Before the Independent Hearing Panel

In the Matter	of the Resource Management Act 1991 (**RMA**)
And	
In the Matter	of an application to the Central Otago District Council and Otago Regional Council for resource consent to establish and operate a gold mining activity at 1346 – 1536 Teviot Road, Millers Flat
Reference	RC230325 (Central Otago District Council) RM23.819 (Otago Regional Council)

Evidence of Dr Barrie John Wills on behalf Hawkeswood Mining Limited

(Botanical Ecology)

Dated 29 April 2024

Jeremy Brabant

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Introduction

1. My full name is Barrie John Wills. I am a Principal Scientist consulting as Central Environmental Services since 2004, based in Central Otago. I hold the qualification of Bachelor of Science in Plant Genetics (Hons) from Canterbury University and a Post-graduate Doctorate in high country revegetation enhancement, utilising symbiotic mycorrhizal inoculation.

2. I have 44 years' experience in the management of indigenous/exotic vegetation and land-related issues in the South Island hill and high country. I worked extensively for Landcare Research and AgResearch, before working for my own consultancy. I have been involved in a multitude of projects, including tenure review; alternative dryland protection methods; soil conservation and shelter, preparation of comprehensive botanical, ecological and environmental reports for tenure review negotiations, resource consent applications, for market compliance and risk management purposes, and field data collection and processing for on-farm, regional/local planning and development purposes.

3. Prior to my time at Landcare, I worked as a plant materials scientist in the Water and Soil Department for the Ministry of Works. My research covered plant breeding, selection, establishment and management of herbs, grasses, shrubs and trees for dryland revegetation, soil conservation, fodder banks and shelter purposes. Trials were established and conducted on many high-country properties throughout Central Otago and the Mackenzie Country (for example, on Black Forest, Haldon, Grays Hills, Glenbrook, Otematata, Bendigo, Earnscleugh, Moutere, Galloway and Beaumont Stations) and in Marlborough.

4. I am currently an editing referee for: NZ Journal of Agricultural Research; NZ Journal of Botany; Plant and Soil; Journal of Environmental Management; and Journal of Restoration Ecology (USA). In total I have authored or co-authored some 54 scientific publications, plus numerous popular articles, and provided refereeing and external examiner services for relevant Canterbury and Massey University theses.

5. I was a Guardian of Lake Wanaka (2009 – 2019), a CODC Community Board & Councillor Elected Member for 4 terms from 2008 and remain a long-term member of the NZ Association of Resource Management, the NZ Plant Conservation Network, and the NZ Grassland Association.

6. I am a Board member of the Roxburgh Gorge Trail Charitable Trust and a Director of the Central Otago Clutha Trails Company.

7. I currently work directly with a number of high country runs in relation to vegetation monitoring and district planning applications involving clearance or development of indigenous vegetation areas, predominantly within the Central Otago District Council, and Mackenzie, Ashburton and Selwyn District Council jurisdictions.

8. I was instructed by Hawkeswood Mining Limited in March 2024 to provide information to aid in the identification, assessment, and management of botanical/vegetation biodiversity and associated ecological aspects relevant to the proposed mining site located on the Teviot alluvial flat. I am familiar with the area to which the application for resource consent relates. I am familiar with the site surrounds and have visited the site specifically 3 occasions, most recently on 18 March 2024.

9. Although this is not a hearing before the Environment Court, I record that I have read and agree to and abide by the Environment Court's Code of Conduct for Expert Witnesses as specified in the Environment Court's Practice Note 2023. This evidence is within my area of expertise, except where I state that I rely upon the evidence of other expert witnesses as presented to this hearing. I have not omitted to consider any material facts known to me that might alter or detract from the opinions expressed.

Scope of Evidence

10. My evidence will address the following:

    a. Site physical environment and botanical/vegetative biodiversity;

    b. Rehabilitation recommendations;

    c. Enhancement opportunities;

    d. Concerns raised by submitters; and

    e. S42A report.

Site Physical Environment and Botanical/Vegetative Biodiversity

11. In preparing my evidence I have referred to and/or relied upon the documentation listed in **Appendix A**.

12. I confirm that I visited the site on 18 March 2024. I prepared a report with respect to vegetation and biodiversity values.[1]

13. With assistance from Simon Johnstone of Hawkeswood Mining a complete circuit of the planned mine site was made on foot. Most of the adjacent Clutha Gold Trail, which I am familiar with, was also walked. The majority of the alluvial flat on which the mining will occur lies at ±50>80m a.s.l., with the Clutha Gold Trail lying some 5-10m below that on the banks of the Clutha Mata-au River.

