




Santana Bendigo-Ophir Gold Mine Compensation and Offsetting Assessment

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Report No:	7861	
Date:	April 2026	

1.0 Introduction

Santana Minerals Ltd (**Santana**) has prepared a Fast Track application to open a new open-cast gold mine at the Bendigo-Ophir site on the Bendigo and Ardour Stations, near Cromwell. The project site is classified as an "Outstanding Natural Landscape" in the Central Otago District Plan.

The Department of Conservation (**DOC**) has requested that Wildland Consultants Ltd (**Wildlands**) undertake an assessment of a proposed offsetting and compensation package put forward by Santana, including an assessment of Biodiversity Offset Accounting Models (**BOAMs**).

2.0 Project scope

The scope of this assessment includes an assessment of the overall effects management package proposed by Santana. A thorough assessment of biodiversity value reports is beyond the scope of this project, although these were reviewed in a targeted manner, where required, to inform this review. The review did include a detailed assessment of the Assessment of Ecological Effects (**AEE**; Alliance Ecology, 2025a) as well as the appended biodiversity offsetting memo (Alliance Ecology, 2025b).

The scope of my works did not include a site visit. Accordingly, this assessment relies on the experience and expertise of other members of the project team, including employees of DOC as well as other consultants. I rely heavily on the reporting of the Applicant's ecologists.

The National Policy Statement for Indigenous Biodiversity (**NPS-IB**) has been referenced within this document insofar as it provides a succinct summary of best practice, applied to the context of Aotearoa New Zealand. "No Net Loss" of biodiversity is a well-established environmental policy approach and considered best practice throughout the discipline. No Net Loss is established in policy in many countries (at least 69 countries as of 2018: Bull and Strange, 2018), is a United Nations Sustainable Development Goal (zu Ermgassen et al. 2019) and was defined by the International Union for Conservation of Nature (IUCN) in 2015. No Net Loss is accepted as a relevant threshold by large international business-centred bodies (e.g. Business and Biodiversity Offsets Programme; BBOP) and is generally the baseline discussed in the academic literature. Within the context of Aotearoa New Zealand, while No Net Loss is not explicitly defined, an idea adjacent to No Net Loss is reflected in the NPS-IB: "The objective of this National Policy Statement is [...] to maintain indigenous biodiversity across Aotearoa New Zealand so that there is at least no overall loss in indigenous biodiversity after the commencement date". Additional considerations apply in the Fast Track context, which requires the balancing of environmental values with other considerations, which is beyond the scope of this work.

3.0 Effects management package adequacy

3.1 General comments

The Applicant has proposed an effects management package with wide ranging activities to address the adverse effects of the project. Despite this and acknowledging the complexity of the proposal and the offsetting and compensation proposed, I consider that a Net Loss of biodiversity for this project is



highly likely, as acknowledged by the Applicant. In my view, the magnitude of this loss has been systematically underestimated. Compensation and/or offset actions are insufficient to address this loss¹ by a substantial margin and as outlined below, the degree of loss is unable to be defined due to lack of relevant information to inform it. As such, I believe the overall effects management package offered by the Applicant is inadequate.

This section outlines overarching concerns that support this conclusion and apply to the proposal as a whole. In the remaining sections, I delve into further considerations for flora and fauna, and I identify gaps in information provided by the Applicant. I provide recommendations in the final section.

Unmanaged biodiversity outcomes

Overall, following all effects management actions proposed², the Applicant's ecologists predict a Net Loss of biodiversity for the following values:

- Mixed/depleted herbfield (cushionfield) and grassland (an ecosystem type assessed as having Very High ecological values).
- Seepage wetlands (an Endangered Naturally Uncommon Ecosystem).
- Gully fens.
- Twenty-three nationally or regionally Threatened or At Risk plant species.
- Two At Risk - Declining and one Not Threatened lizard species.

I consider that the actual list of biodiversity values for which a Net Loss is likely to be more extensive for the following reasons:

- Those values listed above are the losses expected by the Applicant's ecologists even if all effects management, including compensation and offsetting, is entirely successful. Many aspects of the effects management package, particularly many of the offsetting and compensation actions, should be considered experimental (discussed in further detail below) and thus I consider it highly likely that many additional values will fail to achieve a No Net Loss outcome.
- Impacts on two plant, five bird, and 18 invertebrate species that are classified as nationally or regionally Threatened or At Risk are assessed as "Uncertain". This represents *all* invertebrate species in this category. Species for which outcomes are uncertain are not random: they are typically rare or poorly understood and therefore very challenging to design appropriate effects management for. Consequently, I expect that many species in this category realistically represent species for which Net Loss will occur.
- Biodiversity values³ impacted by this project are likely to be greater than those identified by the Applicant's ecologists due to oversights. For example:
 - Non-vascular plants have not been assessed.
 - Wetlands have not been assessed for lizards.
 - Invertebrates have not been considered at higher hierarchical levels, such as by using community indices.

The Applicant's ecologists consider these losses to be beyond the limits to offsetting/compensation and consider that these unavoidable losses will be balanced through:

¹ Residual effects; see Table 1 in the Assessment of Ecological Effects: Terrestrial Effects (Alliance Ecology, 2025) (B.08)

² Including avoidance, minimisation, mitigation/remediation, offsetting and compensation actions at the site.

³Biodiversity values as identified by the Applicant's ecologists include species and habitats but omit communities, natural biodiversity gradients or population-level values.



- Different, alternative, or larger actions elsewhere in the project.⁴
- A \$5 million dollar biodiversity and heritage enhancement fund.

I contend that balance across the project is not achieved. My opinion differs to that of the Applicant's ecologists because both the number of values (species, and assemblages) for which I expect Net Loss is greater, and I have greater uncertainty around purported biodiversity gains.

Further, I consider that there is no sufficient plan for the deployment of a one-off \$5 million dollar enhancement fund to quantify whether this sum is sufficient. Appropriate compensation should consider whether achievable biodiversity gains are comparable to the impacts of the project on biodiversity values at the site. While the adequacy of this sum is challenging to assess, I consider that it is highly unlikely that a one-off \$5 million dollar enhancement fund is sufficient to compensate for the substantial losses expected across the project. While I am unable to say this with absolute certainty, I note that, for example, the "*Ceratocephala pungens* outcome plan" alone (as quantified by DOC's BioInvest database) is estimated to have a cost of \$311,575 over the next 5 years. Similarly, the "Understanding causes of decline of threatened ground beetles outcome plan" alone is expected to cost \$347,918 over the next 5 years. Given the number of unmanaged biodiversity outcomes expected by the Applicant, it seems apparent to me that the fund will be insufficient to address these impacts.

Impacts not considered

I consider that indirect or diffuse impacts, including contributions to cumulative effects in the Ecological District⁵ are poorly assessed in the materials provided by the Applicant's ecologists. No discussion regarding how these were factored in has been provided, if they were considered at all. Fragmentation and edge effects have been "indirectly factored in", however, it is unclear how this was done. Diffuse or indirect impacts are well-established to be major causes of biodiversity loss (I agree with the Applicant's ecologists on this subject). Such impacts can dramatically lower the ability of ecosystems and species to persist in the landscape and are likely to become increasingly important at a regional and national scale in the context of Fast-Track applications. Diffuse or indirect impacts are most important when occurring in aggregate at the landscape scale. Collectively, this omission means that all effects assessments underrepresent true biodiversity impacts of the project.

Additional impacts not considered in this proposal include those driven by a loss of legal protection. Proposed covenant revocation extends >560 hectares beyond the direct disturbance footprint and is based on existing cadastral boundaries rather than ecological values. No evidence has been provided to demonstrate that values within the Bendigo Conservation Covenant that are not impacted by the currently proposed development will remain protected. I consider that this loss of legal protection is likely to result in impacts on biodiversity values that would otherwise have been halted by the covenant. For example, mining exploration impacts will not be subjected to the scrutiny that is currently required. The proposed covenant removal area would include nearly all known habitat of Nationally Critical herb species *Ceratocephala pungens*.

