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APPENDIX D

Terrestrial Ecology Reports

Oceana Gold (NZ) Ltd

Macraes Gold Project

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Deepdell North III Project

Summary of Project Impacts and Management of Effects

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1 Overview

The Deepdell North III project will remove approximately 54.79 ha of indigenous vegetation comprising of low producing grassland, shrubland, seasonal gully drainages, ephemeral wetlands and a seepage wetland. These are inhabited by 71 indigenous plants (including 13 rare species), twenty bird species (nine indigenous and one rare species), four reptile species (three rare species) and a largely unknown invertebrate community. The project will also impact on 54.09 ha of cultivated pasture and shelterbelts. There may be some effect on a further 88.71 ha of indigenous vegetation and 26.47 ha of cultivated pastures, but these effects are expected to be minimal if appropriate controls are employed. The indigenous vegetation communities trigger the significant criteria with regard to representativeness, rarity or distinctiveness as set out within proposed Otago Regional Policy Statement, and all but the seasonal gully drainage are significant under representativeness or rarity criteria of the Waitaki District Plan. The vegetation communities are habitat for 13 At Risk or Rare plant, bird or lizard or species and are underlain by 3 Threatened LENZ. The ephemeral wetland vegetation community is Historically Rare and Critically Endangered and the seepage wetland is Historically Rare and Endangered. Both are priorities for protection. The indigenous vegetation communities are generally of low species diversity and most are characterised by high weed representation. The populations of the At Risk or Rare species are mostly small, except for the Declining Matagouri which is dominant in the shrubland vegetation community and frequent in the low producing grassland plant community. There is doubt concerning the national conservation assessment for this species.

It is assessed that the Deepdell North III project will have low to very low effect on most of the terrestrial ecological features

Table 4). Exceptions to this are a moderate impact on the plant communities together (mainly a result of the presence of the LENZ, rare species, and the Nationally Critical ephemeral wetland) and a high impact on the seven ephemeral wetlands as these will be lost within the Project's footprint.

Project effects will be addressed through the implementation of an Impact Management plan that details actions that follow the impact mitigation hierarchy and consist of avoiding effects through siting of the WRS and isolating important areas, remedy effects through creation of new lizard habitat and a new pit lake, mitigate effects by employing Standard Operating Procedures and rescue of two plant species and to (mainly) offset impacts through funded

actions at two offset locations, one for ephemeral wetlands and supported by a research programme and the other in a high value mixed shrubland and tussockland area. These actions will, if implemented correctly, fully address all non-minor project effects excepting some minor impacts on individuals of some rare plants and common indigenous bird species, or mostly exotic plant-dominated plant communities. It is also considered that benefit of the offset covenant containing a higher quantity of the Macraes biodiversity more than compensates for the impact of the Deepdell North III project on these features.

2 Setting

The Deepdell North III project (Figure 1) is situated on the northern end of the Taieri Ridge in the Macraes Ecological District (E.D.). Past vegetation cover of the Macraes E.D. is thought to have comprised of montane short tussockland grading into subalpine tall tussockland, with areas of mixed hardwood and podocarp forest, kanuka forest and *Coprosma*-flax scrub. Since European settlement in the 1850's, areas have been burnt (sometimes repeatedly) and exotic grasslands induced by ploughing, oversowing, and applying fertiliser and approximately 75% of the district is now dominated by exotic vegetation types (mainly improved pastureland) with the remainder being indigenous plant communities that, despite often being heavily modified, are botanically diverse with a high number of species of conservation concern. Invasion by exotic shrub and tree species, particularly gorse and broom, is an increasing problem in the area.

Of the fauna, the area is noted for its high population densities and diversity of seven lizard species and the invertebrate communities are diverse (for a region at moderate altitude) and contain some rare species. Fifty-four species of birds have been recorded from the Macraes E.D., of which thirty-four are indigenous and twenty are introduced. The area's avifauna and lizard populations are likely being impacted through predation from exotic mammals and by changes to their habitats, however the impact on lizards is somewhat moderated by the abundance of rocky habitats offering safer retreat sites. Some catchments provide habitat for populations of non-migratory galaxiids, freshwater crayfish and longfin eel, which are being affected through predation by trout and changes to their habitats, particularly in the lower reaches of watercourses.

The activities that are permitted in regional and district plants to occur within the project area and that are likely to be having some influence on the site's ecological condition (the permitted baseline) are farming activities such as grazing of stock, topdressing, pasture grass establishment and maintenance and vegetation clearance (up to the extent specified in plans).

3 Assessment methodology

Information gathered during inventory surveys was used to evaluate the ecological importance of the vegetation, birds, reptiles and invertebrates and their habitats within and surrounding the Project Impact Area (PIA), against the following criteria (based on those recommended in the Environment Institute of Australia and New Zealand's 2018 Ecological Impact Assessment Guidelines available at http://www.eianz.org/resources/publications):

- Representativeness of communities.
- Distinctiveness of communities.
- Ecological functionality of communities (intactness, connectivity, buffering).
- Rarity of communities.
- Community diversity.
- Role in ecosystem servicing.
- Sites or communities of significance at
    - National (Threatened Land Environments, National Priorities for Conservation, Historically Rare or Threatened Ecosystems, Wetlands of National Importance, Ramsar Sites).
    - Regional (as identified in the Regional Plan), or
    - Local (as identified in District Plans) scales.
- Sites identified as worthy of protection.
- Presence of rare, At Risk or Threatened species.
- Presence of species of biogeographical interest.
- Presence of genetically or morphologically distinct forms.

A summary table of the magnitude of the project's effects is provided in Table 4.

4 Project impacts

The project impact area (PIA) for the Deepdell North project in total covers 169.9 ha. There will be a loss of around 104.9 of vegetation (both indigenous and exotic) associated with the active mining areas (pit and WRS)(Figure 1).This equates to less than 1% of the extent of these communities within the E.D.

4.1 Project activities likely to affect ecological features

The following have been identified as project activities that have the potential to result in an effect on the PIA's ecological features:

- Excavation of the pit – vegetation and invertebrate community loss, displacement of birds, potential mortality of reptiles;
- Deposition of rock material – covering vegetation and invertebrate communities, displacement of birds, potential mortality of reptiles;
- Sediment runoff (if unmanaged)
- Encroachment of weeds (if unmanaged)
- Potential displacement of indigenous animals through noise, vibration and lighting;
- Wind blown dust accumulation affecting or covering plant species;
- Potential for accidental fire (if unmanaged);
- Changes to surrounding hydrological regimes may result in decreased surface and subsurface flow of water into some wetlands and water courses.

4.2 Impact on vegetation communities

The Deepdell North III project will remove approximately 54.79 ha of indigenous vegetation comprising of low producing grassland, shrubland, seasonal gully drainages, ephemeral wetlands and a seepage wetland inhabited by 71 indigenous plants (including 13 rare species), twenty bird species (nine indigenous and one rare species), four reptile species (three rare species) and a largely unknown invertebrate community (Figure 1, Table 1). The project will also impact on 54.09 ha of cultivated pasture and shelterbelts. There may be some effect on a further 88.71 ha of indigenous vegetation and 26.47 ha of cultivated pastures that occurs in the buffer area, but these effects are expected to be minimal if appropriate controls are employed. The indigenous vegetation communities are generally of low species diversity and most are characterised by high weed representation.

Overall, the indigenous vegetation communities present within the PIA are assessed as being of **high** ecological importance, though the importance of each vegetation community varies between **negligible** for cultivated pasture and shelterbelts, **moderate** for the low producing grasslands and shrublands and **high** for the ephemeral wetlands and seepage wetland. Though

the indigenous plant communities are of moderate to low representation and ecosystem service importance, and moderate diversity and moderate integrity, there are remnants of rare vegetation communities present, the ephemeral wetland vegetation communities and seepage wetlands are a national priority for protection, are Naturally Uncommon and classified as Threatened, there are three Threatened Level IV land environments that are overlain by some natural vegetation and it provides habitat for Threatened, At Risk, or rare plant and animal species.

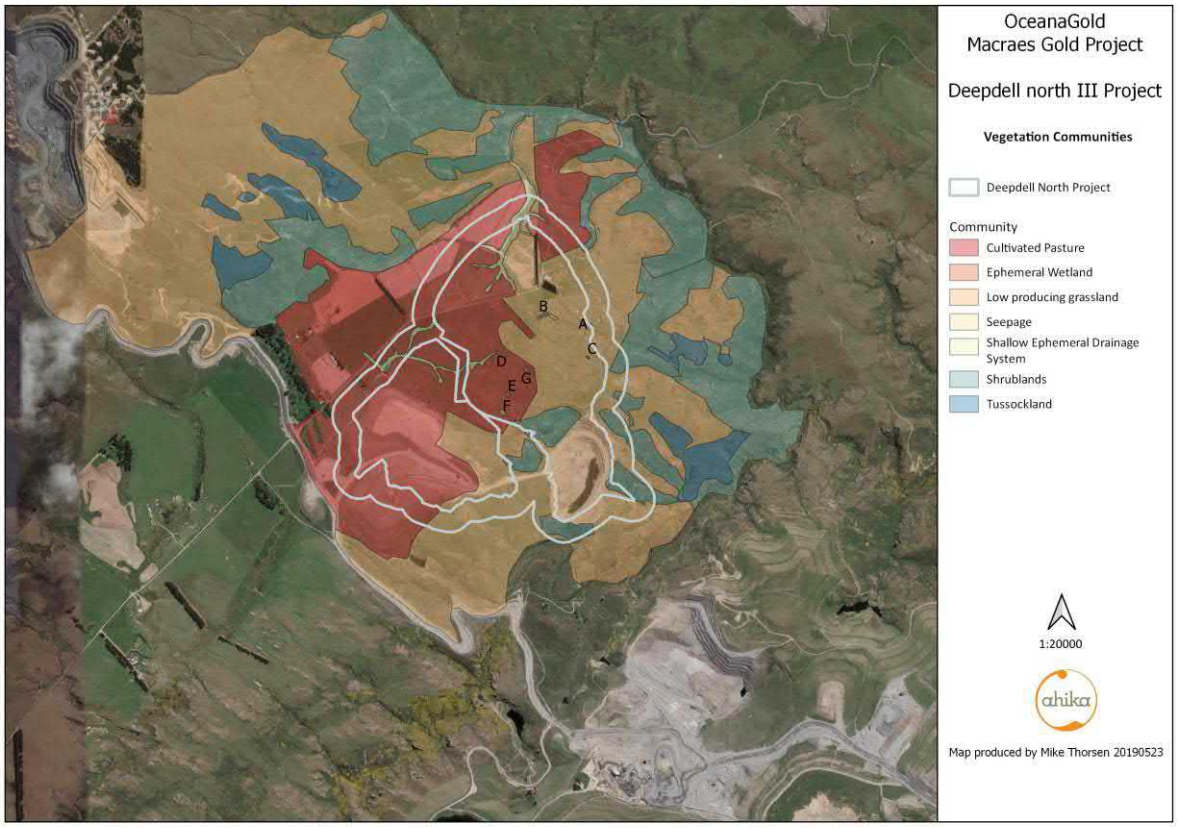

Figure 1. Vegetation communities within the PIA. The seven ephemeral wetlands are labelled A-G.

Vegetation Community	Pit	WRS	Buffer	PIA	Area within	Estimated % loss from E.D.

					Macraes E.D.[1]	
Exotic vegetation communities	*29.16*	*25.46*	*26.47*	*81.1*		
Cultivated Pasture	29.16	24.93	26.39	80.49	79635.17	0.10
Shelterbelts & Exotic Trees		0.53	0.08	0.61	4607.59	0.01
Semi-natural vegetation communities	*9.34*	*45.4*	*33.99*	*88.71*		
Ephemeral Wetland		0.30	0.02	0.31	30.73[2]	<1.01
Low producing grassland	8.76	39.47	24.82	73.04	11957.08	0.61
Seepage		0.07		0.07	43.23[3]	0.16
Shallow Ephemeral Drainage System	0.50	1.91	1.79	4.20	?	?
Shrublands	0.08	3.65	7.36	11.09	3547.15	0.31
Total	**38.49**	**70.85**	**60.46**	**169.81**	**99820.95**	**0.17**

Table 1. Extent of vegetation types in area where loss is expected to be total (within the pit and WRS boundaries) and area where there may be some impact from project activities (area within 100 m buffer).

4.2.1 *Ephemeral wetlands*

The seven ephemeral wetlands cover 0.02 ha within the buffer zone and 0.30 ha within the WRS zone of the PIA. All are of the type which forms on schist pans in some areas of Central Otago and are dominated by exotic grasses with scattered representation by indigenous species including clumps of indigenous rushes, herbs and a fern relative. The coverage and diversity of indigenous species in the sites varies from 1-5 species and at least two are thought to be functionally almost completely transformed into an exotic species-based wetland. The Declining herb *Lobelia ionantha* and Locally Uncommon sedge *Carex resectans* is present in one site.

The result of project effects will be a loss of 0.32 ha of this vegetation community from 7 sites. The extent of this vegetation community in the Otago region is unknown, but mapping of this community in the Macraes E.D. identified at least 1,360 ephemeral wetlands covering 162.39 ha (and at least a further 218 possible examples) mostly in the southern and western parts of the ecological district. The ecological integrity of the ephemeral wetlands in this area is unknown, but nearly all are dominated by exotic grasses and the majority have only 1-4 indigenous species present. Ephemeral wetlands are known habitat for a number of rare plants, but these

[1] As mapped in Landcover Database 4.1 from 2012 satellite imagery,

[2] Based from incomplete mapping

[3] Based on results from Landcare map of vegetation of Macraes E.D.

are present only in a few of the sites and seem to be lost from sites following invasion by sward farming grasses. They may be particularly at risk of this if grazing is also removed. Therefore, it is considered that the impact of this project on ephemeral wetlands of this type will result in an approximately 0.2% reduction in extent of the vegetation community in the Macraes E.D. and about a 0.5% reduction in the number of sites within the Macraes E.D. The loss in the PIA being represented by sites with mostly moderate indigenous plant component and including some rare plant species.

4.2.2 *Seepage wetlands*

A seepage wetland occurs over 0.07 ha at one site within the WRS zone. This community is visually dominated by the Declining indigenous rush *Juncus distegus* and lower-growing exotic grasses and rushes.

The result of project effects will be a loss of 0.07 ha of this vegetation community at 1 site. The extent of this vegetation community in the Otago region is unknown. Wetlands (of which seepage wetlands are a subclass) are mapped by Manaaki Whenua as covering 43.23 ha in the Macraes E.D., though the accuracy of this map is yet to be evaluated. The extent of the seepage wetland in the PIA represents 0.16% of the mapped wetlands in the Macraes E.D. The example in the PIA is highly degraded but is dominated by one At Risk indigenous rush. This vegetation community is a Historically Rare and Threatened plant community.

4.2.3 *Seasonal gully drainage*

The shallowly-incised, flat-bottomed gullies on the road-side terrace are not ephemeral wetlands in the normal sense in that they are connected to the normal gully drainage system, but as they are shallow and of limited water catchment they frequently dry over much of the summer. They cover 4.20 ha within the PIA, and are dominated by exotic grasses, rushes and sedges, and have frequent pukio *Carex secta* pedestals.

The result of project effects will be a reduction by 2.41 ha of this vegetation community in the extent of this community and minor changes to the 1.79 ha in the buffer area. The extent of this community locally or nationally is not known, and therefore the consequence of this reduction in area is difficult to assess. However, this vegetation community in the PIA is heavily modified by exotic species.

4.2.4 *Low-producing grassland*

This predominantly exotic vegetation community, produced by oversowing and top-dressing recently burned tussockland, covers 73.04 ha over much of the PIA. The main species present are exotic grasses and herbs with scattered individuals and areas of short tussock *and* low matagouri and *Coprosma propinqua* shrubs and scattered indigenous herbs and grasses.

The result of project effects will be a reduction by 48.23 ha in the extent of this community and minor changes to the 24.82 ha in the buffer area. This vegetation community has been mapped from satellite photography as covering 11,957 ha in the Macraes E.D., and the area within the PIA represents 0.6% of this extent. Between 2008 and 2012, low-producing grassland coverage decreased by 80% in the Macraes E.D. and this loss appears to be continuing with ongoing conversion to high-producing exotic pasture and reversion to exotic or indigenous shrubland.

4.2.5 *Shrubland*

Areas of shrubland occur as scattered patches over 11.09 ha of the PIA, mainly in the WRS and Buffer areas. The main species present are abundant matagouri, *Coprosma propinqua,* with scattered *Rubus schmidelioides* subsp. *subpauperatus* and *Muehlenbeckia complexa* and a few individuals of the Declining grass *Anthosachne falcis*, coral broom and desert broom, and the Locally Uncommon *Melicope simplex* and *Myrsine divaricata*. Much of the shrublands are of very short stature (to 1.5 m canopy height) with low shrub species diversity interspersed with low-producing exotic grassland tending towards scattered narrow-leaved tussock on slopes above Deepdell Creek.

The result of project effects will be a reduction by 3.73 ha in the extent of this community and minor changes to the 7.36 ha in the buffer area. This vegetation community has been mapped from satellite photography as covering 3,547 ha in the Macraes E.D., and the area within the PIA represents 0.3% of this extent. Between 2008 and 2012, shrubland coverage increased by 0.7% in the Macraes E.D. This vegetation community is well-known as being seral and quickly invading farmland in the Macraes E.D., unless prevented from doing so. The extent of this type of vegetation community is probably greatly affected by farming profitability (especially funds available for vegetation control) and extent decreases when farm profitability is high and large areas of low-diversity and low stature shrublands develop when farm profitability is low.

4.2.6 *Cultivated pasture and shelter belts*

Exotic pasture (including shelter belts) has been induced over 86.5 ha throughout much of the PIA through ploughing and oversowing on the flatter areas. Exotic pastures are comprised exclusively of exotic grasses and herbs. Shelter belts, comprised of macrocarpa and pines cover 0.61 ha, mainly within the WRS area. These vegetation communities are not known to harbour any indigenous plant species but do provide habitat for some common exotic bird species and the cultivated pasture may be used for foraging by indigenous harrier hawks, paradise shelduck, black-backed gull and spur-winged plover.

The result of project effects will be a reduction by 54.09 ha in the extent of this exotic vegetation community and minor changes to the 26.39 ha in the buffer area. This vegetation community provides habitat for some common exotic and indigenous bird species. This vegetation community has been mapped from satellite photography as covering 79,635 ha in the Macraes E.D., and the area within the PIA represents 0.1% of this extent. Between 2008 and 2012, cultivated pasture coverage increased by 166% in the Macraes E.D.

4.2.7 *Notable vegetation communities or sites*

Three Level IV LENZ categories are present in the PIA (Table 2, Figure 2), all of which are currently classified as Threatened Land Environments[4] that have less than ≤20% remaining in indigenous cover: the Acutely Threatened L1.3a and N3.1e, and the Chronically Threatened Q4.3b and some areas of which have indigenous vegetation cover (Table 3).

LENZ	Deepdell North III Buffer	Deepdell North III Pit	Deepdell North III WRS	Total
Acutely Threatened	**44.7**	**37.5**	**59.6**	**141.9**
L1.3a	28.6	24.4	35.3	88.3
N3.1e	16.1	13.1	24.3	53.5
Chronically Threatened	**15.8**	**1.0**	**11.2**	**28.0**
Q4.3b	15.8	1.0	11.2	28.0
Total	**60.5**	**38.5**	**70.9**	**169.9**

[4] Ministry for Environment and Department of Conservation 2007, Walker et al. 2007, 2008.

Table 2. Areas of Level IV LENZ categories within the PIA.

Plant community	L1.3a	N3.1e	Q4.3b	Total
Ephemeral Wetland	0.1	0.2		0.3
Low-producing grassland	17.7	32.5	22.9	73.0
Seepage	0.1			0.1
Seasonal Gully Drainage	4.2			4.2
Shrublands	0.0	6.0	5.1	11.1
Total	22.1	38.7	27.9	88.7

Table 3. Extent of natural vegetation in the PIA occurring on mapped extent of LENZ classified as having less than 20% of their national area being covered by indigenous vegetation.

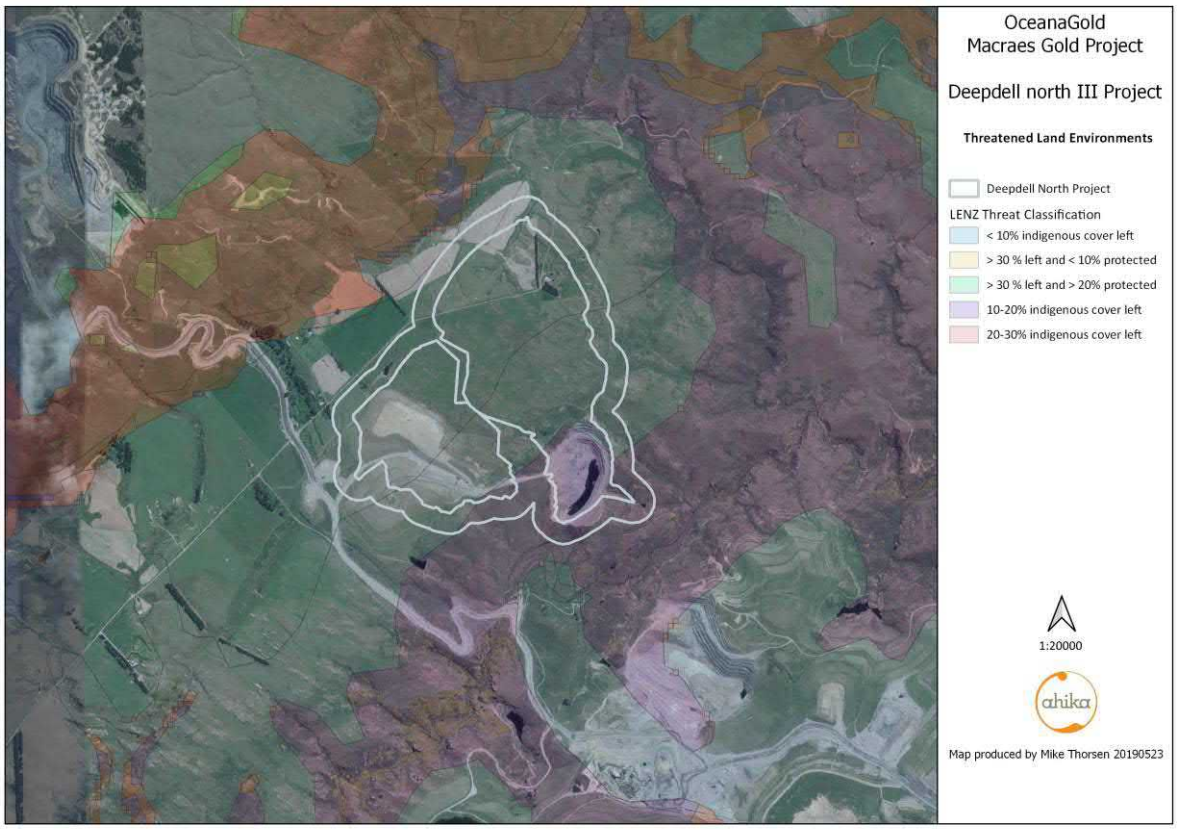

Figure 2. LENZ classification of the PIA at Level IV.

The PIA includes two vegetation communities that are a National Priority for Protection[5]: the ephemeral wetlands and the seepage wetland.

The PIA includes two wetland vegetation communities that are Naturally Uncommon[6] (= Historically Rare): the ephemeral wetlands and the seepage wetland. Both are Threatened ecosystems[7]: the ephemeral wetlands are Critically Endangered and the seepage wetland is Endangered.

4.3 Impact on birds

Twenty bird species were recorded from within the PIA, nine of which are indigenous: grey teal, black-backed gull, pipit, harrier hawk, grey warbler, paradise shelduck, welcome swallow, kereru, and spur-winged plover, and eleven of which are exotic: blackbird, skylark, goldfinch, starling, yellowhammer, chaffinch, redpoll, house sparrow, magpie, mallard, and song thrush.

Of the indigenous birds, a pair of pipit was observed on the existing recently revegetated Deepdell WRS and are assumed to be breeding there. One harrier hawk was seen on most visits to the site. It is assumed that they regularly use the area for hunting and feeding but are unlikely to be breeding there. A pair of grey warbler was seen in the WRS zone near the existing Deepdell North pit. It is assumed that there are likely to be other birds present and they are breeding in some of the more intact shrubland areas. Six paradise shelduck were observed in the WRS zone. A flock of 6 grey teal were observed on the farm pond in the Pit zone and it is assumed they are using this site for feeding, though they may be nesting in the willows outside of the PIA. A group of welcome swallow were also observed feeding over this pond and may be nesting in nearby buildings or rock overhangs. Welcome swallows are probably migrant into the area for breeding over the summer months. Spur-winged plover were vocally conspicuous in the Pit and WRS zones (particularly in the latter). It is estimated that several pairs were present, and it is likely that they breed there. A colony of black-backed gulls is breeding adjacent to the existing Deepdell South pit lake: 45 adults and 15 juveniles were present on the 7 April visit and they are foraging in the surrounding farmland. A single kereru was seen flying 150 m overhead. It is not thought that this species is using this area and is excluded from further consideration. No falcon have been seen or heard during the Deepdell North III or Coronation surveys, though

[5] Ministry for Environment and Department of Conservation 2007

[6] Ministry for Environment and Department of Conservation 2007, Williams et al. 2007

[7] Holdaway et al. 2012.

they are known from further afield in this area. It is possible the species uses this area occasionally for hunting.

Of the exotic birds, blackbird, song thrush and house sparrow are present in gullies in the shrubland and are nesting in these areas or the nearby derelict buildings. Skylark, goldfinch, yellowhammer, starling magpie and redpoll are scattered throughout the PIA in areas of open vegetation. Mallards are using the farm pond for feeding and probably nesting.

The result of project effects will be the displacement of bird individuals from within the PIA, with a temporary increase in competition with neighbouring resident birds leading to the mortality of some individuals. Longer term there is likely to be avoidance of the area by harrier hawks and paradise shelduck. Disruption to the black-billed gull colony is thought to be temporary as they are nesting in an artificial habitat, which will be re-created in the Deepdell North III pit. The overall result of these effects is some disruption of local bird populations, most of which are common on a national scale, and the displacement of a pair of At Risk pipit which are inhabiting an artificial habitat.

4.4 Impact on reptiles

Four reptile species were recorded in the PIA: the skinks *Oligosoma maccanni* (clade 4 genotype)*, Oligosoma polychroma* (clade 5 genotype) and *Oligosoma inconspicuum* and the gecko *Woodworthia* “Otago/Southland large”. Densities of all species are low with 0.6 individuals sighted per kilometre/1.2 individuals sighted per hour of search effort. All except the McCann’s skink are considered to be represented by small populations within the PIA when compared with those known at other nearby sites. This appears to be a result of the lack of high-quality habitat. The McCann’s skink *O. maccanni* (clade 4 genotype) is present in low to moderate numbers throughout the shrubland vegetation community and is commoner in rocky sites and areas with good cover in the WRS zone. The total population of this species within the PIA is estimated at 150 individuals based on encounter rate and quantity of habitat present.

The result of project effects will be the death of an estimated 185 reptile individuals from within the project area and some short-term disruption to reptile populations in the area immediately surrounding the project. As the populations within the PIA of these lizards are relatively small (for the area), it is assessed that the project will have a moderate effect on local lizard populations. As the lizard species concerned are widespread and often numerous, the project is considered to have a minor impact on lizard populations at a national scale.

4.5 Impact on Invertebrates

Sixty-eight invertebrate species were recorded in or near the PIA. The invertebrate community identified to date is mainly a mix of exotic and indigenous species that inhabit pasture, shrublands, low producing grassland, gullies and rock outcrops. The invertebrate diversity in the groups sampled is moderate as the number of species observed is 84% of the 81 species recorded for the Taieri Ridge area. However, only 7 species are shared between these lists. This result is likely because of a paucity of invertebrate survey in this area, rather than a real difference in community between sites.

The invertebrate communities (both exotic and indigenous) are likely to be playing a very important role in their ecosystems through pollination, as disease vectors, competition, herbivory, predation, litter decomposition, soil formation, and as a food source for fish, birds and reptiles. Some species (both exotic and indigenous) are likely to be serious pasture pests. None of the invertebrate species identified to date from within the PIA is currently classified as Threatened, At Risk or rare. However, the ephemeral wetlands could harbour distinctive invertebrate communities.

The result of project effects will be the loss of invertebrate communities within the project area and some disruption to some species in the wider PIA. As most the invertebrate species concerned are widespread and often numerous, the project is considered to have a minor impact on invertebrate communities at a national scale.

4.6 Threatened, At Risk, or rare species

4.6.1 *Plants*

Thirteen plant species that occur within the PIA are either currently classified as At Risk (10 species), or are thought to be rare in the Macraes E.D. (3 species) (Figure 3).

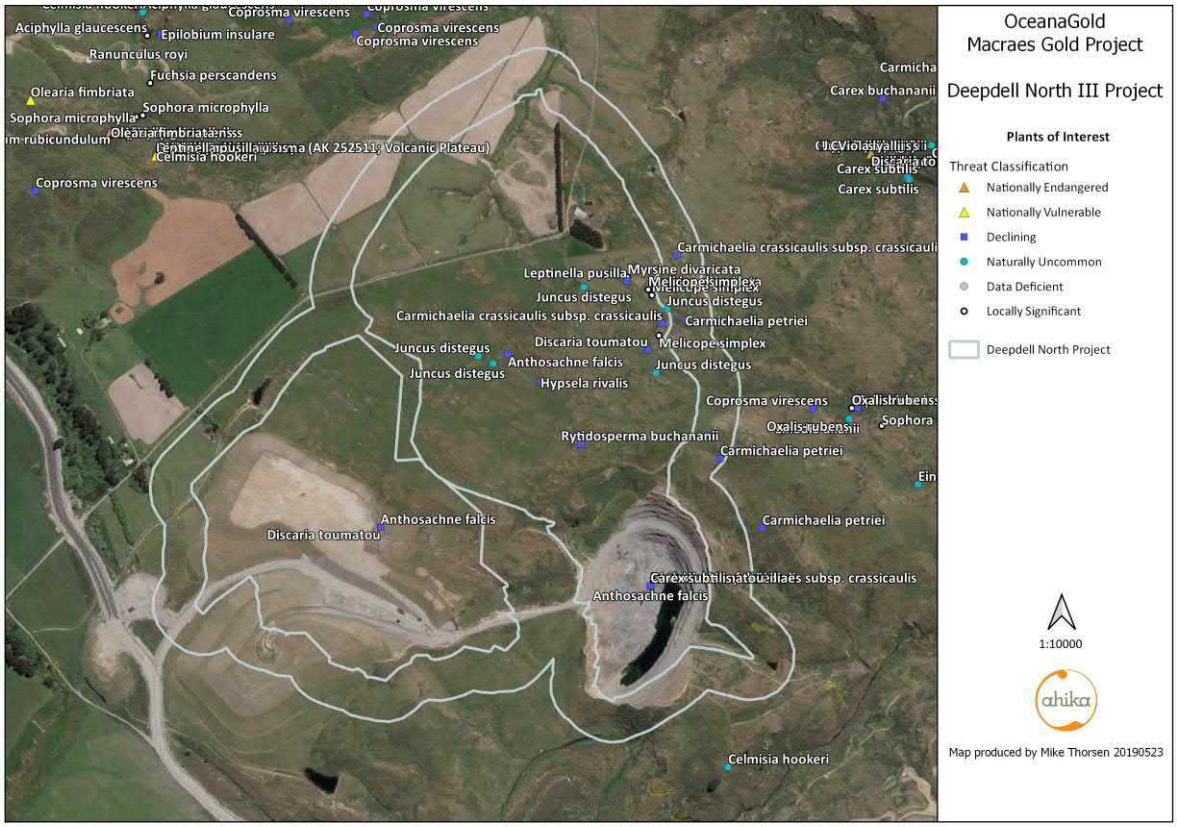

Figure 3. Locations where Threatened, At Risk and other plant species of interest (Data Deficient, rare plants) have been recorded within the PIA.

4.6.1.1 *Anthosachne falcis (Connor) Barkworth et S.W.L.Jacobs (dwarf wheatgrass, Poaceae) - Declining.*

This dryland grass was recorded as scattered plants inhabiting shrubland in the Pit and mainly in the WRS zones and it is estimated that approximately 100 plants could occur in the PIA.

The result of project effects will be the loss of the species from the PIA and some potential impact on plants in the buffer area. As this species is widely and patchily distributed within natural sites in the Macraes area, and is known to occur at multiple locations in the eastern South Island, including many in protected areas throughout its range, the loss of individuals from the PIA is unlikely to majorly impact the longer-term security of the species locally or nationally.

4.6.1.2 *Carmichaelia crassicaulis Hook.f. subsp. crassicaulis (coral broom, Fabaceae) - Declining.*

Three plants of this thick-stemmed broom were recorded at one site in the Pit (one grazed plant) and at one site in the WRS (2 heavily grazed plants). A group of 15 heavily grazed plants and a single nearby plant are present in the Buffer area.

The result of project effects will be the loss of 2 individuals of the species from one site. This would have very little impact on local population dynamics by removing most of the plants in an area where there are few other nearby plants. The impact on the species at a national scale is estimated to result in a negligible reduction in the total population.

4.6.1.3 *Carmichaelia petriei Petrie (desert broom, Fabaceae) - Declining.*

This leafless broom was recorded at several sites in both the Pit and WRS zones where several plants are present.

The result of project effects will be the loss of 2 individuals of this species from within the project area. As this species is widely and patchily distributed within natural sites in the Macraes area, and is known to occur at multiple locations in the eastern South Island, including many in protected areas throughout its range, the loss of individuals from the PIA is unlikely to majorly impact the longer-term security of the species locally or nationally.

4.6.1.4 *Discaria toumatou Petrie (matagouri, Rhamnaceae) - Declining.*

Matagouri was recorded at multiple sites and in considerable numbers in the Pit and WRS zones. Matagouri is a new addition to the threatened plant list and is classified as Declining, with no qualifiers, on the basis that the total population is estimated to exceed 100,000 mature individuals with a predicted decline of 10–70% (Townsend et al. 2007, de Lange et al. 2018). In this assessment, the panel did not consider that the species is known to rapidly expand its range in many parts of the South Island unless physically prevented from doing so. Previously it was not assessed as of conservation significance in 1976 or to 2013 (Given 1976, Given 1986, de Lange et al. 1999, de Lange et al. 2004, de Lange et al. 2009, de Lange et al. 2013).

The result of project effects will be the loss of the species from within the project area. As this species is abundant and widely distributed within natural sites in the Macraes area, and is known to occur over very large areas at multiple locations in the eastern South Island,

including many in protected areas throughout its range, the loss of individuals from the PIA is unlikely to impact the longer-term security of the species locally or nationally.

4.6.1.5 *Leptinella pusilla Hook.f. (a button daisy, Asteraceae) - Declining.*

This creeping button daisy was recorded at one site in the WRS where one patch is present.

The result of project effects will be the loss of the species from one site within the PIA. This will cause some loss from the local area. The impact on the species at a local or national scale is difficult to assess, as the distribution of this species is poorly known. It is widely but sparsely distributed and the mechanism of interbreeding between such widely spaced populations is not known. It appears to flourish in grazed situations. Overall, the loss of the one site in the PIA is unlikely to majorly impact the longer-term security of the species locally or nationally.

4.6.1.6 *Lobelia ionantha Heenan (a wetland herb, Campanulaceae) - Declining.*

This creeping wetland herb was recorded at one site in the ephemeral wetland G in the WRS where several patches totalling an estimated 0.56m^2 are present.

The result of project effects will be the loss of the species from one site within the PIA. This will cause some loss from the local area. The impact on the species at a local or national scale is difficult to assess, as the distribution of this species is poorly known. It is widely but sparsely distributed. It appears to flourish in grazed wetland situations. Overall, the loss of the one site in the PIA is unlikely to majorly impact the longer-term security of the species locally or nationally.

4.6.1.7 *Rytidosperma buchananii (Hook.f.) Connor & Edgar (a dryland bristlegrass, Poaceae) - Declining.*

This grass was recorded at one site in the WRS where one plant is present on a rock stack in the WRS.

The result of project effects will be the loss of one individual of the species from one site within the PIA. This will cause some loss from the local area. The impact on the species at a local or national scale is difficult to assess, as the distribution of this species is poorly known. Overall, the loss of the one site in the PIA is unlikely to majorly impact the longer-term security of the species locally or nationally.

4.6.1.8 *Carex subtilis K.A.Ford (elegant hookgrass, Cyperaceae) – Naturally Uncommon.*

This small sedge was recorded at one site in the WRS zone.

The result of project effects will be the loss of the species from one site. There is some risk of a reduction in the longer-term viability of the species in a local context as this species occurs as widely separated groups.

4.6.1.9 *Juncus distegus Edgar (Two-storey rush, Juncaceae) – Naturally Uncommon.*

This rush was recorded in various numbers bordering the ephemeral wetlands and is the dominant larger plant species in the seepage wetland in the WRS where there are patches covering an estimated 369 m^2 with an additional scattered 56 individuals.

The result of project effects will be the loss of the species from within the WRS. This will cause some loss from the local area. The impact on the species at a local or national scale is difficult to assess, as the distribution of this species is poorly known. It is widely but sparsely distributed. It is considered that the loss will have some impact on local population dynamics, but this is very unlikely to majorly impact the longer-term security of the species locally or nationally.

4.6.1.10 *Juncus pusillus Buchenau (dwarf rush, Juncaceae) – Naturally Uncommon.*

This tiny rush was recorded as two 5 x 5 cm patches in ephemeral wetland A.

The result of project effects will be the loss of the species from within the PIA. This will cause some loss from the local area. The impact on the species at a local or national scale is difficult to assess, as the distribution of this species is poorly known. It is widely but sparsely distributed. It is considered that the loss is very unlikely to majorly impact the longer-term security of the species locally or nationally.

4.6.1.11 *Carex resectans Cheeseman (desert sedge, Cyperaceae) – Naturally Uncommon.*

This small creeping sedge was recorded as three patches totalling 40 x 40 cm in ephemeral wetland G.

The result of project effects will be the loss of the species from within the PIA. This will cause some loss from the local area. The impact on the species at a local or national scale is difficult to assess, as the distribution of this species is poorly known. It is widely but sparsely distributed. It is considered that the loss may have some impact on local plant population

dynamics by reducing the number of populations in the area, but the effect is very unlikely to majorly impact the longer-term security of the species nationally.

4.6.1.12 *Melicope simplex A.Cunn. (poataniwha, Rutaceae) – Naturally Uncommon.*

This shrub was recorded as 11 individuals in one group of rock outcrops in the WRS.

The result of project effects will be the loss of the species from within the PIA. This will cause some loss from the local area. As this species is widespread outside of Central Otago and there are very large populations at some sites, the loss of these individuals is very unlikely to majorly impact the longer-term security of the species nationally.

4.6.1.13 *Myrsine divaricata A.Cunn. (weeping matipo/mapou, Primulaceae) – Naturally Uncommon.*

This shrub was recorded as 2 individuals in one group of rock outcrops in the WRS.

The result of project effects will be the loss of the species from within the PIA. This will cause some loss from the local area. As this species is widespread outside of Central Otago and there are very large populations at some sites, the loss of these individuals is very unlikely to majorly impact the longer-term security of the species nationally.

4.6.2 *Birds*

One of the nine indigenous bird species is classified as At Risk.

4.6.2.1 *Anthus novaeseelandiae Gmelin subsp. novaeseelandiae (pipit, Motacillidae) - Declining.*

Pipits are present within the Pit zone, where it is estimated that there a single pair of birds. Their presence in an artificially created habitat may be an indication of this species' adaptability to novel environments.

The result of project effects will be the loss of the species from the site. This may cause some negligible effect on the Macraes pipit population as the relocating birds may interact with resident birds with the most likely outcome being that the newcomers will be excluded from the resident bird's area. The fate of the displaced pair is unknowable, but it is thought that the project effects are unlikely to cause mortality of the pair as they have shown an ability to utilise an artificial habitat (grassed rock mounds) of which there is plenty in the surrounding area. There

may be a temporary reduction in breeding output if displacement is to occur over the breeding season, but this loss of a breeding season for a single pair is not considered significant to the local population. Overall, there is considered very little risk to the conservation status of this species as it is widely (though sparsely) distributed through rough grasslands of Central Otago and beyond.

4.6.3 *Reptiles*

Three of the reptile species are currently classified as At Risk: the skinks *Oligosoma polychroma* (clade 5 genotype) and *Oligosoma inconspicuum* and the gecko *Woodworthia* "Otago/Southland large".

4.6.3.1 *Oligosoma polychroma (Patterson & Daugherty 1990) (clade 5 genotype) (southern grass skink, Scincidae) - Declining.*

Within the PIA this species has a local distribution mainly in well-vegetated sites and it is estimated based on encounter rate that there are 5 individuals within the PIA.

The result of project effects will be the loss of the species from the site and displacement of some individuals into surround areas in the buffer. This may cause some negligible effect on the Macraes population as the displaced animals will cause some short-term disruption to reptile populations in the buffer area resulting in mortality of the displaced or resident animals equivalent to the number of displaced animals. As the populations within the PIA of this species are relatively small (for the area), it is assessed that the project will have a moderate effect on the local populations.

4.6.3.2 *Oligosoma inconspicuum (Patterson & Daugherty 1990) (cryptic skink, Scincidae) - Declining.*

Within the PIA this species has a very local distribution and was possibly seen at one site and it is estimated that there are very few individuals (if any).

The result of project effects will be the possible loss of a very small number of individuals of this species from the site and possible displacement of some individuals into surround areas in the buffer. This may cause some negligible effect on the Macraes population as the displaced animals may cause some short-term disruption to reptile populations in the buffer area resulting in mortality of the displaced or resident animals equivalent to the number of displaced animals. However, populations of this species are often widely separated, and it is

unlikely that the displaced animals will encounter a resident population. As the populations within the PIA of this species are relatively small (for the area), it is assessed that the project will have a minor effect on the local populations.

4.6.3.3 *Woodworthia "Otago/Southland large" (korero gecko, Gekkonidae) - Declining.*

Within the PIA this species has a local distribution mainly in near larger rock outcrops and are also likely to be present in some of the smaller rock outcrops that are scattered through the steeper areas of the PIA. The total population within the PIA is estimated at 30 individuals based on encounter rate and quantity of habitat present.

The result of project effects will be the loss of an estimated 30 individuals of this species from the site and displacement of some individuals into surround areas in the buffer. This may cause some negligible effect on the Macraes population as the displaced animals may cause some short-term disruption to reptile populations in the buffer area resulting in mortality of the displaced or resident animals equivalent to the number of displaced animals. As the populations within the PIA of this species are relatively small (for the area), it is assessed that the project will have a moderate effect on the local populations.

4.7 Summary of Project Impacts

Ecological Feature Class	Ecological Feature Type	Ecological Feature	Classification of Feature	Buffer	Pit	WRS	PIA	Unit of Measurement	Accuracy of measurement	Ecological Importance of Feature	Magnitude of Project Impact on Feature		Overall Project Effect	Assessment Confidence
											Local Scale	National Scale		
Bird	Community	Ecological function								Moderate	Moderate	Negligible	Very Low	Moderate-Low
Bird	Species	Pipit	Declining				2	individuals	Counted	Moderate	Low	Negligible	Very Low	Moderate-Low
Bird	Species	Black-backed gull					45	individuals	Counted	Low	Moderate	Negligible	Very Low	
Bird	Species	Grey teal					6	individuals	Counted	Low	Moderate	Negligible	Very Low	
Bird	Species	Grey warbler					10	individuals	Estimated	Low	Moderate	Negligible	Very Low	
Bird	Species	Harrier hawk					1	individuals	Counted	Low	Moderate	Negligible	Very Low	
Bird	Species	Paradise shelduck					6	individuals	Counted	Low	Moderate	Negligible	Very Low	
Bird	Species	Spur-winged plover					8	individuals	Estimated	Low	Moderate	Negligible	Very Low	
Bird	Species	Welcome swallow					5	individuals	Estimated	Low	Moderate	Negligible	Very Low	
Environment	LENZ	< 10% indigenous cover left	Cultivated Pasture	26.39	29.16	24.93	80.49	Hectares	Measured					
Environment	LENZ	< 10% indigenous cover left	Ephemeral Wetland	0.02		0.3	0.31	Hectares	Measured					
Environment	LENZ	< 10% indigenous cover left	Low producing grassland	13.24	7.8	29.11	50.15	Hectares	Measured					
Environment	LENZ	< 10% indigenous cover left	Seasonal gully drainage	1.79	0.5	1.91	4.2	Hectares	Measured					
Environment	LENZ	< 10% indigenous cover left	Seepage			0.07	0.07	Hectares	Measured					
Environment	LENZ	< 10% indigenous cover left	Shelterbelts & Exotic Trees	0.08		0.53	0.61	Hectares	Measured					
Environment	LENZ	< 10% indigenous cover left	Shrublands	3.17	0.08	2.79	6.04	Hectares	Measured					
Flora	Community	Ephemeral Wetland	Critically Endangered Historically Uncommon ecosystem type	0.02		0.3	0.31	Hectares	Measured	High	High	Medium	High	Low-Moderate
Flora	Community	Seepage	Endangered Historically Uncommon ecosystem type			0.07	0.07	Hectares	Measured	High	Moderate	Low	Low	Low-Moderate

Flora	Community	Cultivated Pasture		26.39	29.16	24.93	80.49	Hectares	Measured	Negligible	Low	Negligible	Very Low	
Flora	Community	Low producing grassland		24.82	8.76	39.47	73.04	Hectares	Measured	Moderate	Moderate	Low	Low	Moderate-Low
Flora	Community	Seasonal gully drainage		1.79	0.5	1.91	4.2	Hectares	Measured	Low	Moderate	Low	Very Low	Low
Flora	Community	Shelterbelts & Exotic Trees		0.08		0.53	0.61	Hectares	Measured	Negligible	Low	Negligible	Very Low	Moderate-High
Flora	Community	Shrublands		7.36	0.08	3.65	11.09	Hectares	Measured	Moderate	Low	Negligible	Very Low	Moderate
Flora	Community	Ecosystem services								Minor				
Flora	Community	Historically Rare or Threatened Ecosystems				2	2	Communities		See Ephemeral Wetland and Seepage Wetland Flora Communities				
Flora	Community	Integrity								Moderate				
Flora	Community	National Priorities for Protection				2	2	Communities		See Ephemeral Wetland and Seepage Wetland Flora Communities				
Flora	Community	Rarity								High	Moderate	Medium	Medium	
Flora	Community	Representativeness								Moderate	Moderate	Medium	Medium	
Flora	Community	Sites recommended for protection					0	Sites		Nil				
Flora	Community	Wetlands of National Importance or Ramsar sites					0	Sites		Nil				
Flora	Species	Carmichaelia crassicaulis Hook.f. subsp. crassicaulis	Declining	15		2	17	individuals	Counted	High	Very Low	Negligible	Very Low	Moderate
Flora	Species	Carmichaelia petriei Kirk	Declining	10		7	17	individuals	Counted	High	Low	Negligible	Very Low	Moderate
Flora	Species	Discaria toumatou Raoul	Declining	7.36	0.08	3.65	3.73	Hectares	Estimated	High	Negligible	Negligible	Very Low	Moderate-High
Flora	Species	Leptinella pusilla Hook.f.	Declining			1	1	m^2	Estimated	High	Low	Negligible	Very Low	Moderate-Low
Flora	Species	Lobelia ionantha Heenan	Declining			0.561	0.561	m^2	Estimated	High	Moderate	Low	Low	Moderate-Low
Flora	Species	Rytidosperma buchananii (Hook.f.) Connor & Edgar	Declining			1	1	individuals	Counted	Low	Very Low	Negligible	Very Low	Moderate-Low
Flora	Species	Carex resectans Cheeseman	Locally Uncommon			1.6	1.6	m^2	Estimated	Moderate	Moderate	Low	Low	Moderate-Low
Flora	Species	Melicope simplex A.Cunn.	Locally Uncommon			11	11	individuals	Counted	Moderate	Moderate	Negligible	Very Low	Moderate
Flora	Species	Myrsine divaricata A.Cunn.	Locally Uncommon			2	2	individuals	Counted	Moderate	Moderate	Negligible	Very Low	Moderate

Flora	Species	Anthosachne falcis (Connor) Barkworth & S.W.L.Jacobs	Naturally Uncommon				100	individuals	Estimated	High	Moderate	Low	Low	Moderate
Flora	Species	Carex subtilis K.A.Ford	Naturally Uncommon			1	1	individuals	Counted	Moderate	Moderate	Negligible	Very Low	Moderate
Flora	Species	Juncus distegus Edgar	Naturally Uncommon			369	369	m^2	Estimated	Moderate	Moderate	Low	Low	Moderate-Low
Flora	Species	Juncus distegus Edgar	Naturally Uncommon			56	56	individuals	Estimated	Moderate	Moderate	Low	Low	Moderate-Low
Flora	Species	Juncus pusillus Buchenau	Naturally Uncommon			1	1	m^2	Estimated	Moderate	Moderate	Low	Very Low	Moderate-Low
Flora	Species	Diversity								Moderate	Moderate	Medium	Medium	
Invertebrates	Community	Overall importance								Moderate	Moderate	Low	Low	Low
Reptiles	Community	Overall importance								Moderate	Moderate	Low	Low	Moderate
Reptiles	Species	*Oligosoma inconspicuum*	Declining		1			individuals	Counted	High	Moderate	Negligible	Very Low	Moderate-Low
Reptiles	Species	*Oligosoma polychroma* (clade 5 genotype)	Declining				5	individuals	Estimated	High	Moderate	Negligible	Very Low	Moderate-Low
Reptiles	Species	*Woodworthia* "Otago/Southland large"	Declining				30	individuals	Estimated	High	Moderate	Low	Low	Moderate
Reptiles	Species	*Oligosoma maccanni* (clade 4 genotype)					150	individuals	Estimated	Moderate	Moderate	Low	Low	

Table 4. Summary table of project impacts on terrestrial ecological features assessed using the Environment Institute of Australia and New Zealand's 2018 Ecological Impact Assessment Guidelines. Rows shaded pink are effects that are significant under regional or district plan criteria.

5 Impact Management

5.1 Approach

The approach to impact management follow a Mitigation Hierarchy of first seek to avoid the impact, then remediate residual ecological effects[8], then mitigate residual ecological effects, then employ an offset to address as much of the remaining residual ecological effects as practicable, and finally compensate for the outstanding balance of the ecological effects. Moving to the next step in the hierarchy is only possible once the possibility of employing the higher-order option has been fully explored and documented and the residual ecological effects calculated. This approach is consistent with Policies 5.4.6 *Offsetting for indigenous biological diversity* and 5.4.8 *Adverse effects from mineral and petroleum exploration, extraction and processing* of the pORPS (and including Environment Court decision NZEnvC41 of 15 March 2019). For the purposes of giving effect to these policies "significant adverse effects" are considered those where the overall project effect is moderate or greater.

5.2 Summary of Impact Management Activities

OceanaGold's preferred approach to addressing the Deepdell North III project's impact on ecological features is to adopt a hierarchical management approach, as outlined below:

- avoid effects through siting of the WRS and isolating important areas;
- remedy effects through creation of new lizard habitat and a new pit lake;
- mitigate effects by employing Standard Operating Procedures and relocation of two plant species; and to (mainly)
- offset impacts through funded actions at two offset locations, one for ephemeral wetlands and supported by a research programme and the other in a high value mixed shrubland and tussockland area.