14. The majority of the land within the 68ha mining boundary is currently farmed and has an extended history of pastoral agriculture. The ground has been intensively modified via fencing, tilling and drilling, and some of it by historical gold mining. While vegetation was noted and recorded during the walkover, it was not deemed necessary to establish permanent plots/transects across the area as it was composed virtually wholly of exotic

[1] Hawkeswood Mining Ltd 2024, RM23.819: Summary of Vegetation and Biodiversity Values across Proposed Gold Mine land at Millers Flat, prepared by Dr BJ Wills of Central Environmental Services, dated March 2024.

pastoral grasses, legumes and brassica greenfeed within individual paddocks.

15. I have considered the **Physical Environment – Climate** influencing the proposed mine location. Conditions for the NIWA station at Roxburgh (the closest NIWA Weather station) during 2023/24 were as follows:

    a. Precipitation was above average during autumn 2023, average in Jun-Aug, and fluctuating during spring. Heaviest rainfall was during March (±68mm) and Nov (±63mm).

    b. Despite NZ experiencing yet another warm year, Roxburgh air temperatures were at or just above average throughout most of the 2023-24 season (mean annual temp = 11.9°C, so similar to 2022, 2021, 2019 & 2013). Evapo-transpiration rates are (typically) highest in Nov through Feb (at 160-180mm PET), as were Growing Degree Days (@ 10°C), the annual total of which was on a par with 2016.

    c. Soil moisture deficits were lowest during May-Oct 2023, highest in Dec-Feb 2023/24, giving a total of 145 days of deficit for 2023 (similar to last year vs 161 in 2021 and 193 in 2020, and well short of the 227 days of deficit experienced in 2015).

    d. Wind run (mean daily wind run for 2023 = ±275 km) at Roxburgh was above average during most of the period, October being the windiest month with a mean daily wind run of ±333 km). Late autumn was typically the least windy period.

16. Several climate drivers came together to produce an exceptional year of weather in New Zealand. One major climate driver of 2023 was the transition from a La Niña to an El Niño. La Niña is characterised by cooler than average ocean temperatures in the central and eastern equatorial Pacific, while El Niño is the opposite. Both La Niña and El Niño influence atmospheric circulation patterns in the Pacific Ocean, which have flow-on effects to regional climate across the globe.

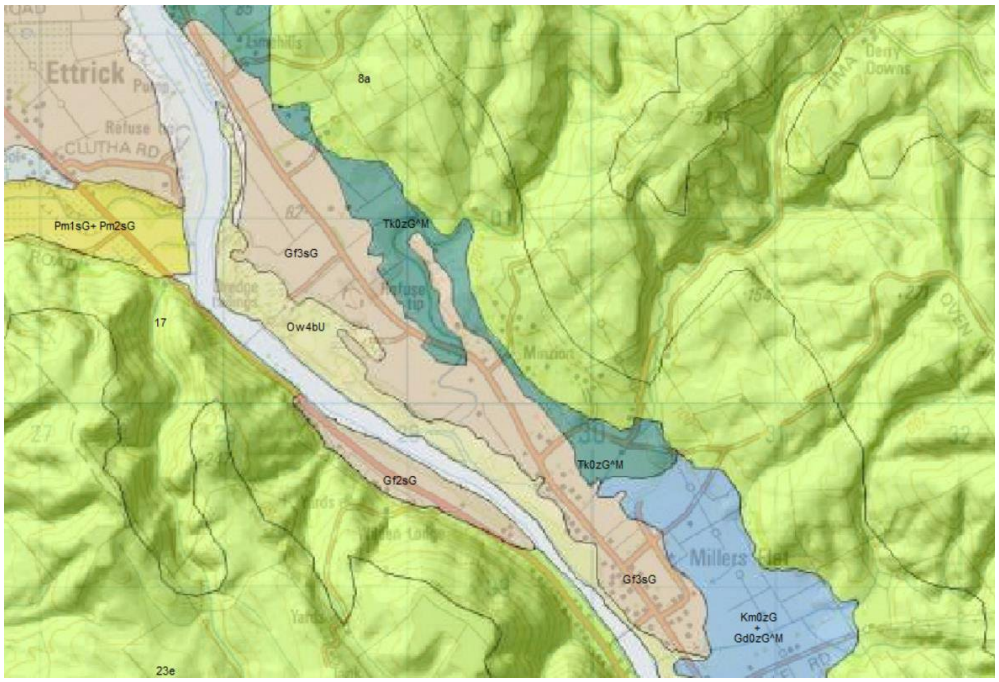
17. For New Zealand, La Niña tends to be associated with higher-than-normal air pressure near and to the east of the country with lower pressures to the north. This can lead to an increased north-to-south pressure gradient, intensifying spring-time westerly winds and fronts as they move across the county. This air flow occurred more consistently during the second half of the year as the ocean-atmosphere transitioned to El Niño. However a persistent blocking high pressure system to the south-east of New Zealand, a holdover from La Niña, slowed the typical progression of weather patterns from west-to-east across the country and led to more northerly winds than is usually associated with a classical El Niño circulation regime.

