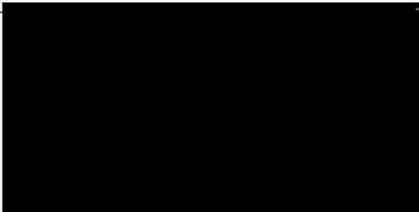


Date	10 February 2026
To	Jon Bright, Project Director – Waitaha Hydro Scheme Westpower Ltd
From	Dougal Clunie
Project advice provided for	<i>Waitaha Hydro Scheme</i>
Qualifications	<i>BE(Hons), PhD and Appendix A</i>
Code of Conduct	<i>Appendix B</i>
Documents referred to	<i>Waitaha Hydro Scheme Substantive Application Appendix 3 Project Overview Report, Appendix 19: Sediment Report, Appendix 42: Conceptual Scheme Design Drawings¹</i>
Signature	

1. I respond, as relevant, to various engineering design matters contained in the peer review reports prepared by the Panel’s technical advisors (the “**Review reports**”):
 - (a) Waitaha Hydro Power Review of Intake Engineering and Fish Passage (26 January 2026) prepared by Mr Paul Morgan (the “**Morgan report**”); and
 - (b) Statement of Evidence of Dr Jon Tunnicliffe on River Geomorphology (23 January 2026) (the “**Tunnicliffe report**”).

2. Overall, my conclusions are that:
 - (a) The sluice gate through the weir immediately adjacent to the intake will provide for the passage of coarse sediment and allow remobilisation of sediment that aggrades within the intake channel. Mechanical maintenance is to assist in reshaping or realigning the intake approach channel following high or unusual sediment deposition events. I consider that a description of a “maintenance-intensive operational

¹ [Appendix-42-conceptual-scheme-design-drawings.pdf](#)

regime” focussed on mechanical excavation misrepresents the approach to sediment management and is incorrect.

- (b) Given the design stage of the Project, with detailed design yet to be undertaken, detailed computational fluid dynamics (CFD) morphodynamic modelling of the intake, approach channel, and upper gorge area is yet to occur. This modelling is planned for subsequent design phases and will provide the inputs necessary to refine the optimal size of the sluice gate opening and optimise shaping of the intake area.
3. Having considered the Tunnicliffe review I remain confident that the Project can be designed and constructed to appropriately:
- (a) address sediment loads through the system and via the desander;
 - (b) pass bedload sediment over the weir and through the sluice gate opening during high flow events, closely matching the natural rates and timing of sediment delivery into Morgan Gorge, and
 - (c) manage sediment flushing through the sluice gates and into Morgan Gorge as the primary means of maintaining the intake channel, , with mechanical intervention only required on an exceptions basis to assist in reshaping or realigning the intake approach.
4. My qualifications and experience are detailed in **Appendix A** and include a PhD in the study of hydrodynamics of bedload transporting flows. I have considered the Review reports and I address material concerns raised within each of these in turn below.

Review of River Geomorphology (The Tunnicliffe report)

5. The Tunnicliffe report provides a review of the Sediment Report, identifying issues in the assessment of effects including bedload (coarse sediment) transport and aggradation in the intake area, and envisions the need for “*repeated mechanical intervention to manage sediment and debris*” and that “*This maintenance dependency... cannot be fully mitigated through detailed engineering design or consent conditions.*” The review notes that a detailed sediment management plan is not included in the Application documentation, concluding “*there does not appear to be a plan to manage potential ongoing aggradation...*”.

