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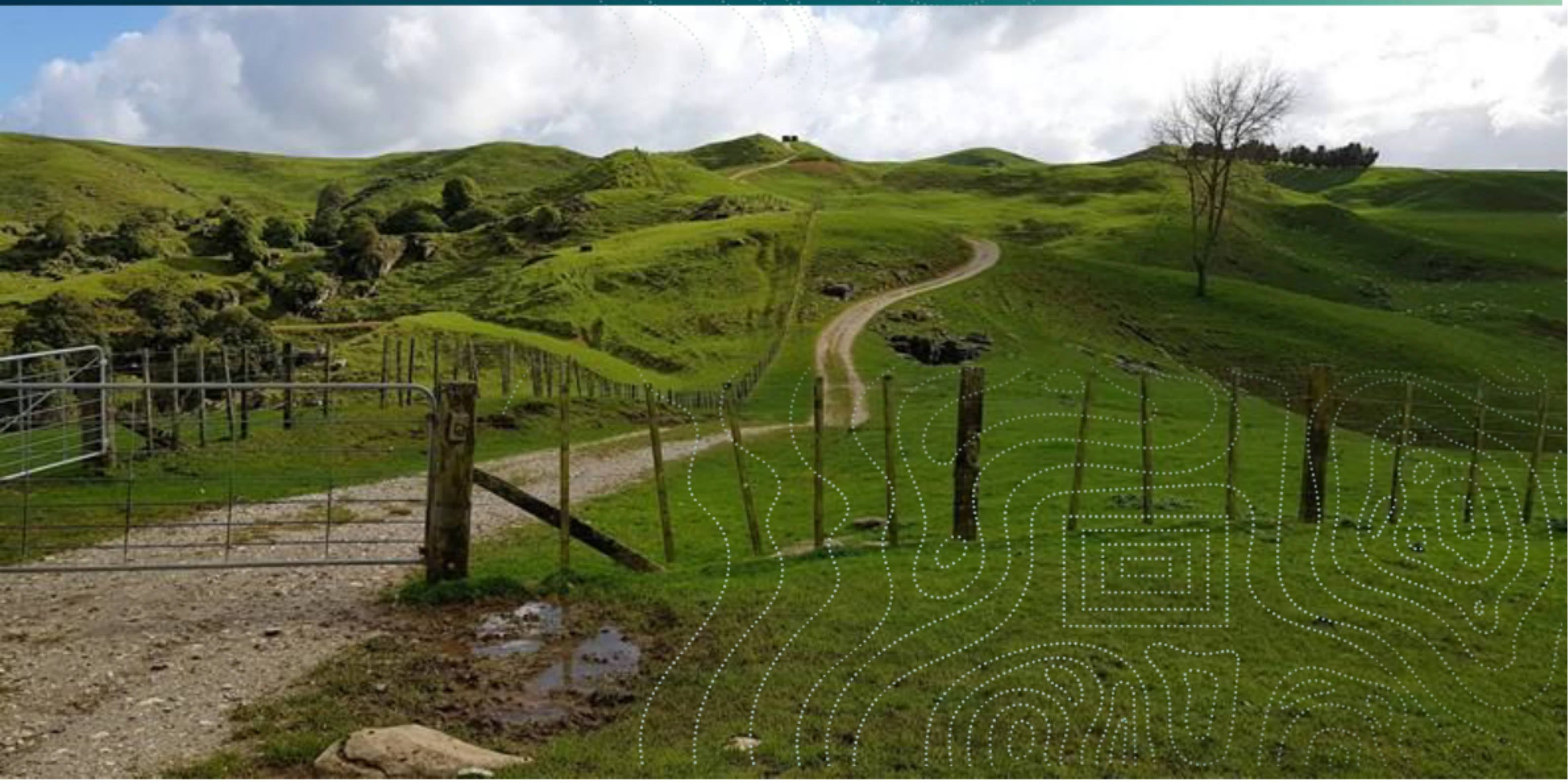

Oparure Quarry South-Western Pit

Terrestrial and Subsurface Ecology Assessment

Prepared by Dr Vaughan Keesing
9 July 2026

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Cover photograph: example of limestone surface rock and trees in pasture @PDP2025

Executive Summary

The South-Western Pit area proposed to be quarried is comprised of grazed pasture with stock present throughout, scattered areas of exposed limestone outcrops and areas of limestone and native vegetation remnants. Indigenous vegetation is concentrated in small bush fragments around limestone surface formations and scattered mature trees across the site made up of both exotic and native species. There are dolines in pasture and 7 cave entrances to 7 small, short caves.

A Significant Natural Area is located near the western boundary of the pit and to avoid potential effects to this area, a buffer has been provided from the South-Western Pit.

Although the site is primarily dominated by pasture, the small native-bush remnants and rock formations provide foraging and nesting habitat for terrestrial fauna.

A single New Zealand bush falcon (*Falco novaeseelandiae ferox:* At Risk-Recovering) was observed on site, but no evidence was found that falcon was using this area for breeding.

Two species of indigenous lizards have been found through survey. The copper skink (*Oligosoma aeneum*: Not Threatened) and the ornate skink (*O. ornatum*: At Risk Declining).

Field surveys have confirmed presence of long-tailed bats (*Chalinolobus tuberculatus*: Threatened - Nationally Critical), along with potential roosting trees on the Project site. It is considered likely that the South-Western Pit area is used for commuting, and foraging, but less likely roosting.

Lizard, bird and bat management protocols will need to be in place to avoid direct harm to those faunal groups. A lizard salvage and transfer permit from DOC is in place. Wildlife authorities to manage effects to other faunal groups are not required because of the avoidance protocols.

The permanent removal of karst features and small indigenous bush remnants are the key terrestrial effects associated with the South-Western Pit (where harm to any of the identified the faunal groups is avoided).

The South-Western Pit has seven cave features present, with none greater than 50 m long and most crawling access only. Each cave system has been surveyed and the in-cave fauna recorded to assist with determining ecological value following the EIANZ process.

Cave surveys recorded no “threatened or at-risk” taxa, and none are expected.

The development of the proposed South-Western Pit will result in around 1 ha of native vegetated Karst features and the loss of the seven caves, with a loss of 111 m^2 of cave floor.

The level of effects at the Ecological District level is less than minor, the level of the residual effect in the absence of remedy is less than minor and does not trigger an offset. However, in keeping with the spirit of the National Policy Statement for Indigenous Biodiversity (NPS IB) policy 7, I recommend that 7 cave entrances be protected and enhanced (including 111m^2 of cave floor), and Graymont volunteer approximately 2.5ha of revegetation, protection and management (in addition to riparian and land sediment revegetation) in and around the existing SNA. Within that area is also a highly managed new lizard habitat area with predator control. Graymont has also committed to protecting and enhancing 21 cave entrances. These elements are included in the extensive ecological betterment plan proposed by Graymont (PDP 2026), which I support.

Overall, the ecological outcomes are a net gain as set against the current permitted land use activities.

Contents

1.0 Background

1.1 Purpose and scope of this report

This report provides an assessment of the actual and potential ecological effects in relation to terrestrial and cave ecology, generated by the proposed Oparure Quarry South-Western Pit (SW Pit) (the Project).

This report forms part of a suite of technical assessments prepared for Graymont to inform the Substantive Application under the Fast-track Approvals Act 2024 (FTAA) for the Project. This report should be read in conjunction with the Substantive Application Report.

The scope of this assessment includes a description of the methodology applied in preparing the assessment, determination of the actual and potential effects generated by the Project, and details of the proposed measures to manage and mitigate adverse effects. I note that the ecological values as defined here do not include cultural values (e.g. taonga species), which are recognised in the Cultural Impact Assessments.

1.2 Qualifications and Experience

I am a senior Ecologist and Director with the consulting firm of BlueGreen Ecology Limited (BGE). My qualifications include a B.Sc. (Hons, 1st) in Zoology and a Ph.D. in Ecology, both from Massey University, as well as a Certificate in Research Statistics. I have been a consulting ecologist for the last 28 years, with skills and experience in community ecology. I have specialist skills in the areas of plant ecology and entomology (I also have caving experience) with numerous Significant Natural Area (SNA) delineation experiences, and many Council hearing, Environment Court and Boards of Inquiry experiences.

This report is a compilation of older reports and surveys undertaken by a wide range of ecologists associated with Ecology New Zealand Limited, WSP and other independents (Dr Mandy Tocher, Dr Titia Schamhart).

1.3 Code of Conduct

Although this application is not before the Environment Court, I confirm that I have read the Code of Conduct for expert witnesses as contained in section 9 of the Environment Court Practice Note 2023. I agree to comply with that Code. My qualifications as an expert are set out above. I am satisfied that the matters which I address in this assessment are within my area of expertise, except where I state that I am relying on information provided by another person or expert. I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

2.0 Introduction

This report is a compilation of the recent history of research, survey and assessment undertaken for the SW Pit (2020-2025). It summarises all of the work done to date to reflect Graymont's response to issues raised during consultation to remove parts of the Project site included in the previous application in order to avoid sub surface stream flows in the northern catchment which drains into the upper Mangawhitikau catchment (which is an ecologically sensitive area, known specifically for glowworms). The application put forward under the FTAA is for a reduced pit area (approximately 2/3rds of the original) and includes a refinement zone related to the Camelot cave system .

The following report utilises Ecology New Zealand and WSP's data (2019-2022) and reporting (Eco NZ September 2022), the various Section 92 responses to the Regional Council, the cave report of Dr Keesing (2025), more recent information supplied by Dr Mandy Tocher and Dr Schamhart in regard to Herpetology and Dr Schamhart in regard to bats, and additions and re-assessment by Dr Bellham.

Minimum requirements for the ecological betterment plan (the effects management regime) initially constructed by PDP from recommendations of the Project ecologist are also identified based on the changes to potential effects from the reduction in the proposed quarry area.

Several species group management plans have also been prepared. The lizard management plan has been certified by DOC with a Wildlife authority in place to salvage and transfer lizards. The bat and bird management plans ensure effects are avoided (as best as is possible) and no further wildlife act permits are required.

2.1 The revised pit extent and activities

The Oparure Quarry SW Pit Project lodged by Graymont (NZ) Limited consists of the operation and progressive rehabilitation of the new limestone pit at Graymont's existing Oparure quarry north of Te Kūiti in the Waitomo District and Waikato Region.

Quarrying at the SW Pit would be, as at the existing pit, opencast. The area to be disturbed over the lifetime of the pit would be 57.4 ha over 53 years (by 2080). However, only small sections would be quarried at a time in stages and then rehabilitated. Mining infrastructure associated with the pit would include a 1.3 km haul road.

The revised SW Pit has reduced the area proposed to be quarried from that for which the original assessments were undertaken. This reduction has avoided potential effects on a number of karst features, dolines and cave entrances. Provisions have also been made to manage potential effects on the Camelot cave system as a whole and on aquatic ecology (see Ms Drummond's report). Effects on the Digme system remain as previously assessed. The revised pit extent also ensures at least a 10m buffer to the recognised draft SNA to the west.

Figure 1 Revised pit area (pale blue)

Only seven cave entrances (and caves) will be affected, and these (Camelot cave aside) are the shorter, poorer examples. Most of the new pit area is only pasture and scattered small limestone outcrops with a low diversity of associated native scrub and fern and small clusters (primarily in the north and east) of native and exotic trees.

2.2 **Location**

The site is situated within the Waitomo Ecological District of the Waikato Ecological Region (McEwen, 1987). Land cover is largely comprised of pasture, but also includes some small native-dominated bush blocks, as well as scattered mature native and exotic trees. The site also contains limestone bedrock and karst features which are common within the Waitomo Ecological District.

According to the Waikato Regional Council's Local Maps vegetation biodiversity layer, the woody vegetation types occurring on-site are predominately "Broadleaved Indigenous Hardwoods" with some areas of "Exotic Hardwoods" and "Pine Forest". The existing Oparure Quarry, located at 806 Oparure Road, is New Zealand's largest single lime quarry. The Quarry is located approximately 8 kilometres west of Te Kūiti.

2.3 **The Activity**

The activity, in summary, requires the stripping of all surface features and extraction of material to a depth of approximately 58 m. This is followed by recovery of the limestone and rehabilitation of the pit to useable land post-quarrying. The activity involves large machinery, haul roads, blasting, dust, noise, lighting and the potential for sediment contamination of watercourses, and so requires careful assessment and proposed mitigation.

3.0 Study and Assessment Methods

Pre-survey reconnaissance site inspections were carried out in June 2019 by ENZL ecologists. An unmanned aerial vehicle (UAV) was used to take high-resolution aerial imagery of the site which assisted in mapping vegetation communities and determining the fauna survey efforts. A site visit was undertaken on 3-4 October 2019. During this visit, a detailed vegetation assessment was completed, and artificial cover objects (ACOs) were set and left to establish for lizard surveys. Acoustic recorders for birds and bats were also set. The final ENZL site visit was undertaken from 4-7 November 2019 and included lizard surveys, bird surveys and bat surveys.

In November 2021, additional surveys were carried out in order to verify and refine assessments and effects management recommendations. This field work (by WSP ecologists) included lizard surveys, acoustic bat and bird monitoring, roost assessments, animal pest monitoring, wetland vegetation assessments and karst system mapping and values assessments. The level of effort put in by both ENZL and WSP is considered by this author as suitable for the site based on its size and complexity.

3.1 Vegetation

The vegetation community and habitat surveys followed standard RECCE (McNutt, 2012) and plant descriptions (Atkinson, 1962) used to then map the areas and species. LENZ, via the Landcare free access web site was used to determine the threat classification of the land environment in which the vegetation sits (Leathwick, J R, F Morgan, G Wilson, D Rutledge, M McLeod, and K Johnston., 2002). Species conservation classifications follow the updated Department of Conservation (DOC) classifications (De Lange et al., 2024; Townsend et al., 2008).

3.1.1 Natural inland wetlands

Potential wetlands were identified during November 2021 using aerial photography. The wetlands that were identified were visited on the 25th of November 2021 (WSP) and assessed using the Clarkson 2013 wetland delineation method which is the same method as has been adopted by the Ministry for the Environment (MfE) delineation protocol (MfE, 2022) -rapid assessment, dominance indices, prevalence indices and then hydrology (MfE, 2021) and soils (Fraser et al., 2018) as required.

