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FROM:	Dougal Clunie (AusHydro)
DATE:	9 January 2026
SUBJECT:	WTA Residual Flow in Abnormal Operating Conditions

Residual Flow in Abnormal Operating Conditions

This memo describes the modelled residual flow of the Waitaha Hydro Project (WHP) under abnormal scheme operating conditions. 'Residual flow' is used to refer to the Waitaha River flow entering Morgan Gorge through the WHP scheme headworks (residual flow gate, sluice gate, kōaro passage and weir overflow).

Abnormal scheme operating conditions are listed in Section 3.6 of the Application, and include the following scenarios:

- Station shutdown and startup
- Extreme Floods (>250 m^3/s)
- Kayak flow days
- Station trip

Control of Residual Flow Rate

In general the flow rate into Morgan Gorge will not be controlled at the headworks. The residual flow gate will remain open at a set position to discharge at least 3.5 m^3/s at normal headwater operating level.

Generally, the flow rate into Morgan Gorge will be controlled by discharge at the power station (turbine and/or bypass valve flow). When the station flow is decreased, river inflows from Kiwi Flat will raise the ponded water level at the headworks, increase flow through the residual flow gate and overtop the diversion weir, increasing flow within the gorge. When the station flow is increased, the ponded water level at the headworks will drop, reducing flow into the gorge.

There will be a small lag time between flow changes at the station and flow changes into the gorge associated with the changing in flow momentum/pressure/compressibility etc. Modelling of flow changes has assumed a simple one minute lag between changes at the station and at the headworks.

The exception in which residual flow is controlled at the headworks is during sediment sluicing operations, where the sluice gate is opened to pass additional flow and sediment into Morgan Gorge.

