

RC Application: – APP042595.01.01

Applicant: Glenview Estate Ltd.

Attention: Alisha Vivian

Consents Officer

Northland Regional Council » Te Kaunihera ā rohe o Te Taitokerau

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PRINCIPAL CONSULTANTS:

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Proposed Purua Rapids Hydroelectric Scheme - Assessment of Ecological Effects



Figure 1: The Falls. The unnamed waterfall in the section of the Wairua River affected by the proposed hydroelectric scheme (sometimes described as Purua Falls).





Figure 3: Showing the affected section of the Wairua River encompassed by the proposed Purua Falls hydroelectric scheme. On the eastern side of the river, the schemes water intake is around the top of the photo and the outlet back into the river is near the bottom of the photo. The river is shown in high flow following a substantial rainfall event.

Introduction

Glenview Estate Ltd is proposing to build a run of river hydroelectricity power generation power station on its farm at 512 Knight Road, Kokopu. Neil Lewis, on behalf of Glenview Estate Ltd, approached Ecoprojects Consulting Collaborative in April 2021 to provide an ecological assessment, as requested by the Northland Regional Council (NRC) detailing the effects of a proposed hydroelectric plant on the Wairua River.

Ecoprojects agreed to provide the following services relating to request S92 (1) from NRC in response to **Resource Consent Application – APP042595.01.01** requiring:

- (1) An updated Assessment of Environmental Effects on the impact of the river diversion and associated structures on flora and fauna within the portion of the river affected by the proposal.
- (4) An assessment of Policy D.1.1 to establish the effects of the activity on tangata whenua and their toanga.

NRC noted the key concern to tangata whenua would be the adverse effects on tuna (eels) which are both mahinga kai and a toanga and access to mahinga kai sites upriver.

An initial assessment of the affected area was carried out by Terry Kennedy and Bernadine Kiro (ecologists). They held a follow up meeting and preliminary consultation with members of the iwi shortly after.

The river was of moderate flow at the time and was representative of its normal condition for the time of year, being between major weather events.

Testing of water quality was carried out utilizing the SHMAK system (NIWA's Stream Health Monitoring Assessment Kit). Counts of river fauna species were carried out on two separate occasions.

This report draws also on the Waitangi document "Northland Rural Rivers Environmental Management, Pollution and Kaitiakitanga since 1991" WAI 1040 #A60, for historical perspectives regarding the potential effects of further activity on the health of the river system.

Ecological assessment of the affected portion of the Wairua River.

The Wairua River flows through the drained Hikurangi Swamp catchment from the Whakapara River over a basalt floored plane heavily populated with dairy farms, cropping areas and beef farms.

The river is rich with nutrients and nitrates carried into the river by groundwater flows and as a result an overabundance of in-stream flora is apparent along the section observed.

There are two large waterfalls on the lower section of the Wairua River that form an impassable barrier to diadromous fish species.

The presence of eels (*Anguilla australis*; *Anguilla dieffenbachia*) above the falls indicates the ability of eels to bypass the falls by climbing overland.

A NIWA ecological survey carried out in 1999 (NRC00203/1) dated February 2000, details the populations and taxa of the river above and below the falls at the time and will not be reproduced herein. The conclusions of this report and gathered anecdotal evidence demonstrate that native fish species have not managed to overcome the obstacles and make the journey upstream.

Our first assessment and subsequent on-site observations confirm this is still the case.

The water tested was carrying no sediment and was of excellent clarity but the pH 4.5 taken during the day was tending toward acidic and had a high nutrient content.

Retesting two weeks later following a rainfall event showed a pH of 4 indicating an upstream discharge of acidic material.

River topography of the affected section.

The section of the Wairua River adjoining Glenview, although anthropologically altered during the swamp drainage is geologically an ideal base for a healthy and energetic freshwater ecosystem. There are varied geological features each presenting changes in the flow patterns.

There are narrow channels interspersed with rapids and scour holes above and below the falls plus boulder fields in the flat areas of the riverbed.

