FISH PASSAGE ASSESSMENT OF THE HAKAPUPU (PLEASANT) RIVER

Prepared by Kāti Huirapa Rūnaka ki Puketeraki

Matt Dale (Waterscape Connections Ltd) and Julia Rata te Raki, 2024

Kāti Huirapa Rūnaka ki Puketeraki

Acknowledgments

We would like to acknowledge the hard mahi and support provided by mana whenua for the field work and preparation of this report. In particular Carolyn Campbell and Grant Meikle.

We would also like to thank the landowners of the Hakapupu catchment for providing access to their whenua and supporting this kaupapa, as well as the Otago Regional Council for funding this mahi.

Contents

Executive summary

The Toitū te Hakapupu project is a Ministry for the Environment (MFE) funded Jobs for Nature project that is managed jointly by the Otago Regional Council (ORC) and Kāti Huirapa Rūnaka ki Puketeraki. As part of this project, Kāti Huirapa Rūnaka ki Puketeraki has been contracted to assess potential fish passage barriers in the Hakapupu catchment and make recommendations on actions to be taken where barriers have been identified.

This will allow the Hakapupu Partnership Group and landowners to make informed decisions around prioritisation and funding of fish passage improvement actions in the catchment and lead a significant increase and the distribution and abundance of migratory fish species within the Hakapupu catchment.

In total, 20 instream structures were assessed for fish passage across the 4 sub-catchments of the Hakapupu catchment. Of these 20 structures 7 were considered to be of high priority for replacement or remediation. In all cases, complete removal and replacement of the existing structures is recommended, although some temporary remediation measures may be appropriate while more permanent solutions are progressed.

1.Introduction

The Toitū te Hakapupu project is a Ministry for the Environment (MFE) funded Jobs for Nature project that is managed jointly by the Otago Regional Council and Kāti Huirapa Rūnaka ki Puketeraki. The project is focussed on the Hakapupu (Pleasant River) catchment, with the aim of enhancing the ecosystem and cultural values, improving water quality through combining Kāi Tahu mātauraka (knowledge) and modern science to inform these kaupapa.

For mana whenua, the Hakapupu awa was an important mahika kai area where tuna (eels), pātiki (flounder), tuaki (cockles) and īnaka (whitebait) were abundant. The awa was also used as a trading hub, and a place to connect with wider Kai Tahu whānui.

As part of this project, Kāti Huirapa Rūnaka ki Puketeraki has been contracted to assess potential fish passage barriers in the Hakapupu catchment and make recommendations on remediation where barriers have been identified.

1.1. Fish species of the Hakapupu catchment

Ten species of freshwater fish, and seven estuarine/marine species have been identified in the Hakapupu catchment using a combination of fish surveys and eDNA monitoring (

Table 1). Of these freshwater species, bluegill bully, īnaka (inanga) and longfin tuna are considered threatened (at risk – declining), and four are considered mahika kai species (banded kokopu, īnaka, longfin tuna, shortfin tuna). Of the estuarine fish species detected, four are considered mahika kai species, kahawai, sand flounder, skate and yellow eyed mullet.

Table 1 Fish species of the Hakapupu catchment

	Species	Threat classification	Mahika kai species
Freshwater migratory	Banded kokopu	Not threatened	Yes
	Bluegill bully	At risk – declining	
	Common bully	Not threatened	
	Īnaka (inanga)	At risk – declining	Yes
	Longfin eel	At risk – declining	Yes
	Redfin bully	Not threatened	
	Shortfin eel	Not threatened	Yes
Freshwater non-Migratory	Upland bully	Not threatened	
	Brown trout	Introduced	
	European perch	Introduced	
Marine/Estuarine	Estuary clingfish	Not assessed	
	Kahawai	Not assessed	Yes
	Sand flounder	Not assessed	Yes
	New Zealand smooth skate	Not assessed	Yes
	Spotty	Not assessed	
	Thornfish	Not assessed	
	Yelloweye mullet	Not threatened	Yes

1.2. Fish passage

Many of Aotearoa's fish species undertake significant migrations as part of their life cycle, including many of our iconic freshwater species such a tuna (eel) and our five whitebait species. Most of our migratory (diadromous) freshwater fish species fall into two categories.

- Amphidromous species that are born in freshwater/estuaries, then drift into the ocean as larvae before migrating back into freshwater to grow into adults and spawn, e.g., īnaka
- Catadromous species that are born in saltwater, then migrate into freshwater as juveniles where they grow into adults before migrating back into the ocean to spawn, e.g. tuna

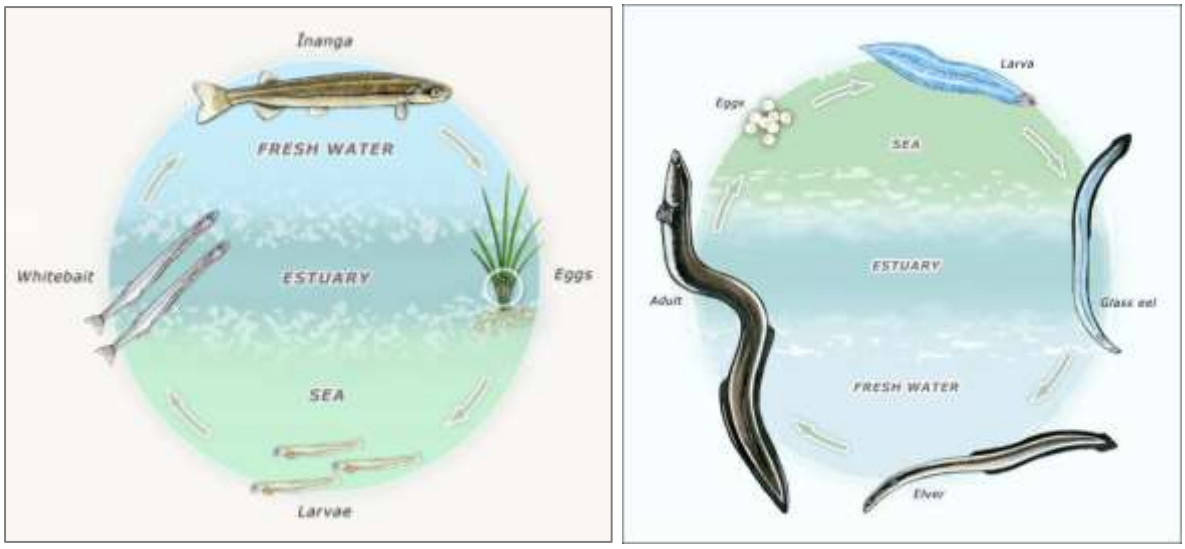

Figure 1 Examples of amphidromous (left) and catadromous (right) lifecycles that require movement between freshwater, estuarine and marine environments.

The kanakana (lamprey) is our only example of the third category of diadromy. They are known as anadromous, which means that they born in freshwater, migrate to the ocean as juveniles where they grow into adults before migrating back into freshwater to spawn.

Instream infrastructure, such as culverts, weirs, and dams can have significant impacts on our freshwater migratory species by preventing them from moving between their breeding, juvenile and adult habitats. In many cases, this can lead to certain species only being able to access a fraction of the habitat that would naturally be available in a river catchment. In some cases, this can lead to the complete local extinction of some species.

The effect of migration barriers varies between species, largely due to their different climbing and swimming abilities. Some species such as tuna, koaro, and kōkopu have excellent climbing abilities and are able to move through or around most structures that impede fish passage. However, species such as īnaka (inanga), smelt, and pātiki (black flounder) are less able to do so and can be impeded by relatively small barriers.

In some cases, the presence of species that are vulnerable to predation will necessitate the maintenance or enhancement of barriers to prevent upstream migration. In Otago, this is particularly necessary for protecting populations of non-migratory *Galaxias* from trout. eDNA monitoring undertaken as part of the Toitū te Hakapupu project has indicated that there are no non-migratory *Galaxias* present in the Hakapupu catchment, therefore intentional barriers have not been considered further in this report.

To address this issue, the New Zealand Fish Passage Guidelines (Franklin *et al,* 2018) were developed in 2018, and adopted into the National Environmental Standard for freshwater (NESFW) in 2020.

This report seeks to assess fish passage barriers in the Hakapupu catchment and make recommendations for remediation in alignment with the New Zealand Fish Passage Guidelines and the NESFW 2020.

2.Methods

Fish passage has been assessed using the Fish Passage Assessment Tool, which is a digital assessment protocol developed by NIWA and the New Zealand Fish Passage Advisory Group. The tool was downloaded to mobile devices and the results uploaded to the New Zealand Fish Passage Database upon completion.

Instream structures were initially identified using aerial imagery and a helicopter flyover. Each site was then visited by trained kaimahi and a full assessment was undertaken using the Fish Passage Assessment Tool.

2.1. Fish passage assessment tool

The fish passage assessment tool provides a method of assessing the risk that a structure provides to fish passage, as well as collecting the key metrics that contribute to this risk. Further details on how to use the app are available in the Fish Passage Assessment Protocol mobile application User Guide (Franklin, 2018).

2.1.1. Fish passage risk

Fish passage risk is defined by the likelihood that fish movements will be impeded by the structure that is being assessed. This can be somewhat subjective and does depend on the assessor's knowledge of fish passage, fish movement capabilities and behaviour. The definitions of each risk class are outlined in Table 2.

Table 2 Qualitative descriptions of the different fish passage risk classes (Franklin, 2018)

Risk class	Description
Very high	Very high chance that most or all fish species will be blocked most or all the time.
High	High chance that the movements of many fish species and life stages will be restricted for much of the time.
Moderate	Moderate chance that movements of some fish species and life stages are commonly restricted.
Low	Some chance that movements of weaker swimming species are restricted some of the time.
Very low	Movements are unimpeded for most or all fish species and life stages for most or all the time.
Not assessed	Select this if you are not confident or do not have the right knowledge to determine the likely risk.

