CLEVEDON QUARRY PLAN CHANGE

ECOLOGICAL ASSESSMENT

Report prepared for

Stevenson Aggregates Ltd

Prepared by

RMA Ecology Ltd

Report number and date

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BETTER ECOLOGICAL OUTCOMES

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1.0 Introduction

Stevenson Aggregates Limited (Stevenson) currently operates a quarry (Clevedon Quarry), located at 546 McNicol Road, Clevedon, Auckland (hereafter 'the site').

In decisions on the Auckland Unitary Plan (AUP), the site is zoned Special Purpose– Quarry Zone - and it was recognised as a regionally significant quarry through the objectives and policies of the AUP's Regional Policy Statement. Stevenson (formerly Fulton Hogan Ltd) recently gained resource consents ENV-2018-AKL-000044 to expand the quarry footprint eastwards to increase annual production to approx. 3 million tonnes.

The existing area that is zoned Special Purpose Quarry Zone (SPQZ) extends north of the current quarry pit, and south to encompass all of the mainstem stream and most side tributaries of the South Stream catchment system (Figures 1 and 2).

A Private Plan Change (PPC) is proposed by Stevenson to shift the boundaries of the SPQZ, including retiring part of the northern part of the Zone, and to re-zone an area to the south. As part of this, the northern part that is north of the existing quarry (see Figure 1) would be rezoned to Rural Production Zone, while the southern part would be re-zoned to SPQZ; the central portion would retain its current SPQZ zoning. Effectively an area of SPQZ is downzoned in the north and replaced with the same area of SPQZ in the south, contiguous with the existing SPQZ. The northern boundary of the SPQZ becomes the northern stream running east to west through the centre of the existing SPQZ.

The benefits of rezoning the northern portion include the preservation of the North Stream, and the preservation of a listed Significant Ecological Area (SEA_T_5588) across the northern slopes. The loss of source of aggregate is proposed to be balanced by the aggregate resource under the southern area that forms the subject of this PPC and ecological assessment.

Therefore, Stevenson proposes to re-zone land currently in the RPZ to the south of the existing SPQZ. The proposed land includes steep hill country that is largely in production pine forest with several tributary watercourses.

Stevenson has engaged RMA Ecology Ltd to undertake an assessment of the ecological values of the PPC site in terms of aquatic and terrestrial ecology. This is to support the PPC re-zoning application.

The approach included survey of terrestrial and freshwater areas and provides the following:

- Review of databases to identify the likelihood of species of conservation significance being present;
- Walkover survey to identify or validate the presence of native vegetation, especially areas that meet criteria for assessing ecological significance under the Auckland Unitary Plan (AUP);
- Walkover and stream-specific sampling (where access is feasible and flow exists) to:
  - Determine stream values, using qualitative scoring methods along multiple reaches of all accessible, flowing streams; and
  - Map the boundaries of stream types (permanent, intermittent and ephemeral).

This report contains the following:

- An overview of the methods used to assess the ecological values;
- A description of ecological values within the land proposed to be re-zoned and the ecological significance of ecological values therein; and
- Recommendations and opportunities if this land is re-zoned and developed as quarry, including a preliminary assessment of the magnitude of potential ecological effects that may result, and a concept for how ecological mitigation and offsetting of unavoidable adverse effects may be applied to this site.

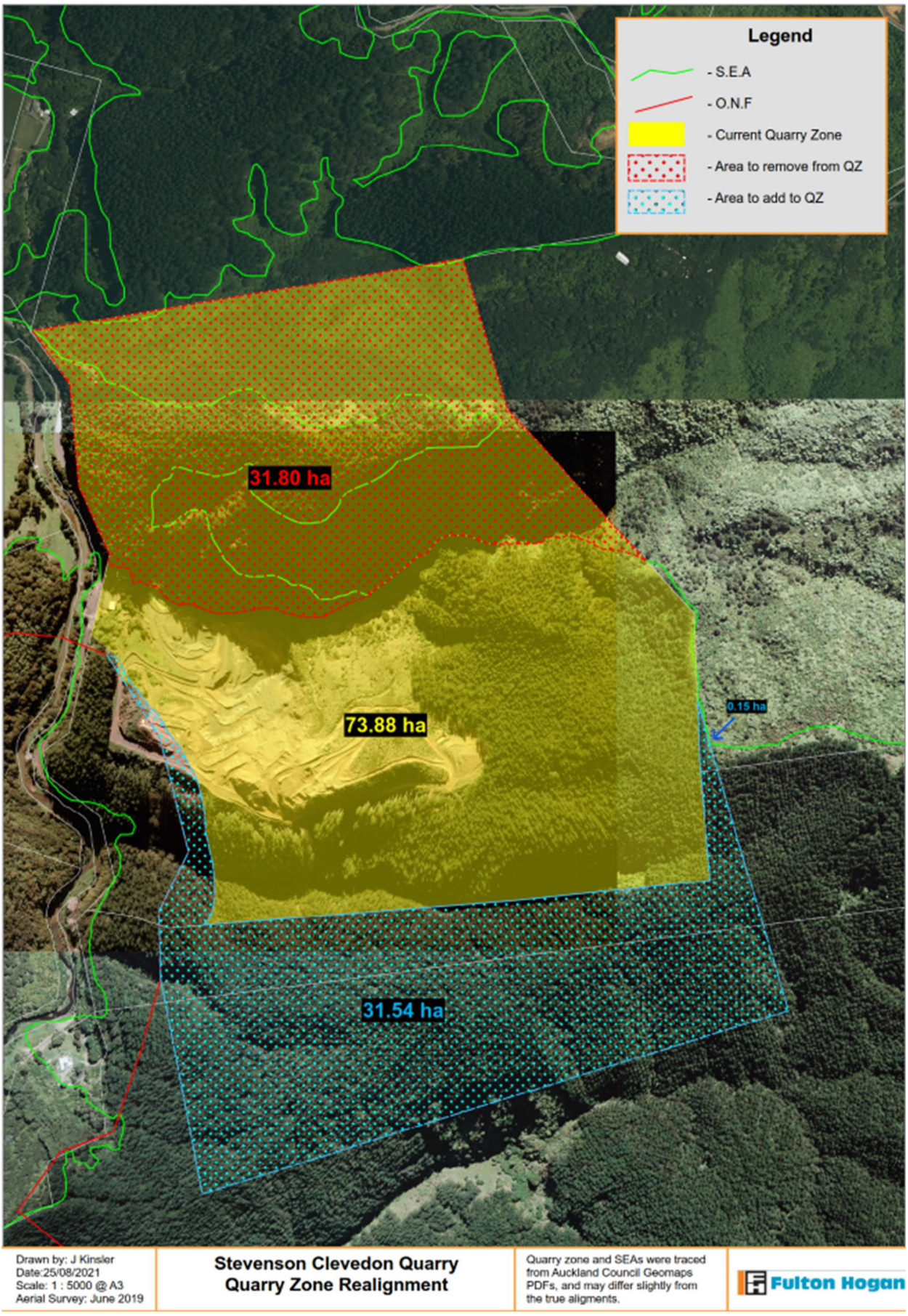

Figure 1: Proposed rezoning.

