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INVERTEBRATE SURVEY & ASSESSMENT

MACRAES PHASE 4 PROJECT

21 MARCH 2024

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COVER ILLUSTRATION: NEW ZEALAND RED ADMIRAL BUTTERFLY (*VANESSA GONERILLA GONERILLA*) ON ROCK TOR, GOLDEN BAR PIT.

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1 EXECUTIVE SUMMARY

- OceanaGold (New Zealand) Limited is proposing to extend the life of mine ("LOM") at its Macraes Gold Project ("MGP"). The Macraes Phase 4 ("MP4") Stage 3 Project is an extension to the existing consented projects and would extend the LOM to around year 2030. The MP4 Project is comprised of ten Project Components ("PCs"), each of which represents an area of mine that would be subject to development, including the construction of new haul roads, realignment of existing roads, mining pit and waste rock disposal area expansions.
- An invertebrate survey of the MP4 Project area were undertaken by ecologists in April, May, and September 2022 to inform an assessment of invertebrate values and effects. A total of 748 individual specimens were recorded during the survey, using moth light trapping, sweep netting, hand-searching, and opportunistic sighting techniques. Fourteen taxonomic orders were recorded, and 56 taxa were assigned to either a genus or species level identifications. The invertebrate community was generally represented by common endemic, native, and exotic invertebrate species.
- One threatened 'Nationally Vulnerable' moth species (Crambidae: *Orocrambus sophistes*) was caught in the Golden Bar WRS PC area. This species is endemic to New Zealand and has a very localised distribution (confined to the inland drier Mackenzie and Central Otago areas of the South Island). It is thought to feed exclusively on tussock grasses.
- Ten broad habitat types were identified in the MP4 Project area. The value of each habitat type for invertebrates was not quantified but rock tors, shrubland, tussockland, riparian vegetation, and open water were considered to provide the highest value habitats for native invertebrates because of their higher naturalness character and/ or because these habitats provided life-history requirements and/ or provided a critical resource(s) for life-history requirements. Some habitat types (e.g., mine workings) offered no habitat for invertebrates.
- The MP4 Project will have direct adverse impacts on a large, but unquantified, number of invertebrates (including threatened species) and on approximately 90 ha of suitable or potentially suitable invertebrate habitat. Indirect adverse impacts may extend over an additional 79 ha of suitable or potentially suitable invertebrate habitat immediately adjacent to areas of direct impact and may affect to a lesser degree a similarly large number of invertebrates. The magnitude of effects on invertebrates, considering timescale, permanence, cumulative effects, and climate change impacts, were assessed as Negligible to Moderate.
- The levels of effect on invertebrates (in the absence of mitigation measures), which accounted for ecological value and magnitude of effect, were considered to range from Very low to High, depending on the nature of the PC.
- Mitigation measures that follow the mitigation hierarchy (avoid, remedy, mitigate, offset, or compensate) are required to reduce the level of impact on invertebrates (especially threatened species) for MP4. Such measures are recommended but not outlined in this report and are addressed specifically in the Impact Management Plan prepared by Ahikā Consultants (2024b) that accompanies the AEE.

2 INTRODUCTION

2.1 MP4 PROJECT OVERVIEW

OceanaGold is proposing to extend the life of mine ("LOM") at its Macraes Gold Project ("MGP"). The Macraes Phase 4 ("MP4") Stage 3 Project (hereafter "MP4 Project") is an extension of existing consented projects (e.g., Macraes Phase 3 [MP3]) and would extend the LOM to around year 2030. The primary development activities associated with the MP4 Project include open mining pit expansions (Coronation Pit Stage 6, Innes Mills Pit Stages 9–10, and Golden Bar Stage 2 Pit), waste rock disposal (in pit backfilling and extending the Golden Bar waste rock stack), rehandling waste rock from Northern Gully Waste Rock Stack, ore stockpiling, a minor road realignment of Golden Bar Road.

The MP4 Project covers a total area of approximately 537 ha (i.e., Zone of Impact; "ZOI"), which includes a 296 ha impact footprint area (where mining activities will take place) and a 240 ha buffer zone (a 100 m buffer area surrounding the impact footprint where indirect effects of mining activities may be realised). The 537 ha project area is divided into ten[1] Project Components ("PCs"), each of which represents an area of mine that would be subject to development. The PCs range in size and are distributed widely across the OGL landholdings (Figure 2.1). Existing resource consent (consented under Macraes Phase 3, "MP3") is held by OGL for mining activities over most (307 ha or 57%) of the 537 ha MP4 Project area. Stage 3 seeks to obtain resource consent for an extension of mining activities over the differential 229 ha of land, which includes 124 ha of land directly impacted by mining and 105 ha in a surrounding buffer zone where indirect effects are anticipated (i.e., some of the areas within the ZOI are already consented and therefore, effects on those areas have already been considered and addressed elsewhere) (Table 2.1; Figure 2.1).

Ecological impacts (both direct and indirect) arising from the MP4 Project are expected to occur within each of the identified PCs. This invertebrate survey and impact assessment describes the invertebrate values within and surrounding the MP4 Project area and identifies potential impacts of the proposed development activities on those values. The report should be read and interpreted alongside similar ecological assessments prepared for vegetation and avifauna (Ahikā Consulting, 2024a) and herpetofauna (Bioresearches, 2024) of the MP4 area. A summary of the overall values and effects on terrestrial ecology is provided in the Impact Management Plan prepared by Ahikā Consulting (2024b).

Also contributing to the MP4 LOM plan, is the Top Tipperary Tailings Storage Facility ("TTTSF") RL570m raise project. The TTTSF was consented as part of MPIII and there is now a requirement to secure additional tailings storage capacity at TTTSF beyond 2024. To enable increased capacity, an embankment raise from RL568 to RL570 to create an additional 3.05 Mm^3 of storage capacity (equating to approximately 8 months of tailings storage) is proposed. The ecological effects of this project are addressed by separate consent application (see Bioresearches, 2022) and therefore, are not addressed as part of the current invertebrate assessment. Similarly, the Innes Mills Stage 8 Pit (part of the Continuity Consent Project application) has been separated from the MP4 and a separate resource consent is being sought.

[1] For the purposes of this document the Frasers Backfill and Frasers WRS are combined into a single Frasers BF/WRS project component as these features will have very similar effects (being earthworks associated with excavation or deposition of rock) with large areas of overlap.

Areal extent measurements

Areal extent measurements (in hectares, "ha") of Project Component footprints and buffer zones were taken from shape files supplied by OceanaGold Limited and using high-definition aerial photographs (i.e., LINZ aerial basemaps and high-definition drone images) in the GIS programme, QGIS (v. 3.34.3). Similarly, the areal extents of various identified habitat types were mapped based on the most recently available (2020–2023) aerial imagery.

While all measurements were regarded as accurate at the time of report delivery, it is acknowledged that variations in areal extents across this and other technical reports are expected due to mapping inconsistencies by authors. Any discrepancies will be minor and should be considered immaterial given the landscape scale of the MP4 Stage 3 project.

Table 2.1. Macraes Phase 4 Project Components (PCs) and their areal extents (in ha), total area inside the footprints and 100 m buffers of all PCs combined (non-overlapping), and the overall area of the Zone of Impact (ZOI) (i.e., all PCs combined excluding PC overlap).

	Project Component name	Acronym	PC footprint area (ha)	PC buffer area (ha)	Unconsented PC footprint area (ha)	Unconsented PC buffer area (ha)
1	Coronation 6 Pit	CO6 Pit	25.0	27.1	5.5	7.1
2	Coronation North Backfill	CN BF	37.6	30.5	0.05	2.1
3	Northern Gully Waste Rock Stack	NGWRS	21.2	0[2]	21.2	0
4	Golden Bar Stage 2 Pit	GB2 Pit	22.7	20.1	22.7	20.1
5	Golden Bar Waste Rock Stack	GB WRS	48.0	32.8	48.0	32.8
6	Innes Mills Stage 9 Pit	IM9 Pit	5.6	15.6	5.6	6.1
7	Innes Mills Stage 10 Pit	IM10 Pit	5.9	16.3	5.9	8.2
8	Frasers Backfill/Waste Rock Stack	Frasers BF/WRS	91.1	47.1	0	0.4
9	Golden Bar Road realignment (indicative)	GB RR	1.2	16.6	1.2	16.6
10	Golden Point Backfill Buttress	GP BB	38.1	40.1	14.2	17.1
	Total area inside footprints and buffers (non-overlapping)		**296.4**	**240.2**	**124.3**	**105.3**
	Total area inside ZOI		**536.6**		**229.6**	

[2] It should be noted that the NGWRS footprint area is highly conservative. That is, the actual extent of the impact associated with the rehandling of waste rock will be smaller the PC outline. Therefore, the 100 m buffer has not been applied and instead, the PC outline represents an estimate of the total area of impact inclusive of a buffer zone.

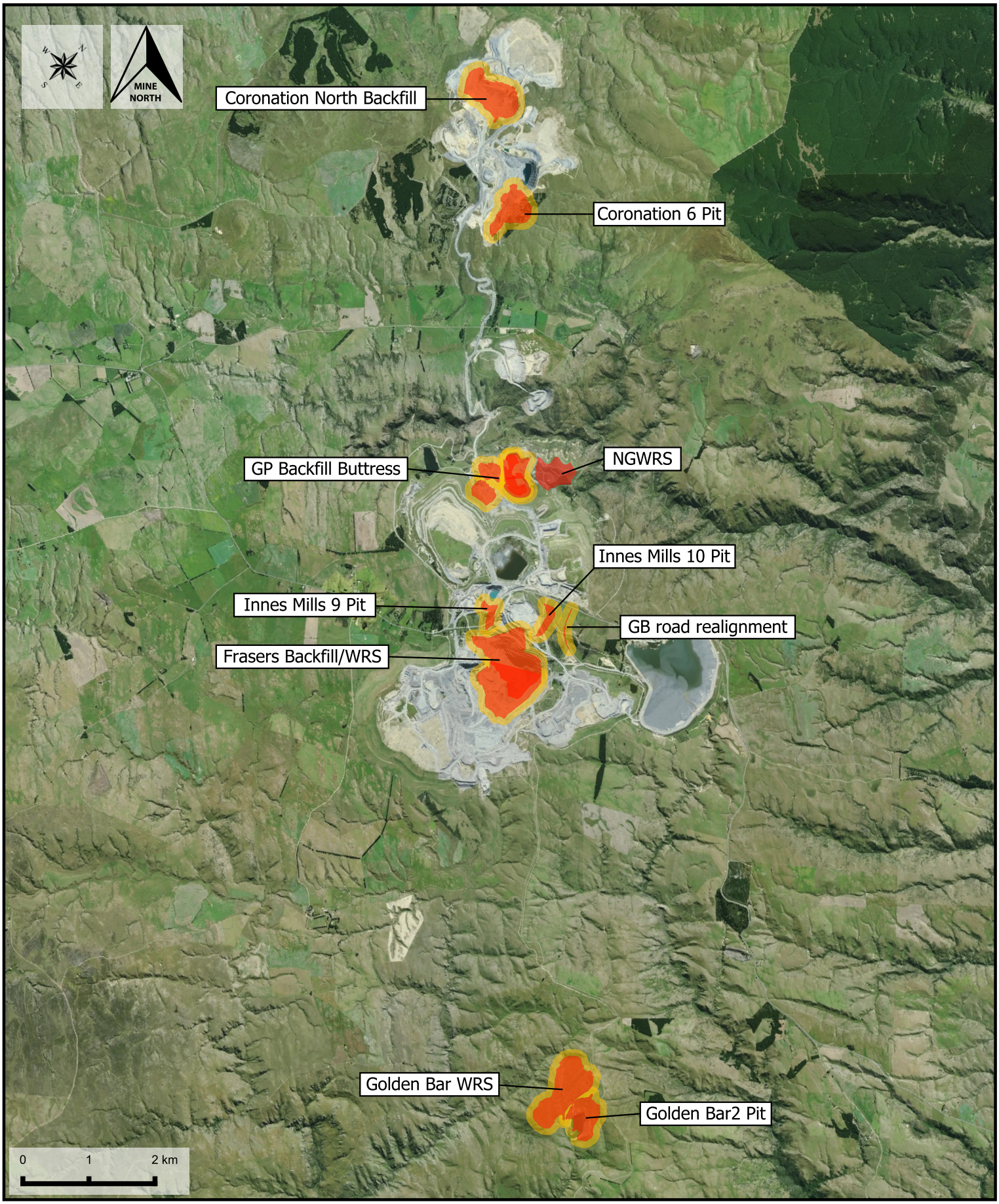

Figure 2.1
Macraes MP4 Stage 3: Zone of Impact (ZOI)

CLIENT / PROJECT
OceanaGold Limited

13 February 2024

MAP PROJECTION:
NZGD2000 / New Zealand Transverse Mercator 2000

SOURCES:
LINZ Basemap aerial

SCALE **@ A4 1:75,000**

61130#BEE09

Legend

MP4 Zone of Impact
Project Components

Impact areas (direct impact)

100 m buffer (indirect impact)

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DISCLAIMER:
This map/plan is not an engineering draft.
This map/plan is illustrative only and all information should be independently verified on site before taking any action.

2.2 PURPOSE AND OBJECTIVES OF THE INVERTEBRATE ASSESSMENT

The purpose of the assessment was to document and describe the invertebrate community and habitats present within the MP4 Project area, in order to understand the potential effects of the proposed activities on indigenous invertebrates.

More specifically, the objectives of the assessment included:

1) Describing the presence and relative abundance of invertebrates within the ZOI;
2) Identifying and quantifying areas of suitable invertebrate habitat in the ZOI; and
3) Assessing the invertebrate values and potential adverse effects on those values within the ZOI in the context of legislation (Resource Management Act 1991; Wildlife Act 1953), policies (National Policy Statement for Indigenous Biodiversity; Otago Regional Policy Statement), and plans (Waitaki District Plan).

2.3 STATUTORY CONTEXT

This section summarises the legislation, policy, plans and strategies relevant to the protection, conservation and enhancement of nature conservation interests associated with the project area. The ecological values described in this report allow significant ecological issues and adverse effects to be identified as they relate to the RMA. The identification of significant values are consistent with standards and objectives of the following legislative, policy statement and regional plan documents.

2.3.1 Legislation

2.3.1.1 Resource Management Act 1991 (RMA)

The purpose of the RMA is to achieve sustainable management. Important elements of this are the maintenance of indigenous biodiversity and protection of significant indigenous vegetation and habitats. The RMA requires that any adverse effects of development be avoided in the first instance, and where avoidance is not reasonably practicable, impacts should be minimised, remedied or mitigated. These elements are given effect in Sections 5, 6 and 7, and Schedule 4 sets out the requirements for effects assessments.

2.3.1.2 Wildlife Act 1953

The Wildlife Act (1953) provides statutory protection for all native wildlife, excluding those species listed in Schedules 1–5. Schedule 7 “Terrestrial and freshwater invertebrates declared to be animals” lists a number of arthropods that are protected under the Act. Of those listed, none are known to occur in the Macraes area.

2.3.2 National Policy Statement for Indigenous Biodiversity (2023)

The National Policy Statement for Indigenous Biodiversity 2023 ("NPSIB") sets out objectives, policies, and implementation requirements to manage natural and physical resources to maintain indigenous biodiversity (i.e., the maintenance and at least no overall reduction in biodiversity and where necessary, restoration and enhancement of ecosystems and habitats) under the RMA. It outlines a system for the management of biodiversity outside of public conservation land. Appendix I of the NPSIB sets out the criteria for identifying significant indigenous vegetation or significant habitats of indigenous fauna, to determine whether an area qualifies as a Significant Natural Area.

2.3.3 Regional Policies, Plans and Acts

This project is situated predominantly within the Waitaki District Council ("WDC") territorial boundary and partially with the Dunedin City Council ("DCC") territorial boundary. It is also within entirely the jurisdictional boundaries of the Otago Regional Council ("ORC") .

2.3.3.1 Partially Operative Otago Regional Policy Statement (2019)

The Partially Operative Otago Regional Policy Statement ("POORPS") provides a policy framework that aims to achieve long term environmental sustainability by integrating the protection, restoration, enhancement, and use of Otago's natural and physical resources. The POORPS gives effect to the statutory requirements set out in the RMA, as well as other statutes, national direction instruments and iwi authority planning documents. Regional and district plans must give effect to the POORPS.

Under the POORPS, the following objectives and policies apply to the MP4 Project:

Objectives
3.1 The values (including intrinsic values) of ecosystems and natural resources are recognised and maintained, or enhanced where degraded;
3.2 Otago's significant and highly valued natural resources are identified, and protected or enhanced where degraded;
4.2 Otago's communities are prepared for and able to adapt to the effects of climate change.

Policies

- 3.1.9 Ecosystems and indigenous biodiversity;
- 3.1.13 Environmental enhancement;
- 3.2.1 Identifying significant indigenous vegetation and habitats;
- 3.2.2 Managing significant indigenous vegetation and habitats; and
- 4.2.2 Climate change.

Criteria for the identification of areas of significant indigenous vegetation and habitat of indigenous fauna are provided in Schedule 4 of the POORPS.

2.3.3.2 Proposed Otago Regional Policy Statement (2021)

The Proposed Otago Regional Policy Statement ("PORPS") is a new RPS that will implement the National Planning Standards and respond to a range of new national direction introduced in 2020, including the National Policy Statement for Freshwater Management. It will set the direction for future management of Otago's natural and physical resources.

Under the PORPS, the following objectives and policies would apply to the MP4 Project:

Objectives:

- ECO–O1 – Indigenous *biodiversity*: Otago's indigenous biodiversity is healthy and thriving and any decline in quality, quantity and diversity is halted;
- ECO-02 – Restoring or enhancing: A net increase in the extent and occupancy of Otago's indigenous biodiversity results from restoration or enhancement; and
- ECO-03 – *Kaitiakiaka* and stewardship: *Mana whenua* are recognised as kaitiaki of Otago's indigenous biodiversity, and Otago's communities are recognised as stewards.

Policies:

- ECO-P1 – *Kaitiakitaka*: Recognise the role of Kāi Tahu as kaitiaki of Otago's indigenous biodiversity;
- ECO-P2 – Identifying *significant natural areas* and taoka;
- ECO-P3 – Protecting *significant natural areas* and taoka,
- ECO-P4 – Provision for new activities: Maintain Otago's *indigenous biodiversity* by following the sequential steps in the effects management hierarchy set out in ECO–P6;
- ECO-P6 – Maintaining indigenous *biodiversity*: Maintain Otago's indigenous *biodiversity* (excluding the coastal environment and areas managed under ECO–P3) by applying the following *biodiversity* effects management hierarchy in decision-making on applications for *resource consent* and notices of requirement; and
- ECO-P8 – Enhancement: The extent, occupancy and condition of Otago's indigenous *biodiversity* is increased.

As well as

- APP2 – Significance criteria for indigenous *biodiversity*,
- APP3 – Criteria for *biodiversity* offsetting, and
- APP4 – Criteria for *biodiversity* compensation.

