Appendix F. Ecological Assessment Report

Te Ruaotehauhau Stream Water Storage Reservoir

Preliminary Assessment of Ecological Values and Effects

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Te Ruaotehauhau Stream Water Storage Reservoir – Preliminary Assessment of Ecological Values and Effects

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1. Introduction

Te Tai Tokerau Water Trust Board ('the applicant') have received provincial growth funding to provide improved water supply in Northland. Williamson Water and Land Advisory (WWLA) is leading the provision of a range of technical services to inform the project. Puhoi Stour Limited (PSL) and its subconsultant Tonkin & Taylor Limited (T+T) have collaborated to prepare this assessment of the potential ecological effects associated with a proposed water supply reservoir (Te Ruaotehauhau Stream Water Supply Reservoir) off Hariru Road, Kaikohe 0472, in the Far North.

In brief, the applicant proposes to construct a new water supply reservoir, by constructing a dam across the Te Ruaotehauhau Stream, and inundating a section of the Te Ruaotehauhau Stream and Waitaia Stream, tributaries, and surrounding land. The construction and ongoing operation of the water supply dam is anticipated to have the following effects on ecological values:

- Construction effects relating to earthworks and works within the bed of a stream or wetland.
- Direct and indirect effects on native freshwater fauna.
- Ongoing effects on native fish passage.
- Downstream effects on water quality and quantity.
- Loss of approximately 2,114 m permanent stream (~5,285 m2 streambed area) and 538 m intermittent stream (~108 m2 streambed area).
- Loss of 0.47 ha of pūriri forest;
- Loss of 0.32 ha of swamp forest.
- Loss of 0.44 ha of secondary broadleaf forest with old-growth signatures.
- Removal of 0.14 ha of tōtara treeland, native treeland, and a further 1.32 ha exotic forest comprising pine, wattle, and redwood.
- Removal of 0.75 ha volcanic boulderfield.
- Loss of 0.03 ha of rautahi wetland.
- Loss of 0.05 ha kutakuta wetland.
- Loss of 0.22 ha of wet pasture.
- Potential direct and indirect effects on terrestrial fauna, potentially including bats, birds, lizards and kauri snails.

The scope of this report is to provide an assessment of the ecological values of the site and to report on the anticipated impacts of the project. Measures to avoid, remedy or mitigate effects are proposed. Recommendations are made to further offset or compensate residual adverse effects that cannot be otherwise avoided, remedied, or mitigated.

2. Site description

The proposed Te Ruaotehauhau Stream Water Supply Reservoir site ('MN06') is located between Hariru Road and Remuera Settlement Road, in Kaikohe, in the Far North District, Northland (Figure 1). Located in the Kaikohe Ecological District (ED), the proposed reservoir is close to ecological features such as the geothermal area of Ngawha Springs (to the south) and Lake Omapere (to the west). The site is in the headwaters of Te Ruaotehauhau Stream and Waitaia Stream, which discharge into the Waiaruhe River approximately 8 km to the east of the site. The Waiaruhe River and Waitangi River, flow over the Haruru Falls before discharging to the coast in Haruru, approximately 20 km to the east. The site is dominated by orthic allophanic (LO) soils that are characteristic of North Island volcanic ash from weathering products of volcanic rocks[1].

There are no mapped areas of ecological significance in the site. However, the site is close to the following protected natural areas (Figure 2):

[1] Manaaki Whenua Landcare Research Soil Portal (information retrieved from https://soils-maps.landcareresearch.co.nz/ on 20/08/2020).

- Waingaruru Stream Swamp (PNAP P05/040) within 2 km to the east,
- Ngawha Bush (PNAP P05/037) within 2 km to the south,
- Remuera Settlement Road Remnants (PNAP P05/038) within 1 km to the west, and
- Bullman Road Broadleaf Remnants (PNAP P05/069), Waikuku Road Bush (PNAP P05/068), and Waimate Broadleaf Remnants (PNAP P05/067) all within 2 km to the north.

These protected natural areas comprise volcanic broadleaf forest, pūriri forest, and habitat for native fauna including kauri snail, North Island brown kiwi, kukupa, spotless crake, banded rail, and bittern.

Vegetative cover in the area (and in the site) would have historically consisted of pūriri, taraire forest (WF7.2)[2]. Much of the indigenous forest in the ED has been cleared for farming and forestry, resulting in a fragmented landscape.

The site is an operational livestock farm and current modification of the landscape is typical of agricultural land use.

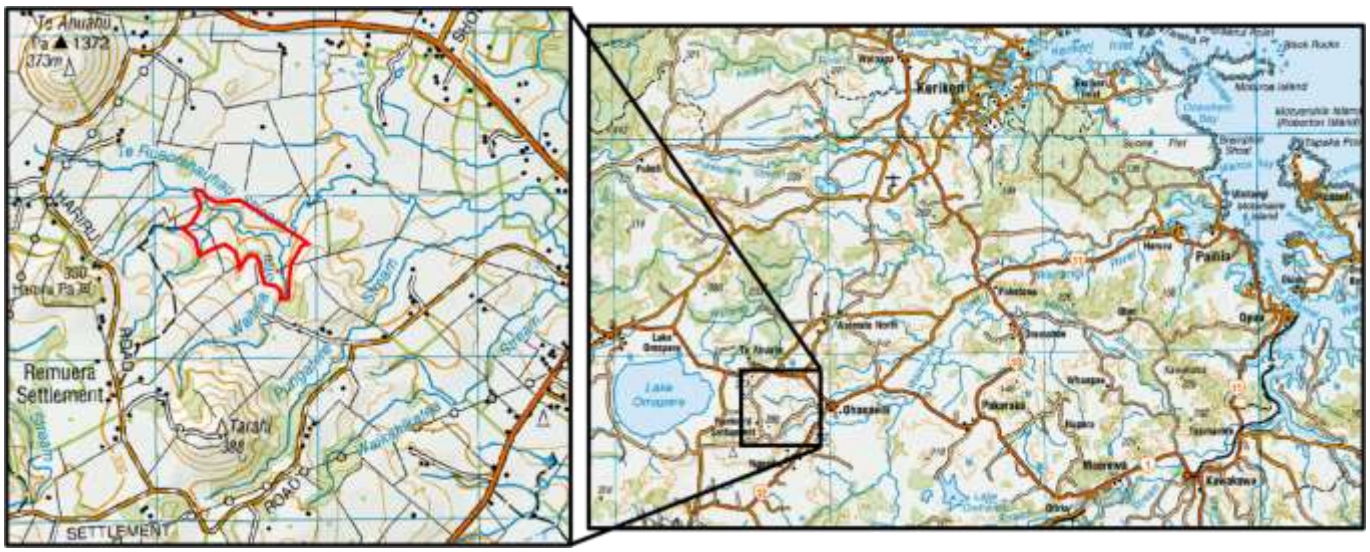


Figure 1: Location of proposed reservoir (in red outline) off Hariru Road, Kaikohe.

[2] Singers, N.J. D. and Rogers, G. M. (2014). A classification of New Zealand's terrestrial ecosystems. The Department of Conservation, Science for conservation 325.

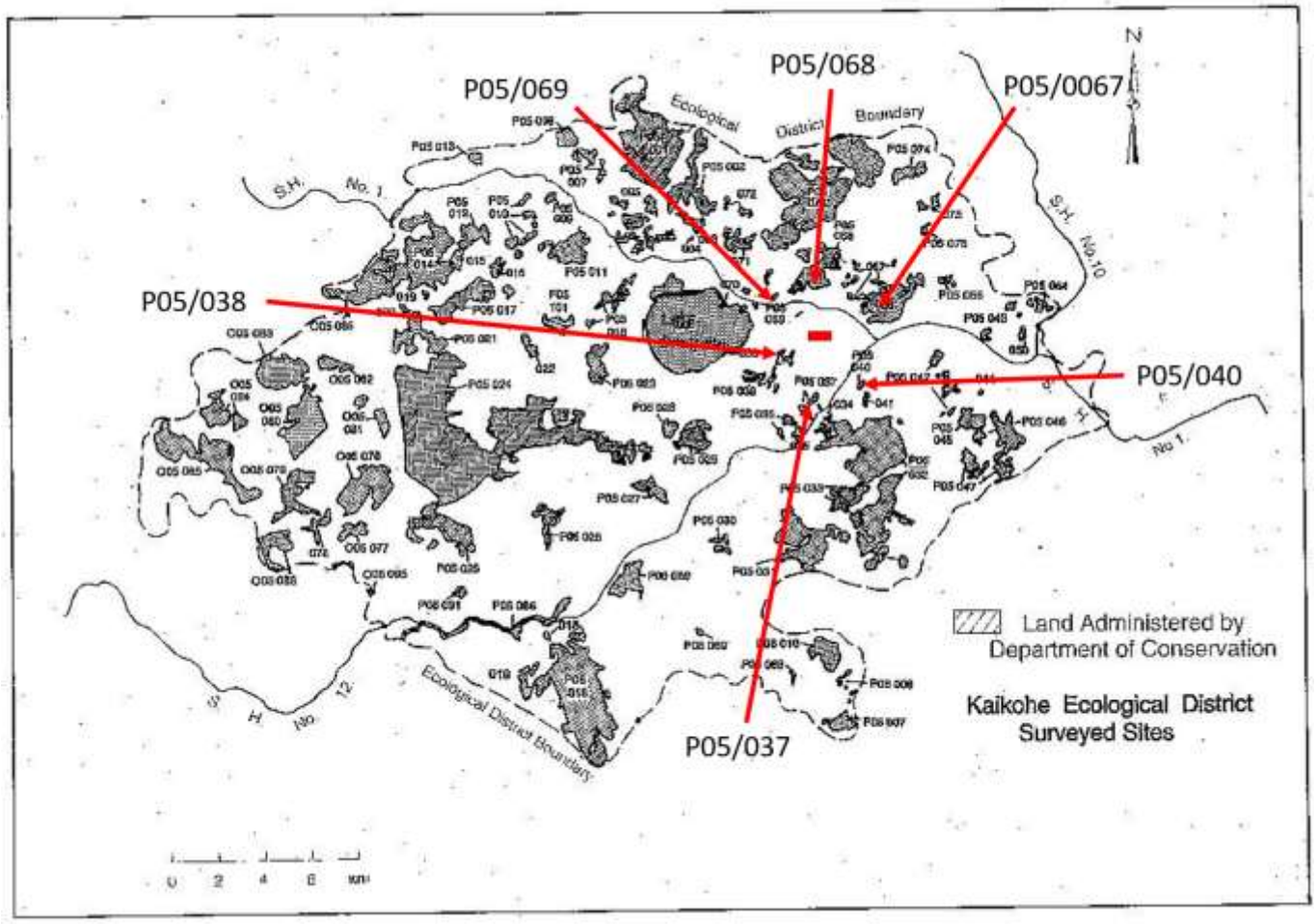


Figure 2: Location of proposed reservoir (red rectangle) in relation to nearby Protected Natural Areas in Kaikohe (modified map from the Department of Conservation).

3. Methods

A site visit to MN06 was undertaken on 15, 16 and 17 July 2020 to assess the presence of any threatened freshwater and terrestrial species and/or habitats in the proposed reservoir development. The assessment was limited to the proposed reservoir footprint and information gathered was to inform the development of an opportunity and constraints assessment report.

A follow-up site visit was scheduled for 19, 20 and 21 August 2020 to inform a more detailed assessment of ecological effects. However, due to COVID19, this site visit could not take place and so this ecological assessment of effects is based on the ecological information collected during our initial site visit and a review of desktop resources.

The details of our site assessment are included in the following sections and all sampling sites are shown in Appendix A, Figure 1.

3.1 Desktop assessment

A desktop assessment of potential freshwater and terrestrial ecological values was undertaken through a review of:

- Ecological databases including:
  - Herpetofauna Atlas;
  - Department of Conservation National bat database;

- iNaturalist (www.iNaturalist.org);
- eBird (www.eBird.org);
- Kiwis for Kiwi North Island brown kiwi distribution 2016;
- New Zealand Plant Conservation Network distribution database; and
- New Zealand Freshwater Fish Database (NZFFD) records for Te Ruaotehauhau Stream and Waitaia Stream, and the wider Waiaruhe River catchment;

› Proposed Regional Plan for Northland, Appeals Version – June 2020;

› Northland Regional Council biodiversity online map;

› Natural areas of Kaikohe Ecological District, Reconnaissance survey report for the Protected Natural Areas Programme, dated 2000;

› Department of Conservation, a classification of New Zealand's terrestrial ecosystems, dated 2014;

› Department of Conservation (2004). Wetland Types in New Zealand.

› Manaaki Whenua Landcare Research Soil Portal;

› NIWA, New Zealand fish passage guidelines for structures less than 4m, dated 2018; and

› Other primary literature sources.

3.2 Freshwater values assessment

3.2.1 Stream classifications

During the site visit, all streams on site were classified in accordance with the definitions of intermittently/flowing river or stream set out in the Proposed Regional Plan for Northland.

Of note, heavy rain had fallen in the 48 hours prior and during the site visits. Typically stream classifications should be undertaken after 48 hours of fine weather to provide confidence that flowing water that may be present is not just related to rainfall runoff. The streams were assessed according to several criteria that define a stream or river including:

- A well-defined channel, such that the stream bed and banks are distinguishable,
- There is evidence of substrate sorting processes, including scour and deposition,
- The absence of rooted terrestrial vegetation across the cross-sectional width of the channel,
- The presence of surface water more than 48 hours after rainfall,
- Organic debris present on the floodplain as a result from flood, and
- Natural pools are present and is connected to the stream channel.

All streams within the reservoir footprint were walked to assess the presence and extent of aquatic habitat within the proposed reservoir development. These observations were recorded in ArcGIS with photographs for later analysis.

3.2.2 Macroinvertebrates

A standard macroinvertebrate (kick net) sample was collected from Te Ruaotehauhau Stream (Macro1), another sample was collected from a tributary of Te Ruaotehauhau Stream (Macro2), and the third sample was collected from Waitaia Stream (Macro3). Locations of the samples are provided in Appendix A, Figure 1.

Macroinvertebrate samples were collected in accordance with a hard-bottom semi-quantitative protocol (C1). The habitat sampled included riffles, predominantly under canopy cover. The upper layer of cobbles and large gravels were dislodged, and macroinvertebrates were collected no more than 0.5 m downstream using a D-net.

Macroinvertebrate sampling should be undertaken when the stream bed has been stable for at least one week, avoiding heavy rainfall events as to reduce the likelihood of underestimating macroinvertebrate communities. Macroinvertebrate samples were

collected on 16 July, after rain had fallen on 15 July and prior heavy rain in the evening/overnight on 16 July. Abundant hard-bottom substrates were observed in the channel, indicating there was refugia for macroinvertebrates.

Macroinvertebrate identification was undertaken by EIA Limited according to the 200 Individual Fixed Count with Scan for Rare Taxa protocol (P2).

Results are presented as follows:

Taxonomic richness. This is a measure of the number of different types of macroinvertebrate present in each sample and is a reflection of the diversity of the sample;

Ephemeroptera, **Plecoptera** and **Trichoptera** ("**EPT**") richness. This index measures the number of pollution-sensitive macroinvertebrates (mayfly, stonefly, and caddisfly (excluding Oxyethira and Paroxyethira taxa because these are tolerant of degraded conditions) within a sample. Percent EPT richness represents the number of EPT taxa as a proportion of the total number of taxa within the sample;

Macroinvertebrate Community Index ("**MCI**"). The MCI is an index for assessing the quality class of a stream using presence or absence of macroinvertebrates; and

Quantitative Macroinvertebrate Community Index (**QMCI**). QMCI is another index-based tool, based on the relative abundance of taxa within a community, rather than just presence or absence.

