ASSESSMENT OF ECOLOGICAL EFFECTS OF QUARRY EXPANSION AT LINTON QUARRY, PALMERSTON NORTH

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ASSESSMENT OF ECOLOGICAL EFFECTS OF QUARRY EXPANSION AT LINTON QUARRY, PALMERSTON NORTH

A view of the of the indigenous forest remnant and the nīkau treeland taken from the southeast edge of the quarry pit.

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1. INTRODUCTION

Hirock Limited (Hirock) commissioned Wildland Consultants to prepare an ecological assessment of the impacts of a proposed expansion of quarrying activity (Goodearthmatters 2022) on indigenous biodiversity at the Linton Quarry, Palmerston North. The habitats most likely to be affected by this expansion include a nīkau palm (*Rhopalostylis sapida*) grove, a larger indigenous forest remnant that directly borders the quarry, wetland habitats and freshwater watercourses (Figure 1). Slip remediation and earthworks that were recently undertaken near both indigenous vegetation remnants have caused a major disturbance to their immediate surrounds (including soil hydrology), which may affect the long-term viability of the two areas of indigenous vegetation.

The nīkau palm grove is of particular interest to local iwi, Rangitāne o Manawatu, who have also expressed concern for the long-term viability of the indigenous forest. Accordingly, in their application to PNCC for Resource Consentin early 2021 () on behalf of Hirock, Good Earth Matters (GEM) state that the area of nīkau palms and indigenous forest along the southern and eastern edges of the proposed quarry will continue to be retained and protected, as required by the existing consent. However, this original consent application was altered by Hirock in late 2021, and they are now seeking consent to expand their quarrying operation to include the area occupied by the nīkau palm grove.

This report provides an assessment of the ecological effects of the proposed expansion of quarrying activity, and includes:

- Maps and descriptions of the vegetation and habitat types present.
- An assessment of the ecological values and ecological significance of the vegetation and habitat types.
- Descriptions of the magnitude and level of potential ecological effects resulting from recent and proposed earthworks.
- Opportunities to avoid, minimise, or mitigate potential adverse ecological effects.

2. METHODS

2.1 Vegetation and habitat survey

The site was surveyed on 14 October 2021 and all forest vegetation and associated habitat types were mapped and described following the structural classes in Atkinson (1985). The site was visited again on 12–13 September 2022. On 12 September a *Powelliphanta* snail survey was undertaken (Wildlands 2022) and on 13 September all wetland and riparian vegetation and associated habitat types were mapped and described. During the site visits, the current ecological values of the vegetation and habitat types were assessed. All vascular plant species observed were recorded and are presented in Appendix 1. Vegetation and habitat types were digitised onto aerial imagery using ArcGis10.8.

The current ecological values of these vegetation and habitat types were assessed using the EIANZ guidelines (Roper-Lindsay 2018) and against the significance criteria for indigenous biodiversity in Schedule F of the Horizons One Plan (Horizons 2016).

2.2 Fauna survey

Targeted intensive fauna surveys for most indigenous taxa were beyond the scope of this report, but the suitability of the vegetation at the site to provide habitat for key indigenous fauna species was assessed, and all fauna species observed at the site were recorded. Fauna species for which habitat values were specifically considered include:

- Long-tailed bat (*Chalinolobus tuberculatus*, Threatened – Nationally Critical).
- Kākāriki (red-crowned parakeet, *Cyanoramphus novaezelandiae,* At Risk – Relict).
- New Zealand bush falcon (*Falco novaeseelandiae ferox*, At Risk – Recovering).
- Pīhoihoi (New Zealand pipit, *Anthus novaeseelandiae novaeseelandiae,* At Risk – Declining).
- North Island kākā (*Nestor meridionalis,* At Risk – Recovering).
- Barking gecko (*Naultinus punctatus*, At Risk – Declining).
- Brown skink (*Oligosoma zelandicum*, At Risk – Declining).
- Copper skink (*O. aeneum*, At Risk – Declining).
- Ngahere gecko (*Mokopirirakau* "southern North Island", At Risk – Declining).
- Northern grass skink (*O. polychroma*, Not Threatened).
- Ornate skink (*O. ornatum*, At Risk – Declining).
- Raukawa gecko (*Woodworthia maculata*, Not Threatened).

Following on from recommendations stated in our initial ecological assessment (submitted to Hirock on 9 December 2022), a survey was undertaken on 12 September 2022 for *Powelliphanta traversi* (Threatened – Nationally Endangered) land snails in the indigenous forest on the property (Vegetation Type 1, Figure 2).

2.3 Evaluation of ecological effects

The Environment Institute of Australia and New Zealand (EIANZ) guidelines for undertaking assessments of ecological effects in New Zealand (Roper-Lindsay *et al*. 2018) were referred to in preparing this report. The ecological values of the indigenous vegetation, and the magnitude and level of the potential adverse ecological effects associated with recent and proposed earthworks, have been assessed using the methods described in the EIANZ guidelines (Roper-Lindsay et. al 2018). However, over and above these guidelines professional opinion and expertise have been applied throughout the assessment to ensure that the results are ecologically robust. Where applicable, effects have also been assessed against relevant statutory criteria.

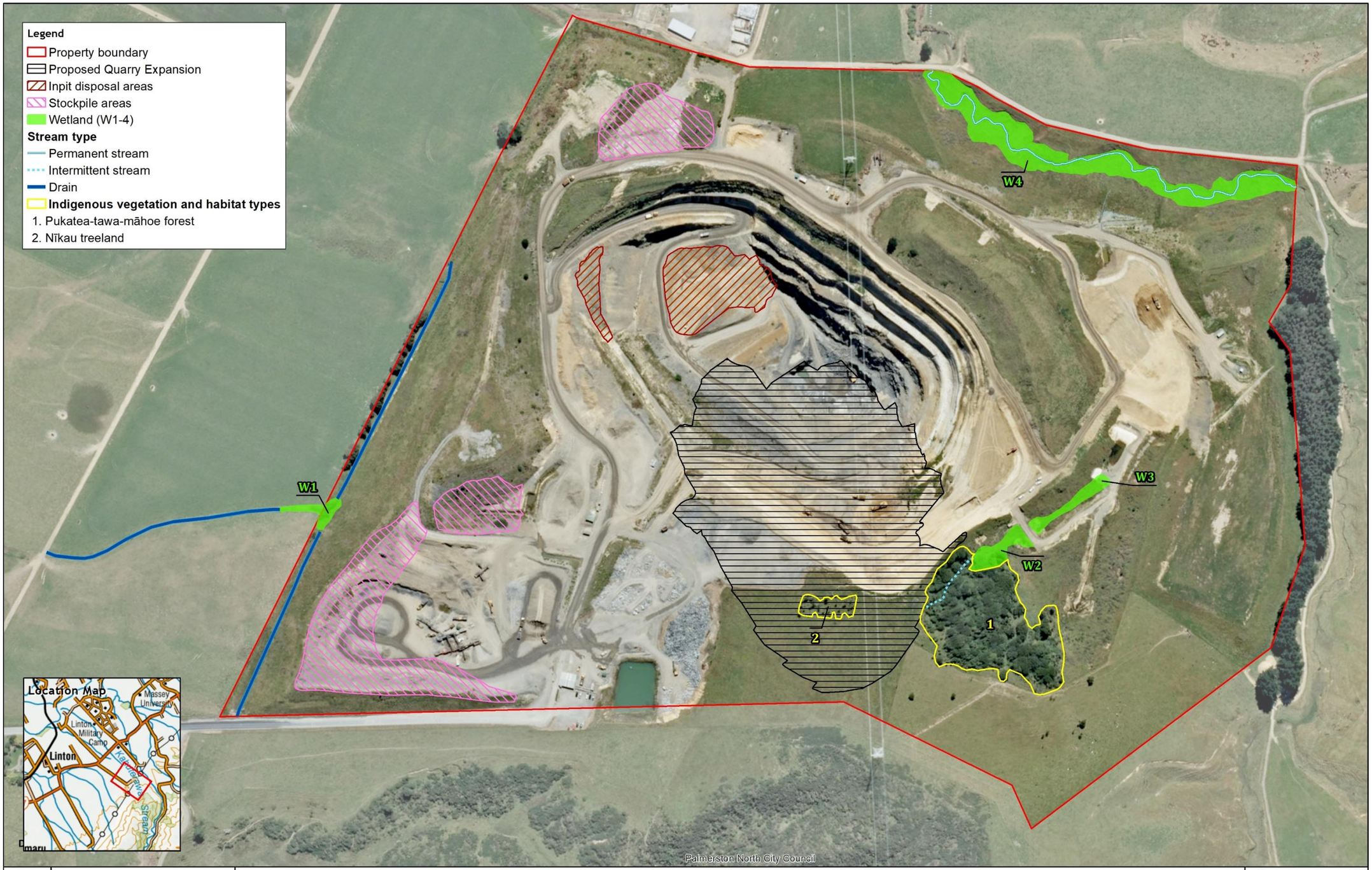

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Figure 1. Proposed quarry expansion design and disposal sites, Linton Quarry, Palmerston North

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3. ECOLOGICAL CONTEXT

3.1 Overview

Hirock Linton Quarry is located within the Manawatū Plains Ecological District in the Manawatū Region. The Manawatū Plains Ecological District is characterised by low altitude, predominantly undissected, loess covered plains and terraces of Holocene alluvium. The ecological district has warm summers and mild winters, with prevailing west to northwest winds and a reliable and evenly distributed rainfall of between 800-1,200 millimetres per annum (McEwen 1987).