2.0 Site description

Clevedon Quarry is within the Hunua Ecological District, which is characterised by the tawa-podocarp and kauri-hard beech forests of the Hunua Ranges to the east, and a large area of production radiata pine forest (Greenridge Forest) to the south.

The existing area zoned SPQZ comprises approximately 74 ha (Figure 1). Approximately half is in production pine (south part), 10 ha is operational quarry (central part), and the remainder comprises regenerating native bush (northern part). The original native vegetation cover was removed in the early 1900s and the whole area (much broader than the quarry itself) was in pastoral farming up until around 1970. The vegetation cover over the wider site reflects a change to plantation forestry (first rotation; southern part) and reversion through gorse weedland into regenerating, early successional native shrublands (in part; northern part).

The existing SPQZ area contains two main streams, referred to as the 'North Stream' and 'South Stream', either side of the quarry respectively (and a further stream on the northern boundary of the site), which pass under McNicol Road via culverts and then into the Wairoa River. The North Stream has an extensive catchment upstream of the SPQZ, within which the predominant forest landcover is regenerating native forest. The South Stream has a smaller and narrower catchment with plantation forest cover. These main streams have various tributaries, some of which branch considerably to drain smaller sub-catchments amongst the very steep terrain.

As part of the previous resource consent work within the current QZ, Ecological Effects Assessments were prepared[1], which describe terrestrial and freshwater ecological values in the areas surrounding the quarry footprint. These include Stream Ecological Valuations (SEVs) undertaken within streams on the site and detailed descriptions of most terrestrial values (e.g. birds, lizards, vegetation), with the exception of native bats.

This assessment uses that information as a basis for describing key ecological values on the site, along with site walkovers undertaken by RMA Ecology Ltd in 2020 and 2021 to confirm and update this base information for the proposed PPC area (31.54 ha; Figure 1 to be rezoned SPQZ).

3.0 Methodology

3.1 Desktop Assessment

A desktop assessment of the development footprint and surrounding area was undertaken to identify sites of ecological value, as well as sites already listed as being ecologically significant based on a review of the AUP.

[1] Boffa Miskell Ltd 2017a: Clevedon Quarry Expansion – Assessment of Terrestrial Ecological Effects. Report prepared by Boffa Miskell Ltd for Fulton Hogan Limited.

Boffa Miskell Limited 2017b. Clevedon Quarry Expansion Project: Ecological Effects on Ephemeral Streams. Report prepared by Boffa Miskell Limited for Fulton Hogan Limited.

Geospatial mapping of the watercourses on site was undertaken to assess catchment sizes and lengths of watercourses. Stream lengths were calculated using the spatial models derived from Auckland Council overland flowpaths mapping.

Databases that were reviewed include:

- National Freshwater Fish database
- National Herpetofauna (lizard and frog location) database & Auckland reptile status (2022)
- National and local bat location databases
- Land Environments mapping database and Threatened Environments database
- Bird Atlas of NZ
- Species threat classification publications (Department of Conservation) as needed.

3.2 Site Survey

3.2.1 Vegetation and Wildlife Habitats

Site surveys were undertaken by RMA Ecology Ltd for the following:

- Survey of streams and ecology values across the existing operational quarry and immediate surrounds in 2018 and 2019;
- Ecological survey of the northern part of the current SPQZ land in September 2018;
- Detailed ecological survey of the southern parts of the current SPQZ and parts of the proposed PPC re-zone land in May 2020; and
- Ecological survey of the proposed PPC land in April 2021.

During the site visits, native and exotic plant species and communities were recorded, and a qualitative assessment of vegetation habitats for herpetofauna (frogs and lizards), birds and bats was conducted. The assessment included, but was not limited to, areas of vegetation on site most likely to be impacted or removed by the proposed works, with a focus on the botanical and ecological value of identified plant communities.

Any threatened species found were recorded and their threat status checked against the relevant national threatened species classification lists (Hitchmough et al. 2016, Robertson et al. 2016 and Dunn et al. 2018).

The survey in April 2021 included application of the specific methods associated with wetland classification and delineation as contained within the National Policy Statement on Freshwater Management 2020 (NPS-FM).

3.2.2 Watercourse Classifications

During the site surveys all watercourses and flow paths were mapped as being permanent, intermittent or ephemeral based on the definitions in the AUP (see below). Photographs were taken and a general description of the waterway was undertaken to note characteristics including riparian species and cover, and connectivity to other waterways.

The definitions of stream types within the AUP are listed below in italics.

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:

1. it has natural pools;
2. it has a well-defined channel, such that the bed and banks can be distinguished;
3. it contains surface water more than 48 hours after a rain event which results in stream flow;
4. rooted terrestrial vegetation is not established across the entire cross-sectional width of the channel;
5. organic debris resulting from flood can be seen on the floodplain; or
6. 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.

3.2.3 Wetland delineation

Wetlands were classified according to the AUP, and the recently released NPS-FM, and the National Environmental Standard for Freshwater 2020 (NES-FW), including recent clarification notes issued by MfE on the matter.

At a coarse level, wetlands were assessed using the definition within the Resource Management Act 1991:

- Wetland: permanently or intermittently wet areas, shallow water, and land/water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions, including within the coastal marine area.

Wetlands were further assessed using the definition within the NPS-FM:

- Natural inland wetland: means a wetland (as defined in the Act) that is not:

  (a) a wetland constructed by artificial means (unless it was constructed to offset impacts on, or restore, an existing or former natural wetland); or

  (b) a geothermal wetland; or

  (c) any area of improved pasture that, at the commencement date, is dominated by (that is more than 50% of) exotic pasture species and is subject to temporary rain-derived water pooling.

The NPS-FM/ NES-FW seeks to manage potential adverse effects on natural inland wetlands by restricting earthworks within a 10 m buffer around those wetlands, and earthworks and discharge or diversion of water within a 100 m buffer around the wetland.