The MCI and QMCI reflect the sensitivity of the macroinvertebrate community to changes in water quality and habitat, where higher scores indicate better stream condition. Macroinvertebrate index values are then translated to quality classes, which describe the ecological health of the stream (Table 1).

Table 1: Interpretation of macroinvertebrate biotic indices[3].

Quality class	MCI MCI-sb	QMCI QMCI-sb
Excellent	>119	> 5.99
Good	100 - 119	5.00 – 5.90
Fair	80 - 99	4.00 – 4.90
Poor	<80	< 4.00

3.2.3 Fish

Two nights of trapping was undertaken in July 2020 across the site and these locations are provided in Appendix A, Figure 1. Fish survey locations were selected based on presence of suitable stream habitat and sufficient water depth.

During the first night, un-baited gee minnow traps (GMT) (*n* = 6) and fyke nets (*n* = 1) were deployed in Te Ruaotehauhau Stream and Waitaia Stream in the footprint of the proposed reservoir.

During the second night, un-baited GMT (*n* = 7) and fyke nets (*n* = 5) were deployed in the same locations along Te Ruaotehauhau Stream and Waitaia Stream. GMT(*n* = 1) and fyke nets (*n* = 1) were also deployed in a tributary of Te Ruaotehauhau Stream.

As described above, there had been some rainfall during the week of the sampling. During the first night of trapping (15 July), the water levels dropped and some of the traps were partially exposed. Heavy rainfall on the second night of trapping (16 July) meant one trap could not be retrieved due to high flows. This trap was retrieved two days later when water levels reduced.

[3] Stark, J D, and Maxted, J R (2007). A user guide for the macroinvertebrate community index. Prepared for the Ministry of the Environment. Cawthron Report No. 1166. 58p.

3.2.4 Stream ecological valuation

The stream ecological valuation (SEV) method[4] is typically used to evaluate the aquatic ecological function of streams by assessing physical characteristics at a reach scale, involving transects and whole of reach parameters. These data are supplemented with collected macroinvertebrate and fish data to inform 29 variables which in turn feed into 14 stream ecosystem functions. These functions fall into four broad categories as described in Table 2. The SEV method is also used to quantify the ecological impact and proposed offset measures to achieve no net loss of ecological function.

Due to COVID19 restricting site access for a second site visit, representative SEVs could not be carried out. To provide an estimate of the likely ecological function/value of the streams on site and the potential quantum of offset required, surrogate SEV scores have been calculated. These have been estimated based on site observations, site photos, and professional judgment for three representative SEVs scores within the proposed reservoir footprint. Macroinvertebrates and fish data were used for two of the SEV to inform the current values.

The selected 'estimated' SEV locations were representative of the streams across the reservoir footprint. Characteristics considered include stream classification, riparian margins, and streambed substrates. Therefore, two SEVs were selected in permanent reaches and one in an intermittent tributary. Of the permanent SEVs, one was selected in the main stem of Te Ruaotehauhau Stream where there was intact vegetation along at least one riparian margin (SEV 1). The other permanent SEV was located further downstream, along Te Ruaotehauhau Stream, where riparian vegetation was limited to rank grass (SEV 2). The intermittent SEV was selected for an area that was representative in that the downstream portion was dominated by rank grass and the upstream portion was under canopy (SEV 3). Other intermittent streams on site had similar characteristics. The three representative SEVs locations are provided in the Appendix A, Figure 1.

The SEV results are reported on a scale of 0 to 1, where 1 is a pristine stream (i.e. native forest, non-modified) and values below this are a departure from those reference conditions. Each function is measured and compared to what would be expected in 'reference conditions' and the final score is an aggregation of weighted attributes that identify how far from 'pristine' the stream reach is.

The SEV is a robust and internationally peer-reviewed method designed to quantify the ecological function of a stream reach. Further, when required, the method also provides a means to quantify offset requirements.

The SEV was developed for use in Auckland streams but has been successfully applied across New Zealand when local reference data has been incorporated into the SEV calculators. To our knowledge, Northland has not formally developed a SEV calculator with local reference data. For the purposes of our assessment the Auckland calculator has been used to inform the ecological values of the site.

[4] Storey, R G, Neale, M W, Rowe, D K, Collier, K J, Hatton, C, Joy, M K, Maxted, J R, Moore, S, Parkyn, S M, Phillips, N and Quinn, J M (2011). Stream Ecological Valuation (SEV): a method for assessing the ecological function of Auckland streams. Auckland Council Technical Report 2011/009.
Neale M W, Storey R G, Rowe D K, Collier K J, Hatton C, Joy M K, Parkyn S M, Maxted J R, Moore S, Phillips N and Quinn J M (2011). Stream Ecological Valuation (SEV): A User's Guide. Auckland Council Guideline Document 2011/001.
Neale, M W., Storey, R G and Quinn, J L (2016). Stream Ecological Valuation: application to intermittent streams. Prepared by Golder Associates (NZ) Limited for Auckland Council. Auckland Council technical report, TR2016/023.

Table 2: Stream Ecological Value (SEV) functions

SEV Functions
Hydraulic Functions
› Natural flow regime
› Floodplain effectiveness
› Connectivity for natural species migrations
› Natural connectivity to groundwater
Biogeochemical Functions
› Water temperature control
› Dissolved oxygen levels
› Organic matter input
› Instream particle retention
› Decontamination of pollutants
Habitat Provision Functions
› Fish spawning habitat
› Habitat for aquatic fauna
Biodiversity Provision Functions
› Fish fauna intact
› Invertebrate fauna intact
› Riparian vegetation intact

3.3 Terrestrial values assessment

3.3.1 Ecosystem types

A site walkover was undertaken on 15, 16 and 17 July 2020 to survey and describe terrestrial ecological values across the Project footprint.

The field assessment included mapping all terrestrial and wetland ecosystems, developing a vascular plant species list, and undertaking targeted searches for key At Risk and Threatened species according to the current threat rankings published by DOC[5]. Terrestrial and wetland ecosystems were assessed and classified according to Singers & Rogers (2014)[6] where the habitat remained intact, and in accordance with the Proposed Regional Plan definitions[7] and criteria set out in Appendix 5 of the Regional Policy Statement for Northland.

Offsetting of impacted ecosystem types has been estimated using previously constructed models in similar habitat types to arrive at an estimated offset quantum that will be required. The actual offsetting will be determined following discussions with the local community and after further field surveys have been undertaken.

[5] Department of Conservation (n.d.).New Zealand Threat Classification Series. Accessed on 28 July 2020 from https://www.doc.govt.nz/about-us/science-publications/series/new-zealand-threat-classification-series/

[6] Singers, N. J., & Rogers, G. M. (2014). *A classification of New Zealand's terrestrial ecosystems*. Department of Conservation.

[7] The definitions relating to wetlands are currently under appeal, however considered appropriate for this assessment.

3.3.2 Bats

The Project footprint is situated approximately 16 km from known long-tailed (*Chalinolobus tuberculatus*) and northern lesser short-tailed (*Mystacina tuberculata aupourica*) bat populations at Puketi Forest[8], and within 4 km of long-tailed bat records identified as part of the Matawii Reservoir Assessment of Ecological Effects[9].

Long-tailed bats ('Threatened – Nationally Critical'[10]) are an edge-adapted species and utilise a variety of ecosystems for foraging and roosting including forest edges, hedgerows and shelterbelts. Long-tailed bats are frequently identified utilising fragments of native and exotic forest for foraging and roosting.

Northern lesser short-tailed bat (Threatened – Nationally Vulnerable) are adapted to mature forest interior habitat and tend to remain within contiguous mature native forest, however given the close proximity of Puketi Forest it is possible that short-tailed bats may be present at the site.

Potential bat foraging, commuting and roosting habitat was assessed across the proposed footprint. Potential bat roost habitat comprised trees greater than 15 cm diameter at breast height (DBH) and with any of the following characteristics:

- Cavities, cracks and crevices;
- Epiphytes, particularly large perching epiphytes; and/or
- Flaky and peeling bark.

Acoustic survey using Automated Bat Monitors (ABMs) would ordinarily be undertaken in order to detect the presence of bats on site. However acoustic survey should only be undertaken during warmer months (October to April inclusive) when bats are more mobile. The site visit took place outside this period, and therefore an acoustic survey was not undertaken.

3.3.3 Birds

To assess avifauna composition across the site, all incidental bird observations (seen or heard) were recorded during the site visit.

North Island brown kiwi (*Apteryx mantelli*) have been recorded at a high density in close proximity to the Project footprint, as determined through a review of Northland kiwi distributions[11] and are conservatively assumed to be present until kiwi surveys are undertaken to determine actual presence or absence across the site. North Island brown kiwi in Northland are known to utilise existing fragmented habitat as foraging and roosting stepping stones across the landscape.

North Island brown kiwi habitat was identified as having any of the following characteristics:

- Indigenous forest and scrub; and
- Exotic forest and scrub.

3.3.4 Herpetofauna

Potential herpetofauna (gecko and skink) habitat was identified as having any of the following potential lizard characteristics:

- Rank grass;
- Coarse woody debris;
- Deep leaf litter;
- Boulders and rocks;

[8] Sourced from Department of Conservation National Bat Database

[9] Puhoi Stour & Tonkin and Taylor Ltd. (2020). Kopenui Stream Reservoir Assessment of Ecological Effects. Prepared for Northland Regional Council. PSL Report Number 2020/02.

[10] O'Donnell, C.F.J., Borkin, K.M., Christie, J.E., Lloyd, B., Parsons, S. & Hitchmough, R.A. 2018: Conservation status of New Zealand bats, 2017. *New Zealand Threat Classification Series 21*. Department of Conservation, Wellington, New Zealand. 4 pp.

[11] Kiwis for Kiwi (2016). North Island Brown Kiwi Estimated distribution 2016.

- Exotic vegetation, such as *Tradescantia* ground cover; and
- Native vegetation (including mature forest and secondary successional vegetation).

Due to the site visit being undertaken during winter, spotlighting for geckos and manual searching for skinks was not undertaken. Lizard searches are best undertaken between October and April (inclusive).

3.3.5 Invertebrates

Potential kauri snail (*Paryphanta* spp.) habitat was assessed by identifying potential areas of deep leaf litter, fern skirts and logs, particularly where indigenous forest is present.

3.4 Assessment of effects

The method applied to this assessment of ecological effects broadly follows the Ecological Impact Assessment Guidelines (EcIAG) published by the Environment Institute of Australia and New Zealand (EIANZ)[12].Using a standard framework and matrix approach such as this provides a consistent and transparent assessment of effects.

Outlined in the following sections, the guidelines have been used to inform the following:

- The level of ecological value of the environment based on the information available;
- The magnitude of ecological effect from the proposed water supply reservoir on the environment;
- The overall level of effect to determine if further measure to address effects are required; and,
- The magnitude of effect and overall level of effect, taking into consideration the additional measures to avoid, remedy or mitigate effects and whether there are residual adverse effects that should be offset or compensated (s 104(ab) RMA).

Consideration was also given to Policy D.2.16 of the Proposed Regional Plan for Northland (Appeals Version June 2020) regarding managing adverse effects on indigenous biodiversity. Criteria set out in Appendix 5 of the Regional Policy Statement for Northland (updated 2018) were used in the assessments of ecological significance.

The framework for assessment provides structure to quantify the level of ecological effects but needs to incorporate sound ecological judgement to be meaningful. Deviations or adaptions from the methodology are identified within each of the following sections as appropriate. Further detail regarding these guidelines is included in Appendix B.

4. Freshwater ecological assessment

4.1 Freshwater values

4.1.1 Stream classification and values

The site is in the Te Ruaotehauhau Stream and Waitaia Stream catchment. Streams had natural channels, had hard-bottom substrates, and were either shaded under remnant native vegetation and exotic treelands or open channels along paddock margins.

Te Ruaotehauhau Stream and Waitaia Stream are both classified as continuously flowing permanent streams. Te Ruaotehauhau Stream is located along the centre of the proposed reservoir. Waitaia Stream forms the eastern arm of the proposed reservoir. Several tributaries of Te Ruaotehauhau Stream and Waitaia Stream are present throughout the site which have also been classified as permanent (labelled and shown in Appendix A, Figure 1). Several of the upper reaches of narrow

[12] Roper-Lindsay, J., Fuller, S.A., Hooson, S., Sanders, M.D., and Ussher, G.T. (2018). Ecological Impact Assessment. EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd edition.

tributaries of Te Ruaotehauhau Stream have been classified as intermittent due to shallow water depth and the likelihood of becoming periodically dry over summer.

The Te Ruaotehauhau Stream is approximately on average 2.5 m wide with an approximate average depth of 0.5 m. The Waitaia Stream is approximately on average 1.5 m wide with an approximate average depth of 0.4 m. The average widths observed on site are bank full widths rather than 'normal' wetted widths, due to the rain that fell prior to and during the site visit. Aquatic habitat was diverse and included gravel, cobbles, bedrock across all streams, and woody debris, and root mats under canopy cover. Instream hydrological heterogeneity was also diverse comprising riffles, small cascades, runs, and pools with a variety of sizes and depths. Fine sediment deposition was observed in isolated sections of the main channels of Te Ruaotehauhau Stream and Waitaia Stream. Tributary 1A, 2, and smaller intermittent streams had relatively high fine sediment loading on the streambed.

Roughly half the streams (permanent and intermittent) on site had riparian vegetation either on both banks or on one bank. Riparian vegetation comprised an intermix of native forest, advanced secondary broadleaf forest, native treelands, and exotic treelands.

Where sections of the streams lacked intact riparian vegetation, the margin was limited to rank grass. These sections of stream had 'very low' to 'no effective' shading. Most of the streams on site were fenced from livestock access. Fences (barbed wire and hot-wire) were generally intact and well-maintained.

Submerged and surface reaching macrophytes were absent in most streams across site, including open channels. Macrophytes only appeared in small clusters along the upper sections of Waitaia Stream where the pine vegetation had recently been felled and along intermittent streams such as Tributary 2.

Based on site observations and site photos, the estimated current stream ecological valuations for representative streams within the proposed reservoir footprint are presented in Table 3.

Te Ruaotehauhau Stream and Waitaia Stream have similar characteristics and are both permanent streams, therefore the estimated SEV for the main stem of the Te Ruaotehauhau Stream is considered representative for the main stem of the Waitaia Stream. Two representative SEV were estimated for these streams, being one with (SEV1) and one without (SEV2) intact canopy cover. Other permanent streams such as Trib1, 1A, 3, and 4 also have similar characteristics to that of Te Ruaotehauhau Stream, therefore these SEV are considered representative.

Tributary 2 of Te Ruaotehauhau Stream is a shaded intermittent stream and is representative of other small intermittent tributaries of Te Ruaotehauhau Stream and Waitaia Stream. SEV3 is considered representative of all intermittent streams.

The fish fauna intact (FFI) and invertebrate fauna intact (IFI) function in the SEV was included for the estimated SEVi-C for SEV1 and SEV2. Fish observations and macroinvertebrate surveys were carried out along the main stem of Te Ruaotehauhau Stream, and so were considered representative.