Vegetation within this ecological district formerly included semi-swamp forests dominated by kahikatea (*Dacrycarpus dacrydioides*) and pukatea (*Laurelia novae-zelandiae*) on low-lying land near rivers, with tōtara (*Podocarpus totara* var. *totara*) forest on free-draining soils and low-rainfall areas. Mixed podocarp forest that contained rimu (*Dacrydium cupressinum*), mataī (*Prumnopitys taxifolia*), tōtara, and kahikatea occurred on parts of the plains and terraces east of the Manawatū River, black beech (*Fuscospora solandri*) forest was present at Aokautere, and a large area of harakeke (*Phormium tenax*) swamp surrounded the lower Manawatū. Currently, small, isolated areas of flax swamp and forest remain, including locally characteristic tōtara forest, and some black beech forest. However, this ecological district is now largely cleared for farms and, increasingly, for areas of orchards and market gardens (McEwen 1987). Nīkau palm likely occurred throughout coastal to lowland forest in this ecological district prior to human settlement.

3.2 Site description

The quarry is located on land zoned as Rural and is administered by the Palmerston North City Council (PNCC). The property is located in the catchment of the Manawatū River and the foothills of the northern end of the Tararua Range, approximately 11 kilometres south of Palmerston North City. The site's legal description is Lot 1 DP 410502, and it is approximately 44 hectares in size. The quarry property is located at the end of Kendalls Line and occupies undulating land that is primarily farmed. Buildings and plant machinery associated with the mining operation surround the edges of the quarry and property.

The quarry operation currently covers 24.2 hectares, with the remainder of the site comprising pasture and two remnants of indigenous vegetation. The largest area of indigenous vegetation is located directly to the south of the existing quarry pit (Plate 1), and has been fenced to exclude livestock, although the fence appears to have been recently damaged. Some pest animal trapping is undertaken within the quarry. There is also a stand of nīkau next to the southwestern edge of the quarry (Plate 2). The nīkau stand is likely to have undergone significant decline in the last hundred years or so. The decline is likely to have begun with the clearance of forest that originally surrounded the nīkau, possibly as farming practice expanded in the area. However, deterioration is likely to have accelerated recently, as evidenced by presence of recently dead (standing and fallen) nīkau stems in the grove (Plate 3).

Plate 1: Recently excavated area on the northwest edge of the indigenous forest remnant. 14 October 2021

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Plate 2: Nīkau grove bordered by recent earthworks. 14 October 2021.

Plate 3: A close-up view of the stand of nīkau. 14 October 2021.

3.3 Threatened environment classification

The Threatened Environment Classification (TEC) is a combination of three national databases: Land Environments New Zealand (LENZ), Land Cover Database (LCDB4), and the protected areas network. It shows how much indigenous vegetation remains within land environments, and how past vegetation loss and legal protection are distributed across New Zealand's landscape. The TEC is most appropriately applied to help identify places that are priorities for formal protection against clearance and/or incompatible land-uses, and for ecological restoration to restore lost species, linkages and buffers (Cieraad *et al*. 2015).

The entire Hirock Linton Quarry occurs within a land environment that has <10% indigenous vegetation remaining (Category 1). Land in Category 1 is a threatened environment.

4. RELEVANT LEGISLATION

4.1 Horizons One Plan

The Quarry is within the Manawatū-Wanganui Region and is subject to provisions in the Horizons One Plan (the region's resource management planning document, Horizons 2018).

4.1.1 Terrestrial vegetation

The Quarry is within the Manawatū-Wanganui Region and is subject to provisions in the Horizons One Plan (the region's resource management planning document, Horizons 2018).

Objective 6-1 of the Horizons One Plan for Indigenous Biological Diversity is to:

Protect areas of significant indigenous vegetation and significant habitats of indigenous fauna and maintain indigenous biological diversity, including enhancement where appropriate.

Policy 6-2 states:

- *Rare and threatened habitats under Schedule F must be recognised as significant indigenous vegetation or significant habitats of indigenous fauna, and*
- *At risk habitats that are assessed as significant under Policy 13-5 must be recognised as significant indigenous vegetation or significant habitats of indigenous fauna.*

Horizons must therefore protect these habitats by the regulation of activities and through decisions on resource consents.

For the regulation of activities which affect indigenous biological diversity, Policy 6-2 states that biological diversity offsets must be considered where appropriate as defined by Policy 13-4.

Policy 13-4 states that consent decision making for rare, threatened, or at risk habitat that is an area of significant indigenous vegetation or significant fauna habitat must consider:

- *The significance of the area of habitat.*
- *The potential adverse effects of the proposed activity on significance.*

Guidance for offsetting of effects is also provided in Policy 13.4.

Under Policy 13-4, consent must generally not be granted unless:

- *Any more than minor adverse effects on a rare, threatened, or at risk habitat's representativeness, rarity, or distinctiveness are avoided*
- *Where these effects are not avoided, they are remedied or mitigated*
- *Where these effects are not avoided, remedied, or mitigated, they are offset to result in a net biological diversity gain.*

Where an activity is proposed for an At Risk habitat that is not significant indigenous vegetation or significant fauna habitat, consent may be granted if there will be no significant adverse effects on that habitat's representativeness, rarity, distinctiveness or ecological context, or significant adverse effects are avoided, remedied, mitigated, or offset to result in a net indigenous biological diversity gain (Policy 13-4).

Policy 13-5 provides criteria for assessing the significance of habitats. Policy 13-5 refers to the rare, threatened, or At Risk habitats defined in Schedule F of the One Plan and

provides additional criteria that may also trigger a habitat being assessed as significant, including:

- *Representativeness*
- *The presence of threatened species, or species at their distributional limits*
- *Ecological connectivity and/or buffering*
- *Ecological sequences.*

Habitat types in the Manawatū-Wanganui Region are identified and then assigned the following status categories developed by Mayseyk (2007):

- *Rare: habitat types that were originally (pre-human) uncommon in the landscape and remain so*
- *Threatened: habitat types that have been reduced to 20% or less of former extent*
- *At risk: habitat types that have been reduced to 50% or less of former extent*
- *No threat category: Habitat where 50% or greater of former extent remains.*

Schedule F of the Horizons One Plan details indigenous biological diversity types subject to protection within the Plan and identifies habitat types. A resource consent is required if the area is determined to be a habitat type classified as rare, threatened or at risk in Table F.1, it meets any of the criteria in Table F.2(a), and it is not excluded by any of the criteria in Table F.2(b). Table F.2 (a) provides a list of criteria (e.g. size thresholds) that must be met before an area of any habitat type described in Table F.1 can qualify as significant for the purposes of this Plan. Table F.2 (b) provides a list of criteria that, if met, would exclude an area of any habitat type that previously qualified as significant in Table F.1.

4.1.2 Wetlands

The One Plan contains numerous provisions relating to wetlands and also Schedule F relating to indigenous biodiversity, which addresses wetlands. Definitions are provided of wetland types that are classified as 'Rare', 'Threatened', or 'At Risk'.

Table F.2(a)

An area of any habitat type described in Table F.1 must meet at least one of the following criteria that apply to the relevant habitat type before it qualifies as a are habitat, threatened habitat, or At Risk habitat for the purposes of this Plan.

Wetland Habitat Types Classified as Threatened

viii. Areas of naturally occurring indigenous wetland habitat covering at least 0.1 hectare.

Or

ix. Areas of indigenous vegetation that have been established in the course of wetland habitat restoration.

Or

x. Areas of artificially created indigenous wetland habitat covering at least 0.5 hectares.

Or

Naturally Uncommon Habitat Types and Wetland^ Habitat Types Classified as Rare

xi. Habitat type that is classified as Rare that covers at least 0.05 hectares.

Or

xii. Areas of indigenous habitat created at some time in the course of dune habitat restoration (including dune stabilisation).

Table F.2(b)

If an area of any habitat type described in Table F.1 meets any of the following criteria it must not be rare habitat, threatened habitat, or at risk habitat for the purposes of this Plan.

Wetland Habitat Types Classified as Rare or Threatened

iii. Damp gully heads, or paddocks subject to regular ponding, dominated by pasture or exotic species in association with wetland sedge and rush species.

Or

iv. Ditches or drains supporting raupō, flax or other wetland species (e.g. Carex sp., *Isolepis* sp.), or populations of these species in drains or slumps associated with road reserves or rail corridors.

Or

v. Areas of wetland habitat specifically designed, installed and maintained for any of the following purposes:
   (a) stock watering (including stock ponds), or
   (b) water storage for the purposes of fire fighting or irrigation (including old gravel pits), or
   (c) treatment of animal effluent (including pond or barrier ditch systems), or
   (d) wastewater treatment, or
   (e) sediment control, or
   (f) any hydroelectric power generation scheme, or
   (g) water storage for the purposes of public water supplies.

Or

vi. Areas of wetland habitat maintained in relation to the implementation of any resource consent conditions or agreements relating to the operation of any hydroelectric power scheme currently lawfully established.

Or

vii. Open water and associated vegetation created for landscaping purposes or amenity values where the planted vegetation is predominately exotic, or includes assemblages of species not naturally found in association with each other, on the particular landform, or at the geographical location of the created site.

4.2 Stream classification

The RMA (1991) defines a river:

River *- means a continually or intermittently flowing body of fresh water; and includes a stream and modified watercourse; but does not include any artificial watercourse (including an irrigation canal, water supply race, canal for the supply of water for electricity power generation, and farm drainage canal).*

The Horizons One Plan (2017) does not further define different types of watercourses, but other councils use definitions similar to those below (from the Auckland Unitary Plan), so we have classified watercourses following the Auckland Unitary Plan.

Permanent river or stream *- the continually flowing reaches of any river or stream.*

Intermittent stream *- stream reaches that cease to flow for periods of the year because the bed is periodically above the water table. This category is defined by those stream reaches that do not meet the definition of permanent river or stream and meet at least three of the following criteria:*

a) it has natural pools;

b) it has a well-defined channel, such that the bed and banks can be distinguished;

c) it contains surface water more than 48 hours after a rain event which results in stream flow;

d) rooted terrestrial vegetation is not established across the entire cross-sectional width of the channel;

e) organic debris resulting from floods can be seen on the floodplain; or

f) there is evidence of substrate sorting process, including scour and deposition.