Positive effects of existing topography:

The Rapids

- Support oxygenation.
- Vary the flow rates.
- Allow the river water to absorb minerals from the rock bed.

The Waterfall

- Drives oxygen into the pool below.
- Creates vortices and backflow energizing the pool.
- Increases turbidity, mobilizes, and transports sediment.

The Deep Pools

- Cool and stratify water into temperature zones.
- Provide rest areas for migrating fish and eels.
- Hold large quantities of water modifying microclimatic conditions.

Adverse effects of existing topography:

The flood remediation canals that have been excavated above the affected area have a detrimental effect on the water passing through the project section of the river.

The canal structures

- Reduce the capacity of the river to deposit sediment.
- Reduce the capacity of the river to accumulate oxygen.
- Expose the river water to sunlight over extended distances.
- Reduce the ability of the river to accumulate energy normally gained by the meandering action.
- Reduce the ability of the river to cleanse itself of nitrates.
- Reduce the ability of the river to maintain a positive temperature gradient.

Water temperature:

The positive temperature gradient for a healthy functioning waterway progresses downward toward 4 degrees Celsius.

The negative gradient is upward toward 9 degrees Celsius.

At this upper level the river sheds its oxygen and overheats.

A habitat for pathogens algae and eutrophic flora is created.

The Wairua's central vortex collapses. See central vortex in **Figure 4** below.

Water temperatures in the Wairua River regularly exceed the 9 degrees maxim and over summer can reach up to 20 degrees.



Figure 4: Showing the vortex that when functioning:

- Centralizes current flow.
- Guides and supports fish migration.
- Carries the Wairua (life force) upstream.

The scour holes

There are two major scour holes in the section of the river being addressed.

The 9m deep scour hole below the falls was deepened during the Hikurangi drainage works by blasting through the basalt bedrock. It penetrates the allochthon clay substrate.

There are strong back flow currents below the falls that draw floating material downward before ejecting it downstream. This presents a dangerous situation for recreational users of the river.

The depth of this pool aids greatly in cooling and enhancing the quality of the water collecting there by creating a stratum of temperature.

Scouring of the riverbanks in this section is minimal as the riversides are mainly basalt cliffs.

The downstream scour hole forms a large pool 100m further downstream (the pool designated for the water discharge from the scheme) - **Figure 9**. It is deep and wide and stabilizes the velocity of flow within a circular current.

The flow into this pool is regulated by the section of shallow rapids (**Figure 7**). The river deposits silt here and water clarity at the surface improves.

The material at the bottom of this pool is likely to be toxic. A pH of 4.5 was recorded there.

It is anticipated that this pool would receive the outflow from the hydroelectric mechanism.

Being the point of water discharge from the tailrace channel, this pool is the southernmost point in the river that is directly affected by the proposed hydroelectric power scheme.

Riverside environs

Along portions of both sides of the river, there is a riparian strip of Crown Land (around 20m wide) that is administered by the Department of Conservation (DoC). Along the parts of the river where there is a break in the continuity of this 20m strip of Crown land, landowner's rights extend to the edge of the river. Within the area of the proposed hydroelectric scheme this variability is mapped (**Figure 8**).

The riparian plantings, together with natural regeneration within this zone includes both native forest species (much of which is mature) and exotic willows.

This vegetation provides shade along some of the narrower parts of the river. The vegetation is generally thinner around the pools and the wider portions of the river, resulting in minimal shading and therefore less cooling of the flow.

Grasses and semi aquatic weeds species are established close to the water edges.

Observed avian species include Pukekos, Kingfishers, Shags, Parakeets, Tuis and Fantails.

Riverside activities affecting the river ecology

During its passage through the Hikurangi farmlands, the Wairua River collects surface water containing silt runoff from croplands and dairy farms, together with ground water containing nutrients and organic residues.

The nutrient content of the stream water sampled was high to the point of being toxic. Measurements have been recorded showing excess e.coli, coliforms, phosphorus and nitrates present.

Extensive cropping on neighbouring properties leaves large areas of bare earth exposed to rainfall at various times of the year. Silt from these areas is regularly mobilized during periods of high rainfall.