18. Variable climatic conditions going forward are a given, thus all mine-site activities must adapt accordingly.

19. The **Physical Environment – Soils** influencing the proposed mine location was assessed. The proposed mine site is located at 1346 – 1536 Teviot Road, Millers Flat. The site topography is relatively level to gently undulating on an alluvial terrace above the Clutha River, in parts encroaching on the steeper, dredge-disturbed ground adjacent to the river on the true left bank.

20. According to ORC GrowOtago data, the predominant soil type across the main mine-site is a “Brown Soil”, one of the most extensive soil types in NZ. They generally contain 2:1 clay minerals, along with iron and aluminium oxides evenly dispersed through the soil, giving it a yellowish-brown colour in the upper B-horizon. Moderate to low base saturation levels (<50%) are typical and P retention is moderate to high (Hewitt 1992).

Figure 1: GrowOtago Mapping of Teviot Mine-site Soils (ORC GrowOtago 2004)



21. The soils across the mine site are classified by the ORC GrowOtago site as Greenfield Stony Sandy Loams (Gf3sG), these being Pallic and Semiarid (yellow grey and brown grey earths) soils formed on loess and colluvium under seasonally dry conditions. Anthropic Mine Workings (OW4bU) with shallow, recent sandy silt soils occur adjacent to the river. Immediately inland on the NE side of the Teviot Road are Tokomairiro Deep Silt Loam soils (TkOzG^M) that are organic in nature. The predominant land use across the mine site is pastoral farming.

22. The **Physical Environment – Land Use Capability** influencing the proposed mine location was identified.

Figure 2: Land Use Capability Mapping of Teviot Mine-site Soils

Reference: https://lris.scinfo.org.nz/layer/48076-nzlri-land-use-capability-2021/

23. Land Use Capability mapping provides additional physical data to soils across similar ground parameters, these typically being slope, erosion and vegetation.

24. The **Mine Site:** For the main LUC Class (4s 6) across the soils that dominate the mine site, the following parameters apply:

    a. 4 = Land with moderate limitations for arable use, but suitable for occasional cropping, pasture or forestry.

    b. S = Soil physical or chemical properties in the rooting zone such as shallowness, stoniness, low moisture holding capacity or low fertility.

    c. 6 = Non-arable land with moderate limitations for use under perennial vegetation such as pasture or forest.

25. In this case the LUC designation is as follows:

96	A
1W	P1/1/3m 7m 8

26. The ORC GrowOtago mapping designates the soil as Greenfield, and the MacDonell Consulting Ltd Application designates it as Gibbston.[2] However the NZ Soil Bureau indicates the soil type is "96" – Gladbrook, which I agree with, is a Recent Soil rather than a "brown" or Pallic soil type. Structurally this soil is usually composed of >90cm deep Silt Loam with a nutty/crumb A horizon; mottled nutty/blocky B+ horizon formed on stony gravels. It has a medium – low nutrient status, pH is 5.7-6.0, Base Saturation = ±60-65%, and is responsive to fertilizer additions (especially Sulphur & Phosphate). It is susceptible to wind and sheet erosion when cultivated. (NZ Soil Bureau Bulletin 27, 1968).

    a. Slope = (A – or G according to GrowOtago) is equivalent to a flat to gently undulating landform (0–3°).

    b. Erosion = (1W) level is slight, mainly wind affected.

    c. Vegetation = (P1/1/3m 7m 8) is as follows: P1 - High producing pasture; dominantly improved pasture with minor inclusions (10–40%) of gorse and broom.

27. The general LUC site description is as follows: Flat to undulating floodplains, low terraces and fans below 600 m asl with shallow (20-45 cm) and stony silt loam to sandy loam textured Recent soils in low to moderate (500-1000 mm) rainfall areas, with a marked summer moisture deficit.

[2] The ORC s42A Report states at [4.1.2] that "S-Map Online indicates that the soils at the site are Gibbston shallow, well-drained loams."

Botanical/Vegetative Biodiversity

28. As indicated earlier, the bulk of the area to be mined currently comprises exotic pastoral grasses (browntop, sweet vernal, cocksfoot, tall fescue, ryegrass and many annual grasses), legumes (white and red clover, lucerne) and brassica greenfeed. Areas previously disturbed by mining exhibited a mixed cover of scrub (mainly brier rose, barberry, broom, elderberry and gorse) with annual grasses (bromes, hairgrass etc) underneath.

29. Exotic vegetative biodiversity across the site at best would be considered moderate. Given the area has such a long history of mining and pastoral farming, it largely consists of monocultures with indigenous biodiversity virtually completely lacking. Indigenous vegetative biodiversity was low, only existing to a minor degree on historical dredge tailings.

Land and Soil Rehabilitation

30. The application proposes:[3]

"Top soil and overburden will be stripped to create a pit that will typically be up to around 18 m deep. A mine pond within the pit will have an area of approximately 150 m by 100 m (1.5 ha). Including areas being stripped, mined and rehabilitated, stockpile areas, roading, bunding, workshop and yard, and sediment ponds, the total work area will be approximately 27 ha, at any one time.