2.3.3.3 Waitaki District Plan (2010)

The Waitaki District Plan ("WDP") sets out the objectives, policies, and rules governing the use of land within the district to achieve integrated and sustainable management of the district's resources and achieve the purpose of the RMA.

Specifically relevant to the MP4 Project are objectives and policies pertaining to the extraction of minerals in a way that avoids, remedies, or mitigates adverse effects on the environment (Objective 6, Policies 6) and the maintenance of biological diversity, nature conservation values, and ecosystem

functioning within the district. Policy 16.9.3 lists criteria to identify areas with significant indigenous vegetation or significant habitats of indigenous fauna.

2.3.3.4 Draft Waitaki District Plan (2022)

The Draft Waitaki District Plan (DWDP) represents a review of the existing WDP 2010 in line with the RMA, which requires that all Councils review their District Plan every 10 years. Once operative, the new plan will replace the WDP 2010. Under the DWDP, the following objectives and policies would apply to the MP4 Project:

Objectives

- ECO-01 – Halt the decline of indigenous biological diversity;
- ECO-2 – Identify and protect Significant Natural Areas; and
- ECO-03 – Restore or enhance Significant Natural Areas.

Policies

- ECO-P1 – Evaluation of Significant Natural Areas;
- ECO-P2 – Protection of Significant Natural Areas;
- ECO-P3 – Appropriate activities within Significant Natural Areas;
- ECO-P4 – Inappropriate activities within or near to Significant Natural Areas;
- ECO-P5 – Managing indigenous vegetation outside Significant Natural;
- ECO-P6 – Supporting the maintenance, restoration, and enhancement of indigenous biodiversity;
- ECO-P7 – National priorities for protection;
- ECO-P8 – Impacts of climate change on resilience of ecosystems;
- ECO-P9 – Hutia te Reo: Recognise the role of mana whenua as kaitiaki of indigenous biodiversity within their rohe, providing for mana whenua involvement in the management of indigenous biodiversity and ensuring that Hutia te Rito is recognised and provided for.

As well as:
APP3 – Criteria for evaluating the significance of indigenous vegetation and habitats of indigenous fauna.

3 INVERTEBRATE SURVEY

3.1 SURVEY METHODS

3.1.1 Literature review/ desktop assessment

A desktop literature and database review of the diversity and distribution of terrestrial invertebrates within the landscape, surrounding the PCs, was undertaken to inform known and potential invertebrate values within the ZOI.

The desktop review focused on previous invertebrate data collected for past OceanaGold resource consent applications within Macraes Ecological District ("Macraes ED"), particularly the Deepdell North III Project, as well as previous invertebrate surveys undertaken in the 1980s and 90s.

iNaturalistNZ (*https://inaturalist.nz/*)[3] records from within a 10 km radius of the ZOI were reviewed.

3.1.2 Invertebrate sampling

3.1.2.1 Survey periods

Invertebrate surveys were conducted by Bioresearches ecologists on two separate visits between 18th–20th April and 9th–12th May 2022, and by Ahikā Consultants ecologists between 8th–10th September 2022.

3.1.2.2 Moth light trapping

3.1.2.2.1 Setup

Moths and other flying nocturnal insects were sampled using Heath moth traps. Heath moth traps consisted of fluorescent bulb (that emits actinic light in the 420-nanometre range) positioned on top of a funnel, on top of a plastic base. The bulb was surrounded by plastic fins that deflected moths flying towards the light down through the funnel and into the base. A mesh bag inserted into the hole in the plastic base acted to contain the captured individuals. Pieces of egg carton were placed inside the mesh bag to provide a place for the insects to settle once inside the trap. Each trap was powered by a 12 V battery and a light sensor automatically activated the light on dark to attract insects. On sunrise, the light sensor automatically deactivated the lighting unit.

The 'light reach' from a Heath moth trap, which effectively attracts mobile invertebrates to the trap, is relatively small (e.g., less than 50 m radius from the trap itself). Therefore, captures in a Heath moth trap may represent either local species (i.e., those occurring in the area immediately surrounding the trap), or species dispersing through the landscape at the time of trapping.

[3] iNaturalist is a website that serves the purpose of sharing information about identification, distribution, and biodiversity of all organisms, and is used worldwide by a variety of individuals from amateurs to specialists. iNaturalist provides useful information into the distribution of species in New Zealand and provides insight into the species observed in the Macraes ED. Records were scrutinised by Bioresearches ecologists, and only used to inform the assessment when certainty could be given regarding the identification (i.e., identified by a recognised New Zealand expert).

3.1.2.2.2 Location

Nine trap locations across the PCs were selected based on areas of suitable invertebrate habitat within each PC and recorded on a handheld GPS (trap locations shown in Appendix I and examples of trap positioning shown in Figure 3.1). In addition, five trap locations were chosen in ecological covenants on OceanaGold Macraes landholdings but outside the MP4 Project area (Appendix I). The purpose of the covenant moth trapping was to collect data on Lepidopteran (moth) diversity for comparison with the MP4 areas.

All traps were left for one night during calm and dry weather. Each trap was disassembled the following morning and the contents collected. The mesh bag (containing the captured invertebrates) was placed inside an invertebrate killing jar, which consisted of a small amount of ethyl acetate, for a minimum of 15 minutes to euthanise the specimens. Once euthanised, the contents of the mesh bag were placed in a plastic vial and labelled. The vials were kept in the freezer for later identification.

Figure 3.1. Heath moth trap set at Site 2 in Golden Bar WRS; left, and heath moth trap set at Site 13 in Macraes Road Realignment; right.

3.1.2.3 Sweep netting/ beat sampling

3.1.2.3.1 Setup

Sweep net samples were undertaken in some of the PCs[4] that contained suitable invertebrate habitat (e.g., tussock grasses, riparian/ wetland habitat) particularly densely vegetated ground cover. No sweep netting was conducted in the ecological covenants. The same sized sweep net was used throughout the survey period to standardise the method. Sweep netting was undertaken by slowly walking and making sweeping motions with a fine mesh net through low-growing vegetation (Figure 3.2). Where woody vegetation was present, beat sampling was also undertaken. This involved holding the net under a variety of trees/ shrubs and hitting the branches above to collect invertebrates as they became dislodged.

[4] Sweep sampling was also carried out in an area adjacent to the current GB RR alignment. The sampled area was previously considered to form the road realignment footprint but project re-scoping in late 2023 resulted in the road realignment being shifted to the west. The survey results are still considered relevant as invertebrates move widely throughout the landscape and the previous and current road realignment footprints are situated near each other.

A combination of sweep netting and beat sampling was undertaken for 20-30 minutes at each site, with a representative sample being collected from each of the main habitat types identified within each site.

3.1.2.3.2 Location

Track logs were recorded using a handheld GPS unit during each sweep netting/ beat sampling session. Once the sampling at each site was completed, the net containing all collected invertebrates and plant debris was placed into a killing jar to euthanise the specimens. The contents were then transferred into plastic zip-lock bags, labelled, and kept in the freezer until later identification.

Figure 3.2. Ecologist undertaking sweep netting.

3.1.2.4 Hand searches and visual observations

Hand searches for invertebrates were opportunistically undertaken during the day at PCs that were visited and where suitable searchable habitat (e.g., ground debris, rocks) was identified. Rocks and woody debris were searched and lifted, and invertebrates were collected and euthanised in a killing jar before being transferred into labelled plastic vials. All disturbed habitats were returned to their original positions. All specimens encountered were recorded and specimens were only collected/ retained if they could not be confidently identified in the field or were not represented in any of the other sweep netting or moth trap samples.

Additional visual and acoustic observations were recorded opportunistically throughout the PCs. No hand or visual searches were carried out in the ecological covenants.

3.1.3 Survey constraints

Terrestrial invertebrate presence and abundance varies with season and community-level surveys are typically undertaken during spring or summer, when temperatures are warmest and species composition and abundance is at its peak. In addition, survey results are directly related to survey effort and the type of sampling techniques employed. It is acknowledged that the current invertebrate survey was limited by both time and effort, as a result of limited project timeframes. Project timeframe constraints (at that time) meant that a rapid assessment survey over two weeks during late autumn and a short survey stint in spring (September) was all that could be achieved. More labour and time intensive survey methods such as pitfall or malaise trapping were not used, and this may have resulted in an underrepresentation of terrestrial invertebrate groups and/ or threatened or 'At Risk' species.

Several PCs (e.g., CN BF, NGWRS, IM9, IM10, Frasers BF/WRS, GP BB) were not surveyed nor visited largely due to time constraints. Though, these areas largely contain existing and ongoing mining activities and ultimately the habitat for invertebrates was very low or of negligible value.

Aquatic invertebrates (useful for stream ecological valuations) were not included in Bioresearches' scope of works. This aspect of the aquatic ecology is reported on by Greg Ryder (Greg Ryder, 2024 a, b and c). However, flighted adults of some aquatic groups (e.g., Odonata, Trichoptera) were captured in the current survey.

Some highly diverse invertebrate groups (e.g., Diptera and Araneae) were sampled but typically not identified to lower taxonomic levels (genus/ species) due to the difficulty in finding suitably qualified experts to provide identification services. Therefore, while abundance (i.e., number of individuals sampled) is provided, the survey is limited in terms of describing diversity and identifying threatened or 'At Risk' species of some invertebrate groups.

Pitfall trapping for ground-dwelling invertebrates was not employed due to the survey timeframes and the resource heavy nature of this technique. Instead, hand searches were used as the primary technique for surveying ground-dwelling groups. It is acknowledged that some ground-dwelling invertebrate groups such as beetles, ground spiders, and a range of detritivores may be underrepresented in the survey data. Consequently, it is possible that threatened and/ or 'At Risk' invertebrate taxa were also missed, which could have implications for the assignment of ecological values (particularly in terms of rarity, representativeness, and ecological function).

The results of this invertebrate survey should be interpreted with caution for the reasons described above, and sampling efforts only provide an Autumn/ early Spring 'snapshot' of the terrestrial invertebrate communities present in the PCs. Seasonal variation in invertebrate community assemblage and abundance and a census of threatened invertebrates have not been captured in the results of the current survey. This has implications for the accuracy of assigning ecological values (the presence of Threatened and 'At Risk' species is a key determinate in assigning ecological value) and magnitude of effects. Consideration of the survey limitations is important when interpreting the level of effects described in this report.

3.1.4 Sample processing

All specimens collected using the Heath moth traps were visually examined and pinned following specimen curation techniques generally as per Walker and Crosby (1988).

Most of the specimens collected in the Heath traps were represented by moths (Lepidoptera). Where it was evident that there were multiples of the same species present from a single trapping site, at least two representative specimens were pinned. Any larger invertebrates that were collected by hand or found within the sweep/ beat samples were also pinned; these included beetles (Coleoptera), ichneumonid wasps (Hymenoptera: Ichneumonidae), and some true bugs (Hemiptera).

All samples collected during the sweep/ beat sampling and hand searches were processed in the Bioresearches Auckland laboratory. A stereo microscope was used to assist with sorting and extracting invertebrates from amongst plant matter that was inadvertently collected during the sweep netting/ beat sampling. Specimens were grouped and identified to the level of Order (e.g., Coleoptera, Hemiptera) and counted. No attempt was made to identify specimens to lower taxonomic groupings during sorting. Macro photographs were taken of some specimens for later identification.

3.1.5 Identification of specimens

Each specimen collected at Macraes was assessed using a stereo microscope and examined by Bioresearches' ecologists with experience in invertebrate taxonomy. Each specimen was identified to the lowest taxonomic unit that could be assigned with confidence. Where there was uncertainty in the identity of a specimen, the assistance of taxonomic specialists via the *iNaturalistNZ* platform was sought. These specialists included Associate Professor Steve Kerr (Otago Museum), Stephen Thorpe (freelance entomologist), and Dr Dave Seldon (University of Auckland).

All pinned Lepidopterans were sent to Dr Robert Hoare (Manaaki Whenua Landcare Research) for specialist identification. The results of the invertebrate sampling are provided in Section 3.3.3.

3.1.6 Habitat mapping

During the site visits, broad habitat types were identified in both the 'footprint' (i.e., areas directly impacted by the proposed activities) and a 100 m buffer zone (i.e., areas in which some impact on ecological features might be expected), and the areal extents (hectares; "ha") of these were subsequently mapped.

The mapped extents of these identified habitat types were used to inform the ecological value and effects assessments pertaining to invertebrate communities within the ZOI.

3.2 SURVEY RESULTS

3.2.1 Desktop assessment

Sampling undertaken during February 1986 identified 66 invertebrate species across 19 orders (Whitaker, 1986). All recorded species were widespread and common in the Otago region, and a few had known regional distributions. Of the 800 specimens collected during this sampling, the orders

Diptera, Hymenoptera, and Orthoptera collectively totalled 69% of these specimens, and the study considered these results typical of Otago grassland fauna. No rare or localised species were recorded.

Patrick (1997) collected more extensive records of the insects within the Macraes ED over an 11-year period between 1983 and 1994 across all seasons. A total of 367 species across 12 orders were found (terrestrial and aquatic), the majority of these being native. Of these, 257 specimens from the order Lepidoptera (noting that the author was experienced in this group). The study noted that several nationally rare insect species (four moths and one caddisfly) occurred within the Macraes ED.

An invertebrate survey undertaken for the OceanaGold Deepdell North III Project recognised 68 species across nine orders over a short survey period in January 2018 (Thorsen, 2019). The survey did not record any threatened, 'At Risk', rare, genetically/ morphologically distinct species, or species at their known distribution limit.

For the current study, *iNaturalist* records (within approx. 10 km radius of ZOI) identified many endemic species within the area in recent years. A significant proportion of recorded Lepidoptera were endemic species, and some regionally restricted, including *Hierodoris polita*, a moth classified as 'At Risk – Naturally Uncommon' due to its restricted range within Central Otago and Dunedin (Hoare *et al*. 2015). The 'At Risk – Naturally Uncommon' alpine shield bug (*Hypsithocus hudsonae*) was also recorded and is range-restricted to the Central and South Otago (Stringer *et al.* 2012).

Other endemic taxa recorded within the area included species of weevils (e.g., *Praolepra squamosa*, *Nonnotus albicans*), the orb-weaver spider *Colaraea verutum*, and endemic flies (e.g., *Saropogon fugiens*, *Empidadelpha propria*). One observation of velvet worm/ peripatus (*Peripatoides* sp.) was recorded.

Larger invertebrate species recorded included large black hunting wasp (*Priocnemis monachus*), beetles such as *Mecodema* spp., *Megadromus bullatus*, and *Oregus aereus*, and giant alpine dragonfly (*Uropelata chiltoni*).

3.2.2 Habitat suitability

3.2.2.1 Habitat types

Ten broad habitat types were identified within the ZOI, including rock tors/ tor complexes, shrubland, tussockland, riparian vegetation, exotic grassland (including rank and grazed pasture), ephemeral wetlands, exotic treeland (e.g., pine plantation, shelterbelts), felled pine, mine workings, and open water (ponds) (Figure 3.3). These habitats varied markedly in areal extent. Mine workings covered the largest land area, and exotic grassland and southern grass comprised the largest vegetation categories. Rock tors and open water (ponds) represented the smallest areal extents (Table 3.2). The mapped habitat types for each PC are shown in Appendix I.

Due to the wide range of differing habitats/ micro-habitats and resource requirements required by different types of invertebrates, all habitat types excluding mine working areas have been assessed as suitable for indigenous invertebrates.

Figure 3.3. Example photographs of some habitat types identified within the ZOI suitable for native invertebrates. From left to right: rock tors; shrubland; tussockland; riparian vegetation; exotic grassland; ephemeral wetland; exotic treeland; and open water.

Table 3.2. Areal (ha) and proportional (%) extents of each identified potential habitat type across the ZOI (note: habitat extents of PCs do not overlap). Green = suitable habitat for invertebrates, Red = unsuitable habitat.

Habitat rank	Habitat type	Area (ha)	Proportion (%) of ZOI area
1	**Rock tors/ tor complexes**	0.06	0.03
2	**Shrubland**	0.5	0.2
3	**Tussockland**	68.7	30.0
4	**Riparian vegetation**	1.3	0.6
5	**Exotic grassland**	92.2	40.3
6	**Ephemeral wetland**	0.9	0.4
7	**Exotic treeland (incl. pine)**	1.1	0.5
8	**Felled pine**	4.8	2.1
9	**Mine workings**	59.7	26.1
10	**Open water (ponds)**	0.2	0.10
	Total	**229**	**100**

3.2.3 Field survey results

3.2.3.1 MP4 Project area

A total of 748 individual specimens were recorded during the survey, comprising 719 specimens recorded from trapping and sampling (moth light and sweep netting) and 29 specimens recorded during hand-searches and/ or opportunistic observations.

A total of 14 taxonomic orders were represented, (excluding an "Unknown" category for damaged specimens), and Araneae (spiders), Diptera (flies), Hemiptera (true bugs), and Lepidoptera (moths/ butterflies) collectively totalled 64% of the overall sample size (Figure 3.4).

Of the 14 orders identified across all survey methods, most (92.8%; n = 13) were represented in the sweep samples and only 42.9% (n = 6) were represented in the moth light trap samples.

Of the total 748 specimens collected or observed, 56 taxa were assigned to either a genus or species. A list of the identified taxa is provided in Appendix II. Photographs of some invertebrates encountered during the survey are shown in Figure 3.7.

Of note, one threatened moth species (Crambidae: *Orocrambus sophistes*) was caught in the Golden Bar WRS PC in May 2022 (Figure 3.7). This species is listed as 'Nationally Vulnerable' under the New Zealand threat classification system (Townsend *et al*., 2008; Hoare *et al.*, 2017). It is an endemic species that presumably feeds on tussock and has a very localised distribution (confined to the inland drier Mackenzie and Central Otago areas of the South Island). The specimen caught during the survey was a winged male, but females of this species are short-winged and flightless; thus, their dispersal abilities are severely limited (R. Hoare, *pers. comm*, 2022).