3.1.2 Karst System Mapping and Value Assessment

Each karst ecosystem present on site was mapped, photographed and classified as either Low, Moderate or High value where Low value consisted of karst with only exotic vegetation (pasture) present, Moderate consisted of karst with mostly exotic vegetation (pasture) but some native vegetation present, and High consisted of karst with a high cover of native vegetation.

Fifty-five areas of karst ecosystem were mapped and classified on site.

3.2 Invertebrates

Terrestrial invertebrate surveys were primarily done alongside the lizard surveys. Any notable terrestrial invertebrates (e.g., weta, native beetles) encountered by ENZL ecologists while on-site were documented. Invertebrates using the ACOs were noted, as well as any invertebrates encountered during nocturnal spotlighting.

3.3 Birds

Two acoustic recorders (DOC AR4s) were set for four consecutive days (04-07 October 2019) and two further deployed by WSP 22—24th November 2021. These were placed within the site, focusing on non-pastural vegetation and limestone outcrops. The acoustic recorders were set to 'Low' and programmed to record throughout the day and night (24 hours a day). All bird species were documented when data analysis was undertaken. Kaleidoscope Pro Analysis Software (Wildlife Acoustics, Inc. 2019) was used to interpret both sets of collected data.

While on site ENZL undertook three separate five-minute bird counts across the site, following standard methodology (Dawson & Bull, 1975).

During site visits of both teams, a record was also taken of all bird species encountered (heard, seen, or recorded) across the site and within immediate vicinity of the site.

Kiwi call surveys were undertaken approximately two hours after sunset in the evenings of the surveys. These were completed from a high point atop one of the hills on site, for a minimum of 10 minutes.

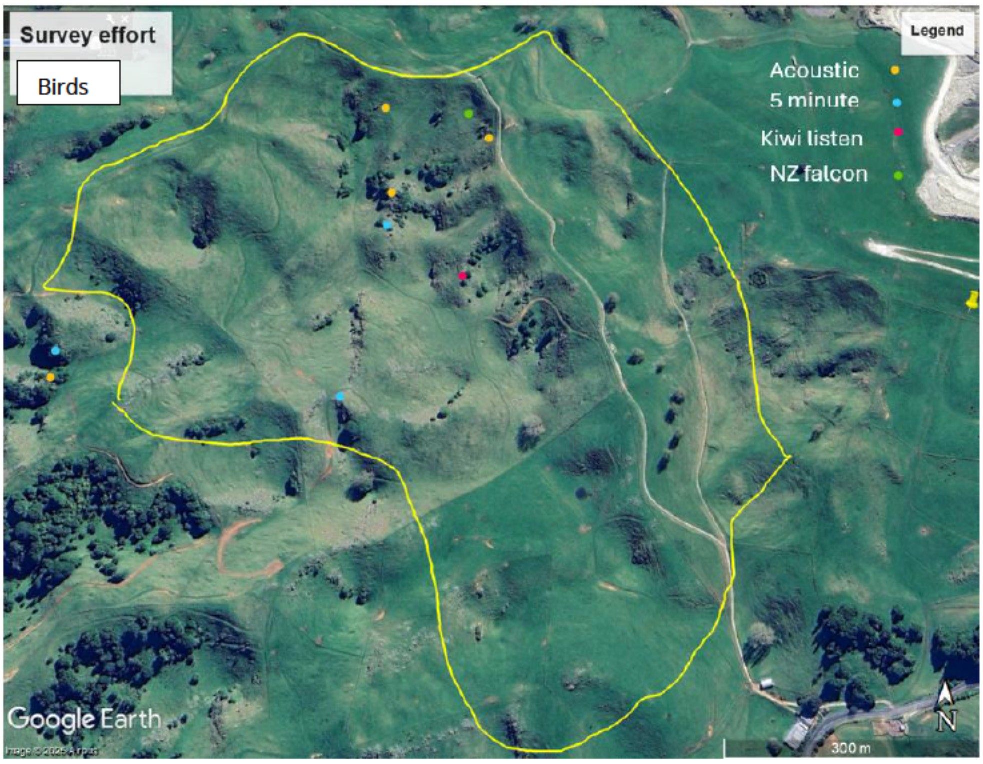


Figure 2 Bird acoustic and spot monitor locations, WSP (2021) norther most two, and ENZL (2019)

3.4 Bats

Six acoustic bat monitors (ABMs) (DOC AR4s) were set for 31 consecutive days (4 October-7 November 2019). The ABMs have been made to specifically target the frequency range for New Zealand bat species, recording a bitmap image of a compressed spectrogram when triggered. These monitors have a range of approximately 50m of omnidirectional detection. The ABMs were set by an ecologist that has been recognised as having the adequate experience required by the DOC.

Monitoring locations were scattered across the site in areas considered most likely to detect bat echolocation during foraging behaviour, specifically focussing on the gully systems and bush block edges. The ABMs were set to start recording 60 minutes before sunset and stop recording 30 minutes after sunrise.

Raw data obtained from the ABMs was processed using DOC's *BatSearch* 3.11 software. The total number of suitable nights for bat activity was determined using both historical climate data (CliFlo, New Zealand's National Climate Database, NIWA, Te Kuiti weather station) and air temperature data loggers within one of the ABMs deployed on-site. At the time best practise thresholds required minimum nightly air temperature to not drop below 6ºC within the first four hours after sunset, less than 2mm of rain within the first two hours after sunset, and exclusion of nights with a full moon (D. Smith et al., 2017). Only data obtained on suitable nights were used for assessment.

A handheld bat detector (Magenta Electronics) was also used 30 minutes prior to sunset and 15 minutes after sunset to detect any potential bat activity while walking the site. The detector was set at 40 kHz which is the peak wavelength for long-tailed bats.

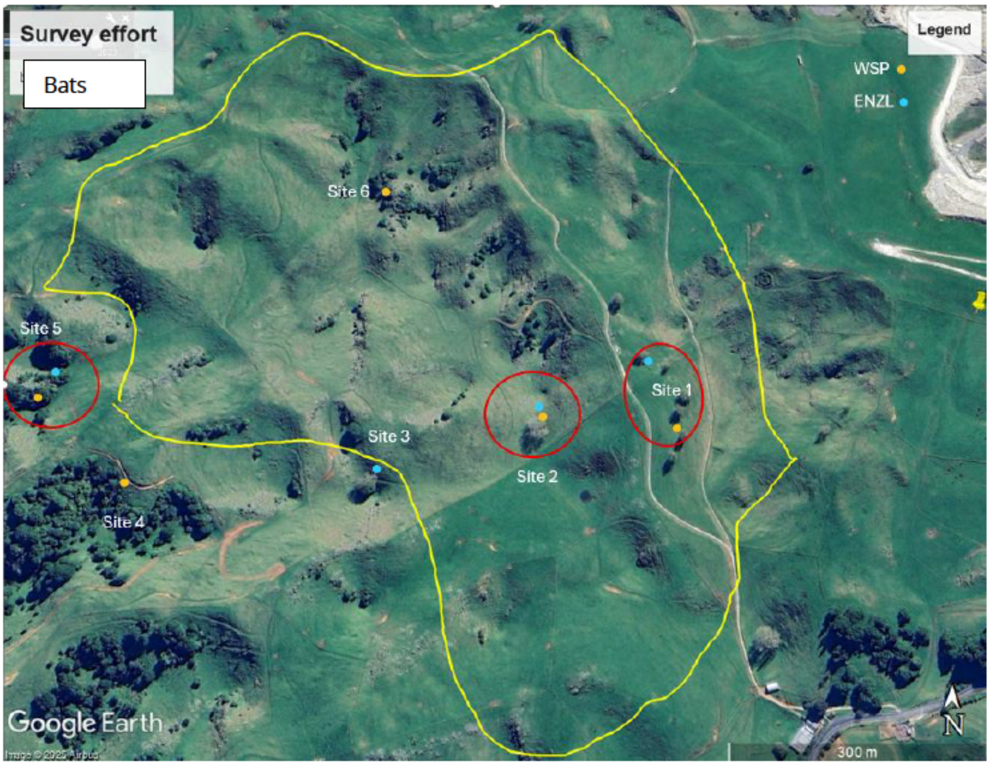


Figure 3. Bat acoustic survey locations, WSP 2021, ENZL 2019, where similar locations these are grouped in the same "site" number. Two further locations were further north and are excluded from this report, but I note those results where it pertains to bat presence generally.

Additionally, all individual and/or fragments of trees within the project area were subject to roost tree assessment by WSP ecologists based on their apparent suitability for roosting long-tailed bats. WSP risk tree assessment is a modified risk tree assessment similar to what has been utilised in the Southern Links Project – Hamilton City Council Section10. A total of 121 individual trees/areas of trees were identified and assessed for roosting suitability. The criteria for assessment are as follows (Table 1):

- Tree/area ID, GPS, Species
- Approximate Diameter at Breast Height (DBH)
- Description of roost features visible
- Roost suitability/value rating
- Rationale for determination.

Table 1: Criteria for assessing suitability of trees for bat roosts

Suitability as a roost	Justification of Assessment
Low	A tree of at least 15cm DBH but with no roost features visible or with only limited roosting potential e.g. loose bark present but not sufficient to provide shelter for roosting bats.
Moderate	A tree of at least 15cm DBH with one or more roost features that could be used by individual bats or where it is not clear from the ground inspection whether roost features are present or not and therefore requires further inspection.
High	A tree of at least 15cm DBH with one or more roost features which could provide roost habitat for several bats due to their size and ability to provide sufficient shelter and protection.

3.5 Lizards

Herpetofauna communities were surveyed through manual habitat searches, Visual Encounter Surveys (VES, scanning habitats for basking or foraging lizards), surveys of pre laid ACO's, trapping and nocturnal spotlighting.

A total of 8 person-hours was spent in November 2019 and then 18 person hours (in different locations to ENZL) in November 2021 undertaking diurnal manual habitat searches and VES in appropriate weather conditions.

A total of 80 ACO stations were installed across the site. The monitoring devices were established with a focus on the large rock outcrops where lizards were likely to be attracted to the warmth and refuge of the ACOs. The ACOs were left for four weeks to allow naturalisation and herpetofauna to become accustomed to them. The ACOs were checked for four consecutive days (4-7 November 2019).

A total of 23 baited gee-minnow traps were placed around rock formations occurring throughout the site. These traps were baited with fruit and set over three consecutive nights from the 4-7 November 2019. All traps were checked and rebaited daily.

A total of 24 person-hours (12 in 2019 and 12 in 2021) of nocturnal spotlighting was conducted. The spotlighting occurred over three and four nights, primarily focusing on arboreal lizard habitat along bush edges and potential terrestrial gecko microhabitats within rock formations.

[redacted]

Figure 4. Lizard survey locations and copper skink sightings

3.6 Animal Pest Surveys

Two trail cameras were deployed in four different locations throughout the site during the four-day field work session from the 22nd to the 26th of November 2021. These cameras focussed on the edges of bush blocks and the middle of two native bush fragments within the impact area. These were set to record throughout the day and night in order to survey the pest animal presence within the area. The trail camera footage was processed by WSP and provided to ENZL who also processed the footage to check for pest animals. Incidental encounters of mammalian pests did occur during field surveys carried out in November and these were recorded.

3.7 Cave Ecology

Because of health and safety issues related to the subterranean nature and a gas issue discovered in early expeditions into the Camelot cave, access to all subterrain areas, but especially Camelot, has been limited. Terrestrial invertebrate fauna surveys have therefore not been undertaken in the Camelot cave system.

A team of experienced cavers reconnoitred the site, located dolines, tomo and cave entrances, and proceeded to explore access into these features, to map their extent. This formed the suite of potential cave systems on site. Their exploration was also much wider than just the proposed quarry site.

I instructed survey cavers as to the nature of incave faunal survey, noting one of the team holds an MSC in cave ecology. Surveys were careful and detailed observations and photographic records as in-cave trapping systems with repeat access could not be employed. I was able to access the caves around 7 months after the initial cave survey. The second survey occurred between December 13th and 16th 2021 and involved the caves H5, B1, D1, AAL C5, C5, E2, E4. The data collection for troglobite fauna and description of their habitats was primarily reliant on the initial cave team: Kieran Mckay, Troy Watson and Kieran Chandler (Absolute Adventures Ltd).

For each cave, a GPS location was taken at the surface entrance. A photograph and notes of the entrance and surrounding environment was taken (vegetation type and cover, and type of entrance). The cave was then explored, requiring sediment removal and rock movement to make sufficient passage, and the cave was mapped. A visual biological survey was undertaken of visible surfaces. As most of the caves were less than 10m in length, the majority of the surface, floor, roof and walls were able to be visually surveyed. Extra searching for fauna was undertaken around water and organic debris as this was where cave fauna was expected to congregate. Most of these caves received in the order of 1-1.5 hours of searching. This is a substantial level of effort for the amount of surface visible in any of the potentially affected caves. Most surveys had to be carried out while lying down or squatting in relatively tight spaces and access to cracks was not possible.

This search method is typical and required, but it can have a bias. Photo-taxic responses of most cave invertebrate is negative to light and these species 'hide' from the light of the searchers. Similarly, detrital and faecal hidden taxa are not seen, only those taxa 'out' in observable locations and which do not 'hide'. That said, the repeat survey found similar species and I am of the opinion that while the negative phototaxic responses did occur, it was not as much as predicted and the species present at the entrance of the cave generally remained present as the observers went deeper into them.

It is useful to use a variety of traps, and collections to assess the faunal community (May, 1963) in addition to the observable, but (for health and safety reasons) the cave team of the initial survey were deemed unlikely to be able to achieve multiple visits and so this was not a plausible method.

The spider specimens collected were sent to Dr Vink at Lincoln University for formal identification. Photographs of the observed invertebrates and cave features, and survey records, including cave maps prepared by the cavers, were used to estimate what taxa were present and the extent of the habitat. Habitat area and quantity of resource present in each cave was measured by the cavers. The cave floor area was estimated from the scaled maps and is used as a proxy for the quantity of cave habitat present and affected.

4.0 Values and significance assessments.

4.1 Ecological Value

Environmental Institute of Australia and New Zealand (EIANZ) values assessment follows the standard provided by the guidelines. Four criteria are used to determine the value of the ecological features, present on site: Representativeness, Rarity/distinctiveness, Diversity and Pattern, and Ecological Context. To assign value under each of these four criteria, an explanation on each criterion and a series of attributes are provided for consideration in Table 4 of the EIANZ guidelines. A scoring system provided in Table 6 of the guidelines requires the combination of these assessment values to provide an overall assignment of ecological value. Particular fauna are also attributed value based on their conservation status (Table 2, chapter 6 EIANZ); those 'At Risk' or 'Threatened' were valued at a higher level than those classified as 'Not Threatened'. Threat classifications have been sourced for plants (De Lange et al., 2024), birds (Robertson et al., 2021), lizards (Hitchmough et al., 2021), and bats (O'Donnell et al., 2023).

