
UNDER The Fast Track Approvals Act (2025) (the Act)

IN THE MATTER OF Application FTA107 - Bendigo-Ophir Gold Project (BOGP)

BY MATAKANUI GOLD LTD

STATEMENT OF EVIDENCE OF GEOFFREY MALCOLM ROGERS - TERRESTRIAL ECOLOGY

DATE 2 April 2026

1. My name is Geoffrey Malcolm Rogers (Dr). I am a retired botanical and ecological researcher, previously with Manaaki Whenua-Landcare Research (now Bioeconomy Science Institute) and the Science & Research Division of the Department of Conservation.
2. My research and publications focus on: New Zealand's landscape history, especially the changes accompanying human settlement; the conservation of threatened plants and ecosystems; understanding trajectories of secondary vegetation with minimal intervention management, particularly depleted, open dryland ecosystems; and classifying Aotearoa/New Zealand's ecosystems.
3. I maintain research currency with ongoing contracts from District and Regional Councils and the Department of Conservation.
4. In relation to the BOGP, I have particular expertise in:
 - a. The ecology of spring annual herbs (the most threatened element of the DDF vegetation) and
 - b. The revegetation and enhancement of dryland plant communities. For instance, I have published on spring annuals and I provide strategic and operational advice and AGM guest lectures to all Central Otago's community revegetation trusts - Haehaeata, Mokihi and Te Kakano - engaged in rebuilding depleted dryland ecosystems.
5. Prior to my plant ecology career, I was educated and employed as a civil engineer.

Approvals sought:

6. In terms of the approvals sought and my field of expertise - terrestrial plant ecology - my statement relates directly to:

D.01 CODC Land Use Consents and Conditions, particularly the Land Use Consent sought to establish, operate, maintain, rehabilitate, and ultimately close an open pit and underground mining operation.
7. My statement is also relevant to the application to revoke the Conservation Covenant.
8. My statement does not provide a comprehensive assessment of ecological effects, rather it is primarily a review of the appropriateness and feasibility of the applicant's ecological restoration proposals.

Code of conduct and evaluation of independence

9. I have read and complied with the Code of Conduct.

10. Whilst I was originally employed by Manaaki Whenua Landcare Research, one of the Applicant's expert witnesses, that employment ceased 28 years ago. Since, I have had no professional or private association with any of the Applicant's ecological experts.

Executive summary

11. I have audited the following evidence of the Applicant's experts:
- a. B. 13A RMA Ecology Vegetation Values Assessment, which includes the Manaaki Whenua Landcare Research Applied Research Plan for the Conservation Management, Rehabilitation and Expansion of Cushionfield and its associated Proposed Spring Annual Herb Work Programme.
 - b. G.07A and B Alliance Ecology Landscape and Ecology Rehabilitation Management Plan and its Appendices in relation to D. 01 – CODC Land Use Consent and Conditions, with particular attention to amended Condition 111 – Mining of the Come-In-Time Pit.

B.13A RMA Ecology Vegetation Values Assessment:

12. The field survey of terrestrial botany and vegetation appears comprehensive and competent, with the caveat that survey information for spring annual herbs, particularly that for *Ceratocephala pungens* (Threatened – Nationally Critical) is incomplete. This represents a critical information gap and constrains judgement on the proposals for offsetting effects. I do support the methods and outputs of the vegetation classification and mapping exercise and the conservation value appraisal of individual plant species and vegetation types.

Manaaki Whenua Landcare Research Applied Research Plan for the Conservation Management, Rehabilitation and Expansion of Cushionfield

13. In proposing to rehabilitate in a like-for-like manner, 19 ha of degraded cushionfield within the DDF to offset that lost, the applicant's experts acknowledge there is virtually no existing research, knowledge or experience of management actions to guide establishing, enhancing and maintaining rehabilitated cushionfield. Landcare Research propose a research plan to guide that process. My audit of the plan highlights several conceptual and methodological shortcomings that will compromise its potential as a science blueprint for rebuilding the community. Moreover, the two techniques available to re-create that community - earthworks salvaging, storing and relocation of recovered turf and transplanting nursery raised *Raoulia* plants as the structurally dominant species – appear infeasible, even at experimental scales. Overall, I see no prospects for re-establishing a substantial area of the community within the DDF (G.02A 2.3.2) for what represents the compositional endpoint of a long history of ecosystem depletion from unsustainable rangeland farming. Establishing de novo, resilient renditions of this dynamically unstable ecosystem that is entirely the result of long-term vegetation depletion is highly improbable.

Manaaki Whenua Landcare Research's plan for researching threatened spring annual herbs

14. Laudable in its intent, I believe this research plan requires more robust consideration as the science platform for confidently offsetting loss of significant populations of threatened spring annuals within the DDF. Moreover, whilst I support the intent of Condition 111 of the CODC's Land Use Consent and Condition to delay excavation of the Come-In-Time Open Pit until a net gain is demonstrated in the status of spring annual herbs in the Dunstan Ecological District, the threshold trigger for delay is ecologically poorly defined and thus, imprecise and potentially contestable.