[8] Residual adverse ecological effects, are the remainder of a project's predicted impact on all of the ecological features within the PIA that would not be addressed once the actions under consideration for that mitigation option have been employed as designed.

5.2.1 *Avoidance of effects*

Four options for siting of the WRS were evaluated, and the option with the least impact over ecological, environmental and social considerations became the preferred option. WRS construction will be staged with initial deposition into the existing Deepdell Pit. This action avoids impacts on significant ecological features if the project is halted before completion.

Areas in the buffer area with higher ecological values will be isolated from unintended effects (such as vehicle movements) by clearly delineating in maps provided to mine operations staff and on the ground by using well-maintained flagging tape, temporary fencing and signage.

5.2.2 *Remediation of effects*

Constructing areas of the margins of the final WRS to provide habitat for lizards. This will provide benefit in 1) creating habitat that will be occupied by populations of the skinks *Oligosoma maccanni* (clade 4 genotype), *Oligosoma polychroma* (clade 5 genotype), and the Declining gecko *Woodworthia* "Otago large", 2) create a safer refuge for these lizard populations by decreasing the hunting efficiency of cats in these areas.

The rehabilitated Deepdell North III WRS is expected to produce replacement habitat of very similar nature to the impacted existing Deepdell WRS which is utilised by one pair of Declining pipits and Not Threatened spur-winged plover.

Likewise, the new pit lake in the Deepdell North III pit will produce replacement habitat similar to that occupied by the breeding colony of black-backed gulls in the existing Deepdell South pit.

5.2.3 *Mitigate effects*

Potential effects associated with dust, noise, disturbance, sediment runoff, weeds and fire risk will be appropriately minimised via the adherence to best practice and Standard Operating Procedures throughout the mining activities.

Relocating certain plant species that are of ecological importance to safe site(s) in an Ecological Enhancement Areas (EEA) (such as the nearby OceanaGold covenants) is also a key mitigation feature. This will be undertaken by a suitably experienced operator removing them (or propagating parts of them such as seeds or cuttings) following OceanaGold's Plant Propagation, Translocation and Management Procedure (updated to include the species listed below) and establishing them at EEA sites with existing suitable habitat. The plants will receive post-introduction care where necessary including watering and suppression of competing vegetation for two years. The success of moving these species will be monitored by counting number of

plants at the recipient site on an annual basis for three years. Relocation is proposed for the following species:

1. The Locally Uncommon shrub *Melicope simplex* from the eleven trees in the WRS to result in twenty individuals at one site in the nearby OceanaGold Highlay Creek Shrubland Covenant to create a new population there.
2. The Naturally Uncommon shrub *Myrsine divaricata* from the two individuals in the WRS to result in 10 individuals at one site in the nearby OceanaGold Highlay Creek Shrubland Covenant to create a new population adjacent to an existing population.

As there are forecast to be residual adverse effects of the project on the site's biodiversity after implementation of the Avoid, Remedy and Mitigate, an offset will be provided to address remaining significant residual adverse effects.

5.2.4 *Offset residual effects*

Creating a multi-outcome offset Ecological Enhancement Area (EEA) at a nearby site with similar or better ecological values and provide funds for the ecological management of this area is recommended. This offset will have several components: an averted loss multiuse offset in an EEA on Redbank Station (Redbank EEA) to address the project's impact on shrublands, low producing grasslands and the seepage wetland, and an ephemeral wetland enhancement offset and supporting research project at sites in another EEA in the south of the Ecological District (Ephemeral Wetland EEA) to address the impact on ephemeral wetlands. There are local constraints on how an offset can be realised in the Macraes situation and these have been considered in the design of the offset package. The disaggregated accounting model[9] was used to calculate the extent of works required within the EAAs to achieve a state of No Net Loss of biodiversity (NNL). The implementation and management of the EEA sites will be documented in an EEA Management Plan. The EEA's will also contain ecological features that are additional to those needed for addressing project effects. These additional features are considered to be a biobank.

[9] Maseyk, F.J.F; Barea, L.T; Stephens, R.T.T; Possingham, H.P; Dutson, G; Maron, M. 2016. A disaggregated biodiversity accounting model to improve estimation of ecological equivalency and no net loss. Biological Conservation 204: 322-332.

5.2.4.1 *Redbank EEA*

The Redbank EEA in the upper Waikouaiti River North Branch offset site (Figure 4) has been chosen on the basis of discussions with both landowners who identify it as a site of low farming usefulness and a site examination that shows the site has considerable ecological value in terms of fauna, vegetation communities and as habitat for rare species. This site is currently part of a farming environment and has no protections beyond that afforded by regional and district plans and therefore ongoing damage to some ecological features is expected and the site could be subject to extensive livestock grazing. Some of the ecological features in the EEA are restricted to areas where stock are not able to access.

Figure 4. Location of Redbank EEA.

A covenant of at least 126 ha will be established under the Conservation Act which contains biodiversity that is of similar character to that being lost, but of better quality and with other inherent ecological values. Sensitive parts of this covenanted area will be fenced to exclude stock and limits will be placed on the type of stocking that can occur in the covenanted area and

on any activities that could result in damage to the soils or to vegetation of high ecological importance. This land will be managed using the income from a fund held by OceanaGold until cessation of mining when the fund will be ceded to another authority.

Important components of this component of the offset are:

- Have a legal protection.
- Will be farmed as appropriate with the objective of protecting the important biodiversity features.
- Be of sufficient size to compensate for uncertainties in ecological outcomes associated with retaining farming in the covenant.
- Satisfy the offset criteria detailed in the pORPS.
- Will have a fund to support the management of the covenant on an ongoing basis.
- Will involve the farming community together with DOC and Councils in the offset design and placement.
- Will incorporate the Science and Traditional Knowledge offset principle by including farming community knowledge of biodiversity management in the Macraes Area.
- Will incorporate the Equity offset principle by sharing the risks and benefits between the farming community, DOC and Councils.
- Be managed with ecological oversight.
- Will result in a Biobank of additional ecological gains that will be used to address a future project's ecological impact.

This offset is currently under investigation to investigate its feasibility. This offset will also address the project's impact on the shrubland, seepage wetlands and low-producing grassland plant communities, as well as the Declining matagouri, desert broom *Carmichaelia petriei*, skinks *Oligosoma inconspicuum* and *Oligosoma polychroma*, gecko *Woodworthia* "Otago/Southland large", Naturally Uncommon grass *Anthosachne falcis*, some components of the invertebrate and bird communities and on McCann's skink through protecting areas inhabited by these species.

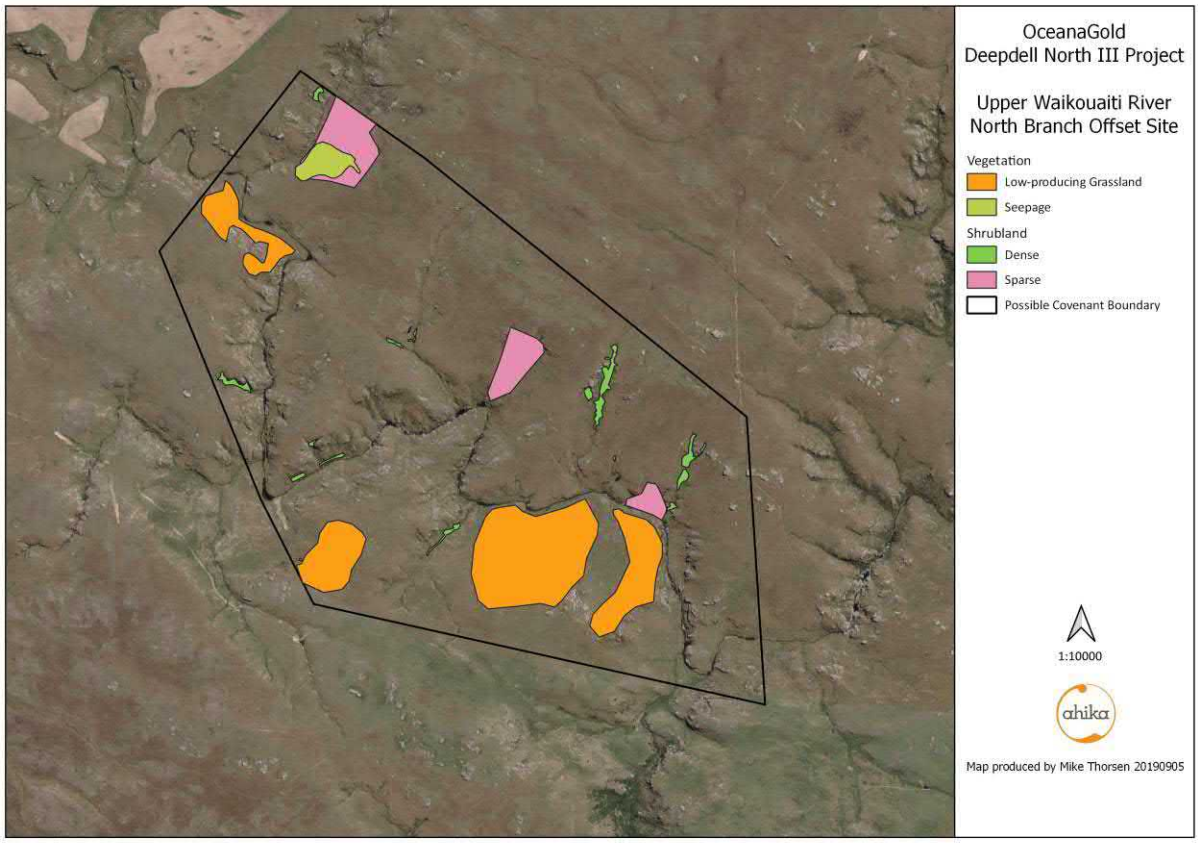

Figure 5. Location off plant community offset sites in Redbank EEA. Remainder of the area is narrow-leaved tussock grassland.

Shrubland Component

Offsetting the loss of an estimated 3.73 ha of shrubland from the Deepdell North III site will be through including 4.23 ha of an equivalent plant community of better ecological integrity. The offset site has a higher diversity of shrub species (22 species), than in the impacted shrubland (15 species), is ecologically more intact with fewer exotic species and a denser canopy, and is of a similar nature (though with some species that reflect a higher elevation and damper area). This component of the offset will involve planting of 5 ha of new shrubland in the EEA that is comprised of at least 18 shrub species and reaching 2 m in height and 75% canopy cover within 10 to 20 years, respectively, and keeping these free of exotic shrub species for 10 years. This produces a Net Present Biodiversity Value of 0.29 and should achieve NNL 20 years after implementation. This offset should also address impacts on the Declining matagouri, desert broom *Carmichaelia petriei*, skinks *Oligosoma inconspicuum* and *Oligosoma polychroma*, gecko *Woodworthia* "Otago/Southland large", Naturally Uncommon grass *Anthosachne falcis*,

some components of the invertebrate and bird communities and on McCann's skink through improving habitat for these species.

Seepage Wetland Component

Offsetting the impact resulting in the loss of 0.07 ha of seepage wetland will be through including the 0.82 ha of an equivalent plant community and managing this to better ecological integrity. This offset is considered to have the elements of both an averted loss offset and an improved condition offset. The averted loss component of the offset is difficult to calculate as there is no available data on loss of these ecosystems in the area, but there have been high reported loss of wetlands from Southland and they are classified as Endangered based on their estimated rate of decline caused by weed invasion over ≥70% of their extent nationally. This offset component will involve using weed control to achieve a 20% improvement in indigenous species dominance within the 0.82 ha seepage wetland at the offset site by 10 years. This produces a Net Present Biodiversity Value of 0.01, but additional to NNL are the gains considered to have been achieved through the averted loss portion of the offset. Protecting this seepage wetland against the background of 70% loss (over an estimated 30 years) would increase the Present Biodiversity Value by c. 70% to 0.017. The impact on the Naturally Uncommon rush *Juncus distegus* will also be addressed through this offset by creating conditions in which this species can flourish, supplemented by planting of 50 individuals.

Low-producing grassland Component

Offsetting the impact resulting in the loss of an estimated 49.47 ha of low producing grassland will be through including 24.55 ha of an equivalent plant community and managing this to better ecological integrity. This offset is considered to be an averted loss offset as this vegetation community decreased in the Macraes E.D. by 79.3% between 2008 and 2012[10]. It is likely this rate of loss is continuing. Based on this rate of loss, NNL will have been achieved within 5 years of protection of the habitat. This offset would be realised on establishment of the covenant with appropriate safeguards against invasion of the habitat by woody weed species and changes to land management (particularly guarding against soil disturbance). The impact on the Declining grass *Anthosachne falcis* (will also be addressed through this offset by creating conditions in which this species can flourish.

[10] Based on change in the NZ Land Cover Database

5.2.5 *Ephemeral wetland EEA*

Offsetting the impact resulting in the loss of 0.81 ha of ephemeral wetlands will be an improved-condition offset with the improvement work informed by a research project investigating ephemeral wetland form, function and threats. This offset will involve using weed control to produce a 25% improvement in indigenous vegetation cover at ephemeral wetlands at 5-7 sites totalling at least 2 ha and an improvement in indigenous plant indigenous plant diversity to at least 11 indigenous plant species characteristic of Macraes ephemeral wetlands by 10 years. This produces a Net Present Biodiversity Value of 0.31 and NNL is achieved by year 10. The 2 ha target of managed ephemeral wetland is double the 1 ha required to reach NNL, but compensates for current uncertainties in ecological state of these systems and lack of proven management tools. These figures are also based on the associated research project addressing deficiencies in knowledge on the form, function, threats and management of ephemeral wetlands. This research project will establish the physical profiles and subsurface nature of 10 selected ephemeral wetlands, documenting their hydrological profile over time and measuring changes in their plant communities 3-4 times a year over 5 years. The threat that ephemeral wetlands face will be established by revisiting 20 previously surveyed sites and documenting their current condition, quantifying surrounding land use of all mapped ephemeral wetlands and visiting a random selection of 50 ephemeral wetlands to describe their current condition. The impact on the Declining wetland herb *Lobelia ionantha* and Locally Uncommon sedge *Carex resectans* will also be addressed through including these species as two of the 11 species.

5.2.6 *EEA Management Plans*

The implementation and management of each of the EEA's will be documented in a management plan (EEAMP). The EEAMP will form a part of a broader project Ecological Management Plan (which will include on-site works to avoid, remedy, and mitigate adverse effects).

The EEAMP will include:

- a description of the offset, the calculation basis, locations and management activities at which enhancements will be generated;
- securing the ability to undertake enhancement works within management sites by way of landowner agreements (e.g. covenants) or acquisitions;
- the technical detail of the offset works;
- the financial costs of site management into bond calculations or other similar instruments as required by Council that secure financial delivery of biodiversity enhancements;

- a monitoring programme to assess the degree to which enhancement targets are being achieved and the ability to adjust biodiversity management to ensure that gains are achieved and maintained for the long term;
- the roles and responsibilities of those carrying out the work, and the governance and management structures relating to the operation of the enhancement site(s); and
- reporting the results of monitoring results and a process for undertaking actions if enhancement targets are not being achieved as anticipated.

5.2.7 *Biobanking*

The proposed Redbank EEA includes 73 ha of narrow-leaved tussock grassland that is additional to that required under this Impact Mitigation Plan. This narrow-leaved tussock grassland is considered a biobank for use when appropriate to address the impact of a future OceanaGold project. The baseline ecological condition and change in condition over time will be measured using vegetation plots. The proposed EEA also provides habitat to an additional 17 plant species of conservation concern which are also considered biobanked (together with any additional species found during future surveys) and their population status will be monitored over time. The reptile, bird and invertebrate communities that inhabit the additional areas are also considered biobanked and their baseline and condition over time.

The ecological condition of these additional communities will be measured as for the offset areas and the biobank will be adjusted to reflect any changes (beneficial or detrimental) in ecological condition.

5.2.8 *Ecological compensation*

As there are expected to be no significant residual adverse effects following implementation of the Avoid, Remedy, Mitigate and Offset options, no activities are proposed as ecological compensation.

5.2.9 *Nil actions*

No mitigatory or compensatory activities are proposed for the two individuals of Declining coral broom, 1 m^2 of Declining rush *Juncus pusillus*, one individual of the Declining grass *Rytidosperma buchananii*, one patch of the Naturally Uncommon hookgrass *Carex subtilis,*

Not Threatened grey teal, Not Threatened welcome swallow, or the seasonal gully drainage plant community, as the impact of the project on these ecological features is predicted to be Very Low.

5.2.10 *Adequacy of Impact Management Activities*

These actions will, if implemented correctly, fully address all non-minor project effects excepting some minor impacts on individuals of some rare plants and common indigenous bird species, or mostly exotic plant-dominated plant communities noted above. It is also considered that benefit of the offset covenant containing a higher quantity of the Macraes biodiversity more than compensates for the impact of the Deepdell North III project on these features.

OceanaGold has overall responsibility for undertaking this work as described in the Impact Management Plan.

6 Site photographs

Figure 6. View of shrublands in Deepdell South pit backfill area of WRS looking east from 1398138 4975528. Old Deepdell South pit in right midground. Photo taken 16 January 2018.

Figure 7. View of Deepdell North III pit eastern boundary looking north towards Horse Flat from 1398028 4975609. Photo taken 16 January 2018.

Figure 8. Ephemeral wetland F near Deepdell North III pit on Horse Flat at 1398013 4975714. Photo taken 16 January 2018.

Figure 9. Seasonal gully drainage at 1397550 4976002. Photo taken 16 January 2018.

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Deepdell North III Project

Impact of Project on Vegetation, Avifauna, Herpetofauna and Invertebrates

December 2019

Report prepared for Oceana Gold (New Zealand) Ltd by Dr M. J. Thorsen,

5 December 2019

Report number: 0219-19

2 Dowling Street
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New Zealand

1 Contents

2 Executive Summary

This report evaluates the potential impact of the proposed Deepdell North III project on the area's vegetation, avifauna, herpetofauna and invertebrates. The Deepdell North III project will remove 54.79 ha of indigenous vegetation comprising of low producing grassland, shrubland, seasonal gully drainages, ephemeral wetlands and a seepage wetland and inhabited by 71 indigenous plants (including 13 rare species), twenty bird species (nine indigenous and one rare species), four reptile species (three rare species) and an invertebrate community. The vegetation communities are underlain by 3 Threatened LENZ. The ephemeral wetland vegetation community is recorded as being Historically Rare and Critically Endangered and the seepage wetland is recorded as being Historically Rare and Endangered. Both types of ecosystem are priorities for protection. The indigenous vegetation communities are generally of low species diversity and most are characterised by high weed representation. The populations of the 17 At Risk or Rare species are mostly small, except for the Declining Matagouri which is dominant in the shrubland vegetation community and frequent in the low producing grassland plant community. Given its prevalence throughout much of the South Island there is doubt concerning the national conservation assessment for this species.The project will also impact on 54.09 ha of cultivated pasture and shelterbelts.

If appropriate controls are employed during the mining activity, there is anticipated to limited impact on the surrounding pastoral and indigenous ecosystems.

Overall the Deepdell North III project is assessed as having low to very low effect on most of the terrestrial ecological features. Exceptions to this are a moderate impact on some indigenous plant communities and a high impact on the seven Historically Uncommon Nationally Critical ephemeral wetlands. These effects will be addressed through an Impact Management Plan.

3 Quality Assurance

The practices and methods set out in this Ecological Impact Assessment are those considered appropriate for delivering accurate information and would withstand scrutiny from a majority of competent ecologists.

No survey can guarantee to detect every species present in an area, and non-detection is likely to be more of a factor in cryptic or rare species, invertebrates, or plant species with no flowering material at the time of survey. All reasonable effort was made in the detection of these species during survey. There is also an element of uncertainty in the distribution of some species that are difficult to identify, or smaller herbs and grasses as these are frequently overlooked during informal surveys. There is approximately 20% of the flora that lacks a formal name and there is limited information available both on how to identify these entities and where they are found. There is limited information on invertebrates.

Due to the limited period of survey the results in this document will not reflect: 1) seasonal variation in abundance or site usage by some species, or 2) inter-annual variation in abundance or site usage by any species.

The identity and boundary of vegetation communities have been determined from interpretation of aerial photographs together with ground-truthing and oblique photography. The map may not accurately represent the correct vegetation community or current border of some vegetation communities, particularly those with a dispersed character or where bordered by similar communities. Smaller occurrences (<1 ha) of some vegetation communities are generally not represented in this document's reports and maps.

This document uses information drawn from previous reports by other organisations and no guarantee can be made on the quality, comprehensiveness or accuracy of that information.

4 Project Overview

4.1 The Deepdell North III Project

The 105 ha Deepdell North III Project (Figure 1) is an extension to the existing consented Deepdell North project at OceanaGold's Macraes Gold Project (MGP). The main elements of the Project are:

1. Open Pit Excavation
    a. Current footprint 38ha, 18.7ha of disturbing previously mined areas and 19.6 ha of new disturbance. Potential to expand if upcoming exploration is successful.
    b. Quantities: Ore 3.5Mt, Backfill waste 9.4Mt, in-situ oxide waste (brown rock) 2.4Mt, in-situ fresh waste 41.5Mt. Total movement 57Mt
    c. Haul roads 30m wide. Roads within pit footprint only.
    d. The top of the pit excavation is at about 520mRL and the base of the pit is at 370mRL, making the total pit depth 150m.
    e. Water management during operations would require pumping of stormwater runoff (primarily) out of the pit and into the existing drain that drains to the Deepdell North Silt Pond
    f. At closure, the pit lake will form slowly through passive ground and surface water inputs and is not expected to overflow to deepdell catchment for approximately 100 years
    g. Ancillary infrastructure associated with the open pit (park-up areas, smoko and ablutions, portable fuel tank etc.) would be located immediately west of the pit in the same areas previously used for these purposes.
2. Waste rock disposal – Deepdell South Backfill
    a. Total backfill footprint 16.4 ha, most (13.2 ha) is filling in a previously disturbed open pit and 3.2ha is new disturbance.
    b. Storage quantities 13Mt
    c. No new access roads required as access via existing Deepdell South haul road. Internal roads will be constructed to access top levels.
    d. Base of waste backfill is the base of the existing open pit at 360mRL, top of design backfill is at 500mRL, thus making the total depth stacked 140 m.
    e. Waste backfill runoff and long term seepage will drain to the existing Deepdell South silt pond
    f. No additional infrastructure will be required.
3. Waste rock disposal – Horse Flat Waste Rock Stack
    a. Total stack footprint 60ha, all of which is new disturbance.
    b. Storage quantities 45Mt
    c. A small access road will need to be constructed off the existing Coronation haul road. Internal roads will be constructed to access top levels.
    d. Base of waste stack is at 485mRL, top of design stack is at 640mRL, thus making the total depth stacked 155m.
    e. Waste stack runoff and long term seepage drainage will enter Highlay Creek and Deepdell Creek via existing and proposed silt ponds.

f. No additional infrastructure will be required.

Mining Method & Equipment

Same as existing operations. Up to two dig fleets may be engaged in the excavation operations.

Project Closure

1. Pit: Not backfilled. Where possible (i.e. rock is soft or within existing backfill) the excavation levels above the final lake level will be shaped to provide aesthetically pleasing and suitable areas for vegetation establishment.
   Surface water from the waste rock stack to be directed to the pit and clean water to be will continue to be diverted to Camp Creek. This lake to drain as per notes above.
2. Waste disposal
   a. Deepdell South backfill is backfilling a previously mined pit (c. 2001), slopes to be dozed down to a 3H : 1V slope and rehabilitated back into pasture using standard site techniques. Note that this will substantially soften the visual amenity from the Golden Point historic reserve.
   b. Horse Flat Waste Rock Stack slopes will be designed to blend into the surrounding topography as far as possible but the slopes will frequently be shallower than some of the surrounding natural slopes in order to establish stable vegetation growth and minimise erosion damage.
3. Site establishment areas and haul roads will be rehabilitated using standard site techniques.

Project Timeline

The Round 2 LOMP17 schedule sees these major project milestones:

- Site establishment and first overburden mining: October 2020
- First ore: December 2020
- Mining finished: July 2022

4.2 Land Tenure

This project is entirely on Oceana Gold New Zealand Limited freehold land.

4.3 Regulatory Authorities

This project is situated within the Waitaki District Council (WDC) territorial boundary. It is also within the jurisdictional boundaries of the Otago Regional Council and Department of Conservation's Kā Moana Haehae/Alexandra Office.

4.4 OceanaGold Environmental Standards

OceanaGold's environmental management programme is based on the complete mine life cycle, from exploration through development and operation, to eventual decommissioning, closure and site rehabilitation. The company seeks to not only meet, but consistently exceed regulatory requirements in place, to protect the environment for future generations and safeguard the sustainability of nearby communities.

OceanaGold is committed to continued improvement in the identification, assessment, mitigation, and monitoring of the environmental effects of its operations. The company works hard to plan and implement environmental projects that protect and support the natural environments associated with its operations, and that demonstrate its focus on international best practice environmental stewardship. Clearly, the company's activities can impact the environment and in some cases, create lasting effects. Wherever possible, OceanaGold seeks to ensure a net environmental gain from its activities, and is diligent in its adherence to all applicable laws and standards in New Zealand and offshore.

The Company aims to be an industry leader in the identification, assessment, mitigation and monitoring of its environmental impacts. Specifically, OceanaGold commits to:

- Identify and mitigate all environmental and human health impacts associated with its activities. In undertaking mitigation measures, the company will aim for a net environmental gain.
- Comply with all applicable laws and standards, and apply company-wide standards, based on international best practice, that minimise adverse environmental impacts arising from its operations.
- Rehabilitate all mine sites to a stable landscape and land use which does not pose any unacceptable risk to the environment.

• Develop an end-of-mine-life land use, in consultation with stakeholders, which will leave a positive legacy.

The aim of this policy is to provide direction to OceanaGold's employees, and contractors undertaking activities on the Company's behalf. The policy aims to place OceanaGold at the forefront of environmental impact identification and mitigation within the mining industry.

The purpose of ecological work at OceanaGold's Macraes mine site is to:

1. Ensure monitoring, management and reporting of flora, fauna and habitat meets relevant legislation, permits or licenses and community consultation outcomes.
2. Pursue a practice of minimum disturbance for the flora, fauna and habitat in the areas the site operates.
3. Ensure that the conservation status of flora and fauna species is not threatened.

These works will be undertaken to at least the Minimum Standard where:

- Sites will develop an Environmental Impact Assessment or Management Plan which will address management of land, flora, fauna and habitat, taking into account relevant legislation, permits or licenses, and community consultation.
- The Environmental Impact Assessment is to be updated where there are changes to any part of the operation (either man-made or natural) that significantly impact on it.
- The minimum area of vegetation required for exploration, construction and operation will be cleared.
- Where practicable, topsoil to a depth of 15 cm will be stockpiled prior, for use in rehabilitation.
- Sites will develop a programme to monitor and evaluate the health of flora and fauna affected by the location, and take steps to mitigate any adverse effects revealed.
- The monitoring programme will include weed and pest species, and appropriate management practices will be used to mitigate adverse effects.
- All employees are prohibited from capturing, purchasing or acquiring native wildlife for any purpose.

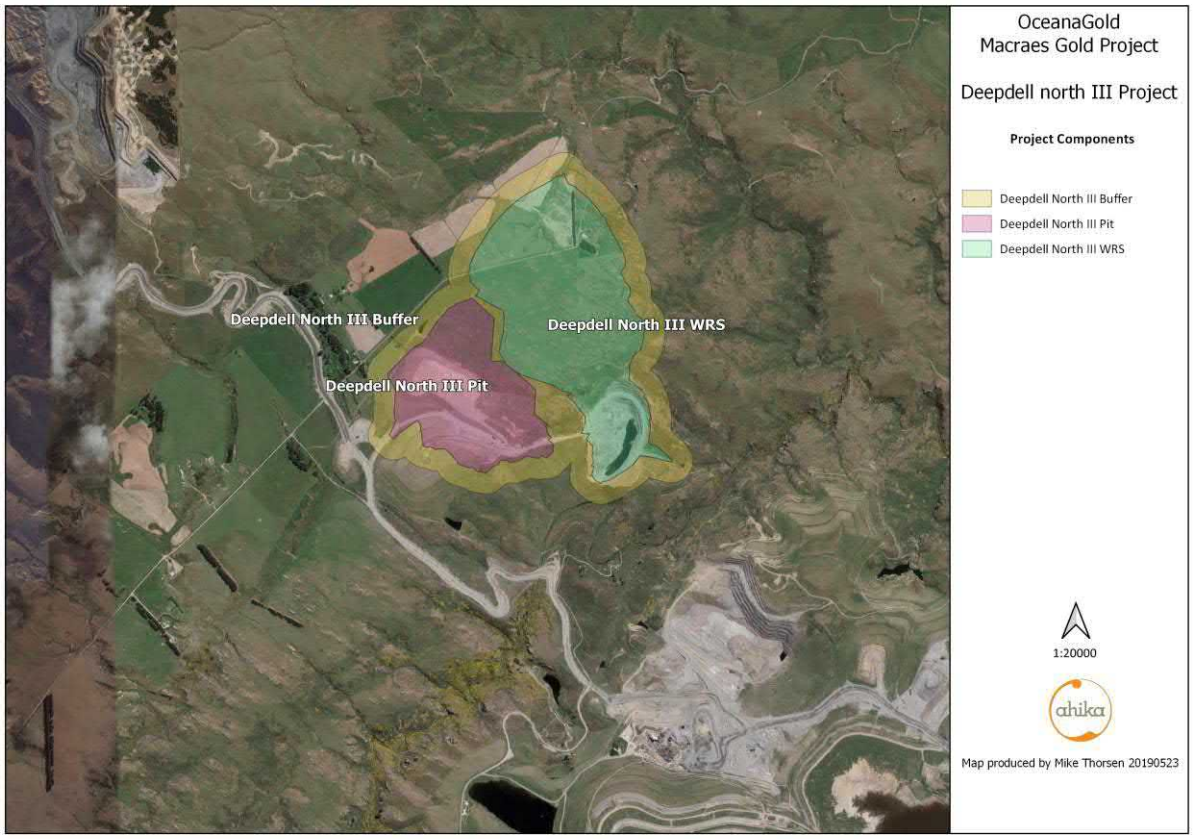

Figure 1. Location of Deepdell North III project area.

5 Assessing Ecological Importance

5.1 The Permitted Baseline

This impact assessment is in consideration to the permitted baseline and current ecological condition of the area. The activities that are permitted in regional and district plants to occur within the project area and that are likely to be having some influence on the site's ecological condition are: farming activities such as grazing of stock, topdressing, pasture grass establishment and maintenance and vegetation clearance (up to extent specified in plans).

5.2 Assessment criteria

The information that was gathered during the inventory surveys was used to evaluate the ecological importance of the vegetation, birds and reptiles and their habitats within and surrounding the Project Impact Area (PIA), against the following criteria (based on those recommended in the Environment Institute of Australia and New Zealand's 2018 Ecological Impact Assessment Guidelines available at http://www.eianz.org/resources/publications):

- Representativeness of communities.
- Distinctiveness of communities.
- Ecological functionality of communities (intactness, connectivity, buffering).
- Rarity of communities.
- Community diversity.
- Role in ecosystem servicing.
- Sites or communities of significance at
    - National (Threatened Land Environments, National Priorities for Conservation, Historically Rare or Threatened Ecosystems, Wetlands of National Importance, Ramsar Sites).
    - Regional (as identified in the Regional Plan), or
    - Local (as identified in District Plans) scales.
- Sites identified as worthy of protection.
- Presence of rare, At Risk or Threatened species.
- Presence of species of biogeographical interest.
- Presence of genetically or morphologically distinct forms.

The results of this assessment of ecological importance, based on Table 3, Table 5, Table 6 and supporting text of the Environment Institute of Australia and New Zealand (EIANZ) guidelines, is provided in Section 6, and summarised in Section 6.10.

5.3 Determining the boundary of ecological impact of project.

The ecological impact that arises from a project's activities includes the footprint of the planned project (the footprint area) but may extend beyond the area where that activity occurs. How far this effect may extend depends primarily on the nature of the activity, the mechanism of the impact, and the sensitivity of the ecological features in the surrounding area. In this instance a

100 m buffer has been selected on the basis of the impact of project activities (Section 7.3), and the sensitivities of the ecological features to these activities (Sections 6.2, 7.4, 7.6, 0 and 7.8). Together, the footprint area and the buffer area comprise the Project Impact Area (PIA) within which some impact on ecological features might be expected.

The PIA for the Deepdell North project in total covers 169.9 ha, of which 109.4 ha is within project activities that will eventually result in the loss of all vegetation and fauna within the identified boundary (footprint areas: the 38.5 ha Pit and 70.9 ha WRS[1]), and 60.5 ha is in the 100 m wide buffer area surrounding the footprint area (Figure 1).

5.4 Assessment Methodology

5.4.1 *Literature review*

All available literature on the natural history of the Macraes area was reviewed as part of the assessment process. Unpublished databases were also utilised: plant location records maintained by the New Zealand Plant Conservation Network (www.nzpcn.org.nz), NatureWatch (www.naturewatch.org.nz) and the author's unpublished database of plants observed in the Macraes area; invertebrate records on NatureWatch (including the author's records); reptile location records maintained by the Department of Conservation (DOC) in their Amphibian and Reptile Distribution Scheme (ARDS), bird location records maintained by eBird (www.ebird.org) and Nature Watch, and for invertebrates involved online searches for the phrase "Macraes Invertebrate/Insect" in Google (www.google.co.nz), Google Scholar (https://scholar.google.co.nz/), ResearchGate (www.researchgate.net) and Bugz (www.bugz.org.nz) and utilising the NZ Arthropod Collection for records of species.

[1] There is a small overlap between the map of the Pit and WRS. This overlap has been removed from my area calculations.

5.4.2 *On-site inventory survey methodology*

The flora, reptiles, birdlife and invertebrates of the Project Impact Area (PIA, see Section 5.3) were assessed using expert walk-through surveys, as it is considered that these are better at finding rare features compared to plot-based assessments, complemented with light-trapping for nocturnal Lepidoptera and night searches for nocturnal invertebrates.

5.4.2.1 *Flora survey*

The flora survey was undertaken by Mike Thorsen on 14 January 2016 and multiple dates in 2019 and Alex Ghaemaghamy on 16, 17 & 31 January and 14 February 2018. During the flora survey all plant species (indigenous and exotic) were recorded during a walk-through survey of the PIA and adjacent area. The survey path traversed the most botanically interesting areas, and an estimate of each plant's abundance both within the WRS and Pit areas of the PIA and in the surrounding area was made using the following criteria:

- Previously Present (recorded by previous visitors, but not recorded during this survey);
- Rare (infrequently seen during survey and in very low numbers covering <1% of area);
- Local (only seen at few areas during survey, but could be quite common within these areas and covering <5% of total area);
- Occasional (individuals were scattered throughout site or were in widely scattered clumps and covering 5-20% of area);
- Common (frequently encountered during survey, but not a dominant part of the flora and covering 20-60% of area);
- Abundant (a dominant part of the flora and covering >60% of area).

The locations of plant species or vegetation communities of interest were recorded using a hand-held GPS unit.

Photographs of general vegetation patterns and sites of interest were taken. The results of this flora survey are provided in Section 6.2.

To provide an estimate of percentage vegetation cover by indigenous species, a Naturalness Index was calculated. This Index is calculated by first assigning each plant species an abundance value assigned during the site inspection. The abundance values used are: Rare = 2, Local = 3, Occasional = 5, Common = 7, Abundant = 10. The abundance values of all

indigenous and exotic species encountered during this survey are then summed, and the Naturalness Index is calculated by dividing the summed abundance values for indigenous species divided by the sum of all abundance values of indigenous and exotic species combined. This Naturalness Index was then compared with results from nearby comparison sites.

5.4.2.2 *Avifauna survey*

Bird species diversity and abundance, particularly of indigenous species, is already low in the Macraes area, and this makes more intensive survey efforts such as distance-sampling or 5-minute bird counts of limited utility. For the survey of the PIA, a record was made of all birds seen or heard during the walkthrough surveys conducted by Sven Stadtmann on 16 & 17 January and 7 February 2018. The locations of species of interest were recorded using a hand-held GPS unit. Overall, 17 km was traversed in 12 hours over the two days of the survey. The results of this survey are provided in Section 6.4.

5.4.2.3 *Herpetofauna survey*

The herpetofauna survey of the PIA was undertaken by Luke Bovill on 16 & 17 February 2018 and of the final WRS position by Mike Thorsen during several visits in 2019. During the surveys, a path was followed that traversed areas considered the most likely to harbour reptiles or amphibians. Overall, 20.5 km was traversed in 10 hours over the two days of the 16 & 17 February survey. At likely sites (and over the space travelled between sites) the area was scanned for visible animals, crevices were inspected (using a torch) for signs of animals or shed skins, and potential retreats (rocks and overhanging vines) were physically searched. The surveys were conducted during reasonably warm and sunny weather. All species seen were identified to species when possible (some sightings were too brief to allow a positive identification of species). A record of the time spent searching and the number of animals was recorded for calculating Catch Per Unit Effort (CPUE). All locations will be recorded onto ARDS cards and submitted to DOC. The results of this herpetofauna survey are provided in Section 6.5.

5.4.2.4 *Invertebrate survey*

The invertebrate survey of the PIA was undertaken by Ian Millar and Fran Thorsen on 12-14 January 2018. It did not include the eastern or northern area of the final WRS as this was a latter change to the project design and it was considered that the information already obtained was sufficient to also assess impact in the final WRS location. Several methodologies were

employed targeting larger terrestrial invertebrates, caddis flies and nocturnal Lepidoptera. To sample nocturnal Lepidoptera, two or three 12v battery visible light traps were deployed over two nights (5 light trap nights in total). To sample nocturnal larger terrestrial invertebrates, areas of promising habitat were searched visually at night on two nights. Time was spent during two days sweep-netting day-flying invertebrates and searching under likely retreats (rocks). The surveys were conducted during reasonably warm and sunny weather. Super-abundant specimens were counted and the bulk discarded except a representative sample. The specimens were prepared post-collection and sorted into taxonomic group which were sent to an expert for identification to lowest possible taxonomic unit (the taxonomy of many invertebrate groups is complex or unclear and it is often difficult to assign a specimen to a species). Coleoptera were identified by Ian Millar, some Lepidoptera were identified by Ian Millar and the others sent to Robert Hoare (Manaaki Whenua, Lincoln), and a leaf-veined slug to Gary Barker (Manaaki Whenua, Hamilton). The results of this invertebrate survey are provided in Section 6.6.

6 Deepdell North III Project Assessment of Ecological Importance

6.1 General Ecological Setting

The Deepdell North III project (Figure 1), located 4 km north of Macraes Flat township, is situated on the northern end of the Taieri Ridge in the Macraes Ecological District (E.D.), being one of two Ecological Districts that make up the Lammerlaw Ecological Region of Otago (Bibby 1997). The climate is moderate, with periodic snow-lie during winter and occasional summer drought. The topography of the area consists of rolling hill country with rounded ridge crests and shallowly to deeply incised drainage associated with the Otago peneplain of the Rakaia Terrane, which has probably been exposed since the late Miocene (Forsyth 2001). Rock outcropping is predominantly associated with drainage systems, with some tor formation on ridge crests. Underlying lithology is well foliated quartzo-feldspathic biotite greenschist and lesser chlorite schist, with occasional auriferous quartz reefs of Chlorite Subzone 3 and 4, Haast Schist Group, and areas of overlying Miocene to Quaternary sediments (Mutch 1963, McKellar 1966, Forsyth 2001). Soils are loess-derived hygrous Wehenga upland and high country yellow-brown earths.

Past vegetation cover of the Macraes ED is thought to have comprised montane short tussockland grading into subalpine tall tussockland, with areas of mixed hardwood and podocarp forest, kanuka forest and *Coprosma*-flax scrub (Bibby 1997). In Otago, much of the original vegetation cover has been dramatically altered as a result of anthropogenic factors (particularly repeated burning by Maori) (McGlone et al. 1995), and this massive vegetation change also occurred at Macraes (Whitaker 1996). Since European settlement in the 1850's (Thompson 1949), areas have been burnt (sometimes repeatedly) and exotic grasslands induced by ploughing, oversowing, and applying fertiliser (Whitaker 1996). The present vegetation of the Macraes ED is of a highly modified nature, with approximately 75% of the district dominated by exotic vegetation types (mainly improved pastureland) and the remainder of the vegetation types being indigenous and comprised of varying density narrow-leaved tussockland, copper tussock-based wetlands and grey shrubland interspersed with remnants of original forest cover and scattered ephemeral wetlands (Bibby 1997, Thorsen pers. obs.). The remaining native vegetation communities currently present within the Macraes area are botanically diverse (Thorsen 2008) and is comprised of 589 indigenous (including 15 Data Deficient, 61 At Risk and 27 Threatened species) and 226 exotic species. The vegetation communities present are likely to be derived from the original vegetation communities that

existed prior to human colonisation of the region, but many are likely to be considerably reduced in extent and species diversity. Invasion by exotic shrub and tree species, particularly gorse and broom, is an increasing problem in the area.

Of the fauna, fifty-four species of birds have been recorded from the Macraes E.D., of which thirty-four are indigenous and twenty are introduced. The area's indigenous avifauna are likely being predated by exotic mammals, though the impact of this predation pressure on population dynamics is not known. They are also being impacted by changes to their habitats, however the nature of these changes and their impacts on the species is again not known.

The area is noted for its high diversity of seven lizard species, including the last known wild populations of grand skink *Oligosoma grande* and Otago skink *Oligosoma otagense* (Whitaker et al. 2002), which are a focus of a Department of Conservation managed Ecological Management Unit. The lizard species is being similarly impacted as birds by exotic mammals and habitat change, though the severity of predation is somewhat moderated by the abundance of rocky habitats offering safer retreat sites. This is thought to be at least part of the reason why Central Otago retains a high density and diversity of lizard species.

The invertebrate communities are diverse (for a region at moderate altitude) and contains some species that are rare or of biogeographic interest (Patrick 1997).

Some catchments provide habitat for populations of non-migratory galaxiids, freshwater crayfish and longfin eel, which are being affected through predation by trout and changes to their habitats, particularly in the lower reaches of watercourses.

6.2 Deepdell North PIA Flora Ecological Features

6.2.1 *Vegetation communities*

Seven vegetation communities are present within the PIA (Figure 2): seasonal gully wetlands, ephemeral wetlands, seepages, low-producing grassland, cultivated pasture, shelterbelts and shrubland (Table 1). There are also small areas of shelter belt amenity plantings.

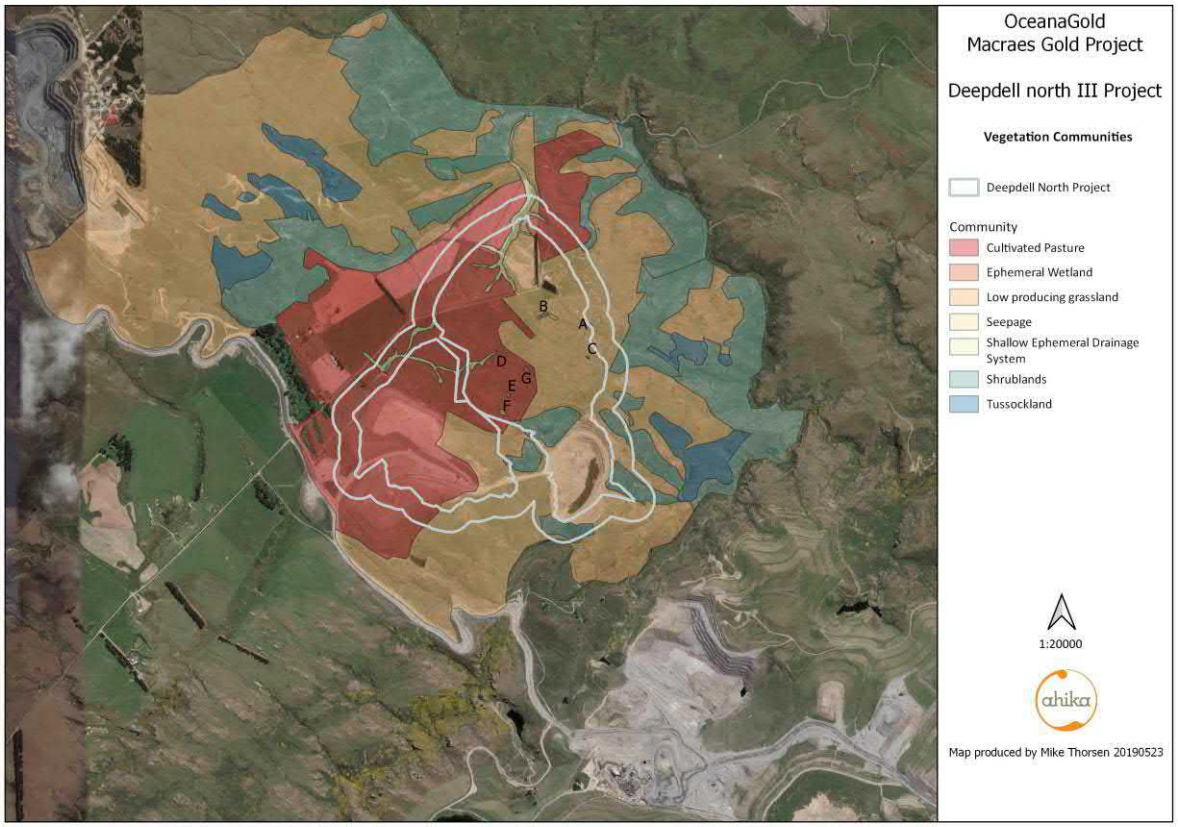

Figure 2. Vegetation communities within the PIA. The seven ephemeral wetlands are labelled A-G.

Vegetation Community	Pit	WRS	Buffer	Total
Exotic vegetation communities				
Cultivated Pasture	29.16	24.93	26.39	80.49
Shelterbelts & Exotic Trees		0.53	0.08	0.61
Semi-natural vegetation communities				
Ephemeral Wetland		0.30	0.02	0.31
Low producing grassland	8.76	39.47	24.82	73.04
Seepage		0.07		0.07
Shallow Ephemeral Drainage System	0.50	1.91	1.79	4.20
Shrublands	0.08	3.65	7.36	11.09
Total	**38.49**	**70.85**	**60.46**	**169.81**

Table 1. Areas of vegetation communities within PIA

6.2.1.1 *Seasonal gully drainage*

The shallowly-incised, flat-bottomed gullies on the road-side terrace are not ephemeral wetlands in the normal sense in that they are connected to the normal gully drainage system,

but as they are shallow and of limited water catchment they frequently dry over much of the summer. They cover 4.20 ha within the PIA, and are dominated by exotic grasses, rushes and sedges, and have frequent pukio *Carex secta* pedestals.

This mostly exotic vegetation community is not classified by Singers and Rogers (2014). It is likely to occur in other lowland flat areas in the Macraes E.D.

This vegetation community is of **low** representativeness due to the predominance of exotic species, of **moderate** rarity/distinctiveness value as it is a landform that is rare in the E.D., of **low** diversity and pattern value and **low** ecological context value. Overall this vegetation community is assessed as having **low** ecological importance.

6.2.1.2 *Ephemeral wetlands*

The seven ephemeral wetlands cover 0.02 ha within the buffer zone and 0.30 ha within the WRS zone of the PIA. All are of the type which forms on schist pans in some areas of Central Otago. Six of the examples within the PIA are short-inundation pans that completely dry in summer. Site B is fed by a seepage and does not dry to the same extent. Sites A and F are particularly deep example of pans. All are dominated by exotic grasses, mainly kneed foxtail *Alopecurus geniculatus*, and have scattered representation by indigenous species including scattered clumps of the indigenous rushes *Juncus edgariae* and *Juncus distegus*, the herbs *Galium* aff. *perpusillum*, *Callitriche petriei*, *Limosella lineata*, *Myriophyllum propinquum* and the fern relative *Azolla rubra*. The Declining *Lobelia ionantha* and Locally Uncommon *Carex resectans* are present at Site G. The coverage and diversity of indigenous species in the sites varies from 1-5 species and at least two sites are thought to be functionally almost completely transformed into an exotic species based wetland.

This vegetation community is classified by Singers and Rogers (2014) as WL14: Herbfield [Ephemeral wetland], though the Deepdell North III examples are more grassland than herbfield. Various forms of ephemeral wetlands are found throughout New Zealand, though those formed in depressions in schist bedrock are restricted to Central Otago (Johnson and Rogers 2003). Schist-based ephemeral wetlands are most common in the Strath Taieri area and are particularly grouped in the Redbank Scenic Reserve, Paddy's Rock, Cranky Jims, Sutton and Styx areas. The examples in the Deepdell North III area are considered short-inundation

subtype in that their profile is so shallow that water is not retained during the driest periods of the year.

Ephemeral wetlands are mainly under threat from invasion by weeds and cattle pugging. It is thought that sheep grazing is beneficial to this vegetation type by reducing competition from taller plants that tend to also be exotic species.

This vegetation community is of **moderate** representativeness due to the predominance of exotic species, of **high** rarity/distinctiveness value as it is a landform that is rare in NZ, of **moderate** diversity and pattern value and **moderate** ecological context value. Overall this vegetation community is assessed as having **high** ecological importance.

6.2.1.3 *Seepage wetlands*

A seepage wetland occurs over 0.07 ha at one site within the WRS zone. This community is visually dominated by the Declining indigenous rush *Juncus distegus* and lower-growing exotic grasses and rushes.

This vegetation community is probably classified by Singers and Rogers (2014) as WL22: *Carex, Shoenus pauciflorus* sedgeland, though the Deepdell North III examples are a rushland.

Seepage wetlands occur at several sites throughout Macraes E.D. where subterranean water is forced to the surface by geological features. They are mainly under threat from invasion by weeds and cattle pugging.

This vegetation community is of **moderate** representativeness due to the predominance of exotic species and low indigenous diversity, of **high** rarity/distinctiveness value as it is a landform that is rare in NZ, of **low** diversity and pattern value and **low** ecological context value. Overall this vegetation community is assessed as having **high** ecological importance.

6.2.1.4 *Low-producing grassland*

This predominantly exotic vegetation community, produced by oversowing and top-dressing recently burnt tussockland, covers 73.04 ha over much of the PIA. The main species present are exotic grasses and herbs such as browntop *Agrostis capillaris*, sweet vernal *Anthoxanthum odoratum, Rytidosperma penicellatum*, sheep's sorrel *Rumex acetosella* and hawkweed *Pilosella officinarum* with scattered individuals and areas of hard tussock *Festuca novae-zelandiae*, blue tussock *Poa colensoi*, scattered individuals and patches of low matagouri and *Coprosma propinqua* bushes and scattered indigenous herbs and grasses.

This induced vegetation community or what it is analogous to is not classified by Singers and Rogers (2014). Fire- and grazing-induced short tussock grassland is widespread on hillslopes in montane pastoral areas of the eastern South Island.

This vegetation community is of **low** representativeness due to the prevalence of exotic species, recent history of burning and oversowing, of **moderate** rarity/distinctiveness value as it hosts lizard and plant species that are At Risk, of **low** diversity and pattern value and **moderate** ecological context value. Overall this vegetation community is assessed as having **moderate** ecological importance.

6.2.1.5 *Shrubland*

Areas of shrubland occur as scattered patches over 11.09 ha of the PIA, mainly in the WRS and Buffer areas. The main species present are abundant matagouri, *Coprosma propinqua,* with scattered *Rubus schmidelioides* subsp. *subpauperatus* and *Muehlenbeckia complexa* and a few individuals of the Declining grass *Anthosachne falcis*, coral broom and desert broom, and the Locally Uncommon *Melicope simplex* and *Myrsine divaricata*. Much of the shrublands are of very short stature (to 1.5 m canopy height) with low shrub species diversity interspersed with low-producing exotic grassland tending towards scattered narrow-leaved tussock *Chionochloa rigida* subsp. *rigida* on slopes above Deepdell Creek.