6. The Tunncliffe report appears to overlook or not appreciate the provision of a large sluice gate through the weir immediately adjacent to the intake, which will provide for the passage of coarse sediment and allow remobilisation of sediment that aggrades within the intake channel. There is no reference in the review to sluicing and/or flushing of coarse sediments and repeated mention of mechanical intervention, highlighting the reviewer's misinterpretation of the Project's design intent.
7. Mechanical intervention by an excavator is allowed for in the Project description for maintenance, i.e. reshaping of the intake approach channel to deal with lateral movement of the channel or excessive/unusual aggradation at the channel approach. It is not intended as the regular means of sediment management. The Application (Project Overview² Appendix A: Summary Project Description) states "*Maintenance work in the river will involve an excavator (~12-20t), clearing gravel/boulders to ensure that the river flows toward the intake and sluice gate. It is not envisaged that the full intake channel profile would be recreated, but rather the channel 'trained', and larger boulders/debris moved so that it can flow in the desired direction and sluicing flows can do the bulk of the work of moving gravels.*"
8. The concept design presented in the Application includes the low-height weir and sluice channel/gate to provide continuous transport of coarse sediment (acknowledging some permanent increase in riverbed aggradation in the lower Kiwi Flat occurring in the very short term possibly during the first high-flow event, as the bed readjusts to the weir and the normal regime then continues) whilst maintaining a low flow channel to the intake to provide for ongoing Project operation. To clarify and further detail the intended sediment management philosophy, **Appendix C** describes the use of the sluice gate for flushing and sluicing of coarse sediments and debris.
9. In summary, the sediment management philosophy is to operate the sluice gate, in conjunction with the majority of high flow and sediment transport passing over the weir, to maintain close-to-natural timing of coarse sediment transport past the intake, i.e. continuously during high flow events, especially on rising and receding flood limbs.

² Appendix 3 Project overview report

10. Should approvals be granted, detailed computational fluid dynamics (CFD) morphodynamic modelling of the intake, approach channel, and upper gorge area is planned for the detailed design stage of the Project. This work will:
 - (a) refine the optimal size of the sluice gate opening;
 - (b) optimise shaping of the intake area to best encourage sediment passage through flushing and sluicing; discourage deposition immediately in front of the intake; and
 - (c) inform the expected duration of flushing flows through the sluice gate at the recession of high flow events.
11. Detailed morphodynamic modelling will require extensive sediment data collection and wider-area (Kiwi Flat) morphological modelling to define the characteristics, quantities and timing of sediment inflows. This will require significant time and cost, and in my opinion is not required to demonstrate the level of effects of scheme. Rather, in addition to design optimisation, the current key uncertainties to be resolved by detailed assessment are of an operational nature (e.g. how long the station will be offline while sluice-channel flushing is undertaken).
12. The Tunncliffe report (in Issue 1) identifies uncertainty in bedload estimates and recommends that higher proportions of bedload be considered with implications for intake operability.
13. I acknowledge the uncertainty and natural variability in bedload rates, and the subsequent importance of a 'passive' (i.e. not reliant on continuous physical excavation) means of maintaining sediment movement past the intake, with an adaptable operation. Sensitivity analyses including varying bedload estimates will be included in morphological modelling planned for the detailed design phase of the Project.
14. The Tunncliffe report (in Issue 2) presents 2D modelling results showing "*extensive slackwater conditions*" on the receding flood limb and concludes that sediment is most effectively transported on rising limb of flood events.
15. The modelled scenario is in my opinion unrealistic, leading to an erroneous conclusion that the receding limb of floods will be significantly less effective in transporting sediment. The modelling simulates recession of a large flood in a very quick time (700 m³/s in just over 1 hour). As set out in the evidence of Dr Hicks dated 10 February 2026, the natural recession of flood flows into

Kiwi Flat are considerably slower. I do not consider that the difference in river extents in rising and receding flow conditions will be as stark as shown in Figure 2 of the Tunncliffe report, and as result, in my opinion (aligned with that of Dr Hicks), significant sediment transport is expected on receding flood limbs.