The key characterises of instream structures that contribute most to fish passage risk depend to some extent on the type of structure (e.g. weir, culvert, etc). The assessment of the Hakapupu catchment showed that most structures that pose a risk to fish passage were culverts or culverted fords, therefore the following examples will be focussed on culvert characterises (Figure 2).

- Fall height – the distance between the culvert lip and the water level at the downstream end.
- Overhang – the horizontal distance that the culvert lip hangs over the water at the downstream end.
- Water velocity – The speed of the water through the culvert barrel.

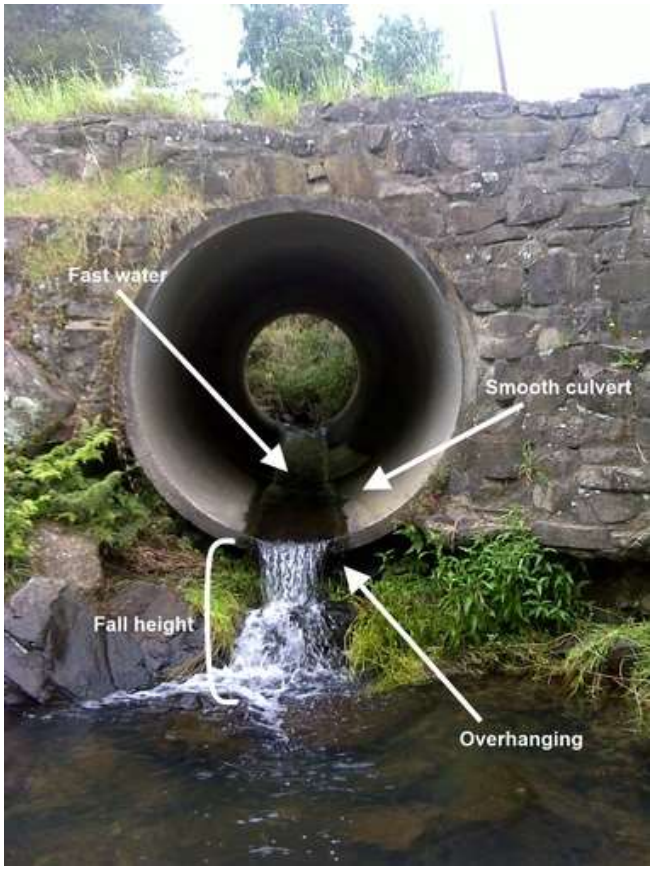

Figure 2 Key characterises of culverts that contribute most to fish passage risk

An additional structure that was added to some culverts in the Hakapupu Estuary were flap gates (sometimes known as tidal gates). These gates are attached to the downstream ends of culverts and are designed to close on an incoming tide to prevent saltwater intrusion into the upstream catchment (Figure 3). These structures are particularly detrimental to īnaka, which not only require access to tidally affected areas for spawning, but also rely on variation in tidal amplitude to spawn. This means that even if adult īnaka are able to navigate the flap gates, there may be insufficient tidal amplitude for successful spawning.

Figure 3 **An example of a flap gate from the Hakapupu Estuary**

2.1.2. Remediation Prioritisation

A key output of this project is to recommend priorities for remediation for all of the identified structures that have negative impacts on fish passage. This prioritisation takes in a number of considerations, some of which are subjective, and others that are more objective. These include;

- Fish passage risk
- Location within the catchment
- The likely species impacted by the structure
- The cultural, ecological and/or recreational value of these species

Note that remediation cost does not factor into the priority assessment, though this may factor in to the type of remediation that is chosen to address the risk posed by the structure.

3.Structure replacement/remediation

Once fish passage risks have been identified and prioritised, landowners should work with the relevant agencies to undertake remediation activities. This may include the replacement of structures, or the retrofitting of existing structures with features that address the specific issues posed by each structure. Where existing structures impede

the movement of aquatic organisms, removal and replacement should always be considered as the first and preferred solution for maximising fish passage at existing structures.

It is outside the scope of this report to provide technical and design specifications for the remediation of individual structures within the Hakapupu catchment, however the following sections provide high level guidance to support the early parts of this decision making process.

Further details on structure replacement and remediation are available in the New Zealand Fish Passage Guidelines and on the Department of Conservation fish passage webpage.

3.1. Removal and replacement of existing structures

The New Zealand Fish Passage Guidelines are clear in the preference of the removal and replacement of structures that impede fish passage. The order of preference of replacement structures is outlined in Figure 4, which prioritises matching the natural stream conditions as much as possible within the constraints of the specific site. This guide can also be useful when considering the installation of new structures.

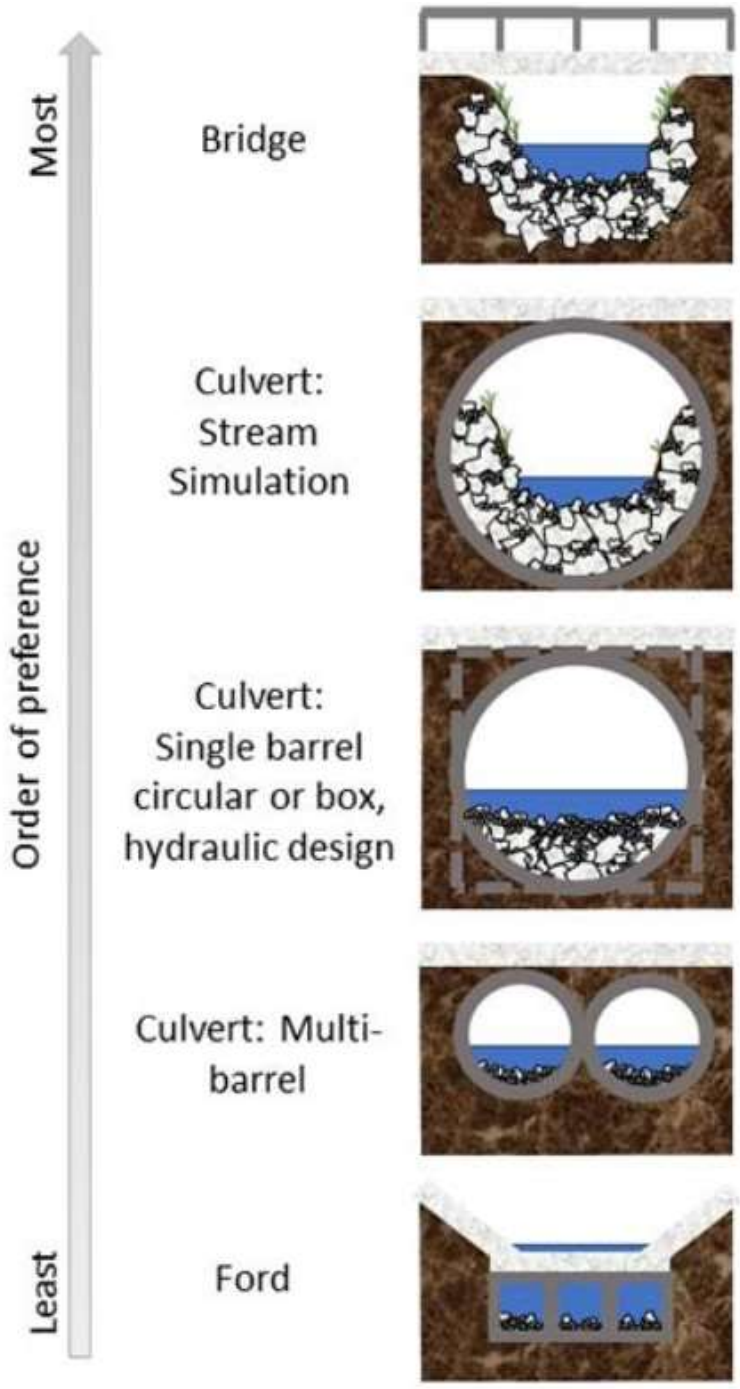

Figure 4 **Order of preference for culvert replacement with regards to fish passage risk.**

3.2. Remediation of existing structures

There are several options for retrofitting existing structures, the suitability of which is determined by a combination of the structure characterises and the specific species that are present in the catchment. As a general rule, remediation is more effective for

climbing species such as tuna, kōkopu and koaro, and is less effective for species such as īnaka.

3.2.1. *Rock ramps*

Rock ramps are the preferred option for overcoming vertical drops that impede the movement of fish Figure 5. Rock-ramp structures typically take the form of a series of transverse rock ridges, with pool sections between the ridges that act as resting areas for migrating fish (Franklin *et al,* 2018).

Figure 5 Example of the retrofitting of a rock ramp to an existing culvert

3.2.2. *Floating ramps*

Floating ramps are considered a low-cost alternative to concrete ramps and are particularly useful as an intermediate step to provide fish passage while funding or resource consents are secured for the replacement of an existing structure. These ramps are generally sections of rubber matting bolted to the bottom of the culvert and can be further enhanced with the addition of mussel spat ropes (Figure 6).

Figure 6 Examples of the retrofitting of floating ramps to existing culverts. The ramp on the right also includes mussel spat ropes to further improve fish passage.

3.2.3. In-culvert baffles

In culvert baffles are used to reduce water velocities and provide resting areas through the length of the culvert barrel (Figure 7). This is particularly important for species with poor climbing abilities such as īnaka.

Figure 7 **Examples of the retrofitting of in-culvert baffles to reduce water velocity through existing culverts**

3.2.4. "Fish friendly" flap gates

Although it is preferable to completely remove flap gates where possible and restore natural connection and hydrology, there are some instances where this may not be possible due to practical or economic considerations.

In these situations, it is possible to install "fish friendly" flap gates that still serve their primary purpose of reducing saltwater intrusion, but also allow fish to pass for a greater part of the tidal cycle. There are two main types of fish friendly flap gates commonly used in Aotearoa, the cantilever gate and offset top hinged (Figure 8).