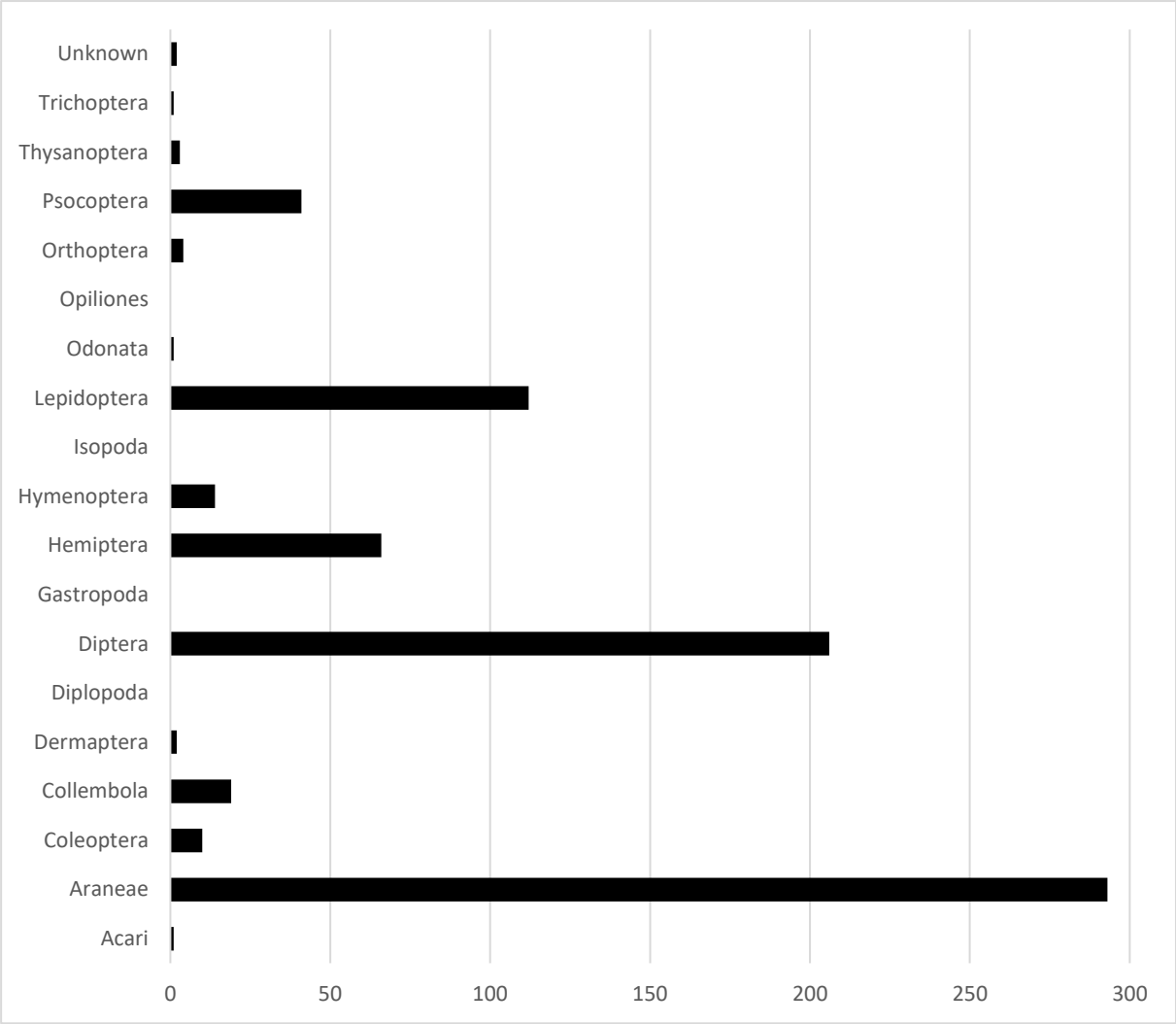


Figure 3.4. Composition of invertebrate taxonomic orders (and subclass Acari) and number of specimens sampled across all surveyed PCs in April and May 2022.

3.2.3.1.1 Sweep netting

Thirteen taxonomic orders (excluding an "Unknown" category) were recorded from sweep net sampling across the three surveyed PCs and adjacent GB RR, and the invertebrate community composition differed markedly between the PCs (Figure 3.5). Araneae, Diptera, Hymenoptera, and Hemiptera were the most represented groups at each of the PCs.

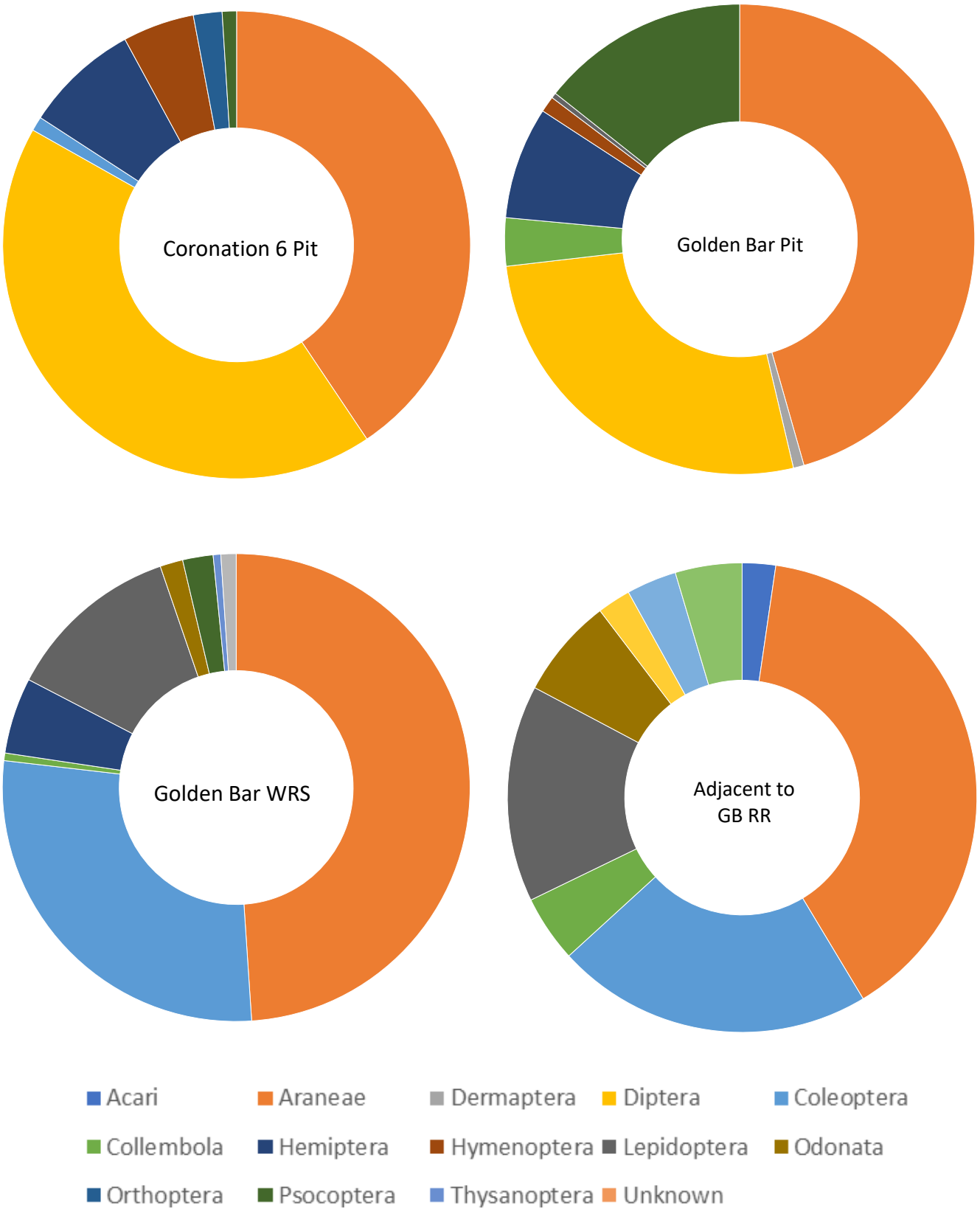


Figure 3.5. Invertebrate community composition across three PCs and the adjacent GB RR using sweep netting methods in April and May 2022

3.2.3.1.2 Moth light trapping

Six taxonomic orders were recorded from moth light trapping across the three PCs and the adjacent GB RR, and the invertebrate community compositions were dominated by Lepidoptera and Diptera, though sample sizes were generally low (Figure 3.6). Significantly more Lepidopterans were caught in the GB RR PC (n = 21), compared to all other sites (Coronation 6 Pit = 2; Golden Bar Pit = 1; Golden Bar WRS = 4).

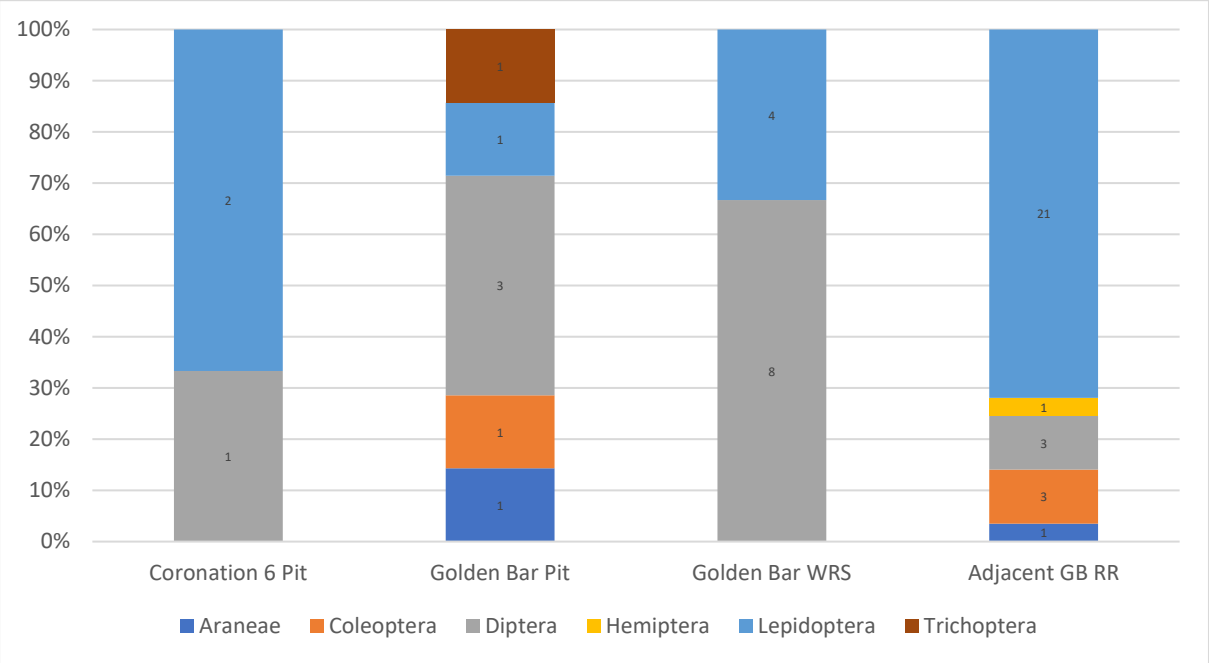


Figure 3.6. Invertebrate community composition across three PCs and the adjacent GB RR using moth light trapping methods in April and May 2022. Numbers shown in bars represent the sample size for each taxonomic group.

3.2.3.2 Ecological covenants

3.2.3.2.1 Moth light trapping

A total of 74 specimens, comprising two taxonomic orders (Lepidoptera and Diptera) were collected from the three covenants. Thirteen species from eleven families were represented. Similar numbers of Lepidopteran specimens were caught at Highlay Creek Ecology Covenant (n = 22), Island Block Covenant (n = 23), and Cranky Jims Creek Ecology Covenant (n = 28). A list of the identified taxa is provided in Appendix III.

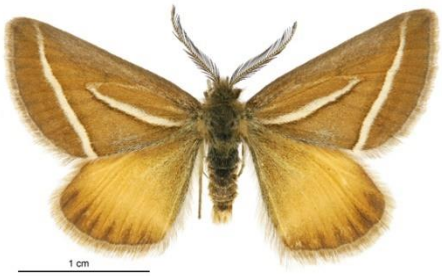
'NATIONALLY VULNERABLE'

Orocrambus sophistes (male) (©Landcare Research)

Homodotis falcata (male) (©Landcare Research)

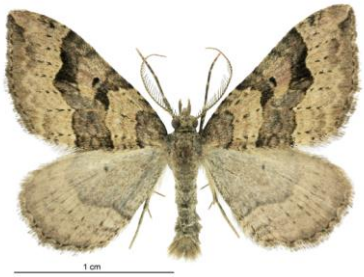
Agrotis ipsilon (female) (©Landcare Research)

Bityla defigurata (female) (©Landcare Research)

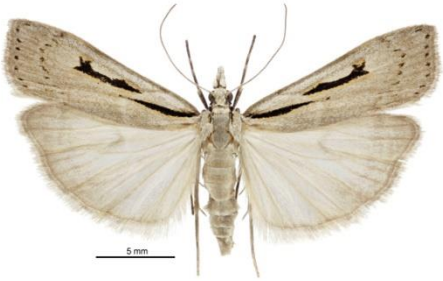


Aponotoreas insignis (male) (©Landcare Research)

Deana hybreasalis (male) (©Landcare Research)



Epyaxa rosearia (male) (©Landcare Research)



Scoparia rotuella (female) (©Landcare Research)

Elvia glaucata (male) (©Landcare Research)

Ichneutica plena (female) (©Landcare Research)

Vanessa gonerilla gonerilla (©Tony Wills)

Vanessa itea (© Peter Waters)

Oregus aereus (Source: Bioresearches)

Megadromus sp. (Source: Bioresearches)

Zeanecrophilus prolongatus (Source: Bioresearches)

Megadromus bullatus (Source: Bioresearches)

Figure 3.7. Images of some Lepidoptera (moths) and larger Coleoptera (beetles) encountered during the survey of the MP4 ZOI.

4 ASSESSMENT OF INVERTEBRATE VALUES AND EFFECTS

4.1 ASSESSMENT METHODOLOGY

This section focuses on assessing project-related effects on the invertebrate ecological values identified during the survey. Invertebrate values and project-related effects (both on invertebrate communities and their habitats) were identified and assessed using:

1) The Environment Institute of Australia and New Zealand ("EIANZ") guidelines for Ecological Impact Assessment ("EcIAG") (Roper-Lindsay *et al*., 2018; Appendix IV), which were adapted based on expert opinion.
    a. **Step 1:** Ecological values ranging from 'Negligible' to 'Very High' were assigned to each of the PCs based on the NZTCS threat status of invertebrates occurring in the zone of impact ("ZOI"). For PCs that were not visited or surveyed for invertebrates, a conservative approach was taken by predicting the likely presence of invertebrate species in the ZOI, based on habitat availability and quality, and assigning the relevant ecological value score based on threat status. Since the EcIAGs (Roper-Lindsay *et al.,* 2018) do not include criteria to determine habitat suitability values for a given species, habitat values were considered only during the magnitude of effects assessment stage (Step 2).

    b. **Step 2:** Magnitude of effect was assessed in accordance with Table 8 of the guidelines and accounted for level of confidence in understanding the expected effect in terms of spatial scale ('local' scale = OGL Macraes landholdings, ~13,063 ha; 'landscape' scale = Macraes Ecological District, ~113,818 ha; and were relevant, 'National' scale), duration and timescale, relative permanence, and timing of the effect in respect of key ecological factors. Habitat suitability criteria outlined by Baber *et al.,* (2021) (Appendix V) were used to assist with informing the magnitude of effects assignments.

    c. **Step 3:** The overall level of effects was determined using a matrix approach (Table 10 in the EIANZ framework; Appendix IV) that combines the ecological values with the magnitude of effects resulting from the activity. The matrix describes an overall level of effect on a scale of 'Negligible' to 'Very High'. Positive effects are also accounted for within the matrix. The overall level of effects on each value was assessed before recommendations to avoid, remedy, or mitigate effects were applied.

2) National Policy Statement for Indigenous Biodiversity 2023 ("NPSIB"). Appendix 1 of the NPSIB sets out criteria for assessing Significant Natural Areas (i.e., areas of significant indigenous vegetation and significant habitats of indigenous fauna). Table 4.2 of this report provides a summary of the assessment against the NPSIB significance criteria.

3) The Partially Operative Otago Regional Policy Statement 2019 ("POORPS"). Criteria for identifying areas with significant indigenous vegetation or significant habitats of indigenous

fauna are set out in in Schedule 4 of the POORPS 2019. Consideration was also given to the criteria listed in the Proposed ORPS 2021 (*APP 2 – Significance criteria for indigenous biodiversity*), which are essentially the same as those in the POORPS 2019. Table 4.3 of this report provides a summary of the assessment against the POORPS criteria.

4) The Waitaki District Plan 2010 ("WDP"), under *16.9.3 Policies - Policy 3 "…criteria to identify areas with significant indigenous vegetation or significant habitats of indigenous fauna…".* Consideration was also given to the criteria listed in the Draft WDP 2022 (*APP3 Criteria for evaluating the significance of indigenous vegetation and habitats of indigenous fauna*), though this document has no statutory effect. Table 4.4 of this report provides a summary of the assessment against the WDP criteria.

An overall assessment of ecological values as they pertain to invertebrates was determined by considering all assessment frameworks (EIANZ guidelines, NPSIB, POORPS, and WDP) (see Table 4.1).

The level of effect would then be used to guide the extent and nature of avoidance measures, and any ecological management response required, which may include remediation, mitigation, offsetting, or compensation. An assessment of the overall level of effects after recommendations to avoid, remedy, or mitigate effects is not covered in this report but rather are provided in the separate, Impact Management Plan (Ahikā Consulting, 2024b).

4.2 Invertebrate Ecological Values

The invertebrate values assessment for each of the PCs is provided in Table 4.1.

The primary criteria for assigning invertebrate ecological value to each of the PCs is the presence and conservation threat status of invertebrate species occurring in the ZOI (Roper-Lindsay *et al.,* 2018). However, a variety of other ecological features of the local invertebrate fauna that may be considered as part of the value score assignments are discussed more broadly in the sections that follow Table 4.1

Table 4.1. Invertebrate values assessment for each of the PCs.

Site	Herpetofauna values	Value score
Coronation Stage 6 Pit	• Nationally and locally common indigenous species. • Qualifies as an area with significant indigenous vegetation or significant habitats of indigenous fauna under the NPSIB, POORPS/ PORP and WDP.	Low
Coronation North Backfill	• Likely supports nationally and locally common indigenous species, as well as exotic species.	Low
NGWRS	• Likely supports nationally and locally common indigenous species, as well as exotic species.	Low
Golden Bar Stage 2 Pit	• Nationally and locally common indigenous species. Site is immediately adjacent to the location where a 'Nationally Vulnerable' moth was detected. • Qualifies as an area with significant indigenous vegetation or significant habitats of indigenous fauna under the NPSIB, POORPS/ PORP and WDP.	Moderate
Golden Bar WRS	• One 'Nationally Vulnerable' moth species present in the impact and/ or buffer areas. • Qualifies as an area with significant indigenous vegetation or significant habitats of indigenous fauna under the NPSIB, POORPS/ PORP and WDP.	Very high
Innes Mills Stage 9 Pit	• Likely supports nationally and locally common indigenous species, as well as exotic species. • Area of habitat for invertebrates is small.	Low
Innes Mills Stage 10 Pit	• Likely supports nationally and locally common indigenous species, as well as exotic species. • Area of habitat for invertebrates is small.	Low
Frasers Backfill	• Small numbers of nationally and locally common indigenous species, as well as exotic species, may be present. • Area of habitat for invertebrates very small.	Low
Macraes road realignment	• Likely supports nationally and locally common indigenous species, as well as exotic species. • Qualifies as an area with significant indigenous vegetation or significant habitats of indigenous fauna under the NPSIB, POORPS/ PORP and WDP.	Low
Golden Point Backfill Butress	• Nationally and locally common indigenous species, as well as exotic species, likely to be present. • Area of habitat for invertebrates is small.	Low

4.2.1 Invertebrate communities/ species recorded

Of the 56 genera/ species identified during this survey, more than half (64.3%) were New Zealand endemics, 8.9% were native, 16.1% were introduced, and the remaining 10.7% had unknown status. Of these taxa, one (1.8%) was listed as threatened 'Nationally Vulnerable' (see Section 3.3.3), five (8.9%) were listed as 'Not Threatened', and the remaining 89.3% were not listed under the NZTCS. The results of the sampling undertaken by Patrick (1997) were consistent in identifying a high proportion of endemic/ native species.