16. Based on the majority of the medium-high flows being passed over the low-height weir with a hydraulic control not dissimilar to the existing natural case (further explained below), supplemented by use of the sluice gate as described in **Appendix C** to maintain a low flow channel, I do not agree with the Tunncliffe report (paras 26 and 27) that there will be a shift *toward persistent accumulation or ongoing aggradation*, nor that *sediment delivery downstream would become increasingly intermittent*.
17. The Tunncliffe report (in Issue 5) raises concerns about the ability of the receiving environment to disperse sand flushed from the desander.
18. I note the desander design allows for at least 12 months of storage at estimated suspended sediment inflows before its functionality is affected. There is therefore not anticipated to be an issue with needing to flush outside of the proposed >75m³/s river flow regime, which occurs on average 35 times per year.
19. I caution any comparison of desander flushing with reservoir flushing research (review para 40). In contrast to a reservoir where generally almost all sizes of sediment are trapped, only a small proportion of sand and small gravel-sized sediment will be settled and subsequently flushed from the Waitaha scheme. This arises from a deliberate design choice (using a side intake) to reduce sediment entering the desander as stated in the evidence of Mr McCahon). Coarse sediment delivery downstream is maintained through the abstraction reach as discussed in the evidence of Dr Hicks, and fine sediment delivery downstream is maintained primarily through suspended passage into the abstraction reach and, for a smaller portion, passage through the turbines. In contrast to reservoir schemes, the proposed scheme is run-of-river, with the flow regime downstream of the power station largely unchanged from its natural state.
20. The Tunncliffe report (in Issue 8) raises concerns around maintenance dependency *“inherent to the intake location”* that *“cannot be fully mitigated through detailed engineering “design or consent conditions.”*

21. As detailed above, I assume that there has been a misunderstanding of the coarse sediment management provisions and philosophy. Given the large and variable flood flows and sediment load of the river, I consider it is prudent to allow for maintenance activities to assist in reshaping or realigning the intake approach channel following extreme or unusual sediment deposition events. I consider that a description of a “*maintenance-intensive operational regime*” misrepresents the approach to sediment management as further outlined in **Appendix C**.

Review of Intake Engineering and Fish Passage (The Morgan report)

22. The Morgan report provides a review of the hydraulic design of the intake, focussing on the reliability of residual flow bypass, the reliability of sediment passage, the functionality of the desander, and advice relating to the robustness of analysis and conclusions, and advice on fish passage.
23. I acknowledge the Morgan report’s comment that detailed hydraulic analysis is not provided in the Application. The Application presents a concept design, focussing on the location, layout/arrangement and key dimensions of the main components of the scheme. Whilst referred to as a ‘concept’, a significant amount of collaborative effort has gone into the design to date as explained in the evidence of Mr Rodger Griffiths, Mr Ian McCahon, and Mr Jeremy Kent-Johnson. Critically, the conditions (Part C9, Conditions 2 and 4) establish and require a process to complete detailed design through collaboration of a suitably qualified and experienced engineer, a freshwater ecologist and an expert familiar with whio. Mr Jackson addresses this process, as required by Westpower’s proposed consent conditions, in more detail.
24. I also acknowledge the Morgan report’s comments that the Application presents no significant analysis as to how coarse sediment will be managed, which has potentially led to a misinterpretation of the sediment management philosophy by the reviewers. This misinterpretation is apparent in the statement that “*the main approach will require physically removing coarse sediment and debris that arrives at the intake.*” That is not correct; rather the design allows the majority of sediment to pass over the weir in medium-high flows, with the sluice gate used to bypass sediment in lower flows and to maintain the intake channel at a lower elevation. Maintenance using an excavator to reshape the intake approach channel to aid sediment

sluicing/flushing is the exception, and the conditions proposed by Westpower require annual reporting on such maintenance works (Part B, Condition 26).

25. The reviewer comments that "*The design for the management of coarse sediment and debris appears to be very limited.*" While the material provided to date has not included extensive discussion on the design of the Project in relation to the management of coarse sediment and debris, in fact a significant amount of thought and discussion has gone into this. To clarify and further detail the intended sediment management philosophy, **Appendix C** describes the use of the sluice gate for flushing and sluicing of coarse sediments and debris.
26. A key issue raised in the Morgan report is the development of the intake concept and whether a weir structure and side intake is the "best" intake type for this location. This issue is addressed in the evidence of Mr McCahon. From my involvement with the Project, I agree with Mr McCahon's concept design with a low weir and a side intake.
27. The Morgan report questions "*Does the weir need to be 7m high as greater height has implications for sediment but also energy to dissipate and environmental effects including upstream fish passage difficulties?*" To clarify, 7m is the **maximum** height of the main weir structure above the excavated sluice channel. This depth is necessary to allow the sluice to keep the submerged intake clear of sediment.
28. The weir crest itself is at EL 238 m, approximately 3 m above the 8 m wide 'notch' in the existing rock bar riverbed at this location. The effect of the weir as a hydraulic control on upstream flows is an approximate 2 m increase in water surface at low flows, decreasing at higher flows to be zero as the weir is drowned by the choking effect of the gorge at flows of around 150 m³/s (**Figure 1**).
29. For fish passage effects, the relevant height would be the difference between tailwater level and weir crest elevation, which is approximately 5.5 m at the lowest bypassed flow condition (3.5 m³/s), reducing as flow into Morgan Gorge increases as illustrated in **Figure 1**. In the existing situation there is a 2-3 m drop in water level across the weir and headworks area in low flows

through a short series of rapids as shown in **Figure 2**.