The EIANZ approach requires ecological features and species values to be assigned on a scale of 'negligible', 'low', 'moderate', 'high', or 'very high' to each ecological feature.

I note again that the ecological values as defined here do not include cultural values (e.g. taonga species), which are recognised in the Cultural Impact Assessments. The EIANZ at section 5 states that mana whenua values cannot be assigned by an ecologist (where the ecologist is not of the appropriate hapū etc). Identification of potential cultural values is important, but should be confirmed and/or assessed by, or in conjunction with, mana whenua.

4.2 RMA Section 6(c) Significance

Significance (as it relates to Section 6(c) of the Resource Management Act 1991) was assessed using the significance criteria described in Waikato Regional Council Technical Report 2017/37[1], Environment Waikato technical report TR2002/15[2] and the Waikato Regional Policy Statement (2016)[3]. The vegetation and/or habitat when tested against those criteria is considered significant if it meets one or more of the criteria described. I note that the regional criteria have not been updated to align with the National Policy Statement for Indigenous Biodiversity (NPS IB) (2022) Appendix 2 significance criteria and where there are material differences, I favour the NPS IB criteria and interpretations.

4.3 Condition versus value

Many of the measures used in this assessment are condition measures which record the state of a stream or wetland and its elements as compared to a stream or wetland in a healthy or pristine or natural state (i.e. comparing the level of modifications and healthiness of the aquatic habitat). While condition is typically tightly correlated with value, it is not the only factor used to understand the state of a stream, as ecological values can exist or persist in run down or poor condition habitat, especially values related to functions such as fish passage. Human values, related often to rarity or use or spiritual aspects, are often different from ecological values which focus on sustainable

[1] der Zwan, W & Kessels, G (2017). Significant Natural Areas of the Waikato District: Terrestrial and Wetland Ecosystems. Report prepared for Waikato Regional Council. PWF Ref: WRC.00137

[2] Environment Waikato and Wildland Consultants Ltd (2002). Areas of significant indigenous vegetation and habitats of indigenous fauna in the Waikato Region – Guidelines to apply regional criteria and determine level of significance. Environment Waikato technical report TR2002/15

[3] Waikato Regional Council (2016). Operative Waikato Regional Policy Statement - Te Tauākī Kaupapahere Te-Rohe O Waikato. PART B (11). Indigenous biodiversity:11A Criteria for determining significance of indigenous biodiversity.

functioning food webs and expected diversity of species assemblages and resilience and tolerance etc.

In this assessment, I use condition as a qualifier tool. The condition of a stream or wetland's physical habitat will inform its ability to sustain an appropriate diverse, complex, resilient assemblage and food web that persists over time. Here, because of the Project's setting (i.e. a long history of use and modification for most of the affected catchments, the size, setting and condition of the streams and wetlands), I consider that rarity or species diversity is of less weight in assessing the state of a stream or wetland because it is the health of the stream or wetland that will govern the probability or presence and persistence of rare taxa.

4.4 Effect Assessment Methodology

The EIANZ guidelines (Roper-Lindsay et al., 2018b) assists in determining the effects in a consistent and transparent way using a value-magnitude of effect matrix (Table 2). However, sound professional judgement is still and always required when applying the framework and matrix approach.

Table 2: Criteria for describing the level of effects (Roper-Lindsay et al., 2018)

Magnitude	Ecological Value				
	Very High	**High**	**Moderate**	**Low**	**Negligible**
Very High	Very High	Very High	High	Moderate	Low
High	Very High	Very High	Moderate	Low	Very low
Moderate	High	High	Moderate	Low	Very low
Low	Moderate	Low	Low	Very Low	Very low
Negligible	Low	Very Low	Very Low	Very Low	Very low
Positive	Net Gain	Net Gain	Net Gain	Net Gain	Net Gain

4.5 Determining the magnitude of the effect

I note that with respect to species and threat classification, the presence of an individual or even a small population of a threatened or at risk species does not automatically cause a habitat to be of high value, as there are a multitude of factors and site context to consider and the value is a "average" of all of the factors and for a value to be assigned it should be a value that is likely to persist.

Then the assessment requires an understanding of the magnitude of the effect/s. The assessment of the magnitude of an effect is based on:

- a proportional consideration of the amount of resource impacted / removed from the system at a relevant spatial scale; and / or
- the temporal extent of an impact (i.e. is it a temporary and recovered condition, or a permanent condition or for how long the temporal process lasts (e.g. will it stop a season's fish migration)).

This approach is based on EIANZ (2018), section 6.3.1- "*it is recommended that an assessment at the scale of the feature (e.g. contiguous dunes, wetland system, forest community) should be done*". That is, magnitude is not just about the effect at the site (or within the site's legal boundaries).

To determine the magnitude of effects, it is necessary to choose an appropriate scale for assessment and have an understanding of the base extent of the resource in that area. In terrestrial ecology assessments, the quantum of a vegetation type in the Ecological District (ED) is commonly used and indicated by the NPS IB.

The only condition where it can be appropriate to consider a feature or smaller scale is where there is a feature of particular special condition, value or size that makes the ED scale too unresponsive. This could be an exceptional indigenous wetland in an otherwise farmed landscape, or a rare indigenous forested reserve which is completely dissimilar to any other feature in the catchment. But where the features tested are "run of the mill" types of systems, then the ED scale is the appropriate scale.

The magnitude of an effect does not consider the value of the feature and is not influenced by rarity or any other such aspect. This is because the overall effect is determined using a matrix that considers ecological values and magnitude of effect.

The magnitude of the effect is then described as 'Negligible', 'Low', 'Moderate', High', or 'Very High' based on the following proportions of the catchment resource stream length:

- <1% of the total catchment's waterway affected = negligible,
- 1-10% = low,
- 10+-25% = moderate,
- 25+-50% = high,
- >50% = very high

Some potential effects (e.g. lighting, noise, dust, biosecurity effects) are not given to proportional assessment and judgement calls are required to establish the likely magnitude in these types of potential effect.

4.6 The management of effects

The NPS-IB provides direction on managing effects on SNAs and other indigenous biodiversity, which councils must consider. The Maniapoto Environmental Management Plan and the Regional Policy Statement also address these matters. However, under the FTAA, I understand some of the directives in those policy instruments (such as avoidance requirements) may be given less weight.

The primary objectives of the NPS IB (2022) direct Councils to seek no loss of extent and value of SNA and to otherwise manage effects on indigenous biological diversity. This is similar to the outcomes sought by the Region, the District and Maniapoto.

The Maniapoto Environmental Management Plan[4] provides guidance on Maniapoto's environmental direction, vision, objectives, policies and actions within the Maniapoto rohe. Of particular relevance to this assessment is the biodiversity objective (Part 19.3) and a policy aimed at ensuring "indigenous biodiversity is maintained, restored, enhanced and protected throughout Maniapoto rohe". The key action in the plan relating to biodiversity and natural resource use is to "ensure natural resource use and development, including land use, occurs in such a way that indigenous biodiversity is enhanced and protected".

[4] Maniapoto Māori Trust Board (2016). Ko Ta Maniapoto Mahere Taiao – Maniapoto Environmental Management Plan

5.0 The Ecology of the Site

5.1 Karst Ecosystems

Karst ecosystems are naturally uncommon in New Zealand (Wiser et al., 2013), but they occur in many parts of the Waitomo District. They can support a wide range of flora and fauna species[5] and are classified as naturally uncommon ecosystems. The site exhibits several landscape features that classify it as a karst ecosystem. Several of the features within this ecosystem type are classified as threatened (Holdaway et al., 2012). Cave entrances are 'critically endangered', sinkholes are 'endangered' and calcareous cliffs, scarps and tors are 'vulnerable'. However, historical agriculture land use and vegetation clearance has diminished the ecological values of the features that are present on site through removal of the natural entrance native vegetation and increased light, weed invasion, desiccation and increased temperatures of cave entrances and cave shafts. The rock outcrops are the most obvious widespread feature representing a Karst landscape and shown below on Figure 6.

Other features observed on site included: tomos, dolines, cliffs, and cave entrances. The sections below outline flora and fauna species that are associated with surface karst features. Surrounding areas are largely composed of a similar ecosystem type with sporadic vegetation blocks interspersed.

WSP mapped, photographed and classified the karst ecosystems as either Low, Moderate or High value during the 2021 survey periods based on the presence of native vegetation and the level of intentness of the feature. Given that most features are small outcrops in pasture, the "high" classification typically reflects the presence of legible limestone on the surface with some native components, rather than an intact and well-functioning limestone community of plants and animals. For example, the following feature (Figure 5) was classified as "High" despite, clearly not being representative of a fully functioning ecosystem etc.

Figure 5: Rock outcrops that are the most obvious widespread feature representing a Karst landscape.

[5] Clark, R., Floyd, Chris, & Clarkson, Bruce. (2017). Significant Natural Areas of the Waikato Region: Karst Ecosystems. Waikato Regional Council Technical Report 2017/35. Document no. 2071016.

Most of the high value karst areas are those with a reasonable amount of native vegetation or else the feature is limestone in pasture, and rock outcrops alone, while perhaps geologically interesting, are not a "karst ecosystem" from an ecological perspective. The following is a refined map from the initial ENZ initial map. This shows 12 better condition areas summing to around 1 ha (red) and a range of limestone in pasture features (yellow).

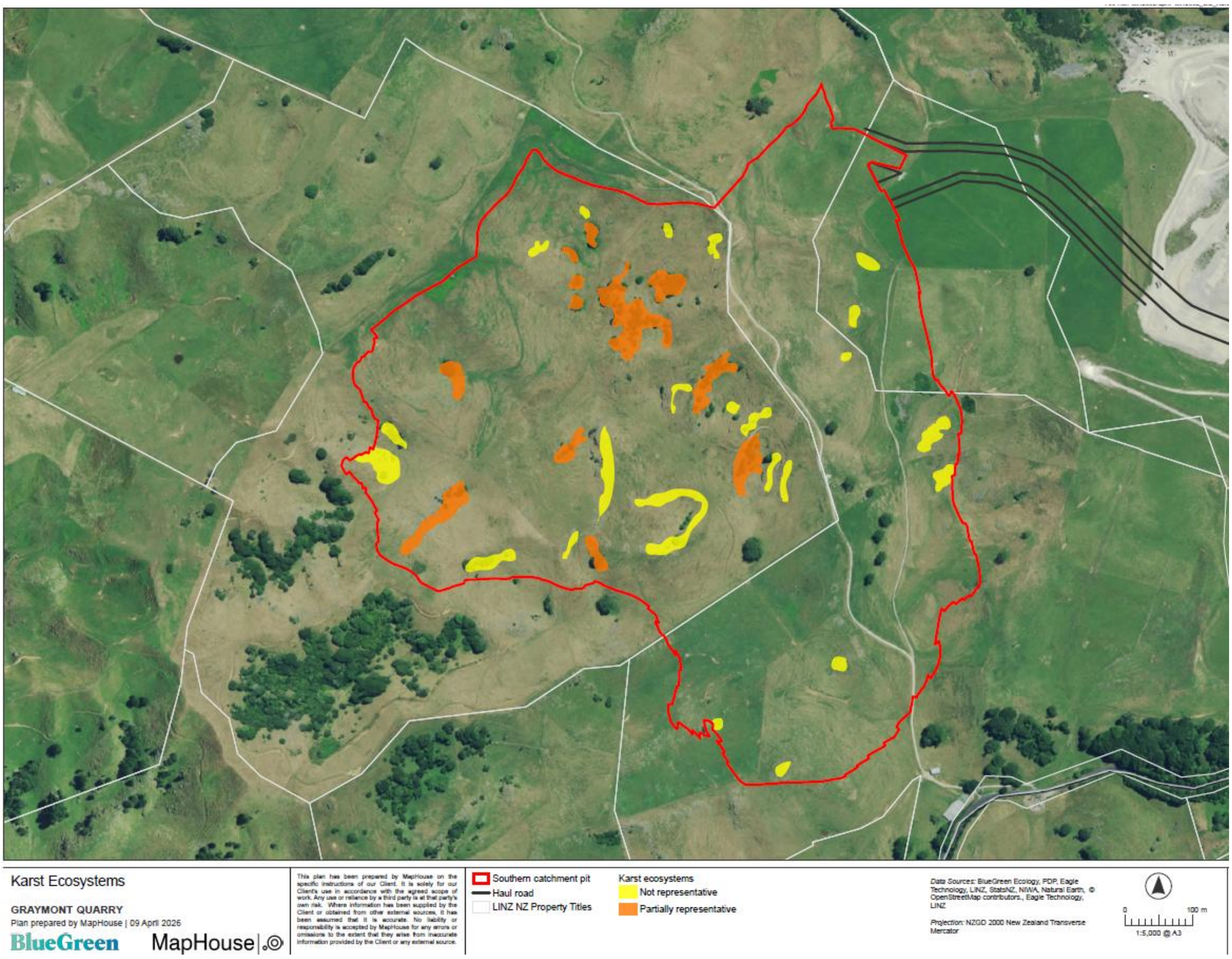


Figure 6: Locations and classification of karst feature condition.

5.2 Vegetation

The majority of the site is grazed pasture with stock present throughout. Indigenous vegetation was concentrated in small bush blocks around large rock formations, that were typically located in the steeper gullies, totalling approximately **1.43ha** within the proposed pit footprint. The vegetation tiers present were generally only ground and mid-tier, due to the formation of rock and growth habitat of the accompanying vegetation in and around these stacks. Indigenous seedling and sapling presence were minimal. The overall appearance of the vegetation was scraggly and windswept characteristic of the rolling hill karst landscape. Ferns were dominant where small wet seepages and cracks in the rocks were present, while small shrubs and tree species grew in and around the stacks or at the bottom of the formations where areas of deeper soils were present. Examples of exotic pasture vegetation were also present throughout the native vegetation on the rock formations, in particular herb Robert (*Geranium robertianum*) and various thistle species were common.