This semi-natural vegetation community is not classified by Singers and Rogers (2014). It may be a fire- and grazing-induced community derived from assemblages that would have naturally occurred on cooler semi-arid slopes such as CDF2: *Dracophyllum*, mountain celery pine, *Olearia*, *Hebe* scrub [subalpine scrub], T12: Kanuka, *Olearia* scrub/treeland, or AL1: Narrow-

leaved and slim snow tussockland/shrubland. The shrubland at Deepdell North III is probably anthropogenic, being created following early Maori burning of eastern South Island dryland forest (McGlone 1989) followed by repeated burning and fertiliser application to narrow-leaved tussock grassland, and is well represented on lower-elevation hillslopes of Central Otago, though its extent is being reduced by conversion to pasture, invasion by exotic shrubs (particularly broom) and, in places, repeated burning.

This vegetation community is of **low** representativeness due to the prevalence of exotic species, recent history of burning and oversowing and low species diversity, of **high** rarity/distinctiveness value as it hosts plant and lizard species that are At Risk or rare, of **low** diversity and pattern value and **moderate** ecological context value. Overall this vegetation community is assessed as having **moderate** ecological importance.

6.2.1.6 *Cultivated pasture and shelter belts*

Exotic pasture (including shelter belts) has been induced over 86.5 ha throughout much of the PIA either through ploughing and oversowing on the flatter areas. Exotic pastures are comprised mainly of browntop, *Bromus hordaceus, Lolium perenne, Erodium cicutarium, Rumex acetosella, Cerastium semidecandrum, Dactylis glomerata* and *Leontodon autumnalis*. Shelter belts, comprised of macrocarpa and pines cover 0.61 ha mainly within the WRS area. These vegetation communities are not known to harbour any indigenous plant species but do provide habitat for some common exotic bird species and the cultivated pasture may be used for foraging by harrier hawks, paradise shelduck, black-backed gull and spur-winged plover.

These exotic vegetation communities are widespread over lower-relief areas and lower hill slopes of Central Otago.

This vegetation community is of **very low** representativeness due to it being a human-induced exotic vegetation type, of **very low** rarity/distinctiveness value, of **very low** diversity and pattern value and **very low** ecological context value as it may provide some habitat for common indigenous bird species. Overall this vegetation community is assessed as having **negligible** ecological importance.

6.2.2 *Vegetation representativeness & pattern*

The PIA is representative of the current general vegetation patterns in this area of the Macraes E.D. The community patterning of shrubland on slopes and gullies with the flatter areas being cultivated for exotic pasture is common in the area.

Of the indigenous vegetation types, the short-inundation ephemeral wetlands are also known at several sites throughout the Macraes area, particularly on Red Bank Ridge, the OceanaGold Protected Wetlands along the Macraes road, and in Cranky Jims Wetland Covenant. An incomplete project mapping the ephemeral wetlands in the Macraes E.D. has located 310 ephemeral wetlands in the upper area of the District and a further 172 potential sites. The shrublands are very typical of that which occur throughout the area. The seasonal water course is of more restricted distribution in the Macraes area in that these only occur on larger areas with gentle slope. The seepages are also of restricted distribution, but expressions of this wetland type in the area are mostly too small and appear similar to ponded wetlands making them difficult to identify from aerial images. Because of this their representativeness is difficult to assess.

Overall, the PIA is assessed as of **moderate** representativeness importance of the current vegetation, **low** representativeness of the pre-European vegetation patterns and **very low** representativeness of the pre-human vegetation patterns.

6.2.3 *Ecological integrity*

The PIA is part of a mosaic of natural and exotic vegetation communities that are found throughout the wider Macraes area. Several of the natural vegetation communities in the Macraes E.D. are decreasing in extent due to conversion to pasture through land conversion and, to a lesser extent, irrigation. They are also being degraded through weed invasion, which is being facilitated by repeated burning, changes in stocking, and fertiliser application. However, some vegetation communities such as low-producing grasslands and shrublands may be increasing in areas within the District as a result of lessened farm attention. Exotic mammals and invertebrates are likely to be having both a negative (through browsing of plants and preventing regeneration) and positive effect (through maintaining some plant communities by suppressing competing weed species). In areas where sheep grazing and land management practices has been continued in a similar fashion for many years, the vegetation appears to reach a semi-stable state with a high diversity of both indigenous and exotic species.

Areas mapped as semi-natural or natural vegetation communities cover 88.7 ha (52% of PIA) and exotic plant communities cover 81.1 ha (48% of PIA). Overall, the PIA has a Naturalness Index of 0.46 (i.e. approximately 50% of the area is covered by indigenous species). No areas within the PIA are reasonably ecologically intact, and there is some impact in all areas from ongoing grazing by sheep and cattle. Some extensive areas of cultivated plant communities are present. The only ecological value of these is that they may occasionally be used as foraging areas for some bird species. The PIA is likely to be playing some role in supporting a metapopulation of some plant species, but the extent and type of this role is unknown and likely to vary between species. To some extent the outer margin of the PIA buffers the surrounding vegetation from mine effects.

Overall, the PIA is assessed as of **moderate** ecological integrity importance.

6.2.4 *Vegetation rarity*

Within the PIA, the ephemeral wetlands, seepage and seasonal gully drainage could be considered as vegetation communities that are rare in the Macraes E.D., mainly due to their limited extent and infrequent representation. These communities have however been altered through surrounding land use practices and are now largely or almost completely comprised of exotic plant species.

Overall, the ephemeral wetland, seepage and seasonal gully drainage vegetation communities within the PIA are assessed[2] as of **high** rarity importance.

[2] The use of the Land Environment New Zealand (LENZ) model for assessing vegetation rarity, as proposed by some organisations (e.g., Ecan), is evaluated separately in this document. This assessment of the rarity of vegetation communities is based on estimated representation within the Ecological District of vegetation communities.

6.2.5 *Botanical diversity*

The total botanical diversity of the PIA is moderate, with 71 indigenous species and 78 exotic species being recorded within 109.4 ha (Table 2). This botanical diversity is due to the large area of pastoral land in the PIA, as the number of species hectare^{-1} is lower than within the OceanaGold covenants (Table 2). The total botanical diversity of the PIA represents 19% of the 815 indigenous and exotic species known for the Macraes E.D. The 71 indigenous species component represents 12% of the 589 indigenous species known by the author from the Macraes area.

Site	**Area (hectares)**	**# indigenous species**	**# exotic species**	**Indigenous species hectare^{-1}**	**Naturalness Index**
Deepdell North	109.4	71	78	0.6	0.40
Coronation North PIA	494	175	78	0.4	0.62
Cranky Jims Shrubland Covenant	47.1	98	39	2.1	0.65
Cranky Jims Wetland Covenant	97.3	92	40	0.9	-
Deepdell Tussock Covenant	109.8	108	37	1.0	0.72
Highlay Creek Covenant	16.9	52	47	3.1	0.55

Table 2. Comparison of botanical diversity and naturalness at sites within the Macraes area

Overall, the PIA is assessed as of **moderate** botanical diversity importance.

6.2.6 *Ecosystem services*

6.2.6.1 ***Linkages and networks***

The PIA probably plays a **moderate** role in providing a patchwork of natural ecological areas assisting the local persistence of some species. There are no ecological sequences in evidence.

6.2.6.2 ***Buffering***

The PIA probably plays a **moderate** role in buffering natural areas (including the nearby Golden Point Historic Reserve, Deepdell Creek Conservation Area and Marginal Strip) and waterways from weed incursion and increased sedimentation arising from nearby cultivated areas and would also play a role in buffering the surrounding vegetation from mine activities.

6.2.6.3 ***Support services***

The PIA has a **minor** ecosystem support services role by protecting genetic diversity.

6.2.6.4 ***Regulating services***

The PIA has a **minor** ecosystem regulating services role in reducing erosion of underlying soils and regulating flood flows in the area.

6.2.6.5 ***Cultural services***

The PIA currently has a **negligible** ecosystem cultural services role.

6.2.6.6 ***Provisioning services***

The PIA has a **minor** ecosystem provisioning services role in providing stock water to downstream areas.

Overall, the PIA is assessed as providing a **minor** ecosystem service.

6.2.7 *Notable vegetation communities or sites*

6.2.7.1 ***Indigenous vegetation associated with Threatened land environments (defined by Land Environments of New Zealand at Level IV) that have ≤20% remaining in indigenous cover (Ministry for Environment and Department of Conservation 2007, Walker et al. 2007, 2008).***

Three Level IV LENZ categories are present in the PIA (Table 3, Figure 3), all of which are currently classified as Threatened Land Environments: the Acutely Threatened L1.3a and N3.1e, and the Chronically Threatened Q4.3b.

L1.3a covers the north-western part of the PIA and is covered by exotic pasture, low-producing pasture and seasonal gully drainage and the rehabilitated WRS of the Deepdell North project.

N3.1e occurs along the south-eastern part of the PIA and is primarily exotic pasture, shrubland and low-producing grassland and the rehabilitated WRS of the Deepdell North project.

Q4.3b covers the slopes of Deepdell Stream gully and is covered by shrubland, low-producing grassland, and the Deepdell North pit.

LENZ	Deepdell North III Buffer	Deepdell North III Pit	Deepdell North III WRS	Total
Acutely Threatened	**44.7**	**37.5**	**59.6**	**141.9**
L1.3a	28.6	24.4	35.3	88.3
N3.1e	16.1	13.1	24.3	53.5
Chronically Threatened	**15.8**	**1.0**	**11.2**	**28.0**
Q4.3b	15.8	1.0	11.2	28.0
Total	**60.5**	**38.5**	**70.9**	**169.9**

Table 3. Areas of Level IV LENZ categories within the PIA.

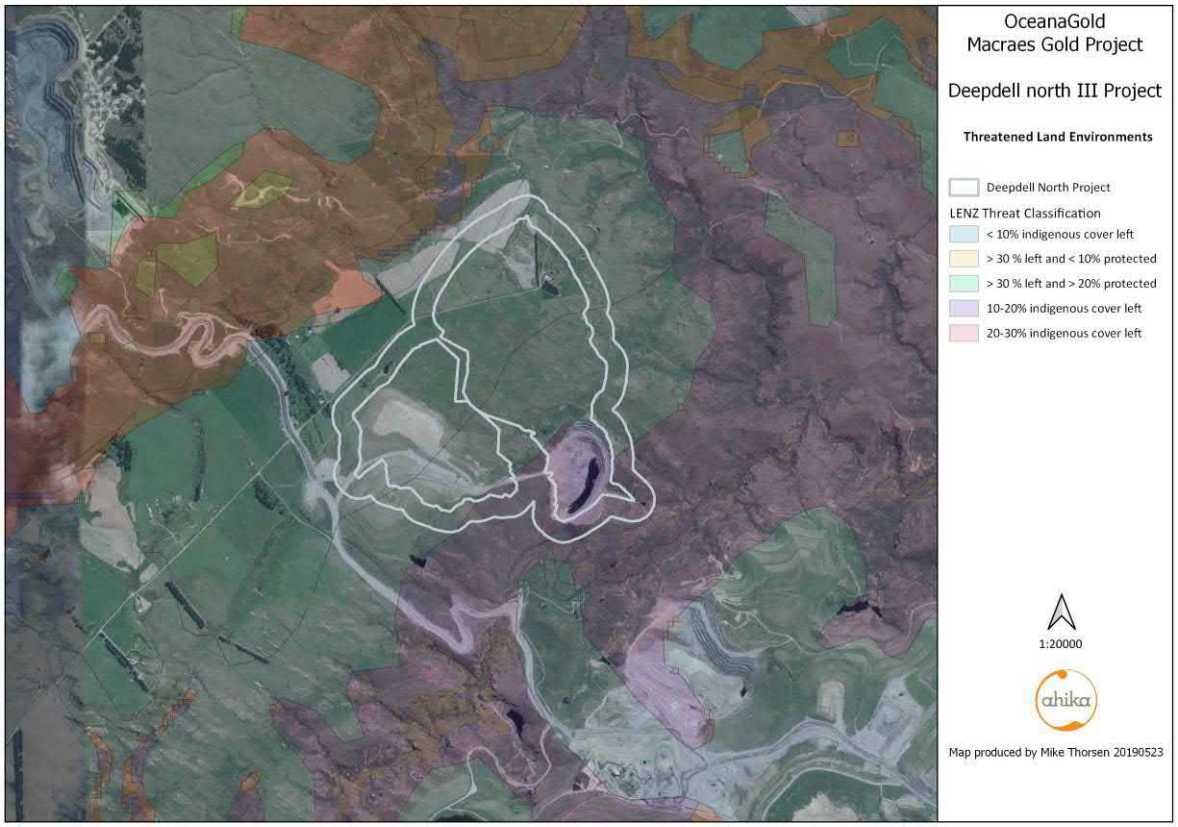

Figure 3. LENZ classification of the PIA at Level IV.

6.2.7.2 *Indigenous vegetation associated with sand dunes and wetlands, ecosystem types that have become uncommon due to human activity and are a National Priority for Protection (Ministry for Environment and Department of Conservation 2007).*

The PIA includes two vegetation communities that are a National Priority for Protection: the ephemeral wetland and the seepage wetland.

6.2.7.3 *Indigenous vegetation associated with 'Historically Rare' or 'Threatened' terrestrial ecosystem types (Ministry for Environment and Department of Conservation 2007, Williams et al. 2007, Holdaway et al. 2012).*

The PIA includes two wetland vegetation communities that are Naturally Uncommon (= Historically Rare): the ephemeral wetlands and the seepage wetland. Both are Threatened ecosystems: the ephemeral wetlands are Critically Endangered and the seepage wetland is Endangered.

6.2.7.4 *Wetlands of National Importance or Ramsar sites.*

The PIA includes no Wetlands of National Importance or Ramsar sites.

6.2.7.5 *Sites previously identified as recommended for protection*

No sites identified by Bibby (1997) as a Recommended Area for Protection (RAP) are situated within the PIA.

6.2.8 *Importance overall of vegetation communities*

Overall, the indigenous vegetation communities present within the PIA are assessed as being of **high** ecological importance, though the importance of each vegetation community varies between **negligible** for cultivated pasture and shelterbelts, **moderate** for the low producing grasslands and shrublands and **high** for the ephemeral wetlands and seepage wetland. Though the indigenous plant communities are of moderate to low representation and ecosystem service importance, and moderate diversity and moderate integrity, there are remnants of rare vegetation communities present, the ephemeral wetland vegetation communities and seepage wetland are a national priority for protection, are Naturally Uncommon and classified as Threatened, there are three Threatened Level IV land environments that are overlain by some natural vegetation and it provides habitat for At Risk, or rare plant and animal species.

All the indigenous vegetation communities (ie all except cultivated pasture and shelterbelts) are **significant** under the Proposed ORPS (Appeals Version) and the WDC District Plan, and the ephemeral wetland, seepage and shrubland vegetation communities are **significant** under the Operative Otago RPS.

6.3 Threatened, At Risk, or rare plant species

Thirteen plant species that occur within the PIA are either currently classified as At Risk or Data Deficient (Townsend et al. 2007, de Lange et al. 2018), or are thought to be rare in the Otago region or Macraes E.D. based on the author's observations (Figure 4).

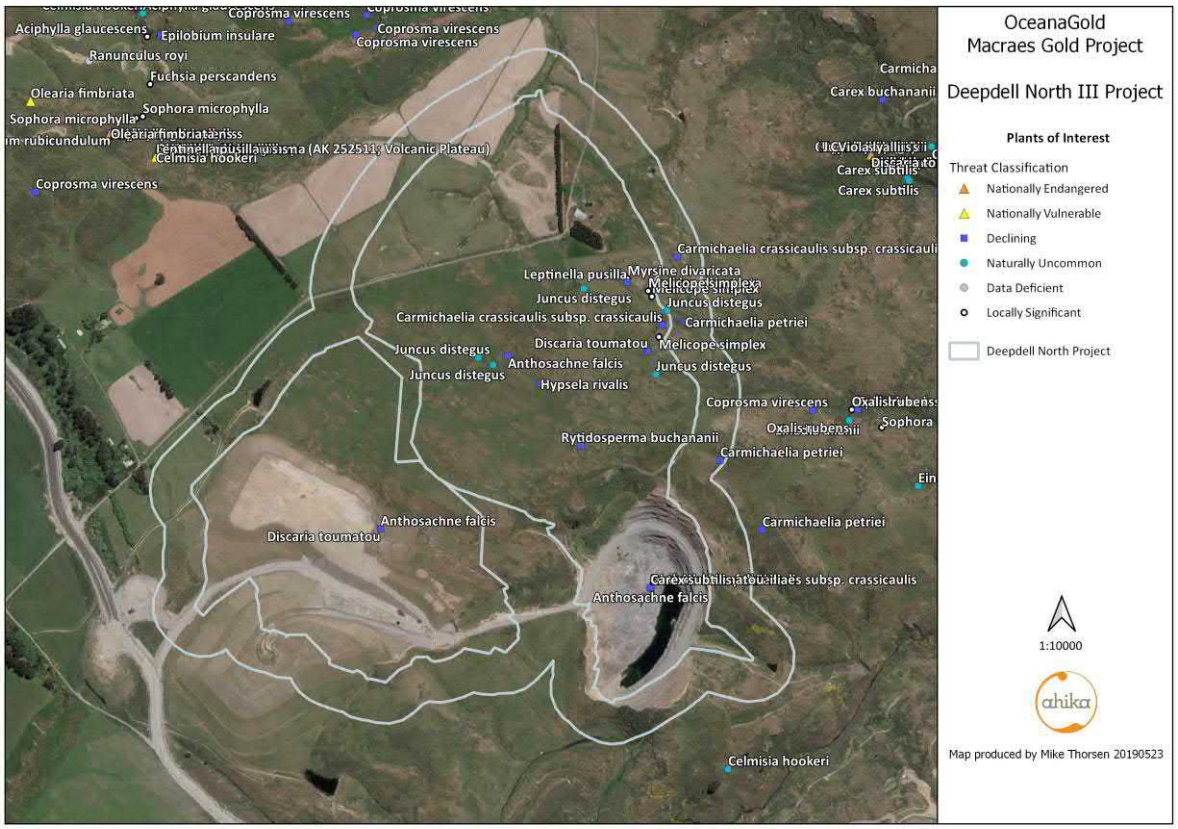

Figure 4. Locations of Threatened, At Risk and other plant species of interest (Data Deficient, rare plants) within the PIA.

6.3.1 *Threatened species*

No Threatened plant species occur within the PIA.

6.3.2 *At Risk species*

10 At Risk plant species are known to occur within the PIA: seven species that are classified as Declining and three species classified as Naturally Uncommon.

6.3.2.1 *Declining Species*

Seven species classified as Declining are known to occur within the PIA: the wheatgrass *Anthosachne falcis,* coral broom *Carmichaelia crassicaulis* subsp. *crassicaulis,* desert broom *Carmichaelia petriei*, matagouri *Discaria toumatou*, the creeping button daisy *Leptinella pusilla,* the wetland herb *Lobelia ioantha* and the dryland grass *Rytidosperma buchananii*.

1. *Anthosachne falcis* (Connor) Barkworth et S.W.L.Jacobs (dwarf wheatgrass, Poaceae).

Distribution within project

This dryland grass was recorded as scattered plants inhabiting shrubland in the Pit and mainly in the WRS zones.

Summary of existing information

Anthosachne falcis was recently reclassified as Declining, with the qualifiers Data Poor and Sparse, on the basis of a predicted decline of 10-50% in total population or area of occupancy over 3 generations and its range being estimated at less than 10,000 ha (Townsend et al. 2007, de Lange et al. 2018). Previously it was not assessed as Rare and Endangered in 1976 or 1986, as Insufficiently Known in 1999, as Range Restricted in 2004, and Naturally Uncommon in 2009 and 2013 (Given 1976, Given 1986, de Lange et al. 1999, de Lange et al. 2004, de Lange et al. 2009, de Lange et al. 2013).

This species occurs in the dry inland basins of the Waimakariri, Ashburton Lakes, Mackenzie, Waitaki and Central Otago. In Otago it had previously been misidentified as *Anthosachne solandri* “channel” in some botanical surveys, and it was only recently that the correct identity of these plants was realised. Subsequent to this discovery it has been found to be widely but sparsely scattered in semi-natural grasslands in the Macraes area, including in OceanaGold covenants and the Deighton Creek Nature Reserve. It inhabits dry, short tussock grassland and open areas in shrubland.

This species is considered to be at risk due to of conversion of its dryland habitat. No conservation programmes are known for this species, but it flourishes in several protected areas where there appear to be few threats.

The ecological importance of the population of this species within the PIA is categorised as **high** on the basis of its:

1) Declining conservation status.

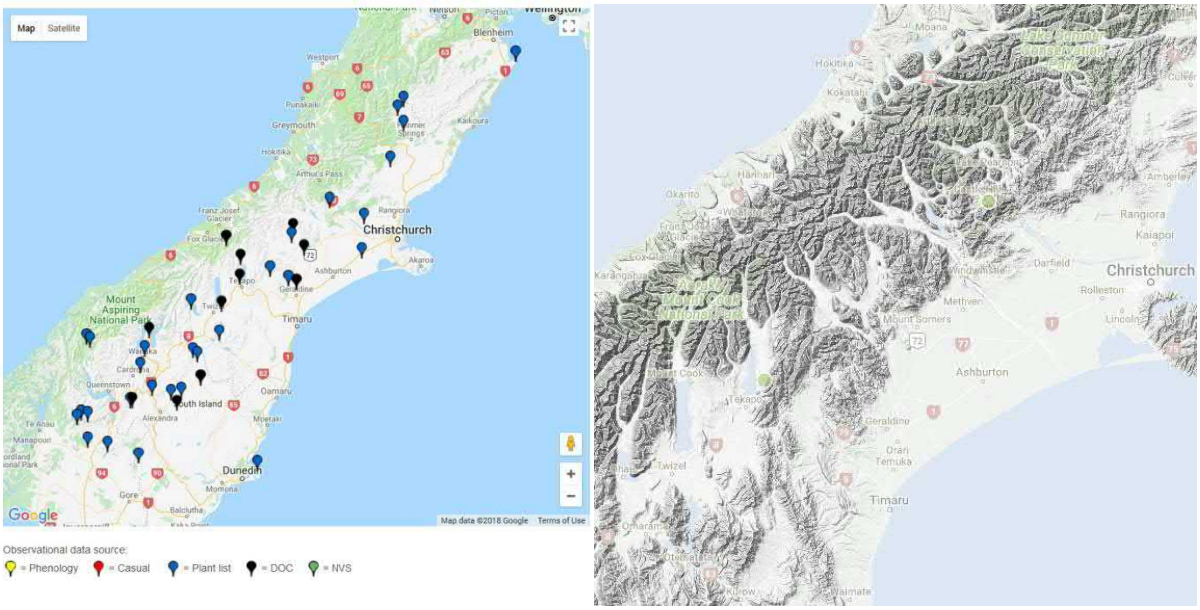

Figure A. Distribution of *Anthosachne falcis* in New Zealand from the NZ Plant Conservation Network (left) and NatureWatch (right) databases (see data sources). No guarantee is given as to the accuracy of the maps or the identification of the species.

Data sources used in this assessment:

Edgar, E; Connor, H.E. 2010. Flora of New Zealand Vol. 5: Gramineae, 2nd Ed. Manaaki Whenua Press, Lincoln.

NZPCN http://www.nzpcn.org.nz/flora_details.aspx?ID=478 accessed 15 February 2018.

NatureWatch http://naturewatch.org.nz/taxa/470787 accessed 15 February 2018.

Dr M. Thorsen unpub. file notes.

2. *Carmichaelia crassicaulis* Hook.f. subsp. *crassicaulis* (coral broom, Fabaceae).

Distribution within project

Three plants of this thick-stemmed broom were recorded at one site in the Pit (one grazed plant) and at one site in the WRS (2 heavily grazed plants). A group of 15 heavily grazed plants and a single nearby plant are present in the Buffer area.

Summary of existing information

Carmichaelia crassicaulis subsp. *crassicaulis* is currently classified as Declining, with the qualifier Recruitment Failure, on the basis that the total population is estimated to number 20,000–100,000 mature individuals with a predicted decline of 10–50%, and there is little evidence of young plants in the populations (Townsend et al. 2007, de Lange et al. 2018). Previously it was not assessed as Rare and Endangered in 1976 or 1986, as Declining in 1999, as Gradual Decline in 2004, and as Declining in 2009 (Given 1976, Given 1986, de Lange et al. 1999, de Lange et al. 2004, de Lange et al. 2009, de Lange et al. 2013).

This species is distributed through the eastern South Island from Marlborough to Otago, with the majority of the populations in Otago. In the wider Macraes area it occurs on OceanaGold tenure land adjacent to the PIA in Coal Creek and Trimbells Gully and is known from 41 sites between Red Bank and Ramrock Roads. It inhabits a variety of dry, usually rocky, sites.

This species is considered to be in decline primarily through loss of its dryland habitat and lack of recruitment of young individuals into populations. No conservation programmes are known for this species, but it occurs in several protected areas where there appear to be few threats (but even at these sites recruitment appears to be rare). A nearby population at Nenthorn has many young seedlings that have germinated after stock were fenced from the area.

The ecological importance of the population of this species within the PIA is categorised as **high** on the basis of its:

1) Presence of only three individuals;
2) Number of nearby populations;
3) Declining conservation status;
4) The reduction in extent of its dryland habitat;
5) the lack of young plants within populations.

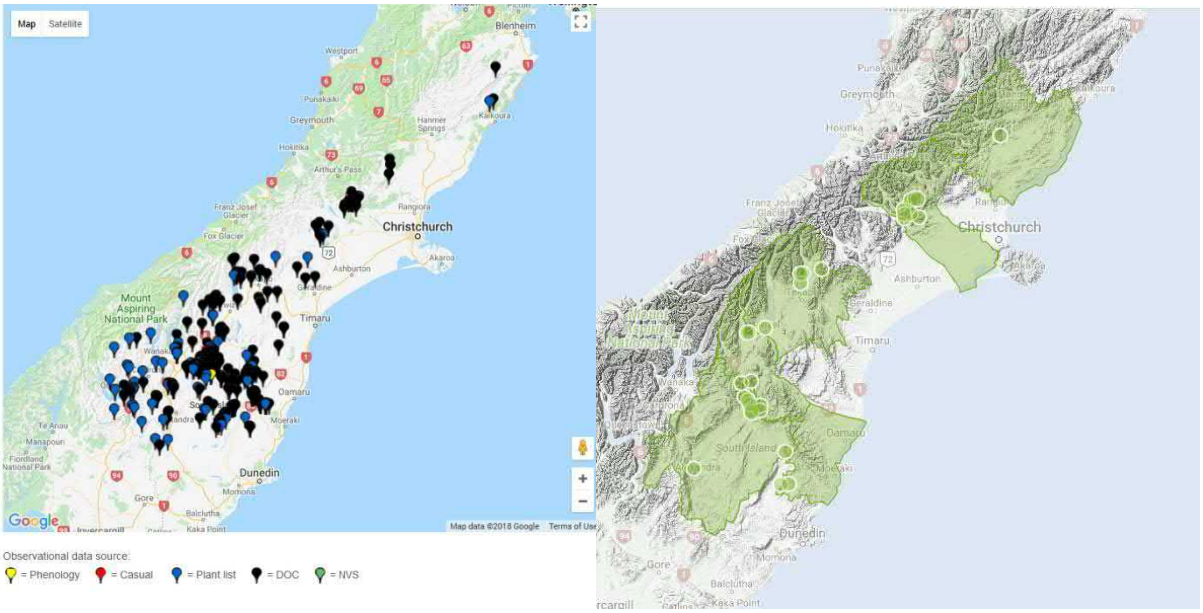

Figure A. Distribution of *Carmichaelia crassicaulis* subsp. *crassicaulis* in New Zealand from the NZ Plant Conservation Network (left) and NatureWatch (right) databases (see data sources). No guarantee is given as to the accuracy of the maps or the identification of the species.

Data sources used in this assessment:

Heenan, P.B. 1998. An emended circumscription of *Carmichaelia*, with new combination, a key, and notes on hybrids. New Zealand Journal of Botany 36: 53-63.

NZPCN http://www.nzpcn.org.nz/flora_details.aspx?ID=152 accessed 15 February 2018.

NatureWatch http://naturewatch.org.nz/taxa/412101 accessed 15 February 2018.

Dr M. Thorsen unpub. file notes.

3. *Carmichaelia petriei* Petrie (desert broom, Fabaceae).

Distribution within project

This leafless broom was recorded at several sites in both the Pit and WRS zones where several plants are present.

Summary of existing information

Carmichaelia petriei is a new addition to the threatened plant list and is classified as Declining, with the qualifiers Data Poor and Recruitment Failure, on the basis that the total population is estimated to number 20,000–100,000 mature individuals with a predicted decline of 10–50%, and there is little evidence of young plants in the populations (Townsend et al. 2007, de Lange et al. 2018). Previously it was not assessed as of conservation significance in 1976 or to 2013 (Given 1976, Given 1986, de Lange et al. 1999, de Lange et al. 2004, de Lange et al. 2009, de Lange et al. 2013).

This species is distributed through the eastern South Island from the Mackenzie Basin to Southland and on Stewart Island, with the majority of the populations in Otago. In the wider Macraes area it occurs in most areas of indigenous shrubland and grasslands, including those that are highly degraded, though numbers vary between sites. Plants are often heavily grazed when smaller, but this does not seem to cause mortality of the plants.

This species is considered to be in decline primarily through loss of its dryland habitat and lack of recruitment of young individuals into populations. No conservation programmes are known for this species, but it occurs in several protected areas where there appear to be few threats (but even at these sites recruitment appears to be rare).

The ecological importance of the population of this species within the PIA is categorised as **high** on the basis of its:

1) Declining conservation status;
2) The reduction in extent of its dryland habitat;
3) Number and size of nearby populations;
4) The lack of young plants within populations.

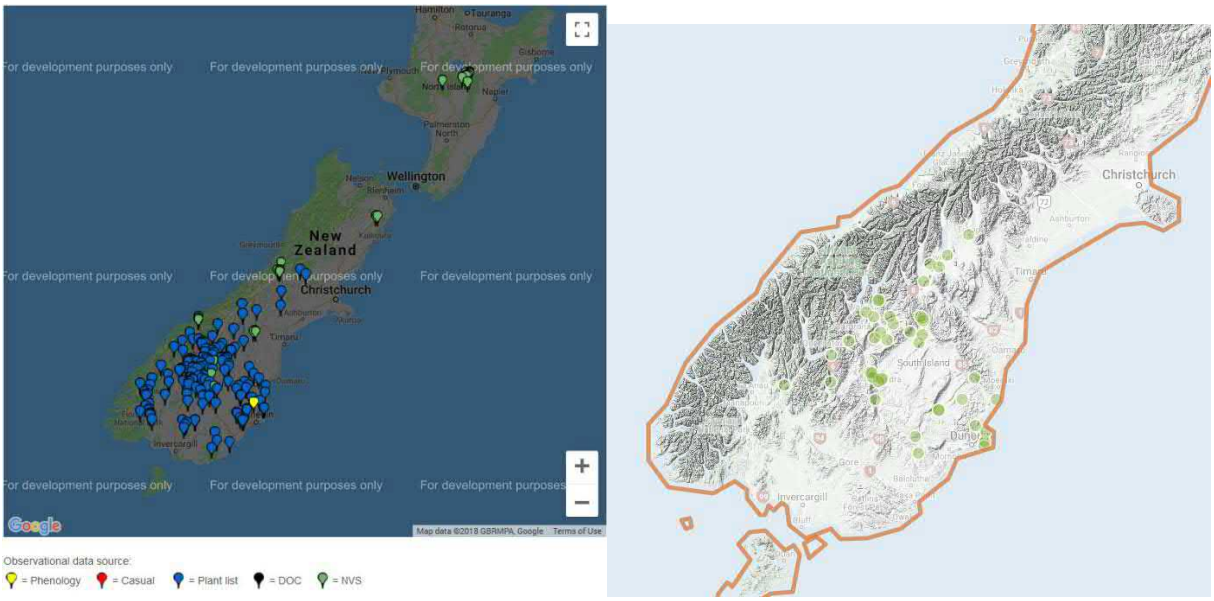

Figure A. Distribution of *Carmichaelia petriei* in New Zealand from the NZ Plant Conservation Network (left) and NatureWatch (right) databases (see data sources). No guarantee is given as to the accuracy of the maps or the identification of the species.

Data sources used in this assessment:

Heenan, P.B. 1996. A taxonomic revision of *Carmichaelia* (Fabaceae-Galegeae) in New Zealand (part II). New Zealand Journal of Botany 34: 157-177.

NZPCN http://www.nzpcn.org.nz/flora_details.aspx?ID=1602 accessed 8 November 2018.

NatureWatch https://inaturalist.nz/observations?place_id=6803&taxon_id=52110 accessed 8 November 2018.

Dr M. Thorsen unpub. file notes.

4. *Discaria toumatou* Petrie (matagouri, Rhamnaceae).

Distribution within project

Matagouri was recorded at multiple sites and in considerable numbers in the Pit and WRS zones.

Summary of existing information

Matagouri is a new addition to the threatened plant list and is classified as Declining, with no qualifiers, on the basis that the total population is estimated to exceed 100,000 mature individuals with a predicted decline of 10–70% (Townsend et al. 2007, de Lange et al. 2018). In this assessment, the panel did not consider that the species is known to rapidly expand its range in many parts of the South Island unless physically prevented from doing so. Previously it was not assessed as of conservation significance in 1976 or to 2013 (Given 1976, Given 1986, de Lange et al. 1999, de Lange et al. 2004, de Lange et al. 2009, de Lange et al. 2013).

This species is distributed patchily through the North Island to Auckland and is widespread and common in montane areas of the South Island, particularly in the east. In the wider Macraes area it occurs in most (all?) areas of indigenous shrubland and grasslands, including those that are highly degraded. Plants are not grazed and it is well known to South Island farmers as a colonist of grazed and fertilised hillslopes.

This species is considered to be in decline primarily through loss of its dryland habitat, particularly in the Mackenzie Basin and intermontane basins of Central Otago. No conservation programmes are known for this species, but it occurs in a multitude of protected areas where there appear to be few threats.

The ecological importance of the population of this species within the PIA is categorised as **high** on the basis of its:

1) Declining conservation status;
2) The reduction in extent of its dryland habitat;
3) Number and size of nearby populations;
4) Vigorous spread at many sites
5) Uncertainty over the validity of the threat assessment.

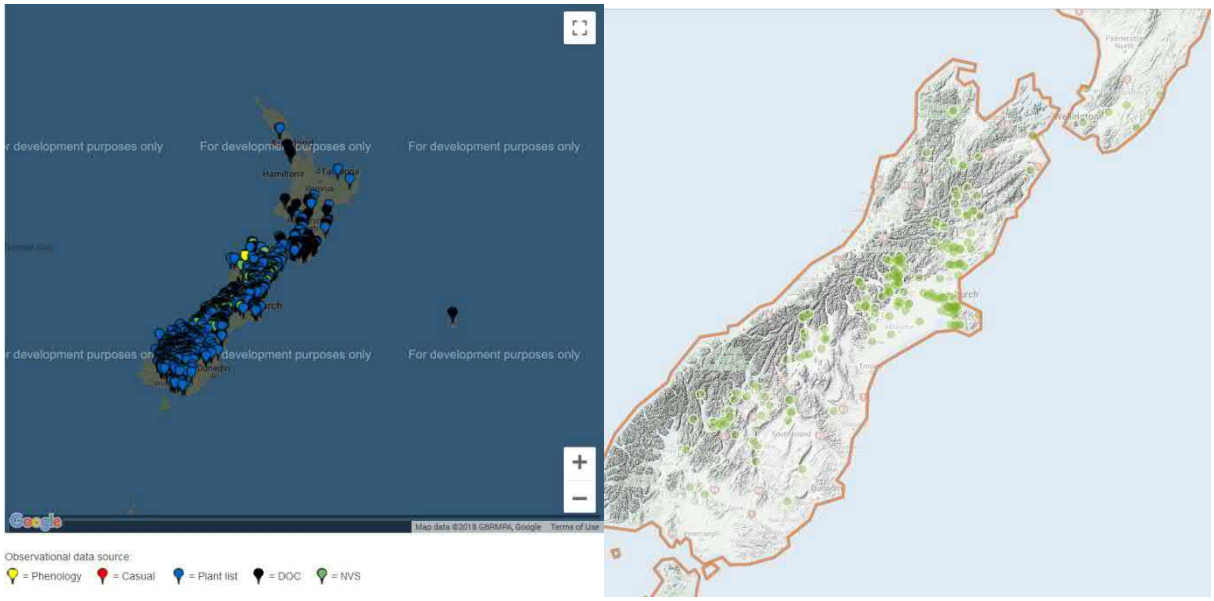

Figure A. Distribution of *Discaria toumatou* in New Zealand from the NZ Plant Conservation Network and NatureWatch (right) databases (see data sources). No guarantee is given as to the accuracy of the map or the identification of the species.

Data sources used in this assessment:

de Lange, P.J; Rolfe, J.R; Barkla, J.W; Courtney, S.P; Champion P.D; Courtney, S.P; Perrie, L.R; Beadel, S.M; Ford, K.A; Breitwieser, I; Schönberger, I; Hindmarsh-Walls, R; Heenan, Ladley, K. 2018. Conservation status of New Zealand indigenous vascular plants, 2017. New Zealand Threat Classification Series 22. Department of Conservation, Wellington.

NZPCN http://www.nzpcn.org.nz/flora_details.aspx?ID=1795 accessed 8 November 2018.

NatureWatch https://inaturalist.nz/observations?place_id=6803&taxon_id=333825 accessed 8 November 2018.

Dr M. Thorsen unpub. file notes.

5. *Leptinella pusilla* Hook.f. (a button daisy, Asteraceae).

Distribution within project

This creeping button daisy was recorded at one site in the WRS where one patch is present on the margin of ephemeral wetland C.

Summary of existing information

Leptinella pusilla is a new addition to the threatened plant list and is classified as Declining, with no qualifiers, on the basis that the species is estimated to occupy less than 1,000 ha and is predicted to decline at 10-30% (Townsend et al. 2007, de Lange et al. 2018). Previously it was not assessed as of conservation significance in 1976 or to 2013 (Given 1976, Given 1986, de Lange et al. 1999, de Lange et al. 2004, de Lange et al. 2009, de Lange et al. 2013).

This species is distributed through the south-eastern North Island and much of the eastern South Island. Exact distribution is not clear as the species is often misidentified for the commoner *Leptinella squalida* (or in some cases *Leptinella serrulata*). In the wider Macraes area it is patchily distributed and has been recorded from 47 sites. It often occurs within small groves of shrubs, often in heavily grazed areas.

This species is considered to be in decline primarily through loss of its dryland habitat. No conservation programmes are known for this species, but it occurs in several protected areas where there appear to be few threats.

The ecological importance of the population of this species within the PIA is categorised as **high** on the basis of its:

1) Single patch present within PIA;
2) Declining conservation status;
3) The reduction in extent of its dryland habitat.

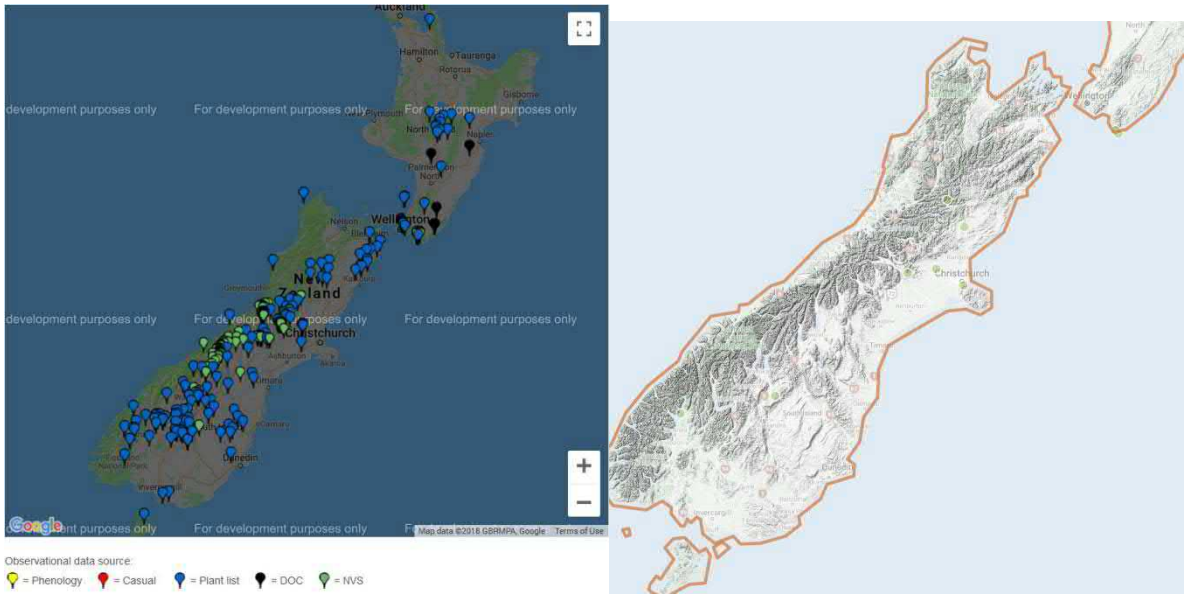

Figure A. Distribution of *Leptinella pusilla* in New Zealand from the NZ Plant Conservation Network (left) and NatureWatch (right) databases (see data sources). No guarantee is given as to the accuracy of the maps or the identification of the species.

Data sources used in this assessment:

Lloyd, D.G. 1972. A revision of the New Zealand, Subantarctic, and South American species of Cotula, Section Leptinella, New Zealand Journal of Botany, 10: 277-372.

NZPCN http://www.nzpcn.org.nz/flora_details.aspx?ID=917 accessed 9 November 2018.

NatureWatch https://inaturalist.nz/observations?place_id=6803&taxon_id=52110 accessed 8 November 2018.

Dr M. Thorsen unpub. file notes.

6. *Lobelia ionantha* Heenan (a wetland herb, Campanulaceae).

Distribution within project

This creeping wetland herb was recorded at one site in the ephemeral wetland G in the WRS where several patches totalling an estimated 0.56m^2 are present.

Summary of existing information

Lobelia ioantha is currently classified as Declining, with the qualifier Data Poor, on the basis that the total area of occupancy Is estimated to exceed > 10,000ha with a predicted decline of 10–70% (Townsend et al. 2007, de Lange et al. 2018). It was first included in the Threatened plant list in 2013 and was assessed as Declining in 2012 and 2017 (de Lange et al. 2013, de Lange et al. 2018).

This species is distributed through the eastern and southern South Island in wetland margins, tarns, river terraces and damp tussock grasslands. Exact distribution is not clear as this species previously included other species of what are now *Lobelia* in *Hypsela rivalis*. In the wider Macraes area it is patchily distributed and has been recorded from 13 sites, mostly in ephemeral wetlands. At Macraes it is most often found within low herbfield in ephemeral wetlands. Its annual lifecycle in these habitats is unknown, particularly when the site is inundated. It is not known to be browsed by mammals, but plants can be damaged through pugging of wetlands.

This species is considered to be in decline primarily through loss of its wetland habitats. No conservation programmes are known for this species, but it occurs in several protected areas where there appear to be few threats.

The ecological importance of the population of this species within the PIA is categorised as **high** on the basis of its:

1) Single site present within PIA;
2) Declining conservation status;
3) The reduction in extent of its wetland habitats.

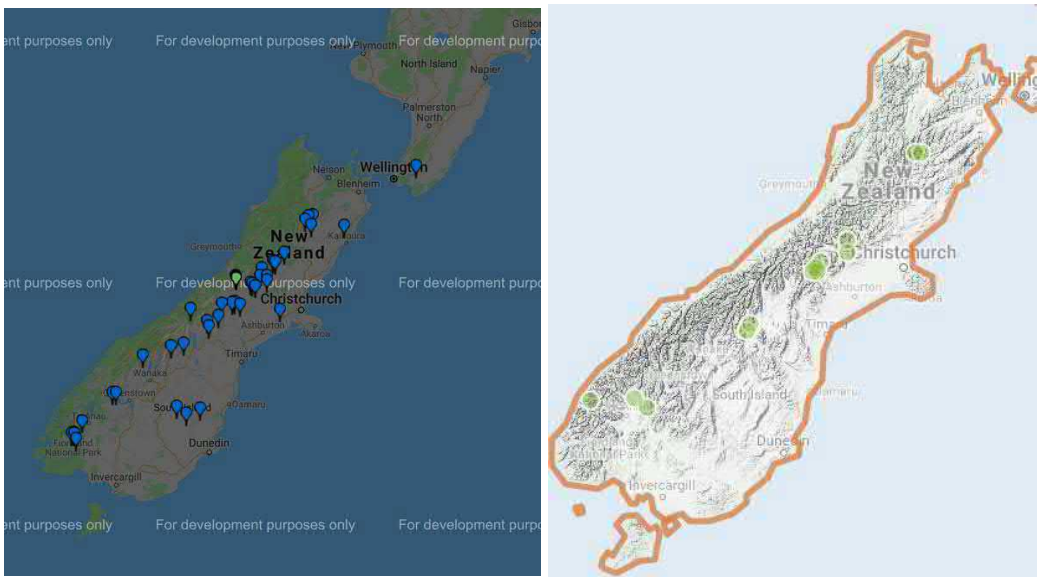

Figure A. Distribution of *Lobelia ionantha* in New Zealand from the New Zealand Plant Conservation Network and NatureWatch databases (see data sources). No guarantee is given as to the accuracy of the maps or the identification of the species.

Data sources used in this assessment:

Heenan, P.B; Knox, E.B; Courtney, S.P; Johnson, P.N; Dawson, M.I. 2008. Generic placement in *Lobelia* and revised taxonomy for New Zealand species previously in *Hypsela* and *Isotoma* (Lobeliaceae). New Zealand Journal of Botany 46: 87-100.

NZPCN http://www.nzpcn.org.nz/flora_details.aspx?ID=857 accessed 31 May 2019.

NatureWatch https://inaturalist.nz/observations?place_id=6803&taxon_id=428642 accessed 31 May 2019.

Dr M. Thorsen unpub. file notes.

7. *Rytidosperma buchananii* (Hook.f.) Connor & Edgar (a dryland bristlegrass, Poaceae).

Distribution within project

This grass was recorded at one site in the WRS where one plant is present on a rock stack in the WRS.

Summary of existing information

Rytidosperma buchananii is a new addition to the threatened plant list and is classified as Declining, with the qualifier Data Poor, on the basis that the total area of occupancy Is estimated to exceed > 10,000ha with a predicted decline of 10–70% (Townsend et al. 2007, de Lange et al. 2018).

This species is distributed through the central North Island and much of the South Island. In the wider Macraes area it is very patchily distributed and has been recorded from 4 sites, usually in low numbers. It is most often found on rocky sites but is also occasionally present in depleted grassland.

It is not known why this species is considered to be in decline. Its rocky habitats appear secure, but it may be lost from some dryland grass habitats. No conservation programmes are known for this species, but it occurs in many protected areas where there appear to be few threats.

The ecological importance of the population of this species within the PIA is categorised as **low**[3] on the basis of its:

1) Single plant present within PIA;
2) Declining conservation status;
3) Uncertainty around justification for Declining status.

[3] While the AIANZ guidelines recommend 'high' a value of low is used here on the basis that only one plant is present.

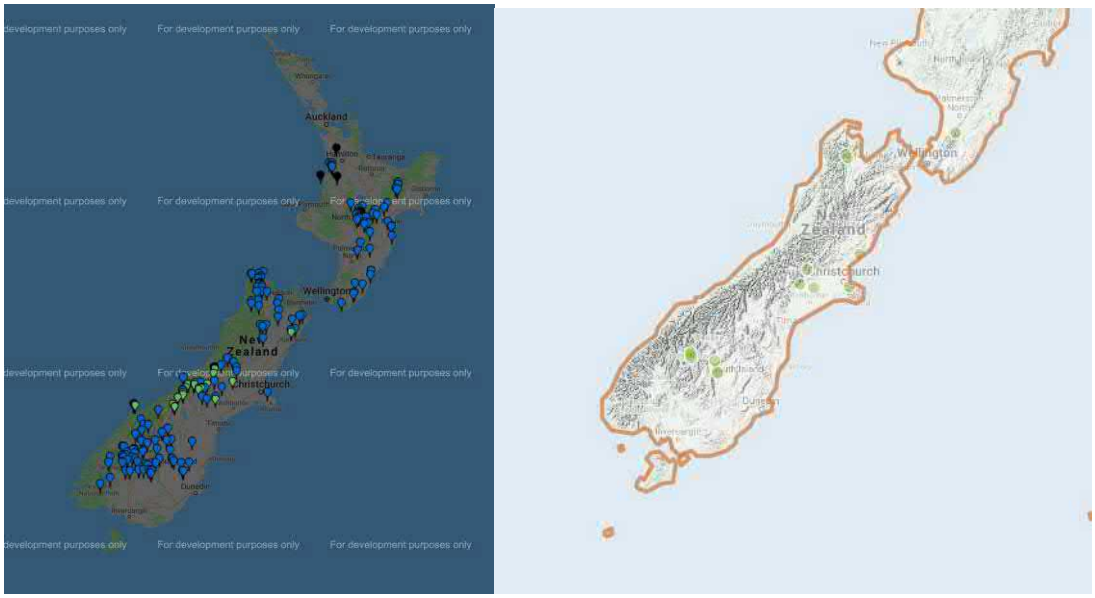

Figure A. Distribution of *Rytidosperma buchananii* in New Zealand from the NZ Plant Conservation Network (left) and NatureWatch (right) databases (see data sources). No guarantee is given as to the accuracy of the maps or the identification of the species.

Data sources used in this assessment:

Connor, H.E; Edgar, E. 1979. *Rytidosperma* Steudel (*Notodanthonia* Zotov) in New Zealand. New Zealand Journal of Botany 17: 311-337.

Edgar, E; Connor, H.E. 2010. Flora of New Zealand, Vol. V: Grasses (2nd Ed.). Manaaki Whenua Press, Lincoln.

NZPCN http://www.nzpcn.org.nz/flora_details.aspx?ID=917 accessed 31 May 2019.

NatureWatch https://inaturalist.nz/observations?place_id=6803&taxon_id=405802 accessed 31 May 2019.

Dr M. Thorsen unpub. file notes.

6.3.2.2 *Naturally Uncommon*

Three species classified as Naturally Uncommon are known to occur within the PIA: the hookgrass *Carex subtilis*, the wetland rush *Juncus distegus* and the dwarf rush *Juncus pusillus.*

8. *Carex subtilis* K.A.Ford (elegant hookgrass, Cyperaceae).

Distribution within project

This small sedge was recorded at one site in the WRS zone.

Summary of existing information

Carex subtilis (previously *Uncinia elegans*) is currently classified as Naturally Uncommon, with the qualifiers Data Poor, Secure Overseas and Sparse because of the widely spaced populations, its inconspicuous nature and its abundance in Tasmania (Townsend et al. 2007, de Lange et al. 2018). Previously it was not assessed as Rare and Endangered in 1976, 1986, or 1999, assessed as Sparse in 2004, Data Deficient in 2009 and Naturally Uncommon in 2013 (Given 1976, Given 1986, de Lange et al. 1999, de Lange et al. 2004, de Lange et al. 2009, de Lange et al. 2013).