G.07A and B Alliance Ecology Landscape and Ecology Rehabilitation Management Plan and its Appendices

15. I have assessed the applicant's rehabilitation proposals over 35 years for terrestrial ecology and landscape values on the 500 ha of the re-engineered Direct Disturbance Footprint (DDF) in terms of certainty of outcomes, including attendant timeframes. This is mainly a like-for-like offset proposition for loss from mining. I have not audited the planned compensation investments in the wider Ecological Study Area (ESA) variously dimensioned at ~2200 and ~5400 ha. Nevertheless, some of the conceptual and methodological shortcomings I raise for ecological rehabilitation in the DDF have relevance to compensation investment in the ESA.
16. In summary, I have low confidence in the following vegetation rehabilitation models and the timeframes for their implementation:
 - a. Salvaging, storing and relocating live tussocks, *Raoulia* cushions, taramea (speargrass) and shrubs numbering in the many thousands, for instance 12,500 tussocks. Numerous environmental and engineering risks confound the chance of success.
 - b. Lenses of rock and soil as mitigation measures for the edges of the high wall benching of excavated pits. Soil erosion will undermine their function as plant colonisation sites.
 - c. Creation of c. 500 rock stacks and rubble pits as lizard and rare plant habitat in the DDF. Artificially creating lizard habitat de novo on engineered landforms has no best practice guidelines in a dryland mountain environment. Confidently predicting success is confounded by many problems, especially the year round provision of food and predator avoidance opportunities. Previous trials of engineered rock stacks as lizard habitat at the Macrae's Flat mine demonstrate the vagaries of completing the necessary experimental science required for confident lizard rehabilitation within a mining footprint.
 - d. Absence of a revegetation paradigm for dryland mountain slopes covering a c. 500 ha DDF. Insights from vegetarian rehabilitation at Oceana Gold's mine at Macrae's Flat and lowland dryland planting elsewhere in Otago attest to the implausibility of re-establishing of indigenous vegetation on 500 ha of engineered surfaces within a climatically stressed environment. Further, improbability surrounds the proposed scale of growing, transplanting and maintaining the millions of plants required for creating 220 ha of tussockland and 230 ha of scrubland.
17. In conclusion, I see substantial uncertainties surrounding successful establishment and long-term survival of translocated, ex-situ-sourced plants in this climatically and edaphically harsh environment on engineered surfaces. In addition, the unprecedented scale of planned ecological restoration for all four vegetation types, especially tussockland and shrubland appear entirely unachievable, even spread over two to three decades of planting. Finally, further risk surrounds the promised 35 year commitment to experimentally rebuilding a large dryland mountain slope by a company with no Otago ancestry.

B. 13A RMA Ecology Vegetation Values Assessment

18. This report describes the vegetation values within the Direct Disturbance Footprint (DDF) (610ha), and the Surrounding Landscape (SL) (5,386 ha) of the Bendigo-Ophir Gold Project (BOGP). While the DDF is heavily modified from its pre-human state - subject to 700 years of woody vegetation clearance and then pastoral farming for over 150 years - it contains very high ecological values and ecologically significant vegetation communities, along with 48 Nationally or Regionally At Risk or Threatened plant species. Four Nationally Threatened species are found

within the ESA, two of which are found within the DDF: *Ceratocephala pungens* (Threatened – Nationally Critical) and *Myosotis brevis* (Threatened – Nationally Vulnerable).

19. **Response:** Overall, this is a comprehensive appraisal of the terrestrial flora and vegetation using methods that I support for field survey and vegetation classification and assessment of ecological value. The botanical survey(s) appears to have been undertaken by competent botanists. However, I have strong misgivings with the completeness of surveys for the Nationally Threatened spring annual herb group. Access restrictions on the survey teams within parts of the ESA imposed by Ardgour Station due lambing in spring 2024 (not disclosed in B.08 and B.13A) and the late timing of surveys in relation to the species' life histories (disclosed) compromise reliable assessment of adverse effects within the DDF. Additionally, I suspect another important spring annual herb (in drylands), *Myosotis glauca* Threatened – Nationally Vulnerable, has been misidentified as the much less threatened *M. antarctica* subsp. *antarctica* or missed entirely in survey. Sparse populations occur within the adjacent Bendigo Historic Reserve (GMR personal unpubl. data).
20. While I have no substantial problem with the derived vegetation classification, I note the high frequency of shared plant guilds between the units and the high compositional variability within six of the seven units. This will render like-for-like remediation within the DDF quantitatively very difficult to achieve.
21. I also note that the numerous and partly contiguous network of Crown conservation reserves and covenants about the proposed mine site reflects the significant historic, landscape and biodiversity values across and beyond the proposed mine site.

B.16 Manaaki Whenua Landcare Research - Applied Research Plan for Conservation Management, Rehabilitation and Expansion of Cushionfield (Cushionfield ARP) (Landcare 2025)

22. As quantified in B.07A and B.07B (Alliance Ecology 2025), the earthworks associated with the BOGP will result in the destruction of up to 103.8 ha of mixed depleted herbfield (cushionfield) resulting in significant adverse effects. Cushionfields have high regional and / or national ecological values, mostly reflecting the declining state of *Raoulia australis* cushions and the presence of threatened, spring annual herbs. Condition 56 of the CODC Land Use Consent and Condition document stipulates that disturbance of the full 103.8 ha area of cushionfield is to be confirmed through detailed cushionfield monitoring and will be subject to the implementation and success of the ARP for cushionfield. In addition, the ARP for cushionfield details that 19 ha are planned for restoration in the DDF.
23. The Cushionfield ARP acknowledges that there is virtually no existing research, knowledge or experience of management actions that have established, enhanced and maintained rehabilitated cushionfield. Applied research is required to reduce the uncertainty and define and refine management interventions for like-for-like offsetting of that vegetation community. In response, Landcare Research (now Bioeconomy Science Institute) has developed the Cushionfield Applied Research Plan (ARP) for conservation management, rehabilitation and expansion of cushionfield and establishment of kōwhai groves within the DDF. They candidly recognise a knowledge void for this objective - "It is considered that independent reviewers could assist the outcomes of this ARP by generating additional ideas for management interventions."

24. Landcare Research (2025) recommends a suite of research/management actions to determine if the area and condition of herbfields and especially cushionfields can be rehabilitated and enhanced. These actions have six components that I comment on below:

6.3.1 ARP Component 1. Map the present extent and record the composition of the present cushionfields across the managed landscape.