The total area affected by mining will be approximately 68 ha over the life of the mine. The top-soil will be stockpiled separately for rehabilitation.

Overburden will be used to create a series of bunds around the perimeter of the site. Any excess overburden will be stockpiled, ready for use in the progressive rehabilitation.

Mining will commence at the northern end of the resource and progress in a generally southerly direction, with the pit traversing from side to side within the resource limits, with rehabilitation (backfilling with tailings, overburden and finally top-soil) occurring progressively".

[3] AEE dated 24 October 2023, page 2 – 3.

31. The staging of the works on the Site has subsequently been updated and illustrated in a Site Plan sequence,[4] with the methodology described in the associated Site Plan Description. Relevantly the pre-stripping and rehabilitation phases are described as follows:

    a. Pre-stripping: Pre-stripping involves taking off the topsoil (10pprox.. 0.3m depth) and stockpiling it separately. This also involves the removal of the silt layer (10approx. 0.5m) and stockpiling this separately. Next is the removal of the overburden (10approx. 12m) which is also stockpiled separately. Stockpiles may be located in dedicated areas and some material will be stockpiled in temporary visual mitigation bunds.

    b. Rehabilitation: Backfilling involves placing overburden back in the mine pit after the gold has been removed from the wash. Once the initial pit has been formed, backfilling will be done with overburden removed from the pre-stripping area. Rehabilitation will be done progressively and involves replacement of overburden, the silt layer and the topsoil in order; then levelling the land to the pre-existing contour; reseeding with grass and irrigating as necessary to achieve coverage; and reinstating farm infrastructure (e.g., fences, troughs).

32. In general the rehabilitation technique will be sufficient to restore the physical land and "soil" profile to a similar undulating landform with sufficient sub-surface stratification that will enhance drainage and provide an upper soil horizon capable of supporting ongoing productive pastoral farming practices.

33. Successful rehabilitation to support ecosystem or agricultural post-mining land uses is underpinned by reconstruction of a healthy soil profile. Regardless of whether the starting material is mine spoil, subsoil, or stockpiled topsoil, rehabilitation outcomes can be improved by soil management activities that focus on modifying the physical, chemical and biological properties of that soil.

[4] Refer Site Plans dated 22/04/2024.

34. There are several issues to be aware of during the stripping and restoration process, namely:

    a. Topsoil Compaction.

    b. Topsoil deficits.

    c. Soil biology.

    d. Comprehensive soil characterization.

    e. Vegetation establishment.

    f. Seed mixes.

35. **Topsoil Compaction**. This can occur both during topsoil stripping and after rehabilitation and could feasibly affect stored overburden as well. During stripping and storage of large volumes of material it is essential that the period that this is stored for is kept to a minimum to prevent possible anaerobic conditions developing within the stockpiles, particularly when the material contains significant quantities of organic matter. This can result in the loss of nutrients (especially available nitrogen) and biological activity (viable seeds, earthworms, microorganisms). As a 'rule of thumb', 6-12 months of storage should be the maximum allowable period of storage for those materials before re-use on site.

36. Once the rehabilitation process has started, it is again essential to avoid excessive compaction within both the sub-soil and top-soil layers from machinery use as those materials are re-distributed across the site. Keeping repetitive machinery passes to a minimum will assist but, in some cases, deep ripping may be required to reduce that compaction and restore drainage.

37. **Topsoil deficits** are an inherent aspect of open cut mining. This is because the post-mining surface area may be greater than the comparatively flat area from which topsoil was harvested prior to mining. As a result of these deficits in quality and/or quantity of topsoil, mine rehabilitation activities

may have to rely on a thin layer of stockpiled topsoil, nutritionally deficient subsoil, overburden, or a combination of these, as the surface layer. These materials present physically and chemically challenging conditions for plant establishment and may be prone to erosion leading to poor rehabilitation outcomes. Careful management is needed to ensure that the surface materials that remain after mining can sustain the proposed vegetation, are not prone to erosion and will support final rehabilitation objectives.

38. **Soil biology** is an important component of soil quality that is often overlooked during rehabilitation. Natural microbial processes are responsible for carbon sequestration, symbiotic associations, nutrient cycling and aggregate formation in soils. There is potential to harness or stimulate these natural processes to accelerate soil formation from poor quality substrates and improve mine rehabilitation outcomes (Wijesekara et al., 2016). Organic-rich materials (e.g., biosolids, compost, worm castings, manure) can promote natural soil forming processes and improve soil quality. There is also emerging research investigating the potential for microbial inoculants to accelerate the spoil-to-soil transformation during mine rehabilitation (Li et al., 2022).