Araneae (spiders) were the most abundant group collected across all the sampling methods, with a total of 293 specimens counted. Araneae represented ~45% of the sweep netting specimens. The second most abundant order was Diptera (flies), and at least 11 families were identified, including but not limited to Muscidae (house flies), Mycetophilidae (fungus gnats), Syrphidae (hover flies), and Limoniidae and Tipulidae (crane flies).

Sixteen species of Lepidopterans (moths) representing seven families were identified. Of the 16 species, all but one were endemic (94%). The other species was native. Aside from one 'Nationally Vulnerable' species, all were relatively widespread and common species.

Large Carabid beetles such as *Ctenognathus* sp., *Megadromus bullatus* and *Megadromus* spp., *Oregus aereus*, and *Prionoplus reticularis* (huhu) were collected and/ or observed under rocks during hand searches across four of the PCs.

Past invertebrate surveys from within the area have shown a similar level of diversity between them but little overlap in species recorded. This is likely due to the poorly known invertebrate fauna of the area overall, as well as differing survey efforts, seasons, and taxonomic knowledge of particular groups. The results of this survey are assumed to have been heavily influenced by the time of year it was undertaken. It is likely that the invertebrates that were collected are more common/ detectable during autumn.

4.2.2 Ecological function

The beneficial roles invertebrates play in ecosystems is well-understood in the scientific community. Invertebrates are crucial components of the food chain, by providing a food source for higher animals, Invertebrates contribute extensively to ecosystem services including pollination, through intraspecific relationships, and for decomposition, nutrient release, and soil formation.

4.2.3 Species diversity

This survey identified 56 species across 10 orders (and 14 orders total), which is comparable to the diversity reported by other studies in the nearby area (e.g., 66 species across 19 orders, Whitaker, 1986; and 68 species across nine orders for the OceanaGold Deepdell North III Project, Thorsen, 2019). Diptera, Hymenoptera, and Orthoptera were the most represented orders in 1986 (total 69%), whereas Araneae, Diptera, Hemiptera, and Lepidoptera (moths/ butterflies) were the highest represented (~ 86%) in the 2022 survey.

It should be noted that the difference in survey duration, seasonal efforts and sampling techniques across the previous studies discussed makes it difficult to directly compare results, and the results cannot be accurately relied upon for detecting changes to community composition in the Macraes ED over time.

Despite a moderate diversity of invertebrate taxa represented in this 2022 rapid survey, due to the nature of the short-term survey the diversity observed is likely to capture only a small proportion of the total invertebrate diversity within the ZOI and wider Macraes ED. As invertebrate abundance is typically highest during summer, it is expected that diversity increases during the warmer seasons when species composition and abundance is at its peak.

4.2.4 Threatened or 'At Risk' taxa

One threatened moth species was collected in the invertebrate samples; a single *Orocrambus sophistes* specimen (endemic tussock moth) was collected in Heath moth trap within Golden Bar WRS. This species is listed as 'Nationally Vulnerable' (Hoare *et al*. 2017), which equates to 'Very high' ecological value as per the EcIAGs (Roper-Lindsay *et al.* 2018).

No 'At Risk' taxa were identified among the specimens that were identified to genus/ species level. However, it should be acknowledged that the survey effort was relatively low given the large project area and it is possible that other threatened (e.g., *Theoxena scissaria*; 'Nationally Vulnerable', Hoare *et al*., 2017) and/ or 'At Risk' taxa could have been missed or overlooked (e.g., *Samana acutata*; 'At Risk – Relict', Hoare *et al*., 2017).

4.2.5 Species of biogeographic interest

Aside from the one locally restricted, threatened moth species described above, no other invertebrate species recorded in this survey are known to be at their distribution limits, or of other biogeographic interest. However, the distribution of many of New Zealand's invertebrates are poorly known, and regionally restricted invertebrate species are known from the Central Otago region (see Section 3.2.1) so these may be present within the ZOI.

4.2.6 Genetically or morphologically distinct forms

No genetically or morphologically distinct forms were identified among the invertebrate specimens collected; however, available taxonomic information is severely limited for many taxa and a significant proportion of the specimens were not identified to species level for this project.

4.2.7 Invertebrate habitats

Ten broad habitat types were identified in the ZOI and of these, nine were considered to provide habitat value for invertebrates (i.e., habitats that provided some, or all, of a species or species assemblages' life-history requirements). These were rock tors/ tor complexes, shrubland, tussockland, riparian vegetation, exotic grassland (including rank and grazed pasture), ephemeral wetlands, exotic treeland (e.g., pine plantation, shelterbelts), felled pine, and open water. Of these, rock tors, shrubland, tussockland, riparian vegetation, and open water were considered the highest value habitats for native invertebrates because of their higher naturalness character and/ or because these

habitats provided life-history requirements and/ or provided a critical resource(s) for life-history requirements of recorded invertebrates.

None of the identified habitat types were exclusive to the ZOI (i.e., all are represented throughout the wider landscape) and the highest value habitats (rock tors, shrubland, tussockland, riparian vegetation, and open water) occur in abundance throughout surrounding local landscape (i.e., OGL's landholdings at Macraes) and throughout the Macraes ED.

4.2.8 Significance criteria under the policy framework

Assessing the herpetofauna values for each PC against the significance criteria provided in the NPSIB, POORPS/ PORPS, and WDP indicated that four of the nine PCs (CO6 Pit, GB Pit, GB WRS, and GB RR) qualified as areas with significant indigenous vegetation or significant habitats of indigenous fauna (Tables 4.2 & 4.4).

Table 4.2. Assessment of invertebrate values in each PC against the National Policy Statement for Indigenous Biodiversity 2023 ("NPSIB") significance criteria. Project Components: 1 = Coronation 6 Pit; 2 = Coronation North Backfill; 3 = Northern Gully Waste Rock Stack; 4 = Golden Bar2 Pit; 5 = Golden Bar WRS; 6 = IM9 Pit; 7 = IM10 Pit; 8 = Frasers Backfill; 9 = Golden Bar Road realignment; and 10 = Golden Point Backfill Buttress."?" denotes uncertainty as PCs were not ground-truthed.

		Project Component									
NPSIB	**Macraes MP4 significance assessment**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Representativeness	The habitats for invertebrates are typical or characteristic of the indigenous diversity of the ecological district, though some habitats are degraded examples of their type (e.g., tussockland, shrubland). Indigenous vegetation and habitats are representative of the full range and extent of ecological diversity across all environmental gradients in an ecological district. The fauna habitat supports a typical suite of indigenous invertebrates that would occur in the present-day environment.	Yes	No?	No?	Yes	Yes	No?	No?	No?	Yes?	No?
Diversity and pattern	The area supports an expected range of diversity and pattern of indigenous invertebrates and/ or invertebrate habitats, similar to the diversity at the level of the Ecological District.	No	No?	No?	Yes	Yes	No?	No?	No?	Yes?	No?
Rarity and distinctiveness	The area supports species, or habitats used by species, that are threatened (e.g., *Orocrambus sophistes*).	No	No?	No?	No	Yes	No?	No?	No?	No?	No?
Ecological context	The terrestrial ecological features in the area, as they pertain to indigenous invertebrates, provide some connectivity between the site and adjoining sites, and provide resources (e.g., food, refuge, breeding sites) for invertebrates.	Yes	No?	No?	Yes	Yes	No?	No?	No?	Yes?	No?

Table 4.3. Assessment of <u>invertebrate values</u> in each PC against the Partially Operative and Proposed Otago Regional Policy Statements (POORPS & PORPS, respectively) significance criteria. Project Components: 1 = Coronation 6 Pit; 2 = Coronation North Backfill; 3 = Northern Gully Waste Rock Stack; 4 = Golden Bar2 Pit; 5 = Golden Bar WRS; 6 = IM9 Pit; 7 = IM10 Pit; 8 = Frasers Backfill; 9 = Golden Bar Road realignment; and 10 = Golden Point Backfill Buttress."?" denotes uncertainty as PCs were not ground-truthed.

		Project Component									
POPORPS/PORPS	**Macraes MP4 significance assessment**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Representativeness	The habitats for invertebrate are typical or characteristic of the natural diversity of the ecological district, though some habitats are degraded examples of their type (e.g., tussockland, shrubland).	No	No?	No?	Yes	Yes	No?	No?	No?	Yes?	No?
Rarity	The area supports species, and habitats that support species, that are threatened (e.g., *Orocrambus sophistes*).	No	No?	No?	No	Yes	No?	No?	No?	No?	No?
Diversity	The area supports a diversity of indigenous invertebrate and/ or invertebrate habitats, similar to the diversity found within the immediately surrounding landscape and at the level of the Ecological District.	No	No?	No?	Yes	Yes	No?	No?	No?	Yes?	No?
Distinctiveness	Of the recorded invertebrate species, none occur at their distribution limits, are endemic to the Otago region, or are of biogeographic interest.	No	No?	No?	No	No	No?	No?	No?	No?	No?
Ecological Context	The terrestrial ecological features in the area, as they pertain to invertebrates, provide some connectivity between the site and adjoining sites, and provide resources (e.g., food, refuge, breeding sites) for invertebrates.	Yes	No?	No?	Yes	Yes	No?	No?	No?	Yes?	No?
Coastal Environment	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 4.4. Assessment of <u>invertebrate values</u> in each PC against the Waitaki District Plan significance criteria. Project Components: 1 = Coronation 6 Pit; 2 = Coronation North Backfill; 3 = Northern Gully Waste Rock Stack; 4 = Golden Bar2 Pit; 5 = Golden Bar WRS; 6 = IM9 Pit; 7 = IM10 Pit; 8 = Frasers Backfill; 9 = Golden Bar Road realignment; and 10 = Golden Point Backfill Buttress."?" denotes uncertainty as PCs were not ground-truthed.

		Project Component									
Waitaki District Plan	**Macraes MP4 significance assessment**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Representativeness	The area supports habitats and ecological processes (e.g., invertebrate community contributions to the environment) that are typical of the ecological district relative to the pre-European baseline and contributes to maintaining an appropriate proportional representation of these features.	No	No?	No?	Yes	Yes	No	No	No	No?	No?
Rarity and Distinctiveness	The area supports threatened invertebrate species and habitats (e.g., rock tors) that are important in the lifecycle of protected or threatened indigenous invertebrates.	No	No?	No?	Yes	Yes	No?	No?	No?	No?	No?
Diversity and Pattern	The area supports a relatively diverse invertebrate fauna, a diversity of habitats for indigenous invertebrates, and ecological processes (e.g., plant pollination, invertebrates as prey for other fauna and as predators of invertebrates, etc.). These features are typical of the immediate surrounding landscape and at the level of the Ecological District.	No	No?	No?	Yes	Yes	No?	No?	No?	Yes?	No?
Ecological Context, Size and Shape	Invertebrate habitats within the area share ecological connections with adjoining habitats allowing dispersal of invertebrates through the landscape and provides regular resources (e.g., food, refuge, breeding sites) for invertebrates.	Yes	No?	No?	Yes	Yes	No?	No?	No?	Yes?	No?

4.3 MAGNITUDE OF EFFECT ON INVERTEBRATE VALUES

Most of the species identified in the sampling were endemic, common, and widespread; however, one moth species classified as 'Nationally Vulnerable' was recorded. Therefore, the potential effects of the proposed project on the local invertebrate communities extend to at least one threatened species. Although no 'At Risk' species were recorded during the survey, 'At Risk' species have been recorded on *iNaturalist* as being present within the wider environment. Given the limitations surrounding the available information regarding invertebrate populations within the ZOI and wider ecological district, the presence of 'At Risk' species (e.g., *Samana acutata*; 'At Risk – Relict') cannot be disregarded, and a conservative approach has been taken when considering the effects.

The mining activities proposed within the ~124 ha impact area (approximately 72% of which supports invertebrate habitat) would result in range of direct impacts on invertebrates and their habitats during the construction stages of the project, through excavation for mining pits, formation or realignment of new haulage and public roads, and construction of waste rock stacks. A range of potential indirect effects are also expected in the wider impact (buffer zone) (~105 ha, of which 75% supports invertebrate habitat) during construction and operational activities.

Potential impacts are expected to be highest in areas supporting suitable habitat for endemic invertebrates within the PC footprints, with lesser impact expected in the surrounding buffer zones. Table 4.5 provides a breakdown of impacted habitats on the scale of the ZOI (all PCs combined but no overlap in PCs).

Table 4.5 provides a detailed assessment of the magnitude and level of unmitigated effects on invertebrates for each of the PCs. Potential direct and indirect impacts on invertebrate ecological values are discussed more generally in the sections that follow.

4.3.1 Potential direct effects

Potential direct effects on approximately 124 ha of land, including approximately 90 ha that supports suitable invertebrate habitat (the remaining 33 ha represents unsuitable mine workings), within the ZOI impact footprint are anticipated (Table 4.4). Here all habitat values would be permanently lost.

Potential direct effects on invertebrates and invertebrate habitats during proposed activities include:

- Loss of habitat and associated resources;
- Invertebrate mortality during physical works (particularly to threatened species); and
- Loss of invertebrate contributions to ecosystem functioning.

4.3.1.1 Effect of construction of waste rock stack

Removal of vegetation and soil from the footprint prior to deposition of WRS material (if the waste rock is deposited on undisturbed ground) will destroy some known habitat of invertebrate species and cause the mortality of an unknown quantity of individuals which may represent 'At Risk', 'Threatened' and 'Not Threatened' taxa.

4.3.1.2 Effect of removing rock material when excavating pit

Excavating the pit extension and associated mining processes (e.g. stripping of soils and vegetation ahead of the mine excavation proper) will destroy some known habitat of invertebrate species and cause the mortality of an unknown quantity of individuals which may represent 'At Risk', 'Threatened' and 'Not Threatened' taxa.

4.3.1.3 Scale of habitat loss

On a wider landscape scale, it is estimated that the direct loss of invertebrate habitat from the surrounding local landscape (i.e., within OceanaGold Macraes landholdings) and from the Macraes ED, would be in the order of < 1% and < 0.5%, respectively.

4.3.2 Potential indirect effects

Potential indirect effects on approximately 105 ha of land, including approximately 79 ha that supports suitable invertebrate habitat (the remaining 26 ha represents mine workings), within the buffer zone are anticipated (Table 4.5). However, there is a moderate level of uncertainty around the magnitude of these impacts as adequately quantifying them is inherently difficult.

Potential indirect effects on invertebrates and invertebrate habitats during proposed activities include:

- Increase in habitat edge effects and habitat fragmentation;
- Reduction in ecological connectivity/corridors due to fragmentation;
- Disturbance within PC buffer zones due to increased noise, vibrations, sediment run-off, dust, artificial lighting, etc; and
- Loss of areas available for restoration and improvement of ecological corridors across the landscape.

The impacts on invertebrate ecological values or features are discussed generally in the following sections. Table 4.6 provides a detailed assessment of the magnitude and overall level of unmitigated effects on invertebrates for each of the PCs.

4.3.2.1 Effect of sediment run-off

Sediment deposition and accumulation could negatively affect some ground-dwelling invertebrates by smothering habitat/ resources within low-lying areas; however, the project's Erosion and Sediment Control Plan will minimise sediment runoff.

4.3.2.2 Effect of changes in weed populations

Negligible to major effect, as importation of weed species, either directly through seed contamination of equipment or material, or indirectly by creating favourable establishment sites, could transform habitat for native invertebrate taxa in the surrounding area, making the area(s) unsuitable.

4.3.2.3 Effects of noise & vibration

The influence of noise and vibration (from heavy machinery and blasting) on the invertebrate populations is largely unknown. Some groups that are known to communicate acoustically such as Orthoptera (crickets, grasshoppers, wētā, etc) and Cicadidae (cicadas) may be particularly susceptible

and thus negatively affected by increased noise and vibrations. Although there is potential for noise impacts on invertebrates (e.g., interference with intraspecific communication), the effect is likely to be inconsequential given these groups are currently found in the vicinity of the working mine.

4.3.2.4 Effects of dust

Effects of dust are likely to be negligible, as dust-fall is minimal outside of work areas due to dust management procedures in place within mining operations.

4.3.2.5 Effects of light

The effects of artificial lighting are difficult to assess, and research on light pollution on invertebrates is limited. Effects will vary depending on the lighting type and invertebrate behaviour. However, some taxa may be significantly affected, such as nocturnal species, for which flood lighting may alter circadian rhythms.

4.3.2.6 Effects of accidental fire

Fires accidentally ignited by mining machinery or activities presents a low to high risk to invertebrate communities, depending on the timing and habitat type(s) subjected to fire. Invertebrates (especially non-flighted groups) will perish as a result of fires. Though, it is likely that invertebrate populations can recover relatively rapidly following grassland fires.

4.3.2.7 Changed hydrological regimes

Changes in hydrological regimes as a result of mining activities may have potential adverse effects on the long-term persistence or quality of habitats utilised by invertebrates that prefer or require damper environments for parts of their lifecycle.

Table 4.5. Areal extent (ha) of invertebrate habitat types directly (i.e., within the footprint) and indirectly (i.e., within the buffer) impacted in the Zone of Impact (ZOI) (all PCs combined, excluding PC overlap). Mine workings (red highlight) not considered suitable habitat for invertebrates.

Habitat type	ZOI Footprint	ZOI Buffer
No. rock tors/ tor complexes	12	71
Rock tors	0.04	0.02
Shrubland	0.04	0.50
Tussockland	31.6	37.08
Riparian vegetation	0.42	0.92
Exotic grasses/pasture	55.97	36.24
Ephemeral wetlands	0.02	0.86
Felled pine	2.60	2.20
Exotic treeland (incl. pine)	0	1.10
Mine workings	33.6	26.26
Open water (ponds)	0.15	0.05
Total (all suitable invertebrate habitat)	**90.7**	**78.97**
Total (all habitat types)	**124.4**	**105.23**

4.3.3 Cumulative effects

The staged implementation approach to OceanaGold's Macraes mine has to date impacted ~2,150 ha of land, of which ~650 ha is now rehabilitated, an unknown portion of which previously supported indigenous vegetation and habitat for invertebrates. For each stage of the Macraes mine project, impact management has been undertaken to address project stage effects. Cumulative effects include the effects that would result if the activity for which consent is sought is approved, in combination with the effects of other existing activities and/ or effects which are likely to arise over time (Milne, 2008). Effects resulting from many different, often individually insignificant, or unaccounted for, effects or because of potential inadequacies in previously implemented effects management can accumulate over time to produce an overall effect greater than envisioned at each project stage. In addition, non-project related effects potentially resulting from surrounding land use practices such as pastoral activities (e.g., conversion of tussock to grazing pastures) can act in conjunction with project effects to generate unforeseen ecological impacts over the longer term.