This species occurs in shady sites at the base of rock outcrops or under shrubs in the eastern South Island. In the wider Macraes area it is very patchily distributed and has been recorded from 8 sites, usually as single patches under shrubs or at the base of shaded rock outcrops. Plants appear to be restricted to these sites either as they provide a suitable shaded environment, or browsers are preventing them expanding outside of these sites. No conservation programmes are known for this species and its presence within the national protected areas network is unknown.

The ecological importance of the population of this species within the PIA is categorised as **moderate** on the basis of its:

1) Naturally Uncommon conservation status;
2) Susceptibility to browsers.

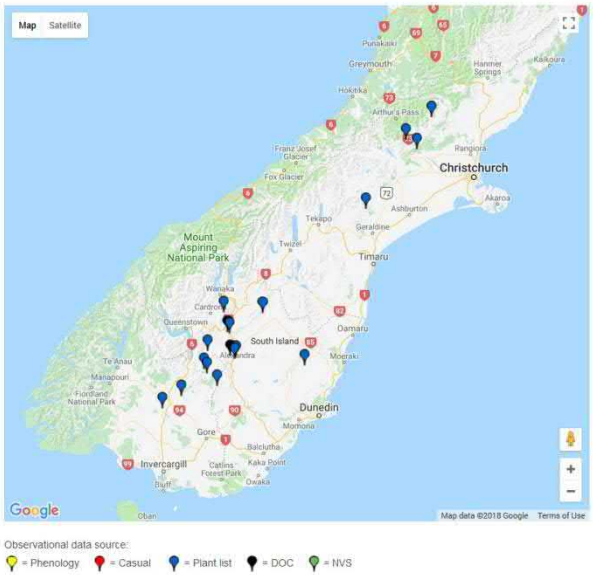

Figure A. Distribution of *Carex subtilis* in New Zealand from the NZ Plant Conservation Network database (see data sources). No guarantee is given as to the accuracy of the maps or the identification of the species.

Data sources used in this assessment:

NZPCN http://www.nzpcn.org.nz/flora_details.aspx?ID=334 accessed 15 February 2018.

Dr M. Thorsen unpub. file notes.

9. *Juncus distegus* Edgar (Two-storey rush, Juncaceae).

This rush was recorded in various numbers bordering the ephemeral wetlands and is the dominant larger plant species in the seepage wetland in the WRS where there are patches covering an estimated 369 m^2 with an additional scattered 56 individuals.

Summary of existing information

Juncus distegus is a new addition to the threatened plant list and is currently classified as Naturally Uncommon, with the qualifiers Data Poor and Sparse, on the basis that it occurs within naturally small and widely scattered populations with less than 20,000 individuals or occupies less than 100,000 ha and with no evidence of declining numbers (Townsend et al. 2007, de Lange et al. 2018).

This species is patchily distributed through the North, South and Chatham Islands. In the wider Macraes area it is patchily distributed and has been recorded from 20 damp areas. No conservation programmes are known for this species, but it probably occurs in many protected areas where there appear to be few threats.

The ecological importance of the population of this species within the PIA is categorised as **moderate** on the basis of its:

1) Healthy population present within PIA;
2) Naturally Uncommon conservation status.

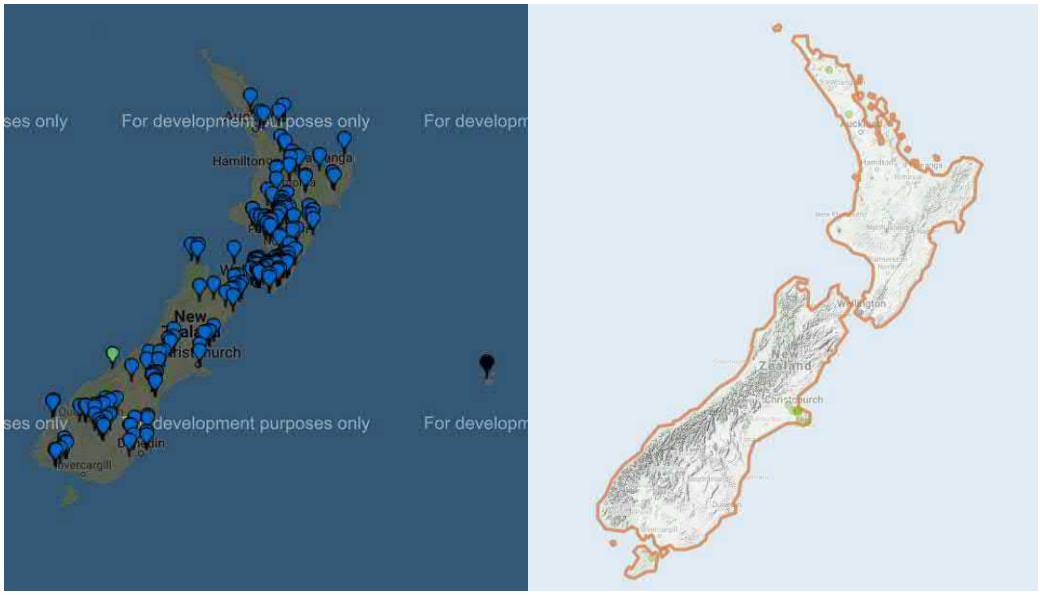

Figure A. Distribution of *Juncus distegus* in New Zealand from the NZ Plant Conservation Network (left) and NatureWatch (right) databases (see data sources). No guarantee is given as to the accuracy of the maps or the identification of the species.

Data sources used in this assessment:

Bodmin, K; Champion, P; James, T; Burton, T. 2015. New Zealand rushes: *Juncus* factsheets. NIWA, Hamilton.

NZPCN http://www.nzpcn.org.nz/flora_details.aspx?ID=868 accessed 31 May 2019.

NatureWatch https://inaturalist.nz/observations?place_id=6803&taxon_id=402872 accessed 31 May 2019.

Dr M. Thorsen unpub. file notes.

10. *Juncus pusillus* Buchenau (dwarf rush, Juncaceae).

This tiny rush was recorded as two 5 x 5 cm patches in ephemeral wetland A.

Summary of existing information

Juncus pusillus is currently classified as Naturally Uncommon, with the qualifiers Data Poor, Secure Overseas and Sparse because of the widely spaced populations, its inconspicuous nature and its presence in Tasmania (Townsend et al. 2007, de Lange et al. 2018), though the Tasmanian records are better referred to *Juncus sandwithii* and *Juncus pusillus* being a New Zealand endemic. Previously it was not assessed as Rare and Endangered in 1976, 1986, 1999, 2004, Naturally Uncommon in 2009 and Not Threatened in 2013 (Given 1976, Given 1986, de Lange et al. 1999, de Lange et al. 2004, de Lange et al. 2009, de Lange et al. 2013).

This species is distributed through much of the North Island and throughout the South, Stewart and Auckland Islands. In the wider Macraes area it is patchily distributed and has been recorded from 10 damp sites some of which are human created. No conservation programmes are known for this species, but it probably occurs in many protected areas where there appear to be few threats.

The ecological importance of the population of this species within the PIA is categorised as **low** on the basis of its:

1) Small population present within PIA;
2) Naturally Uncommon conservation status;

Figure A. Distribution of *Juncus pusillus* in New Zealand from the NZ Plant Conservation Network database (see data sources). No guarantee is given as to the accuracy of the map or the identification of the species.

Data sources used in this assessment:

Johnson, L.A.S. 1991. New Australia taxa in *Juncus* (Juncaceae). Pp. 34-46 in: Banks, M.R. et al. (Eds). Aspects of Tasmanian botany – a tribute to Winifred Curtis. Royal Society of Tasmania, Hobart.

Bodmin, K; Champion, P; James, T; Burton, T. 2015. New Zealand rushes: *Juncus* factsheets. NIWA, Hamilton.

NZPCN http://www.nzpcn.org.nz/flora_details.aspx?ID=871 accessed 31 May 2019.

Dr M. Thorsen unpub. file notes.

6.3.3 *Data Deficient species*

No species classified as Data Deficient are known to occur within the PIA.

6.3.4 *Rare species*

Three species that are considered rare are known to be present within the PIA:

6.3.4.1 ***Species uncommon in region***

No species that are considered uncommon in the Otago region are known within the PIA.

6.3.4.2 ***Species uncommon in Ecological District***

Three species that are uncommon within the Macraes Ecological District are known to be present within the PIA: the small sedge *Carex resectans* and the shrubs *Melicope simplex* and *Myrsine divaricata*.

11. *Carex resectans* Cheeseman (desert sedge, Cyperaceae).

Distribution within project

This small creeping sedge was recorded as three patches totalling 40 x 40 cm in ephemeral wetland G.

Summary of existing information

Carex resectans is distributed in the east of the North and South Islands and is a species rarely recorded within the Macraes E.D. where it has been recorded at one other site. It inhabits short grasslands.

The ecological importance of the population of this species within the PIA is categorised as **moderate** on the basis of its:

1) Rarity within the Ecological District.

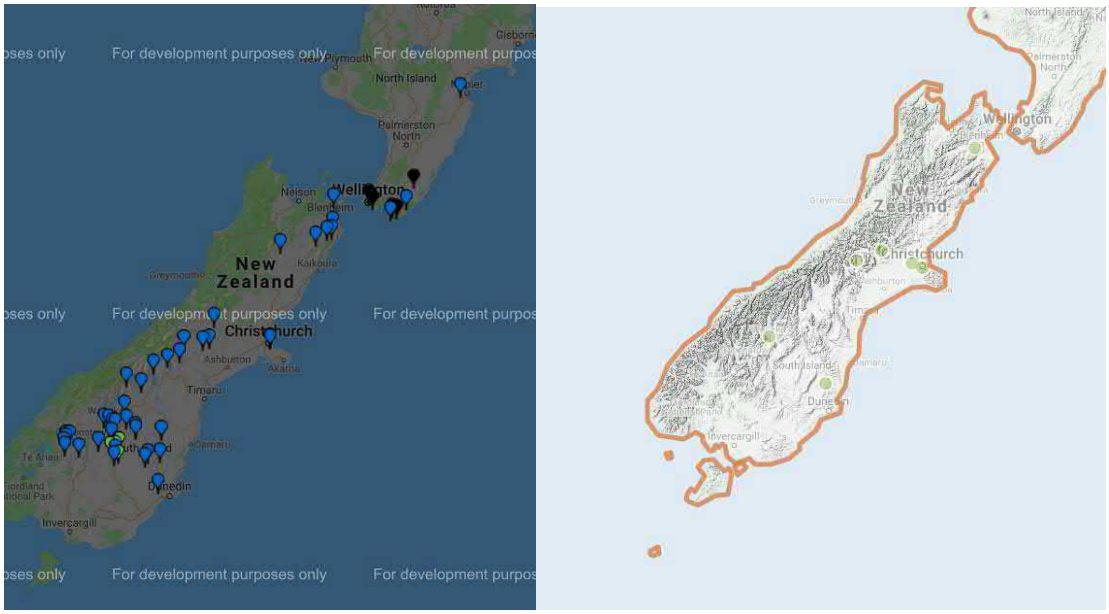

Figure A. Distribution of *Carex resectans* in New Zealand from the NZ Plant Conservation Network (left) and NatureWatch (right) databases (see data sources). No guarantee is given as to the accuracy of the maps or the identification of the species.

Data sources used in this assessment:

NZPCN http://www.nzpcn.org.nz/flora_details.aspx?ID=1417 accessed 31 May 2019.

NatureWatch https://inaturalist.nz/observations?place_id=6803&taxon_id=400461 accessed 31 May 2019.

Dr M. Thorsen unpub. file notes.

12. *Melicope simplex* A.Cunn. (poataniwha, Rutaceae).

Distribution within project

This shrub was recorded as 11 individuals in one group of rock outcrops in the WRS.

Summary of existing information

Melicope simplex is distributed throughout the North and South Islands but is rare in within the Macraes E.D. where it has been recorded at four other sites. At Macraes it inhabits shrublands around rock outcrops and is thought to be a relict species from previous woody vegetation.

The ecological importance of the population of this species within the PIA is categorised as **moderate** on the basis of its:

1) Rarity within the Ecological District.

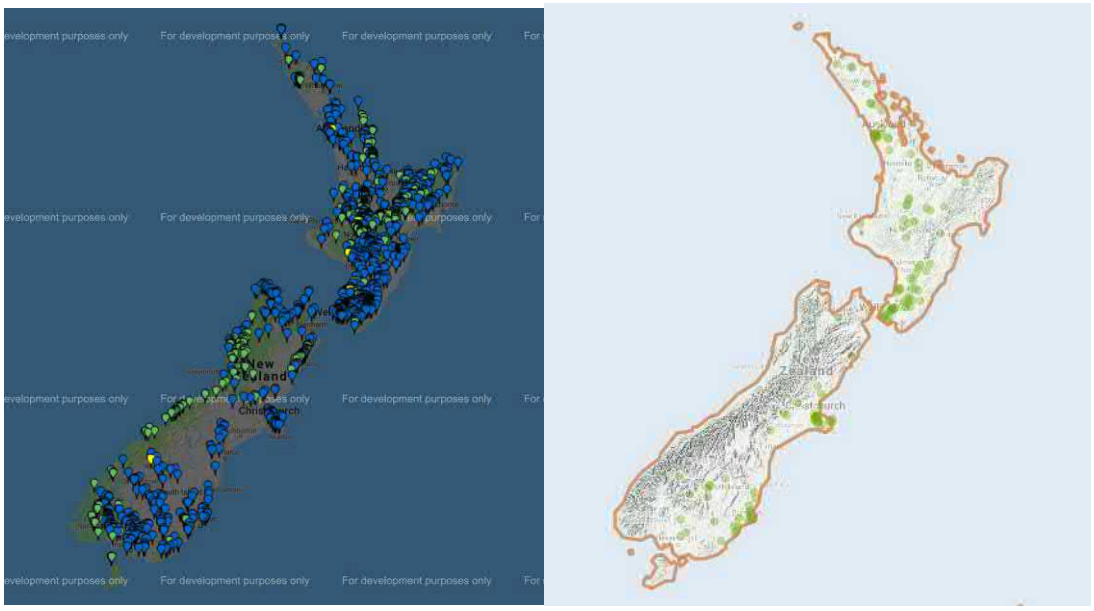

Figure A. Distribution of *Melicope simplex* in New Zealand from the NZ Plant Conservation Network (left) and NatureWatch (right) databases (see data sources). No guarantee is given as to the accuracy of the maps or the identification of the species.

Data sources used in this assessment:

NZPCN http://www.nzpcn.org.nz/flora_details.aspx?ID=966 accessed 31 May 2019.

NatureWatch https://inaturalist.nz/observations?place_id=6803&taxon_id=366690 accessed 31 May 2019.

Dr M. Thorsen unpub. file notes.

13. *Myrsine divaricata* A.Cunn. (weeping matipo/mapou, Primulaceae).

Distribution within project

This shrub was recorded as 2 individuals in one group of rock outcrops in the WRS.

Summary of existing information

Myrsine divaricata is distributed throughout the North and South Islands but is rare in within the Macraes E.D. where it has been recorded at five other sites. At Macraes it inhabits shrublands around rock outcrops and is thought to be a relict species from previous woody vegetation.

The ecological importance of the population of this species within the PIA is categorised as **moderate** on the basis of its:

1) Rarity within the Ecological District.

Figure A. Distribution of *Myrsine divaricata* in New Zealand from the NatureWatch database (see data sources). No guarantee is given as to the accuracy of the map or the identification of the species.

Data sources used in this assessment:

NZPCN http://www.nzpcn.org.nz/flora_details.aspx?ID=1009 accessed 31 May 2019.

NatureWatch https://inaturalist.nz/observations?place_id=6803&taxon_id=70240 accessed 31 May 2019

Dr M. Thorsen unpub. file notes.

6.3.5 *Species of biogeographic interest*

No plant species of biogeographic interest occur within the PIA.

6.3.6 *Genetically or morphologically distinct forms*

No morphologically distinct plant forms are present within the PIA.

6.4 Avifauna Ecological Features

6.4.1 *Avifauna communities*

Twenty bird species were recorded from within the PIA, nine of which are indigenous: grey teal, black-backed gull, pipit, harrier hawk, grey warbler, paradise shelduck, welcome swallow, kereru, and spur-winged plover, and eleven of which are exotic: blackbird, skylark, goldfinch, starling, yellowhammer, chaffinch, redpoll, house sparrow, magpie, mallard, and song thrush. Several birds were not able to be identified, including one sighting of what may have been a flock of three brown creeper in shrubland on the margin of the WRS.

A pair of pipit was observed on the existing recently revegetated Deepdell WRS and are assumed to be breeding there. One harrier hawk was seen on most visits to the site. It is assumed that they regularly use the area for hunting and feeding but are unlikely to be breeding there. A pair of grey warbler was seen in the WRS zone near the existing Deepdell North pit. It is assumed that there are likely to be other birds present and they are breeding in some of the more intact shrubland areas. Six paradise shelduck were observed in the WRS zone. A flock of 6 grey teal were observed on the farm pond in the Pit zone and it is assumed they are using this site for feeding, though they may be nesting in the willows outside of the PIA. A group of welcome swallow were also observed feeding over this pond and may be nesting in nearby buildings or rock overhangs. Welcome swallows are probably migrant into the area for breeding over the summer months. Spur-winged plover were vocally conspicuous in the Pit and WRS zones (particularly in the latter). It is estimated that several pairs were present, and it is likely that they breed there. A colony of black-backed gulls is breeding adjacent to the existing Deepdell South pit lake: 45 adults and 15 juveniles were present on the 7 April visit and they are foraging in the surrounding farmland. A single kereru was seen flying 150 m overhead. It is not thought that this species is using this area and is excluded from further consideration. No falcon have been seen or heard during the Deepdell North III or Coronation surveys, though they are known from further afield in this area. It is possible the species uses this area occasionally for hunting.

Of the exotic birds, blackbird, song thrush and house sparrow are present in gullies in the shrubland and are nesting in these areas or the nearby derelict buildings. Skylark, goldfinch, yellowhammer, starling magpie and redpoll are scattered throughout the PIA in areas of open vegetation. Mallards are using the farm pond for feeding and probably nesting.

6.4.2 *Ecological function*

Of the twenty bird species recorded from within the PIA, eleven are exotic species. Six of these: skylark, goldfinch, yellowhammers, starlings, redpoll and house sparrow are considered of minor ecological importance, being insectivores or seed eaters and as such competing with few native species. The song thrush and blackbird have some ecological importance due to their role in dispersing fruit of native shrubs. The magpies are likely to be predators of indigenous lizards, and the mallards may be competing with the indigenous grey teal for food.

Eight of the indigenous species: grey teal, black-backed gull, pipit, harrier hawk, grey warbler, paradise shelduck, welcome swallow and spur-winged plover, are all likely to be playing some ecological role within the PIA. Pipits are mainly insectivores, but also disperse fruit of native plants (Thorsen et al. 2011). Harrier hawks play a role in regulating rabbit density and behaviour in the area. Grey warblers are predominantly insectivorous and play a role in regulating tree-dwelling invertebrate numbers. Paradise shelduck and grey teal (and other waterfowl) influence the stature and composition of wetland plant communities. Spur-winged plovers are omnivorous, mainly feeding on plant material but also some animal material (Heather and Robertson 2000). They are a recent natural arrival to New Zealand, and their ecological function here is not known. Black-backed gulls are mainly scavengers in this area and are most likely feeding on dead (or dying) farmland animals. Their breeding colonies are fiercely defended, and this could be displacing harrier from the area around the pit lake. The ecological function of welcome swallows is not well known, but they may regulate aquatic invertebrate numbers.

Overall the site is assessed as having **moderate** importance in ecological function of bird species.

6.4.3 *Species diversity*

Dryland Central Otago is depauperate in bird species due to its aridity and lack of forest and wetland habitats. The nine indigenous and eleven exotic bird species observed within the PIA is the normal diversity expected for this site. The eight Non-Threatened indigenous bird species that occur within the PIA are of **low** ecological importance.

6.4.4 *Threatened, At Risk, or rare species*

One of the nine indigenous bird species is classified as At Risk: pipit.

1. *Anthus novaeseelandiae* Gmelin subsp. *novaeseelandiae* (pipit, Motacillidae).

Pipits are currently classified as Declining on the basis of a >100,000 population that is predicted to decline by 10-70% (Robertson et al. 2017). They also held this classification in the assessment in 2012 (Robertson et al. 2012) and were assessed as Not Threatened in 2005 (Hitchmough et al. 2007). This decline is mainly attributed to conversion of rough grasslands (particularly short tussock grassland) to pasture, predation and possibly changes to habitat caused by drought (Heather and Robertson 2000, http://nzbirdsonline.org.nz/species/new-zealand-pipit accessed 19/2/18). Pipit are distributed throughout the North, South and Stewart Islands, with subspecies on the offshore islands (Figure 6b). Macraes is one of the highest densities of sightings of pipits in New Zealand, being recorded in 25-40% of the reports in this area (http://nzbirdsonline.org.nz/species/new-zealand-pipit accessed 19/2/18) and within the Macraes area pipit are widespread, particularly in rough low grassland, although population density varies greatly from site to site. Pipits are present within the Pit zone, where it is estimated, based on encounter rate, that there a single pair of birds. Their presence in an artificially created habitat may be an indication of this species' adaptability to novel environments.

The ecological importance of the population of this species within the PIA is categorised as **high** on the basis of its:

1) Declining conservation status.
2) Very small population size in PIA.
3) Human-created habitat.

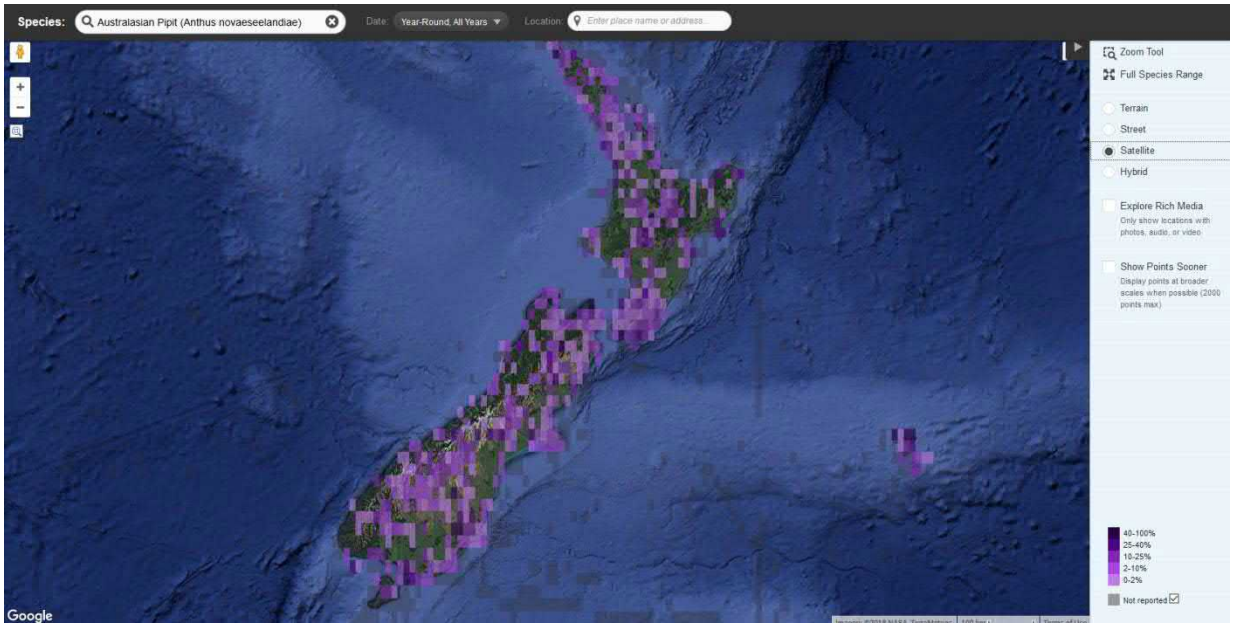

Figure 6b. National distribution of pipit and density of sightings, from:

http://ebird.org/ebird/newzealand/map/auspip1?neg=true&env.minX=156.24755859375&env.minY=-47.82790816919327&env.maxX=-166.83837890625&env.maxY=-33.99802726234875&zh=true&gp=false&ev=Z&mr=1-12&bmo=1&emo=12&yr=all&byr=1900&eyr=2016 accessed 17 February 2018.

Data sources used in this assessment:

Birds Online http://nzbirdsonline.org.nz/species/new-zealand-pipit accessed 13 November 2018.

Dr M. Thorsen unpub. file notes.

6.4.5 *Species of biogeographic interest*

No bird species that are at their distribution limits or of other biogeographic interest were found within the PIA.

6.4.6 *Genetically or morphologically distinct forms*

No bird species within the PIA are thought to be of genetically or morphologically distinct forms.

6.4.7 *Importance overall of avifauna*

The ecological importance of the birds within the PIA is categorised as **moderate-low** on the basis of:

1) The presence of one At Risk species;
2) Bird species role in ecosystem function;
3) Low species diversity and abundance.

6.5 Herpetofauna Ecological Features

6.5.1 *Herpetofauna communities*

Four reptile species were recorded in the PIA: the skinks *Oligosoma maccanni* (clade 4 genotype), *Oligosoma polychroma* (clade 5 genotype) and *Oligosoma inconspicuum* and the gecko *Woodworthia* "Otago/Southland large". Densities of all these species are low with 0.6 individuals sighted per kilometre/1.2 individuals sighted per hour of search effort.

The McCann's skink *O. maccanni* (clade 4 genotype) is present in low to moderate numbers throughout the shrubland vegetation community and is absent from the majority of the exotic grassland. It is commoner in rocky sites and areas with good cover in the WRS zone. The total population within the PIA is estimate at 150 individuals based on encounter rate and quantity of habitat present

The southern grass skink *Oligosoma polychroma* (clade 5 form) is present infrequently in areas with denser vegetation or rock piles. The total population of this species within the PIA is estimated at 5 individuals based on encounter rate and quantity of habitat present.

The cryptic skink *Oligosoma inconspicuum* is rare in this area due to a shortage of suitable habitat. It was sighted in one area of rocks of the existing waste rock stack beside the road. This is anomalous habitat for this species as they are more typically an inhabitant of gully bottoms in the Macraes area. The possibility exists that this was a misidentification of a subadult skink of another species (both McCann's and southern grass skinks are known to occupy this habitat type at Macraes).

The korero gecko *Woodworthia* "Otago/Southland large" was noted in one location in Pit zone though it is likely to also be present on other areas of the PIA, particularly the rocky outcrops in the WRS zone. Only 1-5 individuals are likely to be present where it occurs in the PIA and the total population within the PIA is estimated at 30 individuals based on encounter rate and quantity of habitat present.

It can sometimes be difficult to detect all reptile species during a survey, and other species of reptile are known from the vicinity. Grand skink *Oligosoma grande* were recorded in 1995 2.7

km to the east, and Otago skink *Oligosoma otagense* have been recorded in 1992 from c. 6 km north and in 2003 c. 6 km to the south of the PIA. Neither species were seen in or near the PIA during this survey (the original sites were not resurveyed as they occur outside the PIA). As they have not been detected within the PIA during these surveys, it is considered highly unlikely that these two species are present within the PIA. Green skinks *Oligosoma chloronoton* were present nearby in the 1960's (Whitaker 1986), but there have been no recent records of this species from anywhere within the OceanaGold operational area, including during a ten day species-specific survey of the Macraes area in 2015 which included the valley immediately to the west of the PIA. It is considered unlikely that this species is still present within the PIA.

6.5.2 *Ecological function*

The four reptile species recorded in the PIA: the skinks *Oligosoma maccanni* (clade 4 genotype), *Oligosoma polychroma* (clade 5 genotype) and *Oligosoma inconspicuum* (if present) and gecko *Woodworthia* "Otago/Southland large" play an ecological role in regulating invertebrate numbers and in dispersing the fruit of native plants. They are also prey items of native birds such as falcon (not known from PIA).

6.5.3 *Species diversity*

Four reptile species is a moderate diversity in relation to other sites nearby, where seven species are known to occur in the area (excluding exotic amphibian species). The Not Threatened *Oligosoma maccanni* (clade 4 genotype) is of **moderate**[4] ecological importance.

[4] A value of 'low' is given using the EIANZ guidelines, but a value of 'moderate' is used here to reflect the larger reptile populations that occur in Central Otago relative to that in most of mainland New Zealand.

6.5.4 *Threatened, At Risk, or rare species*

Three of the reptile species are currently classified as At Risk: the skinks *Oligosoma polychroma* (clade 5 genotype) and *Oligosoma inconspicuum* and the gecko *Woodworthia* "Otago/Southland large".

Overall, these species are considered to be represented by small populations within the PIA when compared with those known at other nearby sites. This appears to be a result of the lack of high-quality habitat: complex rocky sites with a high diversity and dense cover of native shrubs and vines.

1. *Oligosoma polychroma* (Patterson & Daugherty 1990) (clade 5 genotype) (southern grass skink, Scincidae).

Southern grass skinks are currently classified as Declining on the basis of its population estimated to occupy >10,000 (100 km^2) with a predicted decline of 10-70% (Hitchmough et al. 2016). Previously it has been assessed in 2012 as Declining (Hitchmough et al. 2013) and Not Threatened in 2009 and 2005 (Hitchmough et al. 2010, Hitchmough et al. 2007). Within the wider Macraes area this species is frequently encountered at many sites and much of the suitable habitat is occupied. Nearby, a large lizard conservation programme run by DOC is benefitting this species (and others). Within the PIA this species has a local distribution mainly in well-vegetated sites.

The ecological importance of the population of this species within the PIA is categorised as **high** on the basis of its:

1) Declining conservation status.

2. *Oligosoma inconspicuum* (Patterson & Daugherty 1990) (cryptic skink, Scincidae).

Cryptic skinks are currently classified as Declining on the basis of its population estimated to occupy >10,000 (100 km^2) with a predicted decline of 10-70% (Hitchmough et al. 2016). Previously it has been assessed in 2012 as Declining (Hitchmough et al. 2013), Not Threatened in 2009 (Hitchmough et al. 2010) and Gradual Decline with the qualifiers Data Poor and Human Induced in 2005 (Hitchmough et al. 2007). Within the wider Macraes area this species is infrequently encountered in gully areas with good shrubland density or rock retreat sites. Nearby,

a large lizard conservation programme run by DOC is benefitting this species (and others). Within the PIA this species has a very local distribution and was seen at only one site.

The ecological importance of the population of this species within the PIA is categorised as **high** on the basis of its:

1) Declining conservation status.

3. *Woodworthia* "Otago/Southland large" (korero gecko, Gekkonidae).

Korero geckos are currently classified as Declining with the qualifier Partial Decline on the basis of its population estimated to total >100,000 mature individuals with a predicted decline of 10-70% (Hitchmough et al. 2016). Previously it has had the same assessment in 2012 and 2009 (Hitchmough et al. 2013, Hitchmough et al. 2010) and was assessed as Gradual Decline in 2005 (Hitchmough et al. 2007). Within the wider Macraes area this species is frequently encountered at many sites and most suitable habitat is occupied. Nearby, a large lizard conservation programme run by DOC is benefitting this species (and others). Within the PIA this species has a local distribution mainly in near larger rock outcrops. Korero geckos are also likely to be present in some of the smaller rock outcrops that are scattered through the steeper areas of the PIA.

The ecological importance of the population of this species within the PIA is categorised as **high** on the basis of its:

1) Declining conservation status.
2) Likely population size within the PIA.

6.5.5 *Species of biogeographic interest*

No reptile species that are at their distribution limits or of other biogeographic interest were recorded within the PIA.

6.5.6 *Genetically or morphologically distinct forms*

Genetically distinct genotypes of three of the reptile species are present in the PIA: skinks *Oligosoma maccanni* (clade 4 genotype) and *Oligosoma polychroma* (clade 5 genotype), and the gecko *Woodworthia* "Otago/Southland large".

Oligosoma polychroma (clade 5 genotype) (Liggins et al. 2008) and *Oligosoma maccanni* (clade 4 genotype) (O'Neill et al. 2008) are members of populations that are genetically distinct from other populations of these species.

The gecko *Woodworthia* "Otago/Southland large" is an unnamed entity within the *Woodworthia* genus that contains several other unnamed entities previously classified as *Woodworthia maculatus* (Hitchmough 1997, Jewell 2008, Nielsen et al. 2011). The population that occurs at Macraes is thought to represent a distinctive eastern form of this unnamed entity (Jewell 2008).

All three of these genetically distinct populations are widespread in the area. The eastern form of *Woodworthia* "Otago/Southland large" occurs at multiples sites between the Waitaki and Clutha Rivers inland to the Rock and Pillar Range (Jewell 2008). The Clade 5 genotype of *Oligosoma polychroma* is known to occur between Banks Peninsula, Mackenzie Basin, Central Otago, Southland and Stewart Island (Liggins et al. 2008). The Clade 4 genotype of *Oligosoma maccanni* is known from south of the Waitaki River through Central Otago east of the Dunstan Mountains to northern Southland (O'Neill et al. 2008).

6.5.7 *Importance overall of herpetofauna*

The ecological importance of the lizard populations within the PIA is categorised as **moderate** on the basis of:

1) The presence of three At Risk species;
2) The presence of genetically distinct lineages (that occur at multiple sites outside the PIA);
3) The role lizards are likely to be playing in ecosystem function;
4) The moderate species diversity and low to moderate abundance.

6.6 Invertebrate Ecological Features

6.6.1 *Invertebrate communities*

Sixty-eight invertebrate species were recorded in the PIA, however the eastern portion of the WRS has not been specifically surveyed and the surveyed area includes the hillslopes of the Taieri Ridge. Some of the specimens collected are awaiting ID. The invertebrate community identified to date is mainly a mix of exotic and indigenous species from the surrounding pasture, shrublands, low producing grassland, gullies and rock outcrops.

Some plant communities such as ephemeral wetlands could harbour distinctive invertebrate communities. However, the invertebrate fauna of New Zealand's ephemeral wetlands is poorly understood. From the literature, ephemeral wetlands in Canterbury typically have similar species richness to permanent wetlands and contain no unique aquatic invertebrate species (Burns *et al*., 1984; Wissenger *et al*., 2009) and are dominated by species with high-dispersal capabilities or species that can tolerate desiccation. This lack of uniqueness differs to similar ecosystems overseas which typically have a diverse array of temporary habitat specialists (Wellborn *et al.*, 1996; Urban, 2004). This discrepancy could either be a result of incomplete studies, or that New Zealand's erratic climate causes an irregular cycle of wetland wetting and drying, preventing the evolution of temporary habitat specialists.

A species of particular interest to ephemeral wetlands in the Macraes E.D. is the clam shrimp *Eulimnadia marplesi* (Timms and McLay, 2005). This species is known from ephemeral wetlands near Sutton and is classified as 'Nationally Critical' by the Department of Conservation (Grainger *et al*., 2018). Recent efforts have failed to relocate this species. Other rare wetland species are known to occur in the Macraes E.D., but it is not known if they occur within ephemeral wetlands.

Significant gaps exist within the knowledge of New Zealand's ephemeral wetland invertebrate fauna, particularly around their use of these habitats during their 'dry phase', and for non-aquatic species such as the Diptera and Lepidoptera that have been observed in ephemeral wetlands at Macraes.

6.6.2 *Ecological function*

The invertebrate communities (both exotic and indigenous) are likely to be playing a very important role in their ecosystems through pollination, as disease vectors, competition, herbivory, predation, litter decomposition, soil formation, and as a food source for fish, birds and reptiles. Some species (both exotic and indigenous) are likely to be serious pasture pests.

6.6.3 *Species diversity*

The invertebrate diversity in the groups sampled appeared to be moderate as the 68 species recorded is 84% of the 81 species recorded in Patrick (1997) or on NatureWatch for the Taieri Ridge area. However, only 7 species are shared between these lists.

6.6.4 *Threatened, At Risk, or rare species*

None of the invertebrate species identified to date from within the PIA is currently classified as Threatened, At Risk or rare.

6.6.5 *Species of biogeographic interest*

No invertebrate species that are known as at their distribution limits or of other biogeographic interest were recorded within the PIA, however the distribution of many of New Zealand's invertebrates are poorly known and the species present in the PIA that may be of biogeographic interest.

6.6.6 *Genetically or morphologically distinct forms*

No distinct morphotypes or genotypes are present in the invertebrate species identified to date, however many invertebrate groups are known for variation in their appearance and some are postulated as distinct, unnamed taxa. Three examples of this are present in the invertebrate species in the PIA: *Harmologa* sp. A, *Orocrambus* sp. B of NZAC, *Tingena* sp. cf. *siderodeta*. All are widespread Lepidoptera. The specimen of *Apoctena* cf. *conditana* differs in colouration

from most of the specimens of this species in the NZ Arthropod Collection, but its genitalia are similar.

6.6.7 *Importance overall of invertebrate fauna*

The ecological importance of the invertebrate communities within the PIA is categorised as **moderate** on the basis of:

1) Moderate diversity and mostly low to moderate density of indigenous species;
2) The importance of invertebrates in ecosystems.
3) The lack of information on invertebrate distribution and ecology.

6.7 Sites or communities identified as significant in regional planning documents

6.7.1 *Otago Regional Council Regional Policy Statement*

Using the criteria within Policy 10.5.2 of the 1998 Otago Regional Policy Statement 10: Biota, the low-producing grassland, seepages, ephemeral wetlands and shrubland vegetation type within the Deepdell North III impact area is considered **significant** as they are, or contain, species or vegetation that meet the criteria specified in Policy 10.5.2(b) "*habitat or vegetation that support the maintenance or recovery of indigenous species that are uncommon or threatened with extinction (rare, vulnerable or endangered) regionally or nationally"*, these being the 17 species listed in Sections 6.3, 6.4.4 and 6.5.4.

6.7.2 *Otago Regional Council Proposed Regional Policy Statement*

Using the criteria in Schedule 4 of Policy 3.2.1, and with regards to Policies 5.3.5 and 5.4.8, of the Partially Operative Otago Regional Policy Statement 2019:

Criteria 1. Representativeness

The seasonal gully drainage, ephemeral wetland, seepages, low-producing grassland and shrubland vegetation types described in 5.2.1 are **significant** under Criteria 1 in that they are "*an example of an indigenous vegetation type or habitat that is typical or characteristic of the natural diversity of the relevant ecological district. This may include degraded examples of their type or represent all that remains of indigenous vegetation and habitats of indigenous fauna in some areas*."

Criteria 2. Rarity

The 17 species listed in Sections 6.3, 6.4.4 and 6.5.4 are **significant** under a. of Criteria 2 in that they are "a*n indigenous species that is threatened, at risk, or uncommon, nationally or within an ecological district*".

The areas of indigenous vegetation that occur on the mapped areas of LENZ categories L1.3a and N3.1e (both classified as having 10% of their natural vegetation remaining nationally) and Q4.3b (classified as having 10-20% of their natural vegetation remaining nationally) (see Section 6.2.7.1) are **significant** under b of Criteria 2 in that they have been mapped as "*Indigenous vegetation or habitat of indigenous fauna that has been reduced to less than 20% of its former extent nationally, regionally or within a relevant land environment, ecological district, or freshwater environment including wetlands*". The natural vegetation communities at these

sites are areas of low-producing grassland, shrublands, seepage, ephemeral wetland and seasonal gully drainages totalling 88.7 ha (Table 4).

The ephemeral wetlands and seepage wetland that occur in the PIA are considered **significant** under c. of Criteria 2 "*indigenous vegetation and habitats within originally rare ecosystems*".

Plant community	L1.3a	N3.1e	Q4.3b	Total
Ephemeral Wetland	0.1	0.2		0.3
Low producing grassland	17.7	32.5	22.9	73.0
Seepage	0.1			0.1
Shallow Ephemeral Drainage System	4.2			4.2
Shrublands	0.0	6.0	5.1	11.1
Total	22.1	38.7	27.9	88.7

Table 4. Extent of natural vegetation in the PIA occurring on mapped extent of LENZ classified as having less than 20% of their national area being covered by indigenous vegetation.

Criteria 3. Diversity

The vegetation communities are considered **not significant** under Criteria 3 "*an area that supports a high diversity of indigenous vegetation and habitats of indigenous fauna or consists of a diverse range or sequence of interrelated vegetation and habitat types*" as 1) the number of species that occurs in each community is not diverse relative to other examples of that vegetation community in the area; 2) the diversity of habitats of indigenous fauna is lower than the diversity of habitats that occur in the surrounding area; 3) none contain a diverse range or sequence of vegetation types.

Criteria 4. Distinctiveness.

The terrestrial ecological features are considered **not significant** under a. of Criteria 4 "*indigenous species at their distributional limit within Otago or nationally*" as none of the species recorded is at its distributional limit either nationally or within the Otago Regional Council territorial area.

The terrestrial ecological features are considered **not significant** under b. of Criteria 4 "*indigenous species that are endemic to the Otago region*" as none of the species is known to be endemic to the Otago Regional Council territorial area.

The seasonal gully drainage and ephemeral wetlands within the PIA are considered **significant** under c. of Criteria 4 "*indigenous vegetation or an association of indigenous species that is distinctive, of restricted occurrence, or has developed as a result of an unusual environmental factor or combinations of factors*" as the ephemeral wetland is a distinctive vegetation community within Otago Regional Council territorial area, both the ephemeral wetland and seasonal gully drainage vegetation communities are of restricted occurrence within the Otago Regional Council territorial area and both have developed as a result of unusual environmental factors (low rainfall, and flat or gently sloping terrain).

Criteria 5. Ecological Context.

The terrestrial ecological features are considered **not significant** under a. of Criteria 5 "*an area that has important connectivity value allowing dispersal of indigenous vegetation and fauna between different areas*" as though there is some connectivity between this site and adjoining sites, this connectivity is not considered important in a regional context.

The terrestrial ecological features are considered **not significant** under b. of Criteria 5 "*an important buffering function that helps to protect the values of an adjacent area or feature*" as though there is some buffering between this site that may help protect the values of the adjacent areas, this buffering is not considered important in a regional context.

The terrestrial ecological features are considered **not significant** under c. of Criteria 5 "*an area that is important for indigenous fauna during some part of their life cycle, either regularly or on an irregular basis, e.g. for feeding, nesting, breeding, or refuges from predation*" as though there is some use of this site for breeding, feeding, as a refuge and for other purposes, this usage is not considered important in a regional context for the species.

6.7.3 *Otago Regional Council Regional Plan: Water for Otago*

The PIA contains no Regionally Significant Wetlands or Wetland Management Areas listed in Schedule 9 of the Regional Plan: Water for Otago.

6.8 Sites or communities identified as significant in district planning documents

6.8.1 *Waitaki District Council District Plan*

The indigenous vegetation communities within the PIA were assessed using the criteria within Policy 16.9.3 of the 2010 Waitaki District Council District Plan, and the ephemeral wetlands, seepage wetland, low-producing grassland, seasonal gully drainage and shrubland vegetation types within the Deepdell North III impact area is considered **significant** as they are, or contain, species or vegetation that meet criteria:

i) *Representativeness*

The area supports an example of a particular vegetation type, habitat or ecological process that is typical of the ecological district relative to the pre-European baseline and contributes to maintaining the appropriate proportional representation of that feature;

In addition, the ephemeral wetlands, seepage wetland, low-producing grassland and shrubland vegetation communities are **significant** as they contain rare species that meet criteria:

ii) *Rarity and distinctiveness*

The area supports an indigenous species, habitat or community, which is rare and vulnerable within the ecological district or threatened nationally;

None of the exotic vegetation types are considered significant using the criteria outlined above.

6.9 Summary of ecological features identified as significant in district or regional planning documents

Vegetation Community	Significant Under operative RPS?	Significant under OPRPS?	Significant under WDC District Plan?
Cultivated Pasture			
Ephemeral Wetland	✓ (habitat of rare species)	✓ (representativeness, distinctiveness, rarity)	✓ (representativeness, rarity)
Low-producing grassland	✓ (habitat of rare species)	✓ (rarity)	✓ (representativeness, rarity)
Seasonal gully drainage		✓ (representativeness, rarity, distinctiveness)	
Shrublands	✓ (habitat of rare species)	✓ (representativeness, rarity)	✓ (representativeness, rarity)
Seepage	✓ (habitat of rare species)	✓ (representativeness, rarity)	✓ (representativeness, rarity)
Plant species		✓ (rarity)	✓ (rarity)
Avifauna		✓ (rarity)	✓ (rarity)
Herpetofauna		✓ (rarity)	✓ (rarity)
Invertebrates			

6.10 Summary Table of Ecological Features

Ecological Feature Class	Ecological Feature Type	Ecological Feature	Classification of Feature	Buffer	Pit	WRS	PIA	Unit of Measurement	Accuracy of measurement	Ecological Importance of Feature
Bird	Community	Ecological function								Moderate
Bird	Species	Pipit	Declining				2	individuals	Counted	Moderate
Bird	Species	Black-backed gull					45	individuals	Counted	Low
Bird	Species	Grey teal					6	individuals	Counted	Low
Bird	Species	Grey warbler					10	individuals	Estimated	Low
Bird	Species	Harrier hawk					1	individuals	Counted	Low
Bird	Species	Paradise shelduck					6	individuals	Counted	Low
Bird	Species	Spur-winged plover					8	individuals	Estimated	Low
Bird	Species	Welcome swallow					5	individuals	Estimated	Low
Environment	LENZ	Cultivated Pasture	< 10% indigenous cover left	26.39	29.16	24.93	80.49	Hectares	Measured	
Environment	LENZ	Ephemeral Wetland	< 10% indigenous cover left	0.02		0.3	0.31	Hectares	Measured	
Environment	LENZ	Low producing grassland	< 10% indigenous cover left	13.24	7.8	29.11	50.15	Hectares	Measured	
Environment	LENZ	Seasonal gully drainage	< 10% indigenous cover left	1.79	0.5	1.91	4.2	Hectares	Measured	
Environment	LENZ	Seepage	< 10% indigenous cover left			0.07	0.07	Hectares	Measured	

Environment	LENZ	Shelterbelts & Exotic Trees	< 10% indigenous cover left	0.08		0.53	0.61	Hectares	Measured	
Environment	LENZ	Shrublands	< 10% indigenous cover left	3.17	0.08	2.79	6.04	Hectares	Measured	
Environment	LENZ	Threatened LENZ with indigenous vegetation	< 10% indigenous cover left	5.26	1.7	15.14	22.09	Hectares	Measured	
Environment	LENZ	Threatened LENZ with indigenous vegetation	< 10% indigenous cover left	12.95	6.68	19.04	38.67	Hectares	Measured	
Environment	LENZ	Low producing grassland	10-20% indigenous cover left	11.58	0.96	10.36	22.89	Hectares	Measured	
Environment	LENZ	Shrublands	10-20% indigenous cover left	4.2		0.86	5.05	Hectares	Measured	
Environment	LENZ	Threatened LENZ with indigenous vegetation	10-20% indigenous cover left	15.77	0.96	11.21	27.94	Hectares	Measured	
Flora	Community	Ephemeral Wetland	Critically Endangered Historically Uncommon ecosystem type	0.02		0.3	0.31	Hectares	Measured	High
Flora	Community	Seepage	Endangered Historically Uncommon ecosystem type			0.07	0.07	Hectares	Measured	High
Flora	Community	Cultivated Pasture		26.39	29.16	24.93	80.49	Hectares	Measured	Negligible
Flora	Community	Low producing grassland		24.82	8.76	39.47	73.04	Hectares	Measured	Moderate
Flora	Community	Seasonal gully drainage		1.79	0.5	1.91	4.2	Hectares	Measured	Low
Flora	Community	Shelterbelts & Exotic Trees		0.08		0.53	0.61	Hectares	Measured	Negligible
Flora	Community	Shrublands		7.36	0.08	3.65	11.09	Hectares	Measured	Moderate
Flora	Community	Ecosystem services								Minor
Flora	Community	Historically Rare or Threatened Ecosystems				2	2	Communities		

Flora	Community	Integrity								Moderate
Flora	Community	National Priorities for Protection				2	2	Communities		
Flora	Community	Rarity								High
Flora	Community	Representativeness								Moderate
Flora	Community	Sites recommended for protection					0	Sites		Nil
Flora	Community	Wetlands of National Importance or Ramsar sites					0	Sites		Nil
Flora	Species	Carmichaelia crassicaulis Hook.f. subsp. crassicaulis	Declining	15		2	17	individuals	Counted	High
Flora	Species	Carmichaelia petriei Kirk	Declining	10		7	17	individuals	Counted	High
Flora	Species	Discaria toumatou Raoul	Declining	7.36	0.08	3.65	3.73	Hectares	Estimated	High
Flora	Species	Juncus pusillus Buchenau	Declining			1	1	m^2	Estimated	Moderate
Flora	Species	Leptinella pusilla Hook.f.	Declining			1	1	m^2	Estimated	High
Flora	Species	Lobelia ionantha Heenan	Declining			0.561	0.561	m^2	Estimated	High
Flora	Species	Rytidosperma buchananii (Hook.f.) Connor & Edgar	Declining			1	1	individuals	Counted	Low
Flora	Species	Carex resectans Cheeseman	Locally Uncommon			1.6	1.6	m^2	Estimated	Moderate
Flora	Species	Melicope simplex A.Cunn.	Locally Uncommon			11	11	individuals	Counted	Moderate
Flora	Species	Myrsine divaricata A.Cunn.	Locally Uncommon			2	2	individuals	Counted	Moderate
Flora	Species	Anthosachne falcis (Connor) Barkworth & S.W.L.Jacobs	Naturally Uncommon				100	individuals	Estimated	High
Flora	Species	Carex subtilis K.A.Ford	Naturally Uncommon			1	1	individuals	Counted	Moderate

Flora	Species	Juncus distegus Edgar	Naturally Uncommon			369	369	m^2	Estimated	Moderate
Flora	Species	Juncus distegus Edgar	Naturally Uncommon			56	56	individuals	Estimated	Moderate
Flora	Species	Diversity								Moderate
Invertebrates	Community	Overall importance								Moderate
Reptiles	Community	Overall importance								Moderate
Reptiles	Species	*Oligosoma inconspicuum*	Declining		1			individuals	Counted	High
Reptiles	Species	*Oligosoma polychroma* (clade 5 genotype)	Declining				5	individuals	Estimated	High
Reptiles	Species	*Woodworthia* "Otago/Southland large"	Declining				30	individuals	Estimated	High
Reptiles	Species	*Oligosoma maccanni* (clade 4 genotype)					150	individuals	Estimated	Moderate

7 Project Impact on Ecological Features

7.1 Assessing Project Impact

The impact of the project on the ecological features, at both a local and national scale, is assessed by considering the effects of the project activities (Section 7.3) identified as having a potential to impact on the ecological features (Section 6, summarised in Section 6.10), within the area identified as the PIA (Section 5.3) against the current ecological condition and permitted baseline/existing environment (Section 5.1). The magnitude of the effect on the ecological feature is assessed at both a local (within approximately 10 km of the site) and national scale based on Table 8 of the 2018 EIANZ guidelines. An overall effect of the project on the ecological feature at a national scale is based on Table 10 of the EIANZ guidelines. An indication of the confidence in the assessment is provided.

The assessment of effect on the vegetation is in Sections 7.3, 7.4, 0, avifauna in Section 7.6, herpetofauna in Section 7.7 and invertebrates in Section 7.8.

A summary of the project impacts is provided in Section 7.9.