No effects management is proposed for this loss of protection. Equally, it does not appear that compensation for the removal of the covenant is provided elsewhere. That is, areas where biodiversity gains are secured through effects management should be covenanted. Taxpayers have paid for the covenant that is proposed to be removed, so it could be considered fair that the Applicant takes on the cost of any compensatory covenanting required.

⁴ That is, that mitigation actions including offsetting and compensation will result in a net loss for some values, but that other values will disproportionately benefit, thus comprising an out-of-kind trade.

⁵ Such as fragmentation, edge effects, introduction and spread of environmental weeds, dust effects, changes to hydrology (surface and ground water), contamination (acid mine drainage and chemical leaching), vegetation clearance as a result of fencing or elevated risk of fire. This should not be considered an exhaustive list.



Finally, existing works undertaken during the exploration phase of this project have not been adequately managed or incorporated into the effects management package. Works such as roading and exploration drilling have resulted in substantial damage to the site. Best practice would require the inclusion of these unmitigated effects within the effects management package.

Impact area

The impact areas considered within the AEE and BOAMs is incomplete and as such are underestimated. While 607- 610 hectares will be affected throughout the documentation, this does not include:

- Areas of the dewatering drawdown zone (discussed below).
- Stockpiles of rock from DDF to use in rehabilitation
- The area of the Bendigo Conservation Covenant that the Applicant seeks to uplift that falls outside the DDF.
- The area of works that have been consented by Central Otago District Council at exploratory stages, including roading and exploratory drilling.
- The footprint of underground trenching to deliver electricity to the site.

Ardgour Rise (Thomson Gorge Road realignment) and the construction zone for the proposed predator proof fences (2.9 hectares) are included within the disturbance footprint but these impacts have not been addressed.

This systematic underestimation of the impact area materially skews the effects assessment and subsequent offsetting and compensation calculations.

Adherence to the mitigation hierarchy

Offsetting and compensation sit at the bottom of the effects management hierarchy, since both are considered riskier ways to achieve environmental outcomes. Compensation is typically considered as a last resort. However, much of the effects management within this project relies on offsetting and, particularly compensation, despite these sitting at the bottom of the effects management hierarchy. As noted by Alliance ecology (2025a): *“for the majority of ecological values affected, offsetting was not considered feasible. This was primarily due to insufficient knowledge of species distribution or the technical infeasibility of salvage, relocation, restoration, or management—particularly for most threatened plants and terrestrial invertebrates present at the site.”* 27 species and 3 habitats are expected to suffer a Net Loss following compensation and offsetting by the Applicant’s ecologists.

This overreliance on compensation means that little evidence is provided that the effects management package will be effective. Uncertainty arises both because the outcomes of management actions are poorly understood, and little has been done to adequately quantify the outcome, where this could be possible. For example, of the 31 values to be offset/compensated for, only eight were modelled using industry standard methods (BOAM). Outcomes for the remaining 23 values are unsubstantiated. Table 26 of the AEE provides a list of these values and the residual effects management measures that may benefit them, but there is no discussion of the level of expected outcome provided. As a result, there is insufficient information to enable a critical assessment of the expected outcomes.

The exceptionally high number of nationally or regionally threatened species at this site is a major component of the value of the biodiversity at this site. Meanwhile, it is such species that are most likely to be poorly understood in their responses to effects management. The responses of these species might require substantial individual consideration. For example, livestock removal has been identified as an action to benefit many plant species, however, palatability has not been discussed. Overall, the substantive application refers to the land being managed as farmland in several places, and it is unclear how any tensions between requirements of farming and biodiversity will be managed.



Additionally, of the modelled values, the parameterisation is mostly very poor. For example, for Kawarau gecko and McCann's skink, success is measured in modelling through only relative abundance (ACO occupancy rates across fixed stations as transects or clusters), while for tussock grassland and native herbfield and shrubland, success is only measured by percentage cover (bird's eye view) across 5 m x 5 m quadrats, or by remote sensing (census). Clearly, this is a gross simplification of ecological value, omitting important aspects of value, such as habitat structure and function. Further, insufficient information has been provided by Alliance Ecology (2025b) to assess how multiple management interventions have been included in the BOAMs and whether the model parameterisation has been undertaken in an appropriate manner overall.

I consider that adherence to the mitigation hierarchy has not been sufficiently prioritised, and that this leads to a much more speculative effects management package than is typically expected.

Replacement of permanent biodiversity value with temporary to long-term solutions

Within this project, it is proposed that substantial ecological values will be permanently destroyed⁶. In contrast, I consider that revegetation of the impact area is unlikely to ever result in ecological value of a comparable longevity following mine closure. The removal of soil horizons that have developed over timescales far greater than those considered as part of this project must be considered a permanent loss. Soils removed in such projects, and stockpiled for later use, typically lose many of their critical characteristics (such as horizon and micro-structure, as well as chemical composition and microbiological communities) which drive the plant communities that they support. I expect that the proliferation of both herbaceous and woody weeds can be expected in these locations, rather than a return to communities with notable indigenous characteristics.

These permanent losses are proposed to be addressed through much more temporary biodiversity gains. Overall, substantial ecological values are proposed to be offset or compensated for through ecological restoration and habitat enhancement across 2,219 hectares in the landscape surrounding the mine footprint. This includes 889 hectares of mine regeneration zone, 1,263 hectares at Ardgour restoration area, and 67 hectares of pest-exclusion fenced areas at Ardgour and Bendigo. In particular, I identify:

- Outcomes in the Ardgour restoration area have a strong reliance on exclusion of livestock and mammalian browsers and predators. These pressures will return following mine closure (without additional ongoing intervention of a third party), which would remove some of the gains in biodiversity.
- Rabbit-proof fences in the Ardgour restoration area will eventually fall into disuse or be removed (without additional ongoing intervention of a third party), which would remove some of the gains in biodiversity.
- Selective pest plant control will eventually cease and cushionfield habitat will be just as susceptible to the invasion of sweet briar and other weeds as it is currently.
- Removal of livestock is likely to be temporary (note that the provision of appropriate covenants may overcome this).
- At the Ardgour and Bendigo sanctuaries, the primary intervention is the elimination of introduced mammalian predators and intensive management. These sanctuaries require consistent monitoring and rapid and often costly responses to breaches by predators.
- The scale of proposed planting is unprecedented and considered unlikely to be feasible in this arid environment. Gains from planting may therefore be short-lived.

⁶ For definitions of permanent, long-term and temporary, see Roper-Lindsay *et al.* 2018.



In this project, losses will be permanent, while many gains may persist for a century or less⁷. As such, this represents a trade of wild ecosystems that are currently likely self-sustaining their value despite numerous threats in the landscape, and trading these for values within facilities that are more akin to zoos or gardens, which must be actively managed. These outcomes are inherently less resilient, particularly in the absence of funds to maintain gains in perpetuity. By considering the overall losses and gains at human timeframes only, I consider that the package has underrepresented true losses of biodiversity.

Additionality

The AEE relies on many predictions of future environment states that do not appear to consider additionality. The principle of additionality appears to have been misunderstood within these works. As defined in the National Policy Statement for Indigenous Biodiversity (**NPS-IB**): “*Biodiversity offset or compensation achieves gains in biodiversity above and beyond that which have occurred in the absence of the offset/compensation*”. The AEE identifies that the principle is met because proposed enhancement measures will all be additional (Table 27). However, it is the biodiversity outcomes, not the proposed actions, that must be additional to satisfy this principle.

As an example, assumptions for assessing uplift potential for woody scrubland at Ardour Station are described as “*No stock or only periodic light sheep grazing to control exotic grass growth. No planting. Mixed shrubland increases extent by 50 % over 35 years, and condition by 1.5 – 3 times depending on attribute, except for plant species richness of naturally established species that indicate functional and structural complexity, which increases from an extremely low level now, to a much greater level after 35 years. Native dominant scrubland increases extent by 10 % over 35 years, and condition by 1.5 – 3 times depending on attribute. Extent increases based on measured increases to woody vegetation in nearby Dry Creek Reserve over 20 years of stock exclusion.*” (Alliance Ecology, 2025b). While the removal of most of the stock effects is likely to have notable positive effects on this habitat, I consider that much (not all) of that uplift would occur in the absence of intervention, as a function of time since the last fire, particularly as the wider landscape contains seed sources. In particular, many unpalatable species are likely to continue to grow in the absence of intervention. Nevertheless, this gain is used within the BOAM to ultimately conclude that native dominant scrubland will increase in both extent and values (Alliance Ecology 2025a), although it does not represent gains above and beyond that which would have occurred in the absence of the offset/compensation.