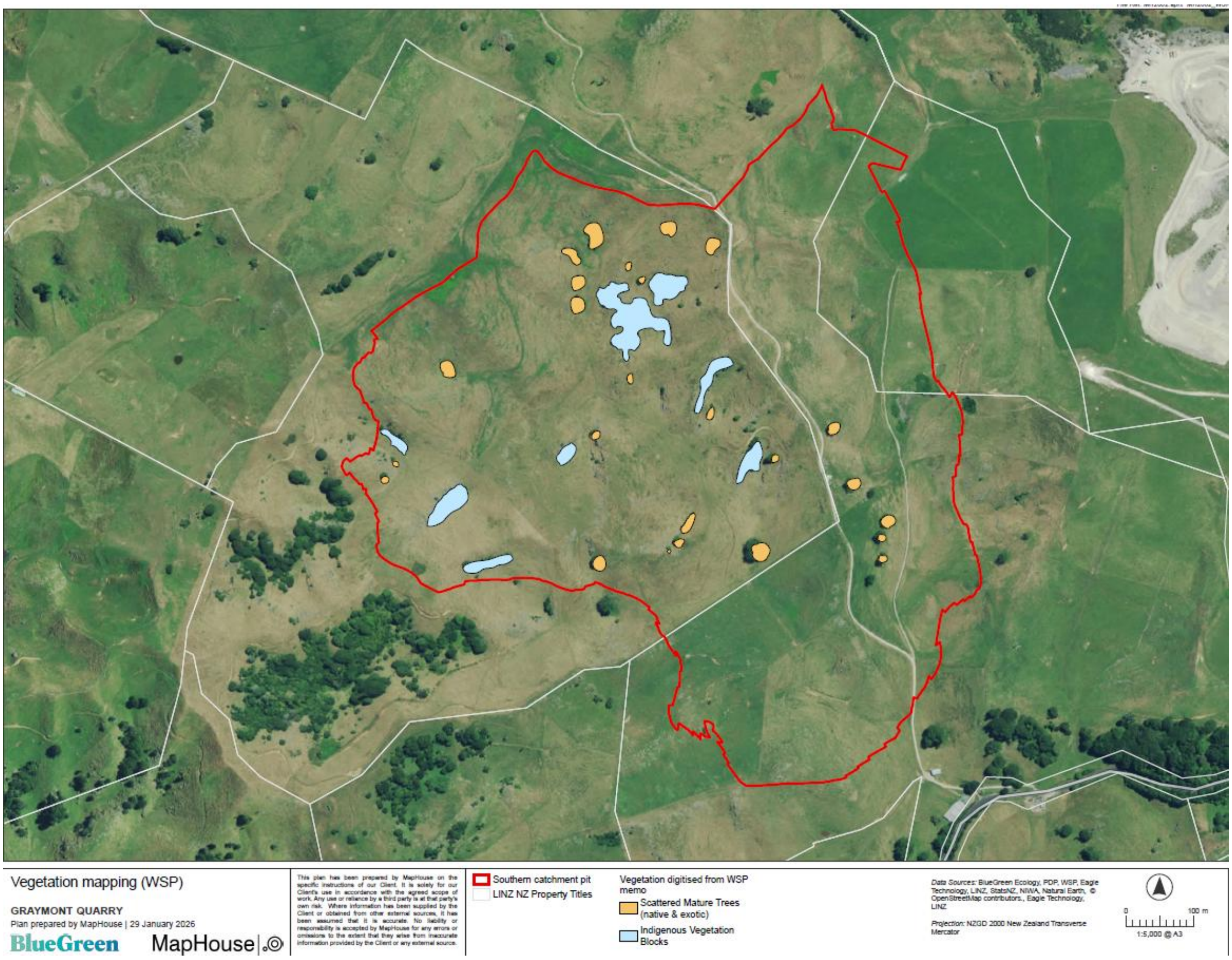


Figure 7 Areas of non pasture vegetation, blue = patches of native vegetation, orange = single trees (exotic and native).

At each area of large rock formation where indigenous vegetation cover persisted, vegetation largely comprised of mangeao (*Litsea calicaris*) and māhoe (*Melicytus ramiflorus*) with button fern (*Pellaea rotundifolia*), pōhuehue (*Muehlenbeckia australis*), climbing rātā (Metrosideros colensoi) and bracken (Pterdium esculentum). There were no plant species with a 'threatened' or 'at risk' classification found on site. A list of plant species observed during the site investigations is presented in Appendix 1.

Figure 8: Small pocket of bush with large mangeao and māhoe.

In June 2025 the Decision Version of the proposed Waitomo District Plan became operative. The appeals version of the proposed WDP (dated 1 October 2025) is operative (except for provisions under appeal) and indicates three portions of Significant Natural Area (S16UP044 Local) located adjacent to the SW Pit (Mangapu Cave System, Pakeho polygonal karst, Waipapa Rd cave system). The vegetation in the SNA is largely comprised of a similar composition to the rest of the bush blocks; however, as it is more intact, the diversity of species greater with additional native species noted, including kaikōmako (Pennantia corymbosa) and tree fuchsia (Fuchsia excorticata).

Scattered mature trees were also observed across the site. These were made up of both exotic and native species: exotic species were primarily poplars (Populus sp.), and native trees were primarily mangeao and māhoe.

Six threatened or at-risk plant species known to be associated with karst ecosystems have been recorded within 10km of the site[6] but not on site. None of these species are likely to be on site and missed by the survey teams. All potential cave entrances were surveyed thoroughly. It is probable that the current and historic agricultural land-use and stock presence throughout the vegetated areas has altered the necessary conditions for these specialised plants, thus meaning that they are either no longer present on the site, were never present on-site, or are present at such low abundance as to be undetectable.

5.3 Terrestrial Fauna

5.3.1 Avifauna

Though the site is primarily dominated by pasture, there are small, isolated native- bush blocks and rock formations that provide foraging and nesting habitat for a range of birds. Several native and exotic bird species common to the Waikato Region were seen and/or heard during site visits, and through the analysis of bird monitoring data collected on-site (**Table 3**). The open pasture lands provide foraging opportunities for some native bird species. WSP encountered similar species on-

[6] Sourced from Department of Conservation-Spatial data- Threatened plants excel spreadsheet

site during their fauna surveys in November 2021, one difference was WSP observed skylark (*Alauda arvensis*) which appeared to be abundant across the site.

Bush falcon (*Falco novaeseelandiae ferox*; At Risk – Recovering) were confirmed to occur on-site through visual and acoustic monitoring. Falcon are known to use features of karst ecosystems where they nest on open, exposed areas of limestone; however, they are not known to have any dependence on karst ecosystems.

Table *3* Avian species observed on-site by ENZL (2019) and WSP (2021).

Common Name	Latin Name	Threat status[24]
Bush Falcon	*Falco novaeseelandiae ferox*	At Risk - Recovering
Grey warbler	*Gerygone igata*	Not Threatened
Kererū	*Hemiphaga novaeseelandiae*	Not Threatened
Kōtare	*Todiramphus sanctus*	Not Threatened
Morepork	*ox novaeseelandiae novaeseelandiae*	Not Threatened
North Island Fantail	*Rhipidura fuliginosa placabilis*	Not Threatened
Paradise Shelduck	*Tadorna variegate*	Not Threatened
Spur-winged plover	*Vanellus miles*	Not Threatened
Swamp harrier	*Circus approximans*	Not Threatened
Tūī	*nadera novaeseelandiae novaeseelandiae*	Not Threatened
Welcome Swallow	*Hirundo neoxena neoxena*	Not Threatened
Australian Magpie	*Gymnorhina tibicen*	Introduced and Naturalised
Blackbird	*Turdus merula*	Introduced and Naturalised
California Quail	*Callipepla californica*	Introduced and Naturalised
Common Pheasant	*Phasianus colchicus*	Introduced and Naturalised
Eastern Rosella	*Platycercus eximius*	Introduced and Naturalised
Goldfinch	*Carduelis carduelis*	Introduced and Naturalised
Myna	*Acridotheres tristis*	Introduced and Naturalised
Skylark	*Alauda arvensis*	Introduced and Naturalised
Song Thrush	*Turdus philomelos*	Introduced and Naturalised
Yellowhammer	*Emberiza citronella*	Introduced and Naturalised
Wild turkey	*Meleagris gallopavo*	Introduced and Naturalised

At-Risk avifauna species that have been observed in the wider area are outlined below in Table 4. However, the habitat on site is not likely to support the indicated species, and the acoustic recorders did not confirm the presence of these species. Kiwi calls were not heard during nocturnal surveys carried out in 2019.

WSP did not carry out kiwi specific nocturnal surveys during the field surveys in 2021, however no kiwi calls were found during the 2021 data analysis.

North Island kāka would be unlikely to use the vegetation on site for nesting as they primarily use cavities that are over 5m above ground, usually in native forest blocks (Powlesland et al., 2009).

Kōkako typically inhabit tall, diverse native forest, usually with a canopy of tawa or taraire. North Island brown kiwi can often utilise farmland for feeding but would expect to be in an area with larger, more contiguous bush blocks than the bush blocks that are present on site. North Island robin usually occur in mature forest, tall scrub, and exotic plantations, particularly those that are relatively mature and have patches of shrubs as an understorey.

Overall, the native bird habitat quality on site was considered moderate.

Table 4: 'At Risk' avifauna species found in the wider area but unlikely to occur on-site (e-bird.com).

Common name	Latin Name	Threat Status	E-bird location
North Island brown kiwi	*Apteryx mantelli*	At Risk – Declining	Waitomo Caves Road (10km)
North Island kāka	*Nestor meridionalis septentrionalis*	At Risk – Recovering	Otorohanga (20km) and Pureora Forest Park (30-40km)
North island kōkako	*Callaeas wilsoni*	At Risk – Recovering	Waitomo Caves Road (10km)
North Island robin	*Petroica longipes*	At Risk - Declining	Mangaokewa Gorge Scenic Reserve (11km)

5.3.2 Herpetofauna

Pasture and bush fragments contain isolated logs (Figure 9) and scattered limestone stacks which are potentially suitable habitat for ground-dwelling lizards, specifically within/under decomposing logs, clumping vegetation, leaf litter and rocks and rock formations.

Figure 9. Isolated log in pasture provides cover for skink

Potential habitat for arboreal geckos was also recorded on-site; however, only within the scattered bush blocks, which were isolated from any other large tracts of bush meaning access to or from those possible refugia is near impossible. The rock structures present also represent suitable habitat for ground-dwelling lizards, such as raukawa gecko (*Woodworthia maculata*) but none have been recorded.

ENZL confirmed the presence of copper skinks (*Oligosoma aeneum*) in 2019 through targeted manual searches, all of which were found under isolated logs across the site. In 2021 WSP reiterated the presence of copper skinks on-site and confirmed the presence of ornate skink (*Oligosoma ornatum*) with one record, the majority of which were observed under rocks surrounded by rank grass but also under logs. The recorded presence of skink is shown on Figure 10.

ENZL and WSP found no lizards during nocturnal spotlighting carried out in 2019 and 2021. Some lizard species that are known to occur within the general area are difficult to find and due to the suitable habitat present their presence cannot be ruled out no matter how intensive the survey efforts. It is feasible that species are present in such low densities that they would only be detected through destructive survey techniques.

Despite the presence of suitable rocky habitats on-site, and the extensive surveys carried out therein, the only lizards found on-site were copper skinks and ornate. No lizards were seen in the traps or during nocturnal spotlighting, and only one additional copper skink was seen under one of the ACO stations during one of the four checks.

Figure 10 Lizard detections collated from all surveys. Red boundary = quarry pit boundary, orange -phase 1 foot print and haul road (to be modified), Yellow dot – copper skink, blue = ornate skink.

5.3.3 Bats

Potential bat roosting habitat was observed within mature native bush blocks, isolated exotic and native trees scattered throughout the site, and potential cave systems. Long-tailed bats (*Chalinolobus tuberculatus*; Threatened - Nationally Critical) have been known to congregate in some cave sites within the wider Waitomo area (e.g., Grand Canyon and Ruakuri Caves) (Clark et al 2017).

The open farmland and gully systems provide foraging opportunities for long-tail bats. ENZL placed ABMs at six locations around the site focussing on areas of potential habitat. Potential cave entrances were found during a site visit in November 2019, and ABMs were placed in front of the entrances from the 4th to the 7th of November 2019.

No bat activity was detected at those locations. WSP deployed ABMs in 2021 at similar sites and added one site in 2021 (see Figure 3).

Table 5 summarises bat activity levels from the ABMs during the surveys carried out in 2019 and 2021. Based on the criteria, 29 nights of the 31-night survey period in 2019 were suitable for recording bat activity. In the 2021 all but one night had suitable data (i.e. 30 nights).

Bat activity was higher in 2019 compared to 2021. In 2019 The ABMs deployed at the most likely roosting and foraging habitats on-site recorded a low amount of bat passes, and one 'feeding buzz' was detected. Site 1 (Figure 3) had multiple nights of activity around the same time (8:45pm – 8:52pm) not long after sunset, but only in 2019. That ABM was deployed to target a large poplar within the lower reaches of a gully system. The results from the 2019 survey indicate that bats are using this gully as a flightpath to/from a possible nearby roost. In 2021 only one pass occurred within one hour of sunset at Site 3 indicating some potential roosting activity in the general area. These survey periods show that the site is being utilised by long-tailed bats, however it appears to be largely used for commuting with limited feeding or roosting behaviour recorded.

Table 5: Bat activity levels from the ABMs during surveys

Figure 3 #	ENZL & WSP Site	Total passes	Nights with passes	Total feeding buzzes	Average passes per night
1	2019	7	6	1	0.241
1	2021	14	10	0	0.084
2	2019	16	5	0	0.552
2	2021	1	1	0	0.030
3	2019	10	5	0	0.345
4	2021	4	4	0	0.154
5	Site 4	3	3	0	0.103
5	2021	0	0	0	0
6	2021	6	5	0	0.208
	Total	61	39	1	0.191

Potential bat roost trees observed on-site included large poplars (Diameter at breast height (DBH) >80cm) and native trees with crevices and/or rotted branches or trunks. WSP identified and assessed a total of 121 individual trees/areas for their habitat value and significance for roosting long-tailed bats. A total of 11 trees/areas of vegetation were assessed as of high potential for bat roosts, while the remaining were assessed as low or moderate potential. The majority of the trees that were assessed as high were due to significant decay and many will likely fall over within the next year or so.