Residual Flow Modelled in Abnormal Operating Scenarios

Station Shutdown

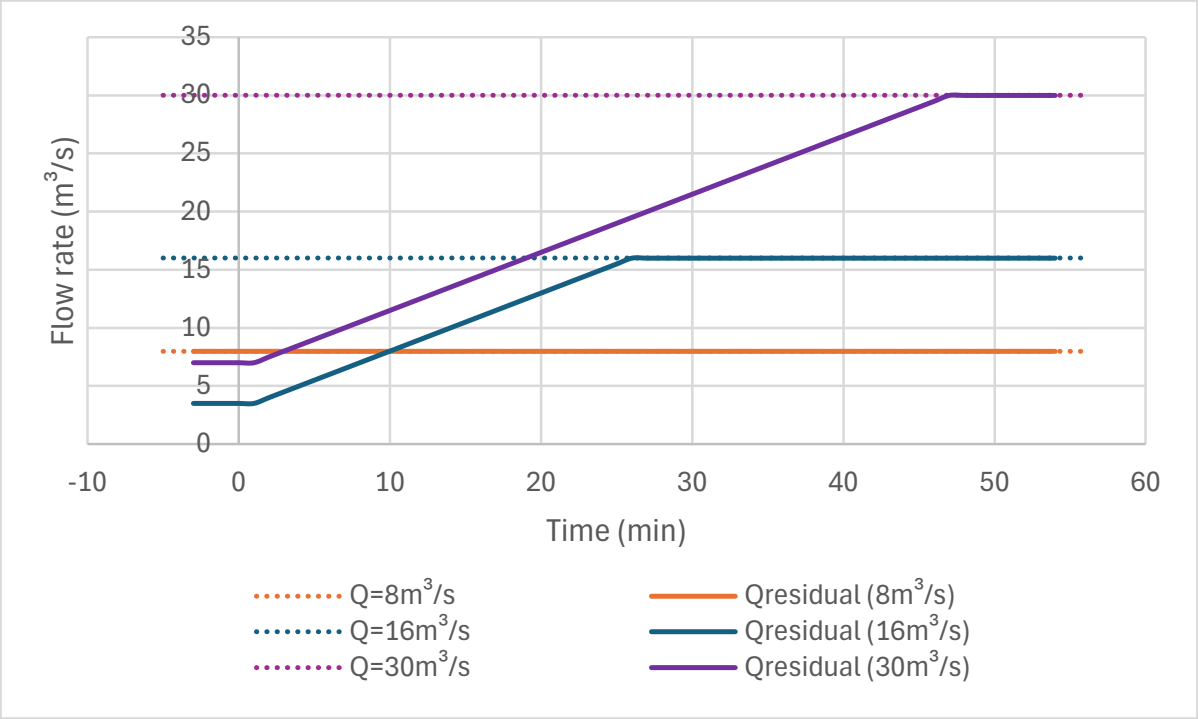

Figure 1: Three flow cases – river inflows of 8, 16 and 30 m^3/s at the headworks (dashed lines) and residual flow into Morgan Gorge following station shutdown at time t=0 minutes (solid lines).

Cases with the station shutting down are shown in Figure 1.

- For river inflow of 8 m^3/s the station will not be operating because the available flow (river inflow – minimum residual flow) is less than the minimum turbinable flow. In such cases the full river inflow will be passed as residual flow.
- For river inflow of 16 $m^3/$ the station will have been operating at up to 12.5 m^3/s discharge. During shutdown this flow will be reduced over a few minutes including relatively rapid changes as units are taken offline. The bypass valve will be opened to compensate for the rapid flow changes, then slowly closed to ensure the overall station ramp rate is 0.5 m^3/s per minute or slower. A corresponding increase in residual flow will occur as the headpond level rises and spills over the weir.
- For river inflow of 30 m^3/s the station will have been operating at up to its full design flow of 23 m^3/s, and residual flow will be at least 7 m^3/s. Station shutdown and gradual increase in residual flow will be as in the 16 m^3/s case.

Station Startup

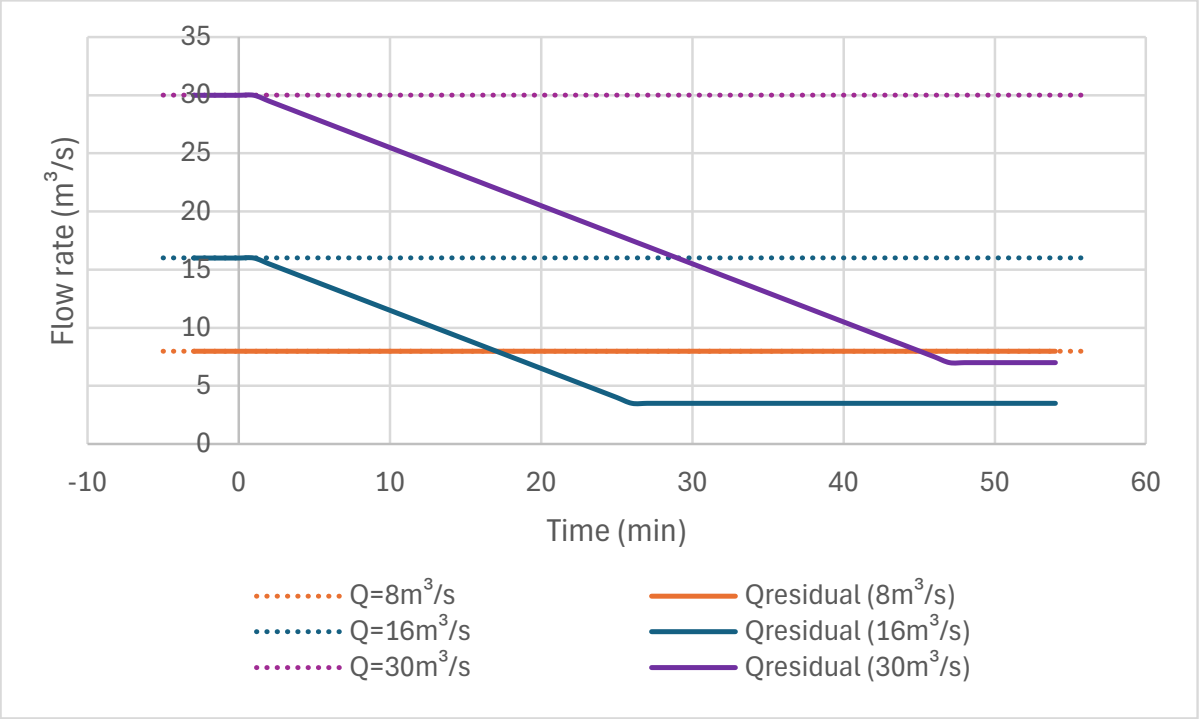

Figure 2: Three flow cases – river inflows of 8, 16 and 30 m^3/s at the headworks (dashed lines) and residual flow into Morgan Gorge following station startup at time t=0 minutes (solid lines).