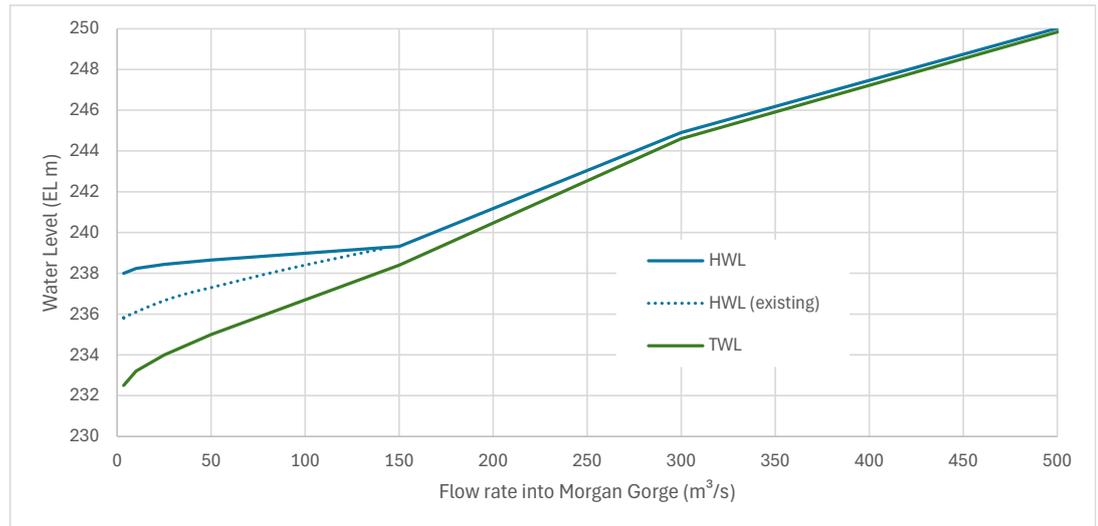


Figure 1: Indicative rating curves showing modelled headwater level upstream of weir (HWL) and tailwater level (TWL) 25m downstream, as well existing headwater level upstream of rock bar.



Figure 2: View of Waitaha River in low flow conditions ($Q \approx 11 \text{ m}^3/\text{s}$) from swing bridge, showing a drop in water surface elevation of 2-3m.

30. I agree with the Morgan review's statements that a river intake is a very complex and challenging structure to design, and that in a modern approach the design process must consider and balance the function in terms of water,

sediment and debris passage with environmental, cultural, social and safety related issues or requirements.

31. Exactly those considerations have driven the site selection, conceptual arrangement with low weir, 'buried' side intake and upstream kōaro passage provision, and concept design of the flow and sediment bypass structures. As emphasised in Mr Griffith's evidence the Project design has taken significant shape from the environmental effects and minimising those as far as practicable.
32. The Morgan report also comments on:
 - (a) The reliability of residual flow passage (review section 1.2, and 7.1a).
 - (i) The concept design arrangement of the environmental release gate in the Application drawings presents a 1m x 1m flow control gate that will normally be partially-open, as identified by the reviewer, to pass at least 3.5 m³/s under the controlled headwater level. The arrangement allows for the gate to be fully opened to pass a greater flow rate to free any blockage, in the case that occurs.
 - (ii) Following the Application, design refinement has reconsidered the position of the gate intake to be downstream of (behind) the intake screens. While this is a small change in terms of the structure, it will minimise the chance of gate blockage by sediment and/or debris. In this position the continuous flow release also acts as a continuously sluiced 'rock trap' for the coarsest material that is transported through the intake screen. These sort of design adjustments, providing continued improvements, will continue during a collaborative detailed design process.
 - (iii) The residual flow release rate will be continuously monitored, and in the unexpected case that if it falls below the required 3.5 m³/s (e.g. if the environmental release gate is blocked), the Project's control system will reduce station output to allow the required bypass flow over the weir.