Cumulative effects are usually neither measured nor accounted for because they are difficult to discern. Yet it is important to consider the impacts of the proposed activity, in conjunction with the effects of existing activities and over time (after avoiding, remedying, and mitigating), to understand a project's overall level of impact.

The assessment of cumulative effects requires the consideration of appropriate temporal and spatial boundaries for the assessment, and consideration of the interactions of the ecological effects of the project along with past and future activities. One type of cumulative effect is incremental habitat loss (permanent or effective) or degradation or fragmentation, which can be difficult to assess on a project-by-project basis.

For the MP4 project, in the context of cumulative effects on native invertebrates, an appropriate temporal scale would be prior to the establishment of the mine in 1990 through to 2030 (the current proposed LOM). An appropriate spatial scale for consideration of cumulative effects is the Macraes ED. With respect to potential future effects, further staged implementation of the mine, ongoing agricultural pressures in the surrounding landscape, and general habitat degradation through spread of pests and weeds are expected to cause potential disturbance to or reduce available habitat for invertebrates and/ or maintain declining population trends.

Due to the limited information available on invertebrate species and populations at the Macraes mine, it is not possible to determine whether any species have declined to extinction or near-extinction in recent decades as a result of mining. One species recorded in the ZOI is nationally threatened and while the reasons for decline of this species is unclear, habitat loss from farming and mining is likely to be a contributing factor. Extensive areas of habitat for invertebrates (e.g., native tussockland, shrubland, and riparian habitats) have been cleared or converted over the decades to accommodate mining and agricultural practices. While no dedicated attempts have been made to quantify cumulative impacts, due to the complexity and uncertainty surrounding cumulative impact analysis, historical habitat loss has been considered in assigning magnitude of effect (see Table 4.6).

4.3.4 Consideration of climate change impacts on invertebrates

Ectothermic species, which include all invertebrates, are particularly sensitive to climate and environmental variables such as temperature, rainfall, and relative humidity regulate their metabolism and physiology, which in turn affects the demographic performance of populations through controls on their development, growth, reproduction, overwinter survival, microhabitat use, and behaviour (Bellis *et al.,* 2020).

Comparatively little is known about how climate change will impact invertebrate distributions in temperate regions such as New Zealand, and this is difficult to predict, particularly when there are significant gaps in the knowledge of existing distributions for many species. However, vulnerability to climate change is expected to vary among New Zealand invertebrate species, and with rising temperatures and more frequent rainfall, climate change in New Zealand is expected to result in a reduction in the amount of climatically suitable area for some species.

Given their comparatively small size, many invertebrates are highly specialised to their microhabitats, therefore are likely to be highly sensitive to both abiotic and biotic changes to the surrounding environment. Species that are known to have regionally/ locally restricted ranges may be at particular risk, as if they are unable to adapt to changing environmental pressures this could put entire populations at risk of extinction. Naturally range-restricted species recorded during the survey (*O. sophistes*, 'Nationally Vulnerable'), are likely to be particularly vulnerable to climate change, and are unlikely to have the capabilities to adapt to warmer temperatures or disperse to new areas. Invertebrate species that rely on a particular host plant/s may also be at risk if the range or survival of the host plant is altered over time.

Although it is predicted/ acknowledged in the literature that climate change will result in negative impacts on organisms and overall biodiversity (Thomas *et al.,* 2004; Winterbourn *et al*., 2008), various studies looking at the impacts of pest species responses to warming temperatures have predicted increased fitness and invasion success (Laštuvka, 2009; McGlone & Walker, 2011). Pest insect species generally show strong adaptability to environmental changes and are likely to be generalists, which increases their range and abilities to utilise a variety of habitats. Warming annual temperatures are expected to result in the introduction of new incursions of exotic species that are currently limited by cool temperatures (e.g., invasive insects and exotic pest plants), which may have adverse effects on invertebrate habitats and on populations through pressures such as exclusion, predation, and competition for resources (McGlone & Walker, 2011). Increased fitness due to warmer temperatures may positively impact some native invertebrates.

While it is not possible to quantify, with any certainty, the potential impacts of climate change on invertebrates or other organisms, it is important to identify species likely to be vulnerable to climate change, understand the climate requirements of focal species, and consider current and future climate suitability when selecting mitigation sites to minimise future biodiversity loss (IUCN, 2013; Pecl *et al*., 2017; Bellis *et al.,* 2020).

Furthermore, consideration of potential climate change effects on species that threaten native invertebrates (e.g., introduced pests), on host plant species, and on general vegetation that provide

habitat for native invertebrates is equally important when designing management packages to address adverse effects of development on native invertebrate species.

4.3.5 Level of effect on invertebrates

Based on the current assessment, the project would result in the direct mortality of an undetermined and indeterminate number of endemic and native invertebrates, including the potential loss of an unknown quantity of individuals of a 'Nationally Vulnerable' species.

Due to a current lack of available information regarding distribution, range, populations, and abundance of the threatened moth species recorded, the true magnitude and overall level of effect on the local and regional populations of these species is unable to be quantified. In total, there is expected to be a direct loss of ~90 ha of suitable invertebrate habitat across all habitat types within the proposed project footprint areas. Project impacts are anticipated to be greatest at the Golden Bar WRS, which supports habitats used by the 'Nationally Vulnerable' moth *O. sophistes,* and in other PCs where larger areas of tussockland, riparian vegetation, and rock tors would be lost (e.g., Golden Bar Pit).

On a landscape scale, the impacted areas are relatively small compared to the availability of habitat for invertebrate taxa within the local (< 1% of land within OGL Macraes landholdings) and Macraes ED (< 0.5%) landscapes. On a national scale, the effects are likely to be negligible. However, considering the potential additive or cumulative effects of historical and future land conversion, habitat clearance, and growing use of agricultural pesticides the scale of the impact on local invertebrates is likely to be higher.

The level of effects on invertebrate populations and their habitats within the PCs, prior to measures to avoid, remedy, or mitigate, range from **Very low** to **High** (Table 4.5).

A level of effect that corresponds to Moderate, High or Very High is generally accepted by ecologists to constitute a 'significant ecological effect' under the RMA and it is usual for a 'Very High' level of effect to trigger re-design or avoidance. A Low or Very Low level of effect is usually considered to correspond to a 'minor ecological effect' or 'less than minor ecological effect', respectively under the RMA. A level of effect of Moderate or higher generally requires mitigation measures to reduce the level of effect.

Table 4.6. Assessment of magnitude of effects and level of <u>unmitigated</u> effects on invertebrate and invertebrate habitats as a result of the proposed MP4 Project activities.

Site	Herpetofauna value score	Direct adverse effect	Indirect effects	Magnitude of effect (Table 8 EIANZ)	Level of unmitigated effects (Table 10 EIANZ)
CO6 Pit	Low	Permanent loss of: • Individuals of nationally and locally common indigenous species, though it is anticipated that only a relatively small proportion of the invertebrate population within the local landscape (OGL Macraes landholdings) and Macraes ED (estimated at < 1% and < 1%, respectively) would be affected. On a national scale, the impact on invertebrates is considered Negligible. • 11.6 ha of invertebrate habitat, including loss of 1 rock tor (0.002 ha), representing a relatively small proportion of the available habitat in the local landscape (OGL Macraes landholdings) (estimated at < 1%) and Macraes ED (estimated at < 0.5%) would be affected. On a national scale, the impact on invertebrate habitat is considered Negligible. Habitat suitability score of Low. Qualifies as an area with significant indigenous vegetation or significant habitats of indigenous fauna under the POORPS/ PORP and WDP. Cumulative effect: loss of invertebrates and invertebrate habitat will contribute to the historical and future loss of these features from the local landscape and Macraes ED. Minor shift away from existing baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances or patterns; AND/OR Having a minor effect on the known population or range of the element/feature.	Invertebrate populations and habitats in the buffer zone (specifically the ~2 ha of tussockland) immediately adjacent to the project footprint may be subject to edge effects, vibration, noise, and dust disturbance.	Low	Very low
CN BF	Low	If indigenous invertebrates are present, there would be a permanent loss of: • Individuals of nationally and locally common indigenous species. • A very small area of lower value invertebrate habitat (~0.02 ha of exotic grassland), representing a tiny proportion of the available habitat in the local landscape (OGL Macraes landholdings) (estimated at < 0.05%) and Macraes ED (estimated at < 0.05%) would be affected. On a national scale, the impact on invertebrate habitat is considered Negligible. Habitat suitability score of Very low. Does not qualify as an area with significant indigenous vegetation or significant habitats of indigenous fauna under one or all the NPSIB, POORPS/ PORP and WDP. Very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation; AND/OR Having negligible effect on the known population or range of the element/feature.	Unlikely to be any indirect effects given the buffer zone is comprised of existing mine working (i.e., no invertebrate values)	Negligible	Very low

NGWRS	Low	If indigenous invertebrates are present, there would be a permanent loss of: • Individuals of nationally and locally common indigenous species. • An area of lower value invertebrate habitat (~17.6 ha of exotic grassland), representing a very small proportion of the available habitat in the local landscape (OGL Macraes landholdings) (estimated at < 0.05%) and Macraes ED (estimated at < 0.05%) would be affected. On a national scale, the impact on invertebrate habitat is considered Negligible. Habitat suitability score of Very low. Does not qualify as an area with significant indigenous vegetation or significant habitats of indigenous fauna under one or all the NPSIB, POORPS/ PORP and WDP. Very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation; AND/OR Having negligible effect on the known population or range of the element/feature.	Invertebrate populations and habitats immediately adjacent to the project footprint may be subject to edge effects, vibration, noise, and dust disturbance.	Low	Very low
Golden Bar 2 Pit	Moderate	Permanent loss of: • Individuals of nationally and locally common indigenous species, though it is anticipated that only a relatively small proportion of the invertebrate population within the local landscape (OGL Macraes landholdings) and Macraes ED (estimated at < 1% and < 1%, respectively) would be affected. On a national scale, the impact on invertebrates is considered Negligible. • Approximately 5 ha of higher quality invertebrate habitat, including loss of 6 rock tors (0.01 ha) and in addition, loss of ~ 9 ha of lower quality exotic pastureland that supports invertebrates. Relatively small proportion of the available habitat in the local landscape (OGL Macraes landholdings) (estimated at < 1%) and Macraes ED (estimated at < 0.5%) would be affected. On a national scale, the impact on invertebrate habitat is considered Negligible. Cumulative effect: loss of invertebrates and invertebrate habitat will contribute to the historical and future loss of these features from the local landscape and Macraes ED. Habitat suitability score of High. Qualifies as an area with significant indigenous vegetation or significant habitats of indigenous fauna under the NPSIB, POORPS/ PORP and WDP. Permanent loss of rock tors may predispose some invertebrate species to climate change impacts. Loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed; AND/OR Loss of a moderate proportion of the known population or range of the element/feature.	Invertebrate populations and habitats immediately adjacent to the project footprint may be subject to edge effects, vibration, noise, and dust disturbance. Invertebrate habitat occurring in the 100 m buffer zone is of moderate quality for invertebrates (i.e., mostly comprised of grazed tussockland and riparian vegetation, with few complex rock tors).	Moderate	Moderate

Golden Bar WRS	Very high	Permanent loss of: • Individuals of a 'Nationally Vulnerable' species, and nationally and locally common indigenous species. Impacts on most species are anticipated to be on relatively small proportion of the invertebrate population within the local landscape (OGL Macraes landholdings) and Macraes ED (estimated at < 1% and < 1%, respectively) would be affected. On a national scale, the impact on invertebrates is considered Negligible. Scale of impact on 'Nationally Vulnerable' *O. sophistes* is largely unknown. • 48 ha of higher quality invertebrate habitat, including loss of 23.5 ha of tussockland. The loss of tussock may have proportionally higher effects on the 'Nationally Vulnerable' *O. sophistes*, which presumably feeds exclusively on tussock. In addition, loss of ~ 24 ha of lower quality exotic pastureland that supports invertebrates. Representing a relatively small proportion of the available habitat in the local landscape (OGL Macraes landholdings) (estimated at < 1%) and Macraes ED (estimated at < 0.5%) would be affected. On a national scale, the impact on invertebrate habitat is considered Negligible. Habitat suitability score of High. Qualifies as an area with significant indigenous vegetation or significant habitats of indigenous fauna under the NPSIB, POORPS/ PORP and WDP. Cumulative effect: loss of invertebrate and invertebrate habitat will contribute to the historical and future loss of these features from the local landscape and Macraes ED. Permanent loss of critical habitats such as tussockland and rock tors may predispose 'Nationally Vulnerable' and other species to climate change impacts. Loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed; AND/OR Loss of a moderate proportion of the known population or range of the element/feature.	Invertebrate populations and habitats immediately adjacent to the project footprint may be subject to edge effects, vibration, noise, and dust disturbance. Invertebrate habitat occurring in the 100 m buffer zone is of high quality for Invertebrates (i.e., tussockland and large complex rock tor complexes, and riparian vegetation)	Moderate	High
IM 9 Pit	Low	If indigenous invertebrates are present, there would be a permanent loss of: • Individuals of nationally and locally common indigenous species. • A small area of lower value invertebrate habitat (~0.46 ha of exotic grassland), representing a very small proportion of the available habitat in the local landscape (OGL Macraes landholdings) (estimated at < 0.05%) and Macraes ED (estimated at < 0.05%) would be affected. On a national scale, the impact on invertebrate habitat is considered Negligible. Habitat suitability score of Very low. Does not qualify as an area with significant indigenous vegetation or significant habitats of indigenous fauna under one or all the NPSIB, POORPS/ PORP and WDP. Very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation; AND/OR Having negligible effect on the known population or range of the element/feature.	Invertebrate populations and habitats immediately adjacent to the project footprint may be subject to edge effects, vibration, noise, and dust disturbance.	Low	Very low

IM 10 Pit	Low	If indigenous invertebrates are present, there would be a permanent loss of: • Individuals of nationally and locally common indigenous species. • Small areas of invertebrate habitat (~0.2 ha of tussockland and ~3.6 ha of exotic grassland), representing a very small proportion of the available habitat in the local landscape (OGL Macraes landholdings) (estimated at < 0.05%) and Macraes ED (estimated at < 0.05%) would be affected. On a national scale, the impact on invertebrate habitat is considered Negligible. Habitat suitability score of Low. Does not qualify as an area with significant indigenous vegetation or significant habitats of indigenous fauna under one or all the NPSIB, POORPS/ PORP and WDP. Very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation; AND/OR Having negligible effect on the known population or range of the element/feature.	Invertebrate populations and habitats immediately adjacent to the project footprint may be subject to edge effects, vibration, noise, and dust disturbance.	Low	Very low
Frasers BF/WRS	Negligible	• No impacts on lizards anticipated inside the footprint as there is no existing lizard habitat present. Habitat suitability score of Negligible. Does not qualify as an area with significant indigenous vegetation or significant habitats of indigenous fauna under the NPSIB, POORPS/ PORP and WDP. No change from the existing baseline condition AND/OR having negligible effect on the known population or range of the element/feature.	No or very minor anticipated indirect effects considering the land surrounding the impact area has been previously disturbed/ worked and is generally of poor quality for invertebrates.	Negligible	Very low
GB RR	Low	Permanent loss of: • Individuals of nationally and locally common indigenous species. • ~ 0.06 ha of tussockland and 0.87 ha of exotic grass that likely supports invertebrates. Representing a relatively small proportion of the available habitat in the local landscape (OGL Macraes landholdings) (estimated at < 1%) and Macraes ED (estimated at < 0.5%) would be affected. On a national scale, the impact on invertebrate habitat is considered Negligible. Habitat suitability score of Moderate. Likely qualifies as an area with significant indigenous vegetation or significant habitats of indigenous fauna under the NPSIB, POORPS/ PORP and WDP. Cumulative effect: loss of invertebrate and invertebrate habitat will contribute to the historical and future loss of these features from the local landscape and Macraes ED. Loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed; AND/OR Loss of a moderate proportion of the known population or range of the element/feature.	Invertebrate populations and habitats immediately adjacent to the project footprint may be subject to edge effects, vibration, noise, and dust disturbance. New road will reduce dispersal capability of ground-dwelling invertebrates by creating a road barrier. Invertebrate habitat occurring in the 100 m buffer zone is of lower quality for invertebrates (i.e., exotic pasture and treeland).	Low	Very low

GP BB	Low	If indigenous invertebrates are present, there would be a permanent loss of: • Individuals of nationally and locally common indigenous species. • Very small area of invertebrate habitat (~0.6 ha of exotic grass), representing a very small proportion of the available habitat in the local landscape (OGL Macraes landholdings) (estimated at < 0.05%) and Macraes ED (estimated at < 0.05%) would be affected. On a national scale, the impact on invertebrate habitat is considered Negligible. Habitat suitability score of Low. Does not qualify as an area with significant indigenous vegetation or significant habitats of indigenous fauna under one or all the NPSIB, POORPS/ PORP and WDP. Very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation; AND/OR Having negligible effect on the known population or range of the element/feature.	Invertebrate populations and habitats immediately adjacent to the project footprint may be subject to minor edge effects, vibration, noise, and dust disturbance.	Low	Very low

5 RECOMMENDATIONS TO ADDRESS POTENTIAL ADVERSE EFFECTS

Efforts to address potential adverse effects are considered necessary for all habitats and species that are expected to incur 'Moderate' or 'High' 'Level of Effects' at the Golden Bar 2 Pit and Golden Bar WRS, respectively, as a result of the project (Table 4.6) (Roper-Lindsay *et al.,* 2018).

The Impact Management Plan (IMP, Ahikā Consulting, 2024b) is a document that has been prepared to identify how OceanaGold will avoid, mitigate, remedy, offset, or compensate for adverse effects on ecological (including invertebrate) values resulting from the MP4 Project. Generally, this document addresses:

- Efforts to avoid or minimise the potential for adverse ecological effects through optioneering and concept design phases of the project and include refining the configuration of the project, where possible, to avoid high ecological value areas.
- Invertebrate mitigation options such as salvage and relocation into suitable and secure habitat outside of the project footprint, where long term site protection is guaranteed.
- Opportunities for remediation such as the restoration of invertebrate habitats on capped waste rock stacks or reversion of pastural land to native vegetation on OceanaGold landholdings to replenish invertebrate habitat within the surrounding landscape.
- Offsetting and compensation measures to address remaining (residual) adverse effects. Offset or compensatory measures will involve land covenanting, revegetation, pest control (i.e., weeds and introduced predatory mammals), and potentially out of kind (like-for-like or trade-up) contributions.

Specifically with respect to the 'Moderate' or 'High' 'Level of Effects' on the 'Nationally Vulnerable' moth at Golden Bar, the IMP proposes to salvage the host plant and undertake research on the habitat of *Orocrambus sophistes* to inform habitat re-creation or enhancement opportunities in a protected site. These activities will contribute to reducing the level of impact on *Orocrambus sophistes*.