39. **Comprehensive soil characterization**: This critical step in rehabilitation is often overlooked, done incompletely or inconsistently across sites. Soil improvement approaches should take into account the proposed post-mining vegetation. For example, native plants often prefer lower nutrient substrates with limited nitrogen or phosphorus levels. Incorrect or excessive fertilizer addition can result in poorer rehabilitation outcomes for some native ecosystem rehabilitation projects. Thus the use of any nutrient or fertilizer(s) application to address macro- and micronutrient deficiencies needs to be carefully considered. The efficacy of such applications for rehabilitation can be determined well prior to any disturbance by analysing a series of randomly placed soil samples across the site prior to mining to provide a soil nutrient status baseline to work to.

40. **Vegetation Establishment:** Taking into account the desired form of post-mining vegetation, decisions then need to be made on the best technique to establish vegetation on a given landform. In extreme cases hydro-seeding or straw-mulching may be the most effective method of establishing and maintaining an effective ground cover. The Landcare Research Factsheet "Implementing Rehabilitation to Pasture" provides an overview of that process: (https://www.landcareresearch.co.nz/assets/Publications/Mining/FS_07_Implementing_rehab_pasture.pdf

41. In the case of indigenous (or exotic) shrubs or trees, establishment is likely to be in the form of containerized seedlings that are planted directly on-site by hand, particularly where steeper slopes and/or inconsistent soil types exist. A further consideration is that of root symbionts, given that most plants host some form of mycorrhizal or rhizobial microflora to extract soil nutrients more effectively, and they in turn gain photosynthates (eg sugars) from the plant to support their growth. Generally nurseries will use sterile potting mixes to raise seedlings, thus the necessary microflora is eliminated. Two options exist to reinstate that – inoculation with a liquid suspension of the appropriate bugs (as is normally done with most legume (eg clover) species; or by the addition of "duff" derived from a living shrub or forest floor used as a mulch when planting.

42. In the case of pastoral or agricultural seed mixes that are to be oversown or drilled, a seed coating may be applied that hosts the microbes (legume rhizobia or grass endophytes) and may help repel bird and insect seedling predation. Rhizobia are usually specific to each legume species – white clover (Trifolium repens) inoculant differs from red clover or Caucasian clover, or lucerne, lotus etc. – so it is essential to obtain the correct inoculant. Ryegrass (Lolium perenne) and some fescue species (eg tall fescue – Lolium arundinaceum) host specific endophytes to protect their foliage against pest insects, so again care is required to obtain the correct fungus.

43. **Seed Mixes:** These will vary from simple, low productivity mixtures of grasses and legumes, to specific high productivity monocultures. At the low productivity end a useful pastoral seed mix for use in Central Otago is the

"Bush Burn Mix" supplied by Kubala Seeds in Gore. It contains mainly Nui Ryegrass, crested dogstail (Cynosurus cristatus) and timothy (Phleum pratense), plus lesser amounts of sweet vernal (Anthoxanthum odoratum), Yorkshire fog (Holcus lanatus) and soft brome (Bromus hordaceous). Crucially it is all derived from Certified Seed during cleaning, so is free of contaminant weed seeds (thistle etc). Certified cocksfoot (Dactylis glomerata) and white clover are added to it pre-application to ensure a biodiverse mix for Central Otago sites.

44. The "Bush Burn Mix" has been successfully used for rehabilitation at several drier disturbed sites in Central Otago, eg the Pioneer Energy Fraser Rv Power Scheme (see comparative photos below) and at Santana Minerals Ltd exploratory mining site near Bendigo. No fertilizer was applied in these instances.

Pioneer Energy Lower penstock slope – 2019 & 2023

Steep Slope above powerhouse – 2019 & 2023

Options for ecological enhancement during rehabilitation

45. Assuming that the bulk of the mined area is to be progressively returned to a productive pastoral and/or agricultural ecosystem, an opportunity exists to provide indigenous offset rehabilitation along the adjacent Clutha Gold Trail corridor berm land. The berm land adjacent to the Clutha Gold Trail and the Clutha Mata-au River has similar vegetative biodiversity values to the area to be mined, although scattered examples of shrubby Coprosma, Olearia, Meuhlenbeckia and Rubus species were evident among the numerous crack willows and other exotics.

46. Such a project would require mechanical removal of pockets of exotic scrub (barberry, brier, broom etc) along the river embankment and the planting of a range of indigenous shrubs along what is essentially a riparian border some 25-50m wide in places between river and property boundaries. Recommended species for any local riparian planting project are set out in Appendix A.

Indigenous or Exotic?

47. Historically TLA's like regional councils have utilized fast growing tree species within stream and river boundaries, primarily because they can be propagated economically, they establish relatively easily, and they have fast growth rates. Poplar and willow species are commonly utilized and a number of varieties exist, only some of which are climatically well-adapted to our Central Otago environment.