Figure 8 **Examples of "fish friendly" flap gates. The cantilever gate on the left, and the offset top hinged on the right.**

4. Results

The results of the Hakapupu fish passage assessment have been organised into three groups based on their location within the catchment.

- Estuary (E) – All sites within the Hakapupu estuary and its tributaries
- Watkin Creek (W) – All sites within the Watkin Creek sub-catchment
- Hakapupu (H) – All sites within the Hakapupu main stem and its minor tributaries.

Although the Owhakaoho (Trotters Creek) sub-catchment was also investigated, no fish passage barriers were identified.

This section provides a high-level overview of fish passage risk and priority for the sites in each sub catchment, however detailed site assessments and photos are provided in Appendices 2 to 21.

The information collected by the Fish Passage Assessment Tool has a high level of detail, and it is not useful to present all this information as part of this report. A catchment-wide summary table is provided in Appendix 1 for those who wish to view more of this detail, and the full dataset is available in the Fish passage Assessment Tool web page.

In total, 20 potential fish passage barriers were identified and assessed (Figure 9), with fish passage risk assigned in alignment with the criteria of the Fish Passage Assessment Tool.

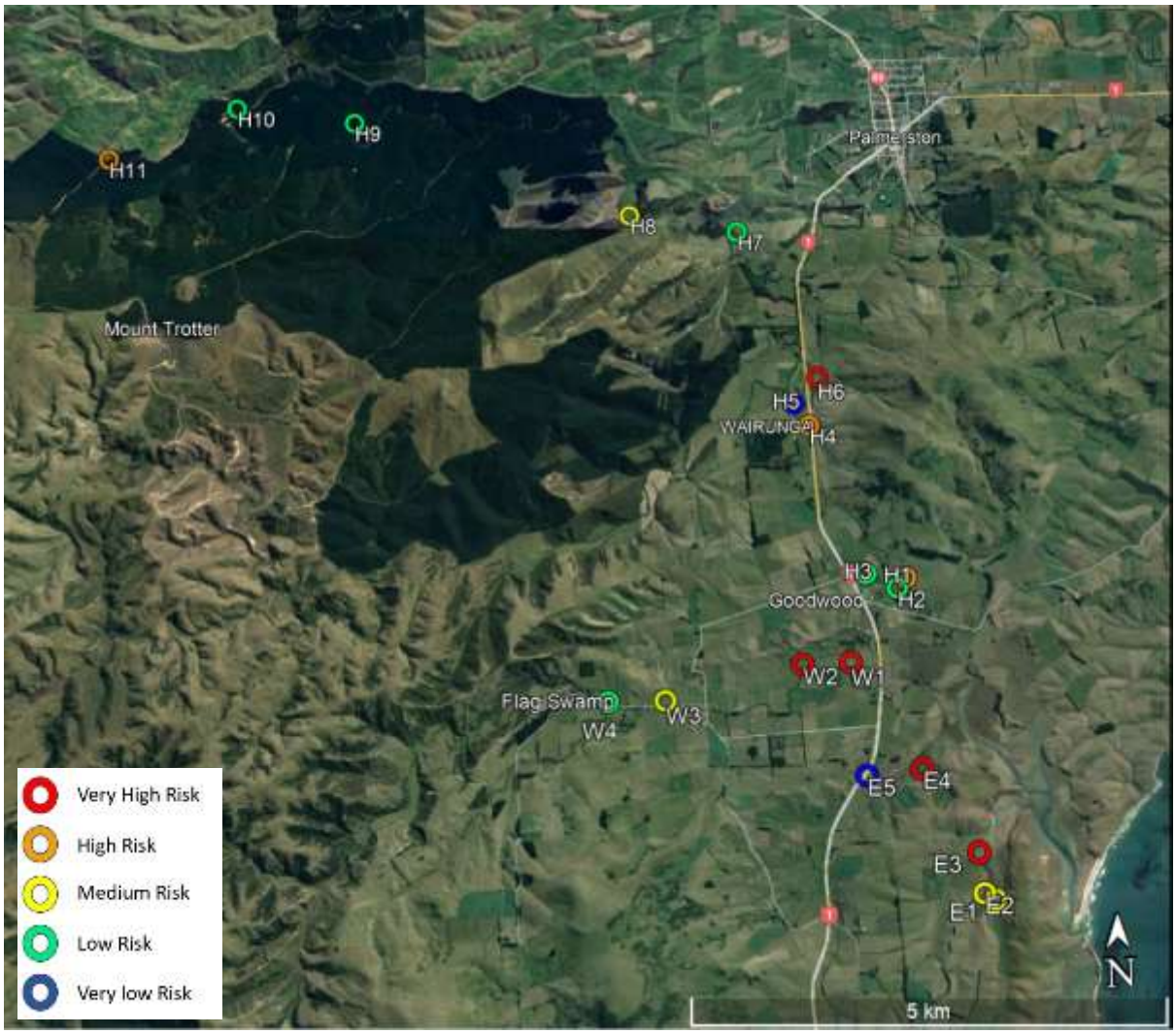

Figure 9 **Location of all instream structures assessed for fish passage risk in the Hakapupu catchment**

4.1. Estuary Sites

There were a total of five estuary sites assessed, located in the tributaries flowing directly into the Hakapupu Estuary (Figure 10).

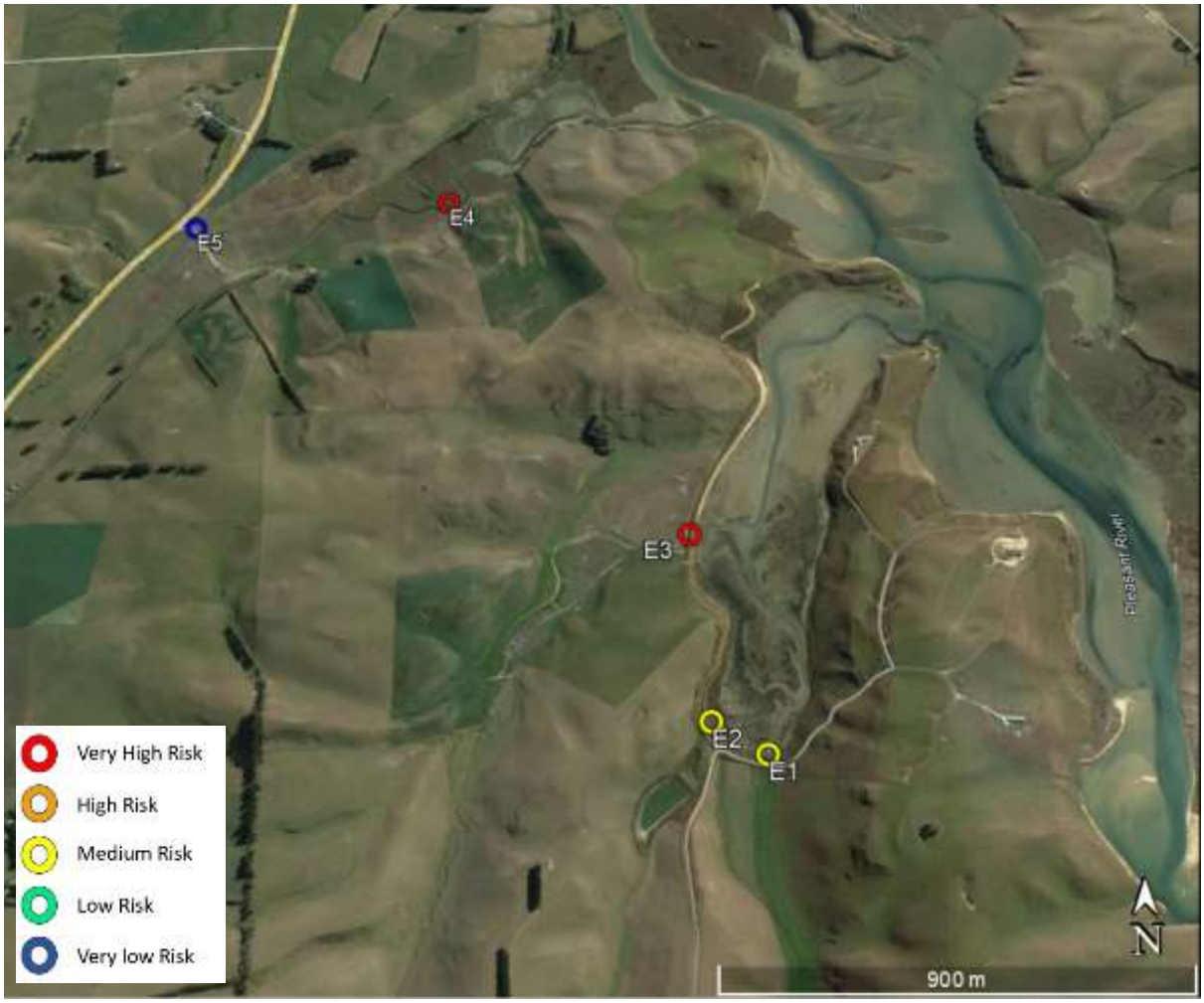

Figure 10 **Location of potential fish passage barriers in the Hakapupu Esturay**

Of these structures, three were culverts with attached flap gates, and two were stand-alone culverts (Table 3). Structures E3 and E4 were considered to be both high risk and high priority. In both cases, the fully closed flap gates prevented almost all fish passage from occurring for most of the tidal cycle, reducing the availability of both adult and spawning habitat for īnaka in particular.