Overall, a failure to account for additionality means that the gains predicted as a result of this effects management package are substantially overestimated. A failure to consider additionality is a critical concern regarding this effects management package.

Additional concerns

I have several concerns regarding the future management of funds and the values at the site in the proposed plan:

- Considering that permanent biodiversity values will be replaced with values that require more management, the management areas, including the sanctuaries, the restoration area, and the wider mine regeneration zones require additional governance consideration.
- Additional governance consideration is also required as substantial portions of the proposed effects management package include untested and experimental management.
- It is unclear what further activities are intended in the conservation uplift area (or may arise in the future), which is substantially larger than the impact area.

⁷ In the absence of provided BOAMs, it is impossible to partition the relative contributions of these interventions.



- The \$5 million biodiversity and heritage enhancement fund is not targeted; therefore, it is impossible to conclusively assess whether it is enough to make the substantial gains in conservation to be commensurate to the biodiversity losses I expect as a result of this project. However, the magnitude of expected losses means the sum is unlikely to be sufficient. Further, it is imperative that consent conditions allow for this sum to be made available contingent on biodiversity impact, rather than on only if the mine is successful.
- I consider that the biodiversity and heritage enhancement fund needs to be tagged to specific relevant projects to be helpful. This will require further discussion between the Applicant and DOC.

3.2 Vegetation and flora

3.2.1 Vegetation and flora values

Overall, the AEE identifies seven broad vegetation types within the surveyed area. I consider this to be insufficiently detailed (discussed in detail below), and the accuracy of the mapping of these vegetation types is uncertain. A total of 58 species that are Threatened or At Risk, either nationally or regionally, were identified within the survey area. The majority (48) of these appeared within the direct mine impact area. I agree with the AEE that this represents a flora that is exceptionally rich in such species.

The report identified all vegetation communities within the survey area as significant under both the NPS-IB and the operative and proposed Otago Regional Policy Statements (**ORPS**). I agree with this assessment.

Coarse vegetation classification

I consider vegetation mapping to be too coarse to adequately identify and describe the vegetation values on-site and to assess impacts.

The area varies in elevation from 270 to 1,222 metres a.s.l. Over this difference of almost 1000 vertical metres, we would expect a temperature difference of nearly 6.2°C based on the environmental lapse rate. Thus, the site hosts ecosystems that would be typically classified as varying from lowland to montane. Nevertheless, most of the ecosystems identified have been mapped throughout the elevational range of the site. I consider that it is extremely likely that habitats would vary substantially in species composition over this elevational gradient. Further, we would expect the distribution of notable or nationally and regionally threatened species to be driven by elevation within these habitats.

Natural habitat variability is also underrepresented taxonomically. For example, RMA Ecology (2025a) identified two distinct forms of scrub dominated by native species: one dominated by tūmatakuru/matagouri (*Discaria toumatou*) and the other by *Kunzea serotina*. These sub-types represent entirely different plant assemblages and are quite different structurally. I am sure that many additional “subtypes” of ecosystems occur which have not been discussed by RMA Ecology (2025a). An ordination of plot data could be used to identify possible ecosystem sub-types to inform vegetation classification and thus meaningful ecological analysis, provided that plots are adequately distributed throughout the site.

There is a gradation between coarse vegetation classifications such as “mixed shrubland” and “native dominant scrubland”, and it is not clear how the distinction between these vegetation types has been made. The presence of exotic species alone within these communities is unlikely to have a significant impact on the indigenous biodiversity values they support.

I consider the current classification to be a substantial oversimplification that limits meaningful assessment of effects and their management. There are several reasons why this matters:



- It is not clear whether vegetation types such as “mixed scrubland” are considered to be offset, rather than compensated for within the package, and are calculated using eight BOAMs. I consider that this coarse resolution does not ensure disaggregation (a key aspect of such models: Maseyk *et al.* (2015) measure like-for-like exchanges and thus does not satisfy requirements for offsetting.
- A map of vegetation surveys and plots has not been provided (presumably it was Figure 8 of RMA Ecology, 2025a; although this has been redacted). It is difficult to assess whether the likely true diversity of ecosystems has been definitively captured. In fact, Figure 11 of the RMA report indicates that the full diversity of ecosystems was not represented within plotwork. Therefore, the Applicant’s assessment of flora and vegetation values may be an underrepresentation.

While RMA Ecology (2025a) discusses the reasons for opting for such a low taxonomic resolution to vegetation classification, it appears that their major concerns related to higher resolution potentially leading to errors in mapping. While I agree that that is a concern, I consider that an underrepresentation of the biodiversity values at the site is more concerning.

Accuracy of vegetation mapping

Despite the coarse resolution of habitats, misclassifications of ecosystems were identified in the field by Max Crowe (field visit December 2025). Overall, vegetation mapping was broadly consistent with vegetation patterns inside the footprint but more errors outside of the footprint, notwithstanding the issues with overly coarse vegetation classifications (Max Crowe, pers. comm. 2026). Notably, there were discrepancies between the mapping of terrestrial and wetland values. These errors may undermine our ability to determine the adequacy of the proposed effects management, and undermine calculations made using BOAMs, although it is unclear to what extent without further field visits.

Trajectory of vegetation without intervention

The AEE identifies the vegetation at the site as being in decline. “[...] *ongoing habitat loss and degradation through stock browsing, topdressing and aerial oversowing with non-native pasture species, spread of competing non-native plants (including weeds), invasive browsers and grazers (especially rabbits and deer), and predation by introduced mammals. A notable exception is the cushionfield ecosystem (which contains threatened plants and invertebrates).*” Based on discussions with other specialists involved in this review, I do not consider this to be an accurate assessment. While RMA Ecology (2025a) outlines the threats to these habitats, this report does not conclude that these ecosystems are in decline. This assertion is not demonstrated with evidence in any documentation I have reviewed.

This is a critical point of contention, as residual effects management is largely based on the alleged halting of this decline. This is discussed in further details in the section below.

Assessment of vegetation and flora values

Overall, I agree with the assessment that the highest value habitats are mixed depleted herbfield (cushionfield) and grassland and native dominant scrubland (assessed as Very High), followed by native dominant tussockland, native herbfield and shrubland, and swamps and marshes (High). I have some concerns regarding the assessment of ecological values:

- Assessments of ecological values for habitats are provided by the AEE at a broad scale across the entire ecological survey area. Overall, the site visit found that ecological values on adjacent land is lower than within the impact site, especially at Bendigo (Max Crowe, pers. comm. 2026). For example, the Ophir site was depleted through burning and grazing. This context should be carefully considered when assessing ecological value. Grouping impact site values with areas of lower quality may artificially decrease the assessment of impact site ecological values.