Cases with the station starting up are shown in Figure 2.

- For river inflow of 8 m^3/s the station will not start up because the available flow (river inflow – minimum residual flow) is less than the minimum turbinable flow. In such cases the full river inflow will be passed as residual flow.
- For river inflow of 16 $m^3/$ the bypass valve will initially be opened to around 5 m^3/s over 10 minutes. Flow will be passed through the first turbine to bring it to speed-no-load (~1m^3/s) before synchronising and bringing it into its operating range (~5 m^3/s). The bypass valve discharge will be reduced to balance the increases in turbine flow. From here turbine flows will be increased and bypass valve flows decreased to respect the maximum station flow ramping rate. A corresponding reduction in residual flow will occur as the headpond level drops.
- For river inflow of 30 m^3/s, the same startup sequence will occur, with the station flow being slowly increased to up to 23 m^3/s.
- Note the figure shows an 'ideal' station startup in the quickest possible time to full available output. In practice the ramping up of flows will likely be slower or more staggered.
- The control system will include monitoring of the headpond level to constrain station flow increases to ensure the headpond level does not drop below that required for 3.5m^3/s discharge through the residual flow gate.

Extreme Flood (River Inflow > 250 m^3/s)

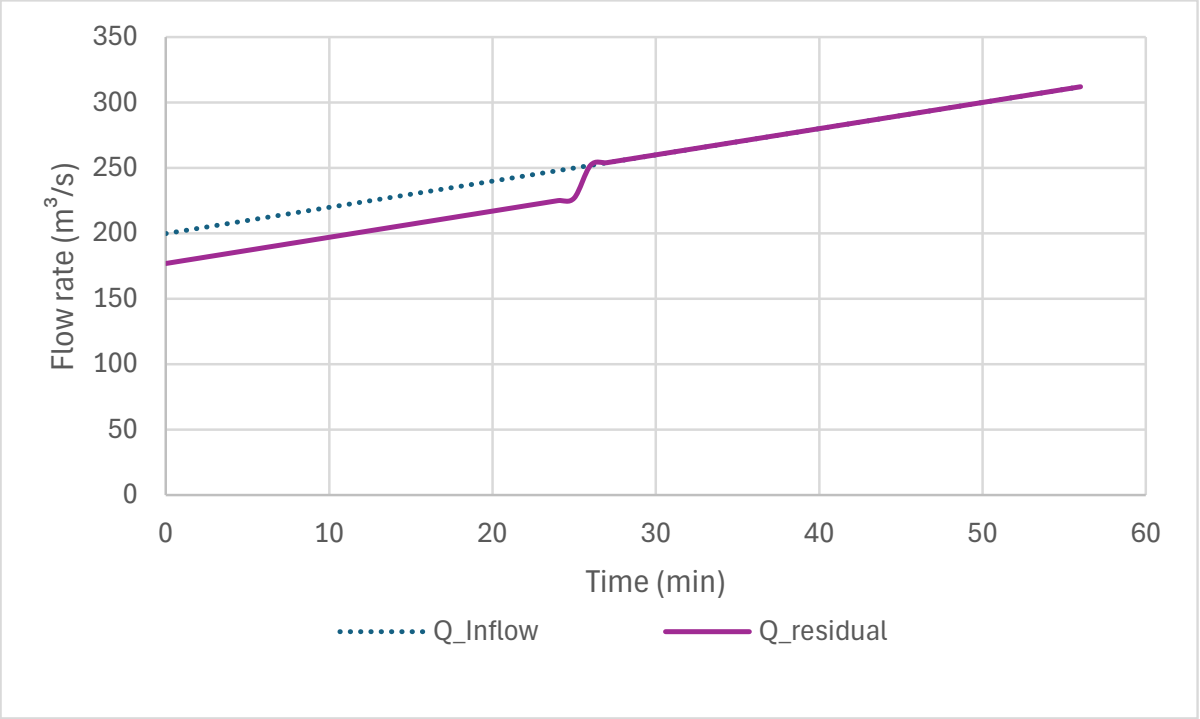

Figure 3: River inflow increasing above 250 m^3/s, resulting in station shutdown.