7.2 Cumulative effects

Some projects that have staged implementations, such as OceanaGold's Macraes mine, can have effects from previous projects that accumulate over time and act in conjunction to produce an overall effect greater than envisioned at the project stage. These cumulative effects can be difficult to discern. The Macraes gold project has now impacted 1,250 ha, an unknown proportion of which was previously indigenous vegetation. Each project has implemented an impact management procedure to address project effects, and these are considered to be achieving their objectives of minimising the environmental impact of the mine's operations. Currently there are no cumulative effects known beyond the impact on the ecological features of each project.

There may be other cumulative effects arising from surrounding land use by pastoral activities and the spread of pests, weeds and diseases. These effects are very hard to measure, and beyond the scope of this assessment.

Any cumulative effects that are occurring are likely to show in reduced extent in quality and quantity of the current indigenous vegetation communities and fauna populations. It is against this benchmark, which includes unknown cumulative effects, that this project's effects are evaluated.

7.3 Project activities likely to affect ecological features

The following have been identified as project activities which are likely to result in an effect on the PIA's ecological features. Ecological feature-specific impacts are assessed in Section 7.3 to 7.8, but general effects are discussed here.

7.3.1 *Excavation of Pit*

Removal of overburden and ore material from the pit will be through bed-rock blasting and removal of material using heavy machinery moving along a haul road graded into the ground surface. This activity will result in the removal of all vegetation from the Pit zone.

7.3.2 *Deposition of rock material in the Waste Rock Stack*

The overburden and rock remnants of the processed ore will be deposited by heavy machinery in a Waste Rock Stacks (WRS). This activity will bury all vegetation within the WRS zone.

7.3.3 *Sediment run-off*

The unconsolidated fine rock and dust that will be deposited with the rock material into the WRS will, if uncontained, be washed into the waterways that lead from the WRS. This could, if unmanaged, inundate areas of streambed vegetation under a layer of sediment that could extend for 100m or more downstream.

7.3.4 *Effect of changes in weed populations*

Importation of weed species, either directly through seed contamination of equipment or material, or indirectly by creating favourable establishment sites, could, if unchecked, transform habitats in the surrounding area, making them unsuitable for some species. The severity of this effect depends on the nature of the weed species and the ability to detect and manage an emerging weed problem.

7.3.5 *Displacement of pests into surrounding area*

Project activities are likely to cause resident pests such as pigs, rabbits, hares, mustelids and rodents to move into the surrounding area, where they will increase browsing and predation on the surrounding areas' fauna and flora. This effect is likely to be temporary.

7.3.6 *Displacement of resident animals*

Some animal species, particularly birds, will be displaced from the PIA as a result of project activities. These displaced individuals will compete with individuals from the surrounding area. As the surrounding area is assumed to be at carrying capacity, this competition will eventually result in the mortality of either the displaced or resident individuals.

7.3.7 *Noise*

Blasting and operating heavy machinery creates considerable noise. Any adverse effects due to noise are likely to be species specific depending in part on the auditory ability of the species and the frequency and proximity of the noise. Previous exposure to such noise is also likely to be important. Plants are not susceptible to noise impacts.

7.3.8 *Wind-blown dust*

Dust could be generated from exposed surfaces (such as roads or deposition areas) at higher wind speeds and at lower speeds from such surfaces disturbed by machinery and vehicle movements. Dust is actively managed within existing Macraes mine operations, and as a result the activities onsite produce very little wind-blown dust. Noticeable dust accumulation only occurs within the immediate vicinity (<100m) of mine works. Within this zone there is likely to be some reduction in a plant's photosynthetic capacity, potentially resulting in a loss of growth and reproductive output.

7.3.9 *Artificial lighting*

The project may use artificial lighting during night operations. Strong artificial lighting can cause either a negative or positive reaction in animals, depending on species. Moths in particular are drawn to these lights and this can disrupt their foraging and mating. Insect accumulations around lights could also attract nocturnal predators such as little owl, which are not known in area, but are possibly present. No seabirds are known to fly near the PIA, and therefore there is no risk of artificial lighting disorienting overflying seabirds. Other nocturnal species are likely to avoid brightly lit areas. The intensity of project lighting is not of a level that it would affect plant growth.

7.3.10 *Accidental fire*

The Macraes environment is often dry, and accidental fires, if unmanaged, have the potential to burn large areas.

7.3.11 *Changed hydrological regimes*

Excavation of the pit may result in decreased surface and subsurface flow of water into some water courses.

7.4 Impact on Vegetation Communities

The proposal involves the clearance of approximately 54.74 ha of indigenous vegetation, and 54.62 ha of exotic vegetation (Table 5. Extent of vegetation types in area where loss is expected to be total (within the pit and WRS boundaries) and area where there may be some impact from project activities (area within 100 m buffer).).

In addition, there may be some effect on the surrounding vegetation resulting from project activities extending to 100 m beyond the project area (the Buffer in Table 5) of 33.99 ha of indigenous vegetation and 26.47 ha of exotic vegetation.

The extent of each vegetation type in each of these areas is provided in Table 5.

Vegetation Community	Pit	WRS	Buffer	PIA	Area within Macraes E.D.[5]	Estimated % loss resulting from project
Exotic vegetation communities	*29.16*	*25.46*	*26.47*	*81.1*		
Cultivated Pasture	29.16	24.93	26.39	80.49	79635.17	0.10
Shelterbelts & Exotic Trees		0.53	0.08	0.61	4607.59	0.01
Semi-natural vegetation communities	*9.34*	*45.4*	*33.99*	*88.71*		
Ephemeral Wetland		0.30	0.02	0.31	30.73[6]	<1.01
Low producing grassland	8.76	39.47	24.82	73.04	11957.08	0.61
Seepage		0.07		0.07	43.23[7]	0.16
Shallow Ephemeral Drainage System	0.50	1.91	1.79	4.20	?	?
Shrublands	0.08	3.65	7.36	11.09	3547.15	0.31
Total	**38.49**	**70.85**	**60.46**	**169.81**	**99820.95**	**0.17**

Table 5. Extent of vegetation types in area where loss is expected to be total (within the pit and WRS boundaries) and area where there may be some impact from project activities (area within 100 m buffer).

Effect of sediment run-off

Moderate effect on gully-side vegetation only as stream bed sedimentation, if uncontrolled, could cause an increase in wet, bare ground which is usually colonised by weed species. This is expected to be more of a risk in the gullies exiting the Deepdell South pit backfill WRS area.

Effect of changes in weed populations

Minor to major effect, if uncontrolled, on all vegetation communities, depending on weed species involved.

Effects of displacement of pest animals

Minor effect on many communities as most pest species will already also be present in the surrounding area. Effect is expected to be temporary as pest species leave the area.

[5] As mapped in Landcover Database 4.1 from 2012 satellite imagery,

[6] Based from incomplete mapping

[7] Based on results from Landcare map of vegetation of Macraes E.D.

Effects of dust

Minor to moderate effect, if uncontrolled, on vegetation communities immediately adjacent to project boundaries. Most lowland to montane plant communities do not seem to be dramatically affected by dust at the sites where they occur close to gravel roads. The effect of dust on vegetation surrounding existing mine operations appears to be confined to less than 10 m where dust coating can be obvious, but no obvious effects have been observed on plant health or mortality. Beyond 10 m the dust coasting is lessened and is regularly removed by rainfall. This is the effect that is expected in the Deepdell North III project.

Effects of accidental fire

Minor to major effect, if uncontrolled, depending on moisture content of vegetation community and whether it occurs in natural fire refugia where it is unlikely that heat levels would reach a level sufficient to effect plant health.

Changed hydrological regimes

Nil to minor effect depending on vegetation community and location. Water draw-down and altered subsurface flow is expected to result in a limited degree of drying of the unimpacted downstream areas of the seasonal gully waterways. This is unlikely to substantially alter the remaining indigenous character of this vegetation type as it is currently already subjected to summer-drying.

Changes in vegetation extent in the Macraes E.D. between 2008 and 2012.

The extent of the vegetation communities in the Macraes E.D. is changing over time. Table 6 gives the estimated change in extent for the plant communities present in the PIA. The plant communities showing the largest changes in extent over that time period are cultivate pasture which has more than doubled in extent and the loss of nearly half of the low producing grasslands. In the Otago area (for where analysis is available) the increase in extent of cultivated pasture has been a result of conversion of low producing grassland and clearance of exotic gorse and broom shrubland. The loss of low producing grassland has been through conversion to cultivated pasture, succession into fernland and invasion by exotic gorse and broom shrubland. Information is not available to assess changes in the other vegetation communities.

Vegetation Community	Area within Macraes E.D. in 2008	Area within Macraes E.D. in 2012	% change in extent 2008 to 2012
Exotic vegetation communities			
Cultivated Pasture	29872.15	79635.17	166.6
Shelterbelts & Exotic Trees	4514.2	4607.59	2.1
Semi-natural vegetation communities			
Ephemeral Wetland	?	162.39[8]	?
Low producing grassland	57760.15	11957.08	-79.3
Seepage	?	43.23[9]	?
Shallow Ephemeral Drainage System	?	?	?
Shrublands	3522.7	3547.15	0.7

Table 6. Changes in vegetation community extent in the Macraes E.D. between 2008 and 2012

Overall effect on the seasonal gully drainage vegetation community

The result of these project effects will be a reduction by 2.41 ha of this vegetation community in the extent of this community and minor changes to the 1.79 ha in the buffer area. The extent of this community locally or nationally is not known, and therefore the consequence of this reduction in area is difficult to assess. However, this vegetation community in the PIA is heavily modified by exotic species.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the vegetation community.

This vegetation community is assessed as having **low** ecological importance.

The magnitude of the project's impact on this vegetation community at a local scale is assessed as **moderate**, and at a national level as **low**.

The overall degree of the project's effect on this vegetation community is **very low**.

The confidence of this assessment is **low** as this vegetation community is of uncertain distinctiveness and its distribution in the wider area is unknown.

[8] Based on mapping in 2019

[9] Based on results from 2018 Landcare map of vegetation of Macraes E.D.

Overall effect on the ephemeral wetland vegetation community

The result of these project effects will be a loss of 0.32 ha of this vegetation community from 7 sites. The extent of this vegetation community in the Otago region is unknown, but mapping of this community in the Macraes E.D. (Figure 5) identified at least 1,360 ephemeral wetlands covering 162.39 ha (and at least a further 218 possible examples) mostly in the southern and western parts of the ecological district. The ecological integrity of the ephemeral wetlands in this area is unknown, but nearly all are dominated by exotic grasses and the majority have only 1-4 indigenous species present (Author pers. obs.). Ephemeral wetlands are known habitat for a number of rare plants (Johnson and Rogers, 2003), but these are present only in a few of the sites that are inspected and seem to be lost from sites following invasion by sward farming grasses. They may be particularly at risk of this if grazing is removed (Author pers. obs.). The ephemeral wetlands in the PIA are all dominated by exotic species, and all but 4 (ephemeral wetlands A [10 indigenous species], B, C [both with 5 indigenous species], G [4 indigenous species]) have a low diversity of indigenous plant species. Ephemeral wetlands F and A are particularly deep examples for their type and size. Therefore, it is considered that the impact of this project on ephemeral wetlands of this type will result in an approximately 0.2% reduction in extent of the vegetation community in the Macraes E.D. and about a 0.5% reduction in the number of sites within the Macraes E.D. The loss in the PIA being represented by sites with mostly moderate indigenous plant component and including some rare plant species (see also Section 6.6.1 for consideration of invertebrate communities inhabiting this habitat). This vegetation community is a Historically Rare and Threatened plant community.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the vegetation community.

This vegetation community is assessed as having **high** ecological importance.

The magnitude of the project's impact on this vegetation community at a local scale is assessed as **high**, and at a national level as **moderate**.

The overall degree of the project's effect on this vegetation community is **high**.

The confidence of this assessment is **low-moderate** as though this vegetation community is distinctive, it is difficult to map using available aerial imagery and therefore its extent in the Macraes E.D. or in Otago is largely unknown. The ecological integrity of these sites is mostly unknown.

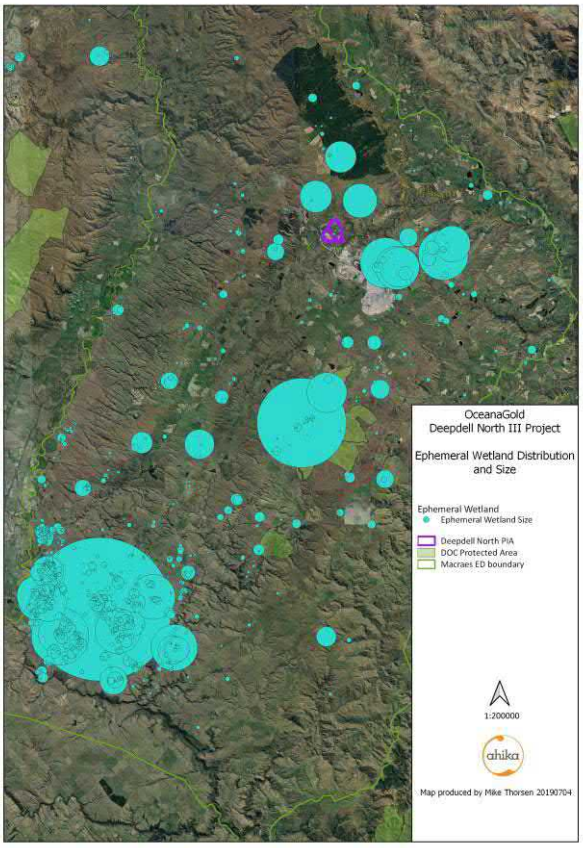

Figure 5. Mapped locations and size of ephemeral wetlands in the vicinity of Macraes E.D. Symbol size based on mapped area of the wetland and is centred on wetland location.

Overall effect on the seepage wetland vegetation community

The result of these project effects will be a loss of 0.07 ha of this vegetation community at 1 site. The extent of this vegetation community in the Otago region is unknown. Wetlands (of which seepage wetlands are a subclass) are mapped by Manaaki Whenua as covering 43.23 ha in the Macraes E.D., though the accuracy of this map is yet to be evaluated. The extent of the seepage wetland in the PIA represents 0.16% of the mapped wetlands in the Macraes E.D. The example in the PIA is highly degraded but is dominated by one rare indigenous rush. This vegetation community is a Historically Rare and Threatened plant community.

Therefore, the impact of this project is assessed as having an **adverse**, **indirect**, **temporary**, **reversible**, **local impact** on the vegetation community.

This vegetation community is assessed as having **high** ecological importance.

The magnitude of the project's impact on this vegetation community at a local scale is assessed as **moderate**, and at a national level as **low**.

The overall degree of the project's effect on this vegetation community is **low**.

The confidence of this assessment is **low**-**moderate** as though this vegetation community is distinctive, it is difficult to map using available aerial imagery and therefore its extent in the Macraes E.D. or nationally is largely unknown. The ecological integrity of these sites is mostly unknown.

Overall effect on the low-producing grassland vegetation community

The result of these project effects will be a reduction by 48.23 ha of this vegetation community in the extent of this community and minor changes to the 24.82 ha in the buffer area. This vegetation community has been mapped from satellite photography as covering 11,957 ha in the Macraes E.D. (Figure 6), and the area within the PIA represents 0.6% of this extent. Between 2008 and 2012, low-producing grassland coverage decreased by 80% in the Macraes E.D. and this loss appears to be continuing with ongoing conversion to high-producing exotic pasture and reversion to exotic or indigenous shrubland.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the vegetation community.

This vegetation community is assessed as having **moderate** ecological importance.

The magnitude of the project's impact on this vegetation community at a local scale is assessed as **moderate**, and at a national level as **low**.

The overall degree of the project's effect on this vegetation community is **low**.

The confidence of this assessment is **moderate-low** as this vegetation community can be very difficult to map accurately from satellite images, particularly when it is of a fragmented nature or been oversown and grazed such as which occurs over much of the Macraes E.D.

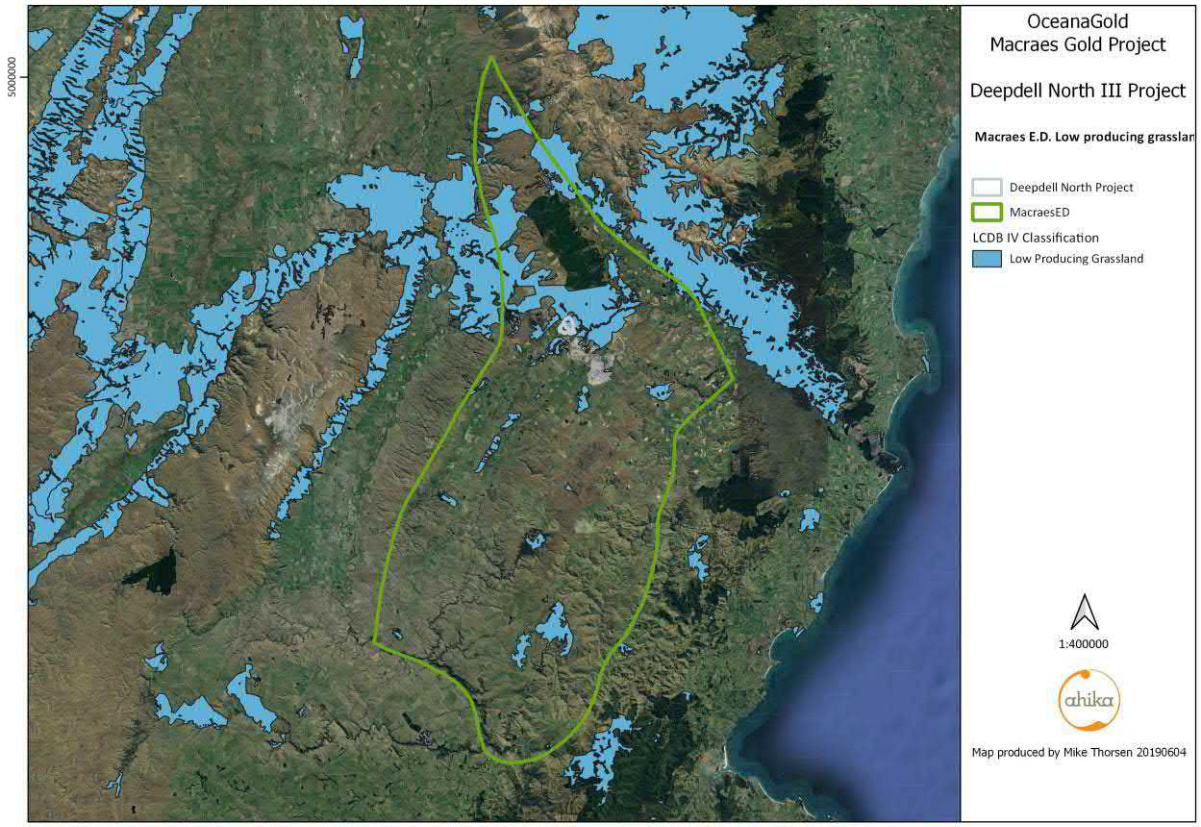

Figure 6. Distribution of low producing grassland vegetation community in the vicinity of Macraes E.D.

Overall effect on the shrubland vegetation community

The result of these project effects will be a reduction by 3.73 ha of this vegetation community in the extent of this community and minor changes to the 7.36 ha in the buffer area. This vegetation community has been mapped from satellite photography as covering 3,547 ha in the Macraes E.D. (Figure 7), and the area within the PIA represents 0.3% of this extent. Between 2008 and 2012, shrubland coverage increased by 0.7% in the Macraes E.D. This vegetation community is well-known as being seral and quickly invading farmland in the Macraes E.D., unless prevented from doing so. The extent of this type of vegetation community is probably greatly affected by farming profitability (especially funds available for vegetation control) and extent decreases when farm profitability is high and large areas of low-diversity and low stature shrublands develop when farm profitability is low.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the vegetation community.

This vegetation community is assessed as having **moderate** ecological importance.

The magnitude of the project's impact on this vegetation community at a local scale is assessed as **low**, and at a national level as **negligible**.

The overall degree of the project's effect on this vegetation community is **very low**.

The confidence of this assessment is **moderate** as this vegetation community can be very difficult to map accurately from satellite images, particularly when it is of a fragmented nature as which occurs over much of the Macraes E.D.

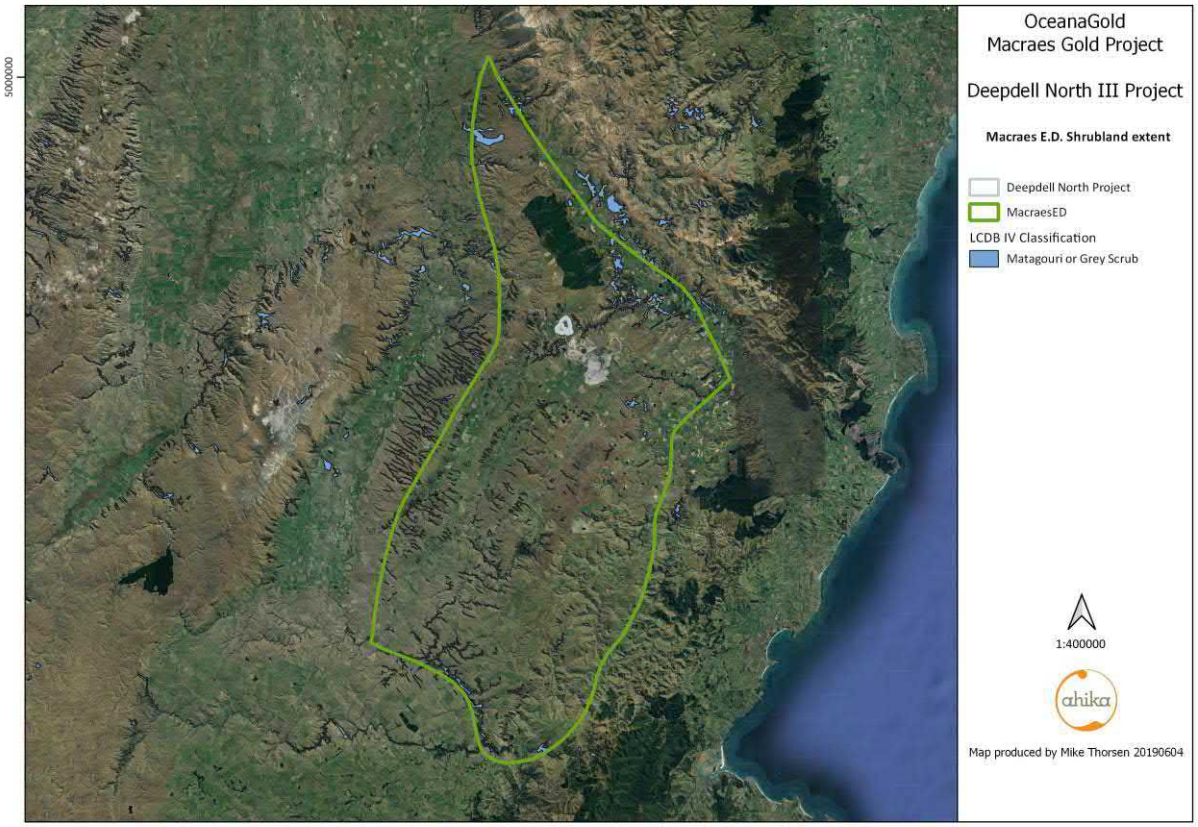

Figure 7. Distribution of shrubland vegetation community in the vicinity of Macraes E.D.

Overall effect on the cultivated pasture vegetation community

The result of these project effects will be a reduction by 54.09 ha in the extent of this exotic vegetation community and minor changes to the 26.39 ha in the buffer area. This vegetation community provides habitat for some common exotic bird species and may be used for foraging by indigenous harrier hawks, paradise shelduck, black-backed gull and spur-winged plover. This vegetation community has been mapped from satellite photography as covering 79,635 ha in

the Macraes E.D. (Figure 8), and the area within the PIA represents 0.1% of this extent. Between 2008 and 2012, cultivated pasture coverage increased by 166% in the Macraes E.D.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the vegetation community.

This vegetation community is assessed as having **negligible** ecological importance.

The magnitude of the project's impact on this vegetation community at a local scale is assessed as **low**, and at a national level as **negligible**.

The overall degree of the project's effect on this vegetation community is **very low**.

The confidence of this assessment is **moderate-high** as this vegetation community is readily discernible in satellite images, except when it is reverting to low-producing grassland, shrublands or weed communities.

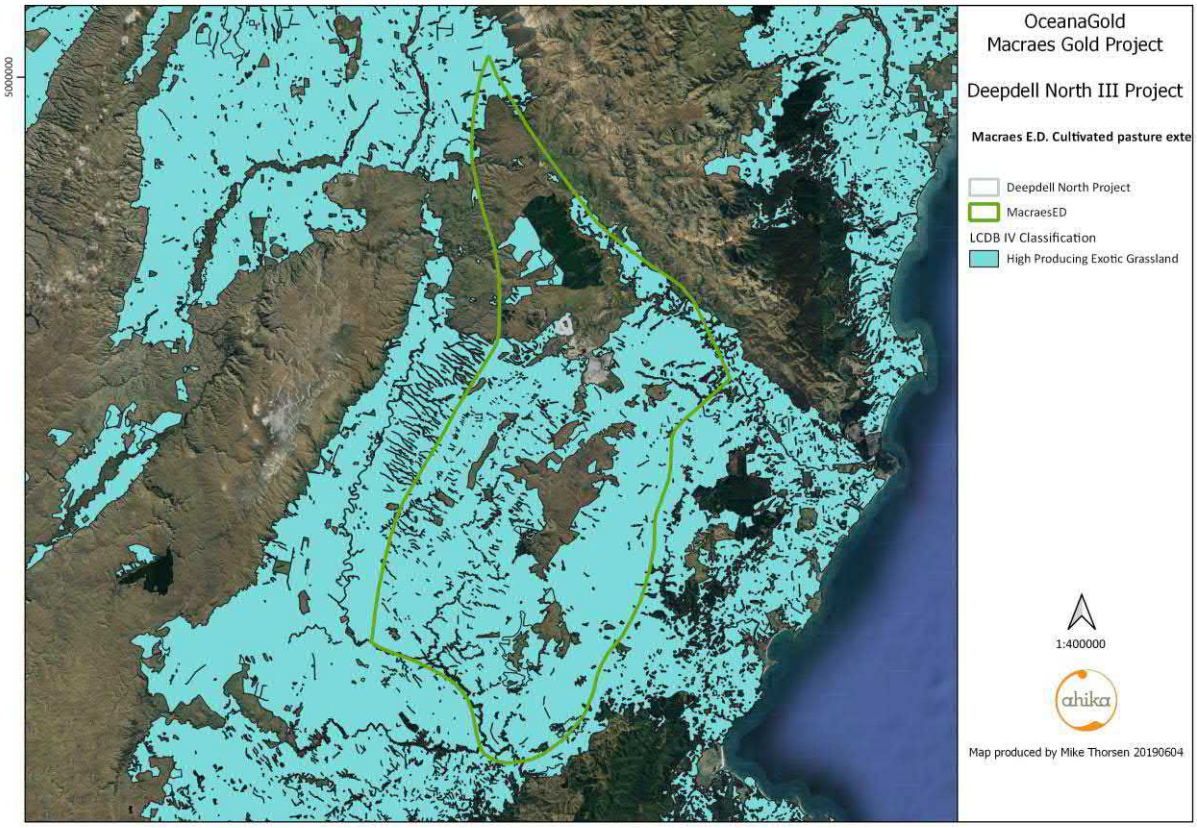

Figure 8. Distribution of cultivated pasture vegetation community in the vicinity of Macraes E.D.

Overall effect on the shelterbelt and exotic trees vegetation community

The result of these project effects will be a reduction by 0.53 ha in the extent of this exotic vegetation community and minor changes to the 0.08 ha in the buffer area. This vegetation community in the PIA is not known to harbour any indigenous species but does provide habitat for some common exotic birds. This vegetation community has been mapped (as exotic forestry) from satellite photography as covering 4,607 ha in the Macraes E.D. (Figure 9), and the area within the PIA represents 0.01% of this extent. Between 2008 and 2012, exotic forestry coverage increased by 2.1% in the Macraes E.D.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the vegetation community.

This vegetation community is assessed as having **negligible** ecological importance.

The magnitude of the project's impact on this vegetation community at a local scale is assessed as **low**, and at a national level as **negligible**.

The overall degree of the project's effect on this vegetation community is **very low**.

The confidence of this assessment is **moderate-high** as this vegetation community is readily discernible in satellite images, except when it is reverting to low-producing grassland, shrublands or weed communities.

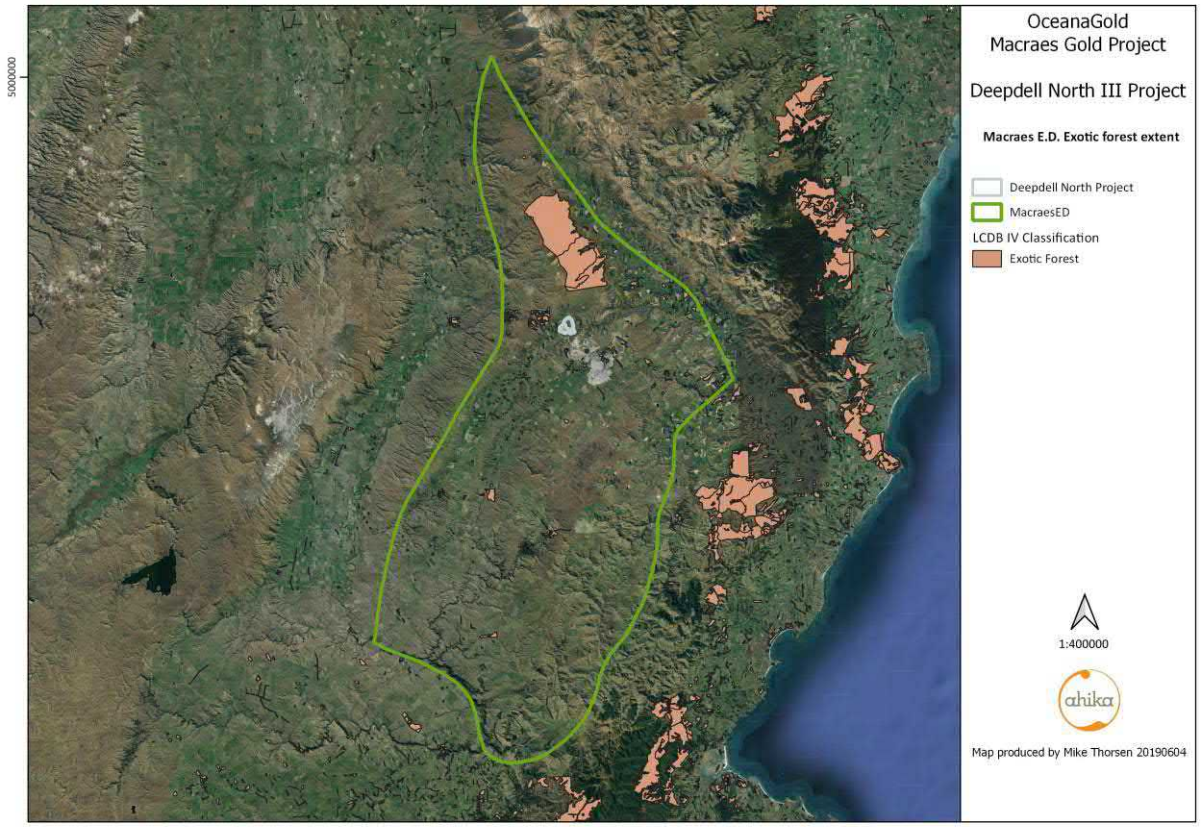

Figure 9. Distribution of exotic forest vegetation community in the vicinity of Macraes E.D.

Summary of effects on vegetation communities

Five indigenous vegetation communities are identified within the PIA. Overall, the indigenous vegetation communities present within the PIA are assessed as being of **high** ecological importance. The communities are of moderate representation, diversity, integrity and ecosystems service importance. There are two Naturally Uncommon vegetation communities present (although degraded by exotic plant invasion), both are national priorities for protection and one is classified as Nationally Critical and the other as Endangered. There are three Threatened Level IV land environments that are overlain to some extent by natural vegetation. The natural vegetation types are significant under the Operative ORPS, new partially operative ORPS and WDC District Plan.

The effects of the project will result in the loss of all vegetation within the Pit and WRS and totals 54.7 ha of indigenous vegetation and 54.6 ha of exotic vegetation. In addition, there may be some effect of the project activities on the vegetation within the buffer zone of the PIA

totalling 33.9 ha of indigenous vegetation and 26.5 ha of exotic vegetation, but this effect is expected to be minor if appropriate mitigation approaches are employed.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the vegetation communities.

The magnitude of the project's impact on the area's vegetation communities at a local scale is assessed as **moderate**, and at a national level as **moderate**.

The overall degree of the project's effect on these communities is conservatively assessed as **moderate**, as although many of the ecological features are highly degraded, the remnants of some have high importance.

The confidence of this assessment is **moderate**, as much of the area surrounding the PIA has not been closely explored. Further, it is difficult to discriminate between vegetation communities using aerial photography, which makes it difficult to assess their distribution at a local scale. Lastly, vegetation communities in this area often interdigitate and intergrade, making it difficult to accurately determine their classification and extent.

7.5 Impact on Threatened, At Risk, or Rare Plant Species

Thirteen plant species that occur within the PIA are either currently classified as Threatened, At Risk or Data Deficient (Townsend et al. 2007, de Lange et al. 2013), or are thought to be rare in the Macraes E.D. based on the author's observations.

7.5.1 *At Risk species*

7.5.1.1 *Declining Species*

1. *Anthosachne falcis* (Connor) Barkworth et S.W.L.Jacobs (dwarf wheatgrass, Poaceae).

This dryland grass was recorded as scattered plants totalling c. 100 individuals mainly in the WRS zone.

The following project activities are likely to impact on this species:

Effect of construction of waste rock stack

Depositing WRS material will destroy an unknown number of this species in the PIA.

Effect of changes in weed populations

Negligible to major effect on this species in the buffer area depending on species of weed.

Effects of displacement of pest animals

Temporary minor effect for this species in the buffer area as it is browsed by animals, particularly hares and pigs. Resident pest animals are likely to be a bigger problem for this species.

Effects of dust

Minor effect as this species in the buffer area as this species is known to occur in dry sites with naturally higher dust loadings.

Effects of accidental fire

Negligible to moderate effect on plants in the buffer area depending on timing of fire and growth of surrounding vegetation.

The result of these project effects will be the loss of the species from the PIA and some potential impact on plants in the buffer area. As this species is widely and patchily distributed within natural sites in the Macraes area, and is known to occur at multiple locations in the eastern South Island, including many in protected areas throughout its range, the loss of individuals from the PIA is unlikely to majorly impact the longer-term security of the species locally or nationally.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the species.

The ecological importance of the population of this species within the PIA is categorised as **high**. The magnitude of the project's impact on this species at a local scale is assessed as **moderate**, and at a national level as **low**.

The overall degree of the project's effect on this species is **low**.

The confidence of this assessment is **moderate**, as this species was only discovered to occur in the area in 2016. Much of the area surrounding the PIA has not been closely explored and all available records from the area are the result of opportunistic (rather than structured) surveys. This species is easily confused with other *Anthosachne* grasses, is relatively inconspicuous, and many New Zealand botanists are unfamiliar with grasses.

2. *Carmichaelia crassicaulis* Hook.f. subsp. *crassicaulis* (coral broom, Fabaceae).

This thick-stemmed broom was recorded as 2 individuals at one site in the WRS zone, 1 plant in the Pit Zone and as 15 individuals in the Buffer Zone.

The following project activities are likely to impact on this species:

Effect of construction of waste rock stack

Depositing WRS material will destroy 2 individuals of this species.

The result of these project effects will be the loss of 3 individuals of the species from one site. This would have very little impact on local population dynamics by removing most of the plants in an area where there are few other nearby plants. The impact on the species at a national scale is estimated to result in a negligible reduction in the total population.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the species.

The ecological importance of the population of this species within the PIA is categorised as **high**. The magnitude of the project's impact on this species at a local scale is assessed as **very low**, and at a national level as **negligible**.

The overall degree of the project's effect on this species is **very low**.

The confidence of this assessment is **moderate** as much of the area surrounding the PIA has not been closely explored, and all available records of this species from the area are the result of opportunistic or limited-scale (rather than structured) surveys, therefore the distribution described here is likely to be a subset of a wider distribution.

3. *Carmichaelia petriei* Petrie (desert broom, Fabaceae).

This leafless broom was recorded at several sites in WRS zone where seven plants are present.

The following project activities are likely to impact on this species:

Effect of construction of waste rock stack

Depositing WRS material will destroy seven individuals within the PIA.

Effect of changes in weed populations

Negligible to major effect on individuals in the buffer zone depending on species of weed.

Effects of displacement of pest animals

Temporary minor effect for this species in the buffer zone as it is browsed by animals, particularly hares. Resident pest animals are likely to be a bigger problem for this species.

Effects of dust

Minor effect as this species in the buffer area as this species is known to occur in dry sites with naturally higher dust loadings.

Effects of accidental fire

Negligible to moderate effect depending on timing of fire and growth of surrounding vegetation.

The result of these project effects will be the loss of 2 individuals of this species from within the project area. As this species is widely and patchily distributed within natural sites in the Macraes area, and is known to occur at multiple locations in the eastern South Island, including many in

protected areas throughout its range, the loss of individuals from the PIA is unlikely to majorly impact the longer-term security of the species locally or nationally.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the species.

The ecological importance of the population of this species within the PIA is categorised as **high**.

The magnitude of the project's impact on this species at a local scale is assessed as **low**, and at a national level as **negligible**.

The overall degree of the project's effect on this species is **very low**.

The confidence of this assessment is **moderate**, as much of the area surrounding the PIA has not been closely explored and all available records from the area are the result of opportunistic (rather than structured) surveys. Therefore the distribution described here is likely to be a subset of a wider distribution.

***4. Discaria toumatou* Petrie (matagouri, Rhamnaceae).**

Matagouri was recorded at multiple sites and in considerable numbers in the Deepdell III pit site, Horse Flat WRS and Deepdell South pit backfill WRS zone.

The following project activities are likely to impact on this species:

Effect of construction of waste rock stack

Depositing WRS material will destroy an unknown number of individuals of this species in the PIA.

Effect of removing rock material when excavating pit

Excavating the pit and associated processes will cause the mortality of an unknown number of individuals in the Deepdell North III pit zone.

Effects of accidental fire

Negligible to moderate effect depending on timing of fire and growth of surrounding vegetation.

The result of these project effects will be the loss of the species from within the project area. As this species is abundant and widely distributed within natural sites in the Macraes area, and is known to occur over very large areas at multiple locations in the eastern South Island, including many in protected areas throughout its range, the loss of individuals from the PIA is unlikely to majorly impact the longer-term security of the species locally or nationally.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the species.

The ecological importance of the population of this species within the PIA is categorised as **high**. The magnitude of the project's impact on this species at a local scale is assessed as **negligible**, and at a national level as **negligible**.

The overall degree of the project's effect on this species is **very low**.

The confidence of this assessment is **moderate-high** as this is a well-marked species whose current distribution is reasonably well known. However, its main habitat (grey scrub) is thought to be in decline nationally, but the speed of this loss is not known. Determining speed of loss of this species is partly complicated by its propensity to establish itself in pasture areas in montane South Island unless actively prevented from doing so.

5. Leptinella pusilla Hook.f. (a button daisy, Asteraceae).

This creeping button daisy was recorded at one site in the WRS where one patch measuring 1 m^2 is present.

The following project activities are likely to impact on this species:

Effect of construction of waste rock stack

Depositing WRS material will destroy one patch of this species in the PIA.

The result of these project effects will be the loss of the species from one site within the PIA. This will cause some loss from the local area. The impact on the species at a local or national scale is difficult to assess, as the distribution of this species is poorly known. It is widely but sparsely distributed and the mechanism of interbreeding between such widely spaced populations is not known. It appears to flourish in grazed situations. Overall, the loss of the one site in the PIA is unlikely to majorly impact the longer-term security of the species locally or nationally.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the species.

The ecological importance of the population of this species within the PIA is categorised as **high**. The magnitude of the project's impact on this species at a local scale is assessed as **low**, and at a national level as **negligible**.

The overall degree of the project's effect on this species is **very low**.

The confidence of this assessment is **moderate-low**. The distribution of this species is poorly known and it is difficult to distinguish from similar *Leptinella* species (see NatureWatch identifications of this species, some of which are of other species).

6. *Lobelia ionantha* Heenan (a wetland herb, Campanulaceae).

This creeping wetland herb was recorded at one site in the ephemeral wetland G in the WRS where several patches totalling an estimated 0.56m^2 are present.

The following project activities are likely to impact on this species:

Effect of construction of waste rock stack

Depositing WRS material will destroy the one site of this species in the PIA.

The result of these project effects will be the loss of the species from one site within the PIA. This will cause some loss from the local area. The impact on the species at a local or national scale is difficult to assess, as the distribution of this species is poorly known. It is widely but sparsely distributed. It appears to flourish in grazed wetland situations. Overall, the loss of the one site in the PIA is unlikely to majorly impact the longer-term security of the species locally or nationally.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the species.

The ecological importance of the population of this species within the PIA is categorised as **high**. The magnitude of the project's impact on this species at a local scale is assessed as **moderate**, and at a national level as **low**.

The overall degree of the project's effect on this species is **low**.

The confidence of this assessment is **moderate-low**. The distribution of this species is poorly known and the vulnerability of its wetland habitats is also unknown.

7. *Rytidosperma buchananii* (Hook.f.) Connor & Edgar (a dryland bristlegrass, Poaceae).

This grass was recorded at one site in the WRS where one plant is present on a rock stack in the WRS.

The following project activities are likely to impact on this species:

Effect of construction of waste rock stack

Depositing WRS material will destroy the one individual at one site of this species in the PIA.

The result of these project effects will be the loss of one individual of the species from one site within the PIA. This will cause some loss from the local area. The impact on the species at a local or national scale is difficult to assess, as the distribution of this species is poorly known. Overall, the loss of the one site in the PIA is unlikely to majorly impact the longer-term security of the species locally or nationally.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the species.

The ecological importance of the population of this species within the PIA is categorised as **low**. The magnitude of the project's impact on this species at a local scale is assessed as **very low**, and at a national level as **negligible**.

The overall degree of the project's effect on this species is **very low**.

The confidence of this assessment is **moderate-low**, as much of the area surrounding the PIA has not been closely explored and all available records from the area are the result of opportunistic (rather than structured) surveys. This species is easily confused with other *Rytidosperma* grasses, is relatively inconspicuous, and many New Zealand botanists are unfamiliar with grasses.

7.5.1.2 *Naturally Uncommon Species*

8. *Carex subtilis* K.A.Ford (elegant hookgrass, Cyperaceae).

This small sedge was recorded as one individual at one site in the Pit zone.

The following project activities are likely to impact on this species:

Effect of construction of waste rock stack

Deposition of rock will destroy the only site of this species in one site in the Deepdell South pit backfill WRS zone.

The result of these project effects will be the loss of the species from one site. There is some risk of a reduction in the longer-term viability of the species in a local context as this species occurs as widely separated groups. The impact on the species at a national scale is negligible.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the species.

The ecological importance of the population of this species within the PIA is categorised as **moderate**.

The magnitude of the project's impact on this species at a local scale is assessed as **moderate**, and at a national level as **negligible**.

The overall degree of the project's effect on this species is **very low**.

The confidence of this assessment is **moderate**, as the majority of the area surrounding the PIA has not been closely explored, and all available records from the area are the result of opportunistic or limited-scale (rather than structured) surveys, therefore the distribution described here is likely to be a subset of a wider distribution. This species when not in flower can be confused with other *Carex* species that occur in the area, particularly *Carex wakatipu* and *Carex breviculmis*. It is a small inconspicuous plant that mostly occurs under vegetation or beside rock outcrops and is likely to be under-recorded.

9. *Juncus distegus* Edgar (Two-storey rush, Juncaceae).

This rush was recorded in various numbers bordering the ephemeral wetlands and is the dominant larger plant species in the seepage wetland in the WRS where there are patches covering an estimated 369 m^2 with an additional scattered 56 individuals.

The following project activities are likely to impact on this species:

Effect of construction of waste rock stack

Depositing WRS material will destroy an estimated 369 m^2 and an additional scattered 56 individuals in the PIA.

The result of these project effects will be the loss of the species from within the PIA. This will cause some loss from the local area. The impact on the species at a local or national scale is difficult to assess, as the distribution of this species is poorly known. It is widely but sparsely distributed. It is considered that the loss will have some impact on local population dynamics, but this is very unlikely to majorly impact the longer-term security of the species locally or nationally.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the species.

The ecological importance of the population of this species within the PIA is categorised as **moderate**.

The magnitude of the project's impact on this species at a local scale is assessed as **moderate**, and at a national level as **low**.

The overall degree of the project's effect on this species is **low**.

The confidence of this assessment is **moderate-low**. The distribution of this species is poorly known and it is difficult to distinguish from similar *Juncus* species.

10. *Juncus pusillus* Buchenau (dwarf rush, Juncaceae).

This tiny rush was recorded as two 5 x 5 cm patches in ephemeral wetland A.

The following project activities are likely to impact on this species:

Effect of construction of waste rock stack

Depositing WRS material will destroy an estimated 1 m^2 of this species in the PIA.

The result of these project effects will be the loss of the species from within the PIA. This will cause some loss from the local area. The impact on the species at a local or national scale is difficult to assess, as the distribution of this species is poorly known. It is widely but sparsely distributed. It is considered that the loss is very unlikely to majorly impact the longer-term security of the species locally or nationally.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the species.

The ecological importance of the population of this species within the PIA is categorised as **low**.

The magnitude of the project's impact on this species at a local scale is assessed as **moderate**, and at a national level as **low**.

The overall degree of the project's effect on this species is **very low**.

The confidence of this assessment is **moderate-low**. The distribution of this species is poorly known and it is difficult to distinguish from similar *Juncus* species.

7.5.2 *Rare species*

7.5.2.1 *Species uncommon in Ecological District*

11. *Carex resectans* Cheeseman (desert sedge, Cyperaceae).

This small creeping sedge was recorded as three patches totalling 40 x 40 cm in ephemeral wetland G.

The following project activities are likely to impact on this species:

Effect of construction of waste rock stack

Depositing WRS material will destroy an estimated 1.6 m^2 of this species in the PIA.

The result of these project effects will be the loss of the species from within the PIA. This will cause some loss from the local area. The impact on the species at a local or national scale is difficult to assess, as the distribution of this species is poorly known. It is widely but sparsely distributed. It is considered that the loss may have some impact on local plant population dynamics by reducing the number of populations in the area, but the effect is very unlikely to majorly impact the longer-term security of the species nationally.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the species.

The ecological importance of the population of this species within the PIA is categorised as **moderate**.

The magnitude of the project's impact on this species at a local scale is assessed as **moderate**, and at a national level as **low**.

The overall degree of the project's effect on this species is **low**.

The confidence of this assessment is **moderate-low**. The distribution of this species is poorly known as it is a small inconspicuous species.

12. *Melicope simplex* A.Cunn. (poataniwha, Rutaceae).

This shrub was recorded as 11 individuals in one group of rock outcrops in the WRS.

The following project activities are likely to impact on this species:

Effect of construction of waste rock stack

Depositing WRS material will destroy 11 individuals of this species in the PIA.

The result of these project effects will be the loss of the species from within the PIA. This will cause some loss from the local area. As this species is widespread outside of Central Otago and there are very large populations at some sites, the loss of these individuals is very unlikely to majorly impact the longer-term security of the species nationally.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the species.

The ecological importance of the population of this species within the PIA is categorised as **moderate**.

The magnitude of the project's impact on this species at a local scale is assessed as **moderate**, and at a national level as **negligible**.

The overall degree of the project's effect on this species is **very low**.

The confidence of this assessment is **moderate**, as much of the area surrounding the PIA has not been closely explored and all available records from the area are the result of opportunistic (rather than structured) surveys. Therefore the distribution described here is likely to be a subset of a wider distribution.

13. *Myrsine divaricata* A.Cunn. (weeping matipo/mapou, Primulaceae).

This shrub was recorded as 2 individuals in one group of rock outcrops in the WRS.

The following project activities are likely to impact on this species:

Effect of construction of waste rock stack

Depositing WRS material will destroy 2 individuals of this species in the PIA.

The result of these project effects will be the loss of the species from within the PIA. This will cause some loss from the local area. As this species is widespread outside of Central Otago and there are very large populations at some sites, the loss of these individuals is very unlikely to majorly impact the longer-term security of the species nationally.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the species.

The ecological importance of the population of this species within the PIA is categorised as **moderate**.

The magnitude of the project's impact on this species at a local scale is assessed as **moderate**, and at a national level as **negligible**.

The overall degree of the project's effect on this species is **very low**.

The confidence of this assessment is **moderate**, as much of the area surrounding the PIA has not been closely explored and all available records from the area are the result of opportunistic (rather than structured) surveys. Therefore, the distribution described here is likely to be a subset of a wider distribution.

7.6 Impact on Avifauna Ecological Features

Twenty bird species were recorded from within the PIA, nine of which are indigenous. The ecological importance of the birds within the PIA is categorised as **moderate** on the basis of the presence of one At Risk species, the avifauna's role in ecosystem function and the low species diversity and abundance within the PIA.

7.6.1 *Impact on Bird Communities*

Effect of construction of waste rock stack

Depositing WRS material will destroy some known habitat of bird species, including the nesting area of a colony of black-backed gulls, and cause the displacement of all individuals from the WRS zone.

Effect of removing rock material when excavating pit

Excavating the pit and associated processes will destroy some known habitat of bird species and cause the displacement of all individuals from the Pit zone.

Effect of sediment run-off

Nil effect as none of the bird species occur in watercourses in the PIA.

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, if unchecked, transform habitat for bird species in the surrounding area, making the area unsuitable.

Effects of displacement of pest animals

Mustelids and rodents, displaced by the commencement of mining activities, will have a temporary minor effect on populations of surrounding birds, particularly ground-nesting birds such as pipits.

Effects of displacement of resident animals

This will be a temporary moderate effect, as birds resident within the PIA are likely to move into the surrounding area where they will compete for space and food with that area's residents. As the areas around the PIA are assumed to be at carrying capacity, this competition is likely to result in the mortality of either resident birds or displaced birds, with the total mortality approaching the number of individuals that are displaced from the PIA.

Effects of noise & disturbance

This will have a negligible effect on the bird populations surrounding the PIA, as most of the species appear to acclimate to regular disturbance. It is likely that harrier hawks will avoid hunting the nearby surrounding area, and that paradise shelducks will not nest within sight of the project.

Effects of dust

Negligible effect as dust-fall, when managed, is minimal at distance. There may be some avoidance of dusty fruit by frugivorous species.

Effects of light

Minor effect as project lighting will attract insects which could attract birds, particularly little owls if they are in the area.

Effects of accidental fire

Minor to moderate effect depending on the timing of fire. If a fire was to occur during the nesting season then bird's nests would be at risk, particularly those of ground-nesting pipit.

Changed hydrological regimes

Nil effect as no species occurs in this zone.

The result of these project effects will be the displacement of bird individuals from within the PIA, with a temporary increase in competition with neighbouring resident birds leading to the mortality of some individuals. Longer term there is likely to be avoidance of the area by harrier hawks and paradise shelduck. Disruption to the black-billed gull colony is thought to be temporary as they are nesting in an artificial habitat, which will be re-created in the Deepdell

North III pit. The possible presence of brown creeper is not considered significant as they are a common bird in many areas of the South Island and are likely to be either using this site as part of a wider feeding range or transiting through. There are extensive areas of similar shrubland habitat in the surrounding area and so the loss of any feeding habitat is likely to be inconsequential. The overall result of these effects is some disruption of local bird populations, most of which are common on a national scale, and the displacement of a pair of At Risk pipit which are inhabiting an artificial habitat.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on these species.