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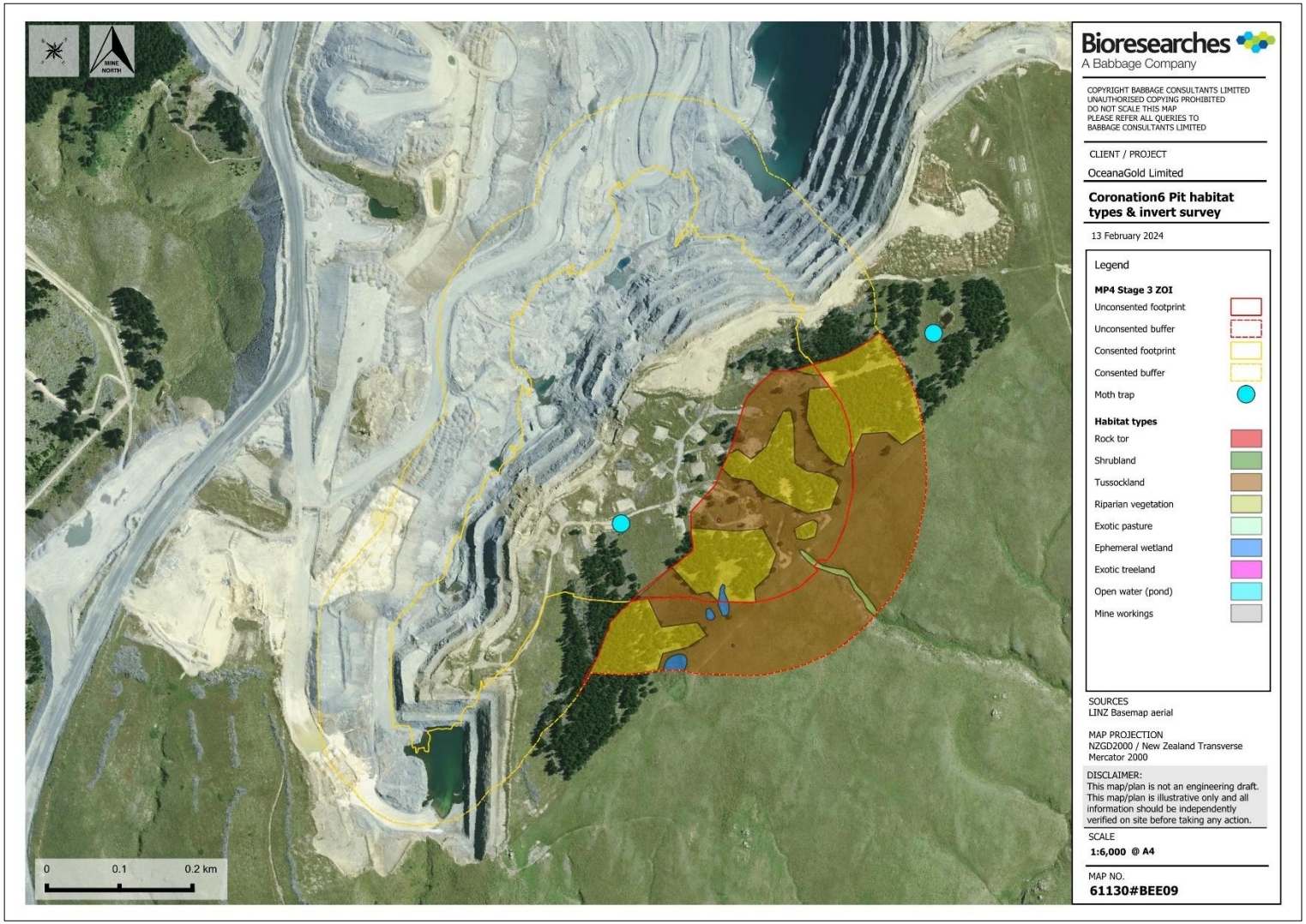
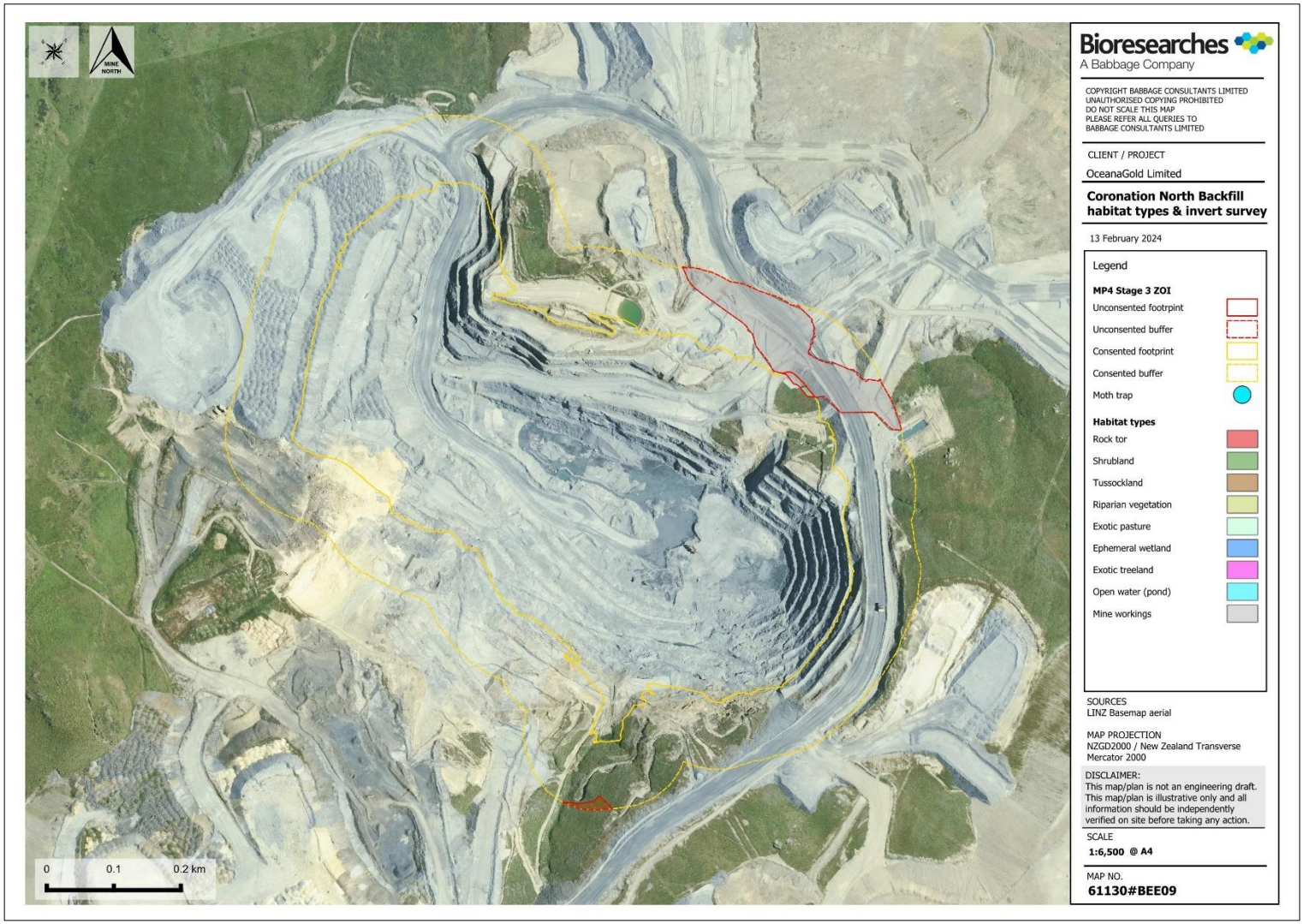
7 APPENDICES

APPENDIX I. MAPS SHOWING INVERTEBRATE MOTH LIGHT TRAPPING LOCATIONS AND HABITAT TYPES WITHIN EACH PROJECT COMPONENT.

