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Committee G Environment –
Case studies involving planning, construction and operation of dams demonstrating environmental and social benefits

Environmental Aspects of Hydroelectric Power Production Run of River Scheme: Matahina Power Station, New Zealand

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Definitions

- **Run of river** – little or no capacity to store or control the flow of water upstream of the power generation stations (except small pondage for peaking): the amount of electricity that can be produced depends on the daily flow of the river (The World Bank, 2012)

- Compared to **Peaking stations which** are designed to provide power when it is required. As such they tend to store water for use in generating power when required. This means that they tend to alter the natural hydrological regime of a river.

It is important that the station is operated with the impact of the associated environmental effects of operation in mind.

Environmental Effects

Environmental effects that may be considered include and are not limited to :

- Physical effects: rate of river shoreline inundation, sediment release, shoreline erosion,
- Biological effects: oxygen content, water temperature, flow rate
- Socio economic effects: impacts on public safety, agricultural and grazing practices, and on recreation.
- Cultural differences, indigenous or first nation rights

Mitigation Measures for Run-of-river

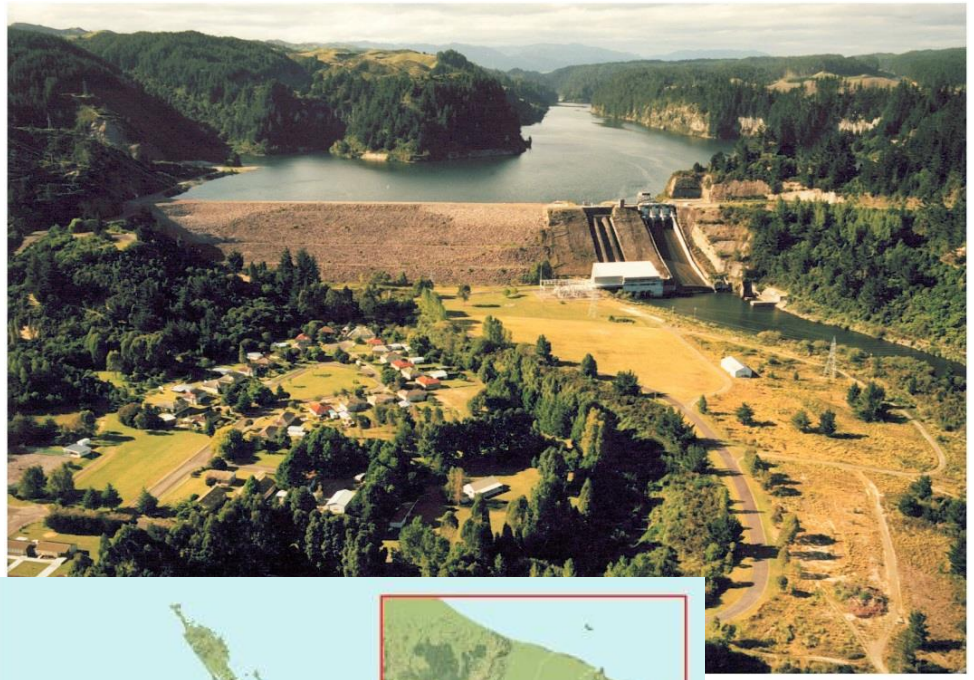
Mitigation measures for run-of-river power stations can include and are not limited to:

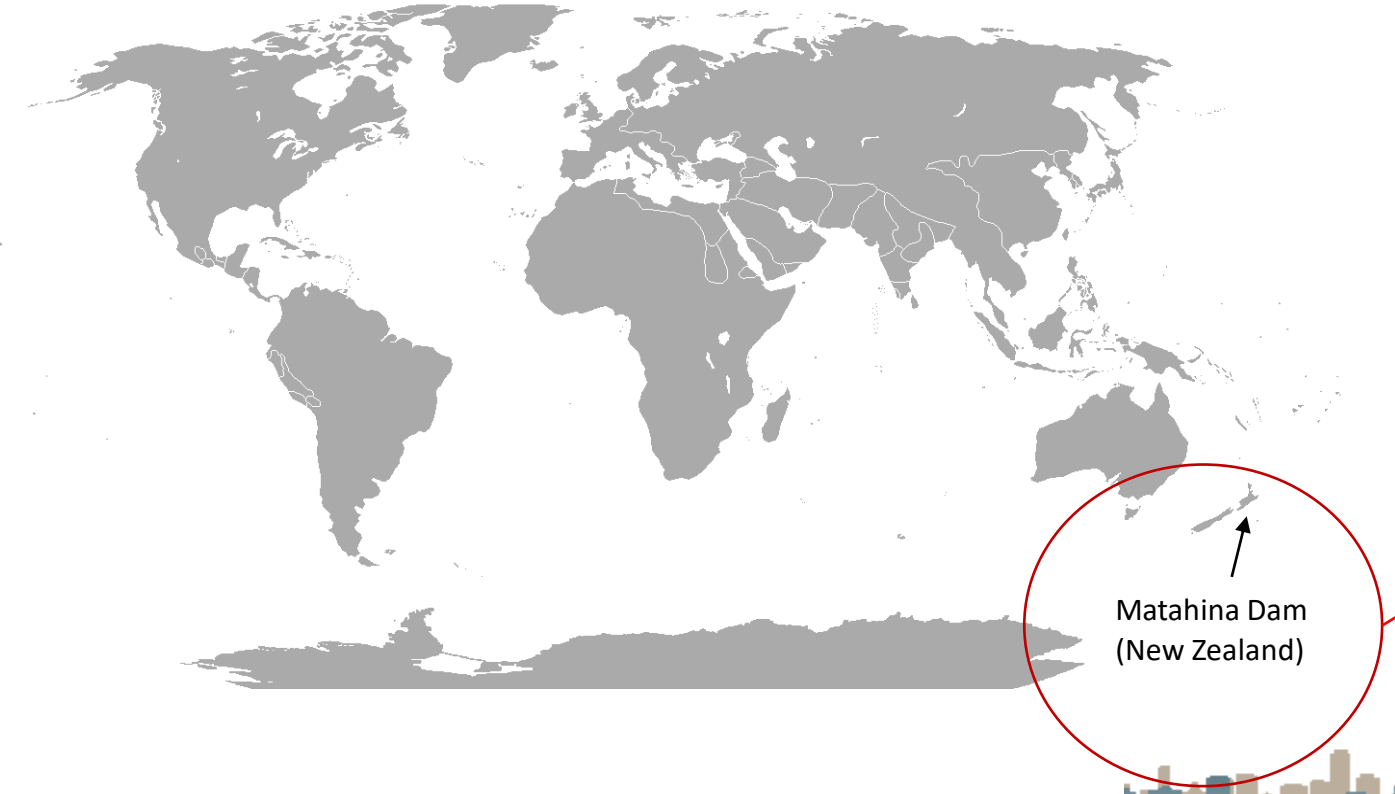
- providing for a flow regulating reservoir downstream from the hydro power plant
- controlling rates of increase or decrease of power station discharge
- providing recreation flows
- providing a means of fish passage
- controlling discharge temperatures and oxygen concentrations
- controlling sediment release.