Fish observations and macroinvertebrate surveys were not carried out in Tributary 2, therefore FFI and IFI functions were not included in the estimated SEV3 score.

Photographs of each of the representative SEV areas are provided in Appendix C.

Table 3: Estimated SEV values for three representative streams within the proposed reservoir footprint.

SEV ID	**SEV1**	**SEV2**	**SEV3**
Location	Te Ruaotehauhau Stream (under riparian canopy)	Te Ruaotehauhau Stream (open channel)	Tributary2
Classification	Permanent	Permanent	Intermittent
SEVi-C	0.75 (incl IFFI, FFI)	0.46 (incl IFFI, FFI)	0.61 (excl IFI, FFI)

A desktop review of the downstream environment outside of the reservoir was undertaken. The downstream environment appears to be similar to the main stem of Te Ruaotehauhau Stream in the footprint. Of note, the riparian margin downstream of the proposed reservoir is limited to rank or grazed grass. It is assumed that the instream substrates are similar to that observed in the most downstream portion of Te Ruaotehauhau Stream on site, consisting of hard-bottom substrates ranging from gravels to cobbles.

4.1.2 Macroinvertebrates

Three kick samples were collected across site, one in the Te Ruaotehauhau Stream, one in a tributary of the Te Ruaotehauhau Stream (Tributary 1), and one in Waitaia Stream.

Twenty-nine invertebrate taxa were recorded from Te Ruaotehauhau Stream. The invertebrate community indicates a 'good' quality class with a MCI value of 101 and a QMCI value of 5.7. Sensitive EPT taxa made up 41% of the individuals within the sample. Of note, *Hydrobiosella*, an uncased caddisfly with very low tolerance to polluted water (MCI score of 9) was relatively abundant (10%) in the sample.

Twenty-six invertebrate taxa were recorded from Tributary 1 (a tributary of the Te Ruaotehauhau Stream). The invertebrate community sample indicates 'good' and 'excellent' water and habitat quality, with a MCI value of 113 and QMCI value of 7.3. Sensitive EPT taxa made up 84% of the individuals within the sample. Of note, *Coloburiscus*, a mayfly with very low tolerance to polluted water (MCI score of 9) and *Zephlebia* (MCI score of 7) collectively dominated (65%) the sample.

The sample from Waitaia Stream had a similar number of taxa, and 'good' MCI and QMCI values. Compared to the other samples, the Waitaia Stream sample had a notably lower proportion of EPT taxa, being only 12%. Instead, the sample was dominated by Potamopyrgus, a relatively tolerant freshwater snail, comprising 60% of the individuals within the sample.

The summary statistics for the samples collected in this survey are provided in Table 4, with full taxa list provided in Appendix D.

Table 4: Summary statistics for macroinvertebrates collected from Te Ruaotehauhau Stream, Trib 1, and Waitaia Stream, in the proposed MN06 reservoir footprint (July 2020).

Site name	Taxa richness	EPT richness	Number of individuals	MCI value	MCI class	QMCI value	QMCI class
Te Ruaotehauhau Stream	29	7	182	101.4	Good	5.7	Good
Tributary 1	26	11	200	113.8	Good	7.3	Excellent
Waitaia Stream	24	9	121	112.5	Good	4.6	Good

4.1.3 Freshwater fauna

During the first night of the fish survey, five kēwai (*Paranephrops planifrons*) were recorded from the Waitaia Stream and two kēwai were recorded from the Te Ruaotehauhau Stream.

During the second night of the fish survey, three longfin eels (*Anguilla dieffenbachii*) (At Risk - Declining) ranging in size from 600 mm to 700 mm were recorded from three separate fyke nets; one in each of the Te Ruaotehauhau Stream, Trib 1, and Waitaia Stream. Two elver were recorded in the downstream portion of the Te Ruaotehauhau Stream. Three common bullies (*Gobiomorphus cotidianus*) ranging in size from 40 mm to 60 mm were recorded; one was caught in a GMT from the downstream extent of the Te Ruaotehauhau Stream, and two were caught in the same fyke net from the Waitaia Stream.

A summary table of the freshwater fauna caught in this survey is provided in Table 5.

A desktop review, using the NZFFD, of streams in the Te Ruaotehauhau catchment and the wider Waiaruhe River catchment was carried out. In addition to the fish species caught during our fish survey, a diverse range of fish species have been recorded downstream and outside the proposed reservoir footprint in the wider catchment. Native fish species include banded

kōkopu (*Galaxias fasciatus*), Cran's bullies (*Gobiomorphus cotidianus*), shortfin eels (*Anguilla australis*), and black mudfish (*Neochanna diver*sus) (At Risk - Declining). Additionally, exotic and pest fish species recorded include gambusia (*Gambusia affinis*), rudd (*Scardinius erythrophthalmus*), and tench (*Tinca tinca*). Some of these fish species (native and exotic) may use the stream network on site. However, black mudfish are unlikely to be present on site because they inhabit wetland stream systems and the streams on site are not associated with wetlands.

The presence of longfin eel, an At Risk – Declining species, at the site meets the 'rarity/distinctiveness' criteria within Appendix 5 of the Regional Policy Statement for Northland. Therefore, the stream channels are classified as 'significant habitats of indigenous fauna'.

Table 5: Freshwater fauna recorded within the proposed MN06 reservoir footprint, survey methods, and threat statutes (including sampling undertaken in July 2020).

Common name	Scientific name	Gee-minnow (GMT)	Fyke net	Threat status[10, 13]	Ecological value[14]
Tuna/longfin eel	*Anguilla dieffenbachii*	-	3	At Risk - Declining	High
Common bully	*Gobiomorphus cotidianus*	1	2	Not threatened	Moderate
Elver	-	1	1	-	-
Kēwai/freshwater cray	*Paranephrops planifrons*	13	4	Not threatened	Moderate

4.1.4 Summary of freshwater ecology values

Stream ecological valuations for representative stream reaches across the site have been estimated based on site walkover observations and photos. Based on the combination of stream characteristics, macroinvertebrate communities, and fish communities, we estimate that the stream ecological values for both intermittent and permanent streams to be between **high** and **very high**. It is recommended that representative SEVs be carried out to assess and confirm the current ecological values.

4.2 Assessment of ecological effects - freshwater

4.2.1 Sedimentation during construction

Works within and adjacent to the bed of wetlands and streams ('streamworks') can result in an uncontrolled discharge of sediment laden water during construction.

The effect of excess in-stream sedimentation is recognised as a major impact of changing land use on river and stream health, through changes in water clarity and sediment deposition dynamics. Sediment entering stream systems can impact water clarity through sediment suspended within the water column ('suspended sediments'). Many native species (including longfin eels) are tolerant of elevated suspended sediment, measured either by turbid water or high concentrations of total suspended solids ("TSS")[15].

Sedimentation can also have noticeable effects on physical habitat in streams when it is deposited on the streambed ('deposited sediments'). Excess deposited sediment can clog the small spaces (interstitial) between hard stream substrates which impacts aquatic macroinvertebrates, alters food sources (i.e. macroinvertebrates for predation by fish), and removes egg-laying sites for native freshwater fauna.

[13] Dunn, N. R., Allibone, R. M., Closs, G. P., Crow, S. K., David, B. O., Goodman, J. M., Griffiths, M., Jack, D. C., Ling, N., Waters, J. M., and Rolfe, J. R. (2017). *Conservation status of New Zealand freshwater fishes*. Department of Conservation.
[14] Roper-Lindsay, J., Fuller, S., Hooson, S., & Sanders, M. (2018). Ecological impact assessment guidelines for New Zealand, 2nd Edition. Environment Institute of Australia and New Zealand Inc.
[15] For summary of research see Clapcott, J.E., Young, R.G., Harding, J.S., Matthaei, C.D., Quinn, J.M. and Death, R.G. (2011) Sediment Assessment Methods: Protocols and guidelines for assessing the effects of deposited fine sediment on in-stream values. Cawthron Institute, Nelson, New Zealand.

The presence of sensitive macroinvertebrate community taxa (mayflies and caddisflies) in the streams on site indicate healthy water quality and habitat. Kēwai were also found within streams throughout the site, which are typically found in healthy streams. No anaerobic sediments were observed during the site visit and the water column had good clarity throughout the site, even after heavy rainfall and at the most downstream section of Te Ruaotehauhau where the channel is open and lacking riparian cover. Therefore, it is recommended that any streamworks are undertaken during earthworks season when there is less flow and potential effects are expected to be easier to manage. It is recommended that the streamworks specific provisions are incorporated into the sediment and erosion controls for the site in accordance with best practice recommendations. We recommend using Auckland Council Guidance Document 5 (GD05).

The streamworks methodology for dewatering, mucking out, and diversion of clean/dirty water has not yet been prepared and therefore, is not included in this assessment. Given that the construction of the reservoir will result in complete and irreversible loss of stream habitat, there are likely to be opportunities to utilise in-line treatment (e.g. sediment traps) that wouldn't normally be in accordance with best practice because they would impact significantly on stream habitat. We recommend those opportunities be considered in the development of the construction methodology.

At the time of writing we do not have any detail pertaining to the construction methodology or staging. Subject to the implementation of best practice methodologies, there are no known site constraints or characteristics that suggest that the short-term effects of sedimentation associated with instream works could not be appropriately mitigated.

The stream habitat is considered to have between **high** to **very high** ecological value due to the macroinvertebrate and freshwater fauna present (including longfin eel which are classified as At Risk – Declining) and potential to support a more diverse range of freshwater fauna. The magnitude of effects of associated with construction of the reservoir was assessed as potentially **high** without sediment management, therefore giving an overall level of effects of **very high**. With the appropriate construction and sediment and erosion control methodologies to mitigate sediment and erosion control effects, the magnitude of effects could be reduced to **low**, and so the overall level of effects could be reduced to a **low** level.

4.2.2 Injury or mortality of freshwater fauna

Construction of the proposed reservoir could cause injury or mortality to native freshwater fauna during works in streams and wetlands. The magnitude of potential effect on native freshwater fauna is driven by the nature of the activity, the area of stream disturbance, density of fish present in each area, the ability of fish to escape disturbance and the controls applied. The conservation status of fish species is also relevant when assessing the potential overall level of effect.

The full construction method is unknown at this stage, but it is anticipated that the streams and wetland will require mechanical modification to form the reservoir basin. The potential impact of these works on stranding, injury and mortality can be minimised by implementing appropriate freshwater fauna salvage methods prior to works commencing. Some sections of the streams to be inundated may not be subject to physical streamworks and in those instances fish may be able to move upstream without salvage. Provided the reservoir is not filled too rapidly we expect fauna within the site to find suitable habitat unaided but should be considered further in the Freshwater Fauna Relocation Plan (FFRP). Eels and common bullies are also known to inhabit lakes. Land-locked common bully populations are known to inhabit lakes where they have been blocked off from sea due to natural processes. The creation of a reservoir is likely to result in an increase of aquatic habitat for eels, common bullies, and kēwai provided passage is maintained.

We recommend a Freshwater Fauna Relocation Plan (FFRP) is prepared as part of the reservoir construction methodology to minimise potential injury or mortality during streamworks and reservoir filling.

Longfin eel are classified as At Risk – Declining and so the freshwater fauna potentially affected by the activity is considered to have a **high** ecological value. The potential magnitude of effects of freshwater fauna stranding, injury, or mortality are assessed as **high**. Therefore, the overall level of effects would be **very high** in the absence of controls. With appropriate salvage and relocation methodologies detailed in a FFRP to minimise effects on fish during construction and reservoir filling, the magnitude of effects could be reduced to **low** and the overall level of effects to **low**.

4.2.3 Fish passage

Many of New Zealand's native fish are diadromous, meaning they migrate to and from the sea as part of their lifecycle. Artificial structures and poor culvert design can restrict fish migration. Often this occurs as a result of culverts being perched, too steep or long, subsequent increases in water flow or a resultant laminar flow with insufficient roughness to allow effective fish movement[16]. Placement of dam structures on streams and rivers can also restrict fish movement unless particular provision is made for them to pass. In addition, temporary restrictions to fish passage during construction may impact a population's reproductive success. The resultant decrease in fish mobility can cause fragmented populations, a reduction in population size, and limit overall available habitat for freshwater fauna. However, the fish community at this location is likely to be affected by the presence of Haruru Falls downstream, which will provide a migration barrier for some species of fish.

Common bullies, longfin eels, kēwai are present in the stream network on site. Common bullies can be either diadromous or non-diadromous. When considering their ability to pass barriers, common bullies are classified as swimmers[17]. This means that they usually swim around obstacles (rather than climb) and rely on areas of low velocity to rest and will exhibit intermittent burst activities to surpass high velocity areas. However, they will be mostly unaffected by the construction of the dam as they can form land-locked populations such as those in some of the Auckland water supply reservoirs[18]. Given that Haruru Falls is located downstream, the common bullies observed on site are likely to be land-locked populations. Eels are catadromous in that they live in freshwater but migrate to sea (or estuarine waters) to spawn, with juveniles returning to freshwater. Longfin eels are accomplished climbers and are well adapted to negotiating barriers to reach catchment headwaters. Kēwai are non-migratory species. They typically inhabit headwater streams but are also known to live in lakes and ponds. They prefer streams with native vegetation margins, hard-bottom substrates, and slow flowing water with areas of shallow pools[19]. Other native fish species recorded further downstream in the wider catchment may also inhabit the stream network on site. These other native fish species (such as banded kokopu and shortfin eels) are considered to be good climbers.

Longfin eels were observed immediately upstream of the proposed reservoir footprint. Kēwai were observed throughout the stream network in the proposed reservoir including Te Ruaotehauhau Stream and Waitaia Stream. Based on aerials, there is estimated to be in the order of15 km of stream habitat upstream of the proposed reservoir. Of that, there is estimated to be ~4 km of partly shaded, permanent and intermittent stream habitats in the upper portions of Waitaia Stream and Tributary 1. The remaining ~11 km appears to be relatively open channels, with little shading and no intact riparian margins.

Common bullies, however, were only observed in the gentle portions of the stream network in the proposed reservoir footprint. Therefore, the provision of fish passage (upstream and downstream) into the proposed reservoir is recommended for eels and kēwai to enable access to the habitat within and upstream of the reservoir. An elver pass for eels and installation of a spat rope for kēwai could be constructed up the face of the dam. If this was not feasible then a trap and haul programme could be established to stock the reservoir with elvers, noting that the long-term costs of this approach would quickly exceed those of constructing an elver pass. Providing downstream passage for migrant adult eels is more problematic but this could be managed by undertaking a periodic trap & haul programme. Consideration for downstream movement of migrant eels and upstream movement of kēwai should be included in spillway design to minimise the potential for injuries to occur. Providing passage is important to realising the compensatory replacement of stream habitat for eels with lake habitat in the reservoir and given the extent of upstream habitat remaining following completion of the reservoir.

It is recommended that upstream and downstream fish passage for eels be included in the design of the reservoir. This approach will be the most cost-effective in the long term and is critical to enabling the use of the proposed reservoir habitat by eels to compensate for the loss of stream habitat that will occur. It is recommended that fish passage is not provided for

[16] 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.
[17] Stevenson, C., Baker, C. (2009). Fish passage in the Auckland Region – a synthesis of current research. Prepared by NIWA for Auckland Regional Council. Auckland Regional Council Technical Report 2009/084.
[18] Baker, C., Smith, J., & Davison, B. (2008). Hunua Ranges Dams – Freshwater Fish Survey (Auckland Regional Council Technical Report 2008/016). Prepared by NIWA for Auckland Regional Council and Watercare Services Ltd.
[19] Smith, J. (2014). Freshwater fish spawning and migration periods. MPI Technical Paper No: 2015/17. NIWA, prepared for Ministry for Primary Industries.

swimming species, to prevent the potential movement of pest fish species into the reservoir. Approval of any fish pass design or dispensation to not install a fish pass is required from the Director-General of the Department of Conservation under Section 43 of the Freshwater Fish Regulations 1983.