- a. **Response:** Ground truthing of remotely mapped cushionfield vegetation with its spring annual component within the 5386 ha Ecological Study Area (ESA) would be an enormous undertaking spanning more than one year. This is partly due to the minute size and inconsistent annual appearance of all spring annual herbs, especially that of *Ceratocephala pungens*, the plant species of greatest ecological value and significance in the DDF (and ESA) (Rogers et al. 2002, 2005; Rogers & Overton 2007; Rogers 2024). The community is likely to be widespread on north-east to north-west aspects of drought-prone, degraded spurs within pastoral farmland of the ESA and throughout the wider Ecological District and Region. In terms of the scale of the exercise, detailed assessment of spring annuals within the 92 ha DDF involved 29 person days. Extrapolating to the 5286 ha ESA alone is anticipated to require multiple two-person teams deployed only during the six weeks of the plant's potential annual appearance, a task that will inevitably span several years.
- b. Further, a defensible census of *C. pungens* (along with *Myosotis brevis* and, desirably, *Daucus glochidiatus*) should span the entire Dunstan Ecological District. Just five viable populations nationwide are presently recorded of *C. pungens* and two of the three *most* viable were recently discovered in the central Dunstan Range during RMA and FTAA land use consent fieldwork (BOGP and Rocky Point residential subdivision).

6.3.2 ARP Component 2. Identify and document the management practices and pressures that lead to cushionfield expansion and contraction

- c. **Response:** Dryland cushionfields are concentrated on the north aspect of spurs for a predictable reason: their landscape history context is that they result entirely from a multi-decadel-long period of rangeland farming, involving deliberate vegetation burning, the absence of aerial over-sowing and topdressing (AOSTD) and sheep and rabbit preferences for warmer topography. Considerable loss of topsoil from wind and stormwater re-distribution has rendered the soils artificially thin, soil carbon-depleted and drought-prone. Compositionally and functionally, the ecosystem is the depleted endpoint of the sequential displacement of secondary scrub with short tussock grassland and finally with bare ground-dominated herbfield from exploitative farming practices. "Sheep-camp" is a colloquial term for hill-country dryland cushionfield. Thus, management other than the present rangeland farming practices would induce alternative vegetation states of greater and smothering biomass. Accordingly, there are no "current pressures on cushionfields" other than removing the farm stock and rabbits or artificially boosting nutrient states. Thus, this component seems conceptually flawed.

6.3.3 ARP Component 3. Develop a range of practical extensive and intensive interventions that have potential to enhance or extend cushionfield and other elements of the cushionfield mosaic. Design trials applying these interventions supported by a suitable associated network of permanent monitoring plots. Plus: 6.3.4 ARP Component 4. Implement restoration trials and establish the permanent plots

- d. **Response:** How can a substantially bare ground community, which is the degraded endpoint of retrogressive loss of vegetation biomass be enhanced by development of

“extensive and intensive interventions” other than plausibly continuing the present rangeland farming practices? Perhaps it is feasible to experimentally manipulate densities of farm stock and rabbits but quantifying testable (cause and effect) parameters of their influences seems improbable. Overall, I cannot see how trials and monitoring plots can be designed and enacted to elucidate the long landscape history and nuanced complexity of farming practices controlling the community. Enriching the community with rare spring annual herbs might constitute enhancement but that is experimentally a highly problematic ask for species with largely unknown autecologies (see further comments on Appendix 3 below).

6.3.5 ARP Component 5. Develop methods for *Raoulia* propagation and establishment of new populations of *Raoulia* cushion species and identify methods that are unsuccessful [sic]

- e. **Response:** I have three comments on this research component:
- i. Yes, it is possible to nursery-propagate *Raoulia australis* and *R. beauverdii* – the physiognomic cushion dominants of dryland cushionfield – but successfully planting them in the wild to function as the structural dominants of a reconstituted upland, dryland, cushion herbfield is likely to have little chance of success. Two attempts to wild plant *R. australis* from propagated material have failed in Central Otago at small and intensively managed scales (Kate Wardle pers. comm.). Moreover, maintaining the predominantly bare ground surface of the community on steep dry hillslopes (engineered or natural) for planting or seeding to meet the species’ specialised habitat requirements will be extremely challenging. A greater physical challenge will be creating and maintaining the substantial bare ground component of cushion herbfield. It could be engineered by surface scraping or raking but applying those techniques at scale maintaining it seems impractical. Further, the unconsolidated surfaces will be prone to stormwater erosion and weeds. Indeed, intense physical removal or herbicide control of weeds will secondarily be required on what will be weed-prone substrates. Farm stock might be seen as a practical disturbance agent for bare ground surfaces but maintaining high densities will require substantial offsite supplementary fodder. Applying any of those bare ground disturbance processes to surfaces supporting *Raoulia* transplants without co-lateral damage seems infeasible.
 - ii. The slow centrifugal expansion, fragmentation and migration of *Raoulia* cushions will require trials over many years to performance measure population outcomes for the species’ prostrate cushion architecture.
 - iii. The intensity of experimental treatment means the trials will inevitably be at small scale (10s of m²) and have questionable potential as a solution to offset the destruction and rebuilding of at least 19 ha of this vegetation type in the DDF.