During flood events drainage pumps in the upper catchment deposit large amounts of biomass and faecal matter into the river

The water velocity in the canal system regularly purges silt from the upper regions of the catchment, transporting it to accumulation areas where it is deposited together with piles of decomposing vegetation.

There is an existing hydroelectric facility about 15 km distant in the lower river, that draws water and channels it along a 1.7-kilometre canal that bypasses the original river course to a hydroelectric generator above the lower falls.

Glenview Estate activities with regard to contamination

Cowshed effluent from the Lewis property is well managed with no apparent surface flow into the waterway.

The wintering pad is well set back from the river and is well constructed to contain waste. It appears that no leachate is entering the system through effluent drainage.

Portions of the river that include the nominally 20m wide DoC administered riparian strip are fenced to exclude cattle from the riverside.

Below the Falls



Figure 5: The Falls. The unnamed waterfall in the section of the Wairua River affected by the proposed hydroelectric scheme (sometimes described as Purua Falls). During median annual flows the falls channel water at 1300-1500 litres per second over a 5m drop into a 9m deep scour hole / pool below. The channel at the right of the rock formation was blasted during the drainage works for the Hikurangi Swamp. During flood events the flow can increase dramatically, covering the entire rock wall and transporting vast amounts of sediment downstream.



Figure 6: Another view of the wide, deep pool below the falls.

After a period of warming over sunlit rapids, the river water plunges over the falls into the pool below, where it is cooled and circulated through a downward vortex to the bottom of the pool. The water in this pool is highly dynamic and it is regarded as a dangerous section to enter.

This pool is approximately 9 metres deep from surface to base, enabling stratification of water temperatures from cool at the bottom to warm at the surface.

As a large portion of the river is shallow, these deeper “cooling chambers” are important to the health of the river.

As the pool is of fixed depth with defined basalt banks and a shallow outlet, the pool level remains constant.



Figure 7: The Rapids between the two wide pools.

Rapids are stretches within a river where the riverbed has a relatively steep gradient, resulting in an increase in velocity and turbulence.

The rapids between the two wide pools perform several physical functions in this section of the river:

- Regulation of flow velocity.
- Aeration – the turbulent rolling and tumbling action of the rapids draws oxygen into the water resulting in improved water quality.
- In the area of the rapids, the river is shallower and allows deposition of gravel and rocks, with some rocks exposed above the rivers flow surface.
- Provides habitat for fish and invertebrates.

This area may experience increased water temperature during periods of low flow. The sun warmed rocks, many of which are exposed, have the effect of raising water temperatures, sometimes to critical levels.

Temperature gradients

A healthy river system has a positive temperature gradient wherein the flowing action over the river topography lowers temperatures toward an optimum of 4 degrees Celsius. A negative temperature gradient, increasing toward 9 degrees Celsius and higher, indicates a deterioration in river quality. (*Schauberger: The Secret Nature of Water, 1942*).

The physical requirements for a positive temperature gradient are present here. However, the contamination levels render such habitat enhancing effects ineffectual.

Aquatic flora

The shallow areas observed contained thick mats of Periphyton covering the boulder substrate. (Periphyton is a complex mixture of algae, cyanobacteria, heterotrophic microbes, and detritus that is attached to submerged surfaces in most aquatic ecosystems - Wikipedia). The long filaments of green algae were abundant across the river profile and brown mat coverage of the submerged boulders was thick. This is indicative of a sustained period of low flow, high nutrient content of the water and high temperatures.

Areas of still water alongside the wider pools tend to accumulate large quantities of Alligator weed (*Alternanthera philoxeroides*) and other aquatic vegetation that decompose during dry spells, further reducing water quality.

The pools contained clusters of introduced Oxygen Weed (*Lagarosiphon major*).

Aquatic fauna

This section of the Wairua River is not accessible to diadromous native fish or introduced trout.

Observations indicated that Mosquito larvae, Water Fleas and New Zealand mud snails (*Potamopyrgus antipodarum*) are thriving in the nutrient rich environment.