Longfin eels are classified as At Risk – Declining, meaning that the potential affected fauna is of **high** ecological value. Longfin eels are accomplished climbers and are typically found to inhabit headwater catchments, therefore the magnitude of effect caused by impeding fish passage is considered **moderate**. This would result in an overall level of effect of **high**, but further dam design to incorporate eel passage is recommended to enable passage and contribute to the compensation package resulting from stream habitat loss.

4.2.4 Permanent modification of stream habitat

The proposed reservoir will inundate the gully system resulting in modification of approximately 2,114 m (~5,285 m^2 streambed area) continually flowing permanent stream and approximately 538 m (~108 m^2 streambed area) of intermittently flowing stream. The length and area of stream bed affected has been estimated based on stream length identified during our site visit and bank full widths after heavy rainfall, therefore will require confirmation on site to determine the actual extent. The filling of the reservoir will impact the main stems and tributaries across the site, turning them from relatively natural, hard-bottom streams to lake type habitat.

Due to the nature of the effect, being a substantive change to the functionality of the stream system, the effects are difficult to mitigate at the point of impact. Even though the construction of a reservoir will likely provide additional habitat, the habitat is not the same as stream habitat. Therefore, measures are required to address the effects associated with the loss of stream habitat.

The stream habitat is considered to have **high** ecological value based on a combination of natural hard-bottom streams, good to excellent macroinvertebrate community scores, the fish community observed with the presence of longfin eels, and estimated stream function SEV scores. The magnitude of effects is considered **very high** due to the permanence and quantity of stream loss. Therefore, the overall level of effects from the permanent loss of stream habitat is **very high**.

4.2.4.1 Restoration length required

To define the quantum of enhancement or restoration required to offset the effects of the proposed reservoir, an environmental compensation ratio (ECR) can be calculated using SEV scores.

The ECR is a tool used to quantify the amount of streambed area that is required to be restored, which takes into account the extent and type of stream impacted or lost and the type of enhancement works proposed. The objective is to achieve a 'no-net-loss' in ecological function as a result of the activities. The ECR calculation formula requires SEV scores to be calculated for both the impact and proposed mitigation (or offset, if applicable) sites. This provides a basis from which to quantify and scale the likely loss in values and functions at an impact site with the increase in stream ecological values and functions at a compensation or mitigation site.

ECR = [(SEVi-P – SEVi-I) / (SEVm-P – SEVm-C)] × 1.5

Where:
SEVi-P is the potential SEV value for the site to be impacted.
SEVi-I is the predicted SEV value of the stream to be impacted after impact.

SEVm-C is the current SEV value for the site where environmental compensation is applied.
SEVm-P is the potential SEV value for the site where environmental compensation is applied.

Restoration length required = (impact area × ECR) / restoration channel width.

Table 6 presents the summary SEV scores for the estimated current (SEVi-C) and modelled potential (SEVi-P) values for the impact permanent (SEV1 and SEV2) and intermittent (SEV3) reaches. Fish fauna intact (FFI) and invertebrate fauna intact (IFI) are excluded from the estimated current SEV score for the purpose of ECR calculations. All other streams on site are similar in their characteristics, and so the estimated SEV scores are applied as follows:

- Te Ruaotehauhau Stream (under riparian canopy) is representative of permanent channels with riparian vegetation margins,
- Te Ruaotehauhau Stream (open channel with no riparian canopy) is representative of permanent channels lacking riparian vegetation margins, and
- Tributary 2 is representative of all intermittent tributaries.

Potential scores for the impact streams have been modelled on a maximum 20 m riparian enhancement planting of native woody vegetation. The assumptions applied also include improvements to the following functions in the SEV: Vlining, Vrough, Vshade, Vdod, Vripar, Vmacro, Vsurf, Vripfilt, Vphyshab, and Vwatqual. Assumptions applied to the estimated current SEV scores and modelled potential SEV scores for SEV1, SEV2, and SEV3 are provided in Appendix E.

Impact scores (SEVi-I) are considered to be 0.2, because while the inundation of the stream will result in a permanent loss of stream habitat type, the resulting reservoir feature will still provide habitat for the fish and macroinvertebrate species observed on site and so it provides some functional value.

Table 6: Estimated and modelled stream ecological valuation (excluding FFI and IFI functions) results used to determine the estimated ECR.

Stream ID	SEV ID	SEVi-C	SEVi-P	SEVi-I	SEVm-C[20]	SEVm-P[20]
Te Ruaotehauhau Stream (under riparian canopy)	SEV1	0.78	0.88	0.2	0.46	0.86
Te Ruaotehauhau Stream (open channel with no riparian canopy)	SEV2	0.44	0.86	0.2	0.46	0.86
Tributary 2	SEV3	0.61	0.75	0.2	0.61	0.75

An estimated area of 5,393 m^2 streambed area will be impacted by the reservoir along 2,114 m of permanent and 538 m of intermittent stream.

While an offset planting location(s) has not yet been identified and confirmed, hypothetical SEVm-C and SEVm-P scores (using estimated SEV scores across site) have been used to estimate the quantum of stream offset required to achieve no net loss of ecological function.

Based on the hypothetical SEV values in Table 6 and 7, an estimated ECR of 2.4 for permanent channels with riparian vegetation margins, 2.4 for permanent channels without riparian vegetation margins, and 5.9 for intermittent channels is calculated. This means approximately 12,671 m^2 and 634 m^2 (collectively 13,305 m^2) of similar permanent and intermittent streambed area habitat enhancement in nearby catchments in Kaikohe is required to achieve no net loss of ecological function.

The ECR could be higher if streams in nearby catchments differ in stream functions from that estimated on site and SEV gains are less, which is likely if planting alongside highly modified stream channels, or infill planting into existing vegetation. Consequently, the quantum of streambed area required will increase or decrease accordingly to achieve no net loss of ecological function.

Once COVID19 restrictions are lifted and site visits can occur, SEV from representative streams will be collected and the SEV values will need to be updated. Offset stream locations will also need to be identified, and SEV's undertaken at these sites. SEV scores from the offset streams and ECR calculations will need to be updated to determine the quantum of riparian enhancement required to achieve no net loss ecological function.

It is considered that the effects associated with habitat modification can be offset by enhancing existing stream systems, the quantum of which will be calculated using the SEV and ECR methodology. While the offset quantum are currently estimations,

[20] SEVm-C and SEVm-P scores for permanent and intermittent reaches are hypothetical scores as offset locations have yet to be identified. It is assumed that the impact reaches are similar to nearby streams in the Te Ruaotehauhau Stream catchment.

the estimated SEV scores are consistent with reference SEV scores[4] in rural catchments dominated by agricultural land-use practices.

The estimated recommended offset requirements are considered positive effects, so cannot contribute to reducing the magnitude of adverse effect. As such the magnitude of effects remains the same as 'before mitigation' (being **very high**) and subsequently the overall level of effects remain **very high**. Notwithstanding, the proposed offset package measures outlined above are recommended to be consistent with biodiversity offsetting principles.

A Stream Offset and Compensation Enhancement Planting Plan (SOCEP) is recommended to identify the location(s) of the proposed planting, updated current on site SEV scores, updated offset SEV scores and ECR calculations, species list, size, spacing, and weed maintenance programme to support the establishment of plantings.

Table 7: Estimated potential SEV scores and ECR's and offset areas required to achieve no net loss of ecological function for the proposed inundation of permanent and intermittent streams across the proposed MN06 reservoir footprint.

Impact Sites Stream ID	SEVi-C	SEVi-P	Average width (m)	Length (m)	Impacted Streambed area (m2)	Stream ID	ECR*	Streambed area compensation required (m2)
Permanent streams (with riparian margins)	0.78	0.88	2.5	1,196.4	**2,991**	**Similar permanent channels (without riparian margins)**	2.4	**7,264**
Permanent streams (without riparian margins)	0.44	0.86	2.5	917.6	**2,294**	**Similar permanent channels (without riparian margins)**	2.4	**5,407**
Intermittent streams	0.61	0.75	0.2	538	**107.6**	**Similar intermittent channels**	5.9	**634**
Totals				**2,652**	**5,392.6**			**13,305**

*As described above, the ECR may increase depending on the offset site identified and the ecological gains that can be achieved.

4.2.5 Downstream water quality effects

Reservoirs can impact downstream water quality depending on how long water is stored and where outlets are located. We understand the reservoir outlet will draw water from the base of the dam. Placement of the outlet in this location will mean that residual flows will be drawn from deeper, cooler water.

An outlet drawn from deeper water is preferable to drawing water from the shallow water layers that will likely be warmer than stream flows and potentially support algal growths, which can be toxic. The downstream channels appear to be predominantly open and lacking riparian vegetation and so fauna present may be less sensitive to temperature changes. Subject to the reservoir outlet being from deeper water, we consider the effect on freshwater fauna from changes in stream temperatures will be low. Further consideration of measures to minimise potential downstream effects will be incorporated into detailed design discussions with the project engineers.

The stream habitat is considered to have **high** ecological value based on a combination of natural hard-bottom streams, good to excellent macroinvertebrate community scores, the fish community observed with the presence of longfin eels, and estimated stream function SEV scores. In the absence of well-designed outlet structures and flow management, the magnitude of effect could be **moderate** or higher. The magnitude of the potential impact on water quality is likely to be **low**, and so the overall level of effects is considered **low**, but further assessment will be required to determine the magnitude and level of effect if the outlet is designed differently from our understanding.

4.2.6 Downstream habitat effects

The construction of a reservoir will interrupt downstream transport of coarse and fine sediment and this may impact on downstream channel form and aquatic habitat as well as reduce the storage capacity of the reservoir over time[21]. The magnitude of this effect is difficult to predict, but due the small area being impacted, may be relatively small. To minimise these impacts, it is recommended that the design of the reservoir consider facilities to allow sediment flushing to occur.

The construction of the reservoir will modify the flow regime downstream of the reservoir. The reservoir will reduce overall flow volumes to the downstream reaches outside the reservoir, but minimum flows will be maintained through the dam outflow. However, flushing flows will be reduced. Modifications to the flow regime may affect fish species more indirectly through changes to water quality, periphyton cover and macroinvertebrate production. The current flow observed on site appear to be steady through the downstream extent of the on-site stream network and fast flowing in the upper tributaries and Waitaia Stream. The freshwater community downstream of the reservoir is generally tolerant of changes in flow regimes, but environmental flow investigations are recommended to fully assess the effects of changes in flow regime.

The habitat downstream of the proposed reservoir appears to be similar to that observed on site, characterised by natural hard-bottom permanent streams and lacking riparian vegetation. Therefore, the downstream habitat is considered to have a **high** ecological value. In the absence of a suitable flow regime, the magnitude of effect could be **moderate** or higher. The magnitude of this impact and the overall level of effects is likely to be **low**, but further assessment will be required to determine the magnitude and therefore the overall level of effect.

5. Terrestrial and wetland ecological assessment

5.1 Terrestrial ecological values

The Project footprint primarily consists of farm paddocks with pasture grass and exotic forest (pine, wattle, eucalyptus and redwood), as well as isolated patches of indigenous forest and wetland along stream margins and at the edges of the proposed reservoir (Appendix A, Figure 1).

Indigenous terrestrial ecosystem types identified include the following described in the following sections:

- Pūriri forest on basalt volcanic substrate (WF7.2)
- Riparian swamp forest (WF8)
- Secondary broadleaf forest with old-growth remnants (VS5)
- Tōtara treeland (AVS1)

Remnant volcanic boulderfields are distributed across the farm which historically would have provided substrate for pūriri forest ecosystems.

Stock have access to areas of pasture grass and some areas of indigenous vegetation, however much of the indigenous vegetation is fenced from stock and therefore in good ecological condition.

A small area of grazed rautahi (*Carex secta*) is present as riparian wetland along the Te Ruaotehauhau Stream margin, and kutakuta wetland (*Eleocharis sphacelata*) is present on the margin of a farm pond in the south-western corner of the proposed reservoir. Wetlands, regardless of ecological condition, are a nationally threatened ecosystem type, with 10% of the original wetland extent remaining nationally[22].

[21] Kondolf, G. M., Gao, Y., Annandale, G. W., Morris, G. L., Jiang, E., Zhang, J., Cao, Y., Carling, P., Fu, K., Guo, Q., Hotchkiss, R., Peteuil, C., Sumi, T., Wang, H.-W., Wang, Z., Wei, Z., Wu, B., Wu, C., & Yang, C. T. (2014). Sustainable sediment management in reservoirs and regulated rivers: Experiences from five continents. Earth's Future, 2(5), 256–280. https://doi.org/10.1002/2013EF000184

[22] Belliss, S, Shepherd, J, Newsome, P, & Dymond, J (2017). *An analysis of wetland loss between 2001/02 and 2015/16*. Landcare Research Contract Report LC2798 for the Ministry for the Environment

In regard to Threatened or At Risk plant species, kānuka (*Kunzea robusta*), and rātā vines (*Metrosideros perforata* and *M. diffusa*) were observed which are classified as Threatened – Nationally Vulnerable[23] due to the potential threat of myrtle rust. Similarly, mānuka (*Leptospermum scoparium*) is present in low abundance and is classified as At Risk – declining due to the threat of myrtle rust. Five swamp maire (*Syzigium maire*) were identified in the proposed footprint which are classified as Threatened – Nationally Critical.

Species lists and photographs of each ecosystem type are presented in Appendix F and Appendix G, respectively.

5.1.1 Pūriri forest (WF7.2)

Pūriri forest is present as fragmented patches of mature native forest in the outlying landscape and is generally fenced and protected from stock access. Mature pūriri forest is present on the margins of the proposed reservoir and is present as remnant patches along some of the riparian margin to Te Ruaotehauhau Stream and its side tributaries. Pūriri forest extents at Tributary 2 are surrounded by exotic pine forest.

Pūriri forest has established on basaltic volcanic rock substrate and consists of large canopy trees pūriri (*Vitex lucens*), taraire (*Beilschmiedia taraire*), tōtara (*Podocarpus totara*), rewarewa (*Knightia excelsa*) and karaka (*Corynocarpus laevigatus*), generally with degraded understorey due to stock damage. Where the understorey is intact it consists of māhoe (*Melicytus ramiflorus*), mapou (*Myrsine australis*), nikau (*Rhopalostylis sapida*) and kawakawa (*Piper excelsum*. Tree ferns and ground ferns are present in this ecosystem type and include mamaku (*Cyathea medularis*) silver fern (*Cyathea dealbata*), kiokio (*Parablechnum novae-zelandiae*) and rasp fern (*Doodia australis*).

Epiphytes of tank lily (*Astelia hastata*), perching lily (*Astelia solandri*) and tawhirikao (*Pittosporum cornifolium*) were observed on the branches of mature trees. Tawhirikao was observed only on pūriri trees outside of the reservoir footprint.