The case of an increasing river flow to above 250 m^3/s resulting in station shutdown is shown in Figure 3.

- Below a river inflow of 250 m^3/s the station may be operating at a flow of up to 23 m^3/s.
- When the river inflow increases above 250 m^3/s, the station will be shutdown to protect the units against high sediment inflows.
- Shutdown may be relatively rapid (a few minutes), and the bypass valve will not be operated as the effects of station ramping rates are insignificant in high flow conditions.
- The reduction in station flow will result in an increase in flow over the weir, such that the full river inflow is entering Morgan Gorge.

Kayak Flow Days

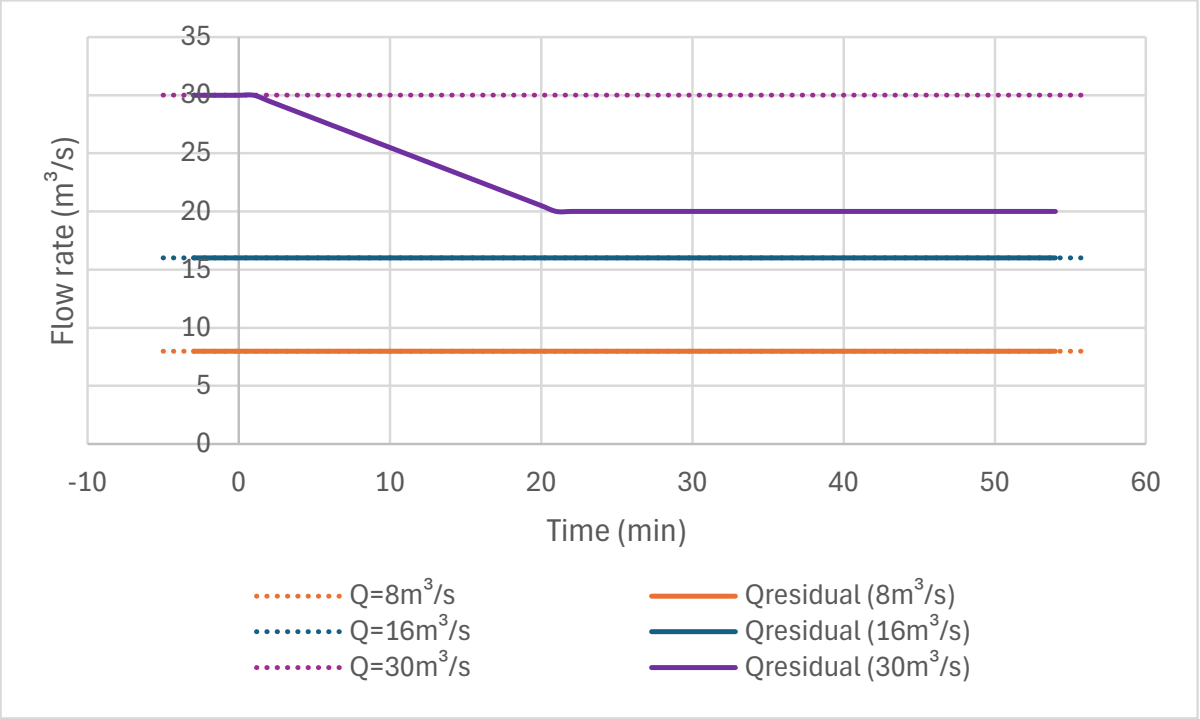

Figure 4: Three flow cases – river inflows of 8, 16 and 30 m^3/s at the headworks (dashed lines) and residual flow into Morgan Gorge on kayak flow days (solid lines).

Potential flow cases for days where agreed flows are provided for kayakers are shown in Figure 4.