- (b) The reliability of sediment passage at the intake (review section 1.2, and 7.1b).
 - (i) As detailed in **Appendix C** the sediment management philosophy is to use the sluice gate for sluicing of coarse sediments and debris, and draw-down flushing where hydrological conditions allow (especially at the recession of floods) to mobilise sediment from further upstream and maintain a clear intake. As addressed in my evidence above, detailed CFD morphodynamic modelling is planned for the detailed design stage of the Project to refine the optimal size of the sluice gate opening and optimise shaping of the intake area.
- (c) A key item of the review scope is the reliability of the desander functionality (review section 1.2, and 7.1c).
 - (i) The Morgan report mentions a concern that coarser sediments may pass the intake bars and deposit upstream of or within the desander. As I have addressed above, the repositioned environmental release gate will be combined with a 'rock trap' shape to provide continuous sluicing of coarse material that passes the intake bars.
 - (ii) The design arrangement allows for the intake to be isolated from the river with intake gates/stoplogs, with access available through a maintenance adit into the dewatered desander chamber. This will allow for the removal of any coarse material that reaches and accumulates within the desander, if necessary.
 - (iii) The design of the desander, in particular the flushing mechanism, is being developed in collaboration with international experts Sedicon, whose flushing system is proven in installations worldwide. Dr Jacobsen addresses that there are fit for purpose mechanical solutions in his memorandum ((attached to Mr Griffith's statement dated 10 February 2026).

Dr Dougal Clunie

APPENDIX A QUALIFICATIONS AND EXPERIENCE

I hold a Bachelor of Engineering (Hons) in Civil Engineering from the University of Auckland (2003) and a Doctor of Philosophy in Civil Engineering from the University of Auckland (2012) for the study of hydrodynamics of bedload-transporting flows.

As a laboratory assistant for Uniservices during my PhD study, I was involved in the design, construction and testing of physical hydraulic models, including mobile bed models (investigating erosion and sediment aggradation) for Oriental Bay beach stabilisation works and Upper Mangatawhiri Dam spillway and plunge pool redesign.

I have 19 years of experience as an engineering consultant with AECOM, SMEC, Norconsult, Damwatch and Aushydro in the assessment, analysis and design of hydraulic structures and hydropower schemes. My work has spanned concept design, preliminary design, consent application, reference design, contractor's and owner's engineering support during detailed design and construction, and operational review. I have worked on projects across New Zealand, Australia, PNG, Solomon Islands, Indonesia, the Philippines and Lao PDR.

Projects with a particular focus on ensuring continuous sediment bypass have included:

- Don Sahong Hydropower Project in Lao PDR, a 1600 m³/s (260 MW) run-of-river scheme where I was responsible for the hydraulic design of the diversion/intake and headpond from feasibility study to reference design, consultation with other affected countries via the Mekong River Commission, and owner's engineering support during construction. This work involved extensive site data collection and hydraulic modelling including morphodynamic modelling of years of operation of the headpond, and hydraulic engineering support to ecologists for the design of fish passage provisions.
- Mangahao Mini-hydro Restoration, where I was involved with the assessment and development of concepts to restore and redesign the intake to a 2MW mini-hydro which had been overwhelmed with sediment deposition.

APPENDIX B CODE OF CONDUCT

As an expert witness or peer reviewer, I have read, and I am familiar with the Environment Court's Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2023.

I have prepared my, or provided input into, an assessment of effects for the Waitaha Hydro Scheme in compliance with the Code of Conduct and will continue to comply with it in this Fast-track Approvals Act process. In particular:

- my overriding duty is to assist the decision-maker impartially on matters within my expertise;
- unless I state otherwise, my assessment is within my area of expertise, and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express; and
- I have not, and will not behave as, an advocate for the Applicants.