48. Conversely there are many indigenous plants that could be utilized within riparian boundaries. In Central Otago the most relevant species tend to be shrubby or woody (and some herbaceous) in nature, again mainly due to our unique climatic factors. That said, initial planting programs would probably only utilize 6 to 8 species to ensure good establishment and protection. Biodiversity can be increased after several years by utilizing duff collected from under existing local stands of native bush. This process will transfer seed and symbiotic organisms into the riparian zone to the benefit of both initial plantings and newly establishing seedlings.

49. If a suitable source of duff can be located, I would suggest placing a handful of it in the hole even when doing the initial site planting (as referred to above). Reason? Most nurseries utilize sterile potting mixes to grow on their containerized stock, so they miss out on mycorrhizal and other microbial symbionts that can benefit their subsequent growth greatly.

50. Most of the Clutha Mata-au marginal strip is already fenced off, thus excluding farmed grazing animals, so sites like these will be priority locations for riparian planting. Some predator control will be necessary to limit the impact of rabbits and possums during the establishment period. With the onset of 'climate warming', weather patterns are becoming more variable and more storm events with higher precipitation can be expected (as with the recent flooding events on Mt Benger that adversely affected Roxburgh/Teviot). Waterways like the Clutha Mata-au have sizeable upper catchments, so flooding events are quite probable during NNE Cyclonic weather patterns bringing moisture-laden air in from the tropics.

Concerns raised by submitters

JP Clarke & KL Franklin and FG Works Limited

51. The submission at [11.1.2] states: *Biodiversity: no assessment of biodiversity has been provided with the application.*

52. I have assessed botanical/vegetative biodiversity. My report and this evidence relate specifically to the flora associated with the potential mine site. My conclusions as set out above are that the Site:

    a. Represents land with moderate limitations for arable use, but suitable for occasional cropping, pasture or forestry. It has soils which are relatively poor quality, with features including shallowness, stoniness, low moisture holding capacity or low fertility.

    b. Has exotic vegetative biodiversity across the site which at best would be considered moderate, and largely consists of monocultures with indigenous biodiversity virtually completely lacking (meaning indigenous vegetative biodiversity was low).

Aukaha Submission

53. At paragraph [6.16] of the submission, a submission is made that the proposal is inconsistent with (among others) Objective 4.3.8 which relates to "areas of significant indigenous vegetation". Areas of significant indigenous vegetation are not present at this Site.

54. Reasons for opposition are set out in section 8 of the submission. At [8.17] under the heading "Effects of Mining Activity on Biodiversity" the submitter seeks a detailed closure and site rehabilitation plan, secured by a bond, which in the submitters view should include planting of indigenous species to restore biodiversity values in this catchment.

55. I agree that the closure and site rehabilitation plan to be prepared should be appropriately detailed. It needs to engage with the matters I addressed above under the heading "Land and Soil Rehabilitation". It could include

areas of ecological enhancement through planting of indigenous vegetation – I have provided some comment on that issue above, identifying the most appropriate location being along the adjacent Clutha Gold Trail corridor berm land thereby improving the riparian border.

56. Appendix 2 of the submission relates to the Kāi Tahu ki Otago Natural Resource Management Plan 2005. To the extent objectives and policies of that document refer to biodiversity on the Site, then with reference to my area of expertise (being botanical/vegetative biodiversity) I reiterate my evidence that the Site has no significant areas of indigenous plant species present – and there is in fact virtually no such vegetation at all.

57. The Site is entirely pastoral in nature and is proposed to be rehabilitated in a like manner. Furthermore there are few substantial stands of natural, indigenous plants in the locality that could contribute to creation of ecosystem networks. Alternative options involving indigenous replanting could occur on adjacent Clutha River margin strip land in association with the Clutha Gold trail and several fruiting trees and shrubs attractive to birds are included in the listing of suggested indigenous plants.

S42A reports

ORC S42A References to indigenous biodiversity (specific to botanical/vegetative biodiversity):

58. Key issues listed in section 2.1[5] suggest further information is required to assess the consistency of the proposal against provisions relating to effects on indigenous biodiversity and safeguarding the life-supporting capacity of soils. These matters have been addressed in my report and in this evidence.

[5] ORC S42A Report, at page 9.

59. With reference to the Proposed Otago Regional Policy Statement (ORPS 2021) and Proposed Otago Regional Policy Statement – Freshwater Instrument Components 2021 (notified September 2022), and provisions relating to Land and Freshwater, the s42A report states in the context of LF-FW-P13[6] that the application does not provide an assessment of effects on indigenous biodiversity. To the degree this statement extends to flora/botanical biodiversity generally, and with respect to LF-FW-P13 to that biodiversity on the margins of the Clutha River/Mata-Au and the Tima Burn, these matters have been addressed in my report and in this evidence. The Regional Policy Statement assessments continue on to address Land and Soil provisions and assert that with reference to LF-LS-O11 - O12, and P16-P19 that no assessment of effects on soil quality has been provided in the application. These matters have been addressed in my report and in this evidence. In addition soil quality and the land's productive capacity can be restored (and therefore maintained) during rehabilitation of the Site following the temporary mining activity.