- The AEE uses a lower value assessment than that provided by RMA Ecology (2025a) for mixed tussock shrubland and exotic grassland, and mixed shrubland. In both cases, the value has been downgraded from “High” to “Moderate”. The lack of consistency between these reports is concerning, particularly as no justification has been provided for these differences.
- I question whether an exotic pasture or herbfield containing 75 indigenous species should be assessed as “Low” even if these are rare or occasional. In comparison with other habitats on-site, 75 indigenous species may be relatively poor, however, in a broader context this is a highly species rich ecosystem type. The assessment appears to have come to this conclusion by following Table 6 of Roper-Lindsay *et al.* 2018 very literally despite instruction to use it as a “broad guide”. This ecosystem does not appear to be well-described by the description for “Low” in Table 6: “*Limited ecological value other than as local habitat for tolerant native species*”. Of the 75 species present, 16 are Nationally and Regionally At Risk and Threatened plant species and occur within the impact footprint. While I suspect that much of this habitat is indeed of low quality, this indicates to me that pockets of higher values (likely, at high elevation) should be separated into an appropriate habitat designation and assessed separately. Further, the AEE discusses this habitat type as having important values at the margins. Despite discussion of ecotones as important areas of biodiversity by RMA Ecology (2025a), these areas are lumped together with low-quality habitats, effectively “watering down” their value and ensuring this value is not adequately assessed (and therefore offset).
- Mixed tussock shrubland and exotic grassland is assessed as Moderate within the AEE, however, I consider that its ecological context is not given due recognition. The community “forms a buffer and connection between most other communities of scrub and tussock” (including habitats assessed as High and Very High), yet its ecological context is only assigned the value “Moderate”. I consider that this habitat is likely to vary in species makeup across the site, and that areas of highest quality and that are most critical to connectivity should be considered separately. Assessing the value of this habitat with sufficient resolution is particularly important, given that this habitat type makes up almost a third of the impact area.
- As with exotic pasture or herbfield, mixed scrubland contains 75 indigenous species; of these 21 are Nationally and Regionally At Risk and Threatened plant species and occur within the impact footprint. One of these, scented tree daisy (*Olearia odorata*; regionally and nationally At Risk) is assessed as occurring frequently. As such, I do not consider this to be a habitat that has diversity and pattern of “Moderate”.
- Seepage wetlands are an Endangered Naturally Uncommon Ecosystem (Holdaway *et al.* 2012). I believe this consideration should be given a higher weighting and that seepage wetlands ought to be considered to have High ecological value on this basis despite their degradation. Seepage wetlands are created through a unique combination of geological, geomorphological and hydrological conditions, which occur rarely. Thus, they can never be re-created once lost.
- The December site visit identified new species that were not identified by the Applicant’s ecologists:
 - *Acaena dumicola* (Regionally At Risk).
 - *Pterostylis tristis* (At Risk – Declining).
 - *Craspedia lanata*.
 - *Sonchus novae-zealandiae* (Threatened - Nationally Vulnerable).
 - *Carmichaelia vexilata* (At Risk – Declining; may have been identified as *C. monroii*).

Further, other values may have been underrepresented. For example, coral broom (*Carmichaelia crassicaulis*) was listed as Rare but an exceptionally large population of >50 individuals was found. These missing species and populations were identified within one very short site visit. It is likely that additional species would be found if more time were available for the site visit and a larger area could be covered. This evidence indicates that flora values are underrepresented.

- No values assessment was provided for non-vascular plant species. Thus, flora values are underrepresented.



- No values assessments have been provided for any concession applications.

3.2.2 Effects and proposed effects management

Many of my concerns relating to effects and propose management are laid out above. In particular, the additionality of the proposed rehabilitation is a major concern for vegetation. The proposed approach relies heavily on management of ecosystems to “reverse the ongoing decline of native habitat” (AEE page 143), which I consider is not proved to be in ongoing decline. The principle of additionality dictates that proposed effects management must not include biodiversity benefits that would have occurred without intervention. I provide additional points below.

Completeness of effects assessment

RMA Ecology (2025a) discusses numerous ecological effects on vegetation and flora. Some of these I consider have been explicitly considered (✓); some have been “indirectly factored in” (~); and some have not been considered in the effects assessment (✗):

- ✓ Physical clearance of vegetation (610 hectares).
- ~ Fragmentation (loss of connectivity).
- ~ Loss of buffer to vegetation communities, and edge effects.
- ✗ Introduction and spread of environmental weeds.
- ✗ Deposition of dust on vegetation.
- ✗ Alteration to stocking rate/other farm practices.
- ✗ Alterations to hydrology (surface and ground water).
- ✗ Contamination (acid mine drainage and chemical leaching) or physical smothering of soils and vegetation.
- ✗ Vegetation clearance caused by fencing.
- ✗ Elevated risk of fire.

Overall, I consider that the most severe effect, that is, the direct removal of vegetation has been considered in the AEE. However, the quality of this assessment is limited by the coarse mapping of vegetation. In contrast, as discussed above, I consider that indirect or diffuse impacts are extremely poorly assessed throughout this work, including for vegetation and flora. I note that dust effects are not adequately addressed, noting it is expected that arsenic and cyanide will be present in the dust (as these are naturally occurring components of the substrate), which has raised public concerns. Cyanide effects may be notable in landscape, especially if such pollutants get into rivers and streams. No quantification or effects management has been provided for the impacts of dust contamination, despite 500-metre recommended setbacks from sensitive ecological receptors. I consider that given that dust effects have not been addressed, and that therefore the impact on ecology is underrepresented.

Hydrological impacts (groundwater depletion) are similarly poorly addressed. Wetland values are considerable in the Rise and Shine catchments and are likely to be affected by altered hydrology within the Draw Down Zone based on the Applicant’s hydrological modelling. It concerns me that no attempt has been made to quantify the magnitude of this potential impact. The Applicant proposes to augment water flows by pumping up water, but I consider this to be a highly speculative solution. Several hectares of wetlands that could be affected by groundwater depletion are not included in the calculations, nor is the c.3 hectare stretch of wetland remaining between the two proposed pits.

Further, methods for determining impact buffers outside of the direct impact areas are not provided. The AEE describes “a range of buffers from 0 – 100m, with widths varying for different components of the design”. It is unclear how these were quantified or whether they are in line with best practice. Buffer locations are not defined.



Finally, pre-existing impacts from existing exploration concessions have not been dealt with directly in this package, and it is unclear whether these impacts are dealt with in this effects assessment. As such, it is unclear whether there are additional effects management requirements for existing exploration impacts.

Proposed effects management

Proposed actions include a broad spectrum of actions, many of which are very sensible, including many attempts to avoid impacts of the project and substantial reliance on natural dispersal and regeneration, which are more likely to provide success in the tough and often dry conditions at the site than transplantation⁸. Overall, I consider that outcomes of much of the proposed impact management for plants and habitats are highly speculative.

Avoidance

I consider that vegetation has been too coarsely identified, and the distributions of At Risk and Threatened species are mapped only at a high level. Without adequate mapping, it is impossible adequately avoid ecological values.

Translocation of plants

Salvage of some vegetation is proposed. A core management strategy of the proposal provides for targeted plants salvaged from the mine footprint transferred in clusters, including around rock stacks and rubble pits, with enrichment transplanting and planting along mine edges, and enrichment planting in mine regeneration zones. The following are discussed in the Landscape and Ecological Rehabilitation Management Plan (Boffa Miskell, Manaaki Whenua Landcare Research and Habitat NZ Ltd, 2025) and other documentation:

- Translocate (direct transfer) at least 0.5 hectares (although in other parts of the document, one hectare is mentioned) of wetland vegetation from Shepherds Creek to Ardgour Terrace.
- At least 25,000 tussocks transferred to live storage for replanting on rehabilitated surfaces.
- Tussock and sedges translocated to permanent stream diversions and sediment treatment ponds at the time of construction.
- Enrich edges of mine regeneration zones by transplanting tussocks and sedges into areas where there are non-native pasture species.
- Transplant taramea (speargrass) into suitable areas (as an inoculation and enrichment method for invertebrates, while not expecting survival of taramea). As noted in the AEE, salvage of live Threatened or At Risk plants from the DDF is restricted to wetland plants and some shallow-rooted grasses, as most woody plants have deep root systems (1-3 metres or more) that cannot be salvaged intact.
- Additional plant species for enrichment for invertebrates, although these are not discussed outside of Habitat NZ Ltd (2025a).
- One plant species (e.g. *Ceratocephala pungens*, *Ranunculus brevis*, white sedge, *Carmichaelia nana*, or tussock bindweed/*Convolvulus verecundus* subsp. *verecundus*) to be transplanted into the Ardgour and Bendigo Sanctuaries following research outcomes.
- Much salvaged vegetation will be stockpiled. I note that substantial vegetation degradation was identified at Stockton with Vegetation Direct Transfer (VDT) when stockpiling was undertaken⁹.