Ephemeral stream *- Stream reaches with a bed above the water table at all times, with water only flowing during and shortly after rain events. This category is defined as those stream reaches that do not meet the definition of permanent river or stream or intermittent stream.*

The assessment was carried out against the intermittent stream criteria as these are clearly defined and, unlike the permanent stream classification, do not require the stream to be flowing year-round to be applicable. Under the AUP, the classification of a stream as intermittent affords it the same level of protection as a permanent (perennial) stream.

4.3 Wildlife Act 1953

Irrespective of the level of effects on indigenous fauna described above, all indigenous macrofauna (i.e. lizards, birds and bats) and some indigenous invertebrates are protected under the Wildlife Act (1953). A permit under the Wildlife Act must be obtained from the Department of Conservation before any indigenous lizards, bats, birds and/or snails (and/or their habitats) can be disturbed, handled, translocated or killed.

Whilst the Wildlife Act provides for the protection of indigenous fauna, the Resource Management Act (1991) provides for the protection of habitats (Section 6(c)). However, once a species is confirmed as utilising a specific habitat, that habitat also becomes protected under the Wildlife Act by default, as it is impossible to disrupt the habitat without disturbing the species. A Wildlife Act Authority (WAA) must be applied for and approved by the Department of Conservation before activities affecting fauna can commence. This will require the submission of a species-specific management plan along with the WAA application form.

5. VEGETATION AND HABITATS

5.1 Overview

Forty-five indigenous and 30 exotic plant species were recorded during the surveys (Appendix 1), including species found naturally within the indigenous remnants and associated with freshwater and wetland habitats, plus species planted specifically for shelterbelts and riparian management. The terrestrial habitats, the wetlands and the aquatic habitats are described below, with their locations shown in Figures 2 and 3.

5.2 Terrestrial habitats

1. Pukatea-tawa-māhoe-(tītoki)-(nīkau) forest (1.0 hectares)

The largest forest remnant on the property abuts the southern boundary of the quarry pit and is characterised by mature (*c.*10-12 metres tall) pukatea and tawa (*Beilschmiedia tawa*), with māhoe (*Melicytus ramiflorus* subsp. *ramiflorus*, *c.*8-10 metres tall) also present in the canopy (Vegetation Type 1, Figure 2; Plates 1 and 4). These canopy trees are likely to be over 100 years old with the diameter at breast height of one māhoe measuring 1.2 metres and the largest pukatea measuring 1.4 metres diameter. Tītoki (*Alectryon excelsus* subsp. *excelsus*) and nīkau are also scattered throughout the canopy. A small number of kahikatea are also present in this tier.

The understorey contains kaikōmako (*Pennantia corymbosa*), kawakawa (*Piper excelsum* subsp. *excelsum*), patē (*Schefflera digitata*), hangehange (*Geniostoma ligustrifolium* var. *ligustrifolium*) and supplejack (*Ripogonum scandens*), all of which are common, as well as scattered tūrepo (*Streblus heterophyllus*), ponga (*Cyathea dealbata*), and elder (*Sambucus nigra*). Seedlings and saplings of northern rātā (*Metrosideros robusta*), and porokaiwhiri (pigeonwood, *Hedycarya arborea*) are also present in the understorey. Epiphytes and lianes present include: puawānanga (*Clematis paniculata*), aka (*Metrosideros perforata*), puka (*Muehlenbeckia australis*), akakaikiore (*Parsonsia heterophylla*), kohia (*Passiflora tetrandra*), makawe (*Asplenium flaccidum*), and leather-leaf fern (*Pyrrosia elaeagnifolia*). *Coprosma* species (*C. areolata* and *C. rhamnoides*) and gorse (*Ulex europaeus*) are common around the edges of the forest.

The ground cover mostly comprises ferns including: *Lastreopsis glabella*, kōwaowao (*Microsorum novae-zelandiae*), kiokio (*Blechnum novae-zelandiae*), rereti (*Blechnum chambersii*), and huruhuru whenua (*Asplenium oblongifolium*) with sparse patches of the indigenous grass *Oplismenus hirtellus* subsp. *imbecillis* near the edges of the forest.

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Figure 2. Vegetation and habitat types at Linton Quarry, Palmerston North

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Scale:	1:180,000
Date:	17/11/2022
Cartographer:	FM
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Plate 4: View of a kererū (indicated by arrow) in the mature pukatea and tawa canopy of the patch of indigenous forest. 14 October 2021.

2. Nīkau-kaikōmako-tawa treeland (0.08 hectares)

A stand of 23 mature nīkau is located on the southwest edge of the quarry pit. The nīkau are interspersed with younger individuals of kaikōmako (ten in total), five tawa, and one kahikatea (Vegetation Type 2, Figure 2; Plates 2 and 3). The nīkau are likely of a similar age to the canopy trees in the larger forest remnant. There are also five dead (standing or fallen) specimens of nīkau in this treeland. The ground beneath this treeland is dominated by rank exotic grasses.

3. Exotic shelterbelt

A shelterbelt of exotic trees (*Eucalyptus* sp.) is present along the west boundary of the site. A lone macrocarpa (*Cupressus macrocarpa*) is also present to the north of this shelterbelt.

4. Pasture

Exotic grassland covers most of the property outside the quarry footprint, most of which is actively grazed with cattle and sheep (Plate 8). Species present include cocksfoot (*Dactylis glomerata*), pink ragwort (*Senecio glastifolius*), and foxglove (*Digitalis purpurea*).

5.3 Wetland habitats

5.3.1 Overview

Four areas of wetland have been identified on the quarry property: two associated with distinct watercourses, as defined in the RMA (1991). A stream and a drain run along the edges of the property and are highly modified or connected to constructed watercourses, and the wetlands are relatively small, and are mostly dominated by exotic species.

All wetland features on the property are heavily modified, but appear to generally be in places where water flow or pooling has occurred.

5.3.2 Wetlands

The four wetlands mapped in Figures 1 and 2 are described below.

Wetland 1: Raupō reedland (*c.* 0.03 ha)

This is a small area of wetland on the northern boundary of the property. It is almost completely dominated by raupō (*Typha orientalis*). Further species were not recorded for this area. This raupō reedland continues downstream from this raupō wetland, to the west and beyond the boundary of the property, eventually draining into an area of wet pasture.

The raupō reedland in this area, plus the wet pasture further downstream appear to have formed at the confluence of a constructed drain (W1, Figure 1). Although these potential wetlands have not been formally delineated, the presence of raupō reedland and other wetland vegetation indicates that it is likely to qualify as an induced wetland according to the RMA (1991) and the NPS-FM (2020).

Wetland 2: Floating sweetgrass-Yorkshire fog-buttercup-(cocksfoot) grassland (*c.* 0.09 ha)

This wetland comprises the area between the road culvert and the forest and is dominated by exotic grasses such as floating sweetgrass (*Glyceria fluitans*) and Yorkshire fog (*Holcus lanatus*) and exotic and indigenous forbs, including buttercups (*Ranunculus acris, R. repens*), lotus (*Lotus pedunculatus*), and clovers (*Trifolium* pratense, *T. repens*). Rushes (*Juncus australis, J. bulbosus, J. edgariae, J. effusus*) and sedges (*Isolepis prolifera*) are scattered through the wetland. The upper edge adjoins the forest and is overhung by kahikatea (*Dacrycarpus dacrydioides*), tītoki (*Alectryon excelsa*) and pukatea (*Laurelia novaezelandiae*) and the more open non-wetland edges have a scattering of mānuka (*Leptospermum scoparium*) and mingimingi (*Coprosma propinqua* var. *propinqua*) (W2, Figure 1; Plates 5 and 6).

Although this wetland appears to have formed as a result of recent earthworks to construct a nearby vehicle track (that has effectively impeded the downstream flow of water from the ephemeral stream), it qualifies as is a natural ('induced') wetland in terms of the RMA (1991) and NPS-FM (2020).

Plate 5: The trunks of mature pukatea that are growing on the edge of Wetland 2. 14 October 2021.

Plate 6: A section of the wet exotic grassland (Wetland 2) on the northeastern edge of the indigenous forest remnant (Vegetation Type 1). 14 October 2021.

Wetland 3: Yorkshire fog-floating sweetgrass-soft rush grassland (Area 3; *c.* 0.06 hectares)

This is the area below the road culvert, above the settling pond, and is highly degraded. Recent modifications include road maintenance near the edge of the wetland, modifying the vegetation and hydrology, and many plants in the area are dead or dying (W3, Figure 1). The remaining vegetation is dominated by the exotic grasses Yorkshire fog and floating sweetgrass, with patches of soft rush. The edge of the wetland is defined by gorse (*Ulex europeaus*) and increased cover of more dryland grass species such as kikuyu (*Cenchrus clandestinus*) and red fescue (*Festuca rubra*).

This is a natural wetland in terms of the RMA (1991) and NPS-FM (2020).

Wetland 4: (*Juncus* spp.)/floating sweetgrass-monkey musk-water celery grassland (Area 4; c. 0.4 ha)

The permanent stream on the eastern side of the property (Plate 7) has been cleared for grazing and is now relatively deeply-incised and surrounded by exotic pasture species. There are several distinct flat areas where water pools, forming obvious damp meadows (W4, Figure 1). In these sites there are large swards of floating sweetgrass and areas covered in tall monkey musk (*Erythranthe guttata*) interspersed with water celery (*Apium nodiflorum*). Other less moisture-tolerant grass species are present along the edges (creeping bent - *Agrostis stolonifera*, Yorkshire fog, red fescue - *Festuca rubra*) and a variety of rush species (*Juncus australis*, *J. edgariae*, *J. effusus*, *J. sarophorus*) are present in patches.