Due to the confirmed presence of long-tailed bats on-site and the potential utilisation of the project area for commuting, foraging, and roosting, as well as the possible presence of roosting habitat on-site the quality of bat habitat on site for bats was considered to be moderate.

Figure 11 Large poplar near the bottom of the gully where bat activity was recorded.

5.3.4 Invertebrates

The site provides some habitat for terrestrial invertebrates. The rock formations were mainly inhabited by common garden snails (*Cornu aspersum*), common pill woodlouse (*Armadillidium vulgare*) and spiders, such as false katipo (*Steatoda capensis*). Other species identified include lemon tree borer (*Oemona hirta*), Auckland tree weta (*Hemideina thoracica*), Asian paper wasp (*Polistes chinensis*), land planarians (Family Geoplanidae), cryptic orbweavers (*Cryptaranea atrihastula*) and tunnelweb spiders (*Hexathele hochstetteri*).

5.3.5 Pest Animals

Given the rural landscape setting of the site a range of pest animal species were expected to be abundant including rats (*Rattus* spp.), possums (*Trichosurus vulpecula*), mustelids (*Mustela* spp.), mice (*Mus musculus*), hedgehogs (*Erinaceus europaeus*), hares (*Lepus europaeus*) and domestic/feral cats (*Felis catus).* Deer (*Cervus* sp.) and goats (*Capra aegagrus hircus*) are also present at the site. Several possums, hedgehogs and hares were observed during nocturnal spotlighting efforts.

The processing of trail camera data from the 2021 field surveys showed the presence of fallow deer (*Dama dama*), possums and rats. A number of mammalian pests were observed throughout the field surveys in 2021, during the day two hares, a rabbit, a hedgehog and a possum were observed. During the 12 hours of nocturnal spotlighting for lizards across three nights a high number of possums were observed in all the bush fragments throughout the site. Several rats were observed within the trees, two hedgehogs were observed within rank grass near tree fragments and a rabbit was observed along the entrance gate. A possible stoat (*Mustela erminea*) was observed within a bush block, however this ID could not be confirmed.

5.4 Natural Inland Wetlands

A potential wetland area was identified within the property, but not in the SW Pit Site, within a basin in otherwise pasture. This potential wetland appears on Waikato Regional Council map layers with a designation of 'lake – unknown'. The soils in this area are generally free-draining karst soils and the presence of a pond or wetland area does not appear to be natural or in keeping with the rest of the landscape in this area. When tested under the MfE delineation protocol the feature qualifies as a natural inland wetland due in the main to the abundance of water pepper (an exotic wetland seasonal plant). However, information provided by the landowner, including formal written communications from the family that has farmed this land for three generations, shows that around the 1980s there was an attempt to create a pond (by excavation) in the basin to create a duck hunting opportunity. Despite the farmer's best attempts, the "pond" that resulted never held water for more than a couple of days following rain, resulting more often than not in a damp soil basin. The landform is evidence of the modification with a mound between two basins intended to be the site of a maimai. It is therefore a deliberately created water body that has then given rise to the presence of wetland indicating wet adapted flora and fauna. Under the NPS FM natural inland wetlands this feature can be excluded as a natural inland wetland. This feature is now outside of the proposed mine pit but is within 100m and so has been considered.

5.5 Caves

The Maniapoto Karst covers an area of approximately 1,000km^2 (Scarsbrook et al., 2008) and is located along the Waikato Region's west coast between Kawhia Harbour in the north and the Mokau River in the south. The main karst host rocks are the Otorohanga and Orahiri limestones of the Te Kūiti Subgroup. The limestone beds of the Te Kūiti Subgroup extend from Northland to Taranaki but are thickest in the central Maniapoto Region. An important feature of the karst in the Maniapoto area is the very high density of pitting by enclosed depressions (dolines (Williams, 2004)), forming the highest density polygonal karst landscape[7] widely recognised throughout the world (D. W. Smith, 1998). These dolines are an important part of the recharge system for karst groundwaters, acting as conduits for precipitation into the underlying drainage networks dissolved in the limestone and associated sandstones of the area. The map below (Figure 12) shows the Karst area of the Maniapoto and the site in relation to this area.

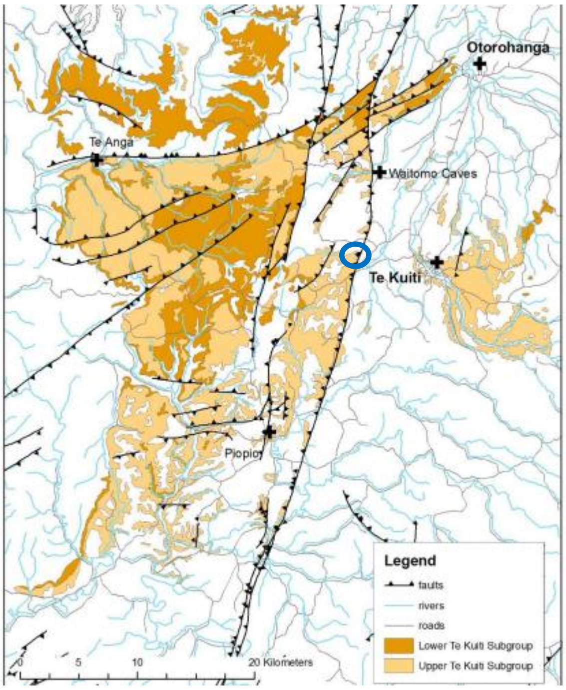


Figure 12 Location of the Maniapoto Karst (Edbrooke, 2005) and the site (blue circle)

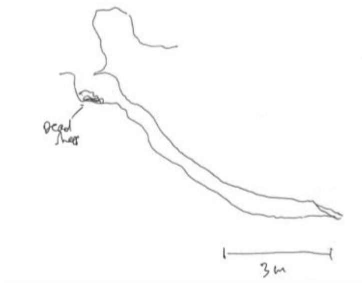
The caver's grid searched the area of the originally Proposed Pit. They determined there to be in the order of 100 potential caves which exhibited limestone-water related entrances, cracks and tomos. Of these, around half were explored. Of those around 20 were sufficiently large to allow entrance

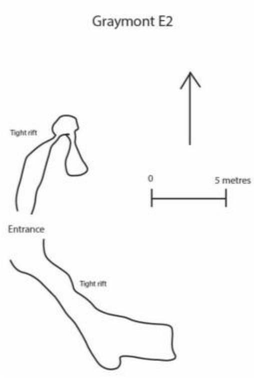
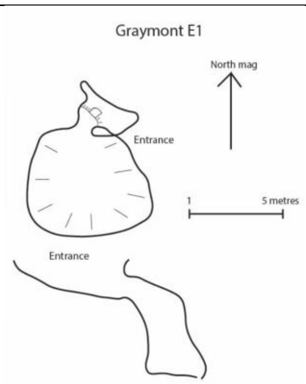
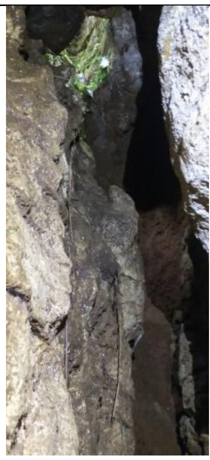
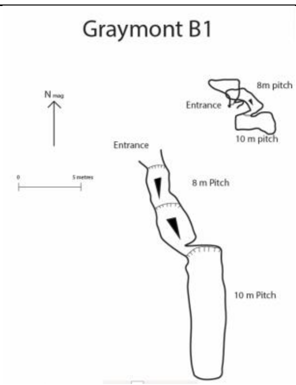
[7] A polygonal karst is one which is very pitted but the pits are enclosed such that there is a beehive type structure.

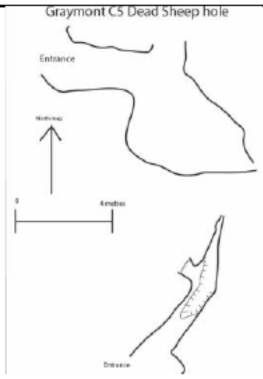
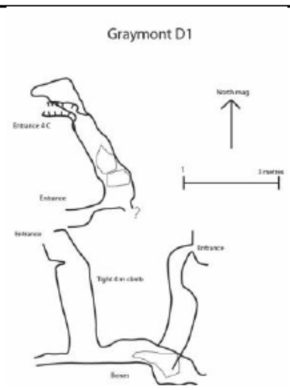
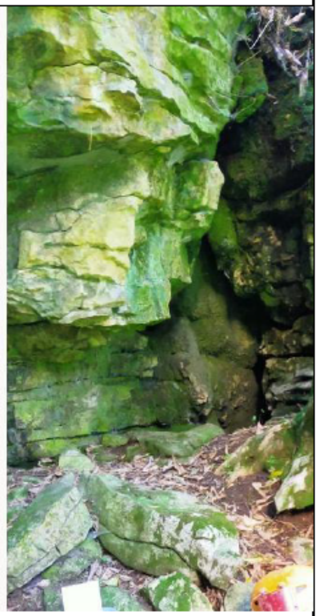
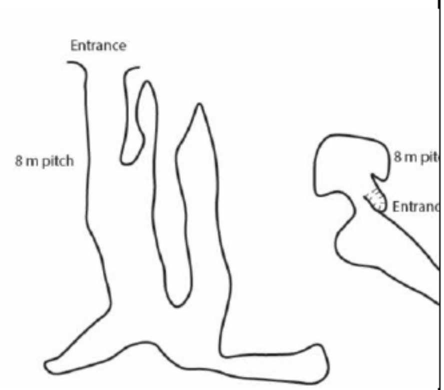
(and so actually classify as a "cave" (Under WRC definition). This landscape is abundant with small cracks and caves and forming caves.

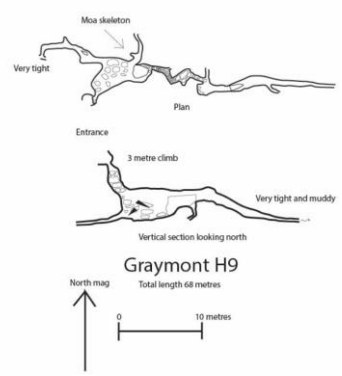
Figure 13 Cave locations in the SW Pit

The following are descriptions from the cave team of each cave surveyed as relayed by the surveyors.

C6 A rift entrance to a small cave (ca. 10m largely vertical). The entrance is in pasture at the base of a limestone outcrop with small native vegetation. The entrance drops onto a dry dirt floor with organic debris (Mahoe and twigs).		

E2 This is a small entrance covered by blackberry at the corner of a paddock that has previously been filled with overburden. This is a small cave. The entrance drops onto a dry dirt floor with minor organic debris. This continued to the end. The cave was dry and due to its small nature the majority of the cave's surface area was able to be surveyed.		
E1 This is a small entrance to a small slot like cave, see map. It is in pasture but at the bottom of a small limestone outcrop.		
B1 A vertical entrance (18m total), with organic material on the floor, see map. This cave is pit-like, with limestone, organic materials and soil throughout. The entrance is in a limestone outcrop, with native vegetation, within the farmed pasture.		

C5 This is a small entrance to a small slot-like cave. It is in pasture but in a limestone outcrop covered in blackberry. The entrance drops onto a lot of dead sheep – bones esp. Moist wall area with snails, isopods and spiders.		
D1 This was a small entrance to a small cave (less than 10m long). The entrance dropped onto a dry dirt floor with organic debris. This dry dirt floor continued to the end – approximately 3 meters. The cave was dry. It had native vegetation around the entrance but is in the middle of pasture.		
B7 This cave was in a limestone outcrop at the top of a hill in pasture. It is a dead-end cave that is a vertical shaft.		

H9 – unaffected system outside boundary This is a small entrance to one of the larger caves surveyed. It is in pasture but at the base of a limestone outcrop with native vegetation. It is outside of the Proposed Pit. The entrance dropped onto a dry dirt floor with organic debris. This cave had a variety of environments from wet to dry, dirt/mud to clean rock and rock fall to open passage. As this cave has a larger chamber and more passages the cavers decided that it was not possible to survey the whole area. As such, all places that could be accessed were surveyed with extra attention being paid to areas with water and organic debris.		

5.5.1 Cave fauna

None of the caves surveyed were substantive, long, complex, or deep. All appear to be in early formation and without constant water inputs which would assist their growth. All are in a farmed landscape with an absence in general of entrances with native vegetation cover and all are open to mammalian pests. Consequently, no troglobite fauna were recorded.

The fauna identified were common to most of the caves surveyed. In summary (see Appendix 2 for full list) in most caves there were:

- Four taxa of spiders (*Anoteropsis hilaris* (wolf spider), *Mynogleninae* (Linyphidae), *Hexathele sp* (tunnel web), and *Cambridgea plagiata* (sheet web));
- three taxa of snail (garden snail, glass snail, turret snail)
- one Oniscidea isopod taxon
- an amphipod (litter hopper)
- two centipedes (Chilopoda)
- two millipeds, Symphla – myriapods.

Species that were occasionally found were slaters (*Isopoda*), harvestmen (*Opiliones*), and cave weta (*Rhaphidophoridae* (*Pachyrhamma waitomoensis*)).

In addition, in one or two of the caves one beetle, one black fly (*Phoridae*) adult, unknown fly larvae, one lepidopteran larva, one green tree frog, one *salticid* (jumping spider) and *Pauropoda* (myriapod) were recorded.

No “threatened or at-risk” taxa were recorded, and none are expected.

Abundances were low or very low with often only one individual seen. Cave B1 (a vertical tomo) had the greatest abundance with relatively numerous *Hexathele sp*. (tunnel web spiders) present.

All of the taxa seen and recorded are taxa common to organic matter and woody material or are predators and are typical of forest and forest floor litter. All of the taxa seen are best described as trogloxenes and are not specific to caves.

6.0 Values assessment

The assessment was undertaken by way of a table as follows:

Table 6: Ecological valuation summary based on EIANZ criteria.