⁸ Although see comments above regarding additionality.

⁹ The extent to which these scenarios are comparable is limited. At Stockton, high water content and consequent anaerobic conditions led to substantial impacts that would not be expected here. In contrast, wind-blown soil loss is likely to be substantially higher in this project.



Evidence in both Aotearoa New Zealand and internationally is patchy, however, significant concerns and unknowns associated with this technique are important to highlight. Re-creation of habitats by transplanting them has a low chance of success even with sophisticated techniques. It is expected that species composition in the transferred habitat will change (Chmolowska *et al.* 2019). Even with successful translocations, changes after translocation can include dieback, declines in functional richness, and divergence of the community from its original form (Swierszcz *et al.* 2019). Survival of transplanted individuals is variable, and a large loss is expected even in a perfectly executed operation (Stover *et al.* 2018; Zimmer *et al.* 2019, Silcock, 2019; Bell 2021, Milne *et al.* 2021), and it is likely that residual losses will occur. This is because relative to conservation relocations, salvage relocations tend to have a crisis-response timeframes (Milne *et al.* 2021), so significantly less research is conducted before translocation (Bradley *et al.* 2022). This is the case here, where impacts will occur prior to the completion of any proposed research programmes. Any transplant at within this project is associated with higher uncertainty than that faced in other systems due to the arid and rabbit-prone nature of the site. To provide a local example, none of the threatened plant translocation work required by consent conditions at the Macraes mine has been successful over 30 years of operation, and arguably the environmental conditions at the Bendigo/Ardgour site are more difficult than those at Macraes Flat (Max Crowe, pers. comm., 2026).

Appropriate accounting of both individual survival and second-generation success is critical to ensure the sufficiency of effects management actions. Monitoring and associated site management includes monitoring of survival (Years 1, 2, 3) and growth rates of salvaged, planted and transplanted species, to be used to direct future propagation, hardening off, infill and planting programmes. I consider this insufficient given that translocations may fail after several years of successful growth (e.g. Lloyd *et al.* 2018)

Overall, in consultation with other experts, I consider that the successful transfer of vegetation is unlikely. Potentially shrubland could be translocated (with some losses of value) but I do not consider that other habitats will be successfully transferred. In particular, I question the transfer of taramea, which has a very long tap root. While the Applicant's ecologists do not expect for this to survive long, I question whether this transplant is worth doing. I additionally question the likely success of wetland communities. This unproven "habitat creation" proposed for wetland features on Ardgour Terrace and Lower Shepards Creek are considered "offsetting" for destruction of wetland values, and this is inappropriate. For example, Box *et al.* (2011) needed to actively manage the hydrological regime when they translocated a wet heathland to an artificially created wetland habitat, and species loss followed the cessation of active management. It is not clear whether this may be required here.

Applied research programme

Highly speculative components of the proposed effects management package may be better understood following the proposed applied research programme (Maanaki Whenua-Landcare Research, 2025). While this research programme is commendable, it is unclear how extensive the research will be, given that a minimum number of monitoring plots has not been supplied, nor a budget cap provided. Critically, there are unclear success criteria, on which the development of the Come-in-Time Pit relies. Further, the management interventions to be trialled are not confirmed, and include several interventions that may only be suitable at small scales. Thus, they could be unsuitable for effects management in this project. Finally, the research programme suggests that the first four years of the project will include most of the set-up, with monitoring required for the following seven or so years. This means that medium-term findings are unlikely to drive conservation outcomes in this project. Finally, no effects management has been proposed to address sites with negative outcomes at the end of the project's life.

Mitigation and remediation



Overall, I consider that the approach to remediation, focussing on enhancement of the mine rehabilitation zone is appropriate. Tailoring the management across the area and allowing for natural regeneration is the most robust approach in this landscape. I nevertheless have concerns:

- The additionality of this approach has not been adequately considered (discussed above).
- A large reliance is placed on the removal of herbivores and we have very little evidence of the degree of benefit that may arise. In particular, species-specific responses of nationally and regionally threatened species are entirely unknown. This is concerning, given that herbivore removal is a core component of the proposed offsetting and compensation.
- Enrichment planting is proposed in the mine regeneration zone as compensation/offsetting. I note that there is little overlap between the list of species proposed (Habitat NZ, 2025) and the nationally and regionally threatened species list. This makes this a very indirect form of compensation.
- It is proposed to reestablish 19 hectares of cushionfield, however, this relies on the success of the applied research programme trials. It is unclear what will occur if the trials are unsuccessful.

Overall, the project, including both impacts and effects management measures represents a trend of ongoing disturbance in the Ecological District. Thus, the ecological trajectory is likely to include the increasing dominance of weeds or quickly-growing indigenous species, which is likely to shape outcomes across the site. The communities that are likely to result from these processes have lower ecological values than original indigenous communities, whether they are ultimately strongly weed-affected or whether resulting indigenous communities have low diversity.

Feasibility

Overall, I have some concerns regarding the feasibility of the proposed works. Highly ambitious numbers are proposed throughout this management strategy. It is important that the quanta of work are critically assessed, including through the provision of costings of the proposed works prior to commencement of the project.

Historically, projects such as this have variably revegetated direct impact zones following mine closure. It is critical that revegetation trials are undertaken as soon as feasible prior to the cessation of the project to ensure ample time for the development of appropriate techniques in this challenging landscape.

Finally, there is a lack of consideration of impacts on rehabilitation staging, should the life of the mine extend beyond 10 years.

Lack of compensation for herbfields

Overall, the Applicant has made clear that the project cannot compensate for the loss of herbfields. Considering the magnitude of this loss alongside compensatory actions such as the fund proposed, I consider that the losses to vegetation substantially outweigh the benefits of effects management actions undertaken.

3.3 Fauna

3.3.1 Fauna values

Lizards

Overall, substantial effort has been made to characterise lizard values. Nevertheless, substantial uncertainties remain.



- A map showing lizard detections was not provided but are unlikely to be comprehensive. RMA Ecology Ltd. (2025b) text and Figures 3 and 4 indicate that lizard surveys did not include:
 - Wetlands
 - Four of the concession areas (Ardgour Rise was surveyed).
 - Bore field and pipeline.
 - Riparian areas¹⁰.
 - Underground trenching to convey electricity cabling.
 - Quarry and silt pond sites.
 - Temporary spoil storage areas.
- Overall, tussock skink (At Risk – Declining) are likely to have been underestimated as wetlands, a habitat where tussock skinks can reach high numbers in an otherwise arid landscape, were not surveyed.
- McCann’s skinks were misidentified as tussock skinks in lizard values report, therefore population numbers are uncertain.
- Kawarau gecko numbers are inconsistent among reports.
- The extent of potential habitats for jewelled geckos and Lake’s skink is not provided. Lake’s skinks are known to be present in the wider adjacent landscape.

Together, these omissions mean that lizard values within the project area are likely to be underestimated and thus effects management is likely to be insufficient to address true value.

Avifauna

Overall, on the advice of my colleagues, I consider there to be good surveys for avifauna. The list of species identified at the site, and the populations of those species, appear to be appropriate.

Invertebrates

Overall, supported by the advice of my colleagues, I consider that a wide variety of survey techniques used was appropriate for many types of invertebrates. In some cases, there has been insufficient invertebrate survey to adequately capture invertebrate values due to the very high diversity of habitats and invertebrate species that these habitats support. For example, no soil samples were taken. Nevertheless, invertebrate values within the project footprint should be considered as poorly characterised for several reasons, as outlined below.

It is unlikely that the invertebrate species identified by Alliance Ecology comprise an exhaustive list of the species on site. A site inspection of the Bendigo site by Warren Chinn in December 2025 found several species that were not previously recorded, including red coat damselfly (*Xanthocnemis zealandica*; Not Threatened) and *Neoramia* spiders, which are endemic to Otago. This site assessment also found that some listed values may be underrepresented. For example, the site survey recorded dozens of seed bugs (*Rhypodes anceps*) on *Raoulia*, whereas only seven individuals were noted in the original reporting. I consider that this indicates insufficient survey effort. Further, while many species have been identified, inconsistencies have been identified throughout the work. For example, there are substantial inconsistencies between the number of species reported and the number appended in the species list (c.222 versus 410). This discrepancy has previously been noted by DOC but has not been addressed by the Applicant.