Controlling hydro power station discharge also relates to public safety in the channel immediately below the power station.

Case Study
Matahina Dam New Zealand

- Peaking hydro plant with minimal storage
- Strict licence controls on discharge based on minimising environmental effects
- Fish transfer measures





Downstream Environment
Flooding Mitigation

- The areas downstream of the dam are prone to flooding and a flood defence scheme was constructed in the 1970's but overtopped in 2004 and again in 2017.
- Floods less than 200 m^3/s are fully attenuated by reservoir but almost no attenuation is possible at the 2% AEP ($690m^3/s$)
- Re-licencing: agreement to lower reservoir in advance of predicted inflows greater than $300m^3/s$,
- Enquiry after 2017 flood (500 year flood) found flood attenuation had occurred at power station but downstream flood defenses were inadequate.
- Conditions of re-licencing require owner to provide annual financial support for the maintenance and remedial works of the flood defence scheme.
- These conditions are reviewed every 5 years

Downstream Environment
Erosion Effects and Water Quality

- **Geomorphology**

  The river downstream of the dam is incised into alluvial floodplains.

  - Prior to the dam, high sediment loads in the river resulted in a rising river bed and coastal progradation.
  - Following construction of the dam this sediment movement has been significantly reduced and active erosion of the river banks now occurs
  - Lake shore erosion studies concluded operation of the reservoir has not significantly increased the rate of erosion
  - Re-licencing approval concluded that the prime cause of erosion was flood events rather than hydro power peaking events

- **Water Quality**
  - Water quality downstream of the dam is primarily related to low flows both in terms of minimum flow and the time at which the low flows occur
  - Dam Owner’s request for lower minimum flows was rejected partially due to concerns regarding water quality

Downstream Environment Ecology

- Eel and trout are the main fish in the river downstream of the dam.
  - Dam has an impact on the movement of the eels.
  - Other migratory and non-migratory fish are also present in smaller numbers.
- There is an elver pass to allow eels to pass upstream
- Other fish types are accommodated through trap and transfer.
- Improvements to these facilities are being investigated including for the downstream passage of eels and improved deterrents for fish entry into downstream water passages
- Inlet screen sizes have been set at 90mm maximum

Case 1: Matahina Dam New Zealand - Downstream Environment

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Station Operation

- Licencing requires owner to demonstrate acceptable mitigation of environmental effects.
- The original operational regime allowed for daily twin peaking operation of the power station
- Re-licencing in 2011 allowed change to multiple daily peaking
- Consultation agreed that multiple peaking would not have an adverse affect on the downstream environment provided no river bed displacement and disturbance of fish habitat occurs
- Lake levels have a normal operating range of 3m and are restricted to changes of less than 0.25m/hr.
- Minimum residual flows are fixed at 40m^3/s. No peaking operation is permitted at flows below this level
- Ramping rates set by licence conditions.
  - Ramping up (level rise of 1.4 to 2.1m/hr depending on location in the river reach) and
  - Ramping down (30m^3/s per hour) from the peak flows

Matahina Dam Case Study Lessons Learnt
Key Impacts, Constraints and Mitigation

- Flood alleviation – control of lake levels provided during predicted floods
- Minimum flows – affect water quality, downstream users, ecology, indigenous people (Maori) concerns. Minimum residual flows are fixed at 40m^3/s. No peaking operation is permitted at flows below this level
- Geomorphology – discharge rates set to provide downstream erosion control
- Recreational users – affected by ramping rates of flows and levels
- Ramping rates for flows and levels – operational restrictions set.
  - Ramping up (level rise of 1.4 to 2.1m/hr) and
  - Ramping down (30m^3/s per hour) from the peak flows
- Fish passage – both upstream and downstream passage. Screen sizes based on fish population.