Matter ⟹ Ecological Feature ⇓	Representativeness, (2) Rarity/distinctiveness, (3) Diversity and Pattern, (4) Ecological Context	Values for each matter	Overall Value
Karst Landscape features	Karst ecosystems are representative of the Waitomo District and can support a range of specialistic flora and fauna species when they are relatively intact and unmodified; however, no intact and representative examples were observed during surveying on site. The majority of features present are not representative of naturally occurring relatively intact ecosystems. Several of the features present fall, very loosely, into the threatened habitat category of Holdaway et al 2012 (endangered, scarps and tors-vulnerable). However, historical agriculture use, and continued use has significantly diminished the representativeness and ecological value of the features present on site to the point where in many cases there is no value remaining to protect. The better intact features as shown on Figure 6(Ca. 1 ha) and have the value assessed here.	(1) Low (2) High (3) Low (4) Low	Moderate
Terrestrial Vegetation	There was a small percentage (2%) of indigenous vegetation on site with intact canopy. However, the understory was heavily impacted by stock access. The majority of the site was pasture grass. Threatened plants observed only comprised of rātā. No karst ecosystem specialist plants were observed. Vegetation could provide small stepping-stones, however the pockets of bush are relatively small compared to the surrounding bush blocks that will remain and have little faunal resources.	(1) Low (2) Low (3) Low (4) Low	Low
Avifauna	Exotic birds were the dominant species observed on site. Common forest birds were observed as well. However, bush falcon (At Risk-Recovering) was also observed, but only once. Falcon are known to use karst ecosystems for nesting but on site there is only limited amounts of habitat for nesting.	(1) Low (2) Moderate (3) Low (4) Low	Low
Herpetofauna	The rock formations on site provide large amounts of habitat for lizard species that specialise in this ecosystem type, but the copper skink are also throughout the pastural areas wherever there is cover. Extensive lizard surveys have confirmed the presence of copper skinks and ornate skinks which are both At Risk – Declining. However, they are open to uncontrolled mammalian predators, farming activities affecting the vegetation, and have limited amounts of habitat items within the small bush blocks. While the species themselves are important the site's habitat is not well suited or has a high abundance of any particular lizard orientated resource.	(1) Low (2) High (3) Low (4) Low	Low

Matter ⟹ Ecological Feature ⇓	Representativeness, (2) Rarity/distinctiveness, (3) Diversity and Pattern, (4) Ecological Context	Values for each matter	Overall Value
Bat habitat	Long-tailed bats are a threatened - nationally critical species and as such they carry a very high species value. Acoustic recorders over the 2019 and 2021 survey periods show a low amount of activity on site. Some trees/areas on-site were assessed as likely potential roosting trees (121 in 2024 (Phoenix Ecology)) but no roosts were confirmed on site. It was noted that many of those roost trees are likely to fall over soon. Some roosting and foraging activity was indicated on-site but largely the activity indicated commuting behaviour. While the value of the bat species increases the importance of habitat in which it occurs, the quality and utilisation of that habitat is of lesser value than the bat itself.	1) Low 2) Low 3) Low 4) Moderate	Low
Terrestrial Invertebrate habitat	The invertebrates (as a species group) are of low value. The taxa observed on site were representative of the pasture ecosystem type. No specialistic karst ecosystem invertebrates were observed on site. There was little diversity and pattern observed on site, with common garden snails occupying most of the rock formations.	1) Low 2) Very Low 3) Low 4) Low	Low
Cave terrestrial Fauna / habitat	Short, small, muddy, relatively new and modified by the land use, modified cave entrance features, loss of wider forest, muds common as substrate, rubbish present, sheep carcases common, rat prominence evident. Some aspects of common faunal components but a reduced taxa richness without apparent troglobite representation and generally reflective of "forest" taxa opportunistically using the short cave systems found	1) Low 2) Low 3) Low 4) Low	Low

The site still contains legible karst features on the surface, though highly modified, and the site also presents foraging, potential roosting and commuting habitat for a nationally threatened species, the long-tailed bat. The limestone formations present some habitat for indigenous herpetofauna species; with copper skinks and ornate skinks found on-site, but also throughout the wider pastural areas where there are non-pasture cover items.

While the avifauna species are largely exotic, bush falcon (At Risk-Recovering) were observed flying throughout the site and are known to use karst ecosystem features for nesting and may do so from time to time here, although no nesting behaviour was observed.

The caves are very young, short and in highly modified condition. The Dolines are similarly highly modified.

Most of the ecological value is focussed on the remnant karst ecosystem features and indigenous bush blocks, which overlap the project footprint. The majority of the proposed pit has been highly modified by a long history of agriculture, and most of the site is classified as having a low ecological value due to the dominance of pastureland. It is like most rural properties in the area.

7.0 Significance Assessment

Table 7: Regional Policy Statement Ecological Assessment Section 11A

	Criteria	Surface Karst features	Terrestrial Vegetation	Pastureland	Caves
1	*It is indigenous vegetation or habitat for indigenous fauna that is currently, or is recommended to be, set aside by statute or covenant or by the Nature Heritage Fund, or Ngā Whenua Rāhui committees, or the Queen Elizabeth the Second National Trust Board of Directors, specifically for the protection of biodiversity, and meets at least one of criteria 3-11.*	No	No	No	No
2	*In the Coastal Marine Area, it is indigenous vegetation or habitat for indigenous fauna that has reduced in extent or degraded due to historic or present anthropogenic activity to a level where the* ***ecological sustainability*** *of the ecosystem is threatened.*	No	No	No	No
3	*It is vegetation or habitat that is currently habitat for indigenous species or associations of indigenous species that are: classed as threatened or at risk; or* ***endemic*** *to the Waikato region, or at the limit of their natural range.*	Potentially - falcon (At Risk-recovering) and long tail bats have been observed onsite but habitat use has not been confirmed and there remains doubt as both taxa may periodically use but not require the site and/or only use a specific part of the widely variate karst features.	Yes-Potential roosting trees (some of which are high risk) for Long-tailed bats (Threatened) occur both in the isolated exotic trees and within trees located in the bush blocks onsite.	Yes-Long-tailed bats (Threatened) use gully systems and pastureland onsite for commuting and foraging purposes. A feeding buzz was detected on-site in the 2019 survey.	No
4	*It is indigenous vegetation, habitat or ecosystem type that is under-represented (20% or less of its known or likely original extent remaining) in an Ecological District, or Ecological Region, or nationally.*	Unlikely – while Karst ecosystems are naturally uncommon they remain in general in the landscape as in pasture systems or under reserves and forests, relatively few have been removed for quarrying such that it is likely 20% of the pre human amount remains now.	No	No	No - These rural modified features are abundant across the farmland of the Waitomo district.

5	*It is indigenous vegetation or habitat that is, and prior to human settlement was, nationally uncommon such as geothermal, chenier plain, or karst ecosystems, hydrothermal vents or cold seeps.*	Yes – technically and only for the native vegetated features because the surface limestone in pasture is just limestone not a karst ecosystem. Most of the Karst features present do not represent those prior to human settlement, missing most species and form and condition – On site there are little to no values worthy of qualifying as significant even while the features carry the label of Karst because they are limestone outcrops. We estimate around 1ha of the features present could be considered to meet this criterion.	No	No	No - Cave entrances and so by extension Caves are naturally uncommon. However, I note that the cave features in and of themselves are not surface limestone karst expressions or traversable lime stone caves. The features regarded as naturally uncommon are those representative of a "natural" cave entrance with appropriate indigenous vegetation cover and fauna, or a limestone geology suture (with vegetation) not a pasture edged hole in the surface of the earth.
6	*It is wetland habitat for indigenous plant communities and/or indigenous fauna communities (excluding exotic rush/pasture communities) that has not been created and subsequently maintained for or in connection with: waste treatment; wastewater renovation; hydroelectric power lakes (excluding Lake Taupō); water storage for irrigation; or water supply storage; unless in those instances they meet the criteria in Whaley et al. (1995).*	No	No	No – no indigenous wetland plants species found on-site.	No - It is not wetland habitat
7	*It is an area of indigenous vegetation or naturally occurring habitat that is large relative to other examples in the Waikato region of similar habitat types, and which contains all or almost all indigenous species typical of that habitat type. Note this criterion is not intended to select the largest example only in the Waikato region of any habitat type.*	No - Karst ecosystem present is not large in comparison to similar habitat types in the Waikato Region, and associated indigenous species specialised to this ecosystem type were not found to be present.	No	No	No - Even summed the total cave area affected is not a large example of short and shallow cave habitat in the relevant ecological district.
8	*It is aquatic habitat (excluding artificial water bodies, except for those created for the maintenance and enhancement of biodiversity or as mitigation as part of a consented activity) that is within a stream, river, lake, groundwater system, wetland, intertidal mudflat or estuary, or any other part of the coastal marine area and their margins, that is critical to the self-sustainability of an indigenous species within a catchment of the Waikato region, or within the coastal marine area. In this context "critical" means essential for a specific component of the*	No	No	No – a non-natural wetland has been identified within the pit footprint within an area of pastureland. This wetland is not likely to be critical to the self-sustainability of an indigenous species	No - The karst features (Camelot aside) have no aquatic habitat.

	life cycle and includes breeding and spawning grounds, juvenile nursery areas, important feeding areas and migratory and dispersal pathways of an indigenous species. This includes areas that maintain connectivity between habitats.				
9	*It is an area of indigenous vegetation or habitat that is a healthy and representative example of its type because: its structure, composition, and ecological processes are largely intact; and if protected from the adverse effects of plant and animal pests and of adjacent land and water use (e.g.* ***stock****, discharges, erosion, sediment disturbance), can maintain its ecological sustainability over time.*	No - Karst ecosystem on-site has been severely impacted by stock access and pest animals. Understory of small bush blocks is sparse.	No-Indigenous bush blocks onsite have been extremely impacted by stock access and pest animals. Understory of small bush blocks is sparse.	No	No - The cave habitats are not, healthy having received farm run off and sediment over many years. They are also "infested" by rats and have no cave entrance indigenous vegetation.
10	*It is an area of indigenous vegetation or habitat that forms part of an* ***ecological sequence****, that is either not common in the Waikato region or an ecological district, or is an exceptional, representative example of its type.*	No - The karst ecosystem type is common within the Waikato Region and ED and these are poorer examples of scattered remnants in the ED.	No	No	No - The caves and entrances are not parts of a sequence or ecotones through gradients.
11	*It is an area of indigenous vegetation or habitat for indigenous species (which habitat is either naturally occurring or has been established as a mitigation measure) that forms, either on its own or in combination with other similar areas, an ecological buffer, linkage or corridor and which is necessary to protect any site identified as significant under criteria 1-10 from external adverse effects.*	No	No	No	No
	Significant?	Yes – but this only applies to the features (red features Figure 6, Ca 1ha) that retain some level of natural indigenous vegetation cover and might be deemed representative of the natural surface karst condition, not surface rock in pasture covered by pasture.	No	No	N0

8.0 Effects and their management

Based on the findings in Sections 6.0 & 7.0, the permanent removal of karst features and small bush blocks of indigenous vegetation (with karst features) as well as the removal of cave entrances are the key terrestrial effects facing the Project on the assumption that lizards and bats are managed to removal any direct harm. The Project's actual and potential ecological effects identified during the assessments are presented below.

Actual Effects:

- Direct and permanent loss of approximately 1.0ha of High value, significant karst ecosystem features (removal of Ca. 10ha of pasture -surface rock also).
- Direct and permanent loss of approximately 1.4ha of native vegetation / habitat.
- Removal / loss of 7 short, small cave systems and entrances.
- Permanent loss of moderate value habitat and food source for native fauna.

Potential Effects:

- Potential injury/death of native fauna (birds, bats, lizards) due to habitat removal.
- Potential indirect effects on fauna, including increased amounts of dust, noise and lighting on the remaining habitats nearby the boundaries of the proposed new pit.
- Potential effects on remaining vegetation on western boundary (e.g., edge effects, damage to root systems).

In regard to the Camelot system, in the absence of current data but some old anecdotal information, and considering the size, depth, length and presence of a stream system I assume that the Camelot cave system is most likely to have a representative habitat and troglobite fauna and therefore will most likely have a high value. Due to its inaccessibility a buffer of 200m has been placed so as to avoid effects to this proper cave system.

The Maniapoto Environmental Management Plan (**MEMP**) makes some reference to caves. At section 17.2.4.1 it refers to burial caves (which obviously have very high cultural value and significance), at section 19.1.2 it references Waitomo glow worm cave reserves as an area of natural heritage and biodiversity value, and notes Waitomo Glow worm and Ruakuri caves as having ecotourism opportunity. It has no reference to any specific ecological value of such small caves as encountered on this site and these small caves have none of the values related to those that are identified in the MEMP.

8.1 Magnitude of Effects (Pre-mitigation)

8.1.1 Karst Ecosystem

The proposed SW Pit will result in the permanent loss of an area of karst ecosystem. A sub set of the karst system, qualifies as "significant" (Ca. 1ha).

The features onsite have been extremely degraded as a result of agricultural land use. Karst ecosystems are a naturally uncommon ecosystem type, with some features classed as threatened or endangered. At a regional scale there is somewhere around 1,000km^2 of karst system. In the Maniapoto area and the half of the Waitomo Ecological District there is an area of around 90,000 ha of Karst area. Of course, that area does not include only karst features, but it is the best approximation of the area of karst landscapes. The area of the site at Ca 1 ha is less than 0.01% of the possible karst ecosystems in the ED, this magnitude of effect (although permanent) is considered to be **Negligible** (see section 4.4), due to the very low amount relative to the total available and also taking into consideration the quality (not value) of karst ecosystem proposed to be lost. In terms of accumulating effects, there are few other activities that currently through the NPS IB and Regional and District plans have an ability to remove karst systems and so we assume that this activity is not and cannot be one of very many which summed might reflect a more than negligible adverse effect.

8.1.2 Terrestrial Vegetation

Indigenous Broad leaf vegetation sums to around 1.4ha. At an ED scale there is some 2,823ha of native broadleaf forest (LCDB6). The fragmented bits of native vegetation on site (treating it all as broad leaf forest) amount to 0.04 % of the ED's native broadleaf forest cover and that amount represents a **negligible** magnitude *albeit* permanent.

Assessment at the site or zone of influence cannot but help deliver a more than minor out come in rural landscapes which typically have more sparse native bush remnants and so typically only small amounts on any one property. The NPS IB directs assessments to the ED scale. The LENZ environment of the site is 20-30% indigenous and so not overly depleted there is no reason to shrink the assessment scale to the zone of influence or to suggest accumulating effects either. The areas are currently farmed not fenced and not protected and are not recognised as Significant in the Regional or districting planning regime, not here and so there is little compelling evidence to take a cautious approach.