Table 3 **Summary of fish passage barriers identified in the Hakapupu Estuary. High priority sites are highlighted in red.**

Site Name	Database ID	Date	Structure type	Risk to fish passage	Priority
E1	177858	13/12/2023	Flap gate with culvert	Medium risk	Low
E2	177856	13/12/2023	Culvert	Medium risk	Low
E3	177868	13/12/2023	Flap gate with culvert	Very high risk	High
E4	177866	13/12/2023	Flap gate with culvert	Very high risk	High
E5	177862	13/12/2023	Culvert	Very low risk	Low

4.2. Watkin Creek

A total of four structures were identified in the Watkin Creek sub-catchment (Figure 11), two of which were considered to be very high risk to fish passage. Additional culverts were identified in smaller ephemeral tributaries, but they were not assessed further due to the lack of fish habitat in the upstream catchment.

Figure 11 **Location of assessed structures in the Watkin Creek sub catchment.**

Of the four structures, W1 and W2 are considered high priority for replacement or remediation (Table 4). This high priority is due to the large upstream catchment and significant amount of adult īnaka habitat that is currently inaccessible to this species.

Table 4 **Summary of fish passage barriers identified in the Watkin Creek sub-catchment. High priority sites are highlighted in red.**

Site Name	Database ID	Date	Structure type	Risk to fish passage	Priority
W1	177872	14/12/2023	Ford with culvert	Very high risk	High
W2	177871	14/12/2023	Culvert	Very high risk	High
W3	177867	14/12/2023	Culvert	Medium risk	Moderate
W4	177869	13/12/2023	Ford without culvert	Low risk	Low

4.3. Hakapupu main stem

Off the 11 structures identified in the main stem of the Hakapupu River, three are considered high risk, and one is considered very high risk (Figure 12).

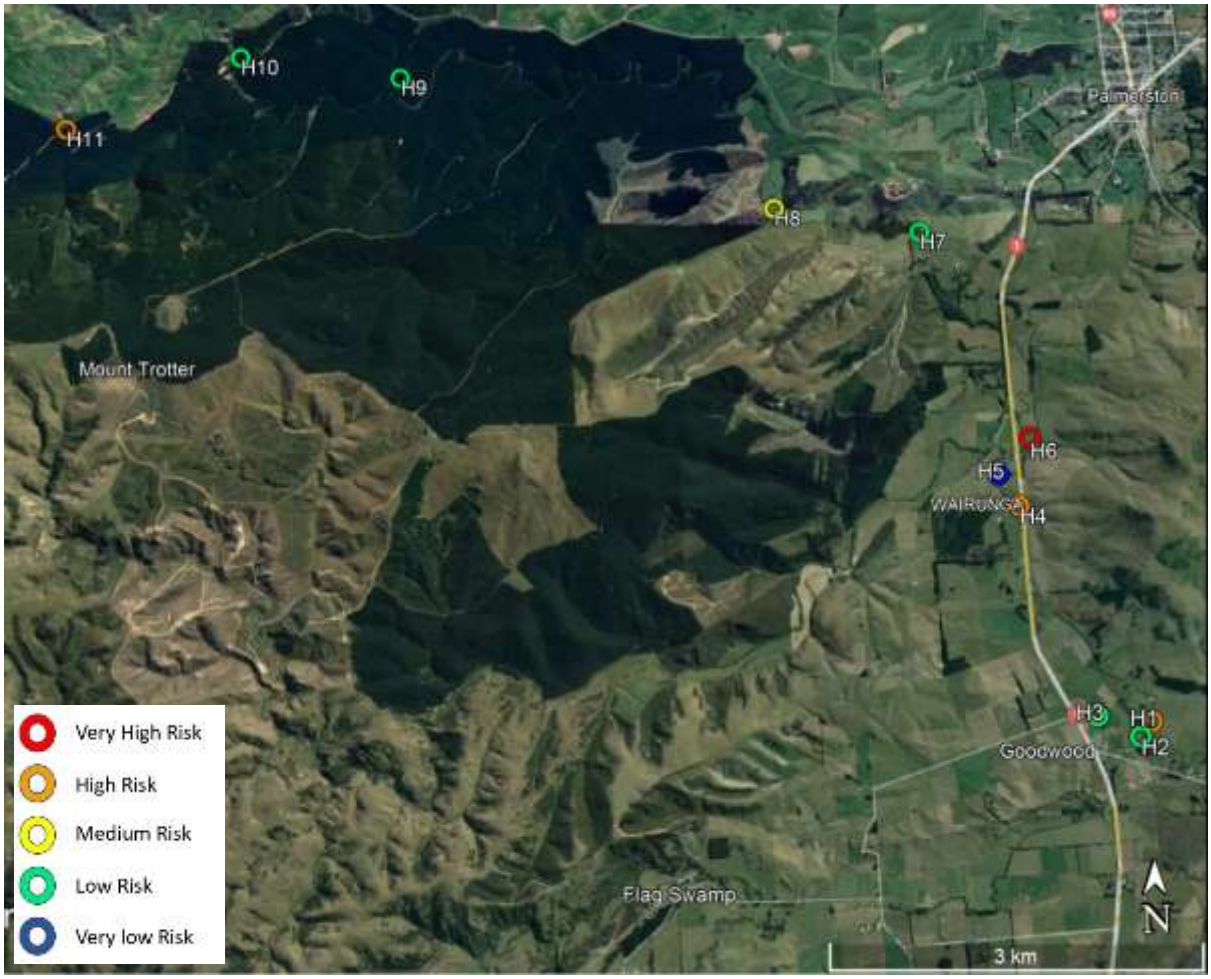

Figure 12 **Location of assessed structures in the Hakapupu main stem and its tributaries.**

Three of these structures are considered high priority for replacement or remediation (Table 5), as the majority of the Hakapupu catchment sits above these sites. The likely impact of these structures is a severe reduction in the amount of adult īnaka habitat, as well as significant reduction in the range of pātiki and smelt within the catchment. H11 is not considered a priority site due to its location high in the catchment and the intermittent flows in this reach over the summer months.

Table 5 Summary of fish passage barriers identified in the main stem of the Hakapupu River. High priority sites are highlighted in red.

Site Name	Database ID	Date	Structure type	Risk to fish passage	Priority
H1	177857	13/12/2023	Ford with culvert	High risk	High
H2	177861	13/12/2023	Ford with culvert	Low risk	Low
H3	178012	27/12/2023	Ford without culvert	Low risk	Low
H4	177855	13/12/2023	Ford with culvert	High risk	High
H5	177859	14/12/2023	Bridge	Very low risk	Low
H6	177863	14/12/2023	Culvert	Very high risk	High
H7	177860	14/12/2023	Bridge	Low risk	Low
H8	177873	14/12/2023	Culvert	Medium risk	Low
H9	177877	14/12/2023	Culvert	Low risk	Low
H10	177876	14/12/2023	Culvert	Low risk	Low
H11	177875	14/12/2023	Culvert	High risk	Moderate

5.Recommendations

In total, 7 sites are considered high priority for removal or remediation (Figure 13). The primary driver for the prioritisation of these sites is to provide sufficient fish passage to ensure that īnaka have full access to their natural range within the catchment. As īnaka are one of the poorest climbers of the fish species in the catchment, it is expected that all other species will also have access to their full range if īnaka passage is restored.

Figure 13 **Location of high priority sites for replacement/remediation in the Hakapupu catchment.**

In all cases, removal and replacement of the structure is considered the preferred option (Table 6), again due mainly to the high value placed on īnaka in this catchment.

Table 6 Summary of high priority structures in the Hakapupu catchment

Site Name	Database ID	Structure type	Detailed assessment	Recommended action
E3	177868	Flap gate with culvert	Appendix 4	Removal of flap gate, installation of fish friendly gate if this is not possible
E4	177866	Flap gate with culvert	Appendix 5	Removal of flap gate, installation of fish friendly gate if this is not possible
W1	177872	Ford with culvert	Appendix 7	Complete removal and replacement with large diameter culvert imbedded in stream bed
W2	177871	Culvert	Appendix 8	Complete removal and replacement with large diameter culvert imbedded in stream bed
H1	177857	Ford with culvert	Appendix 11	Removal and replacement with bridge or large box culvert. Rock ramp as a short-term alternative
H4	177855	Ford with culvert	Appendix 14	Removal and replacement with bridge or large box culvert. Rock ramp as a short-term alternative
H6	177863	Culvert	Appendix 16	Complete removal and replacement with large diameter culvert imbedded in stream bed

Glossary

Amphidromous	Amphidromous fish are born in freshwater/estuaries, then drift into the ocean as larvae before migrating back into freshwater to grow into adults and spawn, e.g., banded kōkopu.
Anadromous	Anadromous fish are born in freshwater, migrate to the ocean as juveniles where they grow into adults before migrating back into freshwater to spawn, e.g., lamprey.
Apron	A hardened surface (usually concrete) placed at the inlet and/or outlet of a structure to protect the structure from erosion.
Baffles	A device used to modify and restrain the flow of water.
Built barrier	An instream structure built with the explicit intent of restricting or preventing the movement of aquatic organisms.
Catadromous	Catadromous fish are born in saltwater, then migrate into freshwater as juveniles where they grow into adults before migrating back into the ocean to spawn, e.g., longfin eel.
Culvert	A connection between two water bodies or parts of a waterbody, typically a pre-formed concrete tube located below roads or other constructions.
Fish passage	The movement of fish and other aquatic organisms between all habitats necessary to complete their life cycle.
Fish passage design flow	The range of flows over which fish passage is required.
Ford	A shallow place in a river or a stream allowing one to walk or drive across.
Impede	Delay or prevent by obstructing them; hinder.
Rock-ramp fishway	A type of fish pass consisting of rock ridges and pools that mimics natural stream conditions to facilitate movements of aquatic organisms around or over an obstruction.
Weir	A barrier across the cross-sectional width of a river that alters the flow characteristics of the water and usually results in a change in the height of the river level.
Wetted margin	A shallow, low velocity area along the edges of the water.

Wetted width	The width of the river channel at the water surface.
Wingwall	A wall on a structure that ties the structure to the river bank.