I note that most surveys (pitfall traps, foliage beating, timed manual searches) were conducted in March and April of 2024 only. Wooden disc assessments were also only undertaken once, in November 2024. Invertebrate populations recorded are typically highly temporally variable both in true number and due to variable detectability. As such, it is highly unlikely that invertebrate populations have been

¹⁰ Riparian areas require gee’s minnow trapping to detect skinks. Very little trapping of this type was done.



adequately characterised. Additionally, March/April (particularly the latter part of this period) is not the ideal time to survey for invertebrates, if only one time period is to be used. At this time of the year, temperatures have dropped, which affects the numbers of many species.

As with botanical values, it is extremely challenging to accurately capture all values within such an extensive area. This is compounded by substantial unknowns within terrestrial invertebrate ecology generally (discussed below under “Unassessed invertebrate species”). Overall, it is concerning that no hierarchical approach has been taken to understand the invertebrate ecology in light of this. For example, community indices along altitudinal sequences or ecosystems may assist in understanding invertebrate patterns given the inherent complexity of this biodiversity type¹¹. As such, the only values considered in the assessment are for individual species of notable threat status; the value of complex invertebrate communities that provide stable food sources for avifauna and lizards, provide pollination services to plants, that regulate competitive interactions among plants or contribute to nutrient cycling within this ecosystem, are not assessed as having any value. This is particularly concerning given the notably species-rich communities of invertebrates found at site which are certain to shape all other aspects of ecology in this landscape. Finally, invertebrate values are not discussed in the context of ecological imperatives such as population viability.

As such, I consider that any effects assessment and proposed effects management for invertebrates lack a robust evidential foundation.

3.3.2 Effects and proposed effects management

Completeness of effects assessment

As discussed in the general comments section of this report, I consider that indirect or diffuse impacts are poorly quantified within this management package. This has substantial impacts on fauna, particularly lizards and invertebrates, which are less mobile. Habitat fragmentation and loss of ecological connectivity is particularly likely to adversely affect these biodiversity types. Additional considerations discussed above, such as an underestimation of the impact area are critical shortcomings of the proposal that relate to fauna but are discussed in more detail above. Below, I discuss additional consideration in the completeness of the effects assessment as pertaining specifically to fauna.

Potential adverse effects on undetected lizards

Potential adverse effects on undetected At Risk and Threatened lizard species (jewelled gecko; At Risk – Declining; Lake’s skink, Threatened – Nationally Vulnerable) are not considered in the effects assessment¹². They are also not managed via the incidental discovery section of the Lizard Management Plan (Alliance Ecology, 2025c). Impacts on undetected lizards thus represent a potential underestimation of project impacts.

Poor quantification of adverse effects on invertebrates

Impacts on *all* nationally or regionally Threatened or At Risk invertebrate species are assessed as “Uncertain” following residual effects management, which I agree with but highlight that this assessment is of concern.

¹¹ They may also aid the understanding of regional biodiversity trends more generally.

¹² Gullies and other places that are challenging to access for survey due to dense shrubs are likely locations for the persistence of these species.



I consider that effects assessments for terrestrial invertebrates both prior to, and following offsetting/compensation are speculative, given how little is known about the ecology of many invertebrates present at the site, as well as their responses to management interventions. Particularly given the latter, I expect that for many terrestrial invertebrate species, management will be either imperfectly executed or entirely unsuccessful. I consider that for many species in this category, an “uncertain” assessment realistically represents a likely Net Loss. The compensation provided across this project must be of a quantum to address these likely losses.

Unassessed invertebrate values

At least 222 native terrestrial invertebrate species have been found within the ecological survey area, of which 18 were considered notable and have been provided with an effects assessment. However, it is likely that additional values have been omitted either because species were not accurately identified, missed, or because species do not satisfy typical criteria for consideration as “threatened species” due to a lack of information. Many invertebrate species, both nationally and worldwide, have been poorly resolved taxonomically. Further, the threat status of many invertebrates has not yet been assessed under the New Zealand Threat Classification System (NZTCS). As such, I consider that it is likely that additional invertebrate values exist at the site. It is appropriate to provide additional management for this loss, which cannot currently be characterised but is very likely to occur.

Further, as discussed in section 3.3.1, the value of notably species-rich invertebrate communities that shape this ecosystem have not been assessed and no ecological effects on them are considered.

Effects on avifauna

Overall, potential adverse effects of the proposal on avifauna are likely to be lesser for avifauna than other fauna, given their mobility and large range sizes. Vulnerable birds that are most likely to be impacted by the project have large territories and as such are less impacted by effects such as habitat fragmentation. Residual impacts are likely to be managed effectively through the predator management that is proposed. Possible nest/egg disturbance in the breeding season can be effectively managed through pre-works surveys and the details in the avifauna management plan (Alliance Ecology, 2025d) adequately address these effects. On the advice of my colleagues, I consider that the effects assessment and effects management is sufficient for avifauna.

Impacts of proposed effects management

Management of biodiversity for the purposes of effects management in this project may result in unintended negative outcomes, which have not been considered in this proposal. I note several examples (although this list is not exhaustive):

- Habitat and flora removal, and harm to fauna, during the creation of predator-proof fences.
- Effects on lizards of toe clipping¹³ during monitoring has not been considered.
- Effects on invertebrates through injury or death during monitoring.
- Predation of nationally or regionally Threatened or At Risk invertebrates by lizards at high densities within sanctuaries.
- Effects on lizards and invertebrates through increased intraspecific competition in translocation sites for salvaged individuals, as well as in areas adjacent to the impact footprint, where impacted individuals may seek refuge.

¹³ Toe clipping is very sensitive to iwi and no evidence of consultation on this matter has been provided. If toe clipping does not proceed the outcomes are not measurable.



- Effects on resident lizards and invertebrates and their habitats where rocks or other habitat enhancement will be placed as part of efforts to enhance/remediate/restore the Ardgour restoration area, as well as in the two proposed sanctuaries.
- Facilitating succession of woody habitats may reduce habitat areas for invertebrates and lizards or may lead to unpredictable changes in the populations of predators, including rodents.

Proposed effects management

Avoidance

Due to the incompleteness surveys of lizards and invertebrates, it is likely that plans are not optimised to avoid these values.

Management of Ardgour restoration area for fauna

The management of vegetation at Ardgour restoration area is designed to “*enhance both woody ecosystems and sustain indigenous dominated herbfield*” (page 145 of AEE). Notably, only 228 of 1,263 hectares (18%) of the restoration area footprint is currently in depleted herbfield (cushionfield) habitat. It is this open habitat that is likely to be of benefit to lizard and invertebrate fauna impacted by this project. While actions that allow other habitats (82% of the area) to succeed to larger stature woody vegetation are beneficial to other biodiversity types, the intention of the management of these areas may make them less suitable for lizard and invertebrate fauna affected by the project. This is acknowledged by the Applicant.