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Coronation North Backfill habitat types & invert survey
13 February 2024
Legend
MP4 Stage 3 ZOI
Unconsented footprint
Unconsented buffer
Consented footprint
Consented buffer
Moth trap
Habitat types
Rock tor
Shrubland
Tussockland
Riparian vegetation
Exotic pasture
Ephemeral wetland
Exotic treeland
Open water (pond)
Mine workings
SOURCES
LINZ Basemap aerial
MAP PROJECTION
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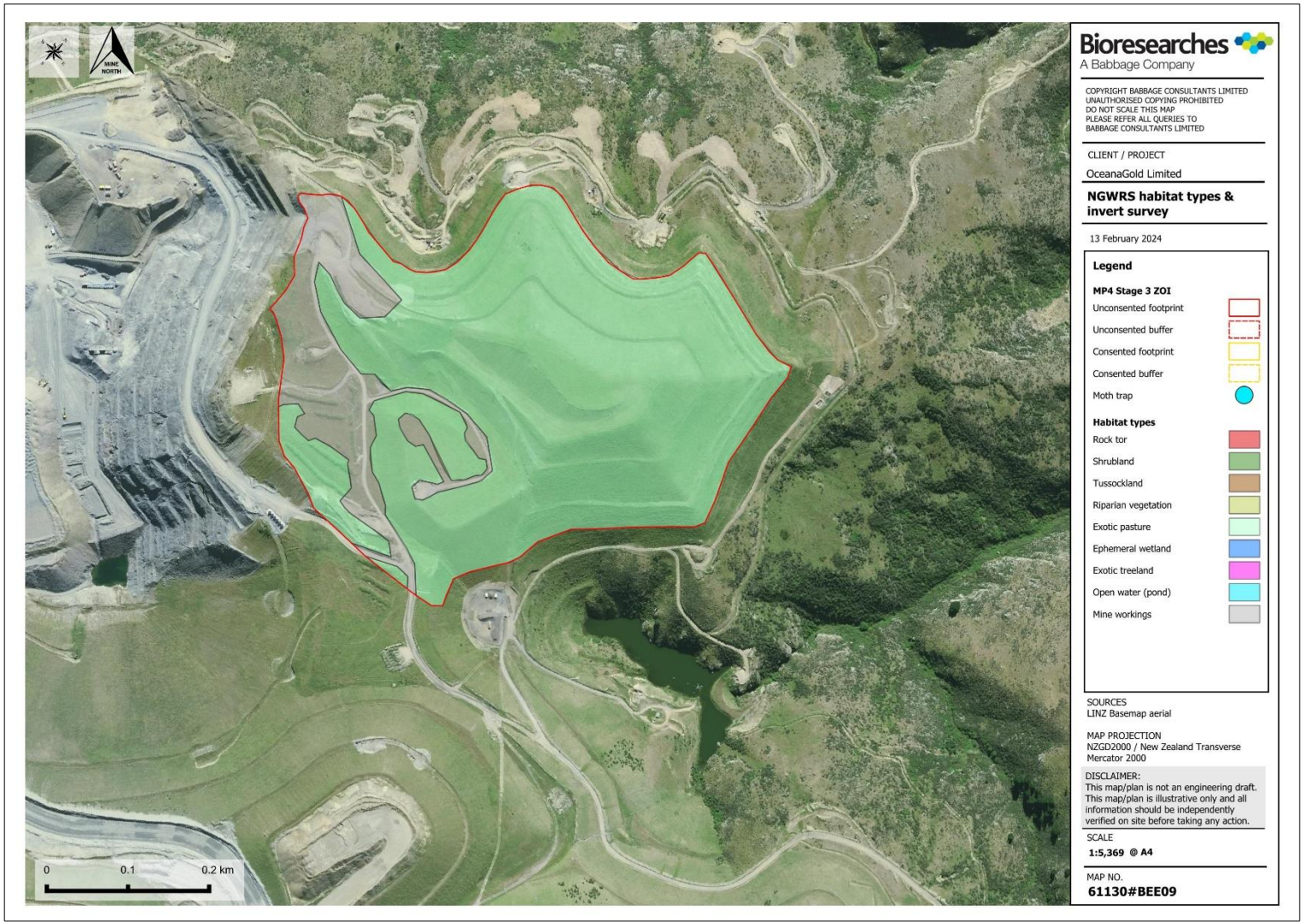
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NGWRS habitat types & invert survey
13 February 2024
Legend
MP4 Stage 3 ZOI
Unconsented footprint
Unconsented buffer
Consented footprint
Consented buffer
Moth trap
Habitat types
Rock tor
Shrubland
Tussockland
Riparian vegetation
Exotic pasture
Ephemeral wetland
Exotic treeland
Open water (pond)
Mine workings
SOURCES
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Frasers BF/WRS habitat types & invert survey
13 February 2024
Legend
MP4 Stage 3 ZOI
Unconsented footprint
Unconsented buffer
Consented footprint
Consented buffer
Moth trap
Habitat types
Rock tor
Shrubland
Tussockland
Riparian vegetation
Exotic pasture
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Open water (pond)
Mine workings
SOURCES
LINZ Basemap aerial
MAP PROJECTION
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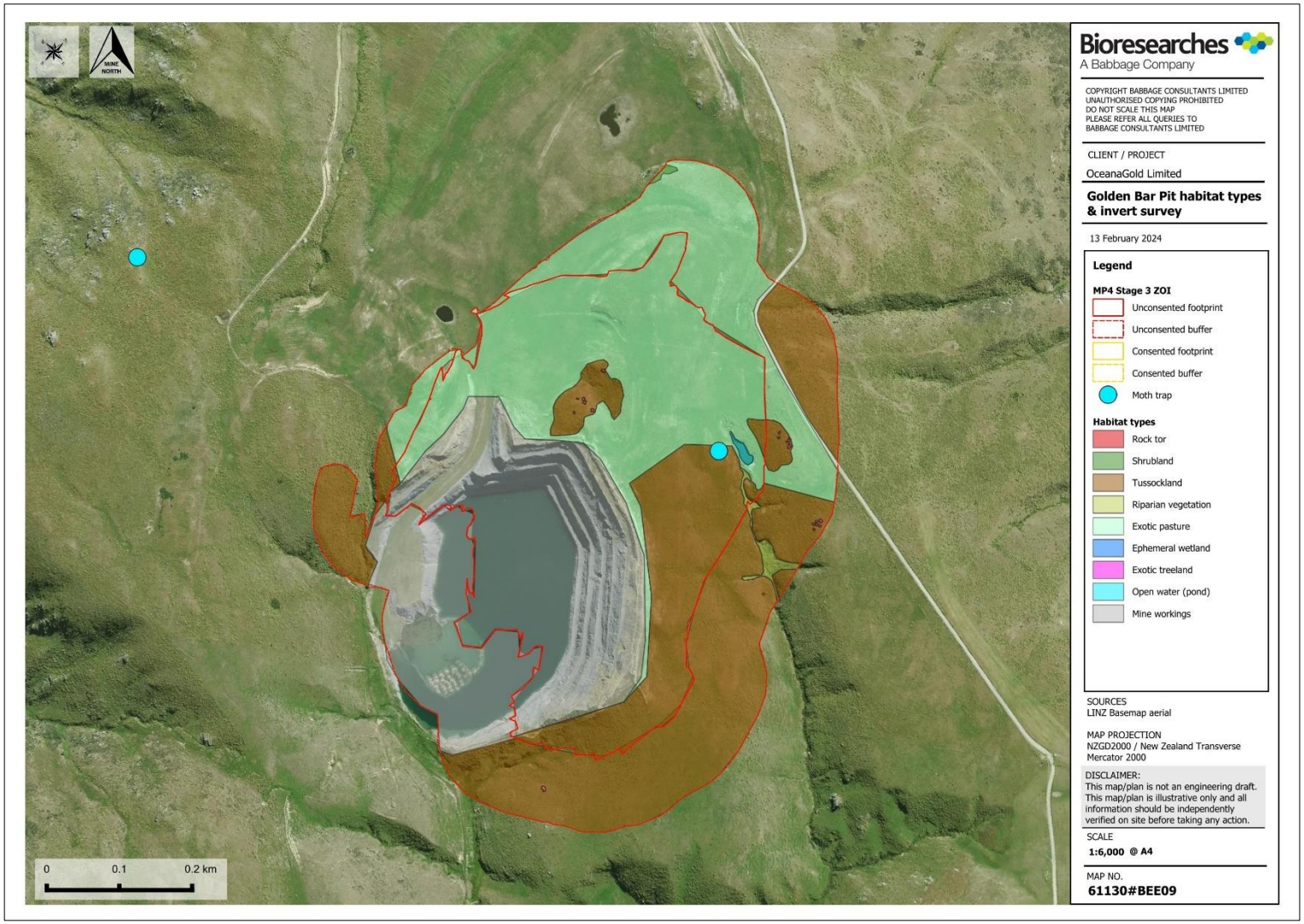
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Golden Bar Pit habitat types & invert survey
13 February 2024
Legend
MP4 Stage 3 ZOI
Unconsented footprint
Unconsented buffer
Consented footprint
Consented buffer
Moth trap
Habitat types
Rock tor
Shrubland
Tussockland
Riparian vegetation
Exotic pasture
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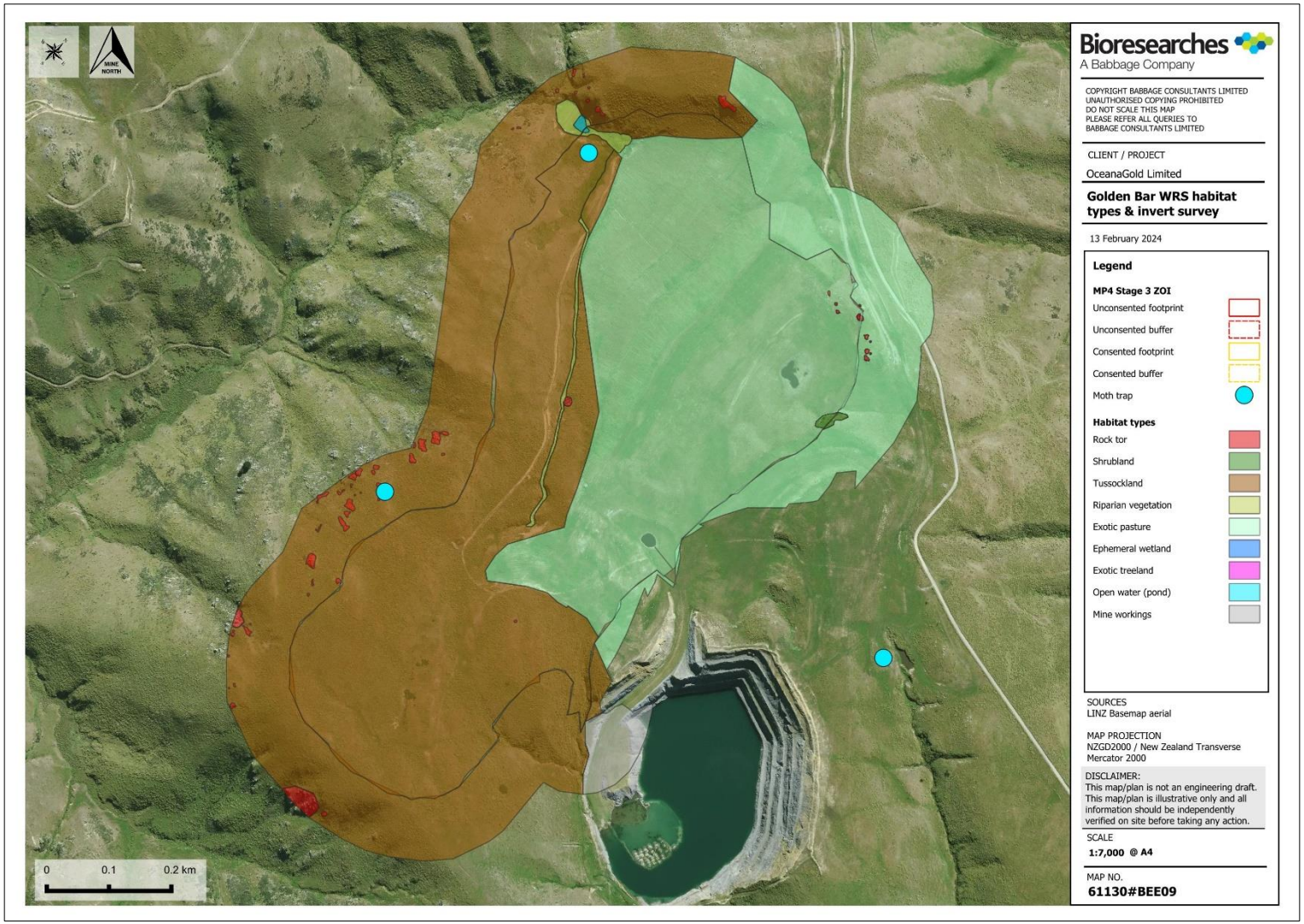
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Golden Bar WRS habitat types & invert survey
13 February 2024
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MP4 Stage 3 ZOI
Unconsented footprint
Unconsented buffer
Consented footprint
Consented buffer
Moth trap
Habitat types
Rock tor
Shrubland
Tussockland
Riparian vegetation
Exotic pasture
Ephemeral wetland
Exotic treeland
Open water (pond)
Mine workings
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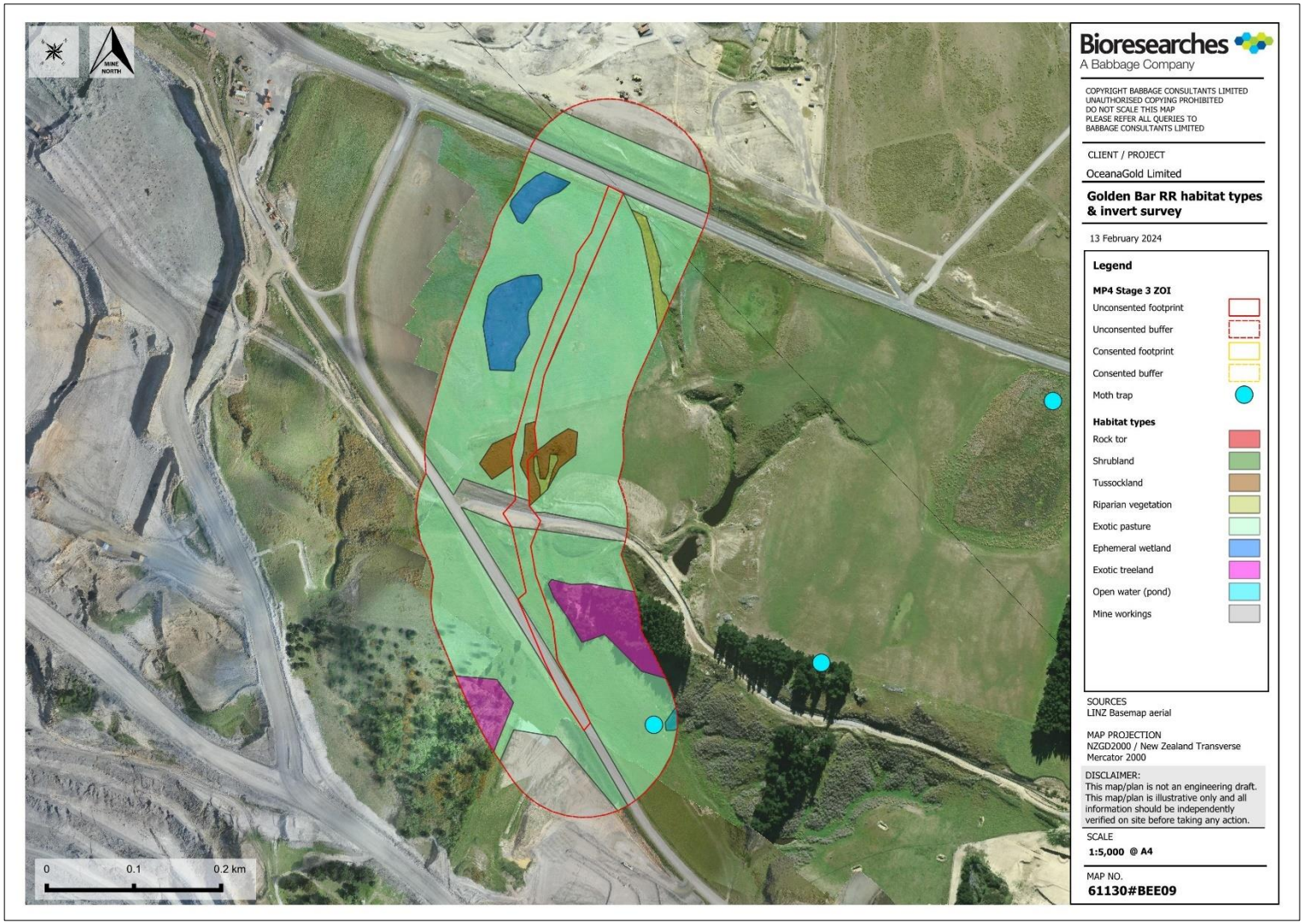
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Golden Bar RR habitat types & invert survey
13 February 2024
Legend
MP4 Stage 3 ZOI
Unconsented footprint
Unconsented buffer
Consented footprint
Consented buffer
Moth trap
Habitat types
Rock tor
Shrubland
Tussockland
Riparian vegetation
Exotic pasture
Ephemeral wetland
Exotic treeland
Open water (pond)
Mine workings
SOURCES
LINZ Basemap aerial
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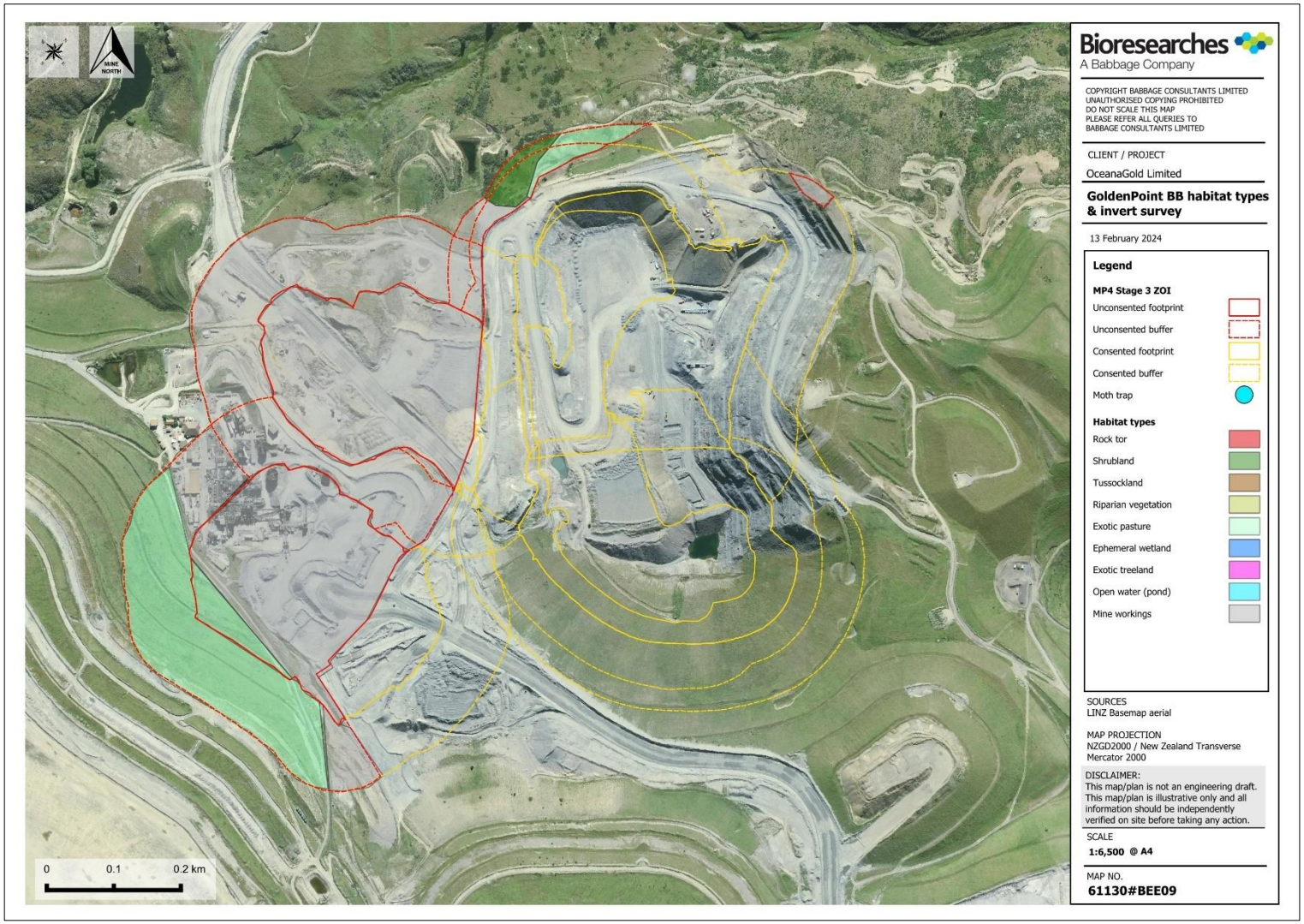
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GoldenPoint BB habitat types & invert survey
13 February 2024
Legend
MP4 Stage 3 ZOI
Unconsented footprint
Unconsented buffer
Consented footprint
Consented buffer
Moth trap
Habitat types
Rock tor
Shrubland
Tussockland
Riparian vegetation
Exotic pasture
Ephemeral wetland
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Mine workings
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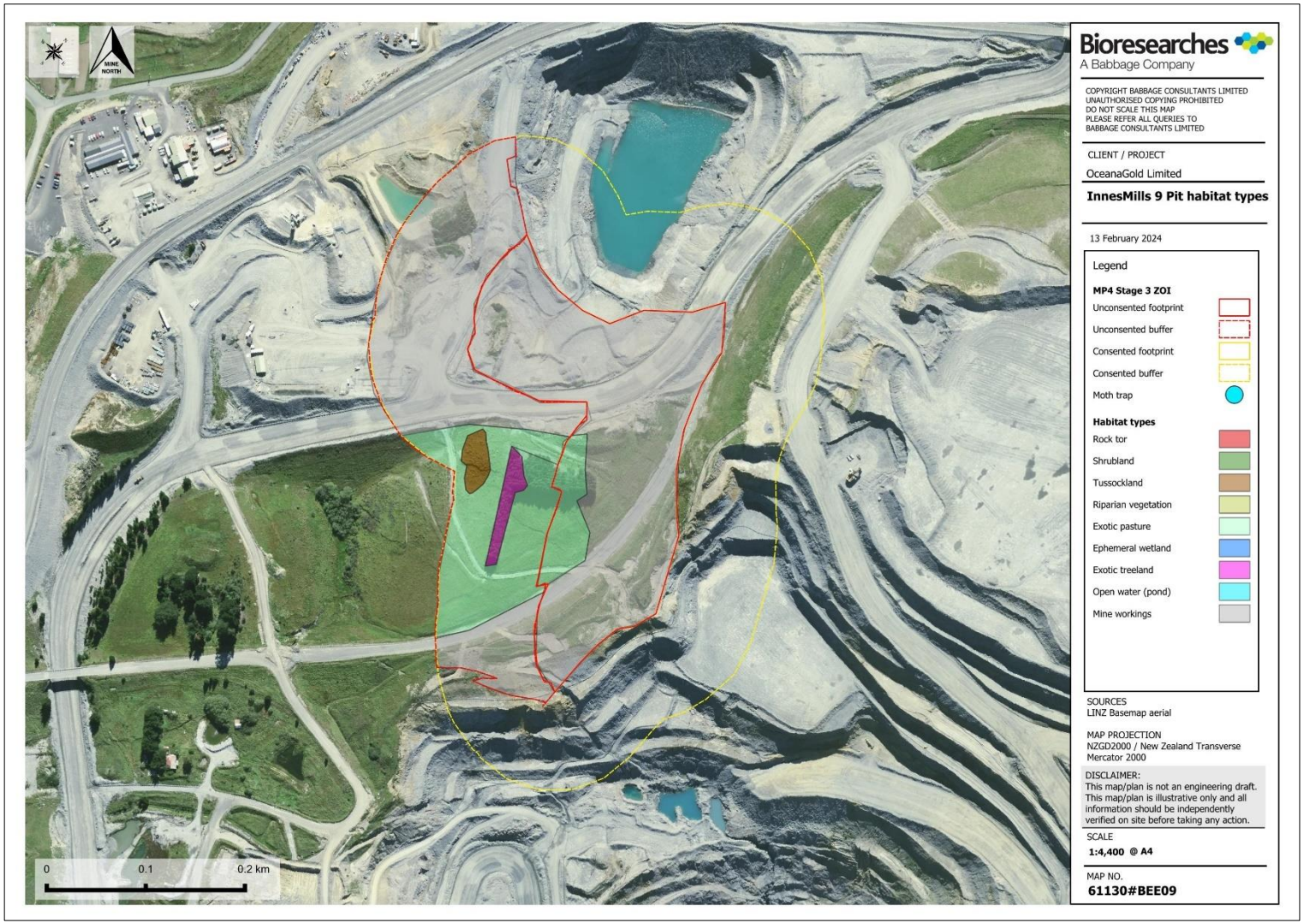
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InnesMills 9 Pit habitat types
13 February 2024
Legend
MP4 Stage 3 ZOI
Unconsented footprint
Unconsented buffer
Consented footprint
Consented buffer
Moth trap
Habitat types
Rock tor
Shrubland
Tussockland
Riparian vegetation
Exotic pasture
Ephemeral wetland
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Open water (pond)
Mine workings
SOURCES
LINZ Basemap aerial
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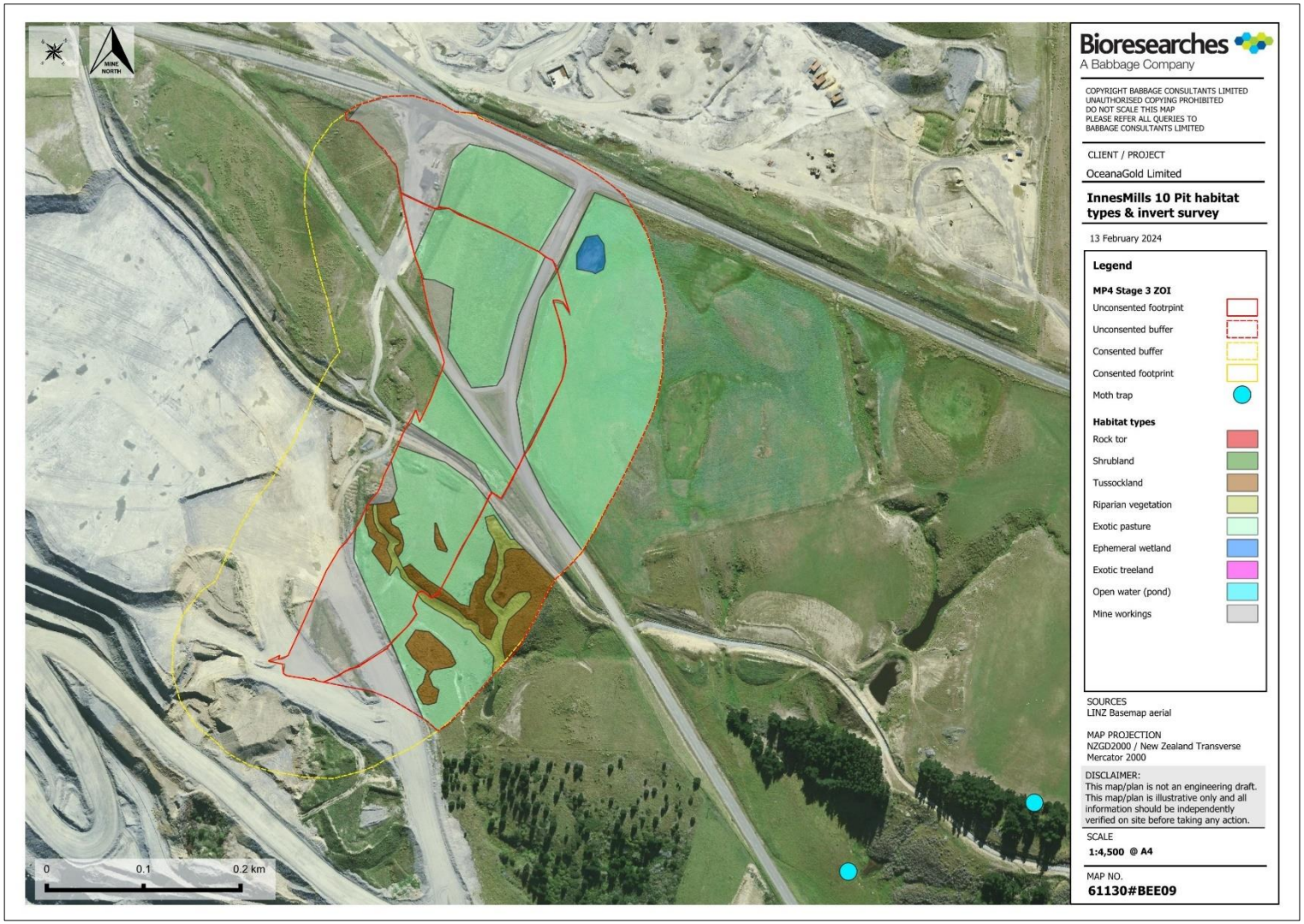
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InnesMills 10 Pit habitat types & invert survey
13 February 2024
Legend
MP4 Stage 3 ZOI
Unconsented footprint
Unconsented buffer
Consented buffer
Consented footprint
Moth trap
Habitat types
Rock tor
Shrubland
Tussockland
Riparian vegetation
Exotic pasture
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Open water (pond)
Mine workings
SOURCES
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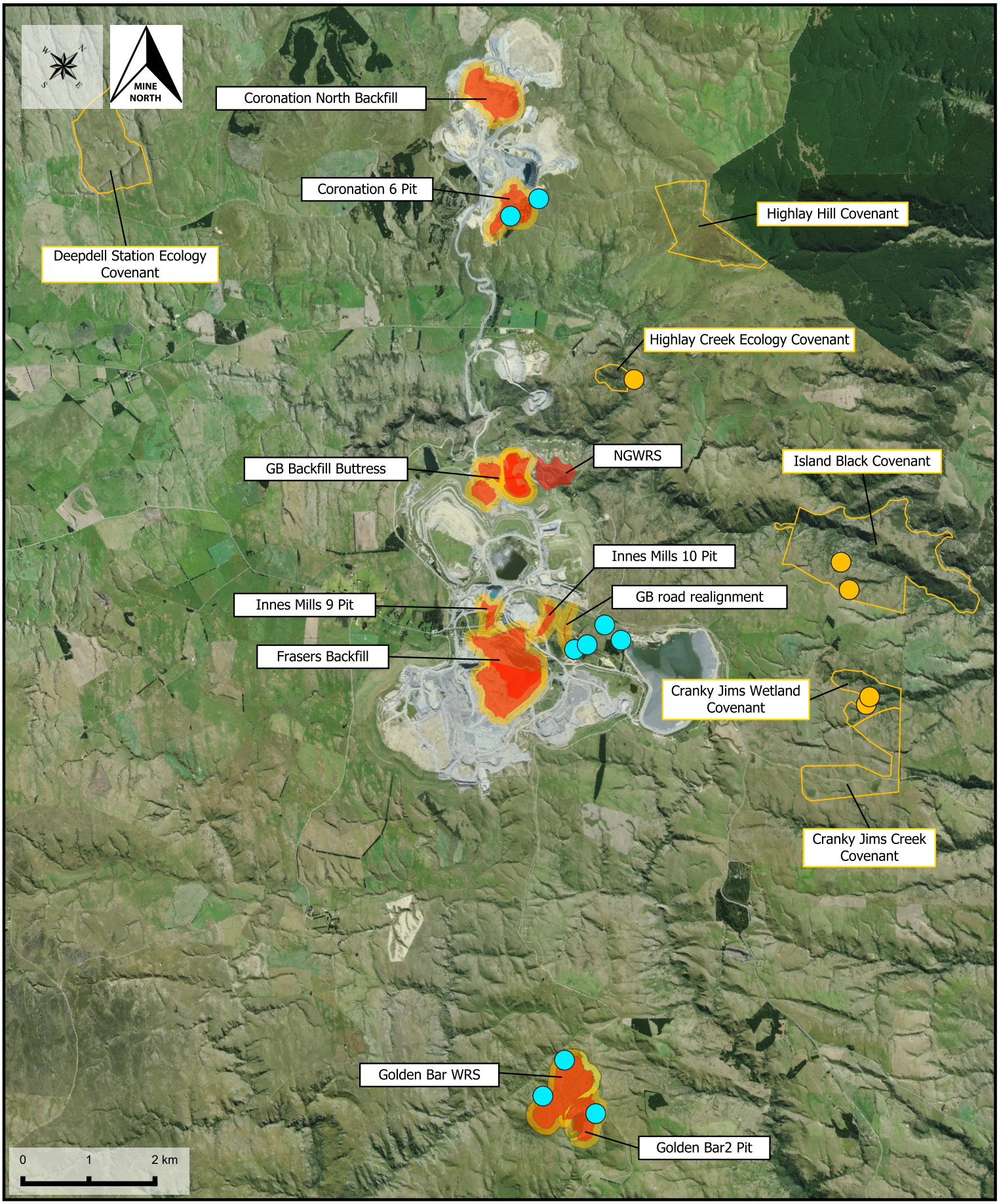