60. With respect to other Regional Policy Statement provisions engaging with indigenous biodiversity,[7] in my opinion (for reasons already expressed) the application is consistent with provisions seeking to address effects on flora/botanical indigenous biodiversity.

61. I have addressed those aspects of the Kāi Tahu ki Otago Natural Resource Management Plan 2005 relevant to my expertise above in the context of the Aukaha submission.

CODC S42A References to indigenous biodiversity (specific to botanical/vegetative biodiversity):

62. To avoid repetition, with respect to flora/botanical indigenous biodiversity, my opinions are set out in my report and in this evidence. The s42A Report records agreement (with respect to indigenous vegetation) with my opinion

[6] ORC s42A Report, page 71.
[7] For example ECO-O1.

that the effect on such vegetation (which is essentially nil) is appropriate.[8] It also acknowledges a level of positive effect is possible if new indigenous vegetation planting were to occur.[9]

Dr Barrie J Wills

Central Environmental Services

Dated 29 April 2024

[8] CODC s42A Report, at [154].
[9] CODC s42A Report, at [169].

Appendix A:

Plant Species Selection for Riparian Ecosystems in Central Otago

A number of regional nurseries can supply suitable plant materials to carry out riparian planting programs.

The following links are worth viewing to source plant catalogues, costings and plant materials

http://www.pukeraunursery.co.nz/attribute/riparian/

https://greenmachine.nz/collections/queenstown

https://www.cops.org.nz/Riparian-planting.html

http://matukitukinatives.co.nz/contact.html

Rehabilitation Options - Tree Species: Exotic

Poplars: The most suitable clones for Otago soil conservation are the *Populus euramericana* clones 'Tasman', and 'Crow's Nest', and *P. deltoides* clone 'Veronese', with many South Island windbreaks being planted in these. Poplar clones suitable for timber include 'Tasman', 'Toa', 'Kawa' and 'Eridano'. Other clones are not ideal for saw log production because of their tendency to sprout large numbers of epicormic shoots following pruning. Most poplars are suitable as forage and in Otago the older clones 'Flevo' and 'Eridano' are well suited for this as they are broader in form and have a high leaf density. Traditional 'Lombardy' poplars are rust-prone (defoliating in early autumn) and sucker badly.

Willows: Eight clones are commonly available in New Zealand, the most important of which for Otago are the S. matsudana x alba clones 'Aokautere' (NZ 1002), 'Tangoio' (NZ 1040), 'Moutere' (NZ 1184), 'Hiwinui' (NZ 1130) and 'Makara' (NZ 1179). 'Aokautere' was an early hybrid release now superceded by the other clones in many areas. While it still has a role in moist river berm and gully sites, it should be used in conjunction with 'Tangoio', 'Hiwinui', 'Moutere' and 'Wairakei' (NZ1149) in the South Island to enhance genetic diversity. All tree willow clones can be used for forage purposes, but they are best suited to wetter sites and require careful management for optimum fodder production.

Shrub/Osier willows. Use of these has generally been restricted to soil conservation/erosion control work although some have been tried as a low-level component in shelter belts. Japanese willow (*Salix kinuyanagi*) is useful for forage planting as it is palatable, has a long growing season and is easily managed. Purple osier (*S. purpurea*) is commonly used in river control works using clones like 'Booth' (F) or 'Irette' (M). Foliage is bitter and therefore not suitable for forage.

Rehabilitation Options - Tree Species: Indigenous

Tī kōuka or cabbage tree (*Cordyline australis*) is readily grown from seed, generally tolerant of medium-dry conditions, wind tolerant and frost hardy. Evergreen and ideal for riparian applications.

Kāpuka or broadleaf (*Griselinia littoralis*) is slow growing but ultimately forms a tree. Best in moister soils and closed canopy situations, so probably better planted later in program when other trees/shrubs have established well.

Narrow-leaf lacebark (*Hoheria angustifolia*) forms a moderate sized tree, prefers better drained soils so plant away from stream banks on gravelly areas.

Pōkākā (*Elaeocarpus hookerianus*), as with broadleaf, tends to be a forest tree, best established in moist, organic soils but hardy and tolerates moderate-dry conditions once established.

Kānuka (*Kunzea robusta/ericoides*) is common in frost-drained valleys and on montane areas of Central Otago, but not recommended for lower-altitude, cold central regions.

Mountain Toatoa (*Phyllocladus alpina*) originally common in mid-altitude montane grasslands, now restricted to rocky outcrops. Slow growing but hardy and would be suited to well drained sites away from stream bed.

Mānatu or ribbonwood (*Plagianthus regius*), prominent small tree on alluvial sites, lowland to montane. Hardy in protected sites and re-seeds readily.