6.3.6 ARP Component 6. Trial methods to protect and replant genetically diverse *kōwhai* treeland and shrubland areas within the cushionfield mosaic

- f. **Response:** I cannot understand why this is part of an “applied research plan”. Propagation and planting of *kōwhai* is an established practice by agencies engaged in dryland ecosystem restoration. In prehuman times, *kōwhai* was naturally, a steep terrain and rock outcrop species with today’s isolated secondary trees occupying sites once the

preserve of taller prehuman forest (competition release from forest removal fosters an expanded niche). Moreover, as a highly palatable species to possums, rabbits, hares, feral ungulates and farm stock, protecting transplants in the wild at scale will be extremely challenging. Each grove will require leak-proof lagomorph, possum and ungulate enclosure fencing. Moreover, attempting to infuse the summer-dry hillslope pavements that support cushionfield with treeland groves of kōwhai (a) denies the species' prehuman habitat, (b) fails to acknowledge the incompatibility of maintaining a browse intolerable tree species within cushionfield that requires high densities of farm stock for habitat regulation and (c) avoids using far more amenable habitat such as scrubland on moist aspects as a nurse host for enrichment planting.

25. In summary, the ARP to guide the establishment and enhancement of *Raoulia*-dominant cushion herbfield:

- a. Has questionable conceptual rationale because the community is a degradational endpoint of long-term extractive farming practices - burning, grazing and nutrient depletion of dryland soils over many decades.
- b. It will be launched de novo as a research initiative in the most environmentally difficult setting for this vegetation type in dryland Otago – basin and valley floor examples might be more amenable for experimental investigation.
- c. Even if an artificial semblance of the community is created by horticultural techniques, it will require contrived disturbance forever as a surrogate for the critical role of farm stock and rabbits to maintain it.
- d. A seven year timeframe is planned, however, I foresee much more being required because semi-woody dryland cushion plants have inherently slow growth rates and the research programme will need periodic review and adaptive management adjustments.
- e. If a best practice paradigm results, it has a very low chance of successful implementation on the man-made or engineered landforms and soils of the DDF. Their lack of landform and soil cohesion, the artificially high nutrient states from earthworks, the inherent weediness of new pavements and their erosion proneness on steep slopes will compromise implementation.
- f. Selecting performance or success measures for the experiment will be problematic: translocated *Raoulia* plants may survive but selecting and quantifying more robust and meaningful measures of ecosystem health and integrity – soil microbiology, plant species recruitment and turnover, insect food webs, etc. – will be an impossibly complex but necessary challenge for like-for-like auditing.

26. Finally, putting aside my reservations that the ARP can provide a meaningful science platform to guide the practice of creating resilient cushionfield on new soil surfaces, I want to comment on the doubtful goal of re-establishing 19 ha of the community within the DDF (G.02A 2.3.2). Two techniques are available to lay the foundations of new dryland herbfield on an engineered surface: 1. Earthworks salvaging, storing and relocation of recovered turf, and, 2. Transplanting *Raoulia australis* (and other structurally important species) from nursery raised plants. Both approaches seem technically infeasible:

- a. Earthworks: I view the salvaging, storing and placement of intact *Raoulia*-dominant turfs as physically impractical: i) the species can have 2-m-deep networks of fine roots

(McIndoe 1932), and ii) present hillslope soils derived from loess and schist colluvium have low cohesion and will crumble with disturbance.

- b. Transplanting *Raoulia australis* (the species defines cushionfield) even at a low density of 1 m⁻² over 19 ha involves 190,000 potted plants, numbers expected to be beyond even the combined resources of a regional pool of plant nurseries. Recognising that two previous trials at wild planting *R. australis* were unsuccessful, 190,000 will be a substantial under estimate. Further, the large bare ground component of cushionfields maintained by environmental stress (climate), nutrient impoverishment and erosional disturbance by grazing animals and stormwater scouring are disturbance factors entirely incompatible with revegetating bare pavements in transplanted herbs.

27. In conclusion, the high ecological value of the cushionfield community reflects more its threatened, spring annual herb component than any inherent ecosystem value, particularly resilience while under a land use of minimum intervention management. Remove the key maintenance driver, pastoral farming and rabbits, and the community will eventually transition to a far more sustainable woody composition as has occurred with advancing grey scrub and kānuka scrubland and forest in the broader landscape. For instance, about 80 years of no fires and light farming use has seen the entire adjacent Bendigo Historic Reserve transition from mainly herbfield and short tussocks to a dense woody cover (refer sequential historical imagery in Retrolens.co.nz). To summarise, I believe an ARP for cushionfields is conceptually flawed in expecting artificial experimental techniques to emulate or recapitulate the degrading effects of decades of burning and grazing on the vegetation and soils of drought-prone hillslopes. Creating from scratch, resilient renditions of this inherently unstable ecosystem that is entirely the result of long-term vegetation depletion seems quite improbable.

Appendix 3 – Proposed spring annual herb work programme

28. The proposed cushionfield research has an integrated research project on spring annual herbs. Threatened spring annual plant species occur sporadically within the degraded cushionfield community and a great deal of survey effort documented their presence within the proposed DDF. I have comments of a general nature, only, of the rationale for this mahi and its four key questions of what is likely to be an extensive and challenging research programme:
29. Experimental research on the spring annual guild is an entirely novel proposition, perhaps because they have an anomalous suite of life history traits and ecologies in relation to those of the remaining NZ vascular flora. There is little to no quantifiable understanding of the physical processes driving their bare ground, micro-habitat requirements, particularly the magnitude of environmental stress factors (temperature, moisture, soil physics and soil chemistry) and the disturbance factors that dynamically maintain them against the competition of taller plants. There are no research paradigms from which to intuit testable hypotheses of the key drivers and their hierarchical relationships that regulate the guild's survival and the nuanced differences of the various species. Thus, there appears to be just secondary recognition, only, (focus on *Ceratocephala*) that spring annuals are a taxonomically and ecologically diverse group of species. Yes, they appear for just 6-8 weeks annually but they occupy very small (mostly <1%) proportions of often, extensive, ostensibly suitable habitat at each site, sometimes together, sometimes individually and then inconsistently, year to year.
30. It is claimed that spring annual populations are in decline in Central Otago. However, there is evidence of a more nuanced situation in terms of their conservation states. Inconsistent annual appearances of species, lack of species-specific search effort in their 6-weeks of annual appearance, lack of botanists with the necessary identification skills and rapidly improving field

knowledge all compromise reliable claims of conservation status.¹ I note that two of the three strongest *Ceratocephala* populations were discovered within the last two years during field surveys for RMA and FTAA consent applications (Wardle 2025; Wildlands Consultants Ltd. 2025; Manaaki Whenua Landcare Research 2025). Accordingly, conservation status can be related to search effort and much of their potential Central Otago mountain habitat lacks deliberate mid-spring survey.