8.1.3 Avifauna

Injury or death of common native forest birds during vegetation clearance for the proposed quarry is a potential adverse effect and is contrary to the Wildlife Act without a permit. That effect only really happens if a female bird is nesting (sitting on eggs), otherwise the birds will move from the disturbance area. The effect of death of nesting natives would have a negligible magnitude of effect on these species populations in the ED, a minor shift from the baseline condition, other than if a falcon was affected (which would be a rare situation). Nevertheless, there are also ways to minimise this potential effect.

Increased noise and dust may also have some indirect or edge effects on the remaining bush blocks adjacent to the new pit boundary (especially the western SNA). Separate assessments of noise/vibration and air quality have been prepared for the Project. Those assessments were reviewed from an ecological perspective. The noise/vibration assessment concluded that noise levels will not be unreasonable within the Rural Zone. The draft air quality assessment noted that dust would largely deposit within 100 m of sources, and that receiving environments were of low sensitivity to the effects of dust.

At both a local and regional scale, the magnitude of effect on avifauna is **Negligible** (noting falcon caveats) due to the small area of existing nesting habitat that will be removed.

8.1.4 Herpetofauna

Injury or death of native herpetofauna during the quarry development is a potential effect and is also contra to the Wildlife Act without a permit. The site contains habitat for specialistic lizard species which is better than standard pasture with fragments of bush because of the presence of karst systems. However, during extensive surveys of the rock formations, no native lizards were observed using this environment. Several copper skinks and ornate skinks were observed across the site, mostly under isolated logs in pasture. Even at a local scale, the magnitude of effect on herpetofauna habitat loss is **low**. Without population information but reflecting the possible habitat capacity limitations (site is predominantly pasture) and low numbers of skink found, we suggest that losses of individuals from this landscape through site disturbance could reflect a **moderate** magnitude in population change locally. Dr Tocher, in the lizard management plan, considers the death or injury of copper skink (at a local level) would be moderate and high for ornate skink and the focus of the lizard management is avoidance of that effect. Dr Tocher also assesses the loss of the habitat in the proposed quarry as moderate for copper skink and high for ornate skink at a local level but low at a national level.

8.1.5 Bats

Injury or death of long-tailed bats during pit development is a potential adverse ecological effect where they are roosting in trees being felled. No cave entrance on site (Camelot excluded) offers bat access and roosting potential. Long-tailed bats were present in low amounts during the surveys and roosting behaviour was not observed; however, potential roost trees and foraging behaviours were observed on site. In the absence of understanding the local bat population and its primary roosting habitat, we can make a reasonable assumption that it is in the very large native mature forested areas north and north west (Tawarau Forest, Ruakuri reserve and a number of unnamed bush blocks) that form the basis of bat populations and roosting habitat in the ED and not isolated tree fragments on farms. Removal therefore of potential roost trees (even at around 90) can be considered a **negligible** magnitude.

Direct impacts of bats if in roost and felled would (in the absence of a known bat population for the ED) need to be considered likely a **High** magnitude of effect (which can of course be managed to avoidance).

Indirect effects such as increased lighting, dust, and noise were considered as potential impacts as the bush blocks are relatively close to the new pit boundary. As discussed above for avifauna, the noise and dust assessments for the project provide a strong indication that the magnitude of ecological effects of noise and dust will be **low**.

8.1.6 Terrestrial Invertebrates

Injury or death of terrestrial invertebrates is a potential effect. However, the species observed on site are not classed as threatened or at risk and are common semi-pastoral natives. Removal in a population sense of these invertebrates at the ED scale will be a **negligible** population impact. The loss of 1.23ha of better than pasture habitat within the rock formations will be permanent but again at an ED scale that level of removal (as discussed in the vegetation section) is a magnitude of effect on terrestrial invertebrates than can be considered **Negligible**.

8.2 Summary of level of effects.

Level of ecological effect based on the EIANZ values and magnitude of effect matrix.

Matter Ecological Feature / effect	Value	Magnitude of effect	Level of Effect
Karst Landscape features - loss	Moderate	Negligible	Very Low (less than minor)
Terrestrial Vegetation - loss	Low	Negligible	Very Low (less than minor)
Avifauna -common native species -habitat loss and / or death	Low	Negligible	Very Low (less than minor)
Bush Falcon At Risk – recovering) -death	Moderate	High	Moderate (more than minor)
Herpetofauna - habitat loss (at an ED level)	Low	Low	Very Low (less than minor)
At risk – declining lizard taxa (copper and ornate skink) -death[8]	High	Moderate	High (major)
Bats -roost tree loss	Low	Negligible	Very Low (less than minor)
Bats - death	High	High	Very High (avoid)
Bats - Indirect effects	High	Negligible	Very Low (less than minor)
Terrestrial invertebrates - habitat loss and death	Low	Negligible	Very Low (less than minor)

Clearly falcon, lizard and bat deaths are the major ecological effects but we note to that where the karst feature/s are considered significant then those effects of loss take on a more stringent response requirements.

8.3 Caves

8.3.1 Potential Effects

- Direct effects – loss of caves
- Sedimentation into caves outside of the boundary
- Indirect effects – ground vibration of such magnitude as to cause disruption to cave fauna and discharge of contaminants to caves

[8] Note the lizard management plan has a more detailed assessment reflective of a wider range of aspects related to each lizard species but in the round concludes a similar, even lesser local level effect and a low national effect for all aspects.

8.3.2 Direct Effects

The proposed pit will result in the loss (through the removal) of seven of these caves, while the remaining surveyed are outside of the direct effects (and thus potential offset opportunities). Some bordering caves on the edges of the pit (specifically: H9, B1, Camelot) may be affected by quarry activity that causes ground vibration or through rock gaseous exchange or sediment discharge via waterways.

The following caves will be removed by the quarrying process: D1, E1, E2, C6, C5, B7, and B1.

These seven caves have the following approximate floor areas and estimated organic debris areas on those floors.

Cave	C5	C6	D1	B1	E1	E2	B7
Totals cave floor area	$10m^2$	$8m^2$	$16m^2$	$31m^2$	$10m^2$	$10m^2$	$26m^2$
Organic debris	$1.5m^2$	$3.23m^2$	$0.5m^2$	$5.2m^2$	$0.43m^2$	$0.16m^2$	$1.73m^2$

Table 8:7 Affected cave systems and their floor and debris areas

This sums to **111 $m^2$of floor area and 12.75 m^2 organic debris** (leaves, wood, roots etc.). Of course, not all the floor, wall and roof surface area is habitat. Habitat for spider fauna is different from that of the snails and that of the millipedes, isopods and amphipods. The area of floor and area of organic debris is used as a reasonable proxy of the area of habitat potential in each of the caves surveyed and so by way of summation a total area of in-cave habitat that will be lost.

8.3.3 Magnitude and level of Effect of Loss of Caves

The cave maps (each with a scale) indicate that there is in the vicinity of $111m^2$ of floor area of cave habitat proposed to be removed. Not all of this surface is habitat (acknowledging, as per the above comments, that this is a gross overestimate of habitat area).

There is no data on the cave habitat area in the ED. In this case, similar local caves (for which there is some survey evidence) have similar areas and there are some scale up estimates based on density from the early cave surveys.

I have considered two scales: a very local and a local catchment scale. The local scale is an area indicated on the NZ 250 Topo north of Oparure Road where stream flows are shown only intermittently on the map as indicating frequent subterranean travel and an extent of doline and rock outcrop between Waipapa Road and north to Trig A8WA. This is an appropriate local scale as the wider landscape from which to assess the magnitude. This area would reflect the local karst expression, but it would really only be a subset of the area in terms of caves and cracks in limestone. There is a small area inside of this (the very local area) which reflects cave systems loosely joined or associated with the affected caves in the Pakeho Pit area (Figure 14**Error! Reference source not found.**).

That said, there is no accurate information on the number and size and condition of these cave features in this landscape spatial scale. The extent of caves found for this project and those known for recreation is understood, as well as 60 cave entrance features and 14 caves in the approximate 140 ha proposed pit. The unaffected caves assessed have habitat proxy floor area which sums to twice that of the affected ($349m^2$) but less organic debris area (total of $10.83m^2$).

If we assume that the ca. 100ha of the investigated area has 15 caves (a conservative estimate), then the very local area (400ha) has 60 such caves and the local landscape (at 3000ha) has 450 similar caves.

On the assumption that the local landscape caves are of similar dimensions and condition (which appears reasonable looking over the entire 15 caves surveyed and so 15m^2), the very local effect (first red circle area ca 400ha, 60 caves of Figure 14) would be 951m^2 of cave habitat of which the seven caves represent around a 11.7% reduction in the amount of subterrain habitat, the wider effect (second red circle ca 3,000 ha, 450 caves, 6,750m^2 of habitat) we think diminishes to 1.6% loss.

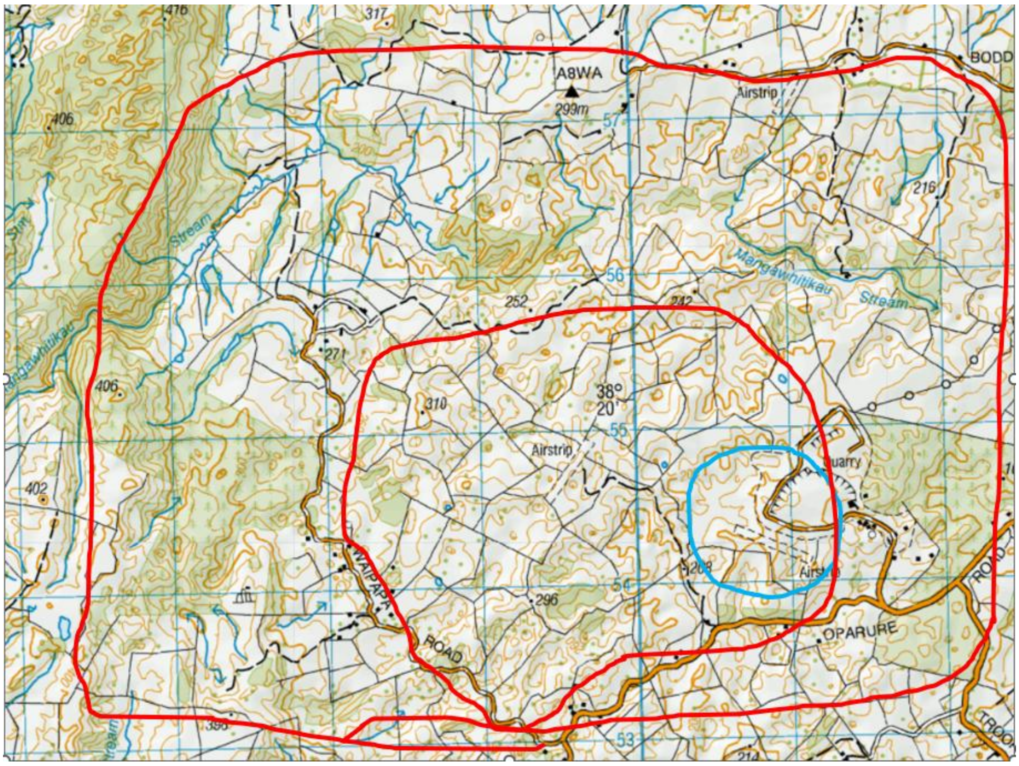


Figure 14. Effect area, the site (blue), very local and wider local catchment.

To establish the total resource present, I have considered the adjacent caves west and south surveyed; these sum to 350 linear meters (and 10m^2 organic debris). The Camelot system (unaffected directly) itself offers a further >250m.

At the very local level the magnitude (relevant to the total resource estimated to be locally present) represents, in terms of the EIANZ (Roper-Lindsay et al., 2018a), a **Low** magnitude at the very local scale and a **Negligible** magnitude of effect at a more reasonable catchment scale.

Where it is the case that these small features are common in this wider landscape as predicted, then the outcome (at the local landscape level) is a set of **low value** subterranean habitats where a loss of 7 caves is considered very locally as a **Low magnitude** and at a wider catchment scale as a **Negligible magnitude** of effect and so a very low level of effect.

At either scale this results in a **very low level of adverse effect**. This is a less than minor adverse effect.

8.3.4 Indirect Effects

8.3.4.1 Vibration

Vibration (often measured using a vibrometer) is a common effect of open pit mining and has been recorded between 0.5 and 2.1 mm/s (Afeni & Osasan, 2009). International limits suggest 5mm/s (ppv) for 95% (of the time) and 10mm/s for 100% of all blasts. The ANZEC Guidelines (1990) state that experience has shown that for almost all sites a ppv of less than 1mm/sec is generally achieved (this equates to a person walking on a wooden floor). We assume that blasting vibration is transmitted through the interceding rock (limestone) to the caves and only becomes noticeable when the blasting is within close proximity (50m) of the cave structure.

Trial blasting evidence to a cave ecosystem in the Gradusa exploration field (Croatia) (Mesec et al., 2018) has shown that within 100m the ppv (mm/s) is over 1 but only over 10 when within 40m and is less than 1 over 100m and approaches zero at 300m (blast strength as used in the trial).

The distance and magnitude of the vibration is related to the charge weight – how much explosive is used – but it appears that where the blasting is beyond 100m the vibrations are less than walking on a wooden floor and that there is a 40m range to humans at least to notice an effect.

Depending on how the expansion is developed those caves that are at the outer boundary and within 50m may be affected and are: B1, E4 and Camelot. That potential effect, however, might not occur for decades. Other caves such as C3.1 and H9 are much further away. The blasting effect in terms of vibration as a magnitude of effect should be considered **Negligible** to cave fauna (it is infrequent and short duration and does not have any effect other than potentially disturbance of the animal which should make minor adjustments and habituate to such levels). At worst then Camelot, the highest value cave potentially affected, would be affected only to a very low level.

8.3.4.2 Discharge of Contaminants

Currently it is clear by the levels of sediment in many of the caves and the state of the entrances that current land use-based contaminants enter the caves and coat the floor and some of the walls of these caves. This sediment is both a resource but more typically adverse to fauna in the cave.

The Project is not of issue as the caves directly affected by the SW Pit because those caves and their fauna are removed. The effect cannot apply to those caves near the outer boundary that are above the elevation of the pit floor, because the quarry surface (as we understand it) is below the entrance level of those caves and not slope directed to the entrances.