The methodology applied for the assessment of wetlands at this site was as follows:

1. Apply the Clarkson (2013) method cited in the NPS-FM 2020 Wetland Assessment Protocol;
2. Assess soils by applying the criteria outlined in Fraser (2018) for identifying hydric (wetland) soils. This involved excavating a hole ca. 400 mm deep to assess and photograph soil moisture, topsoil structure, subsoil structure and presence of gleyed soils and mottling; and
3. When analysing data from the field plots, plots with a vegetation community that meets the definition of improved pasture and are >50 % exotic pasture species dominant would be excluded

from being NPS-FM-level wetlands; the Clarkson method for the Rapid Test and/or Dominance Test/ Prevalence Test would then follow to assess whether an RMA-level wetland was present or not.

3.2.4 Freshwater Habitats

Stream values were assessed using the Stream Ecological Valuation (SEV) method[2].

Stream Ecological Valuation (SEV) is a method for quantifying the values of streams based on the performance of key ecological functions (Table 1).

A range of qualitative and quantitative variables are used to assess the main ecological functions of streams, including in-stream and riparian aspects. Field work includes obtaining aquatic macroinvertebrate samples, fish surveys (or review of existing records of fish presence), cross-sectional measurements of the stream to record depth, velocity and substrate, and a reach scale qualitative visual assessment to record various parameters.

The data is analysed using a series of algorithms to produce a score of between 0 (a stream with no ecological value) and 1 (a pristine stream with maximum ecological value). A score below 0.40 indicates poor ecological function and health and a score above 0.80 indicates excellent ecological function and health (Table 2).

Table 1. The 14 ecological functions used to calculate the SEV score.

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

SEV assessments were undertaken at a representative reach of the South Stream (Stream 1), and its key tributary stream (Stream 1.1) (Figure 2). The character of other streams within the area to be rezoned SPQZ (Streams 1 (upper reach) and tributary Streams 1.2, 1.3, 2, 5.4, 5.5 and 5.9) were assessed against these two SEV sites to ensure that they were adequately represented by these SEV sites.

SEV surveys were undertaken on 20 December 2016, as part of the Boffa Miskell assessments for ENV-2018-AKL-000044. The SEV surveys were designed to understand the values of the streams at summer low flow levels. The site surveys undertaken during May 2020 and April 2021 checked key characteristics of each watercourse against the SEV site data collected in 2016 in order to confirm that stream values had not

[2] Storey RG, Neale MW, Rowe DK, Collier KJ, Hatton C, Joy MK, Maxted JR, Moore S, Parkyn SM, Phillips N and Quinn JM. 2011. Stream Ecological Valuation (SEV): A method for assessing the ecological functions of Auckland streams. Auckland Council Technical Report 2011/009

Neale MW, Storey RG, and Quinn JL. 2016. Stream Ecological Valuation: Application to Intermittent Streams. Auckland Council Technical Report 2016/023.

changed appreciably over that period (all data collected in 2016 is confirmed as still relevant for this assessment).

Table 2. Range of categories for SEV scores relating to overall indicative stream health.

Score	Category
0 – 0.40	Poor
0.41 – 0.60	Moderate
0.61 – 0.80	Good
0.81 – 1.0	Excellent

The specific methodology applied for the SEV is detailed in the Auckland Council technical report 2016/023 for intermittent streams (Neale et al. 2016) and for permanent streams, Storey et al. 2011.

Table 3. SEV assessment reaches. Information source: Boffa Miskell 2017. See also Figure 2.

Location	Site	Coordinates (NZTM)
South Stream tributary (Stm 1.1)	SEV B	E 1784987 N 5899580
South Stream mainstem (Stm 1)	SEV C	E 1784955 N 5899566

4.0 Desktop Assessment Results

A review of the relevant regional planning map and Landcare Research land cover database revealed that there are no areas of vegetation within the PPC area listed as a Significant Ecological Area (SEA) in the AUP, and the vegetation within the site is not legally protected by the Department of Conservation, QEII National Trust, Nature Heritage Fund Covenants, Regional Councils or Nga Whenua Rahu.

Land Environments of New Zealand classifies the entire site in the lowest threatened environment category. Indigenous vegetation within the site is well represented elsewhere and is well protected (LENZ classes > 30 % indigenous vegetation and > 20% is protected). In these environments, indigenous vegetation cover is still vulnerable to threats such as pests, weeds, logging and other extractive land uses (Walker 2015).