31. I have comments on the four key questions of the package:

Key Question 1 – What is the environmental niche extent of these spring annuals?

- a. While I support the question's intent, their "targeted systematic survey" to document the "environmental niche" of individual species mainly from observation is impossible. Understanding and dimensioning environmental niche space is a considerable ask for species vegetatively alive for 6-weeks per year and seed-dormant in the soil for the remainder. Environmental drivers will involve temperature, moisture and disturbance extremes, their interplays and dynamic soil properties. A high degree of botanical and ecological expertise will be needed for even survey effort in the ESA (~5300 ha) and possibly further afield over probably many years to, at best, generate hypotheses of the species' niche drivers². Selecting for priority experimental manipulation, the ecosystem processes regulating the patchiness of individual species will be very difficult. Hierarchical relationships of the key processes will be almost impossible to predict and experimentally process. Further, as this question underpins questions 2 and 4, determining environmental niche in relation to techniques suitable for habitat management seems technically infeasible.

Key Question 2 – What management will ensure existing populations persist (and expand locally)?

- b. Spring annual herbs occur in non-forest ecosystems that result from extreme environmental stress and/or land use disturbance that selects for much bare ground with sparse, low stature herbaceous plants. In the ESA, heavily degraded sheep, cattle and rabbit 'camps' provide their only habitat. Accordingly, I cannot see how management of farm stock and rabbit densities and their impacts can be experimentally embraced.

Key Question 3 – How to maximise seed number and viability of *Ceratocephala pungens*? What pollinates these species, and will increasing pollination increase seed production?

- c. I support this objective but I suspect it involves research well beyond a single factor - species' pollination ecology. Indeed, field observation suggests seed viability does not limit population perpetuation. The species' biological performance needs a wider gambit than pollination as an explanation for why populations disappear when herbivorous animals are removed from its sites.

Key Question 4 – How can new sub - populations be established?

- d. I support this question and the planned experimental approach. However, I note that my two recent attempts to deliberately re-seed *Ceratocephala* into sites from which it has disappeared, one in Central Otago and one in the Mackenzie Basin, have been unsuccessful.

¹ For instance, my survey effort in spring 2025 discovered eight previously unknown populations of the several spring annual *Myosotis* species and *Myosurus* across the upper Clutha/Mata au valley. I uncovered virtually countless subpopulations at each location, with individual plants numbering in the thousands (report in prep. for DoC).

² 19 ha of cushionfield within 92 ha of depleted herbfield required 29 person days of search effort within the DDF in spring 2025.

Timing of excavation of the Come-In-Time (CIT) Open Pit:

32. Condition 111 (Amended) of D.01 CODC Land Use Consent and Conditions specifies mining of the 23.26 ha CIT pit will be delayed for a 20.56 ha area on condition that “sufficient numbers of spring annuals are discovered in the wider Dunstan Ecological District [DED] such that either net gain outcomes can be demonstrably achieved, and/or the population of the two spring annuals within the CIT Open Pit footprint recorded in 2025 is \geq <1 % the known population of these spring annual plants in the wider DED”. Whilst I support the intent of the Condition, I have several crucial concerns with the prescriptive imprecision and, thus, uncertainty of the \geq <1 % threshold for spring annuals:
- a. Does the net gain and/or <1 % threshold apply to each individual species or the group as a whole, in which case the conservation status of the less Threatened species (*Myosotis brevis*) will be unrepresentative or inappropriate for the most Threatened (*Ceratocephala pungens*)?
 - b. Does the threshold apply to numbers of plants and/or populations/sub-populations of one or both species because population number and trends are superior metrics of conservation status and ecological viability than plant numbers?
 - c. Population and habitat perpetuation of spring annuals is very much dependent on the land use situation – particularly rangeland pastoralism for *Ceratocephala pungens*. The Applicant has no influence, bar advocacy, for land use management beyond the ESA section of the DED for potentially newly discovered populations.
33. Concluding comment: The Spring Annual Research Plan as part of the cushionfield ARP appears to have substantial conceptual and methodological shortcomings. Laudable in its intent, it requires more robust thought as the science platform for confidently offsetting loss of significant populations of spring annuals within the DDF. And, whilst I support delaying excavation of the Come-In-Time (CIT) Pit contingent on discovering more populations in the greater DED, the threshold population trigger of \geq <1% represented by the DDF populations of spring annuals is poorly ecologically dimensioned and requires refinement.

G.07A Landscape and Ecological Rehabilitation Management Plan (LERMP)

And G.07B Landscape and Ecological Rehabilitation Management Plan

Appendices

34. The two LERMP documents guide the ecological rehabilitation of the mine footprint within the Dunstan Mountains Outstanding Natural Landscape (ONL) by (as stated) establishing a mosaic of natural ecosystems, enhancing habitat diversity, and supporting native species through strategic revegetation within a reinforced conservation setting.
35. I have structured my audit comments around several rehabilitation themes rather than referencing multiple, specific parts of the documents’ combined 220 pages.