These meadows are along the riparian margins of a stream with a natural flow-path and therefore are natural wetlands.

5.4 Aquatic habitats

5.4.1 Permanent streams

According to the NIWA river mapping tool[1], no overland flow paths exist in the interior of the property, however we mapped a permanent stream on the eastern side of the property that runs NW and is relatively undisturbed by quarrying activity (Plate 7), but does receive some consented drainage from an overburden disposal area.

[1] See: https://shiny.niwa.co.nz/nzrivermaps/

Plate 7: Permanent stream along the eastern boundary of the property. 13 September 2022.

5.4.1 Intermittent streams

The stream running north east through the forest was flowing during the first visit (following recent rain) and had natural pools in the second visit (also following recent rain) (Plate 8). The muddy bed of this stream is 0.5 metres at its widest point and 0.5 metres at the deepest section. The deeply incised channels present suggest that a significant volume of water flows through this waterway during heavy rain. There was muddy water present in the stream during both site visits as rain had fallen earlier in the week. Plants such as kawakawa (*Piper excelsum*) and supplejack (*Ripogonum scandens*) were also present in the stream bed. This stream satisfies three of the criteria for an 'Intermittent stream' type: a) a defined stream channel; b) it has natural pools; c) rooted terrestrial vegetation was not established across the entire cross-sectional width of the channel.

Plate 8: Intermittent stream in the larger forest remnant. 14 October 2021.

5.4.2 Ephemeral streams

No ephemeral streams were observed on the property.

5.4.3 Drains

There is a drain running along the north-western boundary (Plate 9 and Figure 2). This watercourse runs south west and has a channel that is over a metre wide and over a metre deep in places. Based on historical satellite imagery, this drain appears to have been constructed to carry run-off from the farmland as it links two natural streams that originally ran northward from the boundary (Plate 10). This drain now culminates in the raupō reedland identified as Wetland 1 in Figure 3. Another drain continues just to the south of this reedland and appears to be a separate watercourse. Both of these drains receive discharged water via underground pipes from the quarry (Figure 1.1, Goodearthmatters 2022).

Another drain is present outside the property to the south west (Figure 1) parallel to Kendalls Line. This drain flows north west through farmland where it connects to the Linton Drain, approximately 4 kilometres away. Linton Drain is a heavily modified watercourse and is a tributary of the Tokomaru River, which is itself a tributary of the Manawatū River. The drain is a modified and straightened iteration of a natural stream that was still present in 2001 aerial imagery (Plate 10). Therefore the modifications must have occurred after 2001.

5.4.1 Ponds

A surface water storage pond is located along the southern boundary of the property (Habitat Type 5, Figure 2), close to the quarry yard and office, and receives stormwater from a collection pond at the base of the quarry pit (GEM 2022).

Plate 9: Northern-most drain along the northwestern boundary of the property. 13 September 2022.

Plate 10: February 2001 aerial photograph of the quarry showing the original courses of the streams north west of the quarry (courtesy of Retrolens[1]).

6. ECOLOGICAL VALUES

6.1 Overview

The mature indigenous forest remnant represents a much-reduced example of what would have once been a dominant habitat type in the area. Mature stands of nikau are now rarely found across the region and, based on EIANZ criteria (Roper Lindsay *et al*. 2018) are therefore of moderate ecological value.

Wetlands at the site are dominated by exotic species and have been heavily modified for grazing and earthworks. They can still nevertheless provide important ecological services such as nutrient uptake, flood attenuation, and sediment filtering. At this site, however, the ability of wetlands to provide such services has been reduced by historical farming and stock pugging.

Ten indigenous fauna species that are either listed as Threatened or At Risk have been identified as being potentially present at the site and in the surrounding area, and may be adversely affected by the recent earthworks and the proposed expansion of the quarry.

[1] Historical image online library (www.retrolens.co.nz) made available by the Local Government Geospatial Alliance (LGGA) and Land Information New Zealand.

6.2 Terrestrial vegetation

The ecological values of indigenous vegetation within the indigenous forest or nīkau treeland at the Hirock Linton Quarry are described in detail in Table 1. These assessments are based on the key ecological attributes identified in the EIANZ guidelines (Roper-Lindsay *et al.* 2018) and are further informed by professional opinion and expertise.

According to Horizons One Plan, the indigenous forest (Vegetation Type 1) is classified as either "Tawa forest in association with other indigenous broadleaved species, or tawa dominated treeland" or "Tawa and māhoe dominated forest or treeland with scattered emergent podocarp species". According to Table F.1 within Schedule F of the One Plan, if forests of these types cover an area greater than 0.25 hectares, they then qualify as a "Threatened" habitat type (Table F.2(a), Horizons 2016). The larger forest remnant is one hectare, and therefore is a Threatened habitat type. Proposed works that could potentially affect this forest remnant would therefore require resource consent.

Northern rātā is found within the indigenous forest and has a national-level threat classification of Threatened –Nationally Vulnerable (de Lange *et al.* 2018). Northern rātā is a member of the myrtle family (Myrtaceae), which is at risk of infection by myrtle rust (*Austropuccinia psidii*), a potentially devastating rust which has no known treatment. Along with other species in the Myrtaceae family, the threat status of northern rātā has been elevated as a precautionary measure based on the potential threat posed by myrtle rust. None of the other plants recorded during the site visit are nationally threatened (de Lange *et al*. 2018).

Regarding the nīkau treeland (Vegetation Type 2), according to Schedule F (Table F.2(b), Horizons 2016), areas of nīkau dominated treeland are not considered rare, threatened or at risk. However, mature stands of nīkau are now rarely found across the region and are therefore of moderate ecological value.

Table 1: Ecological value assessment for terrestrial habitat types at Hirock Linton Quarry, Palmerston North (as per Roper-Lindsay *et al.* 2018).

Vegetation/Habitat Type	Criteria	Attributes to be Considered	Assigned Value
1: Pukatea-tawa-māhoe-(tītoki)-(nīkau) forest	Representativeness	Pukatea and tawa dominant in canopy, with occasional kahikatea. This habitat type is representative of original landcover in the Manawatū Plains Ecological District.	High
	Rarity/distinctiveness	Habitat type dominated by indigenous species and occurs in an area that has <10% of indigenous cover remaining (Manaaki Whenua 2020). The forest type is therefore considered to be nationally rare due to anthropogenic disturbance.	Moderate High (if rare species present)
	Diversity & Pattern	Supports a high diversity of indigenous plant species. Complex ground cover including dense leaf-litter, debris and vegetation that provides a moist environment for invertebrate species. The indigenous plant community provides fruit, seeds, nectar and insects for indigenous birds. Could support rare invertebrates (e.g. *Powelliphanta traversi*) and rare lizards.	High
	Ecological Context	"Podocarp/tawa-māhoe forest or treeland" is defined as Threatened in Schedule F of the One Plan. It's small area and isolation from other patches of mature forest makes the site particularly vulnerable to edge effects.	High
		Overall Ecological Value	**High**
2: Nīkau-kaikōmako-tawa treeland	Representativeness	Supports some indigenous species, including mature species representative of the Manawatū Plains Ecological District. However, because the remnant has undergone significant modification, it does not comprise the typical structure and composition of intact indigenous forest or treeland.	Moderate
	Rarity/distinctiveness	Canopy dominated by indigenous species and occurs in an area with <10% of indigenous cover remaining (Manaaki Whenua 2020). Considered to be nationally rare due to anthropogenic disturbance.	High
	Diversity & Pattern	Highly modified remnant of original forest that has undergone significant loss of the original diversity (especially loss of mature podocarp/broadleaved canopy and understorey species). Supports a low diversity of indigenous plant species. Unlikely to support a diverse range of terrestrial invertebrate species. The indigenous plant community may provide fruit and seeds for indigenous birds at times. Habitat may provide stepping stones for avian species to move between sites.	Low
	Ecological Context	A small cluster of isolated trees within pasture that may provide some habitat and seasonal fruit supply for indigenous birds. A highly modified example of a habitat type that is very rare in the region.	Moderate
		Overall Ecological Value	**Moderate**
3: Wetland	Representativeness	Exotic species dominate this vegetation type with only scattered indigenous species that are locally common.	Low

Vegetation/Habitat Type	Criteria	Attributes to be Considered	Assigned Value
	Rarity/distinctiveness	As exotic grasses and broadleaved herb species dominate these wetlands, and they are of low indigenous value, they are unlikely to support any rare or threatened species.	Low
	Diversity & Pattern	Supports some diversity of indigenous wetland plant species.	Moderate
	Ecological Context	Although these wetlands are of limited ecological value, the hydrosystems are relatively intact, and their ability to be restored is high. They also currently provide infiltration and water filtering services.	High
		Overall Ecological Value	**High**
4: Freshwater Streams	Representativeness	Typical of streams and drains running through heavily modified habitat such as farmland and not representative of watercourses originally in the region.	Low
	Rarity/distinctiveness	Typical of streams and drains running through heavily modified habitat such as farmland and therefore not ecologically rare or distinctive.	Low
	Diversity & Pattern	May support some diversity of indigenous fish and invertebrates species, including the longfin eel (At Risk – Declining) and kōura.	Moderate
	Ecological Context	This habitat is unlikely to support many rare or threatened species, and the riparian margins are dominated by exotic species. Therefore, limited ecological values are likely to be present at the site. These stream feed larger catchments (e.g. Kahuterawa Stream, Tokomaru River, Manawatū River) and quarrying activity will have impacts on nearby downstream catchments.	Moderate
		Overall Ecological Value	**Moderate**

Much of the rest of the property is covered in grazed pasture and has low ecological value.