MP4 Stage 3: Zone of Impact (ZOI) & Ecology Covenants

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13 February 2024

MAP PROJECTION:
NZGD2000 / New Zealand Transverse Mercator 2000

SOURCES:
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Legend

- Macraes Ecology Covenants

MP4 Zone of Impact
Project Components

- Impact areas (direct impact)
- 100 m buffer (indirect impact)
- Moth trap (MP4 ZOI)
- Moth trap (Covenants)

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APPENDIX II. TAXONOMIC INVENTORY OF INVERTEBRATES RECORDED DURING SURVEYS IN APRIL AND MAY 2022 IN THE MP4 PROJECT AREA, MACRAES.

Collection method acronym key: SN = Sweep netting; MLT = Moth light trapping; HS = Hand searching; Obs. = Observation.

Order	Family	Species	NZ status	NZ cons. status	Project component	Collection method	Notes
Araneae	Araneidae	*Eriophora pustulosa*	Native	Not Threatened	Golden Bar WRS	SN	
	indet.	indet.			Golden Bar Pit Coronation 6 Pit	MLT, SN, HS	Large number of specimens of variable taxa.
Chordeumatida	Metopidiotrichidae	*Schedotrigona* sp.	Endemic	Not listed	Adjacent GB RR	Obs.	
Coleoptera	Agyrtidae	*Zeanecrophilus prolongatus*	Endemic	Not listed	Adjacent GB RR Golden Bar Pit	MLT	2 x specimens
	Anthribidae	*Phymatus cucullatus*	Endemic	Not listed	Adjacent GB RR	SN	
		Sharpius brouni	Endemic	Not listed	Adjacent GB RR	SN	
	Carabidae	*Ctenognathus* sp.	Endemic	Not listed	Coronation 6 Pit	HS	Under rock
		indet. 1			Adjacent GB RR	HS	Under rock
		indet. 2			Adjacent GB RR	HS	Under rock
		indet. 3			Adjacent GB RR	HS	Under rock
		Megadromus bullatus	Endemic	Not listed	Golden Bar WRS Adjacent GB RR	HS	Under discarded oil drum
		Megadromus sp.	Endemic?	Not listed	Coronation 6 Pit	HS	Under rock
		Oregus aereus	Endemic	Not listed	Golden Bar WRS	HS	Under rock
	Cerambycidae	*Prionoplus reticularis*	Endemic	Not listed	Adjacent GB RR	HS	
	Coccinellidae	*Coccinella undecimpunctata*	Introduced	Not listed	Adjacent GB RR Coronation 6 Pit	Obs., HS, SN	One observed on rock tor
	Curculionidae	*Rhinocyllus conicus*	Introduced	Not listed	Golden Bar WRS	SN	
		Sitona lepidus	Introduced	Not listed	Coronation 6 Pit	SN	
	Scarabaeidae	*Odontria* sp.	?	?	Golden Bar WRS	HS	Under rock
	Tenebrionidae	*Artystona* sp.	Endemic	Not listed	Adjacent GB RR	HS	Under rock
		Mimpoeus opaculus	Endemic	Not listed	Golden Bar WRS	HS, Obs.	Under rock slabs on tors
Diptera	Anisopodidae	*Sylvicola* sp. (possibly *S. notatus*)	Endemic	Not listed	Golden Bar Pit	SN	
	Asilidae	*Saropogon fugiens*	Endemic	Not listed	Coronation 6 Pit	SN	
	Chironomidae	indet.			Coronation 6 Pit	SN	

	Dolichopodidae	indet.			Golden Bar WRS	SN	At least two species
		indet.			Golden Bar Pit	SN	
	Ephydridae	*Diasemocera metallica*	Endemic	Not listed	Golden Bar WRS Coronation 6 Pit	SN	
	Heleomyzidae	*Allophylopsis* sp. (possibly *A. scutellata)*	Endemic	Not listed	Golden Bar Pit	SN	
	Limoniidae	indet.			Golden Bar WRS	MLT	
		indet.			Golden Bar Pit	MLT	x 2 specimens
		indet.			Adjacent GB RR	MLT	
		Limonia (Dicranomyia) hudsoni(?)	Native	Not listed	Coronation 6 Pit	MLT	
	Lonchopteridae	*Lonchoptera bifurcata*	Introduced	Not listed	Golden Bar WRS Adjacent GB RR	SN, MLT	
	Muscidae	indet.			Adjacent GB RR	SN	
		indet.			Coronation 6 Pit	SN	
		indet.			Golden Bar WRS	SN	
	Mycetophilidae	indet.			Golden Bar Pit	SN	
		indet.			Adjacent GB RR	SN	
		Mycetophila fagi	Endemic	Not listed	Golden Bar Pit Golden Bar WRS	SN, MLT	x 6 specimens
	Sarcophagidae	*Oxysarcodexia varia*	Introduced	Not listed	Golden Bar WRS	SN	
	Sciomyzidae	*Neolimnia sigma*	Endemic	Not listed	Golden Bar Pit	SN	
	Syrphidae	*Melanostoma fasciatum*	Endemic	Not listed	Golden Bar Pit Golden Bar WRS	SN	
	Tephritidae	indet.			Coronation 6 Pit	SN	
		Trupanea longipennis	Native	Not listed	Coronation 6 Pit	SN	
	Tipulidae	indet.			Golden Bar WRS	SN	
	Superfamily Tipuloidea	indet.			Coronation 6 Pit	SN	
	Zoosubsection Acalyptratae	indet.			Golden Bar Pit	SN	
	indet.	indet.			Golden Bar WRS	MLT	
Hemiptera	Acanthosomatidae	*Rhopalimorpha lineolaris*	Endemic	Not listed	Adjacent GB RR	SN	Adult
	Aphididae	*Tuberolachnus salignus*	Introduced	Not listed	Golden Bar WRS	SN	
	Aphrophoridae	*Philaenus spumarius*	Introduced	Not listed	Golden Bar WRS	SN	

					Adjacent GB RR		
	Berytidae	*Bezu wakefieldi*	Endemic	Not listed	Golden Bar Pit	SN	
	Miridae	*Chinamiris laticinctus*	Endemic	Not listed	Adjacent GB RR	SN	
		indet.			Golden Bar WRS	SN	
	Nabidae	*Nabis maoricus*	Endemic	Not listed	Adjacent GB RR Coronation 6 Pit	SN	Nymph
	indet.	indet.			Golden Bar Pit	SN	
Hymenoptera	Apidae	*Bombus terrestris*	Introduced	Not listed	Adjacent GB RR Golden Bar WRS	Obs.	Flying over tussock and grassland
	Ichneumonidae	*Eutanyacra licitatoria*	Introduced	Not listed	Golden Bar WRS	SN	
		indet.			Golden Bar Pit	SN	
		indet.			Adjacent GB RR	SN	
		indet.			Coronation 6 Pit	SN	
Lepidoptera	Crambidae	*Orocrambus sophistes*	Endemic	**Nationally Vulnerable**	Golden Bar WRS	MLT	Larvae unknown, but presumably feeds on native tussock grasses. Very local species of drier inland South Island, confined to the Mackenzie and Central Otago regions. Female is short-winged and flightless, so dispersal is severely limited.
	Geometridae	*Aponotoreas insignis*	Endemic	Not listed	Adjacent GB RR	SN	Male
		Epyaxa rosearia	Endemic	Not listed	Golden Bar WRS Adjacent GB RR	MLT	
		Pasiphila inductata	Endemic	Not listed	Golden Bar WRS	MLT	
	Lycaenidae	*Zizina oxleyi*	Endemic	Not Threatened	Adjacent GB RR Golden Bar Pit Coronation 6 Pit	Obs.	
	Noctuidae	*Bityla defigurata*	Endemic	Not listed	Coronation 6 Pit Adjacent GB RR	MLT	
		Ichneutica insignis	Endemic	Not listed	Unknown	MLT	Specimen label missing
		Ichneutica mutans	Endemic	Not listed	Golden Bar Pit Adjacent GB RR	MLT	
		Ichneutica plena	Endemic	Not listed	Golden Bar WRS Adjacent GB RR	MLT	x 6 specimens
		Ichneutica skelloni (?)	Endemic	Not listed	Adjacent GB RR	MLT	
		indet.			Golden Bar WRS	SN	Unidentified larva (caterpillar). Several specimens of at least two species.
		Physetica phricias	Endemic	Not listed	Adjacent GB RR	MLT	

	Nymphalidae	*Argyrophenga antipodum*	Endemic	Not listed	Adjacent GB RR Golden Bar Pit	SN	Flying near wetland. Larvae on native and introduced grasses. Widespread and common.
		Vanessa gonerilla gonerilla	Endemic	Not listed	Adjacent GB RR Golden Bar Pit	SN, Obs.	Several individuals seen
		Vanessa itea	Native	Not listed	Adjacent GB RR Golden Bar Pit	SN, Obs.	Several individuals seen
	Pterophoridae	*Amblyptilia repletalis*	Endemic	Not listed	Golden Bar WRS	MLT	
	Tortricidae	*Apoctena conditana*	Endemic	Not listed	Golden Bar WRS	MLT	
Odonata	Coenagrionidae	*Xanthocnemis zealandica*	Native	Not Threatened	Adjacent GB RR Coronation 6 Pit	Obs.	Flying over pond
	Lestidae	*Austrolestes colensonis*	Endemic	Not Threatened	Golden Bar Pit Golden Bar WRS Adjacent GB RR Coronation 6 Pit	SN, Obs.	Flying over wetlands
Orthoptera	Acrididae	*Phaulacridium marginale*	Endemic	Not Threatened	Golden Bar WRS Golden Bar Pit Adjacent GB RR Coronation 6 Pit	Obs., SN, HS, MLT	Several individuals seen and heard
	Trigonidiidae	*Bobilla nigrovus*	Endemic	Not listed	Coronation 6 Pit	SN	
Psocodea	indet.	indet.			Coronation 6 Pit	SN	
Trichoptera	indet.	indet.			Golden Bar Pit	MLT	
Tricladida	Geoplanidae	*Artioposthia subquadrangulata*	Endemic	Not listed	Adjacent GB RR	Obs.	Under rock
		Newzealandia sp.	Endemic	Not listed	Golden Bar WRS	Obs.	Under rock

APPENDIX III. TAXONOMIC INVENTORY OF LEPIDOPTERA RECORDED DURING MOTH LIGHT TRAPPING IN COVENANTS ON OCEANGOLD MACRAES LANDHOLDINGS IN SEPTEMBER 2022.

Collection method acronym key: MLT = Moth light trapping.

Order	Family	Species	NZ status	NZ cons. status	Covenant site	Collection method	Notes
Lepidoptera	Geometridae	*Austrocidaria gobiata*	Endemic	Not listed	Island Block Covenant	MLT	
		Epiphryne verriculata	Endemic	Not listed	Cranky Jims Creek Ecology Covenant	MLT	
		Homodotis falcata	Endemic	Not listed	Cranky Jims Creek Ecology Covenant	MLT	Very dark specimen; very unusual record for Central Otago, usually not so far inland
		Xanthorhoe occulta	Endemic	Not listed	Highlay Creek Ecology Covenant	MLT	
		Xyridacma alectoraria	Endemic	Not listed	Cranky Jims Creek Ecology Covenant	MLT	
	Momphidae	*Zapyrastra (?)stellata*	Endemic	Not listed	Island Block Covenant	MLT	
	Noctuidae	*Bityla defigurata*	Endemic	Not listed	Island Block Covenant	MLT	
		Ichneutica steropastis	Endemic	Not listed	Cranky Jims Creek Ecology Covenant	MLT	
		Meterana stipata	Endemic	Not listed	Highlay Creek Ecology Covenant	MLT	
		Physetica phricias	Endemic	Not listed	Cranky Jims Creek Ecology Covenant	MLT	
	Oecophoridae	*Tingena hastata*	Endemic	Not listed	Island Block Covenant	MLT	
	Plutellidae	*Orthenches chlorocoma*	Endemic	Not listed	Cranky Jims Creek Ecology Covenant	MLT	*Carmichaelia* specialist
	Tortricidae	*Apoctena persecta*	Endemic	Not listed	Cranky Jims Creek Ecology Covenant	MLT	Scarce southern South Island species

APPENDIX IV. EIANZ KEY TABLES FOR ASSESSING LEVEL OF EFFECT.

Table 5 Factors to consider in assigning value to terrestrial species for EcIA

Determining factors	
Nationally Threatened species, found in the ZOI either permanently or seasonally	Very High
Species listed as At Risk – Declining, found in the ZOI, either permanently or seasonally	High
Species listed as any other category of At Risk, found in the ZOI either permanently or seasonally	Moderate
Locally (ED) uncommon or distinctive species	Moderate
Nationally and locally common indigenous species	Low
Exotic species, including pests, species having recreational value	Negligible

Table 6. Scoring for sites or areas combining values for four matters in Table 4.

Value	Description
Very High	Area rates High for 3 or all of the four assessment matters listed in **Table 4**. Likely to be nationally important and recognised as such.
High	Area rates High for 2 of the assessment matters, Moderate and Low for the remainder, or Area rates High for 1 of the assessment maters, Moderate for the remainder. Likely to be regionally important and recognised as such.
Moderate	Area rates High for one matter, Moderate and Low for the remainder, or Area rates Moderate for 2 or more assessment matters Low or Very Low for the remainder Likely to be important at the level of the Ecological District.
Low	Area rates Low or Very Low for majority of assessment matters and Moderate for one. Limited ecological value other than as local habitat for tolerant native species.
Negligible	Area rates Very Low for 3 matters and Moderate, Low or Very Low for remainder.

Table 8. Criteria for describing magnitude of effect (Adapted from Regini (2000) and Boffa Miskell (2011))

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

Table 10. Criteria for describing level of effects (Adapted from Regini (2000) and Boffa Miskell (2011))

Ecological Value ▸ Magnitude ▾	Very high	High	Moderate	Low	Negligible
Very high	Very high	Very high	High	Moderate	Low
High	Very high	Very high	Moderate	Low	Very low
Moderate	High	High	Moderate	Low	Very low
Low	Moderate	Low	Low	Very low	Very low
Negligible	Low	Very Low	Very low	Very low	Very low
Positive	Net gain	Net gain	Net gain	Net gain	Net gain

APPENDIX V. PROPOSED SET OF CRITERIA FOR ASSESSING HABITAT SUITABILITY OF A SPECIES (BABER *ET AL.*, 2021).

Habitat suitability value score	Description
Negligible	Habitat not suitable.
Very low	Marginal habitat that may be used but is not important for any part of the species or species assemblage life cycle(s).
Low	Habitat that provides some, but not all, of a species or species assemblages life-history requirements and/or the habitat is of low quality and the relative abundance within the habitat is low compared to other habitat types.
Moderate	Habitat that provides for most, if not all, of a species or species assemblage's life-history requirements and/or the habitat quality is of moderate quality and the relative abundance within the habitat is moderate compared to other habitat types.
High	Habitat that would typically provide for all species or species assemblage life-history requirements and/or provides a critical resource or resource(s) for life-history requirements. The habitat quality is high and the relative abundance within the habitat is, or is likely to be, high compared to other habitat types.
Very high	Habitat that provides for all species or species assemblage life-history requirements and/or provides a critical resource or resource(s) needed for life-history requirements. The habitat quality is very high and the relative abundance within the habitat is or is likely to be very high compared to other habitat types. Likely to be a local or regional hotspot for that species assemblage or benchmark with the species or species assemblage at carrying capacity.