An abundance of aquatic vegetation supports snails and insect larvae.

A small number of Elvers that would have been hand released have been observed in the channel.

Clusters of Mosquito fish (*Gambusi affinis*) inhabit the fringes of the large pools and appear to have sufficient prey to establish colonies. The absence of predatory native fish and introduced trout plus the abundant cover of Periphyton filaments enable the populations of Gambusi to thrive.

The proposed hydroelectric installation

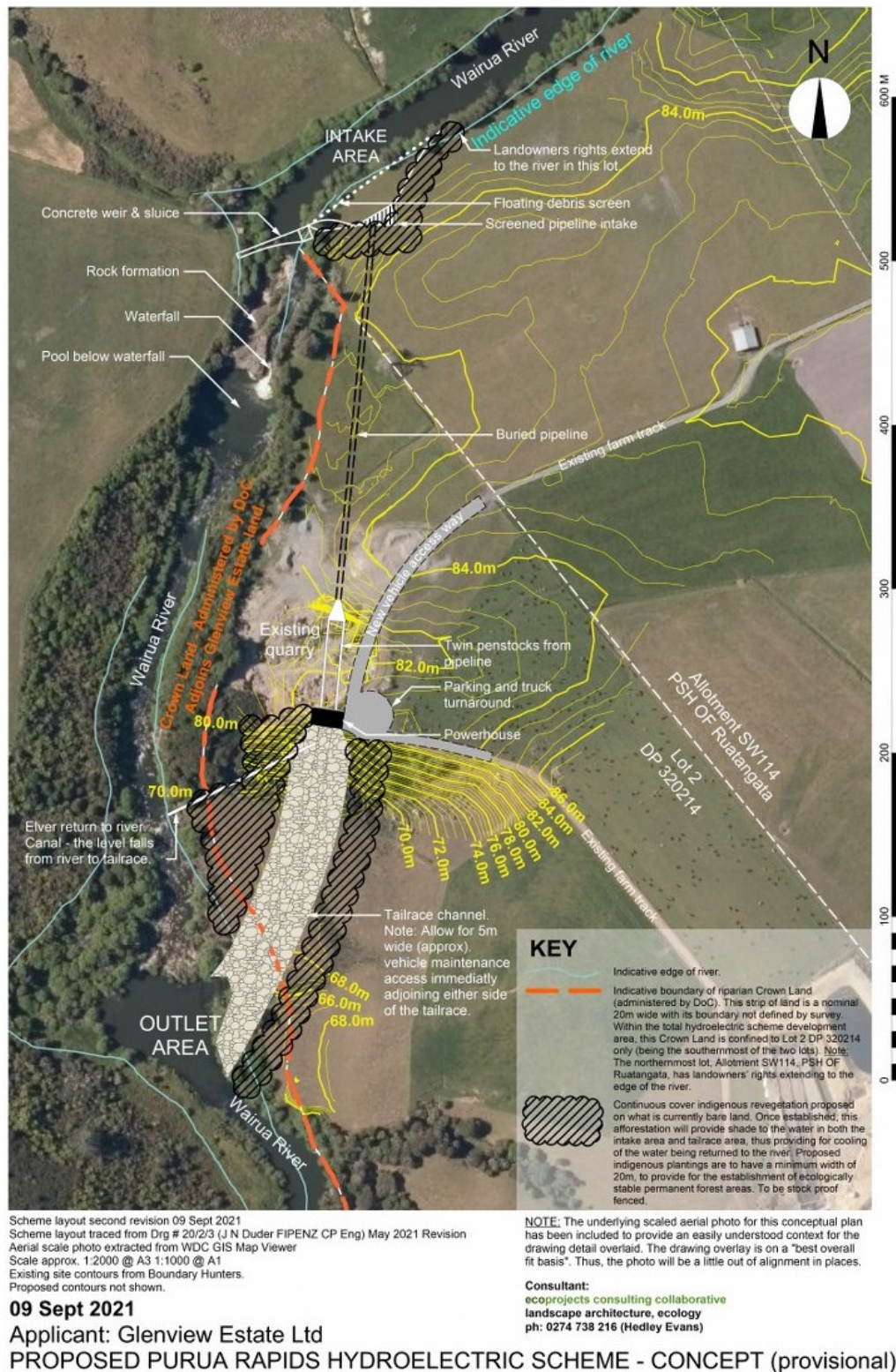


Figure 8:

Other than the proposed hydroelectric scheme layout shown in **Figure 8** and the general descriptions that follow, refer to the engineer's report submitted with the application for further engineering detail.