Pest plant species present at the site include gorse and barberry (*Berberis glaucocarpa*). None of the pest plants are currently widespread and they could easily be controlled.

6.3 Wetlands and seepages

The area of remnant indigenous forest is on a gentle slope leading down into what is now a sediment detention pond. Within the forest, the soils are imperfectly-drained, resulting in an intermittent stream that runs through the forest (Figure 2), becoming a series of small wetlands where water collects, upstream of the pond at the bottom.

Vegetation types described in this section meet the definition of 'wetland' provided in the RMA as they are *"permanently or intermittently wet areas that support a natural ecosystem of plants and animals that are adapted to wet conditions."* They also meet the definition of 'natural wetland' in the NPS-FM. The NPS-FM excludes "*areas of improved pasture subject to temporary rain-derived pooling"* from the definition of 'natural wetland'. While some of the wetland plots had greater than 50% cover (the standard threshold) of identified pasture species (Ministry for the Environment 2022), they nevertheless appeared to be permanently wet, therefore meeting the criteria for a natural wetland.

A sediment detention pond (just north and downstream of Wetland 3 in Figure 1) is a constructed pond and therefore does not comprise a natural wetland.

The four wetlands identified at the site are all small and highly modified:

- Wetland 1 0.03 ha (300 m^2).
- Wetland 2 0.09 ha (900 m^2).
- Wetland 3 0.06 ha (600 m^2).
- Wetland 4 0.04 ha (400 m^2).

The total area of the four wetlands is 0.22 hectares, or 2,200 m^2.

According to Schedule F (Table F.2(b), Horizons 2018), areas are not considered rare, threatened or at risk where it pertains to "damp gully heads, or paddocks subject to regular ponding, dominated by pasture or exotic species in association with wetland sedge and rush species". None of the four wetlands therefore meet the criteria for 'rare, threatened, or at risk' habitats in the Horizons One Plan (refer to Section 4 above). Additionally, Wetland 1 appears to meet the exclusion criterion as it meets the definition of "ditches or drains supporting raupō".

Wetland habitats have been severely reduced in the Manawatū region and across New Zealand, therefore even modified natural wetland habitats represent significant habitat. The wetlands at the site support some diversity of indigenous plant species. Although Wetland 1 is unlikely to support any rare or threatened species, and Wetlands 2-4 are dominated by exotic grass and broadleaved herb species, these wetlands provide other ecological services including nutrient uptake, flood attenuation, and sediment filtering.

These wetlands could easily be enhanced to support indigenous vegetation, and provide habitat for indigenous fauna.

7. FAUNA

7.1 Overview

Ten indigenous fauna species that are either listed as Threatened or At Risk have been identified as being potentially present at the site and in the surrounding area, and may be adversely affected by the recent earthworks and the proposed expansion of the quarry. The relative ecological value, based on the threat status of these species, is summarised in Table 2.

Table 2: Ecological value assessment for Threatened or At Risk indigenous fauna that potentially occur at Hirock Linton Quarry that may be impacted by the earthworks (as per Roper-Lindsay *et al.* 2018).

Species	Threat Status	Assigned Value
Long-tailed bat	Threatened – Nationally Critical	Very High
Kākā	At Risk – Recovering	Moderate
Kākāriki	At Risk – Relict	Moderate
New Zealand bush falcon	At Risk – Recovering	Moderate
New Zealand pipit	At Risk – Declining	High
Ngahere gecko	At Risk – Declining	High
Barking gecko	At Risk – Declining	High
Copper skink	At Risk – Declining	High
Ornate skink	At Risk – Declining	High
Brown skink	At Risk – Declining	High

7.2 Long-tailed bats

Long-tailed bats are classified as Threatened – Nationally Critical by O'Donnell *et al*. (2018). The home range of long-tailed bats is up to 19 kilometres (O'Donnell 2001). They are known to preferentially forage in forest edge and riparian habitats of both indigenous and exotic forest types (O'Donnell 2006, Griffiths 2007, Rockell 2017), and have adapted to roosting in exotic tree species such as pine (*Pinus* sp.) and macrocarpa. They also forage over farmland and urban areas (Griffiths 2007, O'Donnell and Borkin 2021). The large pukatea and māhoe trees at this site could contain cavities large enough for bats to use as roosts. Furthermore, the forest-farmland edges might also be used as flight paths by foraging bats.

The Department of Conservation bat distribution database (searched in November 2021) holds no recent records of long-tailed bats within a 19 kilometre radius of the site. The closest survey point was approximately six kilometres to the east in 1997. Three surveys were also carried out near Palmerston North in 2019, with no bats detected. Extensive sampling at Turitea Wind Farm (approximately eight kilometres to the east) between 2005 and 2008 by Wildlands failed to detect bats (Wildland Consultants 2008). Furthermore, surveys conducted adjacent to the Pahiatua-Aokautere Road in 2020 also resulted in no detection of bats (King 2019, Dodunski 2020).

For New Zealand's bats, it is often difficult to distinguish between the absence of a population and a lack of adequate surveying, as bats are small, nocturnal, and mostly inaudible to the human ear (i.e. their echolocation clicks and vocalisations are usually above 20 kilohertz). As such, they are normally only detected through the use of specialised high-frequency recording devices. Therefore, a cautious approach should be applied to areas of mature indigenous forest that have not been surveyed for the presence of bats. Loss of the nīkau treeland could result in the direct loss of bat foraging habitat. There is also the possibility of indirect impacts through additional disturbance to the larger forest fragment that might lead to bats abandoning roosts, foraging areas and/or commuting routes.

7.3 Birds

Four indigenous and two exotic bird species were seen or heard at the study site during the site visits. The indigenous species were pīwakawaka (North Island fantail, *Rhipidura fuliginosa placabilis*), riroriro (grey warbler, *Gerygone igata*), kererū (*Hemiphaga novaeseelandiae*), and silvereye (*Zosterops lateralis*). All of these indigenous species are common and classified as Not Threatened as per the most recent threat classification for indigenous birds (Robertson *et al*. 2017). The two exotic species recorded were blackbird (*Turdus merula*) and chaffinch (*Fringilla coelebs*).

Using distribution data in Robertson *et al*. (2007), and recent records from the eBird and iNaturalist online databases (i.e. for birds that breed in New Zealand and were observed within 10 kilometres of the property within the last 20 years), no Threatened bird species have been observed in the vicinity of the quarry. However, three At Risk bird species may be present. These are the North Island kākā, New Zealand bush falcon (both At Risk – Recovering) and kākāriki (At Risk – Relict). These species are all strong fliers (Walker *et al.* 2019) that are capable of travelling long distances to forage in fragmented patches of forest, and have been observed in the wider area. Additionally, the pīhoihoi (New Zealand pipit), a small At Risk – Declining indigenous bird that resides in open grasslands as well as areas of gravelfield and bare earth, may periodically occur within the footprint of the proposed works and the wider property.

7.4 Herpetofauna

No lizards were observed during the survey, however suitable habitat for several indigenous lizard species occurs at the site. The canopy and sub-canopy trees at the site provide potential habitat for indigenous arboreal gecko species such as ngahere gecko and barking gecko. Ground-dwelling skink species such as copper skink and ornate skink often occur on bush margins and scrub vegetation and these species may use ground cover vegetation, leaf litter and woody debris at the site. Raukawa geckos may also be present. Copper skink, ornate skink, ngahere gecko and barking gecko are all classified as At Risk – Declining under the New Zealand threat classification for reptiles (Hitchmough *et al.* 2021). Northern grass skink and Raukawa geckos are both classified as Not Threatened. All indigenous lizards are protected by the Wildlife Act (1953).

The Department of Conservation's Herpetofauna Database contains no lizard records for the site, however there are several records for barking gecko within five kilometres of the property.

7.5 Terrestrial invertebrates

Both the forest remnant and the nīkau treeland provide potential habitat for indigenous invertebrates. However, due to the rapid nature of the site visit, an invertebrate survey was not conducted. The only invertebrate observations were the webs of sheetweb spiders (*Cambridgea* spp). in the forest remnant, which was identified by the presence of its webs. In particular, the forest remnant provides varied and diverse habitat that could support a range of species. The mature native trees provide habitat in their roots, bark and leaves for invertebrates such as Lepidoptera. Fallen logs and rotting wood provide habitat for stag beetles (genus *Geodorcus*; protected under the Wildlife Act (1953)) and other indigenous invertebrates that feed on dead wood. Leaf litter and damp, shaded soil provides habitat for short-range endemics such as mite harvestmen (Opiliones suborder Cyphophthalmi).

No *Powelliphanta traversi* snails were seen during the site visits (the initial site visit on 14 October 2021, and the formal snail survey on 13 September 2022). Indigenous snails and slugs may be present within the habitat, but are likely to be at low abundance.

Table 3 lists some invertebrate species that could be present within the remnants, as they have been observed in surrounding areas on iNaturalist, a citizen science application. Although this high-level assessment shows some species in the local area, the invertebrate fauna cannot be characterised, as a comprehensive survey was not undertaken.

Table 3: Noteworthy indigenous invertebrate fauna that may occur within the areas of indigenous vegetation at Hirock Linton Quarry, Palmerston North. Except for *Powelliphanta* snails, none of the other species listed are Threatened.

