- (b) Secondly, and continuing from my comments in paragraph 24, the Waitaha channel through and beyond the residual flow reach has excess transport capacity for at least its sand and gravel load (as confirmed by Dr Tunnicliffe's Figure 1 and its steep, boulder-lined

¹⁰ [Appendix-19-sediment-report.pdf](#), page 49.

¹¹ [Appendix-18-hydrology-report.pdf](#), page 32.

channel). In my opinion, even smaller, common floods and freshes will provide ecological services and mobilise transient fine sediment deposits, even if they have had some of their discharge (and energy) diverted. For example, on average there are approximately 15 floods per year that have a peak discharge exceeding 250 m³/s when the scheme intake will be shut down, and 23 floods per year when the “residual flood” peak in the residual flow reach exceeds 127 m³/s (and the total discharge exceed 150 m³/s).

32. The same excess transport capacity concept as discussed above applies to the already boulder-armoured channel downstream of the power station. The popular analogy of “hungry waters” causing riverbed degradation only applies if a river is transporting bedload at its hydraulic capacity: if its bedload supply is reduced, it recovers the lost load by scouring its channel. The Waitaha River at this location is not acting in that manner. In contrast, in rivers like the Waitaha, with abundant cobble-boulder grade bed material, that “hungry waters” response is arrested by armouring, and the diminished bedload simply passes over the armour. That is how the Waitaha channel is today from Morgan Gorge past the power station site.
33. Therefore, in my opinion:
 - (a) Even relatively modest “residual floods” down the abstraction flow reach should, along with less common large floods, maintain the capacity to flush fine sediment from the bed of the residual flow channel.
 - (b) Thus, the geomorphic effectiveness of the Waitaha at transporting sediment and delivering ecological functions (such as maintaining substrate) along the abstraction reach should not be impaired by the diversion of flows when the natural river flow is under 250 m³/s
 - (c) The monitoring and adaptive management conditions proposed in the Application (Morgan Gorge Flushing Management Plan and the Site Operations and Maintenance Plan (**SOMP**)) are appropriate to safeguard this and, if ever necessary, practices can readily evolve in response to any feedback to reduce adverse effects that, while not anticipated, may potentially arise.

Issue 4: Fine Sediment Deposition and Subsurface Infiltration

34. Dr Tunnicliffe comments that the analysis of fine sediment effects fails to account for spatial heterogeneity of sediment deposition. Spatial heterogeneity in sediment deposition was accommodated in the Sediment Report's analysis (Section D.2)¹² to the level of physical habitat type. This was done by assigning different "effective depositional widths" to each physical habitat type, with deposition occurring over a wider proportion of the wetted width of the slow run habitat than in the fast bouldery run habitat. That produced greater masses of deposition per m channel length in the slow run habitat but the same deposit thickness because the width of channel experiencing deposition was wider. Furthermore, it is relevant that the environmental flow analysis of Allen and Hay (2013)¹³ did not identify any "pool" habitat in the abstraction reach, at least in the context of a pool being a segment of deep, slow velocity flow. Confirming this, while several "pools" can be seen on Google Earth Imagery of this reach (e.g., **Figure 4**), they are short and fed by flow jets that generate strong secondary circulation and turbulence in the pool (both of which entrain sediment) even if the mean streamwise flow velocity may be relatively low.
35. That said, I acknowledge the difficulty in predicting fine sediment deposition in the Waitaha river channel at all scales with adequate precision, and accordingly in the Sediment Report¹⁴ I recommended the monitoring and mitigation program for Morgan Gorge flushing that Westpower has adopted (see Mr Jackson's statement of 10 February 2026).
36. Dr Tunnicliffe has also expressed concern that even the frequent flood regime may not be able to flush fine more entrainment-resistant cohesive sediment that may have infiltrated into the coarse gravelly/cobbly/bouldery substrate framework, particularly in more sheltered locations along the channel. I regard this as unlikely because:
- (a) There are always micro-environments in the natural Waitaha environment where fine, potentially cohesive sediment might collect under the existing regime (e.g. Figure 2.3 in the Sediment Report¹⁵),

¹² [Appendix-19-sediment-report.pdf](#), pages 50-52.

¹³ Allen, C., Hay, J. (2013) In-stream habitat flow assessment for the Waitaha River: Morgan Gorge to Douglas Creek, Cawthron Report No. 2306. Prepared for EOS Ecology on behalf of Electronet Services.