The weir

In consultation with the project engineer the following measures have been incorporated in the weir design to maintain and improve the capacity of the river to sustain aquatic life and to enhance water quality.

The proposed weir is to be designed incorporating a fish ladder and an eel bypass.

The weir height is to be automatically adjusted to maintain above minimal flow rates in the river during dry spells and to allow reduction of impediment to water flow during flood events.

A weir field would be constructed behind the wall to maintain a habitat and minimize temperature increases.

The variable depth weir field would consist of boulder placements, large log insertions (refer to **Appendix 2**) and excavated pools.

A rock base with differing depths would be laid to provide invertebrate habitat.

A channel is to be created on the side opposite the intake to attract eels and fish to a passage over the weir.

There is to be minimal loss of vegetation during construction of the weir abutments.

The intake

The alteration to river flow to serve the power generation system begins at the weir that holds the headwater reserves needed.

The weir will raise water levels behind it high enough to enter the intake pipes of the electricity generation system.

The water passes through the intake screen where it is filtered and transported to the penstocks. The intake screen also excludes rubbish.

Larger materials such as logs, and floating biomass are diverted over the falls.

Logs are returned to the river as an integral component of the river ecosystem (*Refer to **Appendix 2***).

Aquatic detritus can be mechanically removed at the screen and deposited in a facility to be created on the Glenview Estate, where it can be composted and integrated into farm soils.

Mechanical baskets will transport migrating eels over the system and return them to the river.

The discharge

Neil Lewis has undertaken to install a series of steps to return water to the river in a much-improved state following energy extraction at the turbines. These steps include:

- Mechanical insertion of oxygen into the spent water flow.
- Passage through a flow form channel to re-establish the Vortex (refer to *Figure 4*).
- Cooling of the water through the buried intake pipes.
- Establishing a fish ladder for elver passage.
- Strategic placement of the outlet into the discharge pool.



Figure 9: Around 100m downstream from the 9m deep scour hole below the falls, this scour hole forms a large pool. Screened, oxygenated water from the hydroelectric scheme would be discharged into this pool.

The water intake & outlet areas are to be formed across two areas of riparian land that are almost entirely devoid of indigenous vegetation

Refer to **Figure 7**, “Proposed Purua Rapids Hydroelectric Scheme – Concept (provisional)” for the conceptual layout of the hydroelectric scheme intake and outlet areas. Both of the riparian areas that intake and outlet areas will traverse are currently almost entirely devoid of indigenous vegetation (refer to the four photos that follow immediately below (**Figures 10 -13**).



Figure 10: Looking North towards the river. Terry Kennedy (ecologist) to the left & Neil Lewis (landowner) to the right. Near the river edge, intake area excavation is to be carried out in a manner that will direct river water flow to the “screened pipeline intake” (refer to **Figure 8** for the layout). It is proposed that excavation for the intake area is located between the two tall Kanukas’ on the river’s edge (the larger tree being at the top left of the photo & the other being to the right a little further along the river bank).



Figure 11: Looking South towards the river edge, across land where the tailrace is to be formed. It is proposed that the tailrace is located between the Totara just to the left of centre and the tall Kanuka Kanuka to the right. **Figures 12 & 13** are close up views of these two trees. The tailrace discharges to the river at that point (the “outlet area”).



Figure 12: Close up view of the Totara labelled in **Figure 11**. The proposed location of the tailrace outlet is to the right of this tree. As shown in this photo, other vegetation established in this riparian area is predominantly Willow.