Taxon	Date(s) Observed	Notes
Arthropods		
Harvestman (*Forsteropsalis inconstans*)	Found in Turitea September 2019, December 2020; Palmerston North June 2021	Endemic. Other endemic harvestmen found in the area include *Algida chiltoni* and *Prasma tuberculata*
Ichneumonid wasp (*Netelia ephippiata*)	February 2019, August 2020. Also observations in surrounding areas	Widespread endemic ichneumonid wasp that targets cutworm and armyworm moths
Moth (*Antiscopa epicomia*)	December 2020	Endemic with a sparse distribution
New Zealand mantis (*Orthodera novaezealandiae*)	April 2018; commonly found in and around Palmerston North and Turitea	Widespread endemic, At Risk-Declining (Buckley et al. 2012), threatened by introduced mantis species (*Miomantis caffra*), which is also found in the Linton area
Puriri moth (*Aenetus virescens*)	December 2020. October 2021	Common and widespread endemic
Snails		
Land snail (*Powelliphanta traversi*)	No observations within indigenous remnant at Linton Quarry (Wildlands 2022), or the greater Linton area. Observed in bush habitat nearby (September 2019, December 2017) and may be present in the quarry remnant forest, particularly as pests have been controlled there	The six subspecies are all listed as Threatened –Nationally Endangered or Threatened – Nationally Critical (Hitchmough et al. 2007). According to the Horizon's One Plan (Horizons 2016), *Powelliphanta traversi* may be found under leaf litter of tawa or pukatea dominated sites on the Manawatū/Horowhenua Plains.

7.6 Introduced pest mammals

Evidence of possum (*Trichosurus vulpecula*) browse and chew was seen in the larger forest remnant (Vegetation Type 1) and deer droppings (possibly fallow deer, *Dama dama*) was seen under the nīkau trees in Vegetation Type 2. Other pest animals that are also likely to be present include ship rats (*Rattus rattus*), Norway rats (*R. norvegicus*), mice (*Mus musculus*), and hedgehogs (*Erinaceus europaeus*). Mustelids (stoats, *Mustela erminea*; ferrets, *M. furo*; and weasels, *M. nivalis vulgaris*) and feral and domestic cats (*Felis catus*) may also use the site occasionally. Rabbits (*Oryctolagus cuniculus*) and hares (*Lepus europaeus*) are also likely to occur at the property.

7.7 Freshwater fauna

Watercourses at the site have been heavily impacted by grazing and pugging, reducing habitat values for indigenous fauna by disrupting the natural bed and bank structures, and lowering water quality through increased contamination with sediment and effluent. In areas where the riparian margins are vegetated, the vegetation is predominately exotic grass that provides minimal shade to the stream channel. Due to the streams being very high in the catchment, small in size, and adversely affected by grazing, it is unlikely that they support substantial populations of indigenous fish.

While no fish surveys have been undertaken within the watercourses at the Linton Quarry, NZ Freshwater Fish Database (Crow 2017) records from within the same catchment indicate that the indigenous fish species most likely to be utilising these habitats include longfin eel (*Anguilla dieffenbachii*, At Risk - Declining), shortfin eel (*Anguilla australis*, Not Threatened), banded kokopu (*Galaxias fasciatus*, Not Threatened), and a range of bully species including upland (*Gobiomorphus breviceps*, Not Threatened), common (*G. cotidianus*, Not Threatened), and redfin (*G. huttoni*, Not Threatened) bullies. Kōura (freshwater crayfish; *Paranephrops planifrons*, Not Threatened) are also likely to be present, while both the exotic rainbow (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) have also been recorded in the vicinity.

8. POTENTIAL ADVERSE ECOLOGICAL EFFECTS

8.1 Overview

The proposed quarry expansion would involve works that include the creation of three infill sites and two stockpile areas (Figure 1). These features are all planned within areas of current quarry footprint, including sites already developed for the quarry pit, roads and other metalled surfaces (Figure 1). However, the expansion of the quarry pit to the south will have effects on indigenous biodiversity and habitats. Potential adverse effects of the proposed development can be summarised as:

- Loss of the indigenous vegetation.
- Increase in edge effects for indigenous vegetation retained on the property.
- Loss of indigenous fauna habitat.

- Harm to bats, birds, lizards and invertebrates.
- Degradation of freshwater and wetland habitats

Each of these effects is described in detail below. The magnitude and level of each effect has been defined as outlined in the EIANZ guidelines (Roper-Lindsay *et al.* 2018) and summarised in Table 1.

8.2 Loss of indigenous vegetation

The loss of 0.08 hectares of nīkau-dominant treeland is scheduled to occur if the resource consent is approved for the proposed expansion of the quarry pit. This will represent a major alteration to the existing baseline condition of the site and as such would result in significant adverse effects.

Tonkin and Taylor consider instability of the south quarry edge unlikely to have a short-term (years to decades of quarry operation) effect on the significant vegetation in the forest remnant. In the medium to long term (i.e. decades to centuries after post quarry closure), Tonkin and Taylor advised that there is no practical means to reduce the risk of crest failure and/or gradual deterioration of the existing unmitigated south wall slopes pre quarry closure. This could lead to retreat of the crest by at least 5 to 10 metres and loss of some of the remnant.

8.3 Increase in edge effects

Recent earthworks occurred adjacent to both the forest (Plate 1, Vegetation Type 1: Figure 2) and the nīkau treeland (Plate 2, Vegetation Type 2: Figure 2). For the nīkau habitat, the excavation on the southern border of this treeland is likely to disrupt the downhill flow of ground water to the base and roots of the trees. For the larger forest fragment, the recent earthworks and expansion of quarrying activity is likely to cause an increase in edge effects for this forest including larger fluctuations in temperature and humidity compared to the interior of the forest habitat. These effects can impact the area up to 60 metres from the forest edge and can lead to the enhanced germination of pest plant species, reduced regeneration and survival of indigenous plant species, and reduced habitat quality for indigenous fauna.

The small size of the forest fragment means that it is already highly impacted by edge effects and true forest interior conditions are unlikely to be present. At its maximum width, the fragment is less than 90 metres across, so no area of the forest is likely to be unaffected by edge effects. Nevertheless, edge effects are likely to increase with further expansion of quarry to the west of this forest (Figure 1). The magnitude of this effect is therefore predicted to be low-moderate.

8.4 Loss of indigenous fauna habitat

Overall, the loss of habitat for indigenous fauna will represent only a minor shift from the baseline condition. With the retention of the larger patch of indigenous vegetation at the site, foraging and nesting habitat will still be available on the property. As such, displaced birds are likely to have returned to the site following the recent earthworks.

If indigenous lizards are present, the recent earthworks and the likely future loss of the nīkau treeland will result in a reduction in the available habitat for these species. However, given the small size of the clearance area and the retention of most of the indigenous forest habitat, the magnitude of effects is likely to be low.

8.5 Harm to bats, birds, lizards and invertebrates

The bird species that are likely to occur within the forest remnants are all highly mobile. Therefore, the noise and movement associated with the vegetation removal, slip-remediation work and proposed expansion may cause them to move away from the site before they are harmed. It is unlikely that indigenous bird nests are present in the nīkau treeland, therefore the magnitude of effects of the recent earthworks and proposed expansion on indigenous birds is expected to be low. For New Zealand pipit, the small area of rank pasture that will be lost beneath the nīkau trees is unlikely to have an impact on any populations of this indigenous bird species that may occur at the site.

It is unknown if bats are present in the indigenous forest remnant, or if they forage across the wider property. Disturbance associated with the quarry expansion could specifically disrupt resident bats if they are found to be roosting in mature trees on the property.

There is a risk that indigenous lizard or invertebrate populations, including of species that are Threatened or At Risk, may suffer losses as a result of the recent earthworks, the proposed quarry expansion and the likely loss of the nīkau treeland habitat, and the ongoing disturbance to the forest fragment. Therefore, lizard surveys should be undertaken, and a Lizard Management Plan and Wildlife Authority Act application prepared if warranted.

8.6 Degradation of freshwater and wetland habitats

Overall, while the four wetland sites do comprise wetland in terms of the NPS-F and NES-FW, they are all small, degraded, and of relatively low ecological value. Discharge of water into the drain to the south west of the quarry appears to have resulted in the establishment of raupō reedland / induced wetland. Providing sediment discharge into this wetland does not substantially increase, ongoing water and sediment discharge is unlikely to result in adverse effects on this wetland, and may even have a positive effect by maintaining wetland hydrology. Therefore, the magnitude of this ongoing effect is considered to be negligible. There are no proposed works scheduled within Wetlands 2-4.

Some water and sediment from an overburden disposal area enters the unnamed tributary of the Kahuterawa Stream to the east, however these works were consented in a previous application and are not relevant here.

9. OPPORTUNITIES TO AVOID, REMEDY OR MITIGATE POTENTIAL ADVERSE EFFECTS

9.1 Transplantation of nīkau trees

Transplanting the nīkau from their current site in the nīkau treeland to an alternative site within the property was initially considered by our team. However, the degraded state of this nīkau grove (exacerbated by recent earthworks that had affected the area up to the dripline of some trees) was a contributing factor to why transplantation was not considered as a practicable condition of the consent. The earthworks uphill and downhill of the treeland is likely to have not only disrupted downhill nutrient and water flow to the nīkau, but is likely to have also accelerated drainage from the site.

We decided that the process would be costly (in terms of time, labour and expense) for the reasons below:

- The alternative site would need to be prepared for the placement of the transplanted nikau
- The removal of the nīkau would involve a staged process where the root ball sides would be cut one at a time to reduce shock to the plant
- Once the tree and its root ball were able to be released from its site, protective covering to maintain the integrity of the root ball and the 8m stem of the tree would be needed to support the tree while in transit
- Once transplanted to the new site, stabilisation of each tree would be needed
- Specialised machinery and arborists that could safely and effectively undertake the removal and transplanting would be needed
- Ongoing investment would need to be committed for the long-term care of the trees to maximise their chances of survival at the new site

Even if all of these factors were in place, we believed that, considering the current degraded state of the treeland, that the survival rate would be low and that planting of new forest would still be required to supplement losses. The failed transplantation of a single nīkau at the site (transplanted by quarry staff before our site visit) has already shown that the process would not be straight forward. We therefore believe that investment in a new nīkau-dominated forest within the property would be a more successful (and cost-effective) outcome for the client (see following sections).