Earthworks salvaging, storage and placement of vegetation sods

36. There are various rehabilitation undertakings to salvage, store and relocate live tussocks, *Raoulia* cushions, taramea (speargrass) and shrubs numbering in the many thousands, for instance 12,500 tussocks. Numerous environmental and engineering risks confound the chances of success.

37. Climatic extremes will subject the sods to a host of unavoidably damaging stresses:
 - a. Desiccation from wind ablation and summer drought.
 - b. Winter frost-heave will induce freeze-thaw fragmentation.
 - c. Rainfall, stormwater and supplementary watering in summer will fret and erode soil and its attendant plants.
38. Earthworks will:
 - a. Destroy the fragile cohesion of hillslope soils derived from schist colluvium and loess on steep terrain.
 - b. Fragment root masses or boles, particularly around the margins.
39. Machinery operations will damage more in-situ vegetation than the targeted plants. Machinery footprints and impacts will be exacerbated by the steep terrain and small-scale network of valley catchments.
40. Multiple relocations of the stored sods as the mine and tailings footprints expand will induce cycles of damage.
41. Storage for up to 10 years will:
 - a. Smother and destroy more in-situ ecological value as that represented by the targeted plants – soil microbial communities, vascular and non-vascular plants, invertebrates, avifauna and lizards.
 - b. Foster weed invasion within the competitively weakened resident vegetation and the fragmented margins.
 - c. Disrupt plant reproductive cycles, particularly wind and insect pollination relationships and mast seeding events.
42. Emplacement within engineered hollows or pits will:
 - a. Subject plant roots to different soil physical structure and nutrient states. Soils will be both excessively well-drained at depth and have artificially compacted surface densities from machinery.
 - b. Soils will be bereft of fungal associations recognised as critical for survival of some montane vascular plants.
 - c. Plants will have increased weather exposure despite attempts to engineer microtopographic variation.
43. Furthermore, translocation trials of alpine tussocks and megaherbs using earthworks techniques has been unsuccessful at the Remarkables and Cardrona ski fields (N. Simpson and A. Cleland pers. comm., respectively).

Salvaging and stockpiling of topsoil, rock stacks, boulders, weathered rock, and coarse wood for subsequent relocation into ecological rehabilitation sites within the DDF

44. My comments on the co-lateral damage and destruction of in-situ ecological values from salvaging and storing vegetation sods apply equally to the salvaging and storage of soil and rock material.

Mitigation measures for the high wall benching of excavated pits

45. Where benches of the high-walled, excavated pits meet natural ground, it is intended to create 20 m-long wedges of brown rock rubble and soil along the bench step (G.07B: P57). The expectation is that native plants will colonise the soil component of the rubble wedges. However, I have no confidence of unaided revegetation occurring before the emplaced soil erodes away from these highly exposed benches. The soil will lack cohesion and will be readily dispersed by rain, stormwater and wind.

Creation of rock stacks and rubble pits as lizard and rare plant habitat in the DDF

46. Post-mining rehabilitation of lizard habitat is planned. About 500 engineered rock stacks (and extra rubble pits) are intended for 500 ha ($\sim 1 \text{ ha}^{-1}$) of the DDF as potential lizard habitat. The formation of natural rock habitat for lizards is a millennial-long or geological time-scale process of weathering of selective minerals within exposed schist bedrock, some accumulation of colluvium and soil and occupation about the outcrops by generalist and rock-specific plant species. A reliable understanding of the key habitat functions for lizards of thermo-regulation, predator avoidance, population density required for reproduction and food provision from insect food webs and the nectar and fruits of some plants are likely beyond quantifiable scientific methodologies. Attempting to artificially engineer similar structures for a suite of lizard species, both the specialist rock and matrix grassland species even at the low density of 1 ha^{-1} , is a highly experimental endeavour; this is partly acknowledged in the planned, staged review process for identifying and measuring success criteria.
47. Creation of engineered lizard habitat via rock stacks was notionally trialled in association with OceanaGold Ltd. at Macrae's Flat, east Otago (Rufaut 2021; D. Pillai pers. comm.). In the first trial at Camp Creek, baseline monitoring of *in-situ* lizard populations within tussockland and shrubland vegetation surrounding schist outcrops occurred for two years and engineered rock stacks were installed. However, a change in land use by the mining company (reintroduction of cattle grazing) led to the trial's abandonment. In the second trial, large waste rock tors were erected using diggers but the trial fell victim to an unforeseen expansion of the mine footprint. Furthermore, thousands of salvaged geckoes died in captivity.
48. Fundamental to conceptualising and planning the creation of rock stacks as lizard habitat is the recent research of Aitken et al. (2025) undertaken at the Macraes Flat mine. This formative study characterises and quantifies the geological features of schist rock outcrops that host rock-dwelling lizards (not referenced in G.07A and B). The macro- and microhabitat features defined in the study can be used to assist with predicting the most favourable sites for the location and conservation of lizards that depend on schist outcrops across Otago. Two widespread species within the DDF and ESA, McCann's skink and the Kawarau gecko, are known to have strong association with schist outcrops.
49. Outcrops found to favour higher lizard utility are 2–4 m wide and ≤ 3 m high, with narrow, wedge-shaped, sub-horizontal cavities within ledged-crevices that have an opening height ≤ 6 cm, depth greater than 5 cm (preferably < 30 cm), and location within 1 m from the top of the outcrop, capped by a psammitic slab on top of a pelitic layer. Most importantly, the distal, wedge-shaped ends of cavities (< 8 mm deep) are critical for thermo-regulation and avoidance of

mouse predation. Immediate matrix vegetation of mixed native tussocks and divaricating shrubs is also of fundamental importance.