Figure 13: Close up view of the Kanuka referred to in **Figure 11**. The proposed location of the tailrace outlet to this scour hole / pond in the river, is to the left of this tree. As shown in this photo, other vegetation established in this riparian area is predominantly Willow.

Although every reasonable effort will be made to retain them, none of the isolated indigenous specimens identified in the above four photos are of significant ecological value.

Extensive indigenous riparian revegetation

Based on best practice principles, extensive indigenous revegetation is proposed within selected areas of the project site (the site extending for a length of around 650m along the river - refer to **Figure 8**). It is to be mainly continuous cover indigenous revegetation on what is currently pastureland. Once established, this afforestation will provide shade to the water in both the intake and tailrace areas, including the tailrace outlet to the scour hole / pond on the river (Refer to **Figures 9 & 13**). Such shading will contribute to cooling of the water being returned to the river.

Proposed indigenous revegetation zones are to have a minimum width of 20m, to provide for the establishment of ecologically stable permanent forest areas. In cooperation with the Department of Conservation, gaps in the existing 20m zone of riparian vegetation could be infill planted. The balance of farmed land between the tailrace and the nearby 20m DoC managed zone of riparian vegetation, would also be retired and established in indigenous vegetation.

All revegetation areas are to be stockproof fenced and will significantly enhance the overall ecological values of the riverside area adjoining the hydroelectric power scheme.

It is noted that in the project engineer's engineering prefeasibility report (21 May 2021 revision) that the envisaged scheme should have no significant effect on the 20m strip of DoC managed riparian Crown Land, with minimal loss of riverbank vegetation at the river weir abutments, pipeline intake area and the tailrace outlet. The stand of mature totara which screens the southern boundary of the quarry should not be significantly impacted by power station construction.

Concerns of Tangata Whenua

The Tangata Whenua administering Kaitiaki over the Wairua River are Ngati Hau. General concerns on the degraded state of the river are constantly raised in all discussions with Tangata Whenua.

The concerns of the river kaitiaki groups have been well documented in *"WAI 1040 #A60 Northland Rural Rivers Environmental Management, Pollution and Kaitiakitanga Since 1991."*

Interviews with members of the iwi residing in the lower regions of the Wairua indicate their concerns are current and are major.

"The quality of the water arriving in our rohe has deteriorated dramatically over the last 4-5 years. "

"Swimming holes have been too toxic to enter, and children have contracted skin rashes and eye problems after bathing. "

"Pools that have been used recreationally for generations are now off limits."

Mahinga kai, although there are still eels present in large numbers during migration periods, the existing dam and hydro station at Wairua Falls has interrupted their migratory patterns and manual intervention has become necessary to facilitate their breeding cycle.

The efforts of Tangata Whenua and other environmental groups to address the ongoing deterioration of the Wairua River are acknowledged in this report. The authors tautoko the work carried out by the kaitiaki of the Kaipara region.

Discussions with members of Ngati Hau have so far revealed a wealth of local knowledge and multi-generational, anecdotal evidence on the behavior patterns of the eels and other river fauna.

The applicant has expressed a desire to seek ongoing advice from local kaitiaki when designing passages for elvers and migrating mature eels.

Fish passages.

Discussions with the applicant indicate that much thought, research and planning has gone into the design and implementation of eel and fish access to the upper reaches of the Wairua catchment.

Although at present there are no diadromous or native fish species present in the river above the lower dam, the possibility of future corrections to the river ecology and restored access of migrating species to the upper Wairua regions has been a significant consideration in the design process

The weir is to be constructed incorporating recommendations published by NIWA (Doc. 2018019HN) Fish Passage Guidelines.

The tailrace design would also serve as:

- a water quality enhancement unit,
- a fish ladder and an oxygenation system utilising riffles and rock placements to replicate instream conditions.

Future proofing

Although the Wairua River is currently in a highly degraded state, it is not envisioned that this will always be the case. The expectation is that one day the river will be cleaned up, with its health & vitality having been gradually restored to an optimal state. The scheme as proposed will make a significant contribution to cleaning up the river.