9.2 Enhancement and protection of indigenous vegetation

9.2.1 Overview

The loss of the nīkau treeland, and the potential loss of part of the forest remnant (caused by edge effects and expansion of the current quarry extent up to the NW edge of the forest), should be addressed by enhancing and protecting indigenous forest at the site.

This should involve the following measures:

- Planting of new forest
- Management of edge effects (set-back, buffer planting, management of forest edge)
- Establishment of protective covenants to ensure that the newly established indigenous vegetation plus the existing indigenous forest are legally protected in perpetuity.
- Control of pest plant species throughout the existing indigenous forest, particularly elder, and throughout the newly established forest.
- Repair and maintenance of the stock-proof fence surrounding the existing indigenous forest.

An ecological management plan (EMP) will be required to guide planting work at the site. All plants must be eco-sourced locally from the Manawatū Plains Ecological District.

9.2.2 Planting of new forest

With quarry expansion into the area described as Vegetation Type 2 (nīkau treeland), and the resultant loss of 23 mature nīkau trees, plus younger specimens of kaikōmako, tawa and kahikatea, the effects should be addressed with establishment of a new nīkau-dominated forest on the property. To address the effects of removing mature indigenous vegetation and habitat, indigenous planting should be carried out at a minimum ratio of 10:1[1]. This ratio is set to replace the likely loss of the 0.08 hectares of treeland that is likely to have once supported up to 50 mature trees (especially nīkau, but also tawa, pukatea and kahikatea). To achieve a net positive result for indigenous ecosystems on the property, we propose that planting occurs across an area of 0.9 hectares and should take place along the margins of the unnamed tributary (the permanent stream in Figure 2) to enhance its ecological value.

As these margins include areas of potential wetland (Wetland 4, Figure 3), the wet areas should be avoided. The plantings should aim to establish nīkau-dominated forest. This would require initial planting with pioneer shrub and tree species (e.g. mānuka; *Leptospermum scoparium*, kānuka; *Kunzea robusta*, and māhoe), which, once established, would then be followed with the planting of nīkau saplings and other indigenous tree species including tawa, pukatea and kahikatea. Seeds and/or seedlings for a number of forest plant species could be immediately eco-sourced from the existing forest areas (e.g. seed from the nīkau treeland, and pukatea, tawa and kahikatea seedlings from the larger forest fragment). This would secure the local genetic diversity of the tree species within Vegetation Type 2 (i.e. through local-sourcing of seeds and seedlings for the plantings).

[1] This ratio for indigenous treeland was derived using the Department of Conservation Offsets Accounting System (https://www.doc.govt.nz/about-us/our-policies-and-plans/guidance-on-biodiversity-offsetting/biodiversity-offsets-accounting-system/).

9.2.3 Management of edge effects and vegetation loss

Set-Back and Buffer Planting

While the quarrying activity has not encroached into the indigenous forest interior (as required by current consent conditions), recent earthworks and ongoing quarrying activity is likely to cause potential instability and vegetation loss, and increased edge effects along the north west boundary.

To reduce these effects, a 15 metre wide set-back should be provided along the boundaries of the indigenous forest remnant. This would include a five-metre wide planted area of māhoe-dominant vegetation to thicken the vegetation along all edges and to protect it from future quarry expansions and overburden infill activities. Along the north/north west edge of the forest where the quarry has expanded close to the forest, buffer planting will not be possible. An extended 10 metre māhoe-dominant buffer should therefore be planted along the western side to provide extra protection from quarry expansion in this area. We recommend where the buffer includes the wet grassland area (along the northern boundary of the forest comprising Wetland 2, Figure 1), that suitable wetland plant species be selected (e.g. tī kouka, mānuka or harakeke) instead of māhoe.

Geotechnical Management of Forest Edge

For the north west edge of the forest remnant, there is insufficient room for buffer plantings or a 15 metre setback as earthwork (slip remediation) has occurred up to the edge of the forest (i.e. within 10 metres of vegetation dripline). Geotechnical solutions are therefore required to manage the ongoing adverse effects of erosion at the south crest, and the potential for instability along the north west and west edges of the forest remnant.

In the short term (i.e. years to decades of quarry operation), Tonkin and Taylor consider instability of the south slope crest unlikely to have an effect on the significant vegetation (Appendix J: GEM 2022). Some improvement could be gained by polymer hydroseeding of the exposed faces to reduce direct rainfall infiltration and erosion by overland flow and Hirock have recently hydroseeded the exposed face as recommended.

For mid- or long-term solutions (i.e. decades to centuries after post quarry closure), Tonkin and Taylor recommend options be developed as part of the quarry closure design to either offset or mitigate the medium to long term risk to the significant vegetation. Tonkin and Taylor advise that physical mitigation of the slope risk could be achieved, depending on the adoption of final options for quarry closure, such as buttressing the existing slope crest with fill.

In terms of any further impacts to the significant vegetation, the proposed extension of the pit to the south west (near the west edge of the forest) is being planned using batter and bench configurations, and an overall slope angle that mitigate most of the concerns regarding batter scale and overall slope instability from known hazards. Tonkin and Taylor advise that excavating to the proposed angles, berm heights and bench widths, along with ongoing application of the current pit management and operating procedures

should result in an acceptably low risk of slope instability for the proposed pit extension.

Long-term monitoring of slope stability at the site must include quantification of the effects at the forest boundary (vegetation condition, numerical abundance and survival of marked trees) to allow for an estimation of forest health and would be guided by an Indigenous Vegetation Monitoring Plan (IVMP). If significant vegetation loss occurred along the north and north west edges of the indigenous forest remnant (as determined by the IVMP), mitigation actions will be required to offset this loss.

9.2.4 Establishment of protective covenants

Successful restoration at this site would require a long-term commitment by the landowners to protect existing values and to manage the new nikau-dominated forest. To secure such a commitment, formal protection of both the existing indigenous remnant and the newly established forest is warranted. The new forest should be eligible for covenanting after 10 years (John Williamson pers. comm., QEII National Trust regional representative for the Central Manawatū).

9.3 Indigenous bat survey

An acoustic survey should be carried out within the area of indigenous forest to determine the likelihood that bats visit the site. This survey would entail placement of acoustic monitoring devices within the indigenous forest remnant and at a number of sites across the wider property, including within exotic shelterbelts and along stream corridors. If found to be present, a bat management plan will be needed to manage ongoing indirect effects of quarrying activity on bats.

9.4 Herpetofauna management

A lizard survey is needed to assess the lizard species that are present at the site, and what the lizard management requirements should be.

If lizards are present, a lizard management plan (LMP) may be required. The details of a LMP are dependent on the species discovered, but management actions could include habitat enhancement and pest management. An LMP will need to be prepared and implemented as a consent condition by a qualified and herpetologist with a survey and handling permit. This will need to be submitted to and approved by the Department of Conservation along with an application for a Wildlife Act Authorisation.

If lizards are absent, no further management actions are required.

9.5 Bird management

If clearance of rank pasture must occur during the pipit breeding season (August-February), all affected grassland should be assessed by a suitably qualified ecologist to determine if active nests of pipits are present. If active nests are identified, the vegetation clearance must not take place within 100 metres of the nest until the chicks have fledged.

9.6 Management of wetlands and streams

No earthworks are currently proposed within Wetlands 2-4. Although the effect of ongoing discharge of sediment and water from the quarry into the drains is expected to have a negligible effect on Wetland 1, freshwater values of the drains will be affected. Restoration planting should be undertaken in a small area of riparian margin near the permanent stream (0.1 hectares of restoration in 'W 4', Figure 1) to offset overall effects of quarrying activities on waterways and wetlands at the site. This riparian restoration should involve planting of obligate wetland plants such as *Carex* sedges, harakeke (flax; *Phormium tenax*) plus the establishment of a new area(s) of raupō reedland. Cleverly-designed wetland planting may also potentially buffer the wetlands from any sedimentation effects.

9.7 Monitoring

Ongoing monitoring of the survival of planted species, and the spread of pest plants, will be required to ascertain the success of the plantings. This monitoring will be defined in the Ecological Management Plan. If bats and *Powelliphanta traversi* are confirmed as present, management plans for these species should be prepared and implemented. Ongoing monitoring of sediment deposition from the quarry into the drain feeding Wetland 1 is also required.

9.8 Summary

Table 4 provides a summary of the level of potential effects that will remain if all of the above actions are carried out in full.

Table 4: Summary of the adverse effects for indigenous flora and fauna of the recent earthworks at Hirock Linton Quarry following compensation actions (based on the guidelines in Roper-Lindsay *et. al* 2018).