Hall's tōtara (*Podocarpus laetus*) is common on the montane slopes of the Dunstan Mountains, could be used on lower alluvial outwash fans. Very slow growing.

Kōwhai (*Sophora microphylla*) is extremely slow growing, drought and frost tolerant. Needs correct root symbionts to grow effectively. Best planted in well drained sites away from stream bed.

Rehabilitation Options - Shrub Species: Indigenous

Mountain Wineberry (*Aristotelia fruticosa*), small-leaved shrub bearing berries and growing to 2m, grows into alpine zone but suitable for localised riparian planting.

Coral Broom (*Carmichaelia* [*Corallospartium*] *crassicaulis*), restricted distribution, declining in grasslands. Suitable for drier areas on slopes adjacent to streams. Not commonly propagated commercially.

Scented Broom (*C. odorata*), associated with streams, wetter areas etc, but occurs mainly in Northern Sth Is Possibly not frost tolerant enough for Central Otago.

Petries Broom (*C. petriei*), common in Central Otago grasslands, often associated with Cromwell Broom (*C. compacta*), best planted on drier sites only.

Mountain Tauhinu (*Ozothamnus* [*Cassinia*] *vauvilliersii*). Common on shaded aspects on local montane slopes. Suitable for damper soils at less exposed sites.

Tūmatakuru or matagouri (*Discaria toumatou*), locally frequent, not commonly propagated so difficult to source commercially. Could try spreading branches from mature fruiting plants as a means of growing it.

Mingimingi (*Coprosma propinqua & C. rhamnoides*), common 'gray' scrub component in Central, suitable for most sites adjacent to streams, drought & frost tolerant. *C. intertexta*??

Swamp Coprosma (*C. tenuicaulis*), frequents poorly drained swampy ground, ideal for riparian sites but frost tolerance may be an issue in Central.

Korokio (*Corokia cotoneaster*), tough wiry spreading shrub commonly available from commercial nurseries. Suitable for most moist sites.

Inaka (*Dracophyllum longifolium*), commonly found on montane slopes, in wetter areas. Suitable for riparian planting but will be difficult to source commercially.

Hebe (*Veronica odora, pauciramosa, rakaiensis, salicifolia*), several species occur in Central Otago, mainly on hill slopes. Koromiko (*V. salicifolia*) is the tallest, most suitable for initial riparian planting projects.

Porcupine Shrub (*Melicytus* [*Hymenanthera*] *alpinus*), common on drier montane slopes, low, slow growing and spreading. Only suitable for driest sites, not commercially available.

Scrub pōhuehue (*Muehlenbeckia complexa*), low growing, spreading wiry shrub. Suitable for moister sites adjacent to eroding banks. May be difficult to source commercially.

Tree daisy (*Olearia odorata, virgata*), also components of montane 'gray' scrub. Two species (O. *fimbriata & lineata*) are listed as threatened in NZ. Suitable for general riparian planting.

Pimelea (*Pimelea aridula*), an erect, silvery flowering shrub often growing on exposed, sunny, well drained sites. Intolerant of shade and excess moisture so not well suited to riparian application.

Kōhūhū (*Pittosporum tenuifolium*), may grow into a small tree, endemic and widespread in montane shrubland and forest. Not long-lived so best used early in riparian development as a successional species.

Whauwhaupaku or fivefinger (*Pseudopanax arboreus*), not common in Central but colonises streambanks and forest edges so would need shelter, otherwise hardy but also possum tucker.

Rehabilitation Options - Herbaceous/Grass Species: Indigenous

Toetoe (*Austroderia* [*Cortaderia*] *richardii*), native 'toitoi', well adapted to wetland sites from lowland through sub-alpine. Very suitable for streamside, riparian planting.

Pūrei (*Carex secta*), frequents swampy wetland and stream beds, forms trunk-like stems, readily propagated by subdivision, seed. Best where water flow is restricted most of the time.

Copper Snow Tussock (*Chionochloa rubida*), common swamp dweller on montane areas, very hardy and easily propagated, but not drought tolerant.

Fescue tussock (*Festuca novae-zelandiae*), common grassland tussock, widespread in Central, hardy, moderately palatable and easily propagated. Not suitable for continuously wet sites.

Harakeke/flax (*Phormium tenax*), common to wetland and stream side areas, hardy in Central and easily propagated, attractive to native birds.

Silver tussock (*Poa cita*), common grassland tussock, frequenting moister and higher fertility sites. Widespread in Central, hardy, moderately palatable and easily propagated. Not suitable for continuously wet sites.

Recommended Species for preliminary plantings:

Tī kōuka/cabbage tree, lacebark and/or mānatu/ribbonwood.

Mountain tauhinu, mingimingi, korokio, hebe, tree daisy and pittosporum spp.

Toetoe, Pūrei, copper snow tussock, harakeke/flax and silver tussock

Osier or Japanese willow could be used in most erosion-prone areas