APPENDIX C: Memorandum on sediment and debris management at intake

TO:	Jon Bright (Westpower)
FROM:	Dougal Clunie (AusHydro)
DATE:	9 February 2026
SUBJECT:	WTA Sediment and Debris Management at Headworks

Sediment and Debris Management

This memo describes the planned approach to sediment and debris management in the proposed Waitaha Hydro Scheme. The management philosophy involves:

- Maintaining the delivery of coarse sediments past the headworks structures into Morgan Gorge, with:
 - a fully open sluice gate during flood flows to sluice a portion of the sediment load and maintain a low-level flow passage on the true right of the headworks to the intake (the ‘intake channel’),
 - the majority of flow and transported sediment being passed over the weir at high river flows,
 - operation of the sluice gate during medium to high flows to flush sediment deposited within and at the entrance to the intake channel,
 - shaping of the intake channel to guide sluice-gate flows past the intake and encourage scouring of deposited coarse sediments.
 - continual sluicing of coarse sediments that pass the intake screens (30-40mm bar spacing) and settle in the rock trap inside of the intake.
- Anticipating a proportion of the finer sand and small gravel-sized sediment will be entrained into the intake with generation flows, with provision of an underground desander to settle sediments larger than 0.2 mm and periodically flush these through an outlet at the station tailrace.
- Excluding debris from the intake with trashrack screen bars, with debris to be passed over the weir and/or through the sluice gate at high river flows.
- An allowance for an excavator to undertake in-river maintenance work at the recession of flood flows, to move sediment and debris to help ‘train’ the approach channel toward the intake and expedite flushing as necessary.

The planned sediment management will be refined during project detailed design activities, including planned computational fluid dynamics (CFD) morphodynamic modelling of the intake, approach channel, and upper gorge area. This work will:

- refine the optimal size of the sluice gate opening;
- optimise shaping of the intake area to best encourage sediment passage through flushing and sluicing, and discourage deposition immediately in front of the intake; and
- inform the expected duration of flushing flows through the sluice gate at the recession of high flow events.

Coarse Sediment Management at Headworks

At the Waitaha headworks, coarse sediments (sands-gravels-cobbles) will be transported by the river in higher flow rates. In general, the majority of this transport is expected to be over the weir as the flow is routed this way for river inflows above the intake capacity of 26.5 m³/s (being maximum of 23 m³/s generation flow and 3.5 m³/s environmental release).

An intake channel excavated on the true-right of the headworks at a lower level than the weir provides flow passage into the intake. To maintain this channel, the sluice gate will be used to pass sediment that is transported down the channel during high flows, and to remobilise sediment that has deposited within and at the entrance to the channel as flows recede.

Trashrack screen bars with 30-40 mm spacing will exclude the coarsest material from entering the intake. A rock trap behind (downstream of) the screens will encourage the settling of gravel-sized material that enters the intake, connected to the environmental release gate to provide a continuous sluicing of this material.

The sluice gate will be operated to maintain close-to-natural timing of coarse sediment transport past the intake, i.e. continuously during high flow events, especially on rising and receding flood limbs.

The sluice gate will be used in three distinct hydraulic conditions:

- *Sluicing*, being fully open during high flow events to allow the passage of flow and sediment at a low elevation past the intake.
- *Draw-down flushing*, being fully open during medium-flow events where the gate capacity is greater than river inflow, drawing down the water level, increasing velocity and bed shear stress and remobilising settled sediments.
- *Pressure flushing or local flushing*, where inflows and/or tailwater level do not allow for headwater drawdown, but the gate is opened partially or fully to provide locally increased velocity to mobilise and pass settled sediments.