The ecological importance of the bird communities is **moderate**.

The magnitude of the project's impact on bird species at a local scale is assessed as **moderate**, and at a national level as **negligible**.

The overall degree of the project's effect on these species is **very low**.

The confidence of this assessment is **moderate-low**, as the distribution and density of birds within the wider Macraes area is largely unknown.

7.6.2 *Impact on Threatened, At Risk, or Rare Bird Species*

One species that occur within the PIA is classified as At Risk: the pipit.

1. *Anthus novaeseelandiae* Gmelin subsp. *novaeseelandiae* (pipit, Motacillidae).

Pipits are present within the Pit zone in an artificially created habitat, where it is estimated, based on encounter rate, that there is a single pair of birds.

The following project activities are likely to impact on this species:

Effect of excavation of pit

> The earth-moving activities involved in excavating the pit will cause the single pair of pipits to relocate to another area.

The result of these project effects will be the loss of the species from the site. This may cause some negligible effect on the Macraes pipit population as the relocating birds may interact with

resident birds with the most likely outcome being that the newcomers will be excluded from the resident bird's area. The fate of the displaced pair is unknowable, but it is thought that the project effects are unlikely to cause mortality of the pair as they have shown an ability to utilise an artificial habitat (grassed rock mounds) of which there is plenty in the surrounding area. There may be a temporary reduction in breeding output if displacement is to occur over the breeding season, but this loss of a breeding season for a single pair is not considered significant to the local population. Overall, there is considered very little risk to the conservation status of this species as it is widely (though sparsely) distributed through rough grasslands of Central Otago and beyond.

Therefore, the impact of this project is assessed as having both an **adverse**, **direct**, **temporary**, **local impact** on the species.

The ecological importance of the population of this species within the PIA is categorised as **high**. The magnitude of the project's impact on this species at a local scale is assessed as **low**, and at a national level as **negligible**.

The overall degree of the project's effect on this species is **very low**.

The confidence of this assessment is **moderate-low** as much of the area surrounding the PIA has not been surveyed for this species and its population density and population trajectory in the area are unknown.

7.7 Impact on Herpetofauna Ecological Features

Four reptile species were recorded in the PIA. In addition, there are records in the nearby area of a further three Threatened or At Risk reptile species held in the Herpetofauna Database (Figure 10). The ecological importance of the lizard populations within the PIA is categorised as **moderate** on the basis of the presence of three At Risk species, the presence of genetically distinct lineages (that also occur at multiple sites outside the PIA), the role the herpetofauna is likely to be playing in ecosystem function, and the low species diversity and abundance within the PIA.

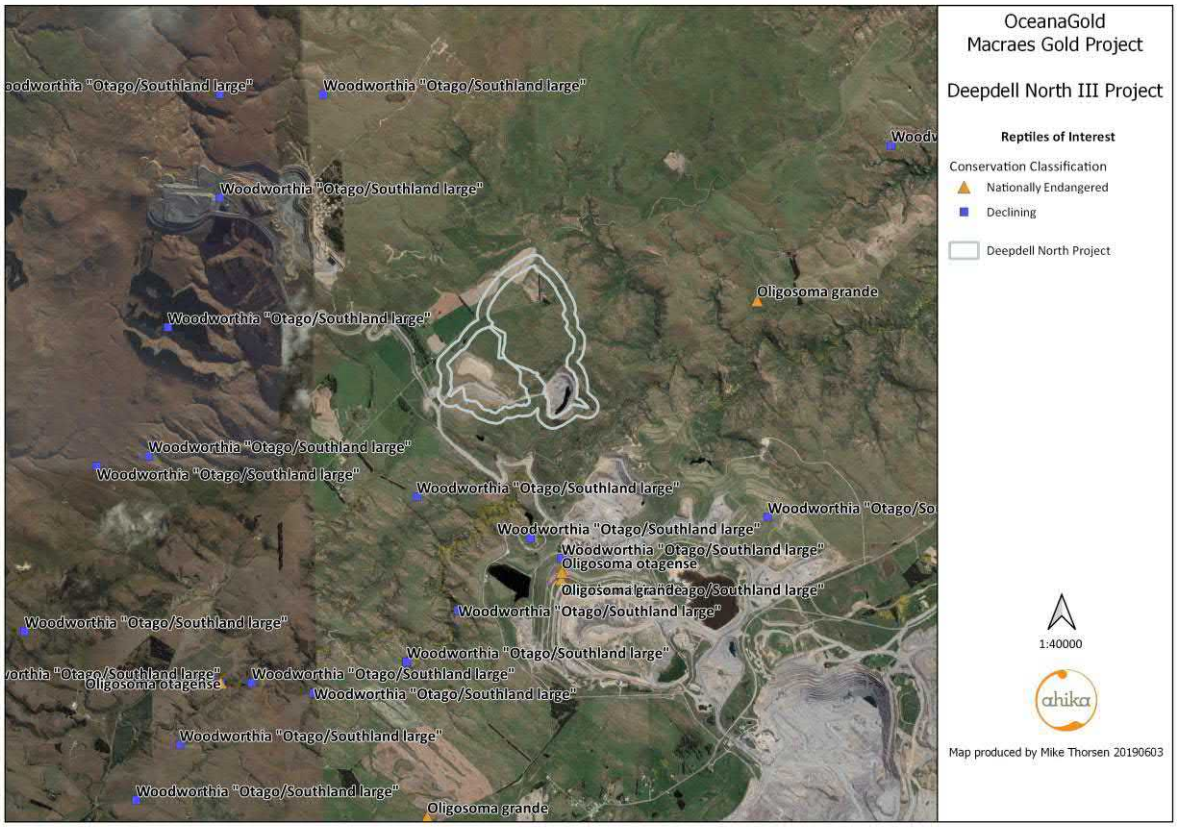

Figure 10. Records of Threatened or At Risk reptiles in the vicinity of the Deepdell North III project. Data from DOC Herpetofauna Database.

7.7.1 *Impact on Reptile Communities*

Effect of construction of waste rock stack

Depositing WRS material will destroy some known habitat of reptile species and cause the mortality of most of the approximately 185 individuals thought to occur in the PIA.

Effect of removing rock material when excavating pit

Excavating the pit and associated processes will destroy some known habitat of reptile species and cause the mortality of some of the approximately 185 individuals thought to occur in the PIA.

Effect of sediment run-off

Negligible effect as sediment accumulation is unlikely to affect either the habitat or food supply of any lizards inhabiting gullies.

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, if unchecked, transform habitat for reptile species in the surrounding area, making the area unsuitable.

Effects of displacement of resident animals

Displacement of individuals is only likely to occur along the fringes of the project area. Most individuals within the project area are likely to be killed outright as a result of earth-moving activities. Displaced individuals will likely compete with surrounding residents, resulting in the death of one of the individuals as the surrounding area is assumed to be at carrying capacity and incapable of supporting additional individuals over the medium-term.

Effects of noise & vibration

Negligible effect of noise on the reptile populations. There may be some effect of the vibrations caused by heavy machinery and earth moving. But the presence of reptiles very close to existing mine activities indicates that any effect is short-range and minor.

Effects of dust

Negligible effect as dust-fall is minimal at distance.

Effects of light

Negligible effect. There is a chance that project lighting will attract insects which could attract *Woodworthia* "Otago/Southland large" into the area, although this is considered unlikely given the types of habitat and disturbance that surround lights.

Effects of accidental fire

Minor to moderate effect, depending on timing of fire and habitat burnt. Most of the larger reptile populations in this area occur at sites that are considered natural fire refuges because of their rocky nature.

Changed hydrological regimes

Minor effect as there may be some changes to the habitat of the skinks *Oligosoma polychroma* and *Oligosoma inconspicuum* but it is unclear whether these changes will adversely affect these species.

The result of these project effects will be the death of an estimated 185 reptile individuals from within the project area and some short-term disruption to reptile populations in the area immediately surrounding the project. As the populations within the PIA of these lizards are relatively small (for the area), it is assessed that the project will have a moderate effect on local lizard populations. As the lizard species concerned are widespread and often numerous, the project is considered to have a minor impact on lizard populations at a national scale.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the species.

The ecological importance of the reptile communities is **moderate**.

The magnitude of the project's impact on this species at a local scale is assessed as **moderate**, and at a national level as **low**.

The overall degree of the project's effect on these species is **low**.

The confidence of this assessment is **moderate** as, although the distribution and density of reptiles to the south of the project area are among the best known in New Zealand, the areas to the west and east of the project area are poorly known in regard to reptiles.

7.7.1 *Impact on Threatened, At Risk, or Rare Reptile Species*

Three of the reptile species considered to be present in the PIA are currently classified as At Risk: the skinks *Oligosoma polychroma* (clade 5 genotype) and *Oligosoma inconspicuum* and the gecko *Woodworthia* "Otago/Southland large".

1. *Oligosoma polychroma* (Patterson & Daugherty 1990) (clade 5 genotype) (southern grass skink, Scincidae).

The southern grass skink *Oligosoma polychroma* (clade 5 form) is present infrequently in areas with denser vegetation or rock piles. The total population of this species within the PIA is estimated at 5 individuals based on encounter rate and quantity of habitat present.

The following project activities are likely to impact on this species:

Effect of construction of waste rock stack

Depositing WRS material will destroy an estimated 5 individuals of this species in the PIA.

Effects of displacement of pest animals

Temporary minor effect for this species in the buffer area.

Effects of noise

Minor effect on individuals in the PIA as reptile populations near existing mine workings appear to acclimate to mine noise.

Effects of dust

Minor effect as this species in the buffer area as this species is known to occur in dry sites with naturally higher dust loadings.

Effects of accidental fire

Negligible to moderate effect on individuals in the buffer area depending on timing of fire and growth of surrounding vegetation.

The result of these project effects will be the loss of the species from the site and displacement of some individuals into surround areas in the buffer. This may cause some negligible effect on the Macraes population as the displaced animals will cause some short-term disruption to reptile populations in the buffer area resulting in mortality of the displaced or resident animals equivalent to the number of displaced animals. As the populations within the PIA of this species are relatively small (for the area), it is assessed that the project will have a moderate effect on the local populations.

Therefore, the impact of this project is assessed as having both an **adverse**, **direct**, **permanent**, **local impact** on the species.

The ecological importance of the population of this species within the PIA is categorised as **high**. The magnitude of the project's impact on this species at a local scale is assessed as **moderate**, and at a national level as **negligible**.

The overall degree of the project's effect on this species is **very low**.

The confidence of this assessment is **moderate-low** as much of the area surrounding the PIA has not been surveyed for this species and its population density and population trajectory in the area are unknown.

2. *Oligosoma inconspicuum* (Patterson & Daugherty 1990) (cryptic skink, Scincidae).

The cryptic skink *Oligosoma inconspicuum* is rare in this area due to a shortage of suitable habitat. It was potentially sighted in one area of rocks of the existing waste rock stack beside the road.

The following project activities are likely to impact on this species:

Effect of excavation of Pit

Excavating the pit and associated earthworks will destroy a very small number of individuals of this species in the PIA.

Effects of displacement of pest animals

Temporary minor effect for this species in the buffer area.

Effects of noise

Minor effect on individuals in the PIA as reptile populations near existing mine workings appear to acclimate to mine noise.

Effects of dust

Minor effect as this species in the buffer area as this species is known to occur in sites with naturally higher dust loadings.

Effects of accidental fire

Negligible to moderate effect on individuals in the buffer area depending on timing of fire and growth of surrounding vegetation.

The result of these project effects will be the loss of a small number of individuals of this species from the site and displacement of some individuals into surround areas in the buffer. This may cause some negligible effect on the Macraes population as the displaced animals may cause some short-term disruption to reptile populations in the buffer area resulting in mortality of the displaced or resident animals equivalent to the number of displaced animals. However, populations of this species are often widely separated, and it is unlikely that the displaced animals will encounter a resident population. As the populations within the PIA of this species are relatively small (for the area), it is assessed that the project will have a minor effect on the local populations.

Therefore, the impact of this project is assessed as having both an **adverse**, **direct**, **permanent**, **local impact** on the species.

The ecological importance of the population of this species within the PIA is categorised as **high**. The magnitude of the project's impact on this species at a local scale is assessed as **moderate**, and at a national level as **negligible**.

The overall degree of the project's effect on this species is **very low**.

The confidence of this assessment is **moderate-low** as much of the area surrounding the PIA has not been surveyed for this species and its population density and population trajectory in the area are unknown.

3. *Woodworthia* "Otago/Southland large" (korero gecko, Gekkonidae).

The korero gecko *Woodworthia* "Otago/Southland large" was noted in one location in Pit zone though it is likely to also be present on other areas of the PIA, particularly the rocky outcrops in the WRS zone. Only 1-5 individuals are likely to be present where it occurs in the PIA and the total population within the PIA is estimated at 30 individuals based on encounter rate and quantity of habitat present. Korero geckos have been recorded form scattered sites throughout the surrounding area (Figure 10).

The following project activities are likely to impact on this species:

Effect of construction of waste rock stack

Depositing WRS material will destroy an estimated 30 individuals of this species in the PIA.

Effects of displacement of pest animals

Temporary minor effect for this species in the buffer area.

Effects of noise

Minor effect on individuals in the PIA as reptile populations near existing mine workings appear to acclimate to mine noise.

Effects of dust

Minor effect as this species in the buffer area as this species is known to occur in dry sites with naturally higher dust loadings.

Effects of artificial light

As this species is nocturnal, there is a possibility that artificial lighting, especially flood lighting, used in the project for various purposes at night may impact on this species by either repelling or attracting korero gecko, or its prey (particularly nocturnal moths). This effect is difficult to assess as the impact of artificial lighting on New Zealand's herpetofauna has not been investigated.

Effects of accidental fire

Negligible to moderate effect on individuals in the buffer area depending on timing of fire and growth of surrounding vegetation.

The result of these project effects will be the loss of an estimated 30 individuals of this species from the site and displacement of some individuals into surround areas in the buffer. This may cause some negligible effect on the Macraes population as the displaced animals may cause some short-term disruption to reptile populations in the buffer area resulting in mortality of the displaced or resident animals equivalent to the number of displaced animals. As the populations within the PIA of this species are relatively small (for the area), it is assessed that the project will have a moderate effect on the local populations.

Therefore, the impact of this project is assessed as having both an **adverse**, **direct**, **permanent**, **local impact** on the species.

The ecological importance of the population of this species within the PIA is categorised as **high**. The magnitude of the project's impact on this species at a local scale is assessed as **moderate**, and at a national level as **low**.

The overall degree of the project's effect on this species is **low**.

The confidence of this assessment is **moderate** as large parts of the area surrounding the PIA has not been surveyed for this species and its population density and population trajectory in the area are unknown.

7.8 Impact on Invertebrate Ecological Features

Mostly common indigenous invertebrate species were recorded in the PIA. The ecological importance of the invertebrate communities within the PIA is categorised as **moderate** on the basis of the role invertebrates are likely to be playing in ecosystem function, and the moderate species diversity and abundance within the PIA.

7.8.1 *Impact on Invertebrate Communities*

The invertebrate communities of the PIA are poorly known but appear to be a mix of indigenous and exotic species. It is generally assumed that invertebrate community diversity and integrity mirror the diversity and integrity of the plant communities of an area. It is possible that some of the rare plant communities such as ephemeral wetlands harbour rare or unusual species, but this habitat type in Otago does not appear to have been sampled for invertebrates.

Effect of construction of waste rock stack

Depositing WRS material will destroy some habitat of invertebrate communities in the WRS zones.

Effect of removing rock material when excavating pit

Excavating the pit and associated processes will destroy some habitat of invertebrate communities.

Effect of sediment run-off

Negligible to minor effect as sediment accumulation, additional to that which already occurs, is unlikely to greatly affect the habitat of terrestrial invertebrate communities.

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, if unchecked, transform habitat for invertebrate communities in the surrounding area, making the area unsuitable or causing influxes of exotic species.

Effects of displacement of resident animals

Invertebrate species are unlikely to be displaced, with the possible exception of some species with flighted life stages.

Effects of noise & vibration

Invertebrates are unlikely to be susceptible to noise, but ground vibrations may make hunting temporarily difficult for some fossorial carnivorous species such as carabids.

Effects of dust

Negligible effect as dust-fall is minimal at distance.

Effects of light

Negligible to major effect, depending on species. Some species, particularly nocturnal Lepidoptera and Trichoptera will be attracted to project lighting when it is in use. This could have the effect of disrupting feeding and mating of these individuals. This effect is poorly understood in New Zealand invertebrates, but there are concerns overseas that this could be a factor causing the rarity of some species.

Effects of accidental fire

Minor to major effect, depending on timing of fire and habitat burnt.

Changed hydrological regimes

Minor effect as there may be some changes to the habitat of invertebrate communities inhabiting ephemeral waterways.

The result of these project effects will be the loss of invertebrate communities within the project area and some disruption to some species in the wider PIA. As most the invertebrate species concerned are widespread and often numerous, the project is considered to have a minor impact on invertebrate communities at a national scale.

Therefore, the impact of this project is assessed as having an **adverse**, **direct**, **permanent**, **irreversible**, **local impact** on the invertebrate communities.

The ecological importance of the reptile communities is **moderate**.

The magnitude of the project's impact on the invertebrate communities at a local scale is assessed as **moderate**, and at a national level as **low**.

The overall degree of the project's effect on these species is **low**.

The confidence of this assessment is **low** as the distribution of many of New Zealand's invertebrate species is poorly known at local and national scales. Invertebrates are also difficult to identify and there are few experts in this field. The taxonomy of many invertebrate groups is uncertain or dated and this makes considerations of impacts difficult. Our knowledge of invertebrate community function is also patchy, as is information on their conservation requirements.

7.9 Summary of Project Impacts

The Deepdell North III project will remove 54.79 ha of indigenous vegetation comprising of low producing grassland, shrubland, seasonal gully drainages, ephemeral wetlands and a seepage wetland and inhabited by 71 indigenous plants (including 13 rare species), twenty bird species (nine indigenous and one rare species), four reptile species (three rare species) and a largely unknown invertebrate community. The project will also impact on 54.09 ha of cultivated pasture and shelterbelts. There may be some effect on a further 88.71 ha of indigenous vegetation and 26.47 ha of cultivated pastures in the surrounding area, but these effects are expected to be minimal if appropriate controls are employed. All of the indigenous vegetation communities are significant under the representativeness, rarity or distinctiveness criteria of the partially operative Otago Regional Policy Statement, and all but the seasonal gully drainage are significant under representativeness or rarity criteria of the Waitaki District Plan. The vegetation communities are habitat for 13 At Risk or Rare plant, bird or lizard or species and are underlain by 3 Threatened LENZ. The ephemeral wetland vegetation community is Historically Rare and Critically Endangered and the seepage wetland is Historically Rare and Endangered. Both are national priorities for protection. The indigenous vegetation communities are generally of low species diversity and most are characterised by high weed representation. The populations of the At Risk or Rare species are mostly small, except for the Declining Matagouri which is dominant in the shrubland vegetation community and frequent in the low producing grassland plant community. There is doubt concerning the national conservation assessment for this species.

Mostly the Deepdell North III project is assessed to having low to very low effect on most of the terrestrial ecological features examined in this document (Table 7). Exceptions to this are an overall moderate impact on the plant communities together (mainly a result of the presence of the LENZ, rare species, and the Nationally Critical ephemeral wetland) and a high impact on the seven Historically Uncommon Nationally Critical ephemeral wetlands. These effects will be addressed through an Impact Management Plan.

Ecological Feature Class	Ecological Feature Type	Ecological Feature	Classification of Feature	Buffer	Pit	WRS	PIA	Unit of Measurement	Accuracy of measurement	Ecological Importance of Feature	Magnitude of Project Impact on Feature		Overall Project Effect
											Local Scale	National Scale	
Bird	Community	Ecological function								Moderate	Moderate	Negligible	Very Low
Bird	Species	Pipit	Declining				2	individuals	Counted	Moderate	Low	Negligible	Very Low
Bird	Species	Black-backed gull					45	individuals	Counted	Low	Moderate	Negligible	Very Low
Bird	Species	Grey teal					6	individuals	Counted	Low	Moderate	Negligible	Very Low
Bird	Species	Grey warbler					10	individuals	Estimated	Low	Moderate	Negligible	Very Low
Bird	Species	Harrier hawk					1	individuals	Counted	Low	Moderate	Negligible	Very Low
Bird	Species	Paradise shelduck					6	individuals	Counted	Low	Moderate	Negligible	Very Low
Bird	Species	Spur-winged plover					8	individuals	Estimated	Low	Moderate	Negligible	Very Low
Bird	Species	Welcome swallow					5	individuals	Estimated	Low	Moderate	Negligible	Very Low
Environment	LENZ	< 10% indigenous cover left	Cultivated Pasture	26.39	29.16	24.93	80.49	Hectares	Measured				
Environment	LENZ	< 10% indigenous cover left	Ephemeral Wetland	0.02		0.3	0.31	Hectares	Measured				
Environment	LENZ	< 10% indigenous cover left	Low producing grassland	13.24	7.8	29.11	50.15	Hectares	Measured				
Environment	LENZ	< 10% indigenous cover left	Seasonal gully drainage	1.79	0.5	1.91	4.2	Hectares	Measured				
Environment	LENZ	< 10% indigenous cover left	Seepage			0.07	0.07	Hectares	Measured				
Environment	LENZ	< 10% indigenous cover left	Shelterbelts & Exotic Trees	0.08		0.53	0.61	Hectares	Measured				

Environment	LENZ	< 10% indigenous cover left	Shrublands	3.17	0.08	2.79	6.04	Hectares	Measured				
Environment	LENZ	< 10% indigenous cover left	Threatened LENZ with indigenous vegetation	5.26	1.7	15.14	22.09	Hectares	Measured				
Environment	LENZ	< 10% indigenous cover left	Threatened LENZ with indigenous vegetation	12.95	6.68	19.04	38.67	Hectares	Measured				
Environment	LENZ	10-20% indigenous cover left	Low producing grassland	11.58	0.96	10.36	22.89	Hectares	Measured				
Environment	LENZ	10-20% indigenous cover left	Shrublands	4.2		0.86	5.05	Hectares	Measured				
Environment	LENZ	Threatened LENZ with indigenous vegetation	10-20% indigenous cover left	15.77	0.96	11.21	27.94	Hectares	Measured				
Flora	Community	Ephemeral Wetland	Critically Endangered Historically Uncommon ecosystem type	0.02		0.3	0.31	Hectares	Measured	High	High	Medium	High
Flora	Community	Seepage	Endangered Historically Uncommon ecosystem type			0.07	0.07	Hectares	Measured	High	Medium	Low	Low
Flora	Community	Cultivated Pasture		26.39	29.16	24.93	80.49	Hectares	Measured	Negligible	Low	Negligible	Very Low
Flora	Community	Low producing grassland		24.82	8.76	39.47	73.04	Hectares	Measured	Moderate	Medium	Low	Low
Flora	Community	Seasonal gully drainage		1.79	0.5	1.91	4.2	Hectares	Measured	Low	Medium	Low	Very Low
Flora	Community	Shelterbelts & Exotic Trees		0.08		0.53	0.61	Hectares	Measured	Negligible	Low	Negligible	Very Low
Flora	Community	Shrublands		7.36	0.08	3.65	11.09	Hectares	Measured	Moderate	Low	Negligible	Very Low
Flora	Community	Ecosystem services								Minor			
Flora	Community	Historically Rare or Threatened Ecosystems				2	2	Communities		See Ephemeral Wetland and Seepage Wetland Flora Communities			
Flora	Community	Integrity								Moderate			

Flora	Community	National Priorities for Protection				2	2	Communities		See Ephemeral Wetland and Seepage Wetland Flora Communities			
Flora	Community	Rarity								High	Medium	Medium	Medium
Flora	Community	Representativeness								Moderate	Medium	Medium	Medium
Flora	Community	Sites recommended for protection					0	Sites		Nil			
Flora	Community	Wetlands of National Importance or Ramsar sites					0	Sites		Nil			
Flora	Species	Carmichaelia crassicaulis Hook.f. subsp. crassicaulis	Declining	15		2	17	individuals	Counted	High	Very Low	Negligible	Very Low
Flora	Species	Carmichaelia petriei Kirk	Declining	10		7	17	individuals	Counted	High	Low	Negligible	Very Low
Flora	Species	Discaria toumatou Raoul	Declining	7.36	0.08	3.65	3.73	Hectares	Estimated	High	Negligible	Negligible	Very Low
Flora	Species	Juncus pusillus Buchenau	Declining			1	1	m^2	Estimated	Moderate	Medium	Low	Very Low
Flora	Species	Leptinella pusilla Hook.f.	Declining			1	1	m^2	Estimated	High	Low	Negligible	Very Low
Flora	Species	Lobelia ionantha Heenan	Declining			0.561	0.561	m^2	Estimated	High	Medium	Low	Low
Flora	Species	Rytidosperma buchananii (Hook.f.) Connor & Edgar	Declining			1	1	individuals	Counted	Low	Very Low	Negligible	Very Low
Flora	Species	Carex resectans Cheeseman	Locally Uncommon			1.6	1.6	m^2	Estimated	Moderate	Medium	Low	Low
Flora	Species	Melicope simplex A.Cunn.	Locally Uncommon			11	11	individuals	Counted	Moderate	Medium	Negligible	Very Low
Flora	Species	Myrsine divaricata A.Cunn.	Locally Uncommon			2	2	individuals	Counted	Moderate	Medium	Negligible	Very Low
Flora	Species	Anthosachne falcis (Connor) Barkworth & S.W.L.Jacobs	Naturally Uncommon				100	individuals	Estimated	High	Medium	Low	Low
Flora	Species	Carex subtilis K.A.Ford	Naturally Uncommon			1	1	individuals	Counted	Moderate	Medium	Negligible	Very Low
Flora	Species	Juncus distegus Edgar	Naturally Uncommon			369	369	m^2	Estimated	Moderate	Medium	Low	Low
Flora	Species	Juncus distegus Edgar	Naturally Uncommon			56	56	individuals	Estimated	Moderate	Medium	Low	Low

Flora	Species	Diversity								Moderate	Medium	Medium	Medium
Invertebrates	Community	Overall importance								Moderate	Medium	Low	Low
Reptiles	Community	Overall importance								Moderate	Medium	Low	Low
Reptiles	Species	*Oligosoma inconspicuum*	Declining		1			individuals	Counted	High	Medium	Negligible	Very Low
Reptiles	Species	*Oligosoma polychroma* (clade 5 genotype)	Declining				5	individuals	Estimated	High	Medium	Negligible	Very Low
Reptiles	Species	*Woodworthia* "Otago/Southland large"	Declining				30	individuals	Estimated	High	Medium	Low	Low
Reptiles	Species	*Oligosoma maccanni* (clade 4 genotype)					150	individuals	Estimated	Moderate	Medium	Low	Low

Table 7. Summary table of project impacts on terrestrial ecological features assessed using the Environment Institute of Australia and New Zealand's 2018 Ecological Impact Assessment Guidelines.

8 References

Bibby, C.J. 1997. Macraes Ecological District, summary report for Protected Natural Areas Programme. Department of Conservation, Dunedin.

Burns, C. W., Butler, M. I. and Cuttance, P. M. (1984) Invertebrates, macroalgae, and chemical features in morainic ponds near Lakes Tekapo and Ohau, including new distribution records of Crustacea. *New Zealand Journal of Marine and Freshwater Research*, 18(2), 197-210.

de Lange, P.J; Heenan, P.B; Given, D.R; Norton, D.A; Ogle, C; Johnson, P.N; Cameron, E.K. 1999. Threatened and uncommon plants of New Zealand. New Zealand Journal of Botany 37: 603–628.

de Lange, P.J; Norton, D.A; Heenan, P.B; Courtney, S.P; Molloy, B.P.J; Ogle, C.C; Rance, B.D; Johnson, P.N; Hitchmough, R.A. 2004. Threatened and uncommon plants of New Zealand. New Zealand Journal of Botany 42: 45–76.

de Lange, P.J; Norton, D.A; Courtney, S.P; Heenan, P.B; Barkla, J.W; Cameron, E.K; Hitchmough, R.A; Townsend, A.J. 2009. Threatened and uncommon plants of New Zealand (2008 revision). New Zealand Journal of Botany 47: 61–96.

de Lange, P; Heenan, P; Norton, D; Rolfe, J; Sawyer, J. 2010. Threatened plants of New Zealand. Canterbury University Press, Christchurch.

de Lange, P.J; Rolfe, J.R; Champion P.D; Courtney, S.P; Heenan, P.B; Barkla, J.W; Cameron, E.K; Norton, D.A; Hitchmough, R.A. 2013. Conservation status of New Zealand indigenous vascular plants, 2012. New Zealand Threat Classification Series 3. Department of Conservation, Wellington.

de Lange, P.J; Rolfe, J.R; Barkla, J.W; Courtney, S.P; Champion P.D; Courtney, S.P; Perrie, L.R; Beadel, S.M; Ford, K.A; Breitwieser, I; Schönberger, I; Hindmarsh-Walls, R; Heenan, Ladley, K. 2018. Conservation status of New Zealand indigenous vascular plants, 2017. New Zealand Threat Classification Series 22. Department of Conservation, Wellington.

Department of Conservation & Ministry for the Environment. 2007. Protecting our places. Publication ME 799. Ministry for the Environment, Wellington.

Forsyth, P.J. (Comp.). 2001. Geology of the Waitaki area. Institute of Geological and Nuclear Sciences 1: 250 000 Geological Map 19. Institute of Geological and Nuclear Sciences, Lower Hutt.

Given, D.R. 1976. A register of rare and endangered indigenous plants in New Zealand. New Zealand Journal of Botany 14: 135–149.

Given, D.R. 1981. Rare and endangered plants of New Zealand. Reed, Auckland.

Heather, B; Robertson, H. 2000. Field guide to the birds of New Zealand. Viking, Auckland.

Hitchmough, R.A., 1997. A Systematic Revision of the New Zealand Gekkonidae. Unpub. Ph.D. Dissertation, Victoria University, Wellington. 370 pp.

Hitchmough, R; Bull, L; Cromarty P. (comps). 2007. New Zealand Threat Classification System Lists – 2005. Department of Conservation, Wellington.

Hitchmough, R.A; Hoare, J.M; Jamieson, H; Newman, D; Tocher, M.D; Anderson, P.J; Lettink, M; Whitaker, A.H. 2010. Conservation status of New Zealand reptiles, 2009. New Zealand Journal of Zoology 37: 203-224.

Hitchmough, R; Anderson, P; Barr, B; Monks, J; Lettink, M; Reardon, J; Tocher, M; Whitaker, T. 2013. Conservation status of New Zealand reptiles, 2012. New Zealand Threat Classification Series 2. Department of Conservation, Wellington.

Hitchmough, R; Barr, B; Lettink, M; Monks, J; Reardon, J; Tocher, M; van Winkel, D; Rolfe, J. 2016. Conservation status of New Zealand reptiles, 2015. New Zealand Threat Classification Series 17. Department of Conservation, Wellington.

Holdaway, R.J; Wiser, S.K; Williams, P.A. 2012. Status assessment of New Zealand's naturally uncommon ecosystems. Conservation Biology 26: 619-629.

Jewell, T. 2008. A photographic guide to reptiles and amphibians of New Zealand. New Holland Publishers (NZ) Ltd, Auckland. 143 pp.

Johnson, P.N; Rogers, G.M. 2003. Ephemeral wetlands and their turfs in New Zealand. Science for Conservation 230. Department of Conservation, Wellington.

Johnson, P; Gerbeaux P. 2004. Wetland types in New Zealand. Department of Conservation, Wellington.

Johnson, P. and Rogers, G. (2003) *Ephemeral wetlands and their turfs in New Zealand*. Science for Conservation, 230, Department of Conservation.

Liggins, L; Chapple, D.G; Daugherty, C.H; Ritchie, P.A. 2008. A SINE of restricted gene flow across the alpine fault: phylogeography of the New Zealand common skink (*Oligosoma nigriplantare polychroma*). Molecular Ecology 17: 3668-3683.

Mark, A.F; McLennan, B. 2005. The conservation status of New Zealand's indigenous grasslands. New Zealand Journal of Botany 43: 245-270.

McGlone, M.S. 1989. The Polynesian settlement of New Zealand in relation to environmental and biotic changes. New Zealand Journal of Ecology 12: 115-129.

McGlone, M.S; Mark, A.F; Bell, D. 1995. Late Pleistocene and Holocene vegetation history, Central Otago, South Island, New Zealand. Journal of the Royal Society of New Zealand 25: 1-22.

McKellar, I.C. 1966. Geological Map of New Zealand 1:250000, Sheet 25, Department of Scientific and Industrial Research, Wellington.

Mutch, A.R. 1963. Geological Map of New Zealand 1:250000, Sheet 23, Department of Scientific and Industrial Research, Wellington.

Nielsen, S.V; Bauer, A.M; 129ominica, T.R; Hitchmough, R.A; Daugherty, C.H. 2011. New Zealand geckos (Diplodactylidae): cryptic diversity in a post-Gondwanan lineage with trans-Tasman affinities. Molecular Phylogenetics and Evolution 59: 1-22.

O'Neill, S.B; Chapple, D.G; Daugherty, C.H; Ritchie, P.A. 2008. Phylogeography of two New Zealand lizards: McCann's skink (*Oligosoma maccanni*) and the brown skink (*O. zelandicum*). Molecular Phylogenetics and Evolution 48: 1168-1177.

Patrick, B.H. 1997. Insects of Macraes Ecological District. Otago Conservancy Miscellaneous Series No. 30. Department of Conservation, Dunedin.

Robertson, H.A; Dowding, J.E; Elliott, G.P; Hitchmough, R.A; Miskelly, C.M; O'Donnell, C.F.J; Powlesland, R.G; Sagar, P.M; Scofield, R.P; Taylor, G.A. 2012. Conservation status of New Zealand birds, 2012. New Zealand Threat Classification Series 4. Department of Conservation, Wellington.

Robertson, H.A; Baird, K; Dowding, J.E; Elliott, G.P; Hitchmough, R.A; Miskelly, C.M; McArthur, N; O'Donnell, C.F.J; Sagar, P.M; Scofield, R.P; Taylor, G.A. 2017. Conservation status of New Zealand birds, 2016. New Zealand Threat Classification Series 19. Department of Conservation, Wellington.

Singers, N.J.D; Rogers, G.M. 2014. A classification of New Zealand's terrestrial ecosystems. Science for Conservation 325. Department of Conservation, Wellington.

Suren, A. and Sorrell, B. (2010) *Aquatic invertebrate communities of lowland wetlands in New Zealand: characterising spatial, temporal and geographic distribution patterns*. Science for Conservation, No. 305, Department of Conservation.

Thompson, H.M. 1949. East of the Rock and Pillar: a history of the Strath Taieri and Macraes Districts. Otago Centennial Historical Publications, Whitcombe & Tombs, Christchurch.

Thorsen, M. 2008. Where in New Zealand is the highest diversity of threatened plants? Trilepidea Newsletter 58: 4-8.

Thorsen, M.J; Seddon, P.J; Dickinson, K.J.M. 2011. Faunal influences on New Zealand seed dispersal characteristics. Evolutionary Ecology 25: 1397-1426.

Timms, B. V. and McLay, C. (2005) A new species of *Eulimnadia* (Crustacea: Spinicaudata: Limnadiidae) from New Zealand. *Journal of the Royal Society of New Zealand*, 35(4), 409-415.

Townsend, A.J; de Lange, P.J; Duffy, C.A.J; Miskelly, C.M; Molloy, J; Norton, D.A. 2007. New Zealand Threat Classification System Manual. Department of Conservation, Wellington.

Walker, S; Cieraad, E; Grove, P; Lloyd, K; Myers, S; Park, T; Porteous, T. 2007. Guide for users of the threatened environment classification, Ver. 1.1. Landcare Research.

Walker, S; Price, R; Rutledge, D. 2008. New Zealand's remaining indigenous cover: recent changes and biodiversity protection needs. Science for Conservation 284. Department of Conservation, Wellington.

Whitaker, A.H. 1986. Macraes Flat Joint Venture area – Terrestrial fauna of the Deepdell catchment, North Otago. Unpub. report to Homestake New Zealand Exploration Ltd. Auckland. 136pp.

Whitaker, A.H. 1996. Impact of Agricultural development on grand skink (*Oligosoma grande*) (Reptilia: Scincidae) populations at Macraes Flat, Otago, New Zealand. Science for Conservation 33. Department of Conservation, Wellington.

Whitaker, A.H; Tocher, M.D; Blair, T.A. 2002. Conservation of lizards in Otago Conservancy 2002–2007. Department of Conservation, Wellington. 92 pp.

Wellborn, G. A., Skelly, D. K. and Werner, E. E. (1996) Mechanisms creating community structure across a freshwater habitat gradient. *Annual Review of Ecology, Evolution, and Systematics*, 27(1), 337-363.

Williams, P.A; Wiser, S; Clarkson, B; Stanley, M.C. 2007. New Zealand's historically rare terrestrial ecosystems set in a physical and physiognomic framework. New Zealand Journal of Ecology 31: 119-128.

Wellborn, G. A., Skelly, D. K. and Werner, E. E. (1996) Mechanisms creating community structure across a freshwater habitat gradient. *Annual Review of Ecology, Evolution, and Systematics*, 27(1), 337-363.

9 Appendices

9.1 Appendix 1. Biodiversity recorded during site inventory

9.1.1 *Flora*

Current Name + Authority	Common name	Group 1	Group 2	Family (Tribe)	Threat ranking (2017)	Abundance Class
Achillea millefolium L.	yarrow	DICOTYLEDONOUS HERBS	Composites	Asteraceae	Exotic	o
Anaphalioides bellidioides (G.Forst.) Glenny	Hells Bells	DICOTYLEDONOUS HERBS	Composites	Asteraceae	Not Threatened	l
Arctium minus subsp. minus	burdock	DICOTYLEDONOUS HERBS	Composites	Asteraceae	Exotic	l
Artemisia absinthium	wormwood	DICOTYLEDONOUS HERBS	Composites	Asteraceae	Exotic	r
Carduus nutans	nodding thistle	DICOTYLEDONOUS HERBS	Composites	Asteraceae	Exotic	o
Cirsium arvense	Californian thistle	DICOTYLEDONOUS HERBS	Composites	Asteraceae	Exotic	o
Cirsium vulgare	Scotch thistle	DICOTYLEDONOUS HERBS	Composites	Asteraceae	Exotic	o
Crepis capillaris	hawksbeard	DICOTYLEDONOUS HERBS	Composites	Asteraceae	Exotic	o
Hypochaeris radicata	catsear	DICOTYLEDONOUS HERBS	Composites	Asteraceae	Exotic	o
Leptinella pusilla Hook.f.	0	DICOTYLEDONOUS HERBS	Composites	Asteraceae	Declining	o
Pilosella officinarum F.Schultz & Sch.Bip.	hawkweed, mouse-ear hawkweed	DICOTYLEDONOUS HERBS	Composites	Asteraceae	Exotic	c
Senecio glomeratus Poir. subsp. glomeratus	fireweed	DICOTYLEDONOUS HERBS	Composites	Asteraceae	Not Threatened	r
Senecio quadridentatus Labill.	cotton fireweed, white fireweed, pahokoraka	DICOTYLEDONOUS HERBS	Composites	Asteraceae	Not Threatened	r
Taraxacum officinale agg.	dandelion	DICOTYLEDONOUS HERBS	Composites	Asteraceae	Exotic	r
Acaena agnipila var. aequispina	sheeps bur	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Rosaceae	Exotic	o
Acaena anserinifolia (J.R.Forst. & G.Forst.) J.B.Armstr.	Bidibid, hutiwai, piripiri	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Rosaceae	Not Threatened	o
Acaena caesiiglauca (Bitter) Bergmans	Glaucus bidibid, piripiri	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Rosaceae	Not Threatened	l

Acaena inermis Hook.f.	Blue mountain bidibid, spineless bidibid	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Rosaceae	Not Threatened	l
Acaena juvenca B.H.Macmill. x Acaena novae-zelandiae Kirk	0	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Rosaceae	Hybrid	r
Acaena novae-zelandiae Kirk	red bidibid	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Rosaceae	Not Threatened	r
Aciphylla aurea W.R.B.Oliv.	Golden spaniard, golden speargrass	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Apiaceae	Not Threatened	o
Anthriscus caucalis	beaked parsley	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Apiaceae	Exotic	l
Aphanes inexspectata	piert parsley	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Rosaceae	Exotic	r
Arenaria serpyllifolia L.	sandwort	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Caryophyllaceae	Exotic	r
Callitriche petriei R.Mason subsp. petriei	Petrie's starwort	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Plantaginaceae	Not Threatened	l
Capsella bursa-pastoris	shepherd's purse	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Brassicaceae	Exotic	o
Cardamine forsteri Govaerts	0	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Brassicaceae	Not Threatened	r
Cerastium fontanum subsp. vulgare (Hartm.) Greuter & Burdet	0	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Caryophyllaceae	Exotic	c
Cerastium semidecandrum L.	little mouse ear chickweed	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Caryophyllaceae	Exotic	o
Chaerophyllum ramosum (Hook.f.) K.F.Chung	0	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Apiaceae	Not Threatened	l
Crassula sieberiana (Schult. & Schult.f.) Druce	0	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Crassulaceae	Not Threatened	l
Dichondra repens J.R.Forst. & G.Forst.	Mercury Bay weed, Dichondra	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Convolvulaceae	Not Threatened	l
Digitalis purpurea L.	foxglove	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Plantaginaceae	Exotic	o

Dysphania pumilio (R.Br.) Mosyakin & Clemants	clammy goosefoot	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Amaranthaceae	Exotic	r
Epilobium pubens A.Rich.	Willowherb	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Onagraceae	Not Threatened	o
Erodium cicutarium (L.) L''Hér.	storksbill	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Geraniaceae	Exotic	c
Erythranthe moschata (Lindl.) G.L.Nesom	musk	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Phrymaceae	Exotic	l
Galium (b) (CHR 469914; aff. G. perpusillum; "lacustrine")	0	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Rubiaceae	Not Assessed	l
Galium aparine	cleavers	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Rubiaceae	Exotic	l
Geranium (d) (; aff. G. microphyllum; "mainland")	0	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Geraniaceae	Not Assessed	r
Geranium molle L.	doves foot cranesbill	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Geraniaceae	Exotic	l
Hydrocotyle heteromeria A.Rich.	waxweed, waxweed pennywort	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Araliaceae	Not Threatened	l
Hydrocotyle novae-zeelandiae var. montana Kirk	0	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Araliaceae	Not Threatened	l
Limosella lineata Glück	mudwort	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Plantaginaceae	Not Threatened	l
Lobelia ionantha Heenan	Hypsela	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Campanulaceae	Declining	r
Lotus pedunculatus Cav.	lotus	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Fabaceae	Exotic	l
Marrubium vulgare	horehound	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Lamiaceae	Exotic	o
Myosotis laxa Lehm. subsp. caespitosa (CF Schultz)	water forget-me-not	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Boraginaceae	Exotic	l
Myriophyllum propinquum A.Cunn.	Common water milfoil	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Haloragaceae	Not Threatened	l

Nasturtium microphyllum Boenn. ex Rchb.	one-rowed watercress	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Brassicaceae	Exotic	r
Oxalis exilis A.Cunn.	creeping oxalis, yellow oxalis	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Oxalidaceae	Not Threatened	r
Plantago major	broad-leaved plantain	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Plantaginaceae	Exotic	r
Ranunculus foliosus Kirk	Grassland buttercup	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Ranunculaceae	Not Threatened	l
Reseda luteola	wild mignonette	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Resedaceae	Exotic	l
Rumex acetosa	sorrel	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Polygonaceae	Exotic	c
Rumex acetosella	sheep's sorrel	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Polygonaceae	Exotic	o
Rumex crispus	curled dock	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Polygonaceae	Exotic	o
Sagina procumbens L.	procumbent pearlwort	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Caryophyllaceae	Exotic	r
Scleranthus uniflorus P.A.Will.	0	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Caryophyllaceae	Not Threatened	l
Sherardia arvensis	field madder	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Rubiaceae	Exotic	l
Solanum dulcamara L.	bittersweet	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Solanaceae	Exotic	r
Spergularia rubra (L.) J.Presl & C.Presl	sand spurrey	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Caryophyllaceae	Exotic	r
Stellaria alsine Grimm	bog stichwort	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Caryophyllaceae	Exotic	l
Stellaria media (L.) Vill. subsp. media	chickweed	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Caryophyllaceae	Exotic	l
Trifolium arvense	haresfoot trefoil	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Fabaceae	Exotic	o

Trifolium dubium	suckling clover	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Fabaceae	Exotic	o
Trifolium repens	white clover	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Fabaceae	Exotic	c
Urtica urens	nettle, stinging nettle	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Urticaceae	Exotic	l
Verbascum thapsus L.	woolly mullein, common mullein	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Scrophulariaceae	Exotic	c
Veronica arvensis	field speedwell, corn speedwell	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Plantaginaceae	Exotic	l
Veronica serpyllifolia	turf speedwell, thyme-leaved speedwell	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Plantaginaceae	Exotic	r
Vicia hirsuta	hairy vetch, tiny vetch	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Fabaceae	Exotic	r
Vicia sativa	vetch	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Fabaceae	Exotic	r
Wahlenbergia albomarginata subsp. albomarginata Hook.	New Zealand harebell, harebell	DICOTYLEDONOUS HERBS	Dicotyledonous Herbs other than Composites	Campanulaceae	Not Threatened	r
Clematis marata J.B.Armstr.	0	DICOTYLEDONOUS LIANES & RELATED TRAILING PLANTS	0	Ranunculaceae	Not Threatened	l
Muehlenbeckia australis (G.Forst.) Meisn.	Pohuehue, large-leaved muehlenbeckia	DICOTYLEDONOUS LIANES & RELATED TRAILING PLANTS	0	Polygonaceae	Not Threatened	l
Muehlenbeckia complexa (A.Cunn.) Meisn. var. complexa	Small-leaved pohuehue, scrub pohuehue, wire vine	DICOTYLEDONOUS LIANES & RELATED TRAILING PLANTS	0	Polygonaceae	Not Threatened	o
Rubus schmidelioides var. subpauperatus (Cockayne) Allan	Tataramoa, bush lawyer, white-leaved lawyer	DICOTYLEDONOUS LIANES & RELATED TRAILING PLANTS	0	Rosaceae	Not Threatened	o
Carmichaelia crassicaulis Hook.f. subsp. crassicaulis	coral broom	DICOTYLEDONOUS TREES AND SHRUBS	0	Fabaceae	Declining	l
Carmichaelia petriei Kirk	desert broom	DICOTYLEDONOUS TREES AND SHRUBS	0	Fabaceae	Declining	o

Coprosma crassifolia Colenso	0	DICOTYLEDONOUS TREES AND SHRUBS	0	Rubiaceae	Not Threatened	l
Coprosma dumosa (Cheeseman) G.T.Jane	0	DICOTYLEDONOUS TREES AND SHRUBS	0	Rubiaceae	Not Threatened	r
Coprosma propinqua var. propinqua A.Cunn.	mingimingi	DICOTYLEDONOUS TREES AND SHRUBS	0	Rubiaceae	Not Threatened	l
Coprosma propinqua var. propinqua X Coprosma crassifolia	0	DICOTYLEDONOUS TREES AND SHRUBS	0	Rubiaceae	Hybrid	r
Cytisus scoparius	wild broom	DICOTYLEDONOUS TREES AND SHRUBS	0	Fabaceae	Exotic	l
Discaria toumatou Raoul	matagouri, wild Irishman	DICOTYLEDONOUS TREES AND SHRUBS	0	Rhamnaceae	Declining	c
Melicope simplex A.Cunn.	Poataniwha	DICOTYLEDONOUS TREES AND SHRUBS	0	Rutaceae	Locally Significant	r
Melicytus alpinus (Kirk) Garn.-Jones	Porcupine shrub	DICOTYLEDONOUS TREES AND SHRUBS	0	Violaceae	Not Threatened	l
Myrsine divaricata A.Cunn.	Weeping matipo, weeping mapou	DICOTYLEDONOUS TREES AND SHRUBS	0	Primulaceae	Locally Significant	r
Olearia bullata H.D.Wilson & Garn.-Jones	0	DICOTYLEDONOUS TREES AND SHRUBS	0	Asteraceae	Not Threatened	o
Olearia lineata (Kirk) Cockayne x Olearia bullata H.D.Wilson & Garn.-Jones	0	DICOTYLEDONOUS TREES AND SHRUBS	0	Asteraceae	Hybrid	r
Ribes uva-crispa	Gooseberry	DICOTYLEDONOUS TREES AND SHRUBS	0	Grossulariaceae	Exotic	l
Rosa rubiginosa	briar	DICOTYLEDONOUS TREES AND SHRUBS	0	Rosaceae	Exotic	l
Sambucus nigra	elder, elderflower, elderberry	DICOTYLEDONOUS TREES AND SHRUBS	0	Adoxaceae	Exotic	o
Sorbus aucuparia subsp. aucuparia	rowan	DICOTYLEDONOUS TREES AND SHRUBS	0	Rosaceae	Exotic	o
Ulex europaeus	gorse	DICOTYLEDONOUS TREES AND SHRUBS	0	Fabaceae	Exotic	r

Asplenium flabellifolium Cav.	butterfly fern, walking fern, necklace fern	FERNS	0	Aspleniaceae	Not Threatened	l
Asplenium richardii (Hook.f.) Hook.f.	Richards spleenwort	FERNS	0	Aspleniaceae	Not Threatened	r
Azolla rubra R.Br.	Pacific azolla, azolla, red azolla	FERNS	0	Salviniaceae	Not Threatened	l
Cranfillia fluviatilis (R.Br.) Gasper & V.A.O.Dittrich	kiwikiwi, kiwakiwa, creek ferm	FERNS	0	Blechnaceae	Not Threatened	r
Hypolepis millefolium Hook.	Thousand leaved fern	FERNS	0	Dennstaedtiaceae	Not Threatened	l
Microsorum pustulatum subsp. pustulatum (G.Forst.) Copel.	hounds tongue, kowaowao, paraharaha	FERNS	0	Polypodiaceae	Not Threatened	r
Polystichum vestitum (G.Forst.) C.Presl	punui, prickly shield fern	FERNS	0	Dryopteridaceae	Not Threatened	l
Pteridium esculentum (G.Forst.) Cockayne	bracken, rarauhe, bracken fern	FERNS	0	Dennstaedtiaceae	Not Threatened	l
Agrostis capillaris L.	browntop	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Exotic	a
Agrostis stolonifera L.	creeping bent	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Exotic	l
Aira caryophyllea L. subsp. caryophyllea	silvery hair grass	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Exotic	l
Alopecurus geniculatus L.	kneed foxtail	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Exotic	r
Anthosachne falcis (Connor) Barkworth & S.W.L.Jacobs	0	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Declining	o
Anthoxanthum odoratum L.	sweet vernal	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Exotic	a
Bromus hordeaceus L.	soft brome	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Exotic	c
Chionochloa rigida (Raoul) Zotov subsp. rigida	narrow-leaved snow tussock	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Not Threatened	l
Critesion murinum subsp. murinum	barley grass	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Exotic	c