Predator control is a core component of the fauna effects management within this project. Much of the proposed control is to be undertaken outside of predator-proof fenced at the Ardgour restoration area. I note several concerns regarding this approach:

- The management of mice is not proposed outside of the two sanctuaries. The only provision for mice in this area is: “*If there is evidence of mice numbers increasing, then establish monitoring and if required some localized trapping*” (Biodiversity Solutions, 2025). Mice can cause significant ecological damage. The effects of mice can become disproportionately important if other mammals are controlled due to predator release, their populations can explode without competition or predation. This can lead to mice becoming the dominant pest, increasing pressure on indigenous species and negating the benefits of controlling other mammals. Given the optimistic outcomes from predator management expected by the Applicant, I consider that this effect has not been adequately considered.
- It is unclear to what extent geography has been considered as pertaining to the efficacy of predator management. While potentially effective for predators with smaller range sizes, such as rats, it is unclear to what extent the predator control area will reduce predation pressure from animals with larger range sizes, such as stoats and feral cats (e.g. Fitzgerald and Karl (1986) found an average home ranges length of 6.34 kilometres for male cats). It is unlikely that three-yearly aerial control operations will remove all such vagrants and result in biodiversity gains. For example, Reardon *et al.* (2012) showed that large suppression buffers, extending far beyond core habitat, are needed so that predator pressure remains low long enough for skink populations to recover. Further, Norbury *et al.* (2023) showed that when mouse abundance exceeds ~5% (tracking index or equivalent low-density benchmark), there were detectable and significant negative impacts on indigenous fauna.
- Aerial 1080 is proposed every three years (Habitat NZ, 2025c), however, Biodiversity Solutions (2025) clarifies that coordination with farming activities and adjacent landowners is required, meaning that aerial 1080 may not be used or may have an interrupted schedule. The use of aerial 1080 may be incompatible with farming requirements at the site. Alternative control, as described by Biodiversity Solutions (2025) (“*targeted control around Land Management Units 1, 2, and 4 initially, then expand to LMU 3, using bait stations around margins and through areas where*”



required") is unlikely to benefit invertebrates and lizards. These land management units all comprise woody vegetation.

I consider that the likely efficacy of predator control, and benefits to fauna, has been grossly overestimated. Further, given the inherent conflicts in management for vegetation and fauna values, I consider that there is significant uncertainty whether there will be overall benefits to fauna in this area as vegetation develops. As such, I do not find strong evidence that the management at Ardgour restoration area will benefit fauna.

Site selection for Ardgour restoration area

In areas with predator pressure as well as successional woody vegetation, habitats such as rock tors provide critical habitats for lizards and invertebrates (intended beneficiaries of management). I have not found any mapping of these small-scale habitats. In the absence of this mapping, it is challenging to determine whether the Ardgour restoration area is appropriate for multiple lizard and invertebrate species. It is possible that mapping would indicate that these species would be most effectively managed if located elsewhere.

Sanctuary site selection

Detailed discussion of the placement of the Ardgour and Bendigo sanctuaries is not provided. I consider the following require consideration:

- The 38-hectare Ardgour sanctuary placement includes 11.7 hectares of exotic pasture or herbfield (i.e. 31% of the total area). This may be intentional; Habitat NZ (2025b) provides that *"both sanctuaries are in areas that represent the wider landscape and have strong potential for ecological improvement."* This does not satisfy the offsetting principle of "trading up".
- It is unclear whether the proposed sanctuaries in the landscape are optimal for the biodiversity values impacted by this project. While the requirements of critically endangered skinks (likely not affected by the project as per the AEE and not proposed to be managed by Santana in any way) have been considered, these two sanctuaries are unlikely to provide the conditions for other biodiversity values. For example, the elevation ranges of the two sanctuaries are 420-480 metres and 380-420 metres a.s.l. for the Bendigo and Ardgour Sanctuaries, respectively. This narrow elevational band does not reflect the diverse conditions to be impacted by the project. Therefore, the sanctuaries are unlikely to provide substantial benefits for the diverse species which are considered to be benefitted by this management. Many of the species, particularly plants and invertebrates, have distributions strongly driven by elevation and micro-site climatic conditions.
- The relative quality of the habitats for both flora and fauna within the proposed sanctuary sites has not been discussed relative to the quality of the habitats within the impacted area.
- The sanctuary size is likely to be insufficient to address biodiversity losses. For example, the large numbers of lizards that may be affected by the project across a vast area are unlikely to be reproducible within the relatively small, proposed sanctuaries.

Sanctuary management

No comprehensive list is provided of the species intended to be benefitted by the sanctuaries, although management for lizard values is discussed. It appears implied by the Applicant that management for lizards is likely to benefit invertebrates. However, this is often not the case. For example, management for invertebrates may require specific habitat features, such as specific plant species or open, bare ground, which may not be prioritised for lizards. Further, lizards can be important predators of invertebrates. Given how little is known of the ecology of the invertebrate species that require management, I consider that it is unclear whether the sanctuaries will provide any benefit to these species.



It appears that rabbits are to be entirely removed from the Bendigo sanctuary and to be controlled to low levels within the Ardour sanctuary, although there are inconsistencies throughout the reporting, so this requires clarification (Habitat NZ, 2025b; e.g. *“This programme will continue until rabbits are eradicated from the sanctuaries”*, page 17). Where rabbits are to be controlled to low levels, it is unclear what levels these are to be. Monitoring using the Modified McClean Scale is discussed, although targets are unclear.

There is no proposal to provide long-term legal protection to these sanctuaries to ensure long-term gains are locked in.

Offsets for lizards

The AEE does not clarify whether an offset for lizards will be provided for two or three species, although Alliance Ecology (2025b) models only Kawarau gecko and McCann’s skink, omitting tussock skink. Overall, I note that a common opinion among ecologists is that the characteristics of lizards (in particular, their cryptic nature and the inability to measure their populations adequately without toe-clipping) puts them beyond the limits offsetting. This is because uncertainties within modelling parameters are considered too large. I agree that in the current case, the parameterisation of a BOAM is highly speculative at best. In addition, the BOAMs use only one attribute, namely relative abundance within ACOs. This is insufficient to accurately capture these elusive ecological values. At a minimum, the inclusion of metrics representing habitat quality would be additionally required to provide a more robust assessment. Finally, insufficient information has been provided by Alliance Ecology (2025b) to assess how multiple management interventions have been included in the model and whether the model parameterisation has been undertaken in an appropriate manner overall. Despite these concerns, I commend the applicant’s ecologists for providing indicative modelling, which can form the basis of structured discussion.

Alliance Ecology (2025b) indicates that offsetting actions are expected to offset approximately two-thirds of the lizard biodiversity value loss for Kawarau gecko and McCann’s skink, thus comprising an important part of their package for lizards. However, I believe that their parameters are unrealistic. For example, a 1.5× increase in relative abundance is expected by the Applicant at Ardour Station and in the mine regeneration zones where control of large mammalian predators to low levels will be undertaken, and rats and mice will not be controlled at all. Rats and mice are known to have substantial impacts on lizard populations; moreover, these predators can experience population booms in response to larger mammal control. The increase predicted by the Applicant is comparable to that recorded at the Mokomoko Dryland Sanctuary¹⁴ (2× increase), where all mammals, including mice, were entirely removed (Turner and Norbury, 2023). I consider that expecting similar responses at a site where rats and mice will be present, and where periodic entry of larger predators is likely to occur, is not realistic. Further, comparisons with Mokomoko Dryland Sanctuary are misleading due to the greatly different habitat in that area.

Proposed lizard salvage

There are considerable uncertainties and concerns in relation to the proposed lizard salvage. Namely:

- According to Alliance Ecology Ltd (2025c) *“it is considered likely that the minimum number of lizards salvaged will represent 10 – 30% of the individuals actually present”*. Thus, this work is likely to salvage only a small proportion of the population that occur within the impact footprint.
- Salvaged lizards will be placed into Ardour restoration area, not pest-proof sanctuaries¹⁵. As discussed in the section *“Management of Ardour restoration area”* in this report, I consider that

¹⁴ *i.e.* within the statistical error distribution of records at Mokomoko Dryland Sanctuary.

¹⁵ However, as per Alliance Ecology (2025a), nationally endangered salvaged lizards will be moved into the Bendigo Sanctuary.



salvaged lizards may receive limited benefit, particularly in the long term, as vegetation succeeds. No assessment has been made of critical microhabitat density in the restoration area¹⁶. The carrying capacity of the recipient areas have also not been assessed, although this may be reasonably expected to rise with predator removal.