¹⁴ [Appendix-19-sediment-report.pdf](#), Appendix F.

¹⁵ [Appendix-19-sediment-report.pdf](#), page 10.

but there is no evidence that such deposits are widespread or last longer than the next fresh.

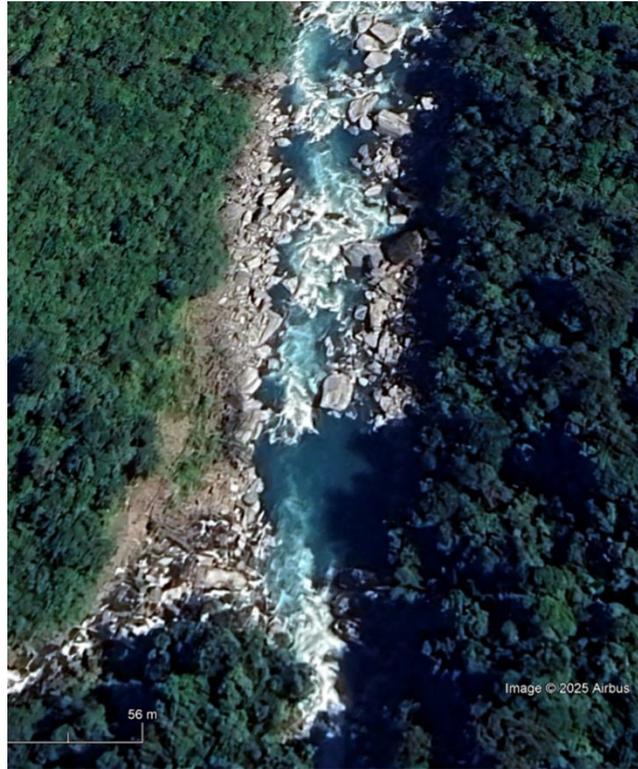


Figure 4: Short pools below the Glamour Glen confluence in the residual flow reach. White water plumes show “jets” of high momentum inflow that energises secondary circulation and turbulence in the pools. Flow direction is up the page. Source Google Earth.

- (b) Cohesion-developing clay minerals travel as “wash load” in steep mountain rivers like the Waitaha and its West Coast neighbours, meaning they remain in suspension during freshes and floods and will be the last to deposit from suspension even in local, low-velocity environments. Indeed, fine sediment samples collected in 2024 from low velocity patches at Kiwi Flat and immediately below Morgan Gorge were, even after treating with chemical dispersant to break-apart flocs of cohesive grains, at least 86% sand grade so had only minor content of potentially cohesive mud (**Figure 5**).
- (c) Section D4 of the Sediment Report¹⁶ notes that the mud content of a gravel bar sample in the Whataroa was only 0.52%, and I expect similar levels of mud “embeddedness” in gravelly bars and patches from Morgan Gorge to the power station.

¹⁶ [Appendix-19-sediment-report.pdf](#), pages 53-56.