However, caves at elevations lower than the pit floor that occur beneath and immediately downgradient of the SW Pit could be affected by the discharge of sediment from the quarrying activities. The only known cave that falls into this category is Camelot Cave. As stated in the Water Quality report (PDP 2026), there will be a range of in-pit sediment retention and management devices and protocol to resist the discharge of sediments from the quarry causing any adverse effects of a more than minor scale. There are, in addition to pit sediment management methods, potential processes such as bunding the entrance of Camelot from the pit to further exclude stormwater related sediment discharge.

With management the magnitude of sediment “contamination” to Camelot should be, when compared to the current farming discharges, Negligible. A high value system faced with a negligible effect results, should it happen, in a very low level of effect. This level of effect is unlikely to be any worse than the current farmed situation. Furthermore, sediment deposition to the cave floor (or instream) does not impact wall and roof dwelling troglobite fauna.

9.0 Effects management Hierarchy

The NPS-IB seeks to protect SNAs. This assessment finds that the small areas of karst feature that maintain a native vegetation cover in the pasture within the SW Pit (or haul road) to be SNA.

The NPS-IB seeks to maintain extent and values of SNA and improve management of indigenous biodiversity outside of SNAs, and requires use of the effects management hierarchy to manage adverse effects on indigenous biodiversity. On that basis, effects must still be considered with regard to the in pit features.

Approximately 1ha of the best-vegetated limestone outcrop areas scattered around the site need to be considered as SNA karst ecosystems, and it is noted that those native vegetated karst fragments could also be significant if long-tailed bats, bush falcon, or ornate skink rely on or frequently use those areas, as opposed to merely visiting them occasionally as part of their wider territories.

The NPS-IB effects management hierarchy is an approach to managing the adverse effects of an activity on indigenous biodiversity that requires that:

a) adverse effects are avoided where practicable; then

b) where adverse effects cannot be avoided, they are minimised where practicable; then

c) where adverse effects cannot be minimised, they are remedied where practicable; then

d) where **more than minor** residual adverse effects cannot be avoided, minimised, or remedied, biodiversity offsetting is provided where possible; then

e) where biodiversity offsetting of more than minor residual adverse effects is not possible, biodiversity compensation is provided; then if biodiversity compensation is not appropriate, the activity itself is avoided (this last requirement is no longer an imperative under the FTAA process).

The effects management analysis concludes that habitat related effects (the loss of farmland with scattered remnant karst features and native scrub and trees, potential bat roost trees and invertebrate and avian habitat) is **less than minor**.

This is because the highly modified remnant systems (even while SNA) are tiny as a proportion of the ED's same and better resources, and the values are at the lower end of the values continuum, as expected because of the accumulated reductions related to the historic and current land uses.

It follows from that analysis that those less than minor effects do not need to be avoided, and (aside from avoidance of death of valued species) do not need any other management other than to minimise as far as possible the losses. That is, no remedy or offsets are required for the less than minor level of effect.

That said the best karst features (approximately 1ha) present, several with bush elements, despite being relatively unrepresentative and low diversity and low value due to the modifications of land use (which are ongoing) are registered as naturally uncommon and threatened and contain At Risk lizard species. There may be a case, irrespective of the EIANZ effects outcome, to consider some form of mitigation for even such highly modified karst features such as on site.

The loss of the 7 cave systems on the site also results in a less than minor effect. This is because there are no representative suitably unmodified cave entrances on site that have the values expected of such systems to be protected.

Harm to lizards, bats, or bush falcon is to be avoided where possible given their threat status and harm to such species would constitute a more than minor effect. Accordingly, avoidance strategies are recommended. To that end, lizard, bat, and bird management plans have been prepared, and wildlife authority permission has already been obtained for lizards. No other DOC permits are needed, provided the potential bat roost tree felling protocol prescribed by DOC is followed, along with the avoidance and effects management measures set out in the native bird management plan.

These plans have been produced by independent subject matter experts.

- See Dr Tocher's report November 2024 (Wildlife authority and management plan)
- See Phoenix Ecology Limited Bat management plan (September 2025).
- See PDP limited Bird management plan September 2025.

Graymont, regardless of the habitat effects outcomes, and in relation to the lizard transfer obligations, have offered as part of the consents (and in conditions) a betterment plan that has substantive ecological gains for karst and cave systems locally, in addition to those required by the freshwater ecology effects management regime.

It is also noted that to minimise potential effects in the wider landscape to bats, invertebrates and some birds, lighting options that avoid/minimise impacts should be utilised for the new pit. Current best practice to minimise effects of artificial lighting on bats in New Zealand is to use downward facing directional lighting with a maximum correlated colour temperature (CCT) of 2700K (Commonwealth of Australia, 2023). These should be conditioned in consents.

We assume that dust and noise, because that also relates to neighbour nuisance issues, will be managed also through consent conditions to a low and acceptable level and where that is so for humans, so it will be for the flora and fauna.

9.1 Karst (surface and cave) feature betterment

Some 1ha of potentially significant and better condition karst features will be removed over time and is the most significant terrestrial ecological adverse effect of the proposal. The level of that effect is very low (less than minor) and does not technically require any remedial or offset action.

However, around 8ha of karst ecosystem area outside the project footprint (west) are proposed be protected and 6.7 ha will be actively restored/enhanced as part of the proposed betterment plan (PDP 2026) and soil conservation approach. This will offer improving resources and habitat locally as restoration efforts proceed. This will result in a significant net ecological gain and protection of the SNA.

Karst ecosystem protection and enhancement will occur in and around the significant natural area (SNA) (**Error! Reference source not found.**) with revegetation efforts made to rejoin these bush features and pest management to enhance the recovery and longer term survival. The area will be protected from further farming influences, and the area also incorporates the more intensive lizard habitat improvements to allow for transfers from the quarry area.

[redacted]

Figure 15. Areas of native forest (SNA), and the terrestrial ecology betterment area red out line – orange dots = cave entrances, red = dolines, solid green = revegetation area. Included in the solid green area is the specific lizard enhanced habitat and release area.

The open pasture joining the bush blocks is in the order of 3ha and will be actively planted in appropriate species, with weed and animal pest management and stock exclusion fencing. The southern feature is enlarged by the southern revegetation.

There are also around 10 cave entrances in this area which will be enhanced through appropriate planting of currently missing representative cave entrance flora. This means that the less than minor effect of the removal of the poor quality cave entrances in the quarry a site are, regardless of the effects hierarchy, managed to a net ecological gain given there is no incentive or requirement under the farming regime to undertake such enhancement and protection.

Protection (and enhancement) of karst ecosystems will include a mix of the following actions:

- Appropriate fencing.
- Karst features protection and enhancement via fencing from stock and pest management.
- Connection of bush fragments via revegetation (active 1ha) and managed natural rehabilitation.
- Management of the 8ha entire feature against weed and pest effects
- Cave entrance protection/planting.
- Reconstruction of rock piles to increase habitat for copper skinks, ornate skinks, and nest sites for NZ bush falcon (within the enhanced karst area linking the two SNAs).
- Pest plant and animal control specific to lizards in that area.

These actions are outlined in the Betterment plan (PDP 2025). There is additional restoration actions related to the freshwater ecology and involving riparian revegetation and wider small catchment revegetation which is separate and additional to this component.

10.0 Conclusion

The development of the proposed South-Western Pit will result in around 1 ha of native vegetated Karst features being removed (over time) and the loss of the seven caves, with a loss of 111 m^2 of cave floor. Effects to the Camelot Cave (in the south) are avoided through a robust distance buffer from the cave.

Effects on a range of At Risk and threatened species that may be, from time to time, present, are managed through avoidance strategies, including capture and relocation, timing of clearance, and implementing a protocol for tree felling. These avoid the potential adverse effects of direct harm to the species targeted.

The level of effects of karst and bush remnant loss at the Ecological District level are less than minor and that level of effect does not require remedy or offset. However, Graymont is proposing an extensive ecological betterment plan such that the end result for ecology locally is better than currently exists, meaning in effect those less than minor effects are more than 'offset'. I recommend that 7 cave entrances be protected and enhanced and note that 7ha of native forest is being restored and two disjunct SNA joined and made secure. Within that area is also the highly managed new lizard habitat area with predator control.

Graymont has committed to protecting and enhancing more caves and revegetating more area than effects require, which will result in betterment (i.e. a net positive ecological outcome). That regime is shown in the betterment plan (PDP 2026).

Through best practice management and consent conditions, noise, light and dust will be managed with respect to adjacent ecology to an acceptable low level and the Camelot cave system will be avoided.

In the round, the ecological outcomes will bring about a net gain as set against the current permitted land use activities.

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Appendix 1: survey plant list

No species recorded has a threat or risk conservation status

Common name/s	Latin name	Alternative name
Akeake	*Dodonaea viscosa*	
Black tree fern	*Cyathea medullaris*	Mamaku, black mamaku
Bracken	*Pteridium esculentum*	Rarauhe, Bracken fern
Drooping spleenwort	*Asplenium flaccidum*	Hanging spleenwort
Hangehange	*Geniostoma ligustrifolium*	Maori Privet
Hounds Tongue	*Microsorum pustulatums* ubsp. *pustulaum*	Kowaowao, paraharaha
Kaikōmako	*Pennantia corymbosa*	
Karamū	*Coprosma robusta*	Glossy karamu
Kawakawa	*Piper excelsum* subsp. *excelsum*	Pepper tree
Kiokio	*Parablechnum novae-zelandiae*	Horokio, palm leaf fern
Kōhūhū	*Pittosporum tenuifolium*	Kohukohu, black matipo
Koromiko	*Veronica stricta*	hebe
Kōtukutuku	*Fuchsia excorticata*	Tree fuchsia
Māhoe	*Melicytus ramiflorus*	Hinahina, whitey wood
Mangeao	*Litsea calicaris*	Tangeao
Mingimingi	*Coprosma propinqua*	
Nertera	*Nertera* sp.	
Nīkau palm	*Rhopalostylis sapida*	
Poataniwha	*Melicope simplex*	
Pōhuehue	*Muehlenbeckia australis*	Large-leaved muehlenbeckia
Pūkio	*Carex secta*	Purei
Putaputawētā	*Carpodetus serratus*	marble leaf
Rātā (lianes)	*Metrosideros colensoi*	Climbing rātā
Rewarewa	*Knightia excelsa*	NZ honeysuckle
Ring Fern	*Paesia scaberula*	Lace fern, scented fern

Shining spleenwort	*Asplenium oblongifolium*	
Small Kiokio	*Blechnum procerum*	
Soft tree fern	*Cyathea smithii*	Katote, Smiths tree fern
Supplejack	*Ripogonum scandens*	Kareao
Wheki-ponga	*Dicksonia fibrosa*	Wheki-kohoonga, golden tree fern, kuripaka

Appendix 2: Cave Fauna

Taxa richness (from both surveys) based on photographic evidence and limited specimen identification

	Number of taxa found and taxa.	**Abundance estimate**	**Richness (below 8 low, 8-15 average, over 20 high[9])**
Cave ALL-C5	4 (Zonitidae & Opacuincola; wolf spider, Cyclotenus sp and Hexathele sp.).	Low – 1-2 individuals each taxa	Low
Cave E2	5 (Cyclotenus, wolf; Styloniscus spp., Porcellio sp.; Milliped)	Low - 1-2 individuals each taxa	Low
Cave H2	2 (cave weta, Styloniscus sp.)	very low – 3 individuals.	very low
Cave H5	11 (cave weta, harvestman, millipede, slater, Hexathele sp., Zonitidae, *Cornu aspersum*, *Cambridgea plagiata*, Isopoda, Zonitidae).	Low -1-2 individuals of each taxa	Average
Cave C6	6 (Millipede 1, cave weta, Opacuincola, Hypodrassodes sp., Millipede 2, Hexathele sp.)	low	Low
Cave B7	4 (Hexathele, Cyclotenus, Zonitidae, *Cornu aspersum*).	low	Low
Cave E1	5 (Cornu aspersum , Hexathele sp., *Cambridgea plagiata*, fly larvae, Zonitidae)	low	Low
Cave B1	10 (Cyclotenus, millipede 3, millipede 4, Mynogleninae spider,m Cormocephhalus, Zonitidae, Amphipod, Cambridgea, *Cornu aspersum*, Phoridae) Glow worms are also present.	Average – 15 Migus recorded in $10m^2$, 3 glow-worm, 1 or 2 individuals of all other taxa.	Average
Cave C5	10 (stag beetle, Saltciudae, Hexathele, lepidoptera larvae, Zonitidae, Cyclotenus, Porcellio, *Cambridgea plagiata*, Styloniscus, Opacuincola)	Low - 1-2 individuals each taxa	Average
Cave I1	1 (Hexathele sp.)	very low – 1 individual	very low
Cave D1	3 (Opacuincola, Mynogleninae sp. , Cyclotenus)	Very low - 3 Migas and 1 of each other taxa	Low
Cave C 3.1	8 (Opacuincola 2, Styloniscus, Cormocephhalus, Hexathele, cave weta, millipede 3, Porcellio sp, Cyclotenus)	Low -1-2 individuals each taxa	Average
Cave E7	2 (Zonitidae, collembola)	Very low - 1 individual each	Low
Cave H9	4 (cave weta, Cormocephhalus, millipede, Zonitidae)	Low -1-2 individuals each taxa	Low

[9] High relative to what is known for NZ caves which are modified and in poor condition, "High" would typically be over 40 taxa.

The common taxa

Photos in the table below were used to identify the common fauna and a range of spiders were identified by Dr Vink. These fauna are typical of most of the caves. Some identification is speculative in the absence of a physical specimen to examine and also reliant on the quality of the photographs.

The common Taxa identification

Garden snail – *Cornu aspersum*	
Zonitidae – snail family – a specimen that is a lot like the introduced predator glass snail – *Oxychilus drapernaudi*.	
Possibly an *Opacuincola* species (turret snail)	

Millipede – Diplopoda. Juliform millipede – normally in leaf and log rot in forest.	
Centipede – *Cormocephhalus* sp.	
Cycloctenidae – *Cyclotenus* sp.	
Garden Wolf spider -*Anoteropsis hilaris*	

<table>
<tr><td>Banded tunnel web (Hexathele sp.).</td><td></td></tr>
<tr><td>Sheet web spider (Cambridgea plagiata)</td><td></td></tr>
<tr><td>Isopoda – slater
Porcellio scaber – introduced species.</td><td></td></tr>
<tr><td>Cave weta – Pachyrhamma waitomoensis</td><td></td></tr>
</table>

Isopoda – Oniscidea – *Styloniscus* spp.