50. Inevitably, salvaged rock will fracture along its differentially erodible, weaker pelitic layers, hence destroying the critical lizard shelter component of slabs. Attempting manufactured creation with machinery of the wedged-crevices as an inter-slab feature will be haphazard and unquantifiable. Trials of manufactured rock stacks at the Coronation Project at Macraes Flat partly created horizontal crevices but did not form the critical micro-dimensions for lizards and were “frequently open to wind, rain and potential mammalian predators” (Rufaut 2021). Furthermore, some lizard species rely on inter-tor movement for persistence (Aitken et al. 2025). At a proposed density of 1/ha in the DDF, the manufactured rock stacks will far exceed the likely minimum densities required for spatial population dynamics. Inter-tor movement will be dependent on a more or less continuous cover of matrix native vegetation but little weight can be given to the likelihood of its re-creation in vegetation remediation - see para 51 and 54.
51. Also planned is the establishment of native plant nodes in the vicinity of rock stacks, partly to provide insect and plant fruits as food for lizards. For this, salvaging of 12,500 live tussocks equating to 1.25 ha in total area is planned, along with some taramea (speargrass) and porcupine shrubs placement. I have no confidence of achieving establishment success for all three plant types in the steep, engineered rendition of their original habitats across the DDF. For example, attempts at relocation of montane tussock sods along the Remarkables skifield road were unsuccessful (N. Simpson pers. comm.) and limited success resulted from experimental attempts at Macraes Flat mine (Rufaut 2021).
52. Additionally, 37 native plant species are planned for propagation and transplanting about the stacks. For at least 50% of the 37, there are no propagation and wild planting paradigms for what are highly, niche-specialised species. Some like the four species of *Pimelea* pose difficulties even as garden amenity species suggesting they will be challenging vegetation restoration propositions on an exposed mountainside.
53. Additionally, predator pressure on relocated lizards across the DDF following rock stack and rubble pit creation could only be effectively and efficiently deflected by non-leaking enclosure fences that are not planned.
54. Perhaps the most significant shortcoming of the plan is the uncertainty of rehabilitating extensive tussock and shrubland vegetation within a short timeframe of integrity sufficient to provide year round, multi-species (two skinks and a gecko) food resources. All the plant establishment uncertainties associated with this uncongenial environment make confident predictions of lizard reintroduction and survival impossible. In other words, achieving widespread and dense rehabilitated tussock and shrubland vegetation that can provide year round food resources for skinks and geckos has a very low achievement probability. Predicting outcomes for quality lizard habitat is further confounded by the absence of science models linking dryland vegetation composition with the provision of lizard food resources.

Ecological rehabilitation lessons from Oceana Golds’ Macraes Mine, east Otago

55. I have consulted Dr. Mike Thorsen, Oceana Gold’s key consultant for ecological remediation at their Macraes Flat mine. Revegetation of the veneer of surface soil on engineered landforms is mostly via hydroseeding of exotic pasture grasses. The rationale for pasture grasses is mainly because the rural community prefers that composition and revegetation outcomes using native plants on the upland plateau landscape experiencing an exposed montane climate cannot confidently be predicted, even at the small and unrepresentative scale of their past trials. In terms of a RMA mitigation hierarchy for lost native tussockland and shrubland vegetation, rather than like-for-like offsetting, there is reliance on offsite compensation via investment in improving

aspects of rare ecosystems. Investment can be via weed control and reintroduction of threatened plants, particularly within ephemeral wetlands. The company's predominantly compensation strategy for loss has evolved from 35 years of adaptive management in a physical environment rather less challenging than the steep, exposed and drought-prone environment of Thomsons Saddle.

56. Over time, the local Government regulatory setting has evolved to increasingly focus on no net loss but that challenges the scientific understanding of the full gamut of ecosystem properties. Quantifying these beyond numbers of plants into functional areas such as soil microbial health, nutrient states and animal food webs, especially their predator-prey relationships requires sustained investment in ecological research mostly furnished by Government science agencies. To reiterate, knowledge deficits on enacting strict like-for-like equivalence, mean compensation is preferred over offsetting, where loss of say 40 ha of tussock grassland is compensated for by covenant protection of a much greater area within the ecological district.
57. While native shrubs and tussocks might be planted at Macraes, the likely low survival and slow growth rates at that altitude mean 30—50 year and longer timeframes will be required for a planted community to approach that of an equivalent natural state. Moreover, replanted short tussocks are difficult to manage for natural values because of their boom-and-bust growth performance and weed proneness, resulting in a recommendation to attempt small areas, only (cf. an undertaking of 220 ha that contains at least 20% tussock for the BOGP).
58. Further risk attends the mine footprint expanding across areas of previous compensation investment with the ongoing search for and discovery of mineral resources.

Difficulty of meeting like-for-like offsetting goals within the DDF

59. Achieving like-for-like offsetting equivalence of the destroyed vegetation communities of the DDF on re-engineered landforms poses conceptual challenges around ecosystem composition and function way beyond placing excavated and nursery-raised plants within bare pavement. I refer to the complex and nuanced, ecosystem processes - nutrient cycling, energy flow, pollination, reproduction and animal food-webs (both below and above ground) - of a natural ecosystem. "Mixed tussock shrubland and exotic grassland", "Mixed scrubland", "Native-dominant tussockland", "Native taramea herbfield and shrubland" are all compositional mosaics with complex interwoven processes that change at scale over time. The present small scale and dynamic, mosaic composition creates complexity in landform creation and planting likely to be technically infeasible to approximate and report on. Further uncertainty accompanies the likely unpredictable vegetation trajectories of the novel landforms created by earthworks.