Below Morgan Gorge, pool-side beach



Kiwi Flat, channel-side berm

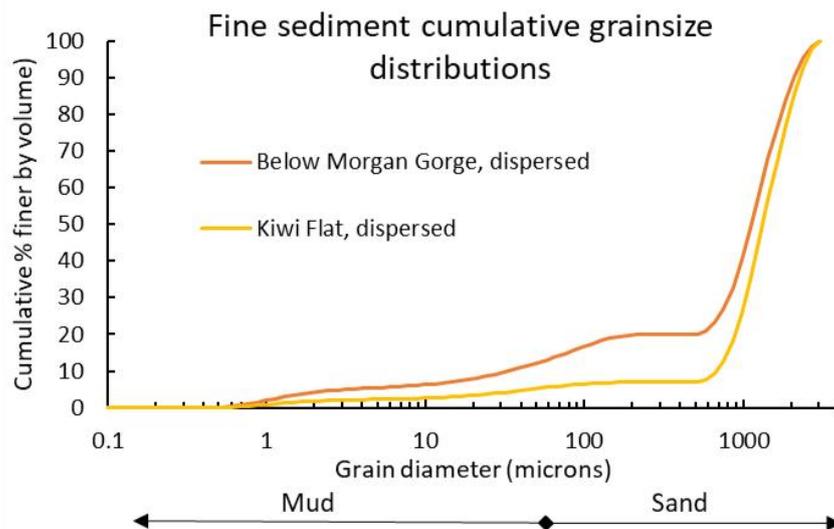


Figure 5: Grainsize distributions of fine sediment samples collected from low-energy sites below Morgan Gorge (a pool-side beach) and at Kiwi Flat (flat berm beside main channel). Samples were dispersed with anti-coagulant to separate grain flocs. Most of both samples were coarse to very coarse sand, with minor populations of very-fine to fine sand (63-250 microns) and clay (<4 microns). Only 5.7% of the Kiwi Flat sample and 13.6% of the Morgan Gorge sample were potentially cohesive, mud-grade sediment finer than 63 microns.

37. Therefore, in my opinion, subsurface infiltration, particularly of cohesive sediment that resists re-entrainment, is unlikely given:
- (a) the dynamic nature of the steep, bouldery abstraction reach, with frequent floods and lack of slow flowing “pools”;
 - (b) the non-cohesive nature of the sediments primarily involved (i.e., only a relatively small clay fraction has been observed on the bed).

38. However, surface cover sediment is included in the proposed monitoring for the Morgan Gorge Flush Management Plan (see Mr Jackson's statement, 10 February 2026).

Issue 5: Desander Flushing and Artificial Sediment Pulses

39. Dr Tunnicliffe comments in his paragraph 38 that the desander flushes will deliver an unnatural pulse of 375 tonnes of sand and that there will likely be times when the desander needs flushing but a suitable river flow event capable of on-flushing the sand down the river is not naturally forthcoming. I disagree because:

- (a) In my opinion, some degree of "unnaturalness" is unavoidable in the scheme's operation, but synchronising the desander flushes with natural runoff events aims to mitigate this as far as practical. Moreover, the excess transport capacity of the receiving channel should disperse the sand quickly. I note that Figure D4 of the Sediment Report¹⁷ shows that the river naturally experiences over a factor-of-ten range in suspended sediment concentration (and load) at a given discharge with no effects having been reported. This confirms that the river's sand transport capacity greatly exceeds its average observed sand load.
- (b) My analysis of event suspended sediment loads using the flow record from 1973 to 2012 showed that if the desander flush was triggered during the next event with a peak discharge exceeding 75 m³/s, the river's suspended sand load coarser than 0.3 mm would be many times greater than the 375 t flush mass during most desander flush events. Specifically, 60% of flushes would have an event sand load / flushed sand mass ratio > 10 while only 11% would have an event load / flush mass ratio < 2. With an average of about 9 flushes per year estimated, this means that the flush mass will approach the associated event load approximately only once per year on a long-term average basis.
- (c) However, as explained by Dr Clunie in his 10 February 2026 statement), the desander design allows for a considerable storage buffer that will allow flushing to be delayed until a suitable event arrives. My analysis showed that there will be on average many more candidate flushing events than will need to be used. For example, on a long-term average basis there are 35 events per year exceeding 75 m³/s, 29 per

¹⁷ [Appendix-19-sediment-report.pdf](#), page 47.

year exceeding 100 m³/s, and 23 per year exceeding 150 m³/s. This shows there is flexibility to select which natural events the desander is flushed into using forecasted high flows.

40. In summary, desander flushing, delivering a relatively brief sand pulse beside the power station quasi-monthly on average, is an unavoidable “unnatural” part of the scheme. However, by discharging into floods this sand discharge will be mixed with typically much larger sand loads carried by the river transporting below its capacity. Moreover, the desander will have sufficient storage capacity, and there will be a surplus of floods available, to enable flushes to be synchronised with floods selected from forecasting. Therefore, I see the desander flushing, so managed, as having no more than minor effects.