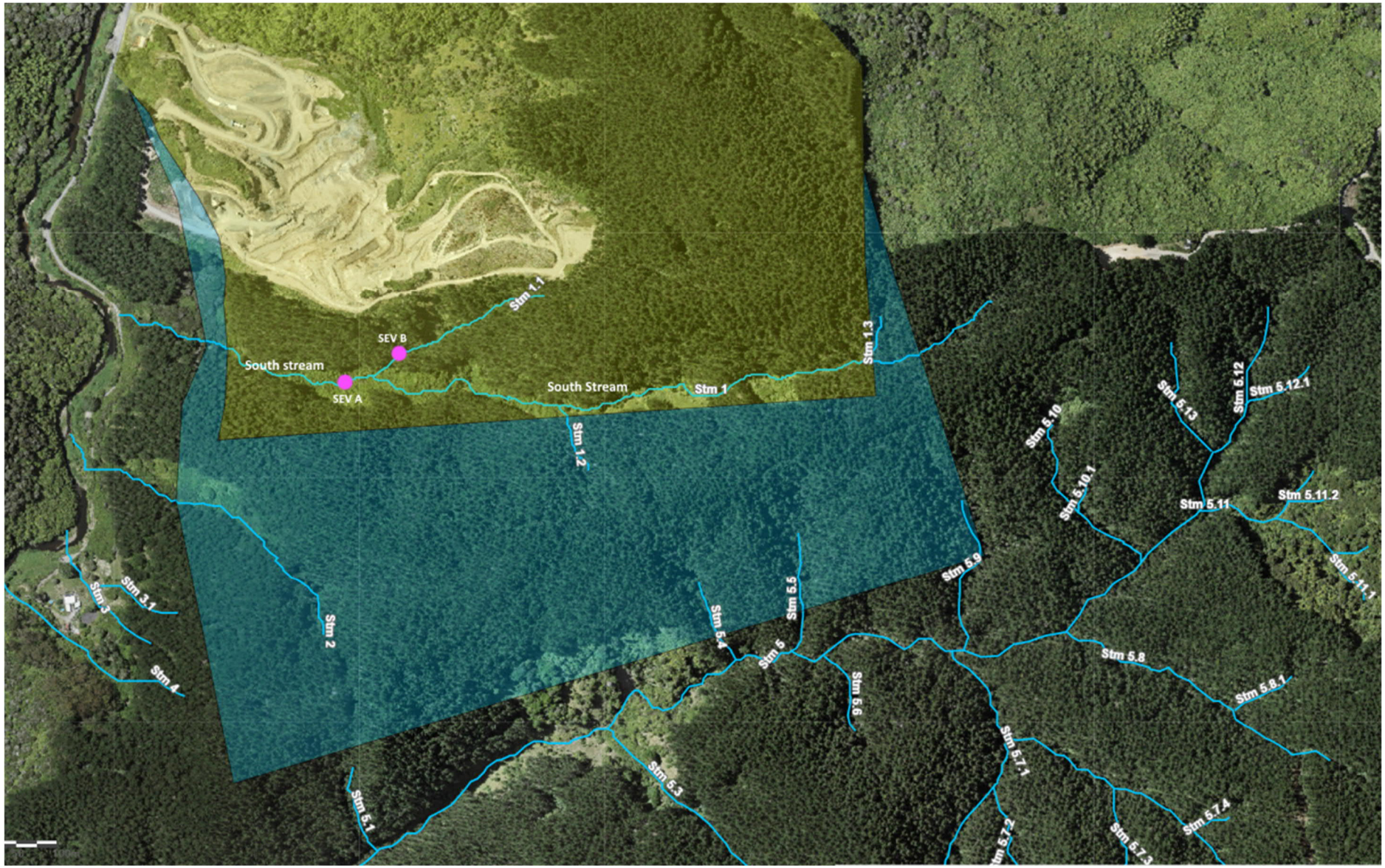

Figure 2. SEV sites (pink points) and streams (blue lines) within and adjoining the PPC re-zone area (blue highlighted area). The existing SPQZ is shown in yellow highlight.

5.0 Terrestrial Ecology

With the exception of habitat values for native bats, terrestrial ecology values are described in detail in the Boffa Miskell report for ENV-2018-AKL-000044. This includes the terrestrial ecological values within the existing SPQZ. Our surveys have added to that information by extending the site survey further south throughout the proposed PCC area.

The ecology values are summarised as follows:

1. Vegetation - values consist of exotic scrub adjacent to the streams, and are bordered by mature pine forest either side. The riparian scrub areas contain a very small component (ca. 1 %) regenerating kanuka (Kunzea robusta). Kanuka has a newly-revised national threat status of 'Threatened – Nationally Vulnerable' (de Lange et al., 2017). While this species is classified as 'Threatened', it is locally very abundant and is not considered to be rare.

   From aerial imagery, the upper parts of Streams 1, 2 and 5 (see Figure 2) appear to support substantial areas of native forest alongside streams. Ground inspection shows that these areas are dominated (90 %) by exotic tree privet (Ligustrum lucidum) of all age classes (very old through to very large numbers of saplings and seedlings) with large scattered areas of exotic blackberry (Rubus fruticosus agg.) amongst rank (overgrown) pasture grasses (9 %). Occasional young mahoe (Melicytus ramiflorus) and kanuka are present. Overall, these areas do not qualify as indigenous vegetation.

   The lower part of Stream 1 (permanent stream) within the existing SPQZ supports riparian vegetation within 5- 10 m of the stream edge that includes a greater proportion of native species including mahoe, pigeonwood Hedycarya arborea, hangehange Geniostoma ligustrifolium var. ligustrifolium, ground cover ferns, some tree ferns (mainly wheki Dicksonia squarrosa) and kanono (Coprosma grandifolia).

2. Herpetofauna - Potential lizard habitats within areas include scattered wood debris and rocks within the pine forest, rank grass and weedy habitats. The rank grass and weedy habitats are suitable for copper skinks. March 2022 review of DOC records revealed that four native lizard species (elegant gecko, forest gecko, pacific gecko and copper skink) have been recorded within 20 km of the site. The exotic plague skink was the most commonly recorded lizard species, but being an Unwanted Organism (Biosecurity Act 1993) does not require further management. Plague skinks were seen throughout the warmer slopes of the site.

   A large number of Hochstetter's frog observations have been recorded over several decades in the national Herpetofauna database. All are from the adjoining Hunua Ranges, with the closest record 4.6 km from the site, at a stream within pine forest. A survey was undertaken for Hochstetter's frog within the northern part of Clevedon Quarry during 2018, and parts of the South Stream during April 2021 by RMA Ecology Ltd (Dr Graham Ussher). The surveys involved turning rocks on steam margins and spotlighting into crevices/ waterfall areas along a 100 m reach of the North Stream, a 200 m reach of a stream to the east of the operational quarry (within 439 Otau Mountain Road), a 100 m reach of the South Stream (Stream 1), and a 200 m reach of stream at the far southern catchment of Greenridge Forest (outside of the PPC area). No frogs were found, and habitat within most of the streams was considered to be poor due to high levels of fine sediments overlying cobble or bedrock substrates (apart from waterfall sections of the North Stream and South Stream). This was particularly evident within the several upper tributary watercourses within the

PPC area, where watercourses were mostly sediment beds with little instream habitat for frogs (see Plate 1).

Plate 1. Upper tributary of Stream 1 in its intermittent state within the PPC area. The stream lacks year-round moist habitat, has a bed of sediment and lacks cobbles, rocks, exposed and creviced bedrock, and other features typically associated with habitat of Hochstetter's frogs. Frogs are very unlikely to be present in streams such as this.

Overall, the recent review of the DOC records provided similar information to the 2016 Boffa Miskell assessment.

All New Zealand lizards are absolutely protected under the Wildlife Act 1953 and a Wildlife Act Authority from the Department of Conservation is required to undertake activities within habitat that may result in a significant impact on a population of native lizards.

Herpetofauna recorded within close proximity to the site, and the likelihood of lizards or frogs being present at this site, are provided in Table 4.

3. Avifauna – The site provides habitat for a range of avifauna, including at least eight native species. No native birds classified as 'At Risk' or 'Threatened' (Robertson et al. 2016) were heard or observed during the Boffa Miskell site visits in 2015 for ENV-2018-AKL-000044. During the RMA Ecology site visit in May 2020 one species of avifauna classified as 'At Risk' was recorded, the North Island kaka (Nestor meridionalis). Several juvenile kaka were observed flying over the proposed quarry expansion footprint. Kaka live within the wider Hunua ranges, and may utilise habitat within the site on a seasonable basis for foraging. Kaka are not likely to nest on site, as they generally require trees with cavities (Moorhouse 2013), which are not present within the plantation forestry and young riparian margin vegetation at this site.

   Birds seen or heard during the RMA Ecology site visit are listed in Table 5.

Table 4: Herpetofauna recorded within 20 km of Clevedon Quarry (Herpetofauna Database; accessed March 2022).