References

Franklin. P., 2018, Fish Passage Assessment Protocol mobile application User Guide, NIWA CLIENT REPORT No: 2018349HN, https://niwa.co.nz/sites/niwa.co.nz/files/User%20guide%20v1.3%20FINAL.pdf

Franklin. P., Gee. E., Baker. C., & Bowie. S., 2018, New Zealand Fish Passage Guidelines for structures up to 4 metres, NIWA CLIENT REPORT No: 2018019HN. https://niwa.co.nz/sites/niwa.co.nz/files/Final%20NZ%20Fish%20Passage%20Guidelines%20with%20Cover%20Page%2014-12.pdf

Appendix 1: Hakapupu fish passage barrier summary table

Site name	Site id	latitude	longitude	Date	Tidal?	Structure type	Number of culvert barrels	Structure slope	Gate type	Risk to fish passage	For NES FW?	Risk class
E1	177858	-45.56686654	170.7165208	13/12/2023	Yes	Flap gate with culvert	1	Same as stream	Top hung	Medium risk		Very High
E2	177856	-45.5662413	170.7151297	13/12/2023	Yes	Culvert	1	Steeper than stream		Medium risk		Very High
E3	177868	-45.5624378	170.715023	13/12/2023	Yes	Flap gate with culvert	1	Same as stream	Top hung	Very high risk		Very High
E4	177866	-45.55437778	170.7084778	13/12/2023	Yes	Flap gate with culvert	2	Same as stream	Top hung	Very high risk		Very High
E5	177862	-45.55491547	170.70067	13/12/2023	Yes	Culvert	1	Same as stream		Very low risk		Medium
H1	177857	-45.53525833	170.7089556	13/12/2023	No	Ford with culvert	3	Steeper than stream		High risk		High
H2	177861	-45.53633585	170.7076013	13/12/2023	No	Ford with culvert	2	Steeper than stream		Low risk	Yes	High
H3	178012	-45.5353197	170.7073661	14/12/2023	No	Ford without culvert				Low risk		High

Site name	Site id	latitude	longitude	Date	Tidal?	Structure type	Number of culvert barrels	Structure slope	Gate type	Risk to fish passage	For NES FW?	Risk class
H4	177855	-45.518875	170.6970389	14/12/2023	No	Ford with culvert	3	Steeper than stream		High risk		Very High
H5	177859	-45.5164003	170.6950885	14/12/2023	No	Bridge				Very low risk		Very Low
H6	177863	-45.51359886	170.6989032	14/12/2023	No	Culvert	2	Less than stream		Very high risk		Very High
H7	177860	-45.4967798	170.6885473	14/12/2023	No	Bridge				Low risk		Very Low
H8	177873	-45.49487592	170.6729098	14/12/2023	No	Culvert	1	Steeper than stream		Medium risk	Yes	Very High
H9	177877	-45.48297888	170.6299422	14/12/2023	No	Culvert	1	Same as stream		Low risk		Medium
H10	177876	-45.48103541	170.6115663	13/12/2023	No	Culvert	1	Same as stream		Low risk		High
H11	177875	-45.48714235	170.5920002	27/12/2023	No	Culvert	1	Same as stream		High risk		High
W1	177872	-45.5437791	170.6999063	14/12/2023	No	Ford with culvert	1	Steeper than stream		Very high risk		Very High
W2	177871	-45.5438971	170.6930407	14/12/2023	No	Culvert	1	Steeper than stream		Very high risk		Very High
W3	177867	-45.54716695	170.6732591	14/12/2023	No	Culvert	1	Steeper than stream		Medium risk		Very High
W4	177869	-45.5471686	170.6651473	13/12/2023	No	Ford without culvert				Low risk		Low

Appendix 2 – Site E1

Fish passage database ID: 177858

Date of assessment: 13/12/23

Location: Lat: -45.5669, Long: 170.7165208

Structure type: Flap Gate with culvert

Risk to fish passage: Medium

Priority for replacement/remediation: Low

Description: Site E1 is located off Thornburn Rd where is crosses a small tributary of the south-western tidal arm of the Pleasant River estuary (Figure 14).

Figure 14 Location of site E1

The structure consists of a single 0.75m culvert with a flap gate attached to the downstream end. A small gap was present between the culvert lip and the flap gate which would have allowed passage for small fish at most (if not all) periods of the tide, however there was very little habitat upstream of the culvert meaning that its priority for replacement should be considered low.

Figure 15 Downstream view of the E1 culvert

Figure 16 **Upstream view of the E1 culvert**

Appendix 3 – Site E2

Fish passage database ID: 177856

Date of assessment: 13/12/23

Location: Lat: -45.5662413, Long: 170.7151297

Structure type: Culvert

Risk to fish passage: Very high

Priority for replacement/remediation: Low

Description: Site E2 is located off Thornburn Rd where is crosses a small tributary of the south-western tidal arm of the Pleasant River estuary (Figure 17Figure 14).

Figure 17 Location of the E2 culvert

The structure consists of a single 0.45m culvert which has an overhang of 0.05m and a drop height of 0.1m at mid-tide. It is likely that fish passage would be possible during high tide, but the culvert would be considered perched for much of the tidal cycle. There is very little fish habitat upstream of the culvert meaning that its priority for replacement should be considered low.

Figure 18 Downstream view of the E2 culvert

Figure 19 Upstream view of the E2 culvert

Appendix 4 – Site E3

Fish passage database ID: 177868

Date of assessment: 13/12/23

Location: Lat: -45.5624378, Long: 170.715023

Structure type: Flap gate with culvert

Risk to fish passage: Very high

Priority for replacement/remediation: High

Description: Site E3 is a privately owned structure located on the western edge of the south-western tidal arm of the Pleasant River estuary (Figure 20).

Figure 20 Location of the E3 flap gate

The structure consists of a 1m wide culvert with an attached flap gate with no fish passage remediation. The flap gate creates a strong seal with the culvert preventing fish passage for most, if not all, of the tidal cycle. This structure prevents fish passage to a significant tributary of the Hakapupu estuary. Although riparian habitat is significantly degraded due to stock grazing and channel modification, this tributary would be expected to provide īnaka spawning and adult habitat, should restoration activities be undertaken. The lower reaches of the tributary would also be expected to provide habitat for estuarine species such as mullet, while the upper reaches would be expected to provide habitat for tuna should fish passage be restored.

Due to the combination of the high risk for fish passage, and the significant amount of upstream habitat, this site should be considered the highest priority for restoration of all of the estuary sites. Ideally, the flap gate would be removed from the culvert to allow for full tidal variation in the upstream catchment. This would allow īnāka to access the area and provide sufficient tidal amplitude for spawning.

If removal of the flap gate is not possible/desirable, then remediation devices such as a cantilevered or offset "fish friendly" flap gate should be considered.

Figure 21 Downstream view of the E3 flap gate

Figure 22 Upstream view of the E3 culvert

Appendix 5 – Site E4

Fish passage database ID: 177866

Date of assessment: 13/12/23

Location: Lat: -45.55437778, Long: 170.7084778

Structure type: Flap gate with culvert

Risk to fish passage: Very high

Priority for replacement/remediation: High

Description: Site E4 is a privately-owned structure located on the northwestern tributary of the Pleasant River estuary (Figure 23).

The structure consists of a 0.6m wide culvert, with a top-hinged flap gate that remains closed for most of the tidal cycle. This flap gate blocks off approximately 1km of tidal channels, which flow through modified and "reclaimed" salt marsh.

This site should be considered a priority for remediation due to the large upstream catchment and potential for restoration. Ideally, the flap gate would be removed from the culvert to allow for full tidal variation in the upstream catchment. This would allow īnāka to access the area and provide sufficient tidal amplitude for spawning.

If removal of the flap gate is not possible/desirable, then remediation devices such as a cantilevered or offset "fish friendly" flap gate should be considered.

Figure 23 Location of the E4 flap gate

Figure 24 **Upstream view from the E4 flap gate**

Appendix 6 – Site E5

Fish passage database ID: 177862

Date of assessment: 13/12/23

Location: Lat: -45.55491547, Long: 170.70067

Structure type: Culvert

Risk to fish passage: Very low risk

Priority for replacement/remediation: Low

Site E5 is located further upstream from E4 where Tumai Rd crosses the northern western tributary of the Pleasant River Estuary (Figure 25). The upstream catchment has very little standing water due to heavy modification, drainage, and stock damage.

The culvert itself is 0.75m high and half submerged within the wetted channel, providing good fish passage throughout the tidal cycle. No further remediation is required.

Figure 25 **Location of the E5 culvert**

Figure 26 **Upstream view of E5 culvert**

Figure 27 **Downstream view of E5 culvert**

Appendix 7 – Site W1

Fish passage database ID: 177872

Date of assessment: 14/12/23

Location: Lat: -45.5437791, Long: 170.6999063

Structure type: Ford with culvert

Risk to fish passage: Very high risk

Priority for replacement/remediation: High

W1 is the most downstream instream structure in Watkin Creek and is located 300m west of SH1 (Figure 28). The culvert is 0.33 m wide and is perched with an estimated drop of 0.2 m and an undercut of 0.05 m, providing a significant barrier to upstream migrating dish. Due to the small size, water velocities through the culvert are particularly high and are likely to pose a significant barrier to upstream migration in addition to the perched culvert. Shoals of īnaka were observed immediately downstream of the culvert.

Figure 28 **Location of W1 ford and culvert**

Due to the large amount of upstream habitat, and the presence of significant restoration projects occurring in the upstream catchment, this structure should be

considered as a high priority for replacement. Due to the small diameter of the culvert, it is recommended that it be replaced, as any remediation efforts such as fish ladders will not address the high water velocities currently occurring through the culvert. Rock ramps and baffles may be considered as a short-term remediation option, but should not be considered a permanent solution.