Invertebrate salvage

I consider that the salvage of invertebrate species within this proposal is highly speculative. Overall, many of the shortcomings and uncertainties associated with invertebrate salvage are common with the salvage of plants, and I will not repeat these here. I have the following concerns specific to invertebrates:

- Release sites have not yet been identified, and suitable release sites will be identified “at least two weeks before starting salvage and relocation operations” (Habitat NZ, 2025a). I consider this timeframe to be too tight to ensure that adequate conditions are found or to enable plan adaptation if unexpected issues arise.
- It is unclear whether relocation sites will be within sanctuaries. Among other reasons, it is impossible to know the likely outcomes of this management for invertebrates.
- No discussion has been provided of the donor or recipient habitat. Invertebrates are highly dependent on microhabitat conditions. While Habitat NZ (2025a) names certain requirements these are too broad to ensure successful habitat selection.
- Inappropriate indicators of relocation success are provided. Plant survival rates are not necessarily tied to the relocation success of invertebrates. Further, detection of target invertebrates (presence/absence) does not provide insight into whether stable populations have established.
- The transfer of taramea is proposed to support invertebrate populations. As discussed above, it is highly unlikely that these plants will survive long enough to make a meaningful contribution to invertebrate populations, given that they have a substantial tap root.

No supplementary actions are provided in the likely event that salvages are unsuccessful.

Invertebrate habitat transfer

There are inconsistencies among reports regarding the plant species proposed to be moved for the purposes of supporting invertebrates. Habitat NZ (2025a) names taramea, fescue tussock, silver tussock, native broom (*Carmichaelia* spp.), and two species of *Olearia* (*Olearia bullata* and *O. odorata*). Most of these species are not mentioned for transfer in any other documentation, including the AEE.

Invertebrate studies

Captive breeding studies are proposed for the moth *Sporophyla oenospora*¹⁷ and the short-horned grasshopper (*Phaulacridium otagoense*)¹⁸. While studies of this type are needed in this rapidly evolving area, there is little evidence of benefit within the scope of this project and future benefit from this research is uncertain.

The programme for *Sporophyla oenospora* is poorly defined, with no clear effort estimates nor clear measures of success.

Lack of targeted management for invertebrates

¹⁶ This is a particular concern for tussock skink, a species with a high level of microhabitat specificity in arid areas of Otago.

¹⁷ Captive breeding study for *Sporophyla oenospora* will only be conducted if additional specimens are found.

¹⁸ A captive breeding/ relocation programme is identified for *Phaulacridium otagoense* in Table 2 of the Terrestrial Invertebrate Management Plan (Habitat NZ, 2025a), it is unclear what the details of this are, as it is not mentioned elsewhere in this document.



Overall, I currently consider it extremely unlikely that invertebrate values will benefit from the proposed management package. Table 26 of the AEE outlines expected biodiversity outcomes for biodiversity values. The column “Residual effects management measures” outlines the management actions that are intended to benefit that species. Notably, for all invertebrate species, this column has few details other than highlighting the general uncertainty regarding outcomes for invertebrates. I consider that more attention is required in these assessments to facilitate meaningful assessment of the effects management package. Further ecological context around invertebrate data, such as the consideration of community indices and the comparison with other studies and locations, would enable a more robust consideration of invertebrate values at the project site by the Panel.

I currently do not consider the management of the mine regeneration zone, Ardour rehabilitation area nor the two sanctuaries to be targeted towards benefits for invertebrates, despite levels of residual effects for many species being Moderate or higher. In these areas, management towards other biodiversity types may not be to the benefit of invertebrates. While predator control may provide some protection for invertebrates, I consider that all management for invertebrate values is speculative and that more targeted management is required to ensure No Net Loss.

3.4 Information gaps

Overall, gaps in information provided by the Applicant undermine certainty in the provided effects management package. I highlight several notable gaps that require addressing:

- Critically, there is no evidence as to whether the vegetation at the site is currently in decline. The Applicant’s proposed effects management hinges on whether this is the case.
- A more detailed delineation of vegetation communities. Current lumping of higher values with broader lower-value habitats means that their losses are not adequately addressed.
- Values assessments are required for non-vascular plant species, and for all concession applications. For example, values where roads are going, including the intersection on SH8, have not been provided (although habitat was identified as largely modified during the field visit).
- Baseline surveys are incomplete, noting that 2025 survey data for spring annuals have not yet been provided.
- It is unclear whether the relevant baseline used for depleted herbfield is the condition pre- or post-mining exploration. Exploration has been destructive at the site, affecting c.10 hectares including tracking. RMA Ecology (2025a) mentions that “*The baseline state is the current state of the site [...] except for impacts associated with the exploratory phase of the project which include earthworks, vegetation clearance, and the construction of roading and drill platforms*” but this requires clarification. I consider it important that this existing impact is adequately addressed.
- As discussed more generally in section 3.1 above, most assessments of No Net Loss are highly speculative and are unsupported. This is particularly concerning for lizards and rare and threatened plants and invertebrates.
- There is little clarity around the relevant contributions of various offsetting and compensation interventions to the overall expected outcomes, making this proposal challenging to assess nor discuss with any substance. Clear weighting is required to allow for discussion of whether the predicted outcomes of each intervention are realistic. In the case of values with BOAMs, these should be provided for review to assess whether the benefits of the various interventions have been parsed. Many additional values should be considered for BOAM modelling.
- Feasibility assessments or peer review of proposed effects management actions are appropriate, particularly for speculative restoration goals, such as the planting of unprecedented numbers of tussocks.
- The Applicant has not provided a detailed assessment of the values within the proposed conservation covenant uplift area, and how the removal of this area would impact the suite of values that the remainder of the conservation covenant provides protection for.



3.5 Recommendations

I have provided several recommendations throughout this document. In summary, I recommend that the following critical matters be addressed:

- Provide evidence that biodiversity is in fact declining within the impact and rehabilitation areas.
- The loss of protection over the entire proposed covenant lift area is assessed and effects duly managed.
- Long-term legal protection (such as covenant or transfer to public conservation land) provided for biodiversity gains. Long-term governance plan provided for all areas managed for biodiversity.
- The effects management package is re-adjusted to consider entire effect footprint, including all effect areas considered here (e.g. dewatering zone, area impacted by proposed sanctuary fences etc).
- Increased discussion/quantification is provided for indirect effects.
- A costing is required for all proposed effects management works to enable a feasibility assessment.
- Given the substantial reliance on predator management to address fauna effects, but the management of mice is not proposed, additional consideration of changing trophic dynamics of predators is appropriate.
- Delineations of habitats should be corrected to ensure adequate representation of value.
- Feasibility assessments for all translocations, particularly those for invertebrates which I consider to be experimental, is appropriate.
- Contingency actions are provided for experimental translocations that fail.
- Better descriptions of the current values for invertebrates.
- Justification should be provided for the placement of both sanctuaries as well as the Ardgour restoration area. An assessment ought to be made of which species that are affected by the proposal these areas may support.
- Additional targeted management for nationally and regionally Threatened and At Risk invertebrate species for which outcomes are currently identified as “Unknown”.
- \$5 million biodiversity and heritage enhancement fund should be tagged to specific projects. Its adequacy should then be assessed and likely increased to be commensurate to the biodiversity losses expected from the project.

4.0 Conclusions

Based on existing known values, I conclude that the currently proposed effects management package (including all actions to avoid, remedy, mitigate, offset and/or compensate) does not adequately address expected impacts to achieve No Net Loss of indigenous biodiversity. Effects management interventions are inadequate, although the degree to which the package falls short is not yet known due to substantial uncertainty. Substantial gaps exist in the current knowledge of both the biodiversity on-site and the likely outcomes of management interventions for many species, especially nationally and regionally threatened plant and invertebrate species. Knowledge gaps in this proposal are directionally biased, such that biodiversity values are likely to be underrepresented, while certainty in the outcomes of interventions is overrepresented.

Accordingly, I conclude that the effects management package is inadequate. Addressing the information gaps I describe would enable a more substantiated assessment of this effects management package. I consider that implementing the recommendations I provide would bring this package closer to No Net Loss, given the information currently provided by the Applicant.



Acknowledgements

I was greatly supported in the preparation of this document by other members of the project team, including employees of DOC as well as other consultants and parties, including Dean van Mierlo, Rogan Colbourne, Warren Chinn, Mandy Tocher, and Max Crowe. I also thank Marie Payne (DOC) for managing the project.

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