Cynosurus cristatus L.	crested dogstail	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Exotic	o
Dactylis glomerata L.	cocksfoot	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Exotic	a
Dichelachne crinita (L.f.) Hook.f.	long-hair plume grass	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Not Threatened	o
Festuca novae-zelandiae (Hack.) Cockayne	Fescue tussock, hard tussock	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Not Threatened	l
Festuca rubra L. subsp. rubra	red fescue	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Exotic	l
Festuca rubra subsp. commutata	Chewings fescue	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Exotic	c
Glyceria declinata Bréb.	blue sweet grass, glaucous sweet grass	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Exotic	l
Holcus lanatus L.	Yorkshire fog	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Exotic	o
Lachnagrostis striata (Colenso) Zotov	Purple wind grass	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Not Threatened	r
Lolium perenne L.	perennial rye grass	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Exotic	c
Phleum pratense L.	timothy	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Exotic	l
Poa annua L.	annual poa	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Exotic	l
Poa cita Edgar	Silver tussock	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Not Threatened	o
Poa colensoi Hook.f.	Blue tussock	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Not Threatened	l
Poa infirma Kunth	annual poa	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Exotic	l
Poa pratensis L.	Kentucky bluegrass	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Exotic	o

Rytidosperma buchananii (Hook.f.) Connor & Edgar	slender danthonia, bristle grass	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Declining	l
Rytidosperma clavatum (Zotov) Connor & Edgar	Bristle grass	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Not Threatened	l
Rytidosperma penicillatum (Labill.) Connor & Edgar	danthonia	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Exotic	o
Vulpia bromoides (L.) Gray	Vulpia hair grass, brome fescue, squirrel-tailed fescue	MONOCOTYLEDONOUS HERBS	Grasses	Poaceae	Exotic	o
Bulbinella angustifolia (Cockayne & Laing) L.B.Moore	0	MONOCOTYLEDONOUS HERBS	Rushes & Allied Plants	Asphodelaceae	Not Threatened	l
Juncus articulatus L.	jointed rush	MONOCOTYLEDONOUS HERBS	Rushes & Allied Plants	Juncaceae	Exotic	l
Juncus bufonius var. bufonius	toad rush	MONOCOTYLEDONOUS HERBS	Rushes & Allied Plants	Juncaceae	Exotic	l
Juncus distegus Edgar	two storey rush	MONOCOTYLEDONOUS HERBS	Rushes & Allied Plants	Juncaceae	Naturally Uncommon	l
Juncus edgariae L.A.S.Johnson & K.L.Wilson	Wiwi, Edgars rush	MONOCOTYLEDONOUS HERBS	Rushes & Allied Plants	Juncaceae	Not Threatened	l
Juncus effusus L. var. effusus	leafless rush	MONOCOTYLEDONOUS HERBS	Rushes & Allied Plants	Juncaceae	Exotic	l
Juncus filicaulis	leafless rush	MONOCOTYLEDONOUS HERBS	Rushes & Allied Plants	Juncaceae	Exotic	l
Juncus pusillus Buchenau	Dwarf rush	MONOCOTYLEDONOUS HERBS	Rushes & Allied Plants	Juncaceae	Naturally Uncommon	r
Carex colensoi Boott	Colensos sedge	MONOCOTYLEDONOUS HERBS	Sedges	Cyperaceae	Not Threatened	l
Carex flagellifera Colenso	Glen Murray tussock, Trip Me Up	MONOCOTYLEDONOUS HERBS	Sedges	Cyperaceae	Not Threatened	r
Carex leporina L.	oval sedge	MONOCOTYLEDONOUS HERBS	Sedges	Cyperaceae	Exotic	l
Carex resectans Cheeseman	Desert Sedge	MONOCOTYLEDONOUS HERBS	Sedges	Cyperaceae	Locally Significant	r

Carex secta Boott	Purei, Pukio, Niggerhead	MONOCOTYLEDONOUS HERBS	Sedges	Cyperaceae	Not Threatened	I
Carex subtilis K.A.Ford	Handsome Bastard Grass, Handsome Hook Sedge	MONOCOTYLEDONOUS HERBS	Sedges	Cyperaceae	Naturally Uncommon	I
Carex testacea Sol. ex Boott	Speckled Sedge, Trip Me Up	MONOCOTYLEDONOUS HERBS	Sedges	Cyperaceae	Not Threatened	I
Carex wakatipu Petrie	Sedge	MONOCOTYLEDONOUS HERBS	Sedges	Cyperaceae	Not Threatened	I
Eleocharis acuta R.Br.	sharp spike sedge	MONOCOTYLEDONOUS HERBS	Sedges	Cyperaceae	Not Threatened	I

9.1.2 *Avifauna*

Name	Common Name	Status	Family	Number of observations
Alauda arvensis	skylark, kaireka, common skylark	Exotic	Alaudidae	58
Anas gracilis Buller, 1869	tētē moroiti, tētē, tete moroiti, tete, gray teal	Not Threatened	Anatidae	6
Anas platyrhynchos Linnaeus, 1758	mallard duck, wild duck, northern mallard, greenhead	Exotic	Anatidae	6
Anthus novaeseelandiae Gmelin subsp. *novaeseelandiae*	New Zealand pipit, pipit, pīhoihoi, pihoihoi, Richard's pipit	Declining	Motacillidae	2
Carduelis carduelis L	goldfinch	Exotic	Fringillidae	29
Carduelis flammea subsp. *cabaret*	redpoll	Exotic	Fringillidae	63
Circus approximans Peale	Australasian harrier, harrier hawk, hawk, kāhu, kahu, swamp harrier	Not Threatened	Accipitridae	14
Emberiza citrinella subsp. *caliginosa*	yellow bunting, yellowhammer	Exotic	Emberizidae	66
Gerygone igata Quoy & Gaimard	grey warbler, riroriro, rainbird, teetotum, gray warbler, New Zealand gerygone, grey gerygone	Not Threatened	Acanthizidae	2
Gymnorhina tibicen subsp.	Australian magpie, magpie, white-backed magpie, black-backed magpie, makipae	Exotic	Artamidae	9
Hemiphaga novaeseelandiae (Gmelin, 1789)	kererū, kereru, kukupa, kuku, wood pigeon, native pigeon, kokopa	Not Threatened	Columbidae	1
Hirundo neoxena Gould, 1842	Welcome swallow, warou, house swallow	Not Threatened	Hirundinidae	19
Larus dominicanus Lichtenstein, 1823	southern black backed gull, karoro, kelp gull, dominican gull, black-backed gull, mollyhawk, seagull, blackbacked gull	Not Threatened	Laridae	5
Passer domesticus Linnaeus, 1758 subsp. *domesticus*	House sparrow, tiu, English sparrow	Exotic	Passeridae	44
Sturnus vulgaris L. subsp. *vulgaris*	common starling, starling, European starling	Exotic	Sturnidae	140
Tadorna variegata Gmelin	paradise shelduck, paradise duck, pūtangitangi, putangitangi, pari, parry, parrie	Not Threatened	Anatidae	6

Turdus merula L	Eurasian blackbird, blackbird, manu pango	Exotic	Turdidae	14
Turdus philomelos subsp. *clarkei*	song thrush, thrush	Exotic	Turdidae	3
Vanellus miles (Boddaert, 1783)	spur winged plover, masked lapwing, masked plover, spur-wing, spurwinged plover	Not Threatened	Charadriidae	14

9.1.3 *Herpetofauna*

Oligosoma maccanni (Patterson & Daugherty, 1990) (clade 4 genotype)	McCann's skink	Not Threatened	Scinicidae	Occasional
Oligosoma inconspicuum (Patterson & Daugherty, 1990)	cryptic skink	Declining	Scinicidae	Rare
Oligosoma polychroma (Patterson & Daugherty, 1990) (clade 5 genotype)	southern grass skink	Declining	Scinicidae	Local
Woodworthia “Otago Large”	korero gecko	Declining	Gekkonidae	Local

9.1.5 *Invertebrates*

Note: this list includes species recorded from nearby on the Taieri Ridge slopes

Current name	Common name	Threat ranking (2012)	Group 2	Family (Tribe)	Notes
Costelytra? *Odontria*? small, shiny scarab	Scarab beetle	Not Threatened	Coleoptera (beetles)	Scarabaeidae - Melolonthinae	This small beetle (c.9mm long) keyed out uncertainly to genus *Costelytra* and could not be successfully keyed to a species of either genus. Taken at night in the Horse Flat Dump site.
Mecodema sculpturatum	carabid beetle	Not Threatened	Coleoptera (beetles)	Carabidae - Trechinae	This ground beetle is a southern South Island species, known predominantly from Southland and Otago, but found as far north as Otira Gorge. Two dead specimens, one only recently dead, were found in the Horse Flat Dump site.
Mimopeus sp.	Darkling beetle	Not Threatened	Coleoptera (beetles)	Tenebrionidae	Moderately large beetle, possibly a small *M. opaculus*, from the Horse Flat Dump site.
Neocicindela sp.	tiger beetle	Not Threatened	Coleoptera (beetles)	Carabidae - Cicindelinae	Tiger beetle larvae holes were visible in some clay banks at the Horse Flat Dump site, usually along road cuttings. A single adult beetle was seen at one site but eluded capture. The beetle was quite light-coloured, suggesting that it may have been a teneral (i.e., a recently emerged adult), which in turn suggests that it was early in the season for the adults to be present. The beetle appeared to have quite a wide marginal line (the whitish band around the edges of the elytra) which may indicate either *Neocicindela latecincta* or *N. parryi*, both of which are known from the Otago area.
Odontria sp.1 "medium brown, mottled, velvety"	Scarab beetle	Not Threatened	Coleoptera (beetles)	Scarabaeidae - Melolonthinae	Four males and a female in the light traps, Horse Flat Dump site.
Odontria sp.2 "darker, grey, mottled"	Scarab beetle	Not Threatened	Coleoptera (beetles)	Scarabaeidae - Melolonthinae	Two apparent males and a female from the Horse Flat Dump site, one male and the female taken in a light trap.
Odontria sp.3 "dark brown, darker & more extensive mottling"	Scarab beetle	Not Threatened	Coleoptera (beetles)	Scarabaeidae - Melolonthinae	Likely male from the Deepdell South site, taken at night
Odontria sp.4 "red-brown" (some similarities to the description of O. smithii)	Scarab beetle	Not Threatened	Coleoptera (beetles)	Scarabaeidae - Melolonthinae	In light trap, Horse Flat Dump site.
Oregus aereus	carabid beetle	Not Threatened	Coleoptera (beetles)	Carabidae - Trechinae	Widespread in Central Otago; previously known from the Deepdell Stream area.
Forficula auricularia	earwig	Exotic	Dermaptera (earwigs)	Forficulidae	The only earwig collected (from Deepdell South) keyed to this widespread introduced species

Anabarhynchus sp.; provisionally keyed to *A. triangularis*	stilleto fly	Not Threatened	Diptera (flies)	Therevidae	A single male, taken from a speargrass at the Deepdell South site. *A. triangularis* was described from two males and two females, taken from the Cromwell Gorge and Kawerau Gorge areas. Previous experience with this group indicates that inland Otago has a number of undescribed species.
Species undertermined	robber fly	Not Threatened	Diptera (flies)	Asilidae	A large male robber fly was seen in the Horse Flat Dump site but not collected due to the lack of an up-to-date taxonomy.
Kikihia sp., possibly *K. angusta*	cicada	Not Threatened	Hemiptera (true bugs)	Cicadidae	On Horse Flat Dump site. *K. angusta* is a widespread species in the South Island, but this identification is very tentative.
Pentatomidae sp.	shieldbug	Not Threatened	Hemiptera (true bugs)	Pentatomidae	A shield bug nymph was collected in the Horse Flat Dump site. There are several reasonably widespread native species known from this group.
Rhodopsalta sp., presumed to be either *Rhodopsalta cruentata* or *R. microdora*	cicada	Not Threatened	Hemiptera (true bugs)	Cicadidae	On Horse Flat Dump site; widespread species in the South Island
Huberia brounii	ant	Not Threatened	Hymenoptera (wasps and ants)	Formicidae	Widespread endemic species.
'Aletia' moderata		Not Threatened	Lepidoptera (butterflies & moths)	Noctuidae	A common species from about Rotorua south in open habitats, larvae on *Raoulia*.
'Chloroclystis' filata		Exotic	Lepidoptera (butterflies & moths)	Geometridae	Naturalised from Australia. Abdunant throughout New Zealand, larvae on flowers of gorse and other plants.
'Hydriomena' deltoidata		Not Threatened	Lepidoptera (butterflies & moths)	Geometridae	Common almost throughout New Zealand, but scarcer in the far North. Larvae on plantains.
'Hydriomena' rixata		Not Threatened	Lepidoptera (butterflies & moths)	Geometridae	Common throughout New Zealand. Larvae on plantains and willowherbs.
Apoctena cf. *conditana*		Not Threatened	Lepidoptera (butterflies & moths)	Tortricidae	*Apoctena conditana* is a widespread tortricid that is supposedly polyphagous, but I believe that more than one species may be confused under this name (hence the 'cf.'). In Auckland I have only reared it from *Lycopodium deuterodensum*, but according to John Dugdale's notes, based on rearings by Brian Patrick in the southern South Island it is polyphagous on various trees, shrubs and herbs. The genitalia of the Macraes specimen show minor differences from those illustrated by John Dudgale (NZ J Zool 1990), which were from a specimen from Opouri (SD) and the whole issue of the taxonomy needs further investigation. We don't have many similar looking specimens under *conditana* in NZAC, and it looks utterly different from Auckland specimens attributed to this species
Argyrophenga antipodum	Tussock ringlet butterfly	Not Threatened	Lepidoptera (butterflies & moths)	Nymphalidae	Tussock ringlet butterflies were common at both sites. A single specimen collected was identified as *A. antipodum*; the study site is probably also within the known range of *A. janitae*.

Asaphodes chlamydota		Not Threatened	Lepidoptera (butterflies & moths)	Geometridae	A fairly common and widespread species throughout New Zealand, larvae on *Clematis* spp.
Asaphodes clarata		Not Threatened	Lepidoptera (butterflies & moths)	Geometridae	A locally common species from the central North Island south.
Austrocidaria similata		Not Threatened	Lepidoptera (butterflies & moths)	Geometridae	A common and widespread species throughout New Zealand, larvae on *Coprosma* spp.
Bityla defigurata		Not Threatened	Lepidoptera (butterflies & moths)	Noctuidae	Fairly common throughout New Zealand, larvae on *Muehlenbeckia.*
Epiphryne undosata		Not Threatened	Lepidoptera (butterflies & moths)	Geometridae	Locally common throughout New Zealand, larvae on *Hoheria*.
Eudonia (?)oculata		Locally Notable	Lepidoptera (butterflies & moths)	Crambidae	A little-known South Island species, larvae presumed to be on moss or in herbaceous swards. Apparently very local and only recent material in NZAC is from Tiwai Point, Southland. Populations on the Chatham Islands may not be conspecific.
Eudonia rakaiensis		Not Threatened	Lepidoptera (butterflies & moths)	Crambidae	A usually rather uncommon but widespread species throughout the country. Larva unknown, probably in moss or herbaceous swards.
Eudonia submarginalis		Not Threatened	Lepidoptera (butterflies & moths)	Crambidae	Abundant throughout New Zealand, larvae in herbaceous swards.
Gadira acerella		Not Threatened	Lepidoptera (butterflies & moths)	Crambidae	Fairly common throughout the country. Larvae presumed to be on lichens.
Graphania lignana		Not Threatened	Lepidoptera (butterflies & moths)	Noctuidae	A common and widespread species throughout New Zealand, larvae on grasses.
Graphania morosa		Not Threatened	Lepidoptera (butterflies & moths)	Noctuidae	A common and widespread species from the central North Island south, larvae on grasses.
Graphania mutans		Not Threatened	Lepidoptera (butterflies & moths)	Noctuidae	A very common and widespread species throughout New Zealand, larvae polyphagous, mainly on herbaceous plants.
Graphania omoplaca		Not Threatened	Lepidoptera (butterflies & moths)	Noctuidae	A common and widespread species from the central North Island south, larvae on grasses, plantain and probably other herbs.
Graphania plena		Not Threatened	Lepidoptera (butterflies & moths)	Noctuidae	A very common and widespread species throughout New Zealand, larvae polyphagous, mainly on herbaceous plants.
Graphania rubescens		Not Threatened	Lepidoptera (butterflies & moths)	Noctuidae	A fairly common and widespread species from the southern North Island south, larvae on herbaceous plants including *Gunnera*.
Harmologa oblongana		Not Threatened	Lepidoptera (butterflies & moths)	Tortricidae	Common and widespread species, larvae polyphagous in shrublands.
Harmologa scoliastis		Not Threatened	Lepidoptera (butterflies & moths)	Tortricidae	Widespread and fairly common species, larvae on *Muehlenbeckia*.

Harmologa sp. A.		Not Threatened	Lepidoptera (butterflies & moths)	Tortricidae	Local but widespread South Island species associated with small-leaved *Melicytus*.
Helastia corcularia		Not Threatened	Lepidoptera (butterflies & moths)	Geometridae	Common throughout the South Island.
Helastia triphragma		Locally Notable	Lepidoptera (butterflies & moths)	Geometridae	Local and usually uncommon species of the southern South Island.
Hierodoris s-fractum		Not Threatened	Lepidoptera (butterflies & moths)	Xyloryctidae	Very local, endemic to the southern South Island (Hoare 2005). Larvae in leaf-litter in shrubland.
Lycaena feredayi	glade copper butterfly	Not Threatened	Lepidoptera (butterflies & moths)	Lycaenidae	A female was taken in the Horse Flat Dump site.
Lycaena salustius	Common copper butterfly	Not Threatened	Lepidoptera (butterflies & moths)	Lycaenidae	This species was present in large numbers throughout the sites investigated
Mnesictena flavidalis		Not Threatened	Lepidoptera (butterflies & moths)	Crambidae	Larvae on various herbaceous plants including *Hydrocotyle*. Common throughout New Zealand.
Monopis ethelella		Exotic	Lepidoptera (butterflies & moths)	Tineidae	Very common and widespread birds' nest species.
Musotima nitidalis		Not Threatened	Lepidoptera (butterflies & moths)	Crambidae	Larvae on various ferns. Common throughout New Zealand, also in Australia.
Opogona comptella		Exotic	Lepidoptera (butterflies & moths)	Tineidae	Fairly common and widespread species in drier parts of the country; larvae in dead wood.
Orocrambus flexuosellus		Not Threatened	Lepidoptera (butterflies & moths)	Crambidae	larvae on native and exotic grasses. Extremely common throughout New Zealand.
Orocrambus sp. B of NZAC		Not Threatened	Lepidoptera (butterflies & moths)	Crambidae	Larvae presumed to be on tussock grasses. A local species of Central Otago and Otago Lakes that has been confused with *O. crenaeus* in collections and was therefore overlooked by Gaskin (1975) in his revision of *Orocrambus*. It needs to be critically compared with the very similar and poorly known *O. dicrenellus*, but genitalia seem to be distinct.
Orocrambus vittellus		Not Threatened	Lepidoptera (butterflies & moths)	Crambidae	larvae on grasses. Common throughout New Zealand.
Pasiphila (?)cotinaea		Not Threatened	Lepidoptera (butterflies & moths)	Geometridae	Very local species occurring from the central North Island south. A worn specimen, identification is doubtful as this genus is unrevised and can be very tricky.
Persectania aversa		Not Threatened	Lepidoptera (butterflies & moths)	Noctuidae	A common and widespread species throughout New Zealand except the northern North Island, larvae on grasses.
Physetica phricias		Not Threatened	Lepidoptera (butterflies & moths)	Noctuidae	A locally common South Island species, larvae on matagouri (*Discaria*).

Tingena sp. cf. *siderodeta*		Not Threatened	Lepidoptera (butterflies & moths)	Oecophoridae	*Tingena* spp. are associated with leaf-litter. an unrevised and very challenging genus; it is not possible to identify the specimen confidently to species without substantial further research.
Tmetolophota atristriga		Not Threatened	Lepidoptera (butterflies & moths)	Noctuidae	A common to abundant and widespread species throughout New Zealand, larvae on grasses.
Tmetolophota propria		Not Threatened	Lepidoptera (butterflies & moths)	Noctuidae	A common and widespread species in the South Island (and central plateau of the North Island), larvae on grasses.
Tmetolophota semivittata		Not Threatened	Lepidoptera (butterflies & moths)	Noctuidae	A common and widespread species throughout New Zealand, larvae on sedges (*Carex* spp.), rushes (*Juncus* spp.) and probably also grasses.
Tmetolophota steropastis (2)		Not Threatened	Lepidoptera (butterflies & moths)	Noctuidae	A common and widespread species throughout New Zealand, larvae mainly on flax (*Phormium*) toetoe (*Austroderia* spp.) and pampas grass (*Cortaderia*)., occasionally on other monocots.
Wiseana (?)copularis		Not Threatened	Lepidoptera (butterflies & moths)	Hepialidae	Endemic. A very common and widespread grassland and pasture species.
Wiseana (?)umbraculata		Not Threatened	Lepidoptera (butterflies & moths)	Hepialidae	Endemic. A common and widespread grassland / wetland species.
Xanthorhoe semifissata		Not Threatened	Lepidoptera (butterflies & moths)	Geometridae	Fairly common from the central North Island south.
Zizina oxleyi	little blue butterfly	Not Threatened	Lepidoptera (butterflies & moths)	Lycaenidae	Presumed to be much declined in range and abundance since European arrival in New Zealand, but still locally common where found, and classified as 'Not Threatened' (Hoare *et al.* 2017). Larvae on *Carmichaelia* and introduced clover.
Pseudaneitea sp.	leaf-veined slug	Not Threatened	Mollusca (snails, slugs, etc.)	Athoracophoridae	*Pseudaneita* sp. A single leaf-veined slug was collected at night in the Horse Flat Dump site.
Anisoptera sp.	dragonfly	Not Threatened	Odonata (damselflies & dragonflies)		Several specimens of at least one species of medium-sized dragonfly (not a *Uropetala*) were seen but not captured. These were especially prevalent at the Deepdell South Backfill site. Any of three species – *Aeshna brevistyla* and the two species of *Procordulia* – could potentially account for these sightings. All three are widespread in New Zealand.
Austrolestes colensonis	Blue Damselfly	Not Threatened	Odonata (damselflies & dragonflies)	Lestidae	Damselflies were common throughout both sites investigated.
Xanthocnemis zealandica	common redcoat damselfly	Not Threatened	Odonata (damselflies & dragonflies)	Coenagrionidae	Damselflies were common throughout both sites investigated.

9.2 Appendix 2. Abbreviations used in text

DOC	Department of Conservation
E.D.	Ecological District
EMP	Ecological Management Plan
OceanaGold	Oceana Gold (New Zealand) Ltd
ORC	Otago Regional Council
PIA	Project Impact Area
WDC	Waitaki District Council
WRS	Waste Rock Stack

9.3 Appendix 3. Site photographs

Figure 11. View of shrublands in Deepdell South pit backfill area of WRS looking east from 1398138 4975528. Old Deepdell South pit in right midground. Photo taken 16 January 2018.

Figure 12. View of Deepdell North III pit eastern boundary looking north towards Horse Flat WRS location (on far hill slope) from 1398028 4975609. Photo taken 16 January 2018.

Figure 13. Ephemeral wetland F near Deepdell North III pit on Horse Flat at 1398013 4975714. Photo taken 16 January 2018.

Figure 14. Seasonal gully drainage at 1397550 4976002. Photo taken 16 January 2018.

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Deepdell North III Project

Impact Management Plan

December 2019

Report prepared for Oceana Gold (New Zealand) Ltd by Dr M. J. Thorsen,

5 December 2019

Report number: 0219-20

2 Dowling Street
Dunedin 9016
New Zealand

1 Contents

1 Document Summary

The Deepdell North III project will remove 54.79 ha of indigenous vegetation comprising of low producing grassland, shrubland, seasonal gully drainages, ephemeral wetlands and a seepage wetland and inhabited by 71 indigenous plants (including 13 rare species), twenty bird species (nine indigenous and one rare species), four reptile species (three rare species) and a largely unknown invertebrate community. The vegetation communities are underlain by 3 Threatened LENZ. The ephemeral wetland vegetation community is Historically Rare and Critically Endangered and the seepage wetland is Historically Rare and Endangered. Both are priorities for protection. The indigenous vegetation communities are generally of low species diversity and most are characterised by high weed representation. The populations of the 17 At Risk or Rare species are mostly small, except for the Declining Matagouri which is dominant in the shrubland vegetation community and frequent in the low producing grassland plant community.

The project will also impact on 54.09 ha of cultivated pasture and shelterbelts. There may be some effect on a further 88.71 ha of indigenous vegetation and 26.47 ha of cultivated pastures, but these effects are expected to be minimal if appropriate controls are employed.

Mostly the Deepdell North III project is assessed to having low to very low effect on most of the terrestrial ecological features. Exceptions to this are a moderate impact on the plant communities together (mainly a result of the presence of the LENZ, rare species, and the Nationally Critical ephemeral wetland) and a high impact on the seven Historically Uncommon Nationally Critical ephemeral wetlands. These effects will be addressed through an Impact Management Plan.

To address these impacts OceanaGold (New Zealand) Limited (OceanaGold) proposes to support the activities within this Impact Management Plan. These activities include avoiding effects by evaluating siting of infrastructure and by isolating higher-value ecological areas in the buffer zone, mitigating general environmental effects such as dust, noise and weeds, and implementing an ecological management programme under an offset design at two sites. Once implemented, this Impact Management Plan will result in avoiding, minimising and rehabilitating all significant adverse ecological effects arising from the Deepdell North III Project.

This document is laid out so that the general condition and threats to biodiversity in the Macraes Ecological District are described (Sections 2 and 3), the predicted impact of the project (Section 4) are summarised

from the project Ecological Impact Assessment, the regulatory framework within which the Impact Management Plan must fit (Section 5), a general evaluation of impact management options in Section 6 and how to quantify these (Section 7), the preferred mitigation options selected for this project in Section 8 and the Impact Management Plan (Section 9) that will give effect to the preferred mitigation options.

2 General Ecological Setting

The general ecological setting of the Deepdell North III project is described in the Ecological Impact Assessment and is summarised here as it provides important context for the Impact Management Plan.

Past vegetation cover of the Macraes ED is thought to have comprised montane short tussockland grading into subalpine tall tussockland, with areas of mixed hardwood and podocarp forest, kanuka forest and *Coprosma*-flax scrub (Bibby 1997). In Otago, much of the original vegetation cover has been dramatically altered as a result of anthropogenic factors (McGlone et al. 1995), and this massive vegetation change has also occurred at Macraes (Whitaker 1996). Since European settlement in the 1850's (Thompson 1949), areas have been burnt (sometimes repeatedly) and exotic grasslands induced by ploughing, oversowing, and applying fertiliser (Whitaker 1996). The present vegetation of the Macraes ED is of a highly modified nature, with approximately 75% of the district dominated by exotic vegetation types (mainly improved pastureland) and the remainder of the vegetation types being indigenous and comprised of varying density narrow-leaved tussockland, copper tussock-based wetlands and grey shrubland interspersed with remnants of original forest cover and scattered ephemeral wetlands (Bibby 1997, Thorsen pers. obs.). The remaining native vegetation communities currently present within the Macraes area are botanically diverse (Thorsen 2008) and is comprised of 592 indigenous (including 15 Data Deficient, 61 At Risk and 27 Threatened species) and 216 exotic species. The remaining vegetation communities are likely to be derived from the original vegetation communities that existed before human colonisation of the region, but many are likely to be considerably reduced in extent and species diversity. Invasion by exotic shrub and tree species, particularly gorse and broom, is an increasing problem in the area.

Of the fauna, fifty-four species of birds have been recorded from the Macraes E.D., of which thirty four are indigenous and twenty are introduced. The area's indigenous avifauna are likely being predated by exotic mammals, though the impact of this predation pressure on population dynamics is not known. They are also being impacted by changes to their habitats, however the nature of these changes and their impacts on the species is again not known. The area is noted for its high diversity of seven lizard species (Whitaker et al. 2002) and the invertebrate communities are diverse (for a region at moderate altitude) and contains some species that are rare or of biogeographic interest (Patrick 1997). The lizard species is being similarly impacted as birds by exotic mammals and habitat change, though the severity of predation is somewhat moderated by the abundance of rocky habitats offering safer retreat sites. This is thought to be at least part of the reason why Central Otago retains a high density and diversity of lizard species. Some catchments provide habitat for populations of non-migratory galaxiids, freshwater crayfish and longfin eel, which are being affected through predation by trout and changes to their habitats, particularly in the lower reaches of watercourses.

3 Threats to biodiversity

Many of the species of conservation concern in the Macraes E.D. retain good population sizes probably at least in part because of past farming practices, but current conversion of narrow-leaved tussockland and dryland herbfield by discing or spraying are reducing the extent of some plant communities. Oversowing and topdressing of areas of indigenous vegetation also alters the species composition, usually at the expense of the indigenous species (matagouri being a notable exception to this). Burning of indigenous grasslands is not now commonly practiced in the area, but escaped fires are very detrimental to grasslands and shrublands. Predation by introduced mammals and invasion by exotic herb, grass, shrub and tree species, (particularly gorse and broom and weed invasion of wetlands) is insidious but difficult to quantify and likely impacts species differently and some "pest" species may be beneficial to some species in some situations.

Efforts to protect the biodiversity in the Macraes E.D. include a DOC skink protection programme in the Redbank-Nenthorn area and conservation activities associated with past OceanaGold projects including the creation of six covenants between 16 and 290 ha in size. The Department of Conservation (DOC) has undergone a process of identifying Ecological Management Units (EMU)[1]: the sites where conservation management would provide the most conservation gain. The Macraes DOC reserves and Mt Watkins are two EMU that are close to the PIA.

The current protected area network protects a full range of the habitat types present in the Macraes E.D., but much of the biodiversity inhabiting these habitat types is of restricted occurrence so a focus needs to be on protecting the under-represented habitat types reflective of this biogeographic pattern.

There are large outstanding conservation needs in the Macraes E.D., particularly for in the conservation of plants, fish and invertebrates.

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[1] See http://www.doc.govt.nz/about-us/our-role/managing-conservation/natural-heritage-management/identifying-conservation-priorities/

4 Project Impacts on Ecological Features

The ecological assessments of the Deepdell North III project (Ahika Consulting Ltd 2019, Ryder Consulting Ltd 2019) identified the following ecological features within the Project Impact Area (PIA) will be impacted by project activities:

Ecological Feature Class	Ecological Feature Type	Ecological Feature	Classification of Feature	Buffer	Pit	WRS	PIA	Unit of Measurement	Accuracy of measurement	Ecological Importance of Feature	Magnitude of Project Impact on Feature		Overall Project Effect
											Local Scale	National Scale	
Bird	Community	Ecological function								Moderate	Moderate	Negligible	Very Low
Bird	Species	Pipit	Declining				2	individuals	Counted	Moderate	Low	Negligible	Very Low
Bird	Species	Black-backed gull					45	individuals	Counted	Low	Moderate	Negligible	Very Low
Bird	Species	Grey teal					6	individuals	Counted	Low	Moderate	Negligible	Very Low
Bird	Species	Grey warbler					10	individuals	Estimated	Low	Moderate	Negligible	Very Low
Bird	Species	Harrier hawk					1	individuals	Counted	Low	Moderate	Negligible	Very Low
Bird	Species	Paradise shelduck					6	individuals	Counted	Low	Moderate	Negligible	Very Low
Bird	Species	Spur-winged plover					8	individuals	Estimated	Low	Moderate	Negligible	Very Low
Bird	Species	Welcome swallow					5	individuals	Estimated	Low	Moderate	Negligible	Very Low
Environment	LENZ	Cultivated Pasture	< 10% indigenous cover left	26.39	29.16	24.93	80.49	Hectares	Measured				
Environment	LENZ	Ephemeral Wetland	< 10% indigenous cover left	0.02		0.3	0.31	Hectares	Measured				

Environment	LENZ	Low producing grassland	< 10% indigenous cover left	13.24	7.8	29.11	50.15	Hectares	Measured				
Environment	LENZ	Seasonal gully drainage	< 10% indigenous cover left	1.79	0.5	1.91	4.2	Hectares	Measured				
Environment	LENZ	Seepage	< 10% indigenous cover left			0.07	0.07	Hectares	Measured				
Environment	LENZ	Shelterbelts & Exotic Trees	< 10% indigenous cover left	0.08		0.53	0.61	Hectares	Measured				
Environment	LENZ	Shrublands	< 10% indigenous cover left	3.17	0.08	2.79	6.04	Hectares	Measured				
Environment	LENZ	Threatened LENZ with indigenous vegetation	< 10% indigenous cover left	5.26	1.7	15.14	22.09	Hectares	Measured				
Environment	LENZ	Threatened LENZ with indigenous vegetation	< 10% indigenous cover left	12.95	6.68	19.04	38.67	Hectares	Measured				
Environment	LENZ	Low producing grassland	10-20% indigenous cover left	11.58	0.96	10.36	22.89	Hectares	Measured				
Environment	LENZ	Shrublands	10-20% indigenous cover left	4.2		0.86	5.05	Hectares	Measured				
Environment	LENZ	Threatened LENZ with indigenous vegetation	10-20% indigenous cover left	15.77	0.96	11.21	27.94	Hectares	Measured				
Flora	Community	Ephemeral Wetland	Critically Endangered Historically Uncommon ecosystem type	0.02		0.3	0.31	Hectares	Measured	High	High	Moderate	High
Flora	Community	Seepage	Endangered Historically Uncommon ecosystem type			0.07	0.07	Hectares	Measured	High	Moderate	Low	Low
Flora	Community	Cultivated Pasture		26.39	29.16	24.93	80.49	Hectares	Measured	Negligible	Low	Negligible	Very Low
Flora	Community	Low producing grassland		24.82	8.76	39.47	73.04	Hectares	Measured	Moderate	Moderate	Low	Low
Flora	Community	Seasonal gully drainage		1.79	0.5	1.91	4.2	Hectares	Measured	Low	Moderate	Low	Very Low
Flora	Community	Shelterbelts & Exotic Trees		0.08		0.53	0.61	Hectares	Measured	Negligible	Low	Negligible	Very Low

Flora	Community	Shrublands		7.36	0.08	3.65	11.09	Hectares	Measured	Moderate	Low	Negligible	Very Low
Flora	Community	Ecosystem services								Minor			
Flora	Community	Historically Rare or Threatened Ecosystems				2	2	Communities					
Flora	Community	Integrity								Moderate			
Flora	Community	National Priorities for Protection				2	2	Communities					
Flora	Community	Rarity								High	Moderate	Moderate	Moderate
Flora	Community	Representativeness								Moderate	Moderate	Moderate	Moderate
Flora	Community	Sites recommended for protection					0	Sites		Nil			
Flora	Community	Wetlands of National Importance or Ramsar sites					0	Sites		Nil			
Flora	Species	Carmichaelia crassicaulis Hook.f. subsp. crassicaulis	Declining	15		2	17	individuals	Counted	High	Very Low	Negligible	Very Low
Flora	Species	Carmichaelia petriei Kirk	Declining	10		7	17	individuals	Counted	High	Low	Negligible	Very Low
Flora	Species	Discaria toumatou Raoul	Declining	7.36	0.08	3.65	3.73	Hectares	Estimated	High	Negligible	Negligible	Very Low
Flora	Species	Juncus pusillus Buchenau	Declining			1	1	m^2	Estimated	Moderate	Moderate	Low	Very Low
Flora	Species	Leptinella pusilla Hook.f.	Declining			1	1	m^2	Estimated	High	Low	Negligible	Very Low
Flora	Species	Lobelia ionantha Heenan	Declining			0.561	0.561	m^2	Estimated	High	Moderate	Low	Low
Flora	Species	Rytidosperma buchananii (Hook.f.) Connor & Edgar	Declining			1	1	individuals	Counted	Low	Very Low	Negligible	Very Low

Flora	Species	Carex resectans Cheeseman	Locally Uncommon			1.6	1.6	m^2	Estimated	Moderate	Moderate	Low	Low
Flora	Species	Melicope simplex A.Cunn.	Locally Uncommon			11	11	individuals	Counted	Moderate	Moderate	Negligible	Very Low
Flora	Species	Myrsine divaricata A.Cunn.	Locally Uncommon			2	2	individuals	Counted	Moderate	Moderate	Negligible	Very Low
Flora	Species	Anthosachne falcis (Connor) Barkworth & S.W.L.Jacobs	Naturally Uncommon				100	individuals	Estimated	High	Moderate	Low	Low
Flora	Species	Carex subtilis K.A.Ford	Naturally Uncommon			1	1	individuals	Counted	Moderate	Moderate	Negligible	Very Low
Flora	Species	Juncus distegus Edgar	Naturally Uncommon			369	369	m^2	Estimated	Moderate	Moderate	Low	Low
Flora	Species	Juncus distegus Edgar	Naturally Uncommon			56	56	individuals	Estimated	Moderate	Moderate	Low	Low
Flora	Species	Diversity								Moderate	Moderate	Moderate	Moderate
Invertebrates	Community	Overall importance								Moderate	Moderate	Low	Low
Reptiles	Community	Overall importance								Moderate	Moderate	Low	Low
Reptiles	Species	*Oligosoma inconspicuum*	Declining		1			individuals	Counted	High	Moderate	Negligible	Very Low
Reptiles	Species	*Oligosoma polychroma* (clade 5 genotype)	Declining				5	individuals	Estimated	High	Moderate	Negligible	Very Low
Reptiles	Species	*Woodworthia* "Otago/Southland large"	Declining				30	individuals	Estimated	High	Moderate	Low	Low
Reptiles	Species	*Oligosoma maccanni* (clade 4 genotype)					150	individuals	Estimated	Moderate	Moderate	Low	Low
Freshwater	Community	Watercourse length					480	Metres	Measured				
Freshwater	Species	Potential *Paranephrops zealandicus* habitat	Declining				120	Metres	Measured				

Other matters requiring consideration are:

- A proportion of the PIA has been classified as a Threatened LENZ environment.
- The ephemeral wetlands are a Critically Endangered Naturally Uncommon ecosystem.
- The shrubland and ephemeral wetland vegetation communities present in the PIA are considered significant under proposed Otago Regional Policy Statement and the Waitaki District Plan.

5 Impact Management Approach

The following impact management approach has been followed for managing the effects of the GPUG Infrastructure project on biological diversity. This approach is consistent with Policies 5.4.6 *Offsetting for indigenous biological diversity* and 5.4.8 *Adverse effects from mineral and petroleum exploration, extraction and processing* of the partially operative ORPS (pORPS) (and including Environment Court decision NZEnvC41 of 15 March 2019). For the purposes of giving effect to these policies "significant adverse effects" are considered those where the overall project effect (last column in **Error! Reference source not found.**) is moderate or greater.

These options follow a Mitigation Hierarchy of first seek to avoid the impact, then remediate residual ecological effects[2], then mitigate residual ecological effects, then employ an offset to address as much of the remaining residual ecological effects as practicable, and finally compensate for the outstanding balance of the ecological effects. Moving to the next step in the hierarchy is only possible once the possibility of employing the higher-order option has been fully explored and documented and the residual ecological effects calculated.

The relevant wording in pORPS (and including Environment Court decision NZEnvC41 of 15 March 2019), and which this Impact Management Plan has been formulated, is:

For project impacts on areas of significant indigenous vegetation and significant habitats of indigenous fauna, or where there are significant adverse effects:

- Avoid where practicable locating activities in areas of significant indigenous vegetation and significant habitats of indigenous fauna;
- Where it is not practicable to avoid locating in areas of significant indigenous vegetation and significant habitats of indigenous fauna avoid, remedy or mitigate, as necessary, adverse effects on values in order to maintain the outstanding or significant nature of the significant indigenous vegetation or habitat of indigenous fauna;
- Consider first biological diversity offsetting, and then biological diversity compensation if significant adverse effects on indigenous biological diversity cannot be practicably remedied or mitigated.

[2] Residual adverse ecological effects, are the remainder of a project's predicted impact on all of the ecological features within the PIA that would not be addressed once the actions under consideration for that mitigation option have been employed as designed.

Consider the offsetting of indigenous biological diversity offsetting, when:

- Adverse effects of activities cannot be avoided, remedied or mitigated;
- The offset achieves no net loss and preferably a net gain in indigenous biological diversity;
- The offset ensures there is no loss of individuals of rare or vulnerable species as defined in reports published prior to 14 January 2019 under the New Zealand Threat Classification System ("NZTCS");
- The offset is undertaken where it will result in the best ecological outcome, preferably:
    - Close to the location of development; or
    - Within the same ecological district or coastal marine biogeographic region;
- The offset is applied so that the ecological values being achieved are the same or similar to those being lost;
- The positive ecological outcomes of the offset last at least as long as the impact of the activity, preferably in perpetuity;
- The offset will achieve biological diversity outcomes beyond results that would have occurred if the offset was not proposed; and
- The delay between the loss of biological diversity through the proposal and the gain or maturation of the offset's biological diversity outcomes is minimised

Consider the use of biological diversity compensation when:

- Adverse effects of activities cannot practicably be avoided, remedied, mitigated or offset;
- The residual adverse effects will not result in:
    - The loss of an indigenous taxon (excluding freshwater flora and flora) or of any ecosystem type from an ecological district or coastal marine biogeographic region;
    - Removal or modification of habitat of a threatened or at risk indigenous species of fauna or flora under the New Zealand Threat Classification System ("NZTCS");
    - Removal or loss of viability of an originally rare uncommon ecosystem type that is associated with indigenous vegetation or habitat of indigenous fauna;
    - Worsening of the NZTCS conservation status of any threatened or at risk indigenous freshwater fauna.
- By applying the following criteria:
    - The compensation is proportionate to the adverse effect;
    - The compensation is undertaken where it will result in the best practicable ecological outcome, preferably;
        - Close to the location of development;
        - Within the same ecological district or coastal marine biogeographic region;
    - The compensation will achieve positive biological diversity outcomes that would not have occurred without that compensation;
    - The positive ecological outcomes of the compensation last for at least as long as the adverse effects of the activity; and

- The delay between the loss of biological diversity through the proposal and the gain or maturation of the compensation's biological diversity outcomes is minimised.

In considering the above approaches, the following assumptions have been made:

Avoidance refers to changing a project's activity so that it no longer impacts on an ecological feature. Mining, by its very nature, makes it difficult to avoid an ecological feature where it overlays the targeted resource, but there are opportunities to avoid impacts arising from some mine activities, such as placement of road and building infrastructure, but this needs to be balanced against other values (including economics, heritage, cultural and other stakeholder concerns). Avoidance can also include staging of project activities – for example by depositing WRS material into lower-value areas first – where there is some uncertainty in the extent of the Project Design.

Remedying refers to undertaking activities, following cessation of the impact, that rehabilitate or restore the site back to an acceptable ecological state. The opportunities to restoring a mining project's impact are limited by the technical challenges associated with rehabilitating mine workings in this location to a functioning natural ecological state, and the previously-expressed wish of the local community that the mine is rehabilitated to farming pasture.

Mitigating (or minimising) refers to adopting a practice that reduces a project's impact on an ecological feature. Minimisation includes salvaging of species from the Project footprint and either translocating directly to a new site, or cultivating for later planting at an appropriate site. It also includes Standard Operating Procedures adopted to reduce the effects of dust, noise, weeds, fire, etc.

Biological Diversity Offsetting refers to measurable conservation outcomes resulting from actions designed to address residual adverse biodiversity impacts arising from project development after appropriate avoidance, minimisation and remediation measures have been taken. The goal of biodiversity offsets is to achieve no net loss and preferably a net gain of biodiversity on the ground. The ability to utilise an offset is included in the pORPS as part of a mitigation hierarchy and the pORPS includes guidance on the necessary features of an offset. There are a number of guiding documents available to guide the design of an offset in NZ including the approaches adopted internationally by Business & Biodiversity Offsets Programme (BBOP), and nationally by DOC and the Biodiversity Working Group's (BWG) guidance to Councils. For this

project the BWG guidance to Councils[3] is used as the guiding document for the design and evaluation of the offset with the offset calculations following a disaggregated biodiversity offset accounting model[4,5] as this is considered the current best practice for the use of offsets in NZ.

Compensation involves undertaking activities that will result in a gain in ecological value outside the project footprint or off-site. Compensation differs from Offsetting in that the biodiversity outcomes are 'like for unlike'. A number of compensatory activities can be undertaken, either separately or in combination, to address a project's impacts, ranging from legal covenanting, enhancing habitat of plants or wildlife, through weed or pest control, research to better understand how to manage ecological features, habitat creation, education and interpretation, supporting community-led biodiversity projects, and undertaking activities that protect rare species.

Biobanking is the undertaking of conservation actions now, that are then used to address the effects of a future project.

The following evaluation considerations are also used to help select the most appropriate activities:

- Where possible align compensatory activities with the greatest conservation need.
- The ecological gain that could be achieved, including gains in knowledge that increase ability to effectively manage conservation issues here or elsewhere.
- That the ecological gain is sufficiently worthwhile.
- That the compensatory activities are technically feasible with an acceptable chance of achieving their desired outcome.
- That the compensatory activity is affordable and delivers benefits appropriate to the cost.
- That ecological resilience is considered when selecting a site for an activity, to ensure that gains are not eroded over time due to ecological processes that are difficult to manage (e.g. lost ecosystem function).
- That land tenure allows certainty of access to undertake the activity over time.
- The ability to maintain the gain achieved by the activity over the term of the project impact.
- That the ecological gain can be monitored to ensure that the compensatory activity is achieving its planned outcome.

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[3] Maseyk, F; Ussher, G; Kessels, G; Christensen, M; Brown, M. 2018. Biodiversity Offsetting under the Resource Management Act: A guidance document. BioManagers Group for the Biodiversity Working Group.

[4] Maseyk, F.J.F; Barea, L.P; Stephens, R.T.T; Possingham, H.P; Dutson, G; Maron, M. 2016. A disaggregated biodiversity offset accounting model to improve estimation of ecological equivalency and no net loss. Biological Conservation 204: 322-332.

[5] Maseyk, F; Maron, M; Seaton, R; Dutso, G. 2015. A Biodiversity Offsets Accounting Model for New Zealand: User Manual. Department of Conservation, Hamilton.

- There is an ability to add additional mitigation measures in response to additional OceanaGold projects.
- That the process of evaluation and implementation is transparent and of high quality.
- That the outcomes of compensatory activities do not unnecessarily constrain future commercial endeavours of either OceanaGold and/or the local community, particularly farming.

6 Options for Impact Management in a Macraes Context

The options available to address a project's impacts in the Macraes context are described here in the order of the Mitigation Hierarchy.

6.1 Avoidance options

The opportunity to avoid ecological features includes siting of all, or part, project infrastructure, staging construction, and excluding (by using temporary fencing) areas in buffer areas, depending on the operational and financial constraints of the sites.

6.2 Remedial options

Remediating an area back to its pre-impact ecological condition is possible in some situations, but is limited by the technical challenges associated with rehabilitating mine workings in this location to a functioning natural ecological state, the timescale to replicate some ecological features (such as old-growth shrubland), the paucity of examples of successful site rehabilitation, and the previously-expressed wish of the local community that the mine is rehabilitated to farming pasture.

6.3 Mitigation options

The opportunities to minimise the impact of this project includes measures to reduce dust, noise, disturbance, and sediment, contaminant suppression, weed surveillance, fire response and rescue (removal to a safe site) of ecological features. These are discussed further here.

6.3.1 *Dust suppression*

Dust-fall can be a problem for plants as it inhibits their photosynthetic capacity. Supressing dust that is created during construction activities is a standard mine operating procedure and will minimise this effect.

6.3.2 *Noise and minimising disturbance*

Operating heavy machinery and construction activities creates considerable noise and disturbance which is likely to create a negative reaction in animal species, though this reaction will vary depending on species. Minimising noise is a standard mine operating procedure and will minimise this effect, though there is likely to be displacement of some animal species from the vicinity of the mine site.

6.3.3 *Weed surveillance*

Importation of new weed species into the area during construction and operations could, depending on the species, have a huge impact on the area's biodiversity. Regular inspection of the area for new weed species can alleviate this risk. Areas of OceanaGold land are regularly inspected for new weed incursions and new environmental weeds that are found are subject to OceanaGold's annual environmental weed control operation.

6.3.4 *Fire response*

The Macraes area is often very dry and any fires that do start have the potential to cover large areas and harm large areas of natural vegetation, as well as farm assets. A site fire avoidance protocol and rapid response to any suspected fires is a standard operating procedure and will minimise this effect.

6.3.5 *Sediment Control*

Ground works associated with buildings and roadway construction disturbs land, removes vegetation and soil cover and so increases the risk of fine sediment discharges to watercourses. Sediment control measures are routinely employed by OceanaGold at Macraes Mine and will continue to be applied to minimise this effect.

6.3.6 *Manage accidental contaminants spills*

The presence of construction machinery in and around waterways presents a risk of contaminants entering watercourses with potential to harm aquatic life. OceanaGold will continue to address this effect by operating an appropriate on-site contaminant management plan.

6.3.7 *Protect against nuisance weed/algae introduction into waterways*

Machinery and personnel involved in construction can potentially transfer nuisance weeds/algae to local watercourses. OceanaGold complies with notices and guidelines issued by Biosecurity New Zealand regarding nuisance weeds/algae and will continue this practice.

6.3.8 *Rescue of ecological features*

Some of the higher-importance ecological features such as some plant species can be rescued by removing them (or propagating parts of them such as seeds or cuttings) following OceanaGold's Plant Propagation, Translocation and Management Procedure and establishing them at suitable areas within existing habitat (for instance nearby DOC and OceanaGold protected areas) (Figure 1. Location of OceanaGold (blue) and DOC (green) protected areas relative to the Deepdell III project (purple).).

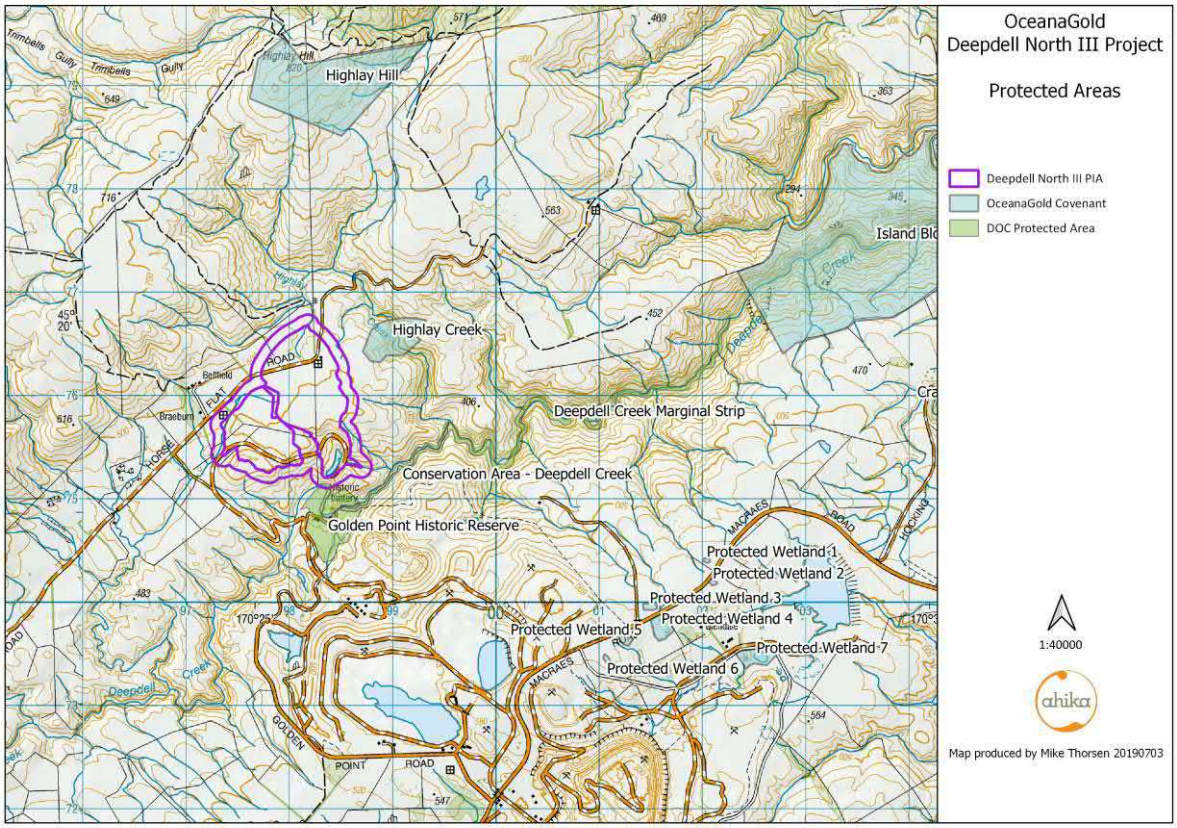

Figure 1. Location of OceanaGold (blue) and DOC (green) protected areas relative to the Deepdell III project (purple).