The proposed reservoir extent affects small extents at the edges of this forest type at the southern, western and eastern sides, while avoiding high-value interior forest.

Mature pūriri forest is one of Northland's rarest ecosystem types, with 1000 ha remaining and less than 50 ha protected. Volcanic broadleaf forests (e.g. pūriri forest) has been identified as a priority area for protection[24]. This forest type typically supports indigenous lizards, keystone birds such as kukupa (*Hemiphaga novaeseelandiae*) and can provide habitat to native bats and kauri snails. It is therefore considered as having **very high** ecological value.

5.1.2 Riparian swamp forest (WF8)

Riparian swamp forest is present on the margins of Te Ruaotehauhau Stream and consists of a canopy of māhoe, towai (*Weinmannia sylvicola*), tōtara, taraire and swamp maire, with remnant pūriri trees on the drier margins. Other species in this ecosystem type include marbleleaf (*Carpodetus serratus*), pate (*Schefflera digitata*) and ferns whekī (*Dicksonia squarrosa*), mata (*Histiopteris incisa*), thread fern (*Icarus filiforme*), gully fern (*Pneumatopteris pennigera*), smooth shield fern (*Parapolystichum glabellum*), hanging spleenwort (*Asplenium flaccidum*) and shining spleenwort (*Asplenium oblongifolium*). Epiphytes and vines include tank lily and rātā vines (*Metrosideros perforata* and *M. diffusa*) and the native ground cover, basket grass (*Oplismenus hirtillus* subsp. *Imbicillus*) is abundant.

Kahikatea (*Dacrydium dacrydioides*) is present alongside mānuka at a small portion of stock-degraded swamp forest at the upstream end of Tributary 1A.

The margins of the swamp forest also contain areas of taro (*Colocasia esculenta*), which were historically cultivated in the catchment.

[23] De Lange, P. J., Rolfe, J. R., Barkla, J. W., Courtney, S. P., Champion, P. D., Perrie, L. R., Beadel, S. M., Ford, K. A., Breitwieser, I., Schönberger, I., Hindmarsh-Walls, R., Heenan, P. B. & Ladley, K. (2017). Conservation status of New Zealand indigenous vascular plants. New Zealand Threat Classification Series 22. 82 p.

[24] Conning, L. and Miller, N. (2000). Natural areas of Kaikohe Ecological District Reconnaissance Survey Report for the Protected Natural Areas Programme. Department of Conservation. 29pp.

Exotic species are present on the edge of this habitat including german ivy (*Delairea odorata*), however the areas are predominantly fenced from stock access and are in good ecological condition, with full understorey and canopy.

Swamp forest habitats have reduced in extent nationally due to the draining of wetlands and habitat clearance. Swamp forest is regionally under-represented with two intact examples left in the Ecological District, constituting 1.5% of natural areas left in the Ecological District.

The presence of Threatened – Nationally Critical swamp maire further increases the quality and importance of this habitat. A total of five swamp maire were identified (Appendix A, Figure 1); the swamp maire are mature and in good health, the largest being of 60 cm DBH (Diameter at Breast Height).

This ecosystem type is therefore considered of **very high** ecological value.

Swamp maire and rātā vines individually are classified as having **very high** ecological value and mānuka as **high** ecological value due to their threat classifications of Threatened and At Risk – declining respectively.

5.1.3 Secondary broadleaf forest with old-growth remnants (VS5)

Secondary broadleaf forest buffers Te Ruaotehauhau Stream and consists of a typical suite of indigenous broadleaf species. The canopy consists of kawakawa, hangehange, mapou, māhoe, kānuka, mamaku, and whekī with occasional old-growth pūriri, tōtara, taraire, rewarewa and tōwai. Kōtukutuku (*Fuchsia excorticata*) was present adjacent to stream banks, and bracken (*Pteridium esculentum*) buffers open edges.

Vines present include supplejack (*Rhopalostylis sapida*), New Zealand passionfruit (*Passiflora tetrandra*), large-leaved pohuehue (*Muehlenbeckia australis*) while ground covers include parataniwha (*Elatostema rugosum*) and ferns such as rasp fern. Exotic plants are present on the edges of this habitat type, including german ivy.

Overall, this habitat is in good ecological condition with stock exclusion resulting in regeneration of indigenous broadleaved species among remnant mature trees. Secondary broadleaf forests provide habitat for indigenous bats, birds, lizards and kauri snails. The relatively small extent of this ecosystem type, and predominantly regenerating nature result in this ecosystem being considered of **moderate** ecological value.

Kānuka is considered as having **very high** ecological value due to its threat classification of Threatened – nationally vulnerable.

5.1.4 Tōtara treeland (AVS1)

Tōtara treeland consisting of mature tōtara trees with degraded understorey is present at the north-western and south-eastern corners of the proposed reservoir footprint. Understorey regeneration appears to have been limited both by stock access and exotic pine litter, however common indigenous understorey species are present, including māhoe, pigeonwood (*Hedycarya arborea*) and kawakawa. Where the tōtara treeland meets the riparian margin of the stream, New Zealand flax (*Phormium tenax*) is present. Wild ginger (*Hedychium gardnerianum*) is present in some areas but in low abundance.

No threatened or at-risk species were present in this ecosystem type, but tōtara treelands may provide habitat for native bats, birds and lizards and are therefore considered of **moderate** ecological value. Tōtara treelands are currently providing buffering and shading to Waitaia Stream and Te Ruaotehauhau Stream.

5.1.5 Volcanic boulderfields

Distributed across the pasture grass areas are remnant volcanic boulders lacking in vascular vegetation.

Volcanic boulderfield substrates are an historically rare terrestrial ecosystem type with a total extent of <0.5% nationally. Volcanic boulderfields (even without vegetation) are classified as an endangered ecosystem type[25] and provide important substrate for rare pūriri forest ecosystems.

[25] Wiser, S. K., Buxton, R. P., Clarkson, B. R., Hoare, R. J., Holdaway, R. J., Richardson, S. J., ... & Williams, P. A. (2013). New Zealand's naturally uncommon ecosystems. *Ecosystem services in New Zealand: conditions and trends. Manaaki Whenua Press, Lincoln*, 49-61.

The volcanic boulderfields are severely degraded due to stock impacts and provide little habitat to native fauna. However native skinks may utilise boulders as shelter and basking, and due to their status as endangered are therefore classified as having **high** ecological value.

5.1.6 Exotic forest

Exotic forest is present across the proposed reservoir footprint, and consists of mature wattle (*Acacia* spp.), pine (*Pinus radiata*), eucalyptus (*Eucalyptus* sp.) and a small area of redwood (*Sequoia sempervirens*).

The understorey of these forest types is spare, having been grazed by stock. Some areas beneath pine and wattle are dominated by the exotic ground cover tradescantia (*Tradescantia flumenensis*). Tradescantia may provide suitable habitat for native skink species. Areas of pine in the south-eastern corner have recently been cleared.

Exotic forestry is used by long-tailed bats and North Island brown kiwi as foraging and roosting habitat. For the purposes of this assessment we have conservatively assumed that indigenous bats and North Island brown kiwi are present and therefore exotic forest is classified as having **moderate** ecological value.

A moderate ecological value was determined through following the EIANZ guidelines, specifically assigning:

- A **low** value for representativeness (e.g. exotic-dominated ecosystem);
- A **high** value for rarity/distinctiveness (e.g. Threatened long-tailed bats and At Risk North Island brown kiwi may be present);
- A **low** value for diversity and pattern (e.g. low overall indigenous diversity); and,
- A **moderate** ecological value in regards to ecological context (e.g. provides a moderate value stepping stone for forest birds, provides some buffering to streams, and are of a relatively large size considered together).

Therefore, the area rates h**igh** for one of the assessment matters and **low** or **moderate** for the remainder, resulting in an overall **moderate** ecological value.

5.1.7 Indigenous-dominated wetlands

Indigenous-dominated wetlands are present on site including a small section of rautahi (*Carex geminata*) and a small artificial pond (Constructed Wetland) dominated by kutakuta (*Eleocharis sphacelata*) buffered by ring fern (*Paesia scaberula*). Both wetlands were compromised by stock grazing and hydrological modification from exotic trees and weeds.

Wetlands, regardless of condition are a nationally threatened ecosystem. Given that the wetlands were of a small extent but dominated by indigenous species, both are considered as having **high** ecological value.

Under the criteria set out in Appendix 5 of the Regional Policy Statement for Northland, none of the wetlands on site are classified as being Significant. Nevertheless, the rautahi wetland is considered natural and therefore captured under the provisions of the recently gazetted National Policy Statement for Freshwater Management 2020 and National Environmental Standards for Freshwater 2020. The kutakuta wetland is considered a Constructed Wetland due to evidence of excavation and the creation of a bund for wetland creation, potentially for an historic detention dam or water supply.

5.1.8 Wet pasture grass

Areas of wet pasture grass dominated by exotic pasture species, as well as small *Juncus effusus* wetlands are present across the site. Under the Proposed Regional Plan for Northland pasture wetlands dominated by rushes are not considered a 'Natural Wetland' and are therefore considered of **low** ecological value.

5.1.9 Bats

Potential roost habitat for long-tailed bats is present within the Project footprint within the following ecosystem types:

- Pūriri forest;
- Swamp forest;

- Secondary broadleaf forest with old-growth signatures; and,
- Exotic forest

Pūriri forest contains mature native trees (over 1.5 m DBH) with abundant cracks and crevices available for long-tailed bat roosting. Pūriri and swamp forest host perching epiphytes such as tank lily which long-tailed bats may use for roosting. Old-growth trees in the secondary broadleaf forest contain cracks and crevices for long-tailed bat roosting, as well as providing native vegetation overhanging Waitaia Stream and Te Ruaotehauhau Stream which creates a suitable fly-way for bats.

Pine, wattle, redwood and eucalypt trees are large (above 40 cm DBH) and cracks and crevices were identified during the site visit which may provide suitable roosting habitat for long-tailed bats.

Furthermore, linear features and a wetland gully corridor provides a suitable potential flyway of approximately 185 m within the pūriri forest along Tributary 2 (Appendix A Figure 1), which may be used by bats for foraging. A potential fly-way of approximately 1 km length may be used for foraging and/or commuting along Waitaia Stream and Te Ruaotehauhau, with approximately 50% of the stream riparian margin vegetated.

Indigenous and exotic vegetation is distributed patchily across the outlying landscape, and these patches may provide a mosaic of roosting and foraging habitat for long-tailed bats.

Short-tailed bat populations are known from contiguous areas of mature native forest and are unlikely to be found within fragmented forest in farmland environments, however acoustic bat surveys will be undertaken to investigate their possible presence.

Acoustic surveys are required to determine whether bats are present at this site. No acoustic bat surveys have yet been undertaken within the footprint, however for the purposes of this assessment we have assumed conservatively that both long-tailed and lesser short-tailed bats are present. Due to both species having a conservation threat status of Threatened[26], they are considered as having **very high** ecological value.

5.1.10 Avifauna

Overall, seven bird species were identified during the site walkover and bird counts which included five native species. In general, the avifauna community was typical of farmland with fragmented patches of indigenous and exotic forest.

Indigenous birds included kukupa (*Hemiphaga novaeseelandiae*) tūī (*Prosthemadera novaeseelandiae*), riroriro (*Gerygone igata*), pīwakawaka (*Rhipidura fuliginosa*), and silvereye (*Zosterops lateralis*) and exotic birds eastern rosella (*Platycercus eximius*) and common myna (*Acridotheres tristis*). Of these, kukupa are considered Regionally Significant[27].

Assessment for the Kopenui Stream Reservoir Assessment of Ecological Effects approximately 4 km away identified miromiro (*Petroica macrocephala*) as present, and it is conservatively assumed they would utilise the habitat on site. Miromiro are considered of Regional and District significance[Error! Bookmark not defined.].

The location of the site is immediately adjacent to known North Island brown kiwi distribution areas including a 'High Density' area. It is conservatively assumed that North Island brown kiwi utilise the site, either permanently or intermittently as part of a series of stepping stones throughout the landscape. No kiwi burrows or signs were observed during the site visit, however burrows can be cryptic, and areas of exotic forestry were not explored fully during the walkover. North Island brown kiwi may utilise the indigenous and or exotic vegetation on site for foraging and roosting, are classified as At Risk – declining and are Regionally Significant[Error! Bookmark not defined.]. Given the size of the site (approximately 30 ha), multiple kiwi pairs may use the site a s part of their territory.

[26] O'Donnell, C.F.G., Borkin, K.M., Christie, B. L., Parsons, S., Hitchmough, R. A. (2017). Conservation status of New Zealand bats. New Zealand Threat Classification Series 21. 4 p.
[27] Conning, L. and Miller, N. (2000). Natural areas of Kaikohe Ecological District Reconnaissance Survey Report for the Protected Natural Areas Programme. Department of Conservation. 29pp.

Miromiro, kukupa and North Island brown kiwi are considered as having **high** ecological value as they are considered Regionally Significant.

Tūī are considered as having **moderate** ecological value as a key pollinator and seed disperser. All other Not Threatened and exotic birds observed during the site visit are considered as having **low** ecological value as they are common in the wider landscape.

Rank grass provides nesting habitat for New Zealand pipit (*Anthus novaeseelandiae*) and although not observed during the site visit, they may intermittently use the site. New Zealand pipit are classified as At Risk – declining and therefore of **high** ecological value.

5.1.11 Herpetofauna

No herpetofauna were observed during the site visit; but lizards are normally active during warmer months, and therefore should be surveyed between October and April.

Through desktop assessment and assessment of habitat on site, six herpetofauna species were identified as potentially utilising the site. These include, nationally At Risk – Declining[28] forest gecko (*Mokopirirakau granulatus*), elegant gecko (*Naultinus elegans*), Northland green gecko (*Naultinus grayii*), ornate skink (*Oligosoma ornatum*), nationally At Risk – Relict Pacific gecko (*Dactylocnemis pacificus*) and Not Threatened copper skink (*Oligosoma aeneum*). At Risk – Declining, At Risk – relict and Not Threatened herpetofauna are considered as having high, moderate, and low ecological values, respectively. Furthermore, ornate skinks are considered Regionally significant[Error! Bookmark not defined.].

Skink habitat was identified on site as consisting of the following microhabitats:

- Rank grass habitat where stock have been unable to graze;
- Tradescantia ground cover beneath exotic trees;
- Boulderfields which provide shelter though cracks and crevices, as well as providing basking habitat;
- Indigenous forest types which provide leaf litter and boulder microhabitats.

Gecko habitat was identified on site as consisting of indigenous terrestrial vegetation including mature native and secondary broadleaf forest. Regenerating and mature native trees provide food and shelter resources for indigenous geckos.

The fragmented habitat with poor connectivity to large contiguous areas of forest and the likely presence of pest mammals on site reduces the likelihood of herpetofauna presence. If present, it is expected that herpetofauna will be in low or moderate abundance.

If present, forest gecko, elegant gecko, Northland green gecko and ornate skink are considered as having **high** ecological value, Pacific gecko as **moderate** ecological value and copper skinks as **low** ecological value due to their threat classifications.

5.1.12 Invertebrates

Kauri snails (*Paryphanta busbii*) have been found within 5 km of the site[29] and it is considered that indigenous forest habitats on site may provide suitable habitat for kauri snails as the leaf litter remains intact in some areas due to stock exclusion fencing.