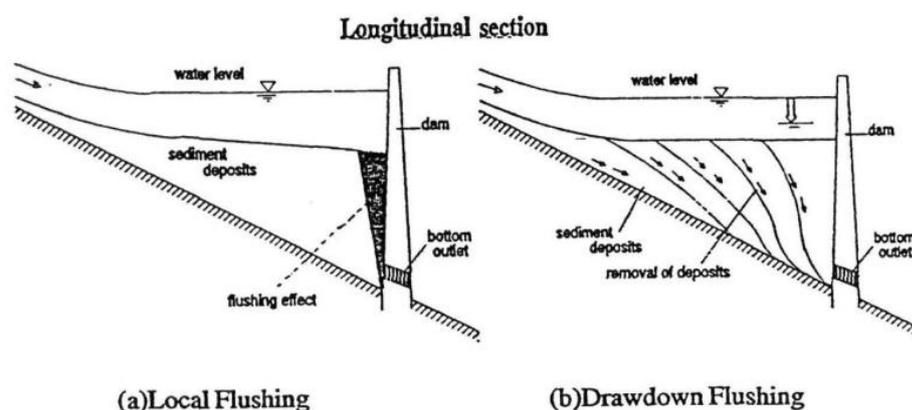


Figure 1: Conceptual difference between local flushing and draw-down flushing (Shen, 1999)

Of these hydraulic regimes, draw-down flushing has the highest capacity for passing sediment, but given the site conditions, with the tailwater rapidly being choked by the narrow gorge downstream, it is only possible in a tight range of river inflows.

Sluice Gate Operation – Low Flow

During low-medium flow conditions (up to around 40 m³/s), when bedload transport from Kiwi Flat is minimal, the sluice gate will typically remain closed.

Sluice Gate Operation – Low-Medium Flows (draw-down flushing)

At inflows of up to around 60 m³/s, especially at the rise of a larger forecast flood, the sluice gate may be opened to draw down the water level in the approach channel and promote draw-down flushing of accumulated sediment.

Given the unique site constraints, it is only in this low-medium flow range that headwater draw-down can be affected. The narrow gorge downstream controls the water level downstream of the sluice gate (tailwater), and from around 60 m³/s the tailwater rises such that gate capacity begins to be reduced.

Opening the sluice gate during low-medium flows will be discretionary, only undertaken as needed to flush accumulated sediments, balancing the need to flush accumulated sediments with maintaining scheme operation and environmental needs. Operation will avoid introducing high concentrations of sediment to Morgan Gorge during extended low-flow periods.

Sluice Gate Operation – Medium Flows (local flushing)

At medium to high flows of around 40-150 m³/s in a rising fresh/flood, if not already opened to provide draw-down flushing, the sluice gate may be used partially- to fully-open to allow local flushing of accumulated and arriving gravels whilst maintaining a headwater and allowing scheme operation to continue.

Sluice Gate Operation – High Flows (sluicing, and draw-down flushing on flow recession)

At high river flows, the sluice gate will be fully open to allow sediment sluicing.

By a river flow of 250 m³/s, the intake will be offline (no flow abstracted) and the sluice gate fully opened. The gate will remain fully open through a large flood, with water and sediment being passed through both the sluice opening and (in greater proportion) over the weir crest.

The choking effect of the downstream gorge means that above around 150 m³/s the weir will become submerged. This hydraulic control at the gorge creates elevated water levels on Kiwi Flat, essentially becoming a temporary lake at very high flows. For example, measurements from site show a 6 m water level rise at inflow of around 400 m³/s. In these conditions, sediment transport rates upstream decrease, with gravels and sands settling on Kiwi Flat.

Importantly, transport rates will pick up again as flow and water level recedes. As a large flood recedes, the sluice gate will be left fully open providing increased sediment transport as water level drops, eventually allowing the intake channel to be drawn down below normal operating levels (draw-down flushing).

The flow splits between the various flow passages at the headworks for varying river inflows are summarised in Table 1.

Table 1: Summary of headworks flow splits for varying river inflows

Q_{inflow} (m^3/s)	Headwater level (EL m)	$Q_{\text{kōaro}}$ (m^3/s)	Q_{enviro} (m^3/s)	Q_{weir} (m^3/s)	Q_{intake} (m^3/s)	Q_{sluice} (m^3/s)	Notes
Up to 9	238-0 - 238.2	~0.1	~3.8	balance	0	0	No flow into intake so all inflows through enviro gate and spilling over weir. Higher HWL means slightly more flow through enviro gate
9-26.5	237.5 *	~0.1	3.5	0	balance	0	* Normal operating HWL will be some small margin below weir crest.
26.5-40	238 – 238.5	~0.1	~3.8	balance	23	0	
40 - 60	~234-235	0	~1-2	0	0	balance	Draw-down flushing (discretionary)
40-250	238.3 – 243	>0.1	3.5 – 1.0		23	10 - 25	Local flushing - sluicing
250+	243+	>>0.1	>1.0	balance	0	~10-20	No flow into desander/power station
Flood recession						20-60	On receding flood limb, sluice will remain fully open to provide draw-down as conditions allow