Scientific Name	Common Name	Threat Status (Hitchmough et al., 2015)	Auckland Regional Threat classification (March 2022)	Habitat Type	Likelihood of being present
Oligosoma aeneum	Copper skink	At Risk – Declining	Regionally declining	Throughout the site. Rank grass, logs, weedy habitats	Moderate
Dactylocnemis pacificus	Pacific gecko	Not Threatened	At Risk – Declining	Scrub and forest. Including manuka and kanuka trees.	Very unlikely
Mokopirirakau granulatus	Forest gecko	At Risk – Declining	Regionally declining	Scrub and forest. Including manuka and kanuka trees.	Very unlikely
Naultinus elegans	Elegant gecko	At Risk – Declining	Regionally declining	Scrub and forest. Including manuka and kanuka trees.	Very unlikely
Leiopelma hochstetteri	Hochstetter's frog	At Risk – Declining	-	Small streams within shaded native forest.	Very unlikely
Lampropholis delicata	Rainbow / plague skink	Introduced and naturalised	Introduced and naturalised	Suitable habitat is throughout the site. Rank grass, logs, weedy habitats	Certain – recorded as present

Table 5. Birds recorded at Clevedon Quarry and the PPC area during the RMA Ecology site surveys in May 2020 and/or April 2021.

Scientific Name	Common Name	Threat Status (Robertson et al.,2016)
Circus approximans	Kahu / Swamp harrier	Native – Not threatened
Gerygone igata	Riroriro / Grey warbler	Native – Not threatened
Hemiphaga novaeseelandiae	Kereru / NZ wood pigeon	Native – Not threatened
Nestor meridionalis	Kaka	Native – At risk - recovering
Petroica macrocephala subsp. toitoi	North Island tomtit	Native – Not threatened
Prosthemadera novaeseelandiae novaeseelandiae	Tui	Native – Not threatened
Rhipidura fuliginosa	Piwakawaka / Fantail	Native – Not threatened
Todiramphus sanctus	Kotare / Sacred Kingfisher	Native – Not threatened
Acridotheres tristis	Common myna	Exotic – Introduced and naturalised
Carduelis carduelis	European Goldfinch	Exotic – Introduced and naturalised
Passer domesticus	House sparrow	Exotic – Introduced and naturalised
Platycercus eximius	Eastern Rosella	Exotic – Introduced and naturalised
Turdus merula	Blackbird	Exotic – Introduced and naturalised

4. Bats –Long-tailed bat (Chalinolobus tuberculatus; Threatened – Nationally Critical (O'Donnell et al. 2018)) have been recorded from several areas of the adjoining Hunua Range Regional Parkland.

   Long-tailed bats require large trees (including standing dead trees) with cavities (e.g. deep knot holes), epiphytes or loose bark for roosting; and typically use linear landscape features such as bush edges, gullies, water courses and roadways to transit between roosting and feeding sites (Borkin

and Parsons 2009). In addition to roosting communally in large trees, bats also roost as individuals in smaller trees.

A review of the national database records for bats within a 5 km radius of the site revealed five (5) records of long-tailed bats, all located within the Hunua Ranges Regional Park, with the closest being 3 km to the PPC site.

There is suitable habitat for bats within the proposed quarry expansion footprint, and based on nearby records there is a reasonable likelihood of bats using the site for feeding or roosting or transit to the upper reaches of the Wairoa River.

ENV-2018-AKL-000044 for the existing quarry operation includes condition 56 which addresses the matter of bats associated with existing pine trees within the consented quarry pit.

The issue of bats (and lizards) possibly being present on the site is matter for resource consent applications and that that stage of site development, permissions will be considered under the Wildlife Act.

6.0 Freshwater Ecology

6.1 Overview

The watercourses within the Clevedon Quarry and proposed PPC area are part of the Wairoa River catchment.

The PPC and existing SPQZ land is characterised by very steep gullies and supports plantation forest cover. Two main catchments are included in the PPC area. These include the South Stream (Stm 1) catchment, of which several upper headwater drainage basins are included within the area, as well as a portion of the lower part of the mainstem of Stream 1 (a permanent stream). The majority of this stream is contained in the existing SPQZ. Parts of sub-catchment Stream 2 and some of the true right upper tributaries of the Stream 5 catchment, which is a broad, branching catchment to the south, are also included in the PPC area.

Overall, the length of stream included within the PPC area is relatively small compared to the extensive branching networks throughout the current SPQZ area and the catchment to the south of the PPC area.

Table 6 summarises the streams that are within the PPC area. Apart from the small portion of lower Stream I, all other streams within the PPC area are upper headwater intermittent streams and ephemeral watercourses of the type shown in Plate 1. Together these form a very small proportion of the overall catchments of Stream 1 and Stream 5. When taken together with the current Quarry Zone, all of the catchment of Stream 1, and a small portion of the catchment of Stream 5 would be within the existing or rezoned SPQZ for this site.

Table 6. Length of each stream class for the three catchments within the PPC area.

Stream Class	Catchment			
	Stream 1	Stream 2	Stream 5	Total (m)
Permanent length (m)	30	nil	Nil	30
Intermittent length (m)	190	280	225	695
Total (m)	220	280	225	725

Streams within the site support hard rock geology (i.e. hard-bottomed streams) and are less common than streams within soft geologies. Table 7 provides a GIS analysis of indicative streams in the Auckland region, as inferred by catchment flow path modelling. Watercourses with catchments greater than 4,000 m^2 on the PPC/ Clevedon Quarry site generate streams that are at least intermittent in nature.

The analysis indicates that there are likely to be several thousand kilometres of hard-bottomed streams on the mainland part of the Auckland Region, with more on the primary islands of the Hauraki Gulf.

The PPC area includes 725 m of hard-bottomed stream (the sediment-filled upper headwater sections are assumed to be hard bottomed under drifts of deposited sediments from farming and forestry practices).

At a regional level, this represents around 0.05 % of the available hard-bottomed watercourse that exists within the Auckland region mainland area.

Table 7. Availability of flow path length over soft and hard-bottomed substrates in the Auckland Region, as a proxy for availability of intermittent and permanent stream type and length.

Watercourses within catchments greater than 4,000 m2; geological type	Mainland Auck Region (m length)	Rest of Auck Region (m length)*
Strong Sedimentary (hard-bottomed)#	1,483,637	804,126
Strong Igneous (soft-bottomed)	1,250,747	956,437
All other geologies (soft-bottomed)	41,892,093	1,603,084

* Rest of Auckland Region includes Waiheke, Kawau, and Great barrier Islands.
# Geology uses NZLRI Surface Rock Type Layer GIS layer.

6.2 Stream Habitats

Stream habitat attributes streams within the PPC area are summarised in Table 8 below. Detailed descriptions are provided in the following sections.

Table 8. Stream habitat attributes within the PPC area. Information source Boffa Miskell 2017. [1]SEV, Vdepth; [2]SEV, Vsurf; [3]SEV, Vrough; [4]SEV, Vshade and RMA Ecology Ltd from onsite measurement.