Kauri snails are classified as a Threatened and regionally significant snail[Error! Bookmark not defined.] and are protected by the Wildlife A ct 1953. Due to their regional distinctiveness kauri snails are considered of **high** ecological value.

[28] Hitchmough, R., Barr, B., Lettink, M., Monks, J., Reardon, J., Tocher, M., van Winkel, D. & Rolfe, J. (2015). Conservation status of New Zealand reptiles. New Zealand Threat Classification Series 17. 14 p.
[29] Inaturalist (2019). Kauri snail (*Paryphanta busbyii*). Accessed on 20 August 2020 from https://inaturalist.nz/observations/36010613

5.2 Assessment of ecological effects - terrestrial

5.2.1 Vegetation effects

It is expected that all vegetation within the reservoir footprint will be removed. The total quantity of indigenous vegetation loss is 1.46 ha, with an additional 0.75 ha of volcanic boulderfield, 1.32 ha of exotic forest and 0.22 ha of wet pasture removal.

This includes a total of:

- 0.47 ha of pūriri forest;
- 0.32 ha of swamp forest;
- 0.44 ha of secondary broadleaf forest with old-growth signatures;
- 0.14 ha of tōtara treeland;
- 0.75 ha of volcanic boulderfield;
- 0.03 ha of rautahi wetland;
- 0.05 ha of kutakuta wetland;
- 1.32 ha of exotic forest; and
- 0.22 ha of wet pasture.

Without mitigation, removal of vegetation will result in the loss of habitat and foraging resources for indigenous fauna, potential mortality of indigenous fauna, increased landscape fragmentation and loss of connectivity, and the loss of nationally threatened wetland habitats and indigenous plant species.

5.2.1.1 Magnitude and overall level of effect

This section outlines the predicted magnitude of effect on each of the affected ecosystem types, Threatened and At Risk plant species and fauna. Through combining the magnitude of effect with the ecological value of the focal characteristic, the overall level of ecological effect is determined.

Removal of 0.47 ha pūriri forest is considered a **moderate** magnitude of effect for this habitat. A **very high** ecological value combined with a **moderate** magnitude of effect results in an overall **high** ecological effect.

Removal of 0.32 ha swamp forest is considered a **moderate** magnitude of effect for this habitat. A **very high** ecological value combined with a **moderate** magnitude of effect results in an overall **high** ecological effect.

Removal of 0.44 ha secondary broadleaf forest with old-growth signatures is considered a **moderate** magnitude of effect for this habitat. A **moderate** ecological value combined with a **moderate** magnitude of effect results in an overall **moderate** ecological effect.

Removal of 0.14 ha tōtara treeland is considered a **moderate** magnitude of effect for this habitat. A **moderate** ecological value combined with a **moderate** magnitude of effect results in an overall **moderate** ecological effect.

Removal of 0.75 ha of volcanic boulderfield is considered a **moderate** magnitude of effect for this habitat. A **high** ecological value combined with a **moderate** magnitude of effect results in an overall **high** ecological effect.

Removal of 1.2 ha of exotic forest is considered a **moderate** magnitude of effect for this ecosystem, as pine is common in the wider landscape, however permanent removal of a substantial quantity of vegetation is proposed. A **moderate** ecological value with a **moderate** magnitude of effect results in an overall **moderate** ecological effect.

Removal of 0.03 ha rautahi wetland is considered a **low** magnitude effect due to the small quantity of wetland loss. A **high** ecological value combined with **low** magnitude of effect results in an overall **low** ecological effect.

Removal of 0.05 ha of kutakuta wetland is considered a **low** magnitude of effect due to the low quantity of wetland loss. A **high** ecological value combined with **low** magnitude of effect results in a **low** ecological effect.

Removal of nationally Threatened swamp maire constitutes a **high** magnitude of effect due to the permanent removal of trees which only remain in small, fragmented populations nationally and which are experiencing ongoing loss. A **very high** ecological value with a **high** magnitude of effect results in a **very high** ecological effect.

Removal of kānuka, rātā vines and mānuka individuals constitutes a **low** magnitude of effect as these species are common locally and nationally and few individuals are being affected. A **very high** ecological value with a **low** magnitude of effect results in a **moderate** ecological effect for kānuka and rātā vines, and a **high** ecological value with a **low** magnitude of effect results in a **low** ecological effect to mānuka.

Removal of 0.22 ha of wet pasture is considered a **low** magnitude effect due to the small amount of wet pasture loss. A **low** ecological value combined with **high** magnitude of effect results in a **low** ecological effect.

5.2.1.2 Vegetation effects management

Residual effects resulting from vegetation removal can be offset and compensated through revegetation planting and enhancement of existing ecosystems which may be degraded. Such enhancement might include planting, pest control, and the provision of coarse woody debris or boulders for indigenous fauna.

Management plans will be required prior to construction in order to remedy, offset and compensate impacts to vegetation and habitats. The following management plans are recommended:

- Final terrestrial offset and compensation package, outlining the quantum of planting or other compensation measures required to account for the loss of terrestrial and wetland habitats, including the use of offsetting guidance (see Section 5.2.1.3). Offset and compensation is recommended to include restoration planting and habitat enhancement. Further field surveys and community engagement will be undertaken to inform the offsetting package.
- Development of a Restoration Management Plan detailing the extents and areas for replanting, planting proportions and densities, planting specifications and a plant maintenance regime.

Effects to Threatened and At Risk plants will be offset and compensated through revegetation plantings. Effects to swamp maire will be offset through replacement at a ratio of 1:200. Effects to mānuka and kānuka will be addressed by including these species as a high proportion of the replacement planting crop. It is expected that rātā vines will re-establish through seed colonisation in time.

Additional site visits will include targeted searching of swamp forest to identify swamp maire that may have been missed during the initial survey. All swamp maire will be measured and recorded.

It is recommended that impacts to volcanic boulderfields be remedied through the relocation of boulders which are inside the footprint to the edge of the proposed reservoir where practicable. Boulders will be effective in providing potential:

- Skink habitat enhancement;
- Kauri snail habitat enhancement; and
- Provision of substrate for pūriri forest offset planting.

5.2.1.3 Biodiversity accountancy offsetting model

The Biodiversity Offset Accounting Model[30] (BOAM) has been developed to provide a transparent, robust, and structured means of assessing an offset proposal. Based on data inputs, the model calculates whether a 'no-net-loss'/'net-gain' biodiversity outcome will be achieved, whilst accounting for uncertainty and time lag between loss at impact sites and gain being created at offset sites. In summary, the model:

- Accounts for 'like-for-like' biodiversity trades/currencies aimed at demonstrating 'no-net-loss' or 'net-gain';
- Calculates the present biodiversity value to estimate whether 'no-net-loss' or 'net-gain' can be achieved;

[30] Maseyk et al. (2015). A Biodiversity Offsets Accounting Model for New Zealand. Contract report prepared for the Department of Conservation, Hamilton Service Centre Private Bag 3072 Hamilton New Zealand

- Incorporates the use of a time discount rate to account for time lag. We will use a discount rate of 3% to account for the temporal-lag between the impact occurring (due to the development) and the biodiversity gains being generated (due to the offset actions). The worked examples provided in the User Manual apply a discount rate of 3%, as informed by research conducted as part of DOC's research project on biodiversity offset in New Zealand; and,
- Makes an allowance for uncertainly of success (i.e. a degree of confidence) in relation to proposed offset actions.

Data will be collected from the impact areas which will inform offset models. An offset site will also be identified which provides opportunity to enhance like for like habitat to those being impacted.

To inform offset models, 10 x 10 m^2 RECCE plots[31] will be undertaken in representative areas of each of the indigenous ecosystem types. Attributes of the vegetation in each RECCE plot will be measured and will include canopy height, canopy cover, Diameter at Breast Height of each tree above 2.5 cm DBH, species richness, as well as fauna proxy measures including the number of flaky bark trees and leaf litter depth.

Biodiversity offsetting and compensation preliminary results

Offset modelling of similar ecosystem types has been undertaken on other projects, and these have been used to estimate the likely offsetting ratio required for each ecosystem with an overall level of effect of moderate of higher.

The effects on rautahi wetland are low, however the Proposed Regional Plan for Northland states that activities must not cause changes to the water level of any Natural Wetland to an extent that may cause adverse effects to the natural ecosystem (C.2.3 Natural wetlands). Therefore, it is proposed that effects to the rautahi wetland also be offset. The kutakuta wetland is considered a Constructed Wetland and as such offsetting is not proposed.

These are summarised in the Table 8.

Table 8: Surrogate estimations of likely offsetting ratio at MN06 which as a result of the proposed reservoir, have an ecological effect of moderate or higher (with the addition of rautahi wetland).

Ecosystem type	Reference model	Reference ecosystem	Offset ratio of reference model	Estimated offset quantum (ha)
Pūriri forest	Kopenui Stream Reservoir Assessment of Ecological Effects	Podocarp-broadleaf forest	1:8	3.76
Swamp forest	Kopenui Stream Reservoir Assessment of Ecological Effects	Swamp forest	1:4	1.28
Secondary broadleaf forest with old-growth signatures	Manawatū Tararua Highway Proposed Conditions of the Resource Consents	Secondary broadleaf forest with old-growth signatures	1:5.2	2.3
Tōtara treeland	Kopenui Stream Reservoir Assessment of Ecological Effects	Old-growth fragments	1:8	1.12
Rautahi wetland	Mānawatu Tararua Highway Proposed Conditions of the Resource Consents[32]	Indigenous-dominated wetland moderate value (rautahi-dominated wetland)	1:2.7	0.08
Total indigenous revegetation estimate				**8.54 ha**

[31] Hurst, J. M., & Allen, R. B. (2007). *The recce method for describing New Zealand vegetation – field protocols.* Landcare Research.
[32] Waka Kotahi New Zealand Transport Agency (2020). Proposed Conditions of the Resource Consents –Mediation Version: 3 August 2020. Manawatū Tararua Highway.

Offset modelling in similar ecosystem types suggests a total of approximately 8.54 ha of offset planting is required to achieve net gain with associated fencing, weed and pest control (e.g. rabbit and hares) to ensure growth of new plantings. Additional field work will be undertaken to gather offset modelling data to update BOAMs and determine final offsetting requirements, and offset sites will be identified.

5.2.1.4 Measures to reduce vegetation ecological effects summary

The overall level of ecological effects on vegetation can be offset and compensated through recommendations outlined in the above sections. Implementing these recommendations in full will ensure 'No Net Loss' of vegetation values can be achieved.

5.2.2 Fauna effects

Without mitigation, vegetation removal can result in the injury or mortality of nesting birds, eggs and fledglings, roosting bats, lizards and kauri snails. Fauna Management Plans will be utilised to mitigate impacts to fauna on site and will be implemented prior to construction commencing. Fauna Management Plans will include vegetation removal protocols and seasonal vegetation clearance constraints which minimise injury and mortality to native fauna.

5.2.2.1 Magnitude and overall level of effect without management recommendations

The magnitude of effect of vegetation removal on native bats is considered **high** due to the presence of potential roost habitat loss and the potential for injury and mortality of bats during vegetation clearance. A **very high** ecological value combined with a **high** magnitude of effect results in a **very high** level of effect.

The magnitude of effect on forest birds of forest removal is considered **moderate** due to the potential of injury or mortality to breeding birds, as well as habitat loss. Forest birds are common in the landscape, therefore the magnitude of effect is considered to be moderate. For miromiro and kukupa, a **high** ecological value with a **moderate** magnitude of effect results in a **high** ecological effect.

For tūī, a **moderate** ecological value combined with a **moderate** magnitude of effect results in a **moderate** ecological effect. For other common forest birds, a **low** ecological value combined with a **moderate** magnitude of effect results in a **low** ecological effect.

The magnitude of effect on North Island brown kiwi is **high** given the possibility of mortality of kiwi during construction activities. Mortality might occur during vegetation clearance or during construction, due to higher vehicle access and the increased potential of bird strike. Adult kiwi are generally capable of escaping from disturbance, however are particularly sensitive during the kiwi breeding season (July to March inclusive). A **high** ecological value combined with a **high** magnitude of effect results in a **very high** ecological effect.

The magnitude of effect rank grass removal on New Zealand pipit is considered **moderate**, due to the potential loss of eggs or chicks during breeding season. A **high** ecological value combined with a **moderate** magnitude of effect results in a **high** ecological effect on New Zealand pipit.

The magnitude of effect on native lizards on site is considered **high** due to the potential of injury or mortality of lizards and habitat loss. A **high** magnitude of effect combined with **high** ecological values results in a **very high** ecological effect for forest gecko, elegant gecko, Northland green gecko and ornate skink. A **moderate** ecological value with a **high** magnitude of effect results in a **moderate** ecological effect for Pacific gecko. A **low** ecological value with a **high** magnitude of effect results in a **low** ecological effect on copper skinks.

The loss of potential kauri snail habitat is considered a **moderate** ecological effect. A **high** ecological value with a **moderate** magnitude of effect results in a **high** ecological effect on kauri snails.

5.2.3 Fauna effects management

5.2.3.1 Bat management

Native bat acoustic monitoring has not yet been undertaken at the Project site and survey using Automatic Bat Monitors is required between October and April to determine their presence.

It is possible that potential roost habitat within the footprint is at least intermittently used as part of a wider roost network for long-tailed bats. There is a very low possibility of short-tailed bat presence. Considering this, the possibility exists that individual bats (or in the worst case, an active communal maternity roost) may be harmed or killed during site clearance. The implementation of a Bat Management Plan (BMP) will avoid, minimise and/or mitigate potential impacts to native bats. As part of the BMP, acoustic surveys will be undertaken to investigate bat activity at the site. Depending on the findings of acoustic survey/s, a range of suitable management options may be recommended. These may include some or all of:

- Best-practice vegetation removal protocols to avoid injury or death during vegetation clearance, potentially involving further acoustic survey immediately prior to clearance, and/or climbing of trees to confirm bats are currently absent;
- Planting of tree species which may form roost habitat over time, to address the loss of potential roost habitat in the affected area;
- Planting of suitable species to replace the loss of foraging/commuting habitat within the affected area; and/or
- Pest control to protect roost habitat off site, over an appropriate area, for an appropriate length of time, to offset the loss of potential roost habitat in the affected area.

5.2.3.2 Avifauna management

The implementation of an Avifauna Management Plan (AMP) will avoid, minimise and/or mitigate effects to avifauna. The AMP will include vegetation removal protocols and bird nest check protocols. Most adult birds can fly away from construction-related impacts but are vulnerable during bird breeding season when nesting. Terrestrial vegetation should be removed outside of the peak bird breeding season (September to December inclusive) to avoid impacts to indigenous forest birds. Bird nest checks can be undertaken where low stature vegetation is to be removed during the bird breeding season.

A monitoring and management programme is proposed for North Island brown kiwi and will be detailed in the AMP. Monitoring via kiwi listening surveys will initially be undertaken to determine potential kiwi presence, locations and abundance in the Project footprint and areas immediately adjacent.

Depending on the results of the listening surveys, various management actions may be used to avoid impacts to kiwi which might include:

- Management through locating and protecting individuals living near or alongside the footprint area;
- Temporary fences to exclude kiwi from entering the construction zone;
- Searching with trained dogs prior to vegetation clearance to determine if nests are present (during the breeding season July to March inclusive)
- Removing vegetation outside of the kiwi breeding season.

5.2.3.3 Herpetofauna management

All native herpetofauna are protected by the Wildlife Act 1953. Lizards are more active during warmer months (October to April inclusive) during fine weather, and therefore vegetation clearance of lizard habitat and lizard salvaging should only be undertaken during this period to minimise impacts to lizards.