The weir and tailrace outlet planning process needs to ensure that any future efforts by council to restore the Wairua River to its optimum ecological status are not impeded by the physical structures or the operations of the proposed hydroelectric facility.

Conclusions

High levels of contamination and engineered flood controls in the Wairua River system have over time, lowered the life sustaining capacity of its waters.

The proposed maximum extraction rate of 24 cubic metres during times of moderate to high flow rates from a total river flow of 1,300 cubic metres is unlikely to have a substantial effect on the ecology of the river in its current ecological state.

A reduction of flow over the section affected will result in less than minor eco-system degradation in either quantity or quality within the affected area or further downstream.

Glenview Estate CEO Neil Lewis has taken an innovative approach to the construction of a facility that would produce energy without further compromising the ecological integrity of the Wairua River and the applicant undertakes to construct a sustainable facility that will not impede any future efforts to restore the river to its optimum health.

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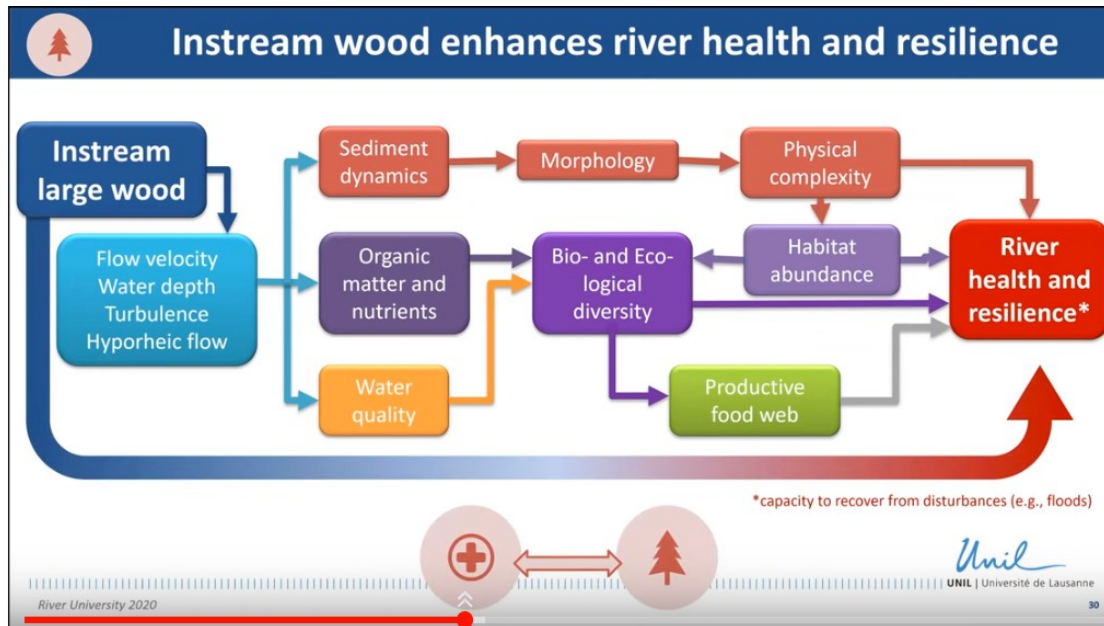
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APPENDICES:



Appendix 1: Area affected by the hydro scheme currently documented as being prone to flooding. The hydro scheme as proposed will withstand such flooding.



- ✓ Instream large wood (LW) is a **functional component** of **healthy fluvial ecosystems**, as important as flow, sediment and vegetation
- ✓ LW contributes to **maintain** and **restore** both the **physical** and **ecological integrity** of forested rivers
- ✓ Impulse river **management strategies** properly accounting for LW: River management that does not incorporate target wood regimes cannot sustain the physical and ecological attributes of rivers
- ✓ The definition of the **LW regime** should complete our **understanding** and **managing** of rivers
- ✓ Wood-related **hazards** and **risks** assessment is critical for **land use planning**
- ✓ Quantifying the LW regime requires **field observation**, and **monitoring** is key

Appendix 2: In support of returning large logs to the river. (River Restoration on Ptolemaic River 1992)