Figure 29 **Downstream view from W1 culvert**

Figure 30 **Upstream view from W1 culvert**

Appendix 8 – Site W2

Fish passage database ID: 177871

Date of assessment: 14/12/23

Location: Lat: -45.5438971, Long: 170.6930407

Structure type: Culvert

Risk to fish passage: Very high risk

Priority for replacement/remediation: High

W2 is located 900m west of SH1 and consists of a large (1m) corrugated iron perched culvert with a 0.2m drop and 0.1m undercut. The culvert is showing signs of rust and degradation, and likely poses a significant barrier to upstream migration. Large shoals of īnaka were observed immediately downstream of the structure.

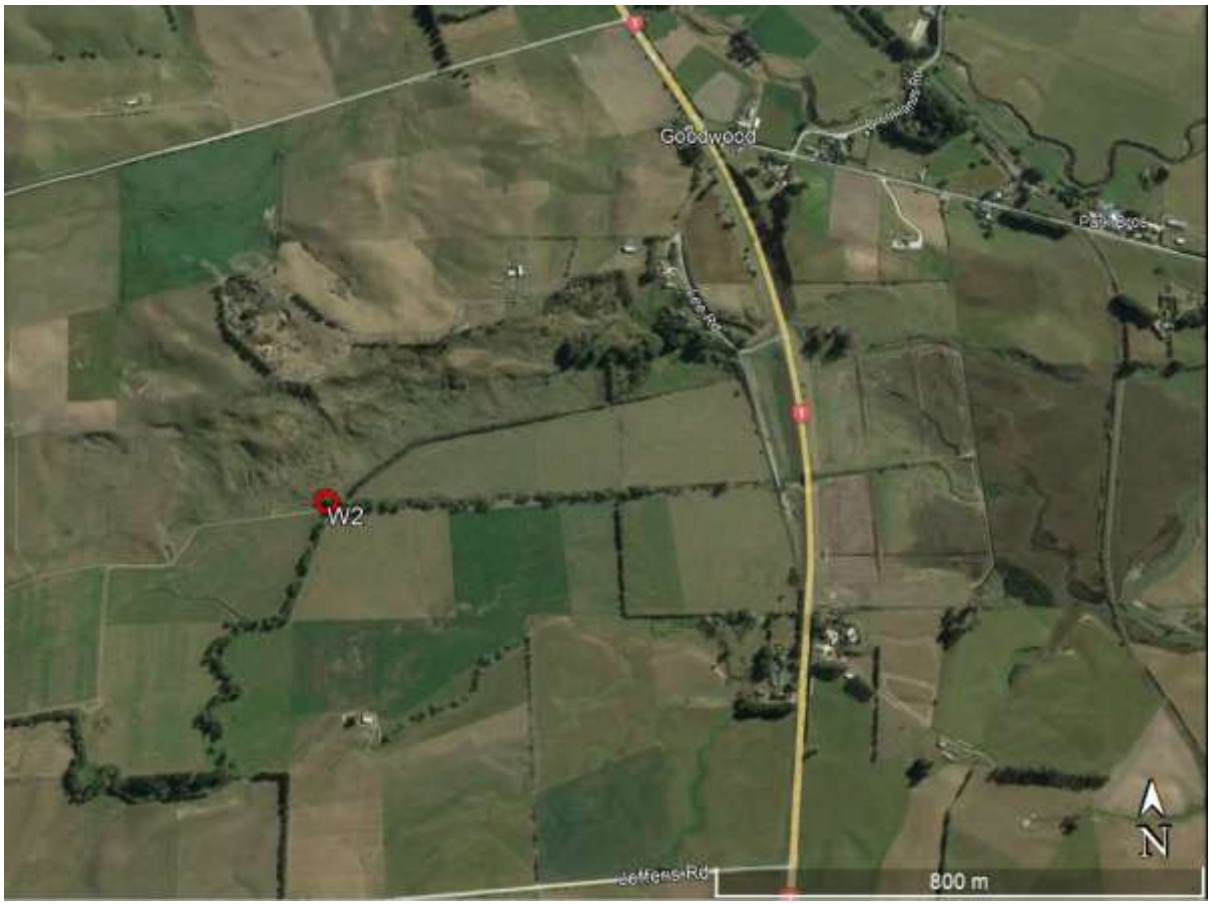

Figure 31 Location of W2 structure

Due to the large amount of upstream habitat, and the presence of significant restoration projects occurring in the upstream catchment, this structure should be considered as a high priority for replacement. Due to the large number of īnaka observed downstream of the site, it is recommended that the structure be replaced by a

similarly sized culvert that is imbedded at an appropriate depth in the stream bed. This is preferable over remediation efforts such as fish ladders, as they will not address the high water velocities currently occurring through the culvert and will be difficult to install and maintain due to the degraded nature of the culvert itself.

Figure 32 **Downstream view of W2 culvert**

Figure 33 **Upstream view from W2 culvert**

Appendix 9 – Site W3

Fish passage database ID: 177867

Date of assessment: 14/12/23

Location: Lat: -45.54716695, Long: 170.6732591

Structure type: Culvert

Risk to fish passage: Medium

Priority for replacement/remediation: Moderate

W3 is a large (1.2m) concrete culvert located on Galbraith Rd (Figure 34). The downstream end of the culvert has a small drop (0.1m) into the downstream pool, and although this can likely be navigated by most fish species present in the catchment (with some difficulty for īnaka), fish passage would be improved significantly though low-cost remediation measures such as a rubber matting/spat rope or a floating fish ladder.

Figure 34 **Location of structure W3**

Figure 35 **Downstream view from W3 culvert**

Figure 36 **Upstream view from W3 culvert**

Appendix 10 – Site W4

Fish passage database ID: 177869

Date of assessment: 13/12/23

Location: Lat: -45.5471686, Long: 170.6651473

Structure type: Ford without culvert

Risk to fish passage: Low

Priority for replacement/remediation: Low

W4 is a ford located immediately downstream of Galbraith Rd in the middle reaches of the Watkin Creek catchment (Figure 37). This ford provides no barrier to fish passage (Figure 38 & Figure 39) and should be considered low priority for mediation.

Figure 37 **Location of site W4**

Figure 38 **Downstream view from W4**

Figure 39 **Upstream view from W4 looking at the Galbraith Rd bridge.**

Appendix 11 – Site H1

Fish passage database ID: 177857

Date of assessment: 13/12/23

Location: Lat: -45.53525833, Long: 170.7089556

Structure type: Ford with culvert

Risk to fish passage: High

Priority for replacement/remediation: High

H1 is the most downstream structure on the main stem of the Hakapupu River, and is located on Brooklands Rd, northeast of Goodwood (Figure 40). The structure consists of a concrete ford with three culverts, with all three culvert barrels being perched well above the downstream water level (Figure 41).

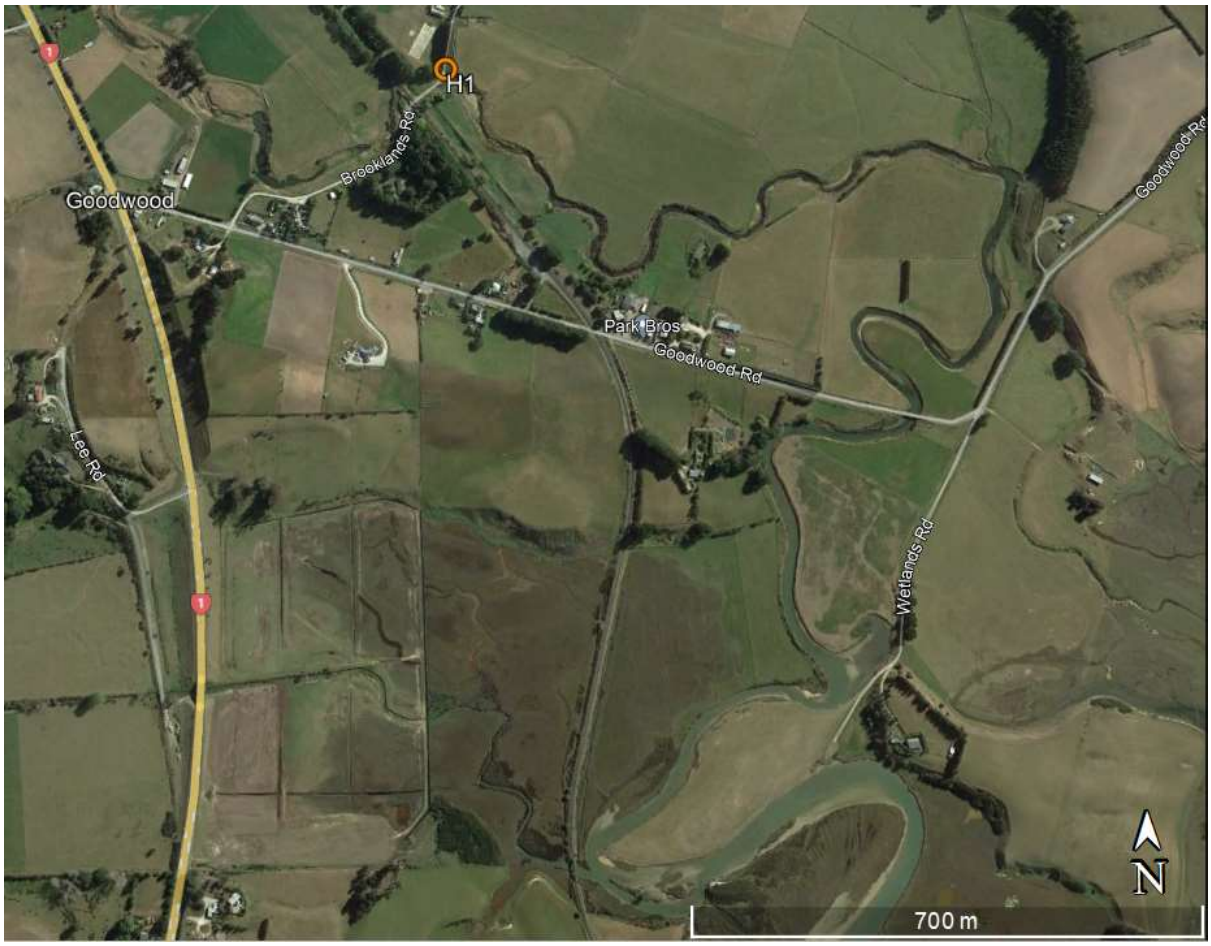

Figure 40 **Location of H1 culverted ford off Brooklands Rd**

Of the three culvert barrels within the structure, those on the true right and middle of the ford are perched and undercut, with flows passing over an undercut concrete apron and then under a large pile of rip rap. It is unlikely that fish passage is provided by either

of these culverts (Figure 41). Flows that pass through the third culvert on the true left pass down a 2m concrete apron, which is perched at the downstream end with a drop of 0.1m.