Destructive habitat searching and construction-assisted salvaging is recommended to avoid impacts to native skinks. This method will involve manually searching through tradescantia, turning over coarse woody debris, and being onsite during vegetation clearance and volcanic boulder relocation.

Spotlighting for geckos is recommended prior to the clearance of indigenous vegetation. After felling, vegetation will be searched for geckos, and vegetation left in situ beside existing indigenous forest prior to mulching.

To avoid, minimise and/or mitigate impacts to lizards, a Lizard Management Plan (LMP) will be implemented, which outlines key methodologies used to mitigate impact to skinks and geckos. The LMP will include details such as:

- Species to be targeted;
- Vegetation removal protocols and timings;

- Salvaging methodology, including destructive habitat searching for skinks and gecko spotlighting;
- Relocation site characteristics and location;
- Other mitigation measures which will benefit lizards such as restoration planting and habitat enhancement through the use of volcanic boulders; and,
- Personnel undertaking lizard salvaging.

Offset planting and the relocation of boulders from the volcanic boulderfields will be used to offset and compensate for potential loss of lizard habitat.

5.2.3.4 Invertebrate management

To avoid, minimise and/or mitigate impacts to kauri snails, an Invertebrate Management Plan (IMP) will be implemented, which outlines key methodologies used to salvage and relocate snails.

Kauri snails will be managed through destructive habitat searching prior to vegetation clearance, which involves searching through leaf litter, at the base of trees and underneath coarse woody debris.

5.2.4 Measures to reduce fauna ecological effects summary

The overall level of ecological effects on fauna with and without mitigation measures are outlined in Table 9. If the recommendations outlined in this report are implemented in full, then the overall effects to fauna on site are all considered to be '**Low'** or '**Very low**'. In addition, vegetation offset and compensation planting will provide habitat for most of the fauna being impacted.

More data is required to accurately estimate the potential level of effect on native bats. If bats are found to be using the site for roosting, or there is high bat activity, then further measures may be required to compensate for the loss of habitat within the site. The extent of this will not be known until bat monitoring is undertaken and data analysis completed. More data is also required in order to determine offsetting requirements for indigenous vegetation and North Island brown kiwi.

Table 9: Ecological effects on fauna without mitigation compared to the overall ecological effect if mitigation implemented in full. Bolded overall ecological effects have changed as a result of recommended mitigation measures.

Species	Overall level of effect without recommended management	Overall level of effect with recommended management	Notes
Long-tailed and northern lesser short-tailed bat	Very high	**Low**	The BMP will include vegetation removal protocols (including seasonal clearance constraints) which will avoid impacts to potentially roosting bats. The results of acoustic monitoring will also guide appropriate measures to address the loss of potential roost, foraging and commuting habitat if required.
Kukupa, miromiro	High	**Low**	Offset and compensation plantings will provide additional habitat. AMP will involve seasonal clearance constraints and bird nest checks, further reducing the magnitude of effect by avoiding disturbance and mortality impacts to nesting birds, chicks and eggs.
Tūī	Moderate	**Low**	
Other Not Threatened avifauna	Very low	**Very low**	
North Island brown kiwi	Very high	**Low**	AMP will detail kiwi monitoring and management protocols. Kiwi monitoring will determine possible kiwi presence after which appropriate management can be applied.
New Zealand pipit	High	**Low**	Seasonal clearance constraints and bird nest checks as outlined in AMP.
Herpetofauna	High	**Low**	LMP includes seasonal vegetation clearance and salvaging protocols. Salvaging protocols will include construction-assisted habitat searches and gecko spotlighting.
Forest gecko, elegant gecko Northland green gecko and ornate skink	High	**Low**	Lizard salvaging and relocation as detailed in the LMP.
Pacific gecko	Moderate	**Low**	
Copper skink	Low	**Very low**	
Kauri snail	High	**Low**	Implementation of the IMP which includes snail searching and salvaging prior to vegetation clearance.

6. Recommendations to manage effects

This assessment of ecological effects has been undertaken in the absence of a detailed construction methodology or final design details for the Water Storage Reservoir. Therefore, a variety of assumptions have been made when determining the magnitude of impact and the measures required to adequately address these effects. The actual and potential adverse effects resulting from the proposed water supply reservoir construction and operation range across freshwater and terrestrial habitats. These include:

- Sedimentation effects from construction activities;
- Injury or mortality to aquatic fauna;
- Impediments to fish passage;
- Permanent modification and loss of stream habitat;
- Impacts on water quality and habitat downstream of the proposed dam;
- Removal of threatened ecosystem types; and
- Direct and indirect effects on native terrestrial fauna.

The following recommendations are required to provide a minimum standard to address ecological effects, which are summarised in Table 10. Further measures may also be required, or a different level of detail required, to actually manage effects.

- Require a construction methodology to be developed for in-stream works that is consistent with GD05 and specifically works to minimise potential effects of deposited sediment on the hard bottom stream system.
- Develop and implement a Freshwater Fauna Salvage and Relocation Plan (FFRP) for all parts of the site where works will occur in-stream or aquatic habitat will be inundated.
- Provide for upstream and downstream passage for longfin eels in the design, construction, and operation of the reservoir.
- Consider the sediment management in the design and operation of the reservoir to minimise downstream effects and long-term storage loss.
- Undertake SEV at representative streams on site to confirm and update estimated current SEV scores (SEVi-C).
- Identify and confirm stream enhancement areas to update hypothetical SEV scores (SEVm-C and SEVm-P) and estimated ECR calculations to determine the required quantum of stream bed habitat enhancement to achieve no net of ecological function and to be detailed through a comprehensive Offset and Compensation Plan.
- Complete an environmental flows assessment to identify and manage potential effects caused by flow modification associated with the reservoir.
- Conduct RECCE plot surveys in each ecosystem type to inform Biodiversity Offsetting Accounting Models to determine offsetting quantities required to achieve Net Gain biodiversity outcomes.
- Undertake acoustic survey for native bats during warmer months (October – April inclusive). This will provide further detail on the likelihood of bats utilising the site, determine the need for further survey and inform appropriate measures to address residual effects, if required.
- Undertake monitoring of North Island brown kiwi to determine their possible use of the habitats on site.
- Exploration of suitable offset sites near to the proposed reservoir.
- Prepare and implement the following plans to manage ecological effects on site:
    - Freshwater Fauna Salvage and Relocation Plan
    - Offset and Compensation Plan to address on both freshwater and terrestrial residual effects

- Bat Management Plan
- Avifauna Management Plan
- Lizard Management Plan
- Invertebrate Management Plan

Given the size of the proposed reservoir, high value terrestrial ecosystems have largely been avoided, with the footprint encroaching only on the edges of pūriri forest habitats, and affecting a relatively small extent of secondary broadleaf forest and swamp forest.

If the above management recommendations are implemented in full, and subject to further site visits to confirm potential offset and compensation input data and areas, it is considered that effects to terrestrial and wetland ecosystems can be mitigated, offset and compensated for sufficiently, primarily through revegetation planting and fauna management plans. Similarly, effects on freshwater ecosystems and fauna can be mitigated through implementation of management plans and residual adverse effects addressed through offset or compensation measures on similar habitats in the wider catchment.

Table 10: Summary of ecological values, magnitude of effects (before and after mitigation) and overall level of effect associated with each activity.

Activity	Ecological values	Magnitude of effect (prior to management measures)	Magnitude of effects (after management measures)	Overall level of effect (if management measures implemented in full)
Sedimentation effects from construction activities	High	High	Low	Low
Injury or mortality to aquatic fauna	High	High	Low	Low
Impediments to fish passage	High	Moderate	Low	Low
Permanent modification and loss of stream habitat	High	Very High	Very High	Very High (can be offset)
Impacts on water quality and habitat downstream of the proposed dam	High	Moderate	Low	Low
Removal of threatened trees and vegetation (refer section 5.2.1 for detail)	Low to Very High	Low to High	Low to Very High	Low to Very High (can be offset and compensated)
Direct and indirect effects on native terrestrial fauna	As described in Table 9			

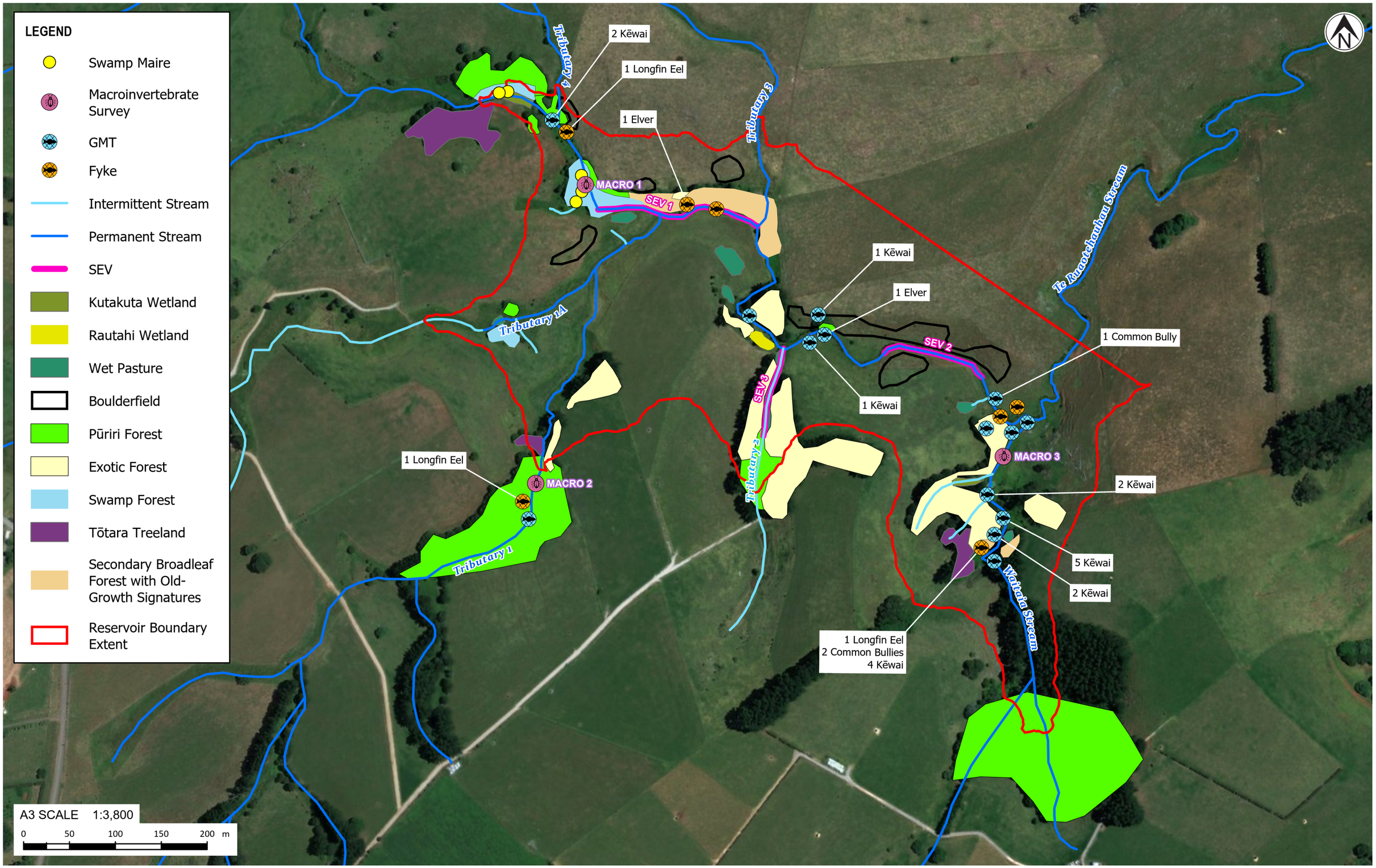
7. Report applicability

This report has been prepared for WWLA with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than WWLA, without our prior written agreement. We understand and agree that this report will be submitted as part of an application for resource consent and that Northland Regional Council and the Far North District Council as the consenting authorities will use this report for the purpose of assessing that application.

8. Appendices

Appendix A Ecological values and sampling locations across MN06

T:\Auckland\Projects\1012828\1012828.1000\WorkingMaterial\03 - GIS\MapSpace\1012828 MN06.aprx Layout: FIG1_TerrestrialFreshwaterEcologicalFeatures 2020-Aug-27 3:06 PM Drawn by JORB



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NOTES:

Basemap NZ Topographic Map: Eagle Technology, LINZ, StatsNZ, NIWA, Natural Earth, © OpenStreetMap contributors.. World Imagery: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

REV	DESCRIPTION	GIS	CHK	DATE
0	First version	SHEG	JORB	06/08/20

LOCATION PLAN

PROJECT No.	1012828.1000	
DESIGNED	SHEG	AUG.20
DRAWN	SHEG	AUG.20
CHECKED	JORB	AUG.20
APPROVED		DATE

CLIENT **PUHOI STOUR LIMITED**

PROJECT **MN06 ECO O+C**

TITLE TERRESTRIAL AND FRESHWATER ECOLOGICAL FEATURES

SCALE (A3) 1:3,800 FIG No. FIGURE 1. REV 0

Appendix B EIANZ ecological impact assessment guidelines

Factors to consider in scoring sites freshwater values in relation to species representativeness, rarity, diversity and pattern, and ecological context (adapted from EIANZ, 2018).

Value	Explanation	Characteristics
Very high	A reference quality watercourse in condition close to its pre-human condition with the expected assemblages of flora and fauna and no contributions of contaminants from human induced activities including agriculture. Negligible degradation e.g., stream within a native forest catchment.	Benthic invertebrate community typically has high diversity, species richness and abundance. Benthic invertebrate community contains many taxa that are sensitive to organic enrichment and settled sediments. Benthic community typically with no single dominant species or group of species. MCI scores typically 120 or greater. EPT richness and proportion of overall benthic invertebrate community typically high. SEV scores high, typically >0.8. Fish communities typically diverse and abundant. Riparian vegetation typically with a well-established closed canopy. Stream channel and morphology natural. Stream banks natural typically with limited erosion. Habitat natural and unmodified.
High	A watercourse with high ecological or conservation value but which has been modified through loss of riparian vegetation, fish barriers, and stock access or similar, to the extent it is no longer reference quality. Slight to moderate degradation e.g., exotic forest or mixed forest/agriculture catchment.	Benthic invertebrate community typically has high diversity, species richness and abundance. Benthic invertebrate community contains many taxa that are sensitive to organic enrichment and settled sediments. Benthic community typically with no single dominant species or group of species. MCI scores typically 80-100 or greater. EPT richness and proportion of overall benthic invertebrate community typically moderate to high. SEV scores moderate to high, typically 0.6-0.8. Fish communities typically diverse and abundant. Riparian vegetation typically with a well-established closed canopy. No pest or invasive fish (excluding trout and salmon) species present. Stream channel and morphology natural. Stream banks natural typically with limited erosion. Habitat largely unmodified.
Moderate	A watercourse which contains fragments of its former values but has a high proportion of tolerant fauna, obvious water quality issues and/or sedimentation issues. Moderate to high degradation e.g., high-intensity agriculture catchment.	Benthic invertebrate community typically has low diversity, species richness and abundance. Benthic invertebrate community dominated by taxa that are not sensitive to organic enrichment and settled sediments. Benthic community typically with dominant species or group of species. MCI scores typically 40-80. EPT richness and proportion of overall benthic invertebrate community typically low. SEV scores moderate, typically 0.4-0.6. Fish communities typically moderate diversity of only 3-4 species.

