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SUBJECT:	WTA Hydraulic Design and Operating Conditions

Hydraulic Design and Operating Conditions

This memo describes the hydraulic design and operation of the scheme headworks and intake components including:

- Main weir
- Sluice gate
- Environmental flow gate
- Main intake including screens, intake gates, desander, head gates and tunnel/penstocks

Main Weir

The proposed weir is a concrete gravity structure, with a 1 m crest width at EL 238.0 m over a main span of approximately 16 m width. A secondary side weir on the right-hand side with a slightly higher crest of EL 238.5 – 239.0 m incorporates the sluice gate chamber. The weir crest will be protected from abrasion by steel capping. The shaping of the weir crest will be defined during detailed design to avoid negative pressures and cavitation risk.

The natural ground level on the downstream side of the weir is approximately EL 234 m. Overflow will spill onto a downstream concrete apron, which may be sloped or stepped to aid energy dissipation, provide structural stability, and improve safety by reducing the maximum vertical drop.

Flows over the weir have been analysed using short-crested weir formulae with coefficients from engineering literature to define upstream water levels for the range of possible river flows.

One-dimensional flow analysis estimates that the weir will become drowned at flows larger than approximately 150 m³/s, where the tailwater level, choked by the gorge increases above the weir level.

Large floods result in very high water levels caused by the gorge choking effect. At a mean annual flood peak of 812 m³/s, a flood arise of approximately 20 m is estimated.

During typical scheme operation, the water level at the upstream side of the weir will be controlled by station operation to be just below weir crest level (nominally EL 237.8 m). Where river inflows are greater than the station capacity of 23 m³/s plus residual gate flow release of 3.5 m³/s, the water level will increase and spill over the main span of the weir. At higher flows water will spill over the side weir (adjacent to sluice gate), then the sluice gate chamber roof.

Sluice Gate

The proposed sluice gate is a 2.5 m wide by 3.0 m high radial gate which allows sediment that has settled outside of the intake screens to be flushed downstream.

The gate is sized to maximise discharge capacity for efficient sluicing while reducing the size of structure required to reduce visual effects. The gate has a discharge capacity of approximately 60 m³/s, noting that water levels through Morgan Gorge begin to rapidly rise at such a flow rate, 'drowning' the gate and so larger gates would provide minimal additional capacity. The sluice gate sill is set at EL 231.0 m, defining the lowest upstream elevation that sediment can be cleared to during operation of the project.

The sluice gate will discharge onto an excavated rock apron, which will be shaped to encourage downstream movement of sluiced sediment.

The gate will be operated to sluice sediment during medium-high flow conditions, to avoid introducing turbid water and large volumes of sediment to the gorge during low flow periods. It is noted that sluicing is only possible when a head differential exists across the weir i.e. flows of less than around 150 m³/s. It is expected that the sluice gate will be most effective at medium-high flows of around 50 m³/s, where it can be fully opened to draw down the headpond and promote effective scouring of settled sediments.

The expected operating regime of the gate will be further defined with CFD flow and sediment modelling during detailed design phases, and optimised with operational experience.

Environmental Flows

Continuous environmental flows (residual flows) will be provided by the environmental flow gate and kōaro passage.

The proposed environmental flow gate is a submerged 1.0 m wide by 1.0 m high vertical gate at a sill elevation of EL 231.5 m adjacent to the intake, which will continuously pass a residual flow of at least 3.5 m³/s.

The gate will typically remain in a part-open position set to pass at least 3.5 m³/s under the normal headpond control level, with discharge increasing slightly as the headpond level rises. Water level will be remotely monitored, and the gate opening can be controlled remotely or manually actuated. The gate has a capacity of greater than 10 m³/s at normal headwater levels, allowing larger flushing flows to clear settled sediment if needed. It will likely be placed inside the intake screens, to minimise the chance of blockage by larger sediments, while allowing the sluicing of finer sediments that settle inside the screens upstream of the intake portal.

The environmental flow gate will discharge onto the excavated sluice apron on the right bank of the gorge.

The kōaro passage is proposed to include a lowered section of the weir at its left abutment, just below the normal headpond control level, such that a small but continuous flow of water will provide a continuously wetted surface. The flow will trickle over a natural rock surface on the left bank of the gorge.

Main Intake

The main intake includes screens, a dual bay intake with isolation gates/stoplogs, leading to an underground pressurised desander. At the downstream end of the desander, the pressurised waterway tunnel begins, protected by a headgate. At the downstream end of the tunnel, the waterway tunnel transitions into a penstock exposed within the tunnel, with a buried penstock bifurcation outside of the tunnel feeding the two generating units.

The intake screens are proposed to be comprise stainless steel bars at 30 - 40 mm centres, to prevent large material from entering the waterway. The intake screens have an open area of approximately 40 m², limiting approach velocities. The sizing of the screen is such that it should not present an insurmountable velocity barrier, meaning that kōaro can swim out if they enter the intake.

The intake isolation gates/stoplogs will always be open during scheme operation, closed only when the station is offline to allow maintenance of the desander.

The desander will be pressurised when the scheme is in operation. Within the desander, flow velocities will reduce to around 0.2 m/s, encouraging the settling of sediments of sizes down to 0.3 mm. Flushing of settled material from the desander system is proposed using the Sedicon slotted pipe sediment extraction system. The piped system leads to a sediment sump at the downstream end of the desander chamber. From the sump, an embedded sediment bypass pipe extending along the waterway tunnel and then down the access tunnel allows flushing of the desander, with sediment discharged downstream to the station tailrace.

The waterway is protected by a 4.0 m by 4.0 m vertical headgate at the downstream end of the desander, able to close against flow to provide safety isolation of the waterway to protect against seismic risk of tunnel damage and penstock rupture.