Site	Stream 1.1 tributary	Stream 1, 5.4 and 1.2 upper headwater	Streams 1.3, 5.9, 5.5, and 2
Location			
Mean width (m)	0.9	0.5	0.55
Mean depth (m)[1]	0.01	0.01	0.01
Substrate percent cover[2]			
Silt %	35	90	70
Gravel, cobble %	35	5	20
Boulder %	30	0	10
Bedrock %	0	2	5
Wood %	0	2	1
Leaf, roots organic %	87	66	70
Riparian Type[3]			
Pine plantation %	30	90	80
Exotic scrub %	70	10	20
Shade class proportion[4]			
High 71-90%	0.9	0.9	0.9
Moderate 51-70 %	0.1	0.1	0.1
Low 31-50%	0	0	0

6.2.1 Streams 2, 5.5, 5,9 and 1.3

These watercourses consist of long narrow gullies which travel through a series of steep cascades (including waterfalls in places). Water flow is very slight (a trickle). Habitats include mossy rock faces and small plunge pools that are packed with leaves. The streams are well shaded by plantation pine forest, with privet understorey and grass ground cover in places.

All of these headwater reaches provide adequate habitat for native freshwater fish, with stable pools and in-stream conditions (e.g. undercut banks) which are adequate to support fish.

In places there is evidence of sediment accumulation from some time ago (bank deposits now rooted with seedlings) – possibly arising from sediment discharge to watercourses prior to conversion to pine forest.

6.2.2 Stream 1 (headwater), Stream 1.2, and Stream 5.4

These watercourses have predominantly sediment beds with very low normal flow. The channel is nominal and habitat for koura and fish is absent. These streams occupy the transition points between ephemeral watercourses and intermittent streams and hence are dominated by typically poor instream habitat, poor hydrological complexity and poor overall habitat for instream fauna (see Plate 1).

Stream width is around 0.5 m on average. Root intrusion into the stream bed (or erosion of root masses by water courses) is high, and leaf litter packs are frequent along the channel.

6.2.3 Stream 1 (lower portion within PPC area)

This section of stream scores highly for almost all SEV function scores and is a good example of a natural, permanent foothills stream. The bed is ca. 1 m wide (narrower at chutes and wider at pools and gravel-plains. Instream habitat is very good for native fish with a complex suite of pools runs, riffles and chutes throughout the stream (Plates 2 and 3). Pools have excellent habitat with undercut banks, fractured bedrock bases and abundant leaves and woody debris. Shade provided by the established privet forest and pine forest overhead canopy is high. Drifts of sediment and gravel along parts of the stream are ongoing evidence of a slip that occurred into Stream 1.1 from widespread flooding several years ago and from which the stream is still recovering from the large volume of deposited material in the watercourse.

6.3 Fish

The New Zealand Freshwater Fish Database (NZFFD) contains records of eight (8) species of fish from the Wairoa River catchment (including two exotic species), of which two are listed as 'At Risk' in the latest threat classification (Dunn et al., 2018) (Table 9).

Table 7: Fish species recorded from the Wairoa River catchment in the NZFFD as of April 2020.

Scientific Name	Common Name	Threat Status (Dunn et al., 2018)
Anguilla australis	Shortfin eel	Native - Not threatened
Anguilla dieffenbachia	Longfin eel	Native – At risk declining
Cyprinus carpio	Koi carp	Introduced and naturalised
Galaxias fasciatus	Banded kokopu	Native - Not threatened
Galaxias maculatus	Inanga	Native – At risk declining
Gambusia affinis	Gambusia	Introduced and naturalised
Gobiomorphus basalis	Crans bully	Native - Not threatened

Scientific Name	Common Name	Threat Status (Dunn et al., 2018)
Gobiomorphus cotidianus	Common bully	Native - Not threatened

A fish survey was undertaken within the mainstem of the North Stream during the 2016 surveys by Boffa Miskell. During this survey three species of fish were recorded, including banded kokopu (Galaxias fasciatus), shortfin eel (Anguilla australis) and 'At Risk' longfin eel (Anguilla dieffenbachia) (Dunn et al., 2017). We expect the same species of fish to be present within Stream 1 where it has permanent flow and pools.

There unlikely to be fish within streams within the PPC area that have no flow for part of the year and where pools or deep sediments provide summer habitat. This applies to most of the streams within the PPC area, apart from the lower part of Stream 1 within the PPC area, where these three fish species (eels and kokopu) are expected to be present.

Plate 2. Lower section of Stream 1.

Plate 3. Lower section of Stream 1.

6.4 Macroinvertebrates

Macroinvertebrate samples were collected as part of the Boffa Miskell assessments at the SEV sites, following the Ministry for the Environment's 'Protocols for Sampling Macroinvertebrates in Wadeable Streams' (Stark et al. 2001). Samples were preserved in 70 % ethanol and processed according to 'Protocol P3: Full Count with Subsampling Option'. Macroinvertebrates were identified to the level required for Macroinvertebrate Community Index (MCI) assessment, which is standard. For each sample macro-invertebrate community health was assessed using the following indices or metrics:

- Total Abundance: This is the total number of invertebrates recorded in the samples.
- Taxonomic Richness: The total number of taxa (usually species or genus) recorded in a sample. This reflects the health of the community through a measurement of the variety of the taxa present.
- EPT Richness: The total number of taxa belonging to the orders Ephemeroptera, Plecoptera and Trichoptera (mayflies, stoneflies and caddisflies, respectively). These insect groups are generally dominated by pollution-sensitive taxa. The EPT index usually increases with improved water quality and increased habitat diversity with a higher value indicating good conditions.
- Macroinvertebrate Community Index (MCI) (Stark and Maxted, 2007a, b): The MCI derives a stream health score from pollution-sensitivity scores assigned to each macroinvertebrate taxon. Taxon scores are between 1 and 10, with 1 representing species highly tolerant of organic pollution (e.g. worms and some dipteran species) and 10 representing species highly sensitive to organic pollution (e.g. some mayflies and stoneflies). A site score is obtained by summing the scores of individual taxa and dividing this total by the number of taxa present at the site. Guidelines for interpretation of scores are given in Table 10.

Table 10. Interpretation of Macroinvertebrate Community Index values (Stark and Maxted 2007).

Quality Class	Description	MCI
Excellent	Clean water	> 119
Good	Doubtful quality	100 – 119
Fair	Probable moderate pollution	80 – 99
Poor	Probable severe pollution	< 80

Macroinvertebrate samples were taken at both SEV locations (Table 11). Macroinvertebrate community health was good at both SEV sites with MCI-hb index score of >100 which indicates a healthy watercourse. This accords with site observations that there is abundant riparian cover at the stream edge, and an unmodified stream bed with complex in-stream morphology and habitat. These results are relevant to the lower downstream portion of Stream 1 within the PPC site; other headwater streams were not sampled due to a lack of flow and invertebrate habitat.