Large shoals of īnaka were observed downstream, however the presence of smaller numbers of īnaka at upstream sites suggest that some fish passage is occurring past this structure.

Figure 41 **Downstream view of the H1 culverted ford**

The use of three smaller culverts has led to regular buildup of debris at the upstream end of the structure, which has created a further hindrance to fish passage (Figure 42).

Figure 42 **Upstream view of the H1 culverted ford**

Due to the location of the Brooklands Rd ford and the high risk it poses to fish passage, this site should be considered one of the highest priorities for remediation in the Hakapupu catchment. Ideally, this structure would be completely replaced with a bridge or large box culvert in alignment with the New Zealand Fish Passage Guidelines (Franklin, 2018), and this should be considered the preferred approach for this site. In the event that these works cannot be undertaken quickly due to budgetary constraints, it is suggested that the rip rap is removed and a concrete/rock ramp is installed along with in-culvert baffles. Note that this should only be considered a temporary measure and should not be undertaken as a long-term alternative to replacement.

Appendix 12 – Site H2

Fish passage database ID: 177861

Date of assessment: 13/12/23

Location: Lat: -45.53633585, Long: 170.7076013

Structure type: Ford with culvert

Risk to fish passage: Low

Priority for replacement/remediation: Low

H2 is a temporary two-barrel culverted ford placed to provide access to the construction site for the replacement of the adjacent rail bridge over the Hakapupu River. The site is located off Brooklands R, east of Goodwod (Figure 43).

The ford has been constructed by laying steel bridge piles along the stream bed and then covering them with rip rap and road metal. The culvert barrels have been laid at the same gradient as the stream bed with low water velocities and sufficient depth to provide fish passage.

Figure 43 **Location of the H2 temporary culverted ford**

H2 is one of only two structures identified in the Hakapupu catchment that is subject to the fish passage requirements of the National Environmental Standards for Freshwater, as

it has been installed after September 2020. These requirements include that all relevant information for the structure is provided to the Regional Council and it "….*must provide for the same passage of fish upstream and downstream as would exist without the weir (or culvert), except as required to carry out the works to place, alter, extend, or reconstruct the weir*"

An initial inspection undertaken on December 7th showed that the ford had partially collapsed over the downstream end of the culverts, preventing most fish passage (Figure 44). A subsequent visit on December 13th showed that this issue has been addressed and that risk to fish passage was low (Figure 45 Figure 46). No further remediation is required at this site, however the structure owners should ensure that further blockages do not occur.

Figure 44 **Partially collapsed ford preventing fish passage at the H2 site on December 7th, 2023.**

Figure 45 **Downstream view of H2 culverts on December 13th 2023**

Figure 46 **Upstream view of H2 culverts on December 13th 2023**

Appendix 13 – Site H3

Fish passage database ID: 178012

Date of assessment: 27/12/23

Location: Lat: -45.5348, Long: 170.7034

Structure type: Ford without culvert

Risk to fish passage: Low

Priority for replacement/remediation: Low

Site H3 is a ford located north of Goodwood on the east side of SH1 (Figure 47). The ford poses no risk to fish passage and does not require any remediation.

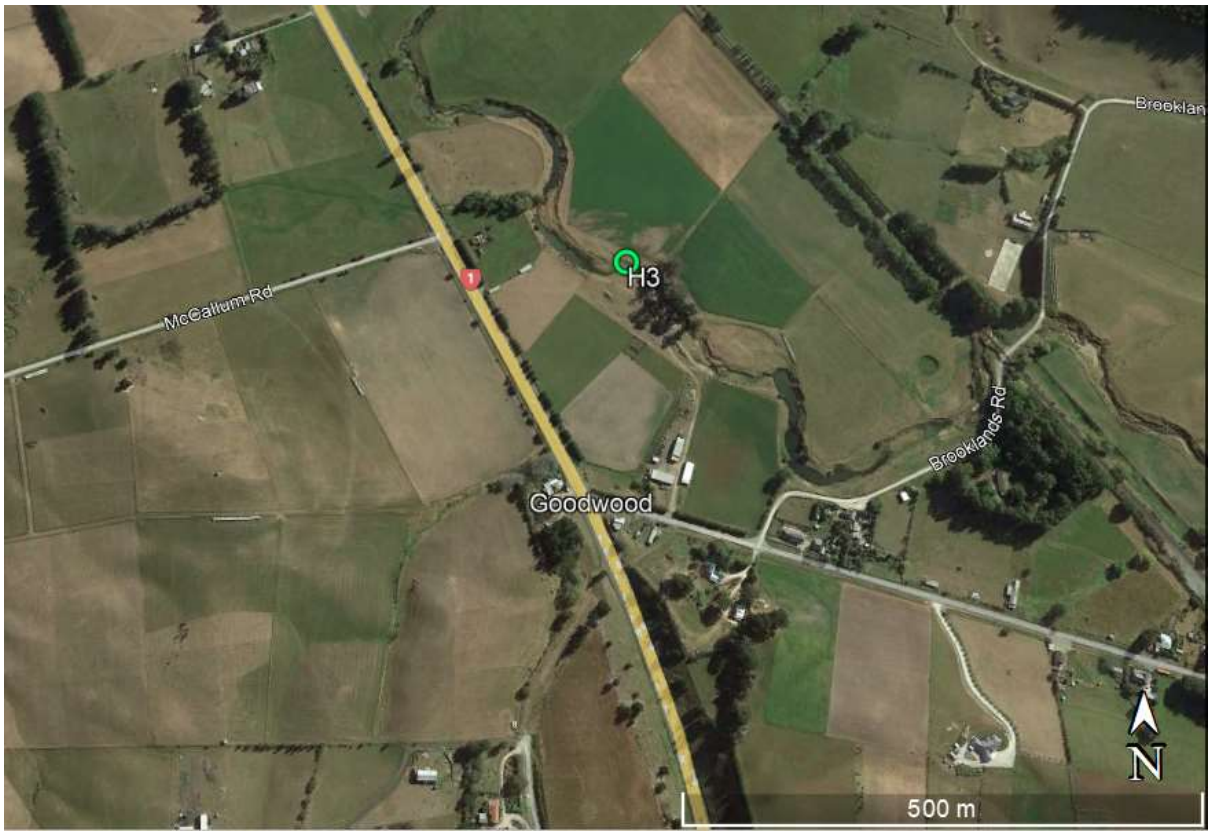

Figure 47 **Location of H3 ford**

Figure 48 **The H3 ford**

Appendix 14 – Site H4

Fish passage database ID: 177855

Date of assessment: 13/12/23

Location: Lat: -45.518875, Long: 170.6970389

Structure type: Ford with culvert

Risk to fish passage: High

Priority for replacement/remediation: High

H4 is a three barrelled culverted ford located where Pattersons Rd crosses the Hakapupu River (Figure 49). Each culvert has a width of 0.65m, with the upstream side of the ford having a 2m apron with wooden baffles to guide low flows through the centre culvert to increase water depth for fish passage (Figure 50). The downstream side of the ford has a short apron with a 0.12m drop to the pool below (Figure 51).

Figure 49 **Location of the H4 culverted ford.**

Although the upstream baffles do increase the water depth within the central culvert, it also acts to prevent any fish that pass through the outer culverts from accessing the upstream channel. Several īnaka were observed trapped between the baffle and the bank while the assessment was being undertaken. It is also likely that the increased velocity in the central culvert caused by the baffles is preventing īnaka from navigating the full length of the barrel, and as such is recommended that the baffles be removed.

Figure 50 Upstream view of the H4 ford at Pattersons Rd showing wooden baffles to channel flows into the central culvert.

Due to the location of the Pattersons Rd ford on the main stem of the Hakapupu, and the high risk it poses to fish passage, this site should be considered one of the highest priorities for remediation. Ideally, this structure would be completely replaced with a bridge or large box culvert in alignment with the New Zealand Fish Passage Guidelines (Franklin, 2018), and this should be considered the preferred approach for this site.

In the event that these works cannot be undertaken quickly due to budgetary constraints, it is suggested that a concrete/rock ramp be constructed, and internal culvert baffles are installed in all three barrels. Note that this should only be considered a temporary measure and should not be undertaken as a long-term alternative to replacement.

Figure 51 **Downstream view of the H4 ford at Pattersons Rd**

Appendix 15 – Site H5

Fish passage database ID: 177859

Date of assessment: 14/12/23

Location: Lat: -45.5164003, Long: 170.6950885

Structure type: Bridge

Risk to fish passage: Low

Priority for replacement/remediation: Low

The H5 site is a small bridge located 250m north of Pattersons Rd (Figure 52). The bridge has no effect on fish passage and should be considered a low priority for remediation.