Potential Adverse Effect	Ecological Feature Affected	Ecological Value[1]	Timescale of Effect	Magnitude of Effect[2]	Non-mitigated Level of Effect[3]	Measure to Address Effect	Final Level of Effect[4]
Loss of vegetation	Vegetation Type 2	Moderate	Permanent	Very High	High	Reforestation (incl. pest plant and animal control, covenanting, compensation planting)	Low
Loss of vegetation and increase in edge effects	Vegetation Type 1	High	Long-term	Low–Moderate	Moderate	Pest plant control, 15-metres setback all edges, buffer planting of N and W edges.	Low
Destabilisation of forest edges	Vegetation Type 1	High	Long-term	Low-Moderate	Moderate	Implementation of geotechnical management options. Monitoring of erosion and tree survival. Offsets and mitigation in the future if vegetation loss occurs.	Low
Harm to bats	Long-tailed bats (if present)	Very High	Long term (if foraging or roosting habitat lost or disturbed)	Low	Moderate	Improved management of forest (pest plant and animal control, fencing).	Low
Harm to indigenous birds	Kākā	High	Temporary	Low	Low	As above	Very low
	Kākāriki	High	Temporary	Low	Low	As above	Very low
	New Zealand bush falcon	High	Temporary	Low	Low	As above	Very low
	Pipit (if present)	High	Temporary	Moderate	High	Avoid active nests.	Low
Harm to indigenous lizards	Ngahere gecko, barking gecko, copper skink, ornate skink, brown skink (if any of these are present)	High	Permanent	Moderate or Low	Moderate or Low	Lizard management planning (habitat enhancement).	Low
	Raukawa gecko, northern grass skink (if present)	Moderate	Permanent	Low-Moderate	Low-Moderate	As above	Very low
Harm to invertebrates	*Powelliphanta traversi* (if present, none found during survey); *Orthodera novaeseelandiae* (likely to be present); potentially other invertebrates not detected	Very High	Long-term	Low	Moderate	Improved management of forest (pest plant and animal control, fencing).	Very low
Discharge of water and sediment from quarry to wetlands	Wetland 1	High	Long-term	Negligible	Low	Riparian planting along the permanent stream. Riparian planting in northern buffer zone (Wetland 2)	Very low
Discharge of water and sediment from quarry to waterways	3 x Drains	Low	Long-term	Low	Low	Riparian planting along the permanent stream.	Very low

[1] Ecological Value: Intrinsic value of ecological feature (considering Representativeness, Rarity and distinctiveness, Diversity and pattern, and Ecological context).
[2] Magnitude of Effect: The extent of the effects on ecological components (considering the implication on individuals and populations).
[3] Non-mitigated Level of Effect: A step-wise combination of the magnitude of the effect and the value of the ecological component.
[4] Final Level of Effect: The resultant level of the effect after measures to address the effect are implemented.

10. CONCLUSIONS

Earthworks at the Hirock Linton Quarry recently occurred adjacent to a nīkau grove and an indigenous forest remnant on the property. An ephemeral stream runs through the northern end of the larger forest area and ends in an area of wet grassland. Protection of both the area of forest and the nīkau treeland is specified in current resource consent conditions, however Hirock are now looking to expand the footprint of the quarry into the area currently occupied by the nīkau grove. The forest remnant is listed as a Threatened habitat type within the Horizons Regional Council' s One Plan. No plant or animal species recorded on the property during the site visit are classified as Threatened or At Risk, but additional fauna surveys could locate threatened species in the future.

A key focus of ecological management at the site should be to protect and enhance existing natural areas. The majority of the high value indigenous forest remnant will not be modified or adversely impacted but, the quarry is proposed to further expand along its western edge, and some of the forest may be lost through erosion into the quarry. The nīkau treeland is of moderate ecological value and the entire loss of this habitat type would result from the proposed expansion of the quarry into this area.

Opportunities to address the potential adverse effects of vegetation loss include reforestation of indigenous forest on the property along the unnamed tributary of Kahuterawa Stream to the east of the quarry. The objective for this planting is to establish nīkau-dominated forest to offset the loss of the nīkau treeland. A 15 metre setback is also required along the entire boundary of the indigenous forest remnant to protect this forest from ongoing effects of quarrying at the Site. This setback zone would also include a 5–10 metre buffer of indigneous-dominant forest or wetland vegetation along all edges of the forest, to protect the forest from increased edge effects.

Along the north west and west edges where earthworks have encroached to within 10 metres of the forest boundary, geotechnical stabilization is required to maintain integrity of the cut faces and to prevent loss of vegetation along those edges in the future. Long-term monitoring of these cut faces is required and if loss of vegetation occurs in the future, mitigation actions will be required to offset this loss. An Indigenous Vegetation Monitoring Plan would guide this.

In order to achieve net positive ecological outcomes for the site, enhanced management should also involve formal protection for both the newly established forest, and the existing indigenous forest remnant, in perpetuity. Long-term control of pest plants will also provide benefits for the condition and ongoing regeneration of natural areas. Ecological restoration can be further enhanced through sustained pest animal control across both the new and existing forests (namely rabbits, possums and deer), plus stock exclusion from the existing forest.

Planting of the newly established nīkau-dominated forest, and the buffer area around the existing indigenous forest, plus control of pest plants on the site, will be guided by an Ecological Management Plan. In addition, a Lizard Management Plan will be required if indigenous lizards are located within the remnants. A management plan for long-tailed bats should be prepared and implemented if they are detected during the bat survey at the site.

In relation to effects on streams, the permanent and intermittent watercourses at the site are heavily modified due to the effects of both farming and quarrying activities. As such, they will currently provide limited habitat for indigenous fish and invertebrates. Restoration of the terraces along the permanent stream on the eastern side of the property (including a small area of wetland restoration), and buffer planting within wetland habitat near the forest remnant (Wildland Consultants 2022), is likely to result in net positive effects for indigenous habitat values of streams at the site.

If the measures described above are properly implemented then the overall adverse ecological effects of the proposed development will be appropriately addressed. Ecological management will provide multiple ecological benefits. Restoration may also contribute to positive cultural outcomes by safeguarding the populations of indigenous plant species within existing indigenous forest habitats at the site through the eco-sourcing of seed and seedlings. Proposed restoration initiatives will protect indigenous forest on the property, help to reduce the dispersal of pest plants, and will eventually improve the legal protection and ecological integrity of the indigenous forest at the site.

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VASCULAR PLANT SPECIES RECORDED AT HIROCK LINTON QUARRY, MANAWATŪ

INDIGENOUS SPECIES

Gymnosperms

Dacrycarpus dacrydioides	kahikatea

Monocot. trees and shrubs

Rhopalostylis sapida	nīkau

Dicot. trees and shrubs

Alectryon excelsus subsp. *excelsus*	tītoki
Beilschmiedia tawa	tawa
Brachyglottis repanda	rangiora
Coprosma areolata	
Coprosma rhamnoides	
Coprosma propinqua var. propinqua	mingimingi
Corynocarpus laevigatus	karaka
Geniostoma ligustrifolium var. *ligustrifolium*	hangehange
Hedycarya arborea	porokaiwhiri; pigeonwood
Kunzea linearis	
Kunzea robusta	kānuka
Laurelia novaezelanidae	pukatea
Leptospermum scoparium	mānuka
Melicytus ramiflorus subsp. *ramiflorus*	māhoe
Metrosideros robusta	northern rātā
Myrsine australis	māpou, matipou, māpau
Pennantia corymbosa	kaikōmako
Piper excelsum subsp. *excelsum*	kawakawa
Pseudopanax crassifolius	horoeka, lancewood
Schefflera digitata	patē
Streblus heterophyllus	tūrepo

Monocot. lianes

Ripogonum scandens	supplejack, kareao

Dicot. lianes

Clematis paniculata	puawānanga
Clematis forsteri	

Metrosideros perforata	aka
Muehlenbeckia australis	puka
Parsonsia heterophylla	akakaikiore
Passiflora tetrandra	kohia; native passionfruit

Ferns

Asplenium bulbiferum	mouku, hen and chicken fern
Asplenium flaccidum	makawe, ngā makawe o Raukatauri
Asplenium hookerianum	
Asplenium oblongifolium	huruhuru whenua
Blechnum chambersii	rereti, nini
Blechnum filiforme	pānako
Blechnum fluviatile	kiwikiwi, kiwakiwa
Blechnum novae-zelandiae	kiokio
Cyathea dealbata	ponga, silver fern
Cyathea medullaris	mamaku
Hypolepis ambigua	
Lastreopsis glabella	
Microsorum pustulatum	kōwaowao, pāraharaha, hound's tongue fern
Microsorum scandens	mokimoki
Paesia scaberula	mātātā
Pellaea rotundifolia	tarawera, button fern
Pyrrosia elaeagnifolia	leather-leaf fern

Grasses

Oplismenus hirtellus subsp. *imbecillis*

Sedges

Isolepis prolifera

Rushes

Juncus australis	wi, wīwī
Juncus edgariae	wi, wīwī
Juncus sarophorus	wi, wīwī

Monocot. herbs (other than orchids, grasses, sedges, and rushes)

Typha orientalis	raupō

Dicot herbs (other than composites)

Cardamine debilis

NATURALISED AND EXOTIC SPECIES

Gymnosperms

Cupressus macrocarpa	*macrocarpa*

Monocot. trees and shrubs

Eucalyptus sp.	*eucalyptus*

Dicot. trees and shrubs

Berberis glaucocarpa	barberry
Sambucus nigra	elder
Ulex europaeus	gorse

Grasses

Agrostis stolonifera	creeping bent
Cenchrus clandestinus	Kikuyu grass
Cortaderia selloana	pampas
Cynosurus cristatus	dogstail
Dactylis glomerata	cocksfoot
Festuca rubra	red fescue
Glyceria fluitans	floating sweetgrass
Holcus lanatus	Yorkshire fog
Lolium arundinaceum	tall fescue

Rushes

Juncus bulbosus	bulbous rush
Juncus effusus var. effusus	soft rush, leafless rush

Composite herbs

Helminthotheca echioides	oxtongue
Hypochaeris radicata	catsear
Senecio glastifolius	pink ragwort

Dicot. herbs (other than composites)

Apium nodiflorum	water celery
Daucus carota	wild carrot
Digitalis purpurea	foxglove
Lotus pedunculatus	lotus
Mimulus guttatus	monkey musk
Plantago lanceolata	narrow-leaved plantain
Ranunculus acris	giant buttercup
Ranunculus repens	creeping buttercup
Rheum rhabarbarum	rhubarb

Solanum chenopodioides	velvety nightshade
Trifolium pratense	red clover
Trifolium repens	white clover
Vicia sativa	vetch

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