Issue 6: Limitations of Visual Monitoring

41. Dr Tunnicliffe (in his paragraphs 41 and 42) is concerned that the proposed visual monitoring of fine sediment deposition on the bed surface of the residual flow channel will overlook fine sediment more deeply embedded in the substrate. He recommends quantitative monitoring of such embeddedness. He also questions if the 20% change threshold proposed is scientifically robust.
42. Given my comments in response to Issue 4 I do not consider that embeddedness monitoring is warranted. It would also:
- (a) be challenging (from a practical as well as a health and safety perspective) in the steep, bouldery channel of the abstraction reach, and realistically, even at flows as low as 3.5 m³/s this could only be done at gravelly/cobbly patches; and
 - (b) add considerably to the proposed monitoring effort (2-weekly inspections during extended periods when the residual reach flow is at 3.5 m³/s). Fine sediment cover is part of the proposed monitoring plan and relevant triggers will be developed following trials (refer to Mr Jackson’s statement of 10 February 2026).
43. As discussed in Appendix F of the Sediment Report¹⁸, the proposed 20% change from the reference bed state is a Waitaha-specific criterion that acknowledges the expected variability in the reference state once that has

¹⁸ [Appendix-19-sediment-report.pdf](#), pages 74-76.

been measured. This tolerance could be reduced to 10% to align with the criterion of Clapcott et al. (2011)¹⁹. However, the Clapcott et al. criterion was developed for wadeable streams and not for large, non-wadeable rivers like the Waitaha; moreover, it was a guideline rather than a fixed value. As explained by Ms McMurtrie in her evidence, even sampling under residual flow conditions in the Waitaha will be challenging, with the high variability in depositional environments and expected high temporal variability over the baseline period requiring a large number of samples to establish the baseline condition to a precision (which would need to be much less than 10%) to enable a 10% change to be detected with confidence. A way forward is to delay setting the adaptive management response trigger until the baseline dataset has been collected and the baseline precision determined. Indeed, this is now reflected in the Morgan Gorge Flushing Management Plan consent condition as covered in Jackson's statement of 10 February 2026.

44. Therefore, given my opinions above, I continue to support the visual monitoring approach as proposed without quantitative monitoring of embeddedness. The fine sediment cover change tolerance for triggering adaptive management is a Waitaha-specific criterion that acknowledges the expected variability in the reference state and can be set within the Morgan Gorge Flushing Management Plan once the baseline dataset has been collected and the baseline precision determined.

¹⁹ Clapcott, J.E., Young, R.G., Harding, J.S., Matthaei, C.D., Quinn, J.M. and Death, R.G. (2011) *Sediment Assessment Methods: Protocols and guidelines for assessing the effects of deposited fine sediment on in-stream values*. Cawthron Institute, Nelson, New Zealand.

Issue 7: Fundamental Limitations of Adaptive Management

45. Given my opinions expressed above, and in my technical report, I do not agree with Dr Tunnicliffe's assertion (at paragraph 44) of reliance on adaptive management as the primary safeguard against adverse effects. As discussed above, I consider that the primary issues around continuity of sediment transfer are being dealt with by the weir and sluice / intake design, the SOMP and the fact that the Waitaha channel along the impacted reach has, by virtue of its steep gradient and frequent flood regime, the physical capacity to transport considerably more sediment than is supplied to it. The monitoring and adaptive management that has been proposed is designed to optimise mitigation measures (e.g., flushing flow releases, synchronising desander flushes with floods) within the parameters of the Project.
46. I therefore support the management regime as set out in the proposed conditions, and in particular, the requirement to include operational and maintenance procedures in the SOMP²⁰ and associated provisions to monitor and report the frequency, duration, and spatial extent of in-stream sediment excavation works required above the Headworks²¹ and the ability to review and update the SOMP if required.

Issue 8: Long-Term Maintenance Dependency

47. As pointed out in the 10 February 2026 evidence of Mr McCahon and Dr Clunie, the in-channel maintenance works are primarily to train the river flow towards the intake and sluice channel as needed. My understanding is that they will extend upstream only as far as necessary to achieve this purpose, likely some 10s of metres. There will likely also be a secondary need to clear debris (logs and/or gravel) blocking the intake and sluice channel from time to time. As a consequence of such works, some gravel will no doubt pass into Morgan Gorge, but this is not intended as the primary means of bypassing gravel as Dr Tunnicliffe asserts. That will occur via the sluice channel and during larger flow, directly over the top of the weir itself.
48. As noted above, plans for sluice operation and intake maintenance are included under the SOMP. An outline of these is included in the statement of Dr Clunie dated 10 February 2026.

²⁰ Part B, Conditions 23

²¹ Part B, Conditions 26

49. I also note that annual reporting to the consenting authority is to include the frequency, duration, and spatial extent of in-channel maintenance works at the intake.

Dr Murray Hicks