Absence of a revegetation paradigm for dryland mountain slopes

60. At ~500 ha, the scale of planned restoration of native vegetation within the DDF involves:
 - a. 222 ha of indigenous tussockland that contains at least 20% tussock cover.
 - b. 230 ha of Indigenous woody scrubland.
 - c. 19 ha of cushionfield with an increased number of sub-populations of the three spring annual herb species.
 - d. 2 ha of taramea herbfield and shrubland.
61. The north-western flanks of the Dunstan Range represent uncharted environmental territory for vegetation restoration. Restoration of native vegetation by commercial and voluntary agencies is widespread in Aotearoa New Zealand, no more so than in Central Otago. However,

almost all native revegetation work done by community trusts in Central Otago targets lowland, basin and valley floor and lower hillslope terrain. Central Otago's seasonal climatic extremes of freezing winters and droughty summers dictate revegetation be confined to the most sheltered lowland sites. Furthermore, almost all transplants other than grasses and sedges - lianes, sub-shrubs, shrubs and trees - require enhanced microclimatic protection from framed and staked shade cloth surrounds, combined with mulch topdressing and, commonly, irrigation. Survival of transplants requires ongoing maintenance, particularly weed suppression for three years minimum. All plantings require protection from herbivores such as rabbits and feral ungulates. Success in the first three years is measured more by survival than growth rates because transplants physiologically invest in root establishment ahead of growing arboreal tissue. The resources commanded by plant nursery production, out-planting and maintenance effort inevitably limits each agencies' yearly investment to <2 ha of coverage. Thus, I estimate that the total area annually revegetated across all of Otago is a very small fraction of the 500 ha planned for the DDF.

62. To emphasise, dryland montane hillslope environments (equivalent to that of the DDF) are deliberately beyond the purview of Central Otago's revegetation agencies.
63. Yes, one large scale revegetation project is underway in the Wakatipu basin using predominantly mountain beech on a Coronet Peak mountain-slope in a reliably moist, deep soil environment. The prehuman forest composition as a guide to revegetation goals and objectives can be confidently predicted there. However, the project's environmental and methodological relevance to an interior Otago environment is distant. In addition, the degree of ecosystem transformation/degradation since human arrival is far greater in dryland Otago than in the humid west, meaning restoration goals can embrace a semi-climax forest in the wet west vs being limited to early secondary communities in the dry interior.
64. Another apparently insurmountable issue attends the number of nursery-sourced plants required to achieve the predicted coverage of the various vegetation types in the DDF. For 220 ha of short tussock grassland at 20% coverage, at least one tussock per m^{-2} is required (100% coverage would require c. 5—10 m^{-1}). Thus, 2,200,000 are required; that equates to 110,000 per annum if spread over c. 20 years, a quite unimaginable number for nursery production, out-planting and compounding maintenance alongside all the other planned ex-situ plants.
65. While a multi-decadal rehabilitation period is planned, designing a long-term monitoring framework encompassing robust measures of ecosystem health and integrity beyond numbers of plants is another scientific challenge in the absence of established practices.
66. Accordingly, I believe the lack of a revegetation paradigm for the uncompromising environment of the western Dunstan Range prevents the applicant from confidently predicting any measure of environmental remediation success. If the predominant revegetation paradigm of exotic pasture grasses used at the Macrae's Flat mine is adopted for the DDF of the BOGP, the landscape will change from the present brown and grey hues with landform textural variety to a bright green vegetation matrix surrounding engineered rock outcrops.

Challenge of rehabilitating compositionally-specialised vegetation communities

67. Previously, I have dealt with the risks associated with undertaking the restoration of 19 ha of cushion herbfield. Also included in the DDF rehabilitation proposal is 2 ha of taramea (speargrass) herbfield and shrubland. It is widely accepted by the landscape ecology, science collective that taramea herbfield is another localised hillslope community resulting from spring burning and immediate stock grazing of taller, secondary vegetation such as scrub and tussock grassland. It is quintessentially an indicator of replacement of fire-intolerant woody plants and

tussock grasses with a fire-tolerant and unpalatable (sharp spines) megaherb. Alongside dryland cushionfield, the community is a symptom of degraded pastoral rangeland. In terms of revegetation prospects, taramea is a deep, tap-rooted species, a life trait that will handicap earthworks relocation attempts due to its intolerance of root disturbance. As a nursery-raised species it has a short life span when planted as a garden amenity. Additionally, there is no revegetation paradigm for the species within revegetation agencies. Again, putting all the earthworks and propagation challenges aside, 2 ha of restored taramea herbfield with scattered shrubs seems a very high risk and impossibly large restoration undertaking on engineered surfaces of an exposed dryland mountain-slope.

Summary comment

68. In summary, considerable risks attend the plan to rehabilitate ~500 ha of engineered landforms and soils in native vegetation within the DDF. Conceptually and methodologically the plan presents as an uncharted proposition, a prototype demanding a long and flexible period of plot-based trials driving adaptive learning rather than confidently predicting de novo reconstituted ecosystems. Even small-scale approximations to the compositionally diverse secondary plant communities (mixed grasses, herbs, shrubs) obliterated in the DDF will require a multi-decadal commitment to experimental research at trial size, spatial scales. Even then, I have low confidence that an adaptive paradigm to tolerate the environmental stress will emerge based on the lessons in vegetation rehabilitation over 35 years at Oceana Gold's Macraes Mine. There, exotic grass pasture is relied upon to revegetate engineered landforms. Insights from the restoration of dryland vegetation by Otago community trusts that focus entirely on the lowlands, reinforces my judgement that revegetating the DDF surfaces is implausible. A further risk to a long-term experimental investigation of rebuilding a large dryland mountain slope is the expected 10-year life of the mine by a company with no Otago ancestry.

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