Figure 52 **Location of the H5 bridge north of Pattersons Rd.**

Figure 53 **Upstream view of the H5 bridge**

Figure 54 **Downstream view of the H5 bridge**

Appendix 16 – Site H6

Fish passage database ID: 177863

Date of assessment: 14/12/23

Location: Lat: -45.51359886, Long: 170.6989032

Structure type: Culverted ford

Risk to fish passage: Very high

Priority for replacement/remediation: High

The H6 site is a two barrelled culverted ford located on a stock and vehicle crossing point on the Hakapupu River 100m east of SH1 (Figure 55). The ford itself is constructed from packed earth and the culvert barrels are constructed from welded truck wheel hubs (Figure 56) and are perched 0.2m above the stream with significant overhangs (Figure 57).

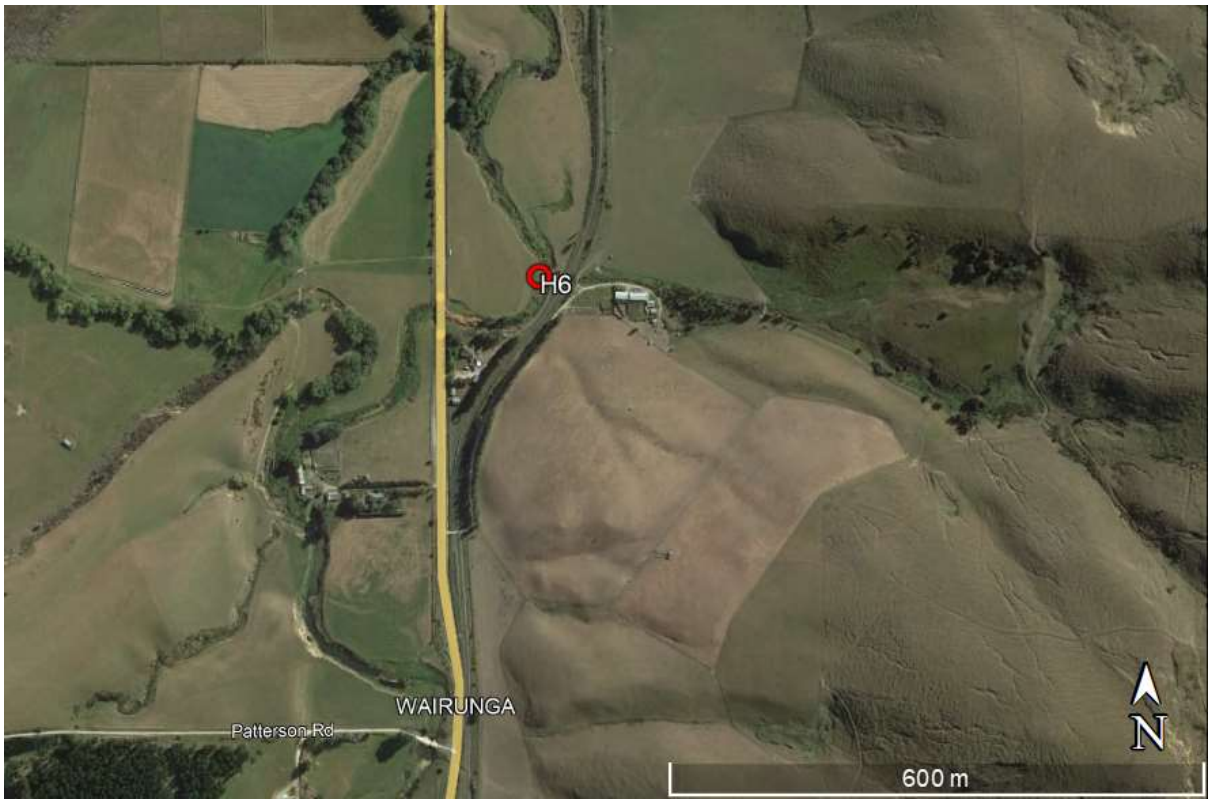

Figure 55 **Location of the H6 culvert**

The internal structure of the culverts have internal baffles created by the connection points of the wheel hubs used in their construction. These baffles have the effect of reducing water velocities within the culvert barrel (Figure 56).

The perched culverts with large overhangs means that this structure has the highest risk to fish passage within the Hakapupu catchment and should be considered a high

priority for replacement. Because of its location on the main stem of the Hakapupu with a large area of upstream habitat, this site should be prioritised for full replacement rather than remediation. It is suggested that the two culverts be replaced with a single large culvert fully embedded in the stream bed to ensure a natural substrate and water velocities.

Figure 56 **Internal view of the H6 culvert.**

Figure 57 **Downstream view of the H6 culverts.**

Figure 58 **Upstream view of the H6 culverts.**

Appendix 17 – Site H7

Fish passage database ID: 177860

Date of assessment: 14/12/23

Location: Lat: -45.4967798, Long: 170.6885473

Structure type: Bridge

Risk to fish passage: Low

Priority for replacement/remediation: Low

Site H7 is a partially collapsed bridge and adjacent ford on the main stem of the Hakapupu River 300m north of Stenhouse Rd (Figure 59). This structure is unlikely to have any impact on fish passage and should be considered a low priority for remediation.

Figure 59 **Location of site H7 on the main stem of the Hakapupu River**

Figure 60 **Downstream view of the H7 ford and bridge**

Figure 61 **Upstream view of the H7 ford and bridge**

Appendix 18 – Site H8

Fish passage database ID: 177873

Date of assessment: 14/12/23

Location: Lat: -45.49487592, Long: 170.6729098

Structure type: Culvert

Risk to fish passage: Medium

Priority for replacement/remediation: Low

Site H8 is located at the end of Stenhouse Rd on an intermittent tributary of the Hakapupu River, and has recently been installed as part of a road upgrade to support logging operations (Figure 62). At the time of assessment there were pools of water remaining at either end of the culvert, but the tributary was not flowing in the immediate reach (Figure 63 & Figure 64). Conversations with the forestry manager have indicated that this site is regularly damaged during flood events and has had to be repaired on several occasions in the past.

Figure 62 **Location of the H8 culvert in the middle reaches of the Hakapupu catchment.**

H8 is one of only two structures identified in the Hakapupu catchment that is subject to the fish passage requirements of the National Environmental Standards for Freshwater

(NESFW), as it has been installed after September 2020. These requirements include that all relevant information for the structure is provided to the Regional Council and it "*….must provide for the same passage of fish upstream and downstream as would exist without the weir (or culvert), except as required to carry out the works to place, alter, extend, or reconstruct the weir*"

The gradient of the culvert is steeper that the surrounding stream bed and would likely restrict fish passage for species such as īnaka, therefore it is possible that the culvert would not meet the NESFW under conditions of continuous flow. However, the intermittent nature of the stream and a natural lack of fish passage over the summer months reduces the remediation priority for this structure.

It is unclear if there is permanently wetted habitat further upstream of the culvert, therefore as a precautionary measure the landowner should ensure that the culvert is installed in alignment with the NZ Fish Passage Guidelines when it is next repaired following a flood event.

Figure 63 **Downstream view from the H8 Culvert**

Figure 64 **Upstream view from the H8 Culvert**

Appendix 19 – Site H9

Fish passage database ID: 177877

Date of assessment: 14/12/23

Location: Lat: -45.48297888, Long: 170.6299422

Structure type: Culvert

Risk to fish passage: Low

Priority for replacement/remediation: Low

The H9 culvert is located in the Calder Steward forestry estate in the upper reaches of the Hakapupu catchment (Figure 65).

Figure 65 **Location of the H9 culvert**

The culvert is 1m wide and located under a forestry access track. It has been damaged and partially collapsed by historic flood events. At the time of assessment surface flows had ceased in several locations either side of the culvert, however the presence of macrophytes, upland bully and stream invertebrates in the remaining pools indicate that they are perennial in nature.

Overall, this structure does not restrict fish passage any more than the surrounding stream bed at low flows. Although its remediation priority is low in its current state, the continued degradation of the culvert due to flood damage will likely result in fish passage issues in the future at which point it will need to be replaced.

Figure 66 **Downstream view of the H9 culvert**

Figure 67 **Upstream view of the H9 culvert**

Appendix 20 – Site H10

Fish passage database ID: 177876

Date of assessment: 14/12/23

Location: Lat: -45.48103541, Long: 170.6115663

Structure type: Culvert

Risk to fish passage: Low

Priority for replacement/remediation: Low

H10 is a concrete culvert located in the upper reaches of Hakapupu catchment within the Calder Steward forestry estate (Figure 68). The culvert is set at the same gradient as the surrounding stream, has good water depth and low velocity and does not impede fish passage in any way.

Figure 68 **Location of the H10 culvert**

Figure 69 **Downstream view of the H10 culvert**

Figure 70 **Upstream view of the H10 culvert**

Appendix 21 – Site H11

Fish passage database ID: 177875

Date of assessment: 14/12/23

Location: Lat: -45.48714235, Long: 170.5920002

Structure type: Culvert

Risk to fish passage: High

Priority for replacement/remediation: Low

Culvert H11 is located in the upper reaches of the Hakapupu catchment in the Calder Stewart Forestry estate (Figure 71). The structure is a steel box culvert with a slightly raised lip on the upstream edge (Figure 73), however historic floods have undermined the structure and it had collapsed at the downstream end. At low flows all surface water is directed underneath the structure to reappear at the downstream end (Figure 72).

Figure 71 **Location of the H11 culvert**

At the time of assessment, there was not continuous surface flow in the reach surrounding the culvert, with the stream consisting of a series of disconnected pools. As such, it is likely that the culvert would create a high risk to fish passage at moderate flows, but not at the low flows observed in mid-December. Although its remediation

priority is low in its current state, the continued degradation of the culvert due to flood damage will likely result in the need to replace the structure in the medium term.

Figure 72 **Downstream view of the H11 culvert.**

Figure 73 **Upstream view of the H11 culvert**