Refinement of Sluicing Operation

Detailed CFD morphodynamic modelling of the intake and gorge area is planned for detailed design stages. This work will more precisely define flow rates at which draw-down flushing is possible and refine the optimal size of the sluice gate opening. The modelling will be used to optimise shaping of the intake area to best encourage sediment passage through flushing and sluicing and discourage deposition immediately in front of the intake.

There should remain flexibility/discretion in the sluice gate operation, to account for uncertainty inherent in any morphodynamic modelling, and the natural variability of sediment inflow rates and characteristics. It can be expected that the frequency and duration of flushing operation will be optimised through operational experience.

Mechanical Excavation

The allowance for an excavator on site undertaking occasional in-river works has been included. In-river excavation is only intended to help 'train' the approach channel toward intake and expedite intake channel flushing as necessary. Examples of such instances include:

- Significant gravel movement and deposition in a flood, resulting in the upstream approach to the intake channel filled in with a channel reforming toward the centre of the valley and over the weir.
- Hydrological conditions meaning effective draw-down flushing at the recession of a flood is not possible, and excessive deposition at the head of the intake approach channel requires physical intervention to open channel toward intake and sluice.
- Earthquakes or extreme rain and associated local slips introducing large volumes and/or sizes of sediment.
- Sediment sluicing operation being compromised due to damage or other mis-operation of the gate, requiring physical intervention to reopen channel.
- Other unexpected sediment deposition patterns.

It is envisaged that if/when required, mechanical excavation would typically be utilised at the recession of large floods, in combination with draw-down flushing.

Excavator use will not be a frequently or primary means of sediment management. The excavator will be used to move sediment within the river channel, not to physically transport sediments downstream.

Mechanical excavation may also be used as necessary to move large debris (e.g. logs) away from the intake channel.

Fine Sediments

Finer sands and silt-sized sediments will be transported as suspended load over a broader range of flow conditions.

Suspended sediments will remain entrained and be passed into the desander, through the environmental release gate, through the sluice gate, and over the weir, in proportion to the flow rates through each passage.

Desander design and operation

The desander has a large cross-sectional area and length, designed to encourage sands and any gravels entrained through the intake to settle.

The desander is sized for a design particle of 0.2 mm (quartz), with a removal efficiency of 90%. The removal efficiency is higher for larger particles – with a 100% trapping efficiency estimated for particles 0.27 mm and larger.

Suspended fine sands and silts, with particles sizes less than 0.2 mm, will likely remain entrained in the flow transported to the turbines. There, runner coatings, and choice of specific speed are optimised to reduce risk of runner erosion/damage.

It is presently intended that a Sedicon flushing system, or similar, will be used within the desander to flush settled sediment. The system can remove particles up to 150 mm size and can be operated independently of the accumulated sediment level. The desander flushing outflow is piped to an outlet at the power station tailrace.

The large desander volume has storage for over one year of sand and fine gravel inflows at estimated rates before functionality is affected. This provides flexibility as to the timing of flushing releases, with discretion to make flushing releases when best for ecology/river health. Desander flushing will only occur when coincidental river flows are above 75 m³/s, when the river is naturally more turbid and flows are able to disperse flushed material.

Debris Management at Headworks

The trashrack screen bars will exclude large debris from entering the intake.

A ‘skimming wall’ at the trashrack, meaning the bars are submerged by at least 1 m during flow abstraction, will prevent floating debris from snagging on the trashrack bars.

The majority of large floating debris is expected during high flow events, where it will be passed over the weir. Debris which enters the intake channel will be passed through the open sluice gate during draw-down flushing.

Maintenance work with an excavator may include the movement of large, settled debris (e.g. logs) away from the intake channel, to be passed over the weir in subsequent flood rises.

References

Shen, H.W. (1999). Flushing sediment through reservoirs. *Journal of Hydraulic Research*, 37(6).