Table 11. Macroinvertebrate results. Information sourced from Boffa Miskell 2017.

SEV site	Number of taxa	% EPT taxa	MCI-hb
Stream A	28	56	117
Stream B	21	15	108

SEV function scores are summarised in Table 12.

SEV assessments were undertaken in Stream 1 and tributary 1.1 and, with the SEV scores are shown in full in the SEV excel spreadsheets attached to this report.

The SEV function scores reported here are relevant to the downstream section of Stream 1 that is within the PPC, and also to the upper headwater sections of Streams 1.3, 5.9, 5,5 and 2 within the PPC site.

Streams 1.2, 5,4 and the upper headwaters of Stream 1 were not assessed for SEV values, however they are expected to have a lower score although the scores will be indicative of moderate quality stream environments.

Table 2. SEV function scores for streams B, C, D. Information sourced from Boffa Miskell 2017.

Site	SEV A	SEV B
Location	South stream	South stream tributary
Hydraulic mean score	0.94	0.97
Biogeochemical mean score	0.89	0.96
Habitat provision mean score	0.84	0.61
Biodiversity mean score	0.70	0.41
Overall mean SEV score	0.86	0.79

6.5 Wetlands

There are no areas within the PPC area that meet the definition of a wetland.

7.0 Recommendations

Streams exist within the current SPQZ and within the area proposed to be rezoned SPQZ. The provisions of E3 apply to the modification of streams where relevant, along with the regulations of the NES-FM and National Environmental Standards for Plantation Forestry 2018 (relevant to the existing forest cover). The AUP definitions of streams and the existing rules provide the framework to manage effects of activities on these features.

There are no wetlands or areas of indigenous vegetation within the PPC area. The AUP's mapping of SEAs is considered to be accurate for the PPC area.

The AUP includes a comprehensive set of rules relating to identified features (for example E3 for streams) and for the management of adverse effects arising from the development of the PPC site (for example, Appendix 8 of the AUP relating to biodiversity offsetting).

These are considered to be appropriate to address the potential for adverse effects in the same way they already apply to the existing SPQZ as and when resource consents for development of the quarry are sought.

From an ecological perspective, these rules are appropriate to address relevant effects that may be generated at the time of resource consent.

8.0 Opportunities

If this PPC application is successful, it could result in areas of stream most probably being applied for under E3 of the AUP and the NES-FM to be diverted, modified or removed to access the underlying aggregate resource. Lengths watercourses could be diverted, modified or removed permanently from the site, along with the ecological values associated with them.

While no resource consents are being sought associated with the PPC at this time and the PPC is relying on the operative policies and rules of the AUP, this section of the report investigates where and how the probable adverse effects of stream removal could be managed - even if only in concept at this PPC stage. This is provided as information only.

Management of adverse effects can be divided into two key areas - mitigation (minimisation) of the magnitude of adverse effect and offsetting (redress) whereby enhancements are proposed at locations elsewhere to provide an overall balance of ecological losses and gains.

The tools available to guide decisions and method selection in this regard are widely used in ecological practice and have recognised standards associated with them. The EIANZ EcIA guidelines (Roper-Lindsay et al. 2018) provides tools to assess significance of effects and a step-wise guide to applying the effects management hierarchy. The Local Government Guidance on Biodiversity Offsetting under the RMA (Maseyk et al. 2018) provides guidance on how and when to apply biodiversity offsetting, and supports the AUP Appendix 8 criteria around offsetting.

We have undertaken a preliminary design for mitigation and offsetting that could be applied to this PPC area if resource consents to develop the land as a quarry are approved in the future. As part of this we have worked through a geo-spatial analysis of stream enhancement sites, field-tested several of these areas, and used a standard offsetting accounting tool (the Steam ecological Valuation offset model) to evaluate losses and potential gains as part of constructing a working biodiversity offset concept for this site.

We describe key parts of this below.

8.1 Avoidance and Mitigation

There is little opportunity to avoid adverse effects, given that the resource (aggregate) is spatially fixed and the area affected by vegetation and stream clearance is largely governed by the depth of the resource, quarry pit planning and geotechnical design constraints. Therefore, for the purposes of the concept design proposed below, we have assumed that all of the vegetation and streams within the PPC area will be removed.

Mitigation initiatives include:

- Salvage and relocation of native fish to adjoining streams within Greenridge forest;
- Consider formal survey for herpetofauna within the area of the resource consent; salvage and relocation if populations are recorded and if numbers warrant relocation.
- Ensuring that earthworks on the site adheres to a comprehensive sediment and erosion control management plan to GD05 standards.

Typically, management plans would be prepared as conditions of resource consent for these matters.

Offset:

- Greenridge Forest comprises ca. 500 ha of plantation pine forest adjoining (east and south) of the PPC area. The forest is owned by Fulton Hogan (parent company of Stevenson) and could be available as an offset site.
- The current land use of Greenridge Forest supports cyclical harvesting and re-planting of plantation species. Evidence from plantation harvest cycles elsewhere indicates that even with best current practice and restrictions around harvesting and replanting near watercourses (as per the National Environmental Standards for Plantation Forestry 2018), the following will likely result in streams within Greenridge Forest:
    - Removal of woody vegetation cover over all ridges, spurs, valley sides and down to within 5 m of all streams.
    - Mobilisation of soil through the use of heavy machinery on the site, which will migrate downslope and enter watercourses as fine sediments.
    - Sediment entering watercourses has wide-ranging adverse effects on fish and macroinvertebrate populations and can change stream substrate quality for many years as silts fill in cobble interstices.
    - Following plantation tree harvest, there is likely to be a narrow band of vegetation remaining along each stream (mostly comprising privet trees and understorey privet and native shrubs). Shade for watercourses is likely to reduce substantially as the pine canopy overhead and understorey beyond 5 m is removed. Some limited areas may have a wider band of vegetation retained where streams become broad wetlands or where planting was not to the stream edge (we estimate this to be ca. 3 % of the Greenridge Forest area).
    - If the Greenridge Forest site is replanted in plantation tree species, the stream margin vegetation may be further affected if broadscale spraying to remove weeds across the site is applied (which we understand is common practice prior to replanting plantation areas). Following this, the margin vegetation should gradually improve over several years to an increased density of shrubs and trees (Year 10 - 15 or thereabouts). When pine forest canopy cover fully closes over once again (Year 15 or thereabouts), the understorey vegetated margin closest to the stream will likely thin to a less dense understorey cover for the duration until the next harvest (Year 28 or thereabouts).