		Pest or invasive fish species (excluding trout and salmon) may be present. Stream channel and morphology typically modified (e.g., channelised) Stream banks may be modified or managed and may be highly engineered and/or evidence of significant erosion. Riparian vegetation may have a well-established closed canopy. Habitat modified.
Low	A highly modified watercourse with poor diversity and abundance of aquatic fauna and significant water quality issues. Very high degradation e.g., modified urban stream	Benthic invertebrate community typically has low diversity, species richness and abundance. Benthic invertebrate community dominated by taxa that are not sensitive to organic enrichment and settled sediments. Benthic community typically with dominant species or group of species. MCI scores typically 60 or lower. EPT richness and proportion of overall benthic invertebrate community typically low or zero. SEV scores moderate to high, typically less than 0.4. Fish communities typically low diversity of only 1-2 species. Pest or invasive fish (excluding trout and salmon) species present. Stream channel and morphology typically modified (e.g., channelised). Stream banks often highly modified or managed and maybe highly engineered and/or evidence of significant erosion. Riparian vegetation typically without a well-established closed canopy. Habitat highly modified.

Factors to consider in scoring sites terrestrial values in relation to species representativeness, rarity, diversity and pattern, and ecological context (adapted from EIANZ, 2018).

Value	Species Values	Vegetation/Habitat Values
Very High	Nationally Threatened - Endangered, Critical or Vulnerable.	Supporting more than one national priority type. Nationally Threatened species found or likely to occur there, either permanently or occasionally.
High	Nationally At Risk - Declining,	Supporting one national priority type or naturally uncommon ecosystem and/or a designated significant ecological area in a regional or district Plan. At Risk - Declining species found or likely to occur there, either permanently or occasionally.
Moderate-high	Nationally At Risk - Recovering, Relict or Naturally Uncommon.	A site that meets ecological significance criteria as set out the relevant regional or district policies and plans.
Moderate	Not Nationally Threatened or At Risk, but locally uncommon or rare	A site that does not meet ecological significance criteria but that contributes to local ecosystem services (e.g. water quality or erosion control).
Low	Not Threatened Nationally, common locally	Nationally or locally common with a low or negligible contribution to local ecosystem services.

Criteria for describing the magnitude of effect (adapted from EIANZ, 2018).

Magnitude	Description
Very High	Total loss of, or very major alteration to, key elements/features/ of the existing baseline[1] conditions, such that the post-development character, composition and/or attributes will be fundamentally changed and may be lost from the site altogether; AND/OR Loss of a very high proportion of the known population or range of the element/feature
High	Major loss or major alteration to key elements/features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed; AND/OR Loss of a high proportion of the known population or range of the element/feature
Moderate-high	Loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed; AND/OR Loss of a moderate proportion of the known population or range of the element/feature
Moderate	Minor shift away from existing baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances or patterns; AND/OR Having a minor effect on the known population or range of the element/feature
Low	Very slight change from the existing baseline condition. Change barely distinguishable, approximating the 'no change' situation; AND/OR Having negligible effect on the known population or range of the element/feature

[1] Baseline conditions are defined as 'the conditions that would pertain in the absence of a proposed action' (Roper-Lindsay et al., 2018).

Timescale for duration of effect (adapted from EIANZ, 2018).

Timescale	Description
Permanent	Effects continuing for an undefined time beyond the span of one human generation (taken as approximately 25 years)
Long-term	Where there is likely to be substantial improvement after a 25 year period (e.g. the replacement of mature trees by young trees that need > 25 years to reach maturity, or restoration of ground after removal of a development) the effect can be termed 'long term'
Temporary[1]	• Long term (15-25 years or longer – see above) • Medium term (5-15 years) • Short term (up to 5 years) • Construction phase (days or months)

[1]Note that in the context of some planning documents, 'temporary' can have a defined timeframe.

Criteria for describing overall levels of ecological effects (adapted from EIANZ, 2018).

	Ecological value				
Magnitude	**Very high**	**High**	**Moderate**	**Low**	**Negligible**
Very high	Very high	Very high	High	Moderate	Low
High	Very high	Very high	Moderate	Low	Very low
Moderate	High	High	Moderate	Low	Very low
Low	Moderate	Low	Low	Very low	Very low
Negligible	Low	Very low	Very low	Very low	Very low
Positive	Net gain	Net gain	Net gain	Net gain	Net gain

Interpretation of assessed ecological effects against standard RMA terms (adapted from EIANZ, 2018).

Level of ecological effect	RMA interpretation	Description
Very high	Unacceptable adverse effects	Extensive adverse effects that cannot be avoided, remedied or mitigated.
High	Significant adverse effects that could be remedied or mitigated	Adverse effects that are noticeable and will have a serious adverse impact on the environment but could potentially be mitigated or remedied.
Moderate	More than minor adverse effects	Adverse effects that are noticeable and may cause an adverse impact on the environment, but could be potentially mitigated or remedied.
Low	Minor adverse effects	Adverse effects that are noticeable but that will not cause any significant adverse impacts.
Very low	Less than minor adverse effects	Adverse effects that are discernible from day to day effects but which are too small to adversely affect the environment.
Nil	Nil effects	No effects at all.

Appendix C Photographs of streams for SEV score estimations

SEV 1 (Te Ruaotehauhau Stream under riparian canopy – permanent stream)

SEV 2 (Te Ruaotehauhau Stream without riparian margins – permanent stream)

SEV 3 (Tributary 2 – intermittent stream)

Appendix D Macroinvertebrate sample results

		Te Ruaotehauhau stream	Tributary 1	Waitaia stream
Mayfly	Atalophlebioides		9	
Mayfly	Austroclima		1	5
Mayfly	Coloburiscus	2	59	1
Mayfly	Deleatidium		1	1
Mayfly	Neozephlebia	24	14	1
Mayfly	Zephlebia	24	72	2
Stonefly	Acroperla		5	1
Caddisfly	Hydrobiosella	20		
Caddisfly	Hydrobiosis		1	
Caddisfly	Oeconesidae			2
Caddisfly	Orthopsyche	1	2	
Caddisfly	Plectrocnemia		1	1
Caddisfly	Polyplectropus	4		1
Caddisfly	Psilochorema		4	
Caddisfly	Pycnocentria	1		
Dobsonfly	Archichauliodes		3	1
Beetle	Hydrophilidae	1		1
Beetle	Ptilodactylidae	1	2	
Beetle	Scirtidae	1		
True fly	Austrosimulium	15	2	1
True fly	Dolichopididae		1	
True fly	Hexatomini	3	2	
True fly	Orthocladiinae	2	1	
True fly	Polypedilum	4	1	
True fly	Psychodidae	1	1	
True fly	Syrphidae	1		
True fly	Tanypodinae	5	1	3
True fly	Tanytarsini	1		
Collembola		4	5	7
Crustacea	Isopoda	2	5	4
Crustacea	Ostracoda	2		
Crustacea	Paraleptamphopus	46		1
Crustacea	Paranephrops	1		
Crustacea	Talitridae	1	1	2
Water mite		4	1	1
Spider	Dolomedes	1	2	2
Mollusc	Latia			1
Mollusc	Potamopyrgus	3		73
OLIGOCHAETES		5	3	5
LEECHES				2
NEMERTEANS		2		2

Appendix E SEV modelling assumptions

Function Category	Variable	ID: SEV2 Stream ID: Te Ruaotehauhau stream (without riparian margin - permanent) SEV: SEVm-P Offset: max 20 m riparian margin enhancement on both banks	ID: SEV3 Stream ID: Tributary 2 (intermittent) SEV: SEVm-P Offset: max 20 m riparian margin enhancement on both banks
Hydraulic	Vchann	Assumes no change to stream channel – no instream enhancement.	Assumes improvements to channel from reduction of excessive roughness elements.
	Vlining	Assumes slight reduction in fine silt from riparian margin.	Assumes reduction in fine silt from riparian margin.
	Vpipe	Assumes no pipe.	Assumes one pipe.
	Vbank	Assumes no change to current bank conditions.	Assumes no change to current bank conditions.
	Vrough	Assumes dominated by native regenerating vegetation in late stage of succession, some low diversity regenerating and stock exclusion and remnant mature exotic trees (to 20 m on each bank).	Assumes dominated by native regenerating vegetation in late stage of succession, some low diversity regenerating and stock exclusion and remnant mature exotic trees (to 20 m on each bank).
	Vbarr	Assumes no change to current with no physical barriers.	Assumes no change to current with no physical barriers.
	Vchanshape	Autopopulated.	Autopopulated.
Biogeochemical	Vshade	Assumes very high, high, and moderate shading from 20 m riparian margin enhancement along entire length.	Assumes very high, high, and moderate shading from 20 m riparian margin enhancement along entire length.
	Vdod	Assumes no change to current optimal.	Assumes no change to current sub-optimal.
	Vveloc	Assumes no change to estimated fast flow observed during site.	Assumes no change to estimated gentle flow observed during site.
	Vdepth	Assumes no change to estimated depth observed during site.	Assumes no change to estimated depth observed during site.
	Vripar	Assumes a full 20 m riparian margin.	Assumes a full 20 m riparian margin.
	Vdecid	Assumes no change from no deciduous (no deciduous observed on site).	Assumes no change from no deciduous (no deciduous observed on site).
	Vmacro	Assumes no change to no macrophytes observed.	Assumes reduction in macrophytes following shading and planting.
	Vretain	Autopopulated.	Autopopulated.
	Vsurf	Assumes slight increase in woody debris.	Assumes slight increase in woody debris and leaf litter input.
	Vripfilt	Assumes slight improvement to filtering following planting.	Assumes slight improvement to filtering following planting.
Habitat Provision	Vgalspwn	Assumes no change to existing gradients.	Assumes no change to existing gradients.
	Vgalqual	Assumes high quality following planting.	Assumes high quality following planting.
	Vgobspawn	Autopopulated.	Autopopulated.

	Vphyshab	Assumes slight increase in aquatic habitat diversity including wood, undercut banks, and rooted aquatic vegetation that are evenly distributed along reach. Assumes no changes to existing hydrological heterogeneity. Assume very high channel shade and vegetation integrity with 20 m planting on both banks.	Assumes slight increase in aquatic habitat diversity including wood, undercut banks, and rooted aquatic vegetation that are evenly distributed along reach. Assumes slight changes to existing hydrological heterogeneity. Assume very high channel shade and vegetation integrity with 20 m planting each bank.
	Vwatqual	No change from minimal due to similar landuse in catchment above site.	No change from minimal due to similar landuse in catchment above site.
	Vimperv	Assumes no change to existing <10% impervious above site.	Assumes no change to existing <10% impervious above site.
Biodiversity	**Vfish**	-	-
	Vmci	-	-
	Vept	-	-
	Vinvert	-	-
	Vripcond	Autopopulated.	Autopopulated.
	Vripconn	Assumes no change to current not impeded connection.	Assumes no change to current not impeded connection.

Appendix F Plant species list

Table 1: Vascular plant species list developed from site walkover. * indicates species was observed outside but close to the Project footpritn

Common name	Species name	Threat classification
Wattle	*Acacia spp.*	Introduced
Hanging spleenwort	*Asplenium flaccidum*	Not Threatened
Shining spleenwort	*Asplenium oblongifolium*	Not Threatened
Tank lily	*Astelia hatatum*	Not Threatened
Perching lily	*Astelia solandri*	Not Threatened
Taraire	*Beilschmieidia tawa*	Not Threatened
Rautahi	*Carex geminata*	Not Threatened
Marbleleaf	*Carpodetus serratus*	Not Threatened
Taro	*Colocasia esculenta*	Introduce/Culturally important
Large-leaved coprosma	*Coprosma grandifolia*	Not Threatened
Karaka	*Corynocarpus laevigatus*	Not Threatened
Silver fern	*Cyathea dealbata*	Not Threatened
Mamaku	*Cyathea medullaris*	Not Threatened
Kahikatea	*Dacrydium dacrydioides*	Not Threatened
German ivy	*Delairea odorata*	Introduced
Whekī	*Dicksonia squarrosa*	Not Threatened
Rasp fern	*Doodia australis*	Not Threatened
Kohekohe	*Dysoxylum spectabile*	Not Threatened
Parataniwha	*Elatostema rugosum*	Not Threatened
Kutakuta	*Eleocharis sphacelata*	Not Threatened
Eucalyptus	*Eucalyptus spp.*	Not Threatened
Kōtukutuku	*Fuchsia excortica*	Not Threatened
Wild ginger	*Hedychium gardnerianum*	Not Threatened
Pigeonwood	*Hedycarya arborea*	Not Threatened
Thread fern	*Icaris filiformis*	Not Threatened
Soft rush	*Juncus effusus*	Not Threatened
Rewarewa	*Knighta excelsa*	Not Threatened
Kānuka	*Kunzea robusta*	Threatened - Nationally Vulnerable
Mānuka	*Leptospermum scoparium*	At Risk - Declining
Ox-eye daisy	*Leucantheum vulgare*	Introduced
Mahoe	*Melicytus ramiflorus*	Not Threatened
White rātā	*Metrosideros diffusa*	Threatened - Nationally Vulnerable
Akatea	*Metrosideros perforata*	Threatened - Nationally Vulnerable
Large-leaved pohuehue	*Muehlenbeckia australis*	Not Threatened
Mapou	*Myrsine australis*	Not Threatened
Basket grass	*Oplismenus hertillus subsp. Imbicillus*	Not Threatened
Ring fern	*Paesia scaberula*	Not Threatened
Kiokio	*Parablechnum novaezelandiae*	Not Threatened

Swamp kiokio	*Parablechnum minus*	Not Threatened
Smooth shield fern	*Parapolystichum glabellum*	Not Threatened
NZ passionfruit	*Passiflora tetrandra*	Not Threatened
New Zealand flax	*Phormium tenax*	Not Threatened
Pine	*Pinus radiata*	Introduced
Kawakawa	*Piper excelsum*	Not Threatened
Tawhirikaro*	*Pittosporum cornifolium**	Not Threatened*
Gully fern	*Pneumatopteris pennigera*	Not Threatened
Tōtara	*Podocarpus totara*	Not Threatened
Nīkau	*Rhopalostylis sapida*	Not Threatened
Supplejack	*Ripogonum scandens*	Not Threatened
Pate	*Schefflera digitata*	Not Threatened
Redwood	*Sequoia sempervirens*	Introduced
Woolly nightshade	*Solanum mauritianum*	Introduced
Swamp maire	*Syzigium maire*	Threatened - Nationally Critical
Tradescantia	*Tradescantia flumenensis*	Introduced
Purīrī	*Vitex lucens*	Not Threatened
Towai	*Weinmannia sylvicola*	Not Threatened

Appendix G Site visit photographs

Photograph 1: Tōtara treeland

Photograph 2: Secondary broadleaf forest with old-growth signatures

Photograph 3: Taraire and pūriri amongst pine forest on Trib 2

Photograph 4: Tank lily within swamp forest

Photograph 5: Pūriri forest remnants

Photograph 6: Volcanic boulderfield next to secondary broadleaf forest with occasional exotic redwood

 Photograph 7: Row of mature pine trees	 Photograph 8: Small kutakuta wetland surrounded by exotic forest