- Discussions with kayak groups suggest that the ideal flow conditions for kayaking are flows of 15-25 m^3/s in Morgan Gorge.
- In general, there will be no flow through the station on kayak flow days.
- If river inflows are greater than the preferred range for kayakers, discharge through the station (bypass valve and/or turbines) may be initiated if requested by the kayakers, to reduce the flow into Morgan Gorge to a preferred level.
- If discharge through the station is initiated, flow changes will respect the proposed maximum station ramping rates.

Power Station Trip

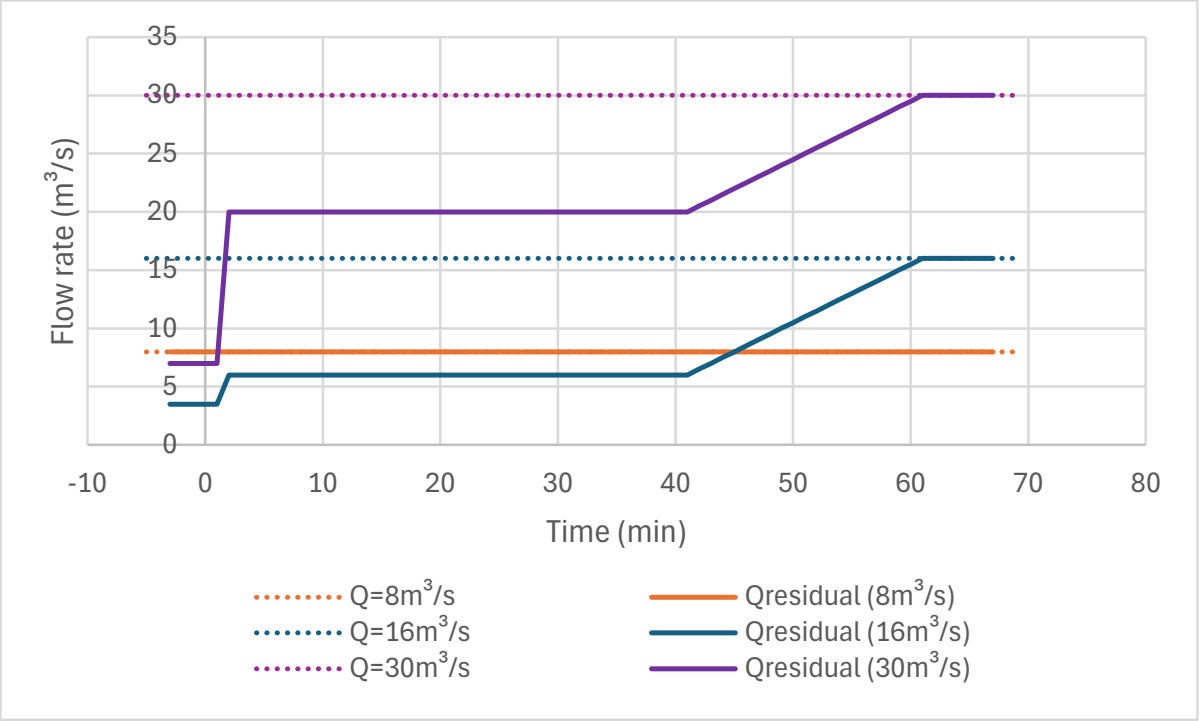

Figure 5: Three flow cases – river inflows of 8, 16 and 30 m^3/s at the headworks (dashed lines) and residual flow into Morgan Gorge following power station trip.

Cases following power station trip up are shown in Figure 5.

- Power station trip will result in near instantaneous (less than 1 min) cessation of flow through the turbines to protect the units.
- The bypass valve will be rapidly opened to 10 m^3/s (or to match the preceding station flow if less) to maintain flow in the river downstream and reduce the rapid increase in flow into Morgan Gorge.
- The bypass valve will remain open for up to around 40 minutes to allow the flow spilled over the weir to 'catch up' and restore full flow to the river downstream of the station.
- The bypass valve will then be slowly shut off at a rate of up to 0.5 m^3/s per minute, with corresponding slow increase of residual flow over the weir.