6.4 Offsetting and Compensation options

Offsetting and compensation can employ the same mechanisms, and these mechanisms are described here. The main difference between Offsetting and Compensation under the pORPS is that that there is less focus on the 'like-for-like' component in a compensation scenario. Both offsetting and compensation, either in full or partially, of residual adverse effects may be a useful tool to address impacts of a project. The opportunity to employ an offset is determined by the availability of comparable sites in which to undertake the offset, the technical challenges of employing the offset, the ability to set a reference baseline and to measure progress towards a No Net Loss situation, and the cost of these activities. There are some local constraints on establishing protected areas as an 'averted loss' offset (see 6.4.1), which is a commonly applied offsetting approach. Compensation has limitations in that there is reduced certainty in the ecological gain under this approach. Preference is given to adopting an offset over utilising a compensation approach to address the projects residual ecological effects unaddressed following implementation of the Avoid, Remediate and Mitigate Hierarchy.

6.4.1 *Land protection*

Protecting areas of high conservation value, which may have different ecological values to those being impacted, via a legal covenant has been used in previous OceanaGold projects. While land protection is a valuable tool to remediate a project's impacts, and their benefits are long-lasting, care needs to be taken when pursuing a covenant as they can unintentionally constrain land use if they are sited on an area of land that has commercial value (for instance for mining or farming). There is also a need for on-going management to maintain the covenant's biodiversity features, which requires landowner support and both funds and labour over the life of the covenant (usually in-perpetuity) otherwise the covenant's 'degrade' in value over time and become reservoirs for pests. OceanaGold manages the covenants on its land to appropriate standards, but when that land changes ownership (the intention of OceanaGold) then management of the covenant becomes the responsibility of the new landowner. There has been concern expressed in the local farming community about this as in their view a covenant decreases the area of land available to farming and causes impediments to farming operations in adjacent areas. This is of concern as there is increasing evidence that social support is critical in achieving the objectives of establishing a protected area[6].

OceanaGold currently manages six ecological covenants covering a total of 655 ha. Other protected lands in the vicinity include the 590 ha Deighton Creek Nature Reserve, the 1,452 ha Redbank Scenic Reserve and the 332 ha Manuka Stream Conservation Area (**Error! Reference source not found.**), giving a total of 3,029 ha of legally protected land in the Macraes Ecological District. This equates to 2.4% of the Ecological District's land area and is similar to the proportion protected of the ecologically similar nearby Manorburn Ecological District (Ahika Consulting Ltd unpub. data).

6.4.2 *Habitat enhancement*

Enhancing the habitat of indigenous plants or wildlife (usually through enrichment planting, pest control or weed control) as a compensatory measure can provide benefit to both a habitat and its inhabitants by removing predators that are limiting populations, removing weed species that are displacing plants or animals from their preferred habitat, or by creating barriers to movement of trout into high-value aquatic environments.

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[6] See for example Oldekop, J.A; Holmes, G; Harris, W.E; Evans, K.L. 2015. A global assessment of the social and conservation outcomes of protected areas. Conservation Biology 30: 133-141.

Protecting or enhancing rare habitats can provide high ecological benefit. A number of New Zealand's habitats are considered rare, either because they were always of very limited distribution (see Williams et al. 2007) or because human activity has reduced their extent and/or intactness. Also, some habitats are now considered Threatened (Holdaway et al. 2012). Several examples of these rare and threatened habitats are present in Otago, and in the Macraes E.D. there are Critically Endangered saline sites and ephemeral wetlands as well as Endangered seepages and flushes. Other important communities are the schist bluff communities, dryland shrubland (grey scrub) and riparian margin vegetation as these are of limited extent and host a number of rare species. Without conservation attention many of these habitats and communities will be lost.

6.4.3 *Invasive weed and animal pest control*

Removing or controlling aggressive environmental weeds or animal pests can be a compensatory measure. The NZ Biodiversity Strategy regards invasive introduced species which have become animal pests and weeds as a more serious threat to biodiversity than ongoing habitat loss and modification. Some weeds that have the potential to transform local wetlands are known from just one locality within the Macraes E.D. and are of very limited occurrence in Otago. There are other species that have recently arrived in the Macraes E.D. and which could become a nuisance to agriculture and biodiversity. Eradicating these species will save a large amount of biodiversity protection work into the future. Instigating a weed surveillance programme together with the capacity to remove newly arrived weed species would have benefit to protecting both biodiversity areas and agricultural areas.

Invasive animal control in the Macraes E.D. has been shown to benefit local lizard populations and there are opportunities to employ predator control to benefit other lizard populations as well as populations of birds and large invertebrates. The high cost of predator control, uncertainty of level of effectiveness and population responses of the protected fauna, and the rapid loss of benefit when predator control ceases needs to be considered.

6.4.4 *Protecting species of conservation concern*

In New Zealand, a number of plant and animal species are considered at risk of extinction. Of plants, there are 402 species which are considered Threatened (i.e. of high risk of extinction) and a further 885 are considered At Risk (de Lange et al. 2018). Many more are rare in a local context.

The Macraes E.D. is known to contain the highest diversity of rare plants of any site in New Zealand (Bibby 1997, Thorsen 2008, Figure 3). However, the known distributions of the rare species in this area reflects

the location of past survey effort, including those conducted by OceanaGold around mine projects. In the Macraes E.D. are populations of 6 Nationally Critical plant species, 10 Nationally Endangered plant species, 12 Nationally Vulnerable plant species, 35 Declining plant species, 26 Naturally Uncommon plant species, and 15 Data Deficient plant species, with populations of some of these being the largest known nationally. Many of the plant species and the rarer plant communities are facing considerable threat from weed competition and exotic animals.

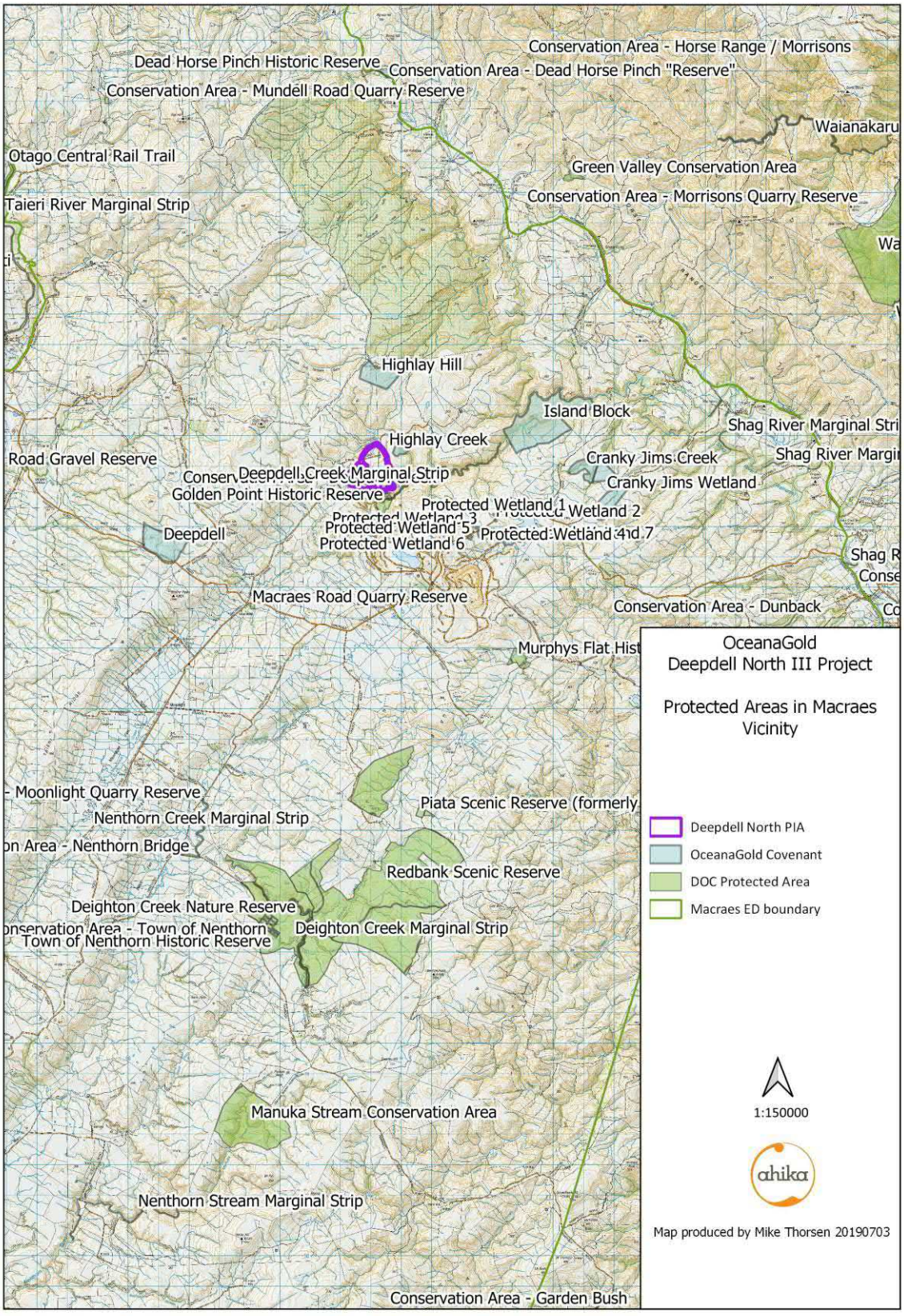

Figure 2. Location of protected areas in the Macraes vicinity.

The Macraes E.D. also contains the last wild populations of Critically Endangered grand and Otago skinks, and important populations of 3 At Risk lizard species. The invertebrate fauna of the Macraes E.D. has been poorly explored, but is known to include at least 412 indigenous species, including 2 Threatened, 6 At Risk, and 7 Data Deficient Species. It is also home to a number of indigenous freshwater fauna that are of conservation concern: the Declining freshwater crayfish *Paranephrops zealandicus* and long-finned eel *Anguilla dieffenbachii*, and the Nationally Vulnerable non-migratory roundhead galaxias *Galaxias anomalus* and Taieri flathead galaxias *Galaxias depressiceps*.

There is a large conservation programme nearby focussed on protecting the grand and Otago skink populations between Redbank and Nenthorn, and this project is also providing benefit to other lizard and bird species. However, there is currently little focus on management of the area's aquatic fauna, invertebrates, rare plants or vegetation communities beyond control of some woody weed species and pests at a few sites. The Macraes E.D. has extensive potential for plant and freshwater species-focussed conservation programmes using specific tools such as translocation, cultivation and replanting in order to enhance populations, and to protect populations through building trout barriers, or controlling weeds, browsing mammals, and pest insects.

6.4.5 *Research*

Research on topics that inform our ability to manage ecosystems or species successfully is a valuable remediation tool. Currently, there is little available research to help guide management of most of New Zealand's rare species or habitats. In the Macraes area there is an opportunity to build on past research projects (e.g. ephemeral wetlands by Johnson and Rogers (2003)), as well as build research into the adaptive management component of other compensatory activities.

6.4.6 *Environmental education and awareness*

Education and awareness on conservation issues, particularly on the importance of biodiversity and its management in a mine environment, is in line with the New Zealand Biodiversity Strategy and Action Plan and can be a valuable compensation activity when well-designed.

6.4.7 *Community conservation*

Local communities undertake a number of important biodiversity projects throughout New Zealand. All of them struggle to be financially sustainable, primarily due to the temporary nature of most funding arrangements, and this factor alone frequently leads to project failure. There are no active biodiversity conservation groups in the Macraes area, but the Landscape Connections Trust[7] is planning pest control activities in the east Otago area and the Central Otago Ecological Trust[8] runs a lizard conservation project centred on the Mokomoko Dryland Sanctuary near Alexandra. Funding of a reputable trust to provide sustainable support for the ongoing efforts of community groups and other conservation organisations in the Macraes region is an option.

6.4.1 *Biobanking*

Biobanking is the undertaking of conservation actions now, that are then used to address the effects of a future project. While there are a number of potential approaches to biobanking, we advocate for adopting an approach that encapsulates the features of a biodiversity offset, as this is conceptually simpler and the measurement metrics can be the same. In the Macraes situation undertaking any project mitigation, offsetting or compensation at a greater scale than required or in anticipation of a future project is considered a biobank. There are advantages to biobanking in that ecological gains are often realised and measurable before a project's impact occurs, giving greater certainty of a positive ecological outcome.

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[7] See http://www.beyondorokonui.org.nz/

[8] See http://www.coet.org.nz/

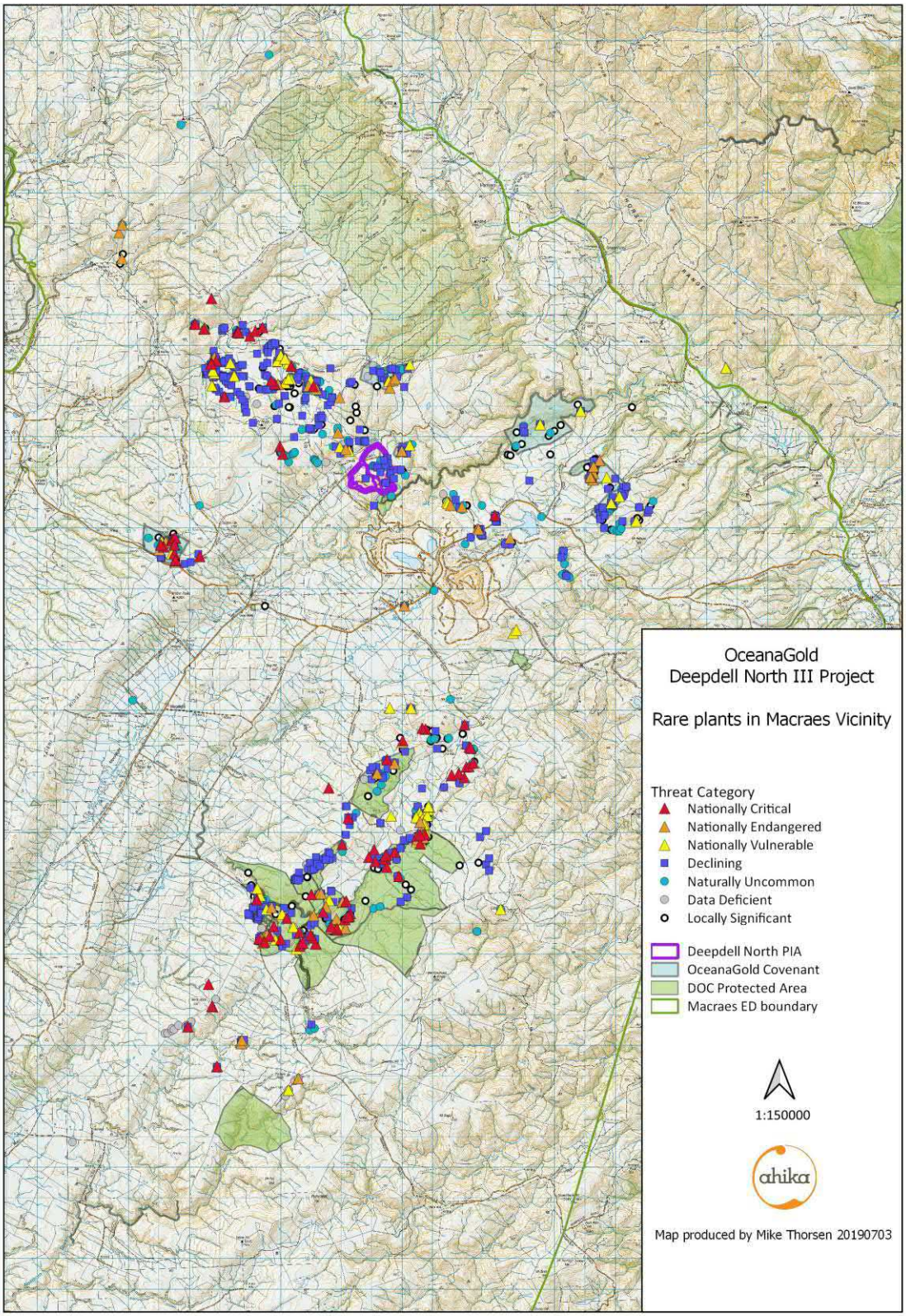

Figure 3. Locations of Threatened, At Risk and rare plant species in the vicinity of the Macraes E.D. Note, clustering of dots reflects survey effort more than actual distribution of rare plant species.

7 Quantifying the loss

Calculating the quantity and 'value' of the biodiversity likely to be lost and therefore replaced under an effects mitigation approach, such as the one used in this Impact Management Plan, is difficult. Measures that are most frequently used are often simplistic: 'like for like' (i.e. 10 *Carex tenuiculmis* plants predicted to be lost from the project site and 10 *Carex tenuiculmis* planned to be planted at a nearby proposed mitigation site), or with additional consideration given to the condition of the feature (i.e. 25 hectares of narrow-leaved tussock grassland of 1m stature and 60% ground cover at both the project site and at a nearby proposed mitigation site). The emergence of disaggregated offset calculations and replacement multipliers is increasing the accuracy of these evaluations. Calculating the value of biodiversity loss when considering a number of features, or features that are 'like for unlike', becomes even more problematic. This approach is best termed 'value for value'. The most frequently used measure (or metric) in these situations consists of combining expert opinions with cross-party negotiation in order to reach a consensus that the projected gain at the mitigation site is appropriate to the value of the ecological loss of the different features in the project site. In these types of calculations, it is important to incorporate consideration of uncertainties and the baseline condition and trend of the feature: for example, halting or slowing a declining trend is a conservation gain.

Another method is to adopt a value of land approach, in which the area of the impact is calculated and then either an equivalent area is protected or payment made at the purchase price of an equivalent area of land in that district. Similar methods have been used in previous OceanaGold projects at Macraes and Reefton.

The impact management plan should adequately address the value of the lost ecological features.

8 Preferred Approach

A range of mitigation and compensatory measures for the project's impacts on ecological features (Section 4) were evaluated against the considerations in Sections 5, 6, 7 (see Appendix 1). For the reasons explained in this evaluation, and the forecast project impacts, OceanaGold's preferred approach to addressing the Deepdell North III project's impact on ecological features is:

Avoid effects by:

1) Siting infrastructure away from areas with high ecological value wherever possible.
2) Staging deposition of rock material into WRS areas.

Remedy effects by:

3) Constructing areas of the margins of the final WRS to provide habitat for lizards.
4) Creating freshwater crayfish habitat in the western clean water drain.

Mitigate impacts by:

5) Minimising project effects of dust, noise, weeds, fire, sediment, contaminants on the surrounding area.
6) Rescuing those plant species that are of moderate or high ecological importance or that are of restricted distribution within the Macraes E.D., to safe site(s) in Ecological Enhancement Areas (EEA) (such as the nearby OceanaGold covenants).

As there are forecast to be residual adverse effects of the project on the site's biodiversity after implementation of the Avoid, Remedy and Mitigate (see Section 9.4), an offset will be provided to address remaining significant residual adverse effects.

Offset all residual effects by:

7) Creating a multi-outcome offset EEA at nearby sites with similar or better ecological values and provide funds for the ecological management of this area.
8)

Compensate for final residual adverse effects by:

9) Planting of freshwater crayfish habitat along the margin of the Camp Creek reservoir.

OceanaGold has overall responsibility for undertaking this work as described in Section 9.

9 Ecology Impact Management Plan

The following are the activities that Oceana Gold (New Zealand) Limited propose to undertake as recompense for the predicted impact on the area's ecological features resulting from implementation of the Deepdell North III project. Task descriptors and responsibilities are provided in Appendix 2. OceanaGold has overall responsibility for undertaking this work as described in this Impact Management Plan.

9.1 Avoiding impact

The opportunity to avoid ecological features in the Deepdell North III project is limited by operational necessities to placement and re-configuring the waste rock stack (WRS) margins and re-routing access routes.

9.1.1 *Siting of WRS and infrastructure*

Three alternative locations for part of the WRS were proposed on 15 November 2017 (Figure 4). None of the options would avoid areas of significant indigenous vegetation and habitats of indigenous fauna. Of these configurations Option A has the least impact on ecological features but is not considered practicable due to other effects on the environment, especially from noise. Options B and C have similar impact on ecological features with higher impact on plants in Option B and higher impact on waterways in Option C. The total area of disturbance is larger in Option C. Because of this a fourth option was developed (the current design) which is sited predominantly on pasture and avoids the effects of the 3 previous options, but has an impact on a Critically Endangered Naturally Uncommon ecosystem, some areas of indigenous vegetation that is habitat to plants and fauna (including some rare species). It is thought that the effects on these ecological features can be managed through implementation of this Impact Management Plan.

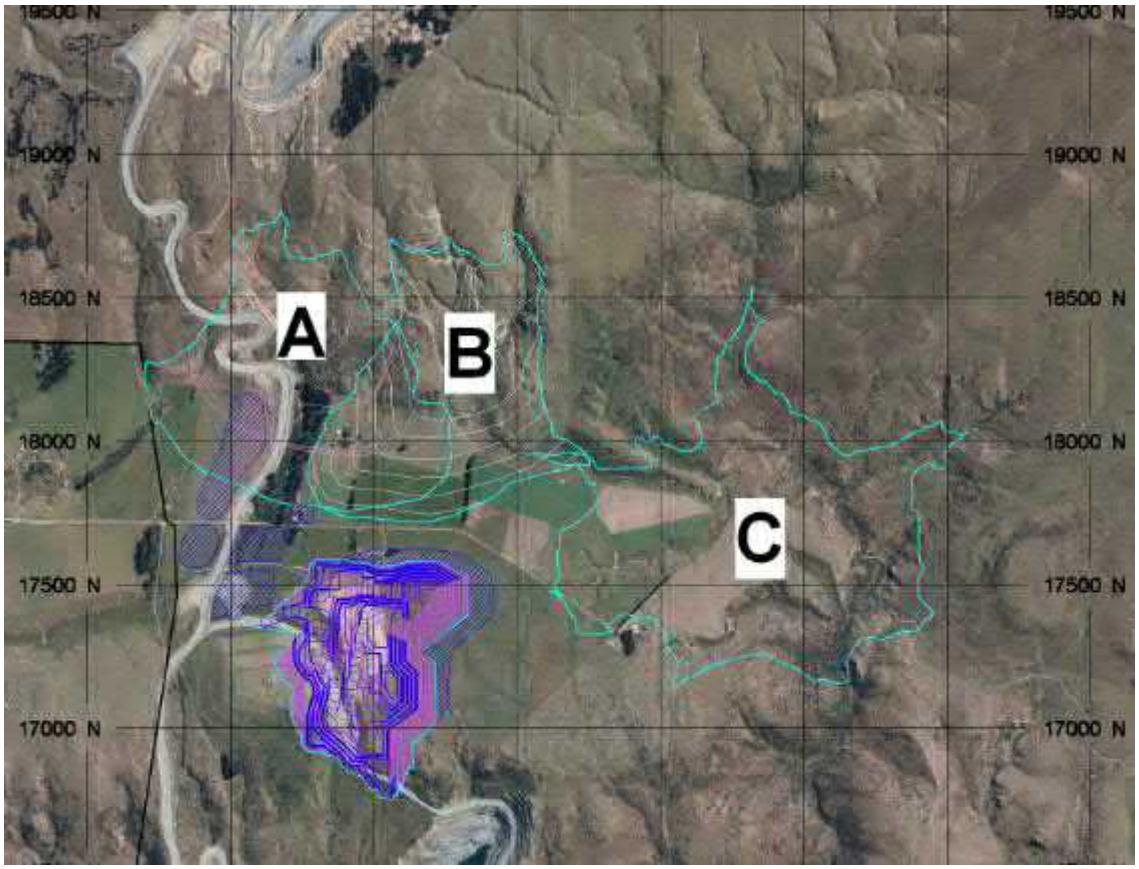

Figure 4. Three original options (A, B, C) considered for siting part of the WRS of the Deepdell North III project.

9.1.2 *Staging WRS construction*

The WRS will be constructed in sequential stages to delay impacts on higher biodiversity areas. The first stage will be infilling of the original Deepdell South pit backfill WRS, the second stage will be deposition of material on the flat areas of the Horse Flat. This action avoids impacts on significant ecological features if the project is halted before completion.

9.1.3 *Isolating high ecological value areas in the Buffer*

Areas in the buffer area with higher ecological values will be isolated from unintended effects (such as vehicle movements) by clearly delineating in maps provided to mine operations staff and on the ground by using well-maintained flagging tape, temporary fencing and signage.

9.2 Remedy impact

The opportunities to remedy this project's impact are limited by the technical challenges associated with rehabilitating mine workings in this location to a functioning natural ecological state, and the wish of the local community that the mine is rehabilitated to farming pasture. However, there is opportunity to undertake some rehabilitation on the WRS margin. Opportunity to utilise the post-excavation Deepdell North III pit lake is limited by the future grazing of this site, and so is not pursued here.

9.2.1 *WRS margin and Pit rehabilitation*

There is some opportunity to rehabilitate the WRS margin and other surfaces such as roadways to provide habitat for lizards by depositing larger aggregate and boulders in identified areas under guidance of the expert working on a similar project in the Coronation North area. These rocky areas will be naturally colonised by lizards from the surrounding area, and the population density at these sites should increase as habitat quality increases with plant growth, particularly if vegetation regrowth includes fruit-bearing plants. It is not planned to monitor lizard colonisation of these sites as previous work has shown that similar created rock habitats such as other waste rock stacks and the lizard rock piles are colonised by lizard species (EcoGecko 2013, OceanaGold unpub. data).

Undertaking this action will provide benefit in 1) creating habitat that will be occupied by populations of the skinks *Oligosoma maccanni* (clade 4 genotype), *Oligosoma polychroma* (clade 5 genotype), and the Declining gecko *Woodworthia* "Otago large", 2) create a safer refuge for these lizard populations by decreasing the hunting efficiency of cats in these areas.

The rehabilitated Deepdell North III WRS is expected to produce replacement habitat of very similar nature to the impacted existing Deepdell WRS which is utilised by one pair of Declining pipits and an estimated six Not Threatened spur-winged plover.

Likewise, the new pit lake in the Deepdell North III pit will produce replacement habitat similar to that occupied by the breeding colony of black-backed gulls in the backfilled existing Deepdell North pit.

9.2.2 *Rehabilitation of the western cleanwater drain*

The western cleanwater drain will be constructed to provide appropriate habitat for freshwater crayfish by including schist flakes on a clay drain bed and with riparian planting of overhanging indigenous plants.

9.3 Mitigate impact

The opportunities to minimise the impact of this project are controls on dust, noise, disturbance, sediment, contaminant suppression, weed surveillance, fire response and rescue (salvage) of ecological features.

9.3.1 *Dust suppression*

Dust-fall can be a problem for plants as it inhibits their photosynthetic capacity. Though none of the species present in the PIA is thought to be particularly susceptible to dust, supressing dust that is created during mine activities is a standard operating procedure and will minimise this effect.

9.3.2 *Noise and minimising disturbance*

Blasting and operating heavy machinery creates considerable noise and disturbance which is likely to create a negative reaction in animal species. Though this reaction will vary, most of the bird species recorded at this site appear to acclimate to regular disturbance. Minimising noise is a standard operating procedure and will minimise this effect, though is likely that harrier hawks will avoid hunting the nearby surrounding area, and that paradise shelducks will not nest within sight of the project.

9.3.3 *Weed surveillance*

Importation of new weed species into the area during mine operations could, depending on the species, have a huge impact on the area's biodiversity. To minimise this risk an inspection of the area around mine operations for new weed species every two years by a qualified ecologist will alleviate this risk. New environmental weeds that are discovered in the area will be subject to OceanaGold's annual environmental weed control operation.

9.3.4 *Fire response*

The Macraes area is usually very dry and any fires that do start have the potential to cover large areas and harm large areas of natural vegetation. A site fire avoidance protocol and rapid response to any suspected fires is a standard operating procedure and will minimise this effect.

9.3.5 *Sediment Control*

Mining disturbs land, removes vegetation and soil cover, and so increases the risk of fine sediment discharges to watercourses. Sediment control measures are routinely employed by OceanaGold at Macraes Mine and will continue to be applied to minimise this effect. Specific efforts on sediment control in the Deepdell North III development are contained in the Erosion and Sediment Control Report (EGL, 2019).

9.3.6 *Manage accidental contaminants spills*

The presence of construction machinery in and around waterways presents a risk of contaminants entering watercourses with potential to harm aquatic life. OceanaGold will continue to address this effect by operating an appropriate on-site contaminant management plan.

9.3.7 *Protect against nuisance weed/algae introduction into waterways*

Machinery and personnel involved in construction can potentially transfer nuisance weeds/algae to local watercourses. OceanaGold complies with notices and guidelines issued by Biosecurity New Zealand regarding nuisance weeds/algae and will continue this practice.

9.3.8 *Rescue of ecological features*

Some of the higher-importance ecological features identified in Section 4 and in Appendix 1 will be rescued by a suitably experienced operator removing them (or propagating parts of them such as seeds or cuttings) following OceanaGold's Plant Propagation, Translocation and Management Procedure (updated to include the species listed below) and establishing them at EEA sites with existing suitable habitat (for instance DOC and OceanaGold protected areas) (Figure 2). The plants will receive post-introduction care where necessary including watering and suppression of competing vegetation for two years. The success of moving these species will be monitored by counting number of plants at the recipient site on an annual basis for three years. Rescue is proposed for the following species:

1) The Locally Uncommon shrub *Melicope simplex* from the eleven trees in the WRS to twenty individuals at one site in the nearby OceanaGold Highlay Creek Shrubland Covenant to create a new population there.

2) The Naturally Uncommon shrub *Myrsine divaricata* from the two individuals in the WRS to 10 individuals at one site in the nearby OceanaGold Highlay Creek Shrubland Covenant to create a new population adjacent to an existing population.

These two species have been selected on the basis of their importance in the local situation, and their probable amenity to being rescued, whilst taking into account the extent of the project impact upon them that was identified in Section 4. The recipient sites have been chosen on the basis of their proximity to the project area and the availability of suitable habitat there. As the overall project impact on these two species is expected to be Very Low, these actions are considered discretionary.

Undertaking this action will provide benefit in 1) preventing a reduction in population density of these two species in this area, and 2) removing these two species to a safer environment within nearby protected areas to create new populations.

9.4 Residual adverse effects subsequent to Avoid, Remedy and Minimise actions

The residual adverse effects remaining subsequent to implementation of Avoid, Remedy and Minimise, are detailed here:

Biodiversity Class	Biodiversity Type	Biodiversity Component	Ecological Importance of Feature	Magnitude of Project Impact on Feature Locally	Magnitude of Project Impact on Feature Nationally	Overall Project Effect on Feature	Overall Loss	Loss Unit
Bird	**Community**	**Ecological function**	Moderate	Moderate	Negligible	Very Low		
Bird	**Species**	**Grey teal**	Low	Moderate	Negligible	Very Low	6	individuals
Bird	**Species**	**Welcome swallow**	Low	Moderate	Negligible	Very Low	5	individuals
Flora	**Community**	**Ephemeral Wetland**	High	High	Medium	High	1.8383	Hectares
Flora	**Community**	**Seepage**	High	Medium	Low	Low	0.0651	Hectares
Flora	**Community**	**Low producing grassland**	Moderate	Medium	Low	Low	49.46519	Hectares
Flora	**Community**	**Seasonal gully drainage**	Low	Medium	Low	Very Low	2.50069	Hectares
Flora	**Community**	**Shrublands**	Moderate	Low	Negligible	Very Low	4.09766	Hectares
Flora	**Species**	**Carmichaelia crassicaulis Hook.f. subsp. crassicaulis**	High	Very Low	Negligible	Very Low	2.75	individuals
Flora	**Species**	**Carmichaelia petriei Kirk**	High	Low	Negligible	Very Low	7.5	individuals
Flora	**Species**	**Discaria toumatou Raoul**	High	Negligible	Negligible	Very Low	3.803212	Hectares
Flora	**Species**	**Juncus pusillus Buchenau**	Moderate	Medium	Low	Very Low	1	m2
Flora	**Species**	**Leptinella pusilla Hook.f.**	High	Low	Negligible	Very Low	1	m2
Flora	**Species**	**Lobelia ionantha Heenan**	High	Medium	Low	Low	0.561	m2
Flora	**Species**	**Rytidosperma buchananii (Hook.f.) Connor & Edgar**	Low	Very Low	Negligible	Very Low	1	individuals
Flora	**Species**	**Carex resectans Cheeseman**	Moderate	Medium	Low	Low	1.6	m2

Flora	**Species**	**Anthosachne falcis (Connor) Barkworth & S.W.L.Jacobs**	High	Medium	Low	Low	55	individuals
Flora	**Species**	**Carex subtilis K.A.Ford**	Moderate	Medium	Negligible	Very Low	1	individuals
Flora	**Species**	**Juncus distegus Edgar**	Moderate	Medium	Low	Low	369	m2
Flora	**Species**	**Juncus distegus Edgar**	Moderate	Medium	Low	Low	56	individuals
Invertebrates	**Community**	**Ecological function**	Moderate	Medium	Low	Low	?	?

9.5 Offsetting

As there are forecast to be residual adverse effects of the project on the sites biodiversity after implementation of the Avoid, Remedy and Mitigate (see Section 9.4), an offset as described under the pORPS will be provided to address remaining significant adverse effects. This offset will have several components: an averted loss multiuse offset in an Ecological Enhancement Area (EEA) on Redbank Station to address the impact on shrublands, low producing grasslands and the seepage wetland, and an ephemeral wetland enhancement offset and supporting research project at sites in another EEA in the south of the Ecological District to address the impact on ephemeral wetlands. There are local constraints on how an offset can be realised in the Macraes situation (see comments in Sections 6.4 and 6.4.1) and these have been considered in the design of the offset package. The implementation and management of the EEA sites will be documented in an EEA Management Plan (sometimes also termed an Offset Plan).

9.5.1 *Offset design*

This offset is designed to fulfil an offset as prescribed in the pORPS (and including Environment Court decision NZEnvC41 of 15 March 2019)[9]: The offset achieves no net loss and preferably a net gain in indigenous biological diversity;

- The offset ensures there is no loss of individuals of rare or vulnerable species as defined in reports published prior to 14 January 2019 under the New Zealand Threat Classification System (“NZTCS”);
- The offset is undertaken where it will result in the best ecological outcome, preferably:
    - Close to the location of development; or
    - Within the same ecological district or coastal marine biogeographic region;
- The offset is applied so that the ecological values being achieved are the same or similar to those being lost;
- The positive ecological outcomes of the offset last at least as long as the impact of the activity, preferably in perpetuity;
- The offset will achieve biological diversity outcomes beyond results that would have occurred if the offset was not proposed; and
- The delay between the loss of biological diversity through the proposal and the gain or maturation of the offset’s biological diversity outcomes is minimised.

[9] Note the offset described in the pORPS does not require use of any offset guidance such as that provided by BBOP, DOC or in recent guidance to Councils.

The disaggregated accounting model[10] was used to calculate the extent of works required within the EAAs to achieve a state of No Net Loss of biodiversity (NNL) using the March 2015 user manual and spreadsheets.

9.5.2 *Site selection*

The upper Waikouaiti River North Branch offset site (Redbank EEA) (Figure 5) has been chosen on the basis of discussions with both landowners who identify it as a site of low farming usefulness and a site examination that shows the site has considerable ecological value in terms of fauna, vegetation communities and as habitat for rare species. This site is part of a farming environment and has no protections beyond that afforded by regional and district plans and therefore ongoing damage to some ecological features is expected and the tussock grassland and shrubland could be actively managed to enhance livestock grazing. Some of the ecological features present are restricted to areas where stock are not able to access.

[10] Maseyk, F.J.F; Barea, L.T; Stephens, R.T.T; Possingham, H.P; Dutson, G; Maron, M. 2016. A disaggregated biodiversity accounting model to improve estimation of ecological equivalency and no net loss. Biological Conservation 204: 322-332.

Figure 5. Location of Redbank EEA.

9.5.3 *Redbank EEA*

A covenant of 126 ha will be established under the Conservation Act in the upper Waikouaiti River North Branch (Figure 1Figure 5) which contains biodiversity that is of similar character to that being lost, but of better quality and with other inherent ecological values. Sensitive parts of this covenanted area will be fenced to exclude stock and limits will be placed on the type of stocking that can occur in the covenanted area and on any activities that could result in damage to the soils or to vegetation of high ecological importance. This land will be managed using the income from a fund held by OceanaGold until cessation of mining when the fund will be ceded to another authority.

Important components of this component of the offset are:

- Have a legal protection.
- Will be farmed as appropriate with the objective of protecting the important biodiversity features.

- Be of sufficient size to compensate for uncertainties in ecological outcomes associated with retaining farming in the covenant.
- Satisfy the offset criteria detailed in the pORPS.
- Will have a fund to support the management of the covenant on an ongoing basis.
- Will involve the farming community together with DOC and Councils in the offset design and placement.
- Will incorporate the Science and Traditional Knowledge offset principle by including farming community knowledge of biodiversity management in the Macraes Area.
- Will incorporate the Equity offset principle by sharing the risks and benefits between the farming community, DOC and Councils.
- Be managed with ecological oversight.
- Will result in a Biobank of additional ecological gains that will be used to address a future project's ecological impact.

This offset will also address the impact on the Declining matagouri, desert broom *Carmichaelia petriei*, skinks *Oligosoma inconspicuum* and *Oligosoma polychroma*, gecko *Woodworthia* "Otago/Southland large", Naturally Uncommon grass *Anthosachne falcis*, some components of the invertebrate and bird communities and on McCann's skink through protecting areas inhabited by these species.

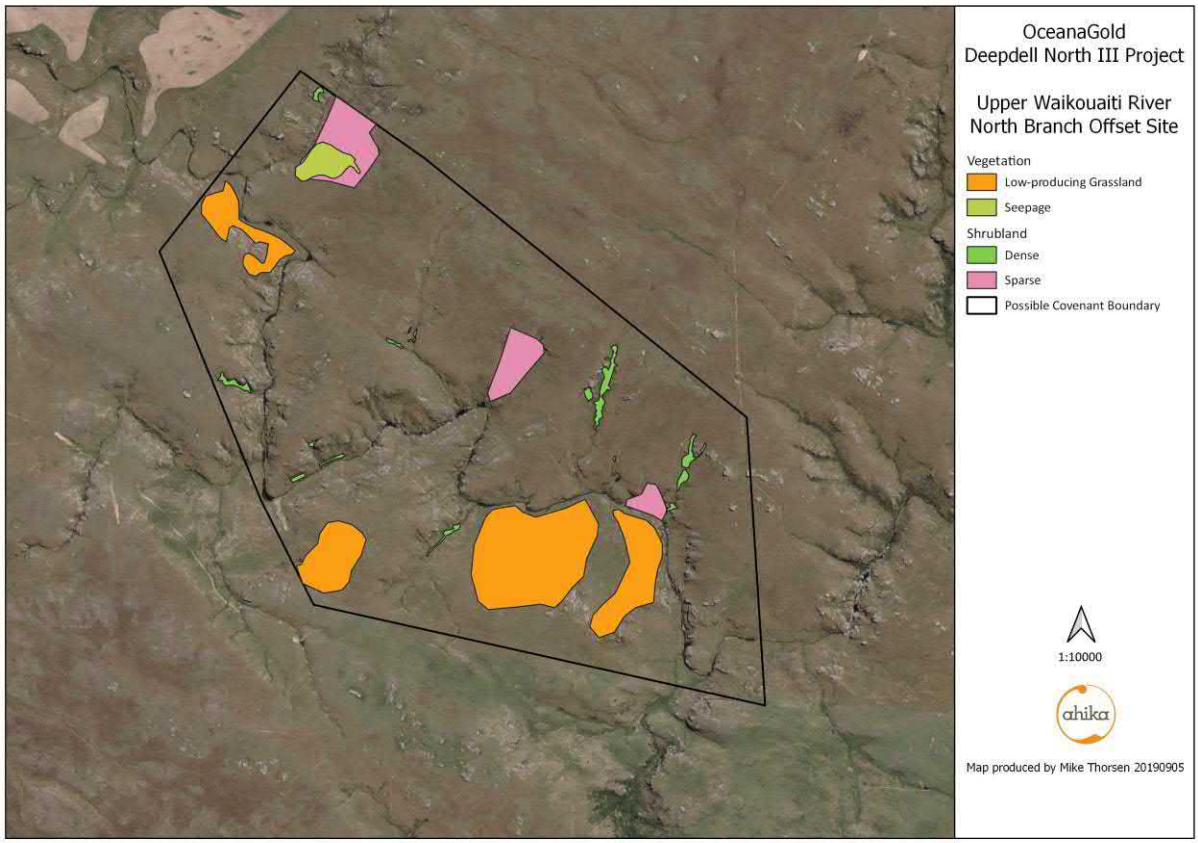

Figure 6. Location off plant community offset sites in Redbank EEA

Shrubland Component

Offsetting the loss of an estimated 3.73 ha of shrubland from the Deepdell North III site will be through including an equivalent plant community of better ecological integrity in the Redbank EEA (Figure 6). The offset site has a higher diversity of shrub species (22 species), than in the impacted shrubland (15 species), is ecologically more intact with fewer exotic species and denser canopy, and is of a similar nature (though with some species that reflect a higher elevation and damper area). Within the offset site there is currently 4.23 ha of equivalent shrubland. This offset will involve planting of 5 ha of new shrubland in the offset area that is comprised of at least 18 different shrub species and reaching 2 m in height and 75% canopy cover within 10 to 20 years, respectively and keeping these free of exotic shrub species for 10 years. This produces a Net Present Biodiversity Value of 0.29.

Seepage Wetland Component

Offsetting the impact resulting in the loss of 0.07 ha of seepage wetland will be through including an equivalent plant community of larger size and managing this to better ecological integrity in the Redbank EEA (Figure 6). This offset is considered to have the elements of both an averted loss offset and an improved condition offset. The averted loss component of the offset is difficult to calculate as there is no available data on loss of these ecosystems in the area, but there have been high reported loss of wetlands from Southland and they are classified as Endangered based on their estimated rate of decline caused by weed invasion of over ≥70% of their extent nationally. This offset will involve using weed control to achieve a 20% improvement in indigenous species dominance within the 0.82 ha seepage wetland at the offset site by 10 years. This produces a Net Present Biodiversity Value of 0.01, but additional to NNL are the gains considered to have been achieved through the averted loss portion of the offset. Protecting this seepage wetland against the background of 70% loss (over an estimated 30 years) would increase the Present Biodiversity Value by c. 70% to 0.017. The impact on the Naturally Uncommon rush *Juncus distegus* will also be addressed through this offset by creating conditions in which this species can flourish, supplemented by planting of 50 individuals.

Low-producing grassland Component

Offsetting the impact resulting in the loss of an estimated 49.47 ha of low producing grassland will be through including 24.55 ha of an equivalent plant community and managing this to better ecological integrity in the Redbank EEA (Figure 6). This offset is considered to be an averted loss offset as this vegetation community decreased in the Macraes E.D. by 79.3% between 2008 and 2012 based on change in the NZ Land Cover Database. It is likely this rate of loss is continuing. Based on this rate of loss, NNL will have been achieved within 5 years of protection of the habitat (

Table 1). This offset would be realised on establishment of the covenant with appropriate safeguards against invasion of the habitat by woody weed species and changes to land management (particularly guarding against soil disturbance). The impact on the Declining grass *Anthosachne falcis* (which is present in the EEA) will also be addressed through this offset by creating conditions in which this species can flourish.

Year	Area of habitat	
0	49.47	Impacted extent
1	39.66	

2	31.80	
3	25.50	NNL achieved
4	20.44	
5	16.39	

Table 1. Predicted extent of unprotected low-producing grassland habitat over time based on a 19.8% annual rate of loss

9.5.4 *Ephemeral wetland EEA*

Offsetting the impact resulting in the loss of 1.84 ha of ephemeral wetlands will be through an improved-condition offset with the improvement work informed by a research project investigating ephemeral wetland form, function and threats. This offset will involve using weed control to produce a 25% improvement in indigenous vegetation cover at ephemeral wetlands at 5-7 sites totalling at least 2 ha and an improvement in indigenous plant diversity at each site to at least 11 indigenous plant species characteristic of Macraes ephemeral wetlands by 10 years. . This produces a Net Present Biodiversity Value of 0.31 and NNL is achieved by year 10. The 2 ha target of managed ephemeral wetland is double the 1 ha required to reach NNL, but compensates for current uncertainties in ecological state of these systems and lack of proven management tools. These figures are based on the research project addressing deficiencies in knowledge on the form, function, threats and management of ephemeral wetlands. This research project will establish the physical profiles and subsurface nature of 10 selected ephemeral wetlands, documenting their hydrological profile over time and measuring changes in their plant communities 3-4 times a year over 5 years. The threat that ephemeral wetlands face will be established by revisiting 20 previously surveyed sites and documenting their current condition, quantifying surrounding land use of all mapped ephemeral wetlands and visiting a random selection of 50 ephemeral wetlands to describe their current condition. The impact on the Declining wetland herb *Lobelia ionantha* and Locally Uncommon sedge *Carex resectans* will also be addressed through including these species as two of the 11 additional species.

9.5.5 *EEA Management Plans*

The implementation and management of each of the EEA's will be documented in a management plan (EEAMP). The EEAMP will form a part of a broader project Ecological Management Plan (which will include on-site works to avoid, remedy, and mitigate adverse effects).

The EEAMP will include:

- a description of the offset, the calculation basis, locations and management activities at which enhancements will be generated;
- securing the ability to undertake enhancement works within management sites by way of landowner agreements (e.g. covenants) or acquisitions;
- the technical detail of the offset works;
- the financial costs of site management into bond calculations or other similar instruments as required by Council that secure financial delivery of biodiversity enhancements;
- a monitoring programme to assess the degree to which enhancement targets are being achieved and the ability to adjust biodiversity management to ensure that gains are achieved and maintained for the long term;
- the roles and responsibilities of those carrying out the work, and the governance and management structures relating to the operation of the enhancement site(s); and
- reporting the results of monitoring results and a process for undertaking actions if enhancement targets are not being achieved as anticipated.

9.6 Biobanking

The proposed covenant in the upper Waikouaiti River North Branch includes 73 ha of narrow-leaved tussock grassland that is additional to that required under this Impact Mitigation Plan. This narrow-leaved tussock grassland is considered a biobank for use when appropriate to address the impact of a future OceanaGold project. The baseline ecological condition and change in condition over time will be measured using vegetation plots. The proposed also provides habitat to an additional 17 plant species of conservation concern which are also considered biobanked (together with any additional species found during future surveys) and their population status will

be monitored over time. The reptile, bird and invertebrate communities that inhabit the additional areas are also considered biobanked and their baseline and condition over time.

The ecological condition of these additional communities will be measured as for the offset areas and the biobank will be adjusted to reflect any changes (beneficial or detrimental) in ecological condition.

9.7 Ecological compensation

As there are expected to be no significant residual adverse effects following implementation of the Avoid, Remedy, Mitigate and Offset options, no activities are proposed as ecological compensation.

9.8 Nil actions

No mitigatory or compensatory activities are proposed for the two individuals of Declining coral broom and 1 m^2 of Declining *Juncus pusillus*, one individual of the Declining grass *Rytidosperma buchananii*, one patch of the Naturally Uncommon hookgrass *Carex subtilis,* Not Threatened grey teal, Not Threatened welcome swallow, seasonal gully drainage plant community, as the impact of the project on these ecological features is predicted to be Very Low.

9.8.1 *Adequacy of Impact Management Activities*

10 Evaluation of adequacy of plan

These actions will, if implemented correctly, fully address all non-minor project effects excepting some minor impacts on individuals of some rare plants and common indigenous bird species, or mostly exotic plant-dominated plant communities noted above. It is also considered that benefit of the offset covenant containing a higher quantity of the Macraes biodiversity more than compensates for the impact of the Deepdell North III project on these features. It is considered that overall this Impact Management Plan will maintain the biodiversity in the local area (see Appendix 1). This assessment is based on the actions within the Impact Management Plan (Section 9) being successful.

It is also considered the proposed approach meets the Impact Management principles set out in Section 5, noting in particular that it is not practicable to maintain the significant nature of the biological diversity present at the Deepdell North III project site by avoiding, remedying or mitigating effects, and the proposed offsetting meets the criteria set out in Section 5 for when offsetting can be considered as an appropriate management mechanism.

As a result of the proposed management measures, including the proposed environmental compensation, residual adverse effects on ecological features will be very low, and the affected values will be protected in the local area.

11 References

Ahika Consulting Ltd. 2019. Deepdell North III: impact of project on vegetation, avifauna, herpetofauna & invertebrates. Unpub. report to Oceana Gold (New Zealand) Limited.

Bibby, C.J. 1997. Macraes Ecological District, summary report for Protected Natural Areas Programme. Department of Conservation, Dunedin.

de Lange, P.J; Rolfe, J.R; Champion, P.D; Courtney, S.P; Heenan, P.B; Barkla, J.W; Cameron, E.K; Norton, D.A; Hitchmough, R.A. 2013. Conservation status of New Zealand indigenous vascular plants, 2012. New Zealand Threat Classification Series 3. Department of Conservation, Wellington.

EcoGecko Consultants Ltd. 2013. Lizard survey of the northern gully waste rock stack and western waste rock stack for Oceana Gold (New Zealand) Limited at Macraes Flat, Otago, New Zealand. Unpub. report to Oceana Gold (New Zealand) Limited.

Holdaway, R.J; Wiser, S.K; Williams, P.A. 2012. Status assessment of New Zealand's naturally uncommon ecosystems. Conservation Biology 26: 619-629.

Johnson, P.N; Rogers, G.M. 2003. Ephemeral wetlands and their turfs in New Zealand. Science for Conservation 230. Department of Conservation, Wellington.

Ryder Consulting Ltd. 2019. Deepdell North Stage III Project, Aquatic Ecology Assessment. Unpub. report to Oceana Gold (New Zealand) Limited.

Thorsen, M. 2008. Where in New Zealand is the highest diversity of threatened plants? Trilepidea Newsletter 58: 4-8.

Williams, P.A; Wiser, S; Clarkson, B; Stanley, M.C. 2007. New Zealand's historically rare terrestrial ecosystems set in a physical and physiognomic framework. New Zealand Journal of Zoology 31: 119-128.

12 Appendix 1. Impact Management Assessment

See file “DeepdellNorth_AffectedEcolFeatures_20190613.xlsx”