The most damaging parts of this harvest cycle are the partial loss of shading to the stream, and the discharge of sediments to the stream environment. Both have the effect of reducing habitat quality and availability, and resulting in a decline of fish and instream invertebrate species that are susceptible to poorer water quality.

The concept envisaged by Stevenson is to retire large parts of Greenridge forest around the riparian margins of watercourses and create permanent protection for streams from cyclical harvesting impacts.

The specific areas that could be retired could be determined in accordance with the amount of offset that is needed to provide a clear net-benefit outcome in relation to the types and lengths of streams that could be affected by a quarrying resource consent. If the loss of streams is small, the offset area may encompass only part of Greenridge Forest; if the proposed loss of streams is great, all or most of Greenridge Forest streams may be required for enhancement and protection.

The concept includes:

- Retirement of stream margins (width to be determined by an ecology assessment at time of resource consent) from harvesting and plantation management.

- Natural revegetation could be assisted through weed and pest animal control and enrichment planting at low densities. The natural introduction of seed from the adjoining Hunua Ranges Regional Parkland by wind and birds is predicted to substantially kick-start native regeneration processes.
- Plantation forestry would be restricted to areas away from streams and their margins. Crossings of stream (where necessary) would follow required practice laid out in the AUP and NES-PF.
- Within Greenridge Forest there are five areas of regenerating or secondary mature native forest. These patches have been isolated from other patches and from the Hunua Ranges during many decades of farming and forestry. The stream enhancement concept could incorporate these forest patches and link them to streams. Animal pest control could enable natural regeneration of canopy native trees to restart.
- The concept could result in a large swath of indigenous vegetation and stream corridors being protected in perpetuity. The number of streams, catchments and linkages provided between the Hunua ranges to the east and to the various reserves along the western side of the Wairoa River to the west of Greenridge Forest would be multiple and have enormous benefits for the movement of native birds, native plants and ecosystem processes.
- The Plates and Figures below show parts of the Greenridge site, including streams types across the site, and the indicative network of streams across the site that are available for riparian protection an enhancement.

Plate 1. Stream P1 upper – central eastern part of Greenridge Forest.

Plate 2. Stream P1 lower - central eastern part of Greenridge Forest.

Plate 3. Stream I9 – far southern part of Greenridge Forest.

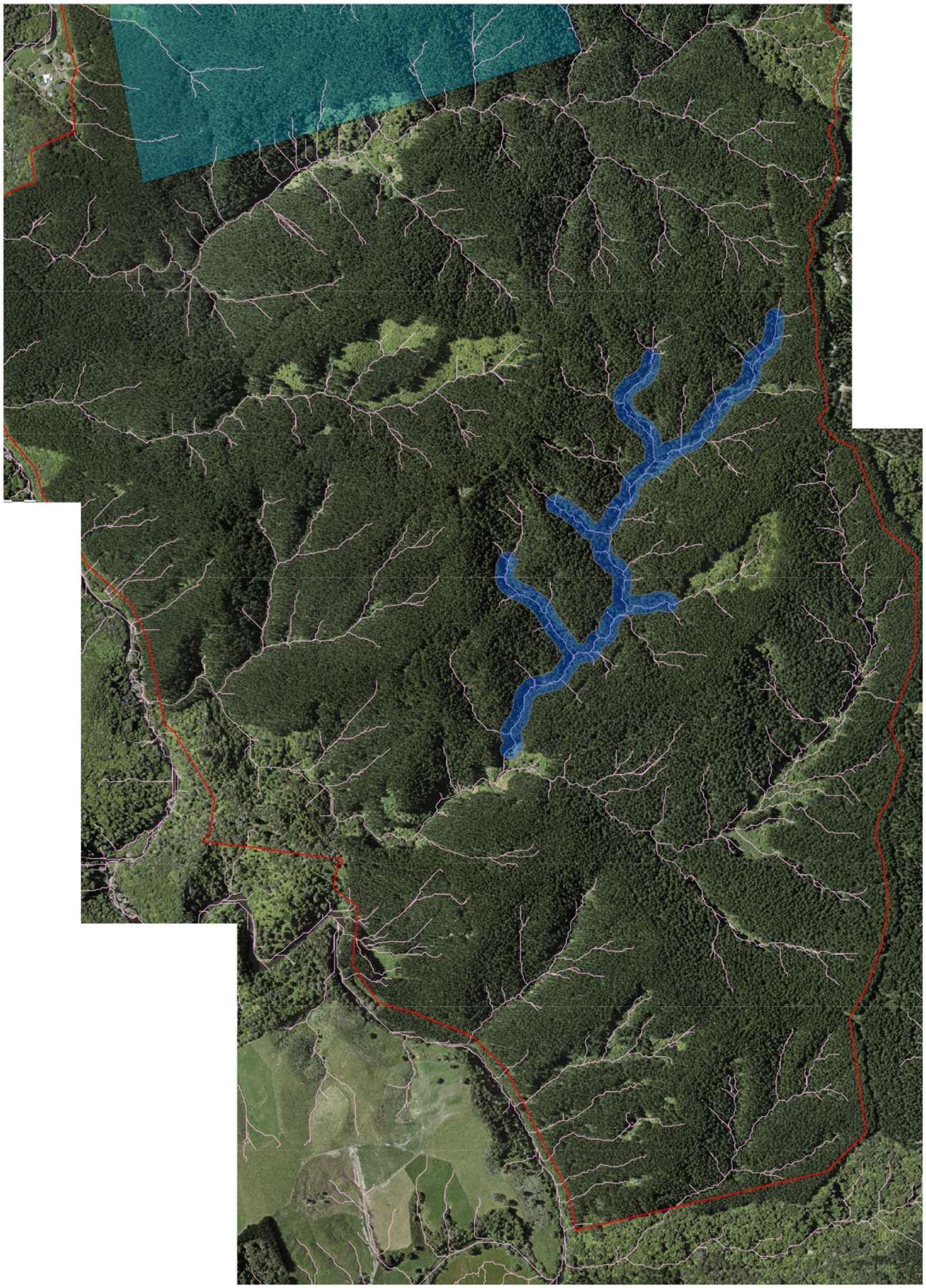

Figure 3. Indicative stream network across Greenridge Forest (red boundary) as modelled based on catchment sizes (source – AC Geomaps). The blue shaded area at the top of the Figure is part of the PPC SPQZ area. See Figure 4 for an explanation of the stream with blue border.

Figure 4. Example of an intermittent and permanent stream system (solid white line) in the southern part of Greenridge Forest), with modelled stream mapping (light-coloured purple lines), and a riparian margin buffer (blue boundary around stream).

9.0 References

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