Before Independent Hearings Commissioners Appointed by Canterbury Regional Council and Selwyn District Council

In the matter of	The Resource Management Act 1991
And	
In the matter of	Applications by **Fulton Hogan Limited** for all resource consents necessary to establish, operate, maintain and close an aggregate quarry (**Roydon Quarry**) between Curraghs, Dawsons, Maddisons and Jones Roads, Templeton

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EVIDENCE OF VICTOR MKURUTSI MTHAMO
ON BEHALF OF FULTON HOGAN LIMITED

REHABILITATION

DATED: 23 SEPTEMBER 2019

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Introduction

1 My full name is Victor Mkurutsi Mthamo.

2 I am a Principal Consultant for the environmental science, engineering and project management consultancy Reeftide Environmental and Projects Limited (Reeftide). I have been in this role for over 7 years. Prior to this I was a Senior Associate with the surveying, environmental science and engineering, and resource management consulting firm CPG New Zealand Limited (now rebranded to Calibre Consulting Limited), where I was also the South Island Environmental Sciences Manager. I have worked in the area of environmental science and engineering for over 25 years.

3 I have been asked by Fulton Hogan Limited (**Fulton Hogan**) to provide evidence in respect of its application for resource consents to establish, operate, maintain and close the proposed Roydon Quarry (**Proposal**).

4 My area of expertise is the development of effective and sustainable rehabilitation plans for quarries. I focus on ensuring a rehabilitated site that can be used for as many land use options as are possible and permissible under the current statutory planning requirements.

Qualifications and Experience

5 I have the following qualifications: Bachelor of Agricultural Engineering (Honours) with a major in Soil Science and Water Resources (University of Zimbabwe); Master of Engineering Science in Water Resources (University of Melbourne); Master of Business Administration (University of Zimbabwe). I hold an Advanced Certificate in Overseer Nutrient Management modelling qualification. I am a member of Engineering New Zealand (CMEngNZ) and I am a Chartered Professional Engineer (CPEng) and an International Professional Engineer (IntPE). I am a past National Technical Committee Member of both (i) Water New Zealand and (ii) New Zealand Land Treatment Collective (NZLTC).

6 I have been involved in the design and implementation of numerous on-farm irrigation schemes, soil investigations, and land use assessments in New Zealand. Prior to this I was involved in irrigation scheme development projects and water resource investigations in most southern African countries and parts of Asia. As a Consultant for the Food and Agricultural Organisation (FAO), I have worked on land use projects in Papua New Guinea and The Maldives. I was also involved in the preparation of an irrigation design and management

manual for FAO. While working as a Senior Consultant for the audit and consulting firm PricewaterhouseCoopers (Harare Office), I was involved in the preparation of feasibility studies for large scale irrigation/land use projects, conceptual and detailed designs, environmental impact assessments, capacity building, cost-benefit analyses and providing sustainable management expertise to the beneficiary communities. Some of the infrastructure development projects and assessment of environmental effects/environmental impact assessments I have been involved in New Zealand include Hunter Downs Irrigation Scheme, North Bank Hydro Project, Mararoa-Waiau Rivers Irrigation Feasibility Study, and North Canterbury Lower Waiau Irrigation Feasibility Assessment.

7 With regards to the Hunter Downs irrigation Scheme, North Bank Hydro Project and Lower Waiau Irrigation Scheme, one of my key roles was assessing the potential impacts of the proposed infrastructure and works on groundwater, soils, surface waterways and existing abstractive infrastructure, and developing possible mitigation and rehabilitation strategies for implementation to ensure post development sustainability.

8 The Northbank Hydro Tunnel Project involved significant areas of quarrying for gravel for the tunnel and canal construction. My involvement also included assessing the impact on the quarried areas and the rehabilitation requirements to ensure that the land could be sustainably used for agriculture post development.

9 I have been involved in assessment of large subdivisions in relation to stormwater management, earthworks and the associated actual and potential impacts on soils, groundwater and surface waterways. These assessments included how to effectively use erosion and management control plans to mitigate the potential impacts that may occur during the construction works. This work is relevant to my input in this hearing as it demonstrates the ability to assess and present soil mitigation strategies associated with earthworks and rehabilitation of sites post development.

10 More recently I was the expert witness on rehabilitation for the extension of the Road Metals Quarry on West Coast Road in Templeton. The proposed rehabilitation works involved topsoiling the extraction area to produce a minimum rehabilitated site that was at least 1.3 metres above the highest groundwater level. In this work, I assessed the effectiveness of adopting a 300 mm topsoil layer and whether or not this was sufficient for: (i) plant growth; and (ii) providing contaminant attenuation, treatment and removal to protect the underlying groundwater. I also assessed the proposed quarrying operations,

the rehabilitation using cleanfill materials, and the possible land uses post development.

11 I acknowledge that I have read and am familiar with the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2014 and agree to comply with it. I confirm that this evidence is within my area of expertise, except where I state that this evidence is given in reliance on another person's evidence. I have considered all material facts that are known to me that might alter or detract from the opinions I express in this evidence.

Scope of Evidence

12 In my evidence I will:

12.1 Outline my involvement in the Roydon Quarry Proposal to date.

12.2 Describe how progressive rehabilitation will work in practice for this Proposal.

12.3 Describe rehabilitation considerations with regards to soils and plant management.

12.4 Describe the final rehabilitated outcome that can be expected from the rehabilitation programme proposed.

12.5 Describe the range of uses that could be accommodated on rehabilitated land.

12.6 Provide my opinion on whether the conditions of consent offered are sufficient to provide certainty of outcome in respect of rehabilitation.

12.7 Provide an assessment of actual and potential effects on the soils as result of the reduced unsaturated soil zone.

12.8 Identify and discuss rehabilitation issues raised by submitters or the s42A reports.

My Involvement in the Roydon Quarry Proposal

13 I have been engaged by Fulton Hogan to prepare rehabilitation evidence for the resource consent applications for the Roydon Quarry.

14 I was engaged by Fulton Hogan in September 2018 to provide rehabilitation advice, respond to the s92 in March 2019, and prepare evidence for this hearing.

15 I have read the Assessment of Environmental Effects ("AEE") by Fulton Hogan and Golders Consultants, and the technical reports accompanying the application, along with the section 92 further information responses and the submissions.

16 I have visited the site on numerous occasions – twice in September 2018, in March 2019 and more recently in September 2019.

17 I have provided rehabilitation advice to Fulton Hogan and Golder Associates, for the proposal and in doing so I have:

17.1 Read the original proposal Roydon Quarry by the applicant and the subsequent s92 responses.

17.2 Had discussions with and/or read evidence from various experts including: **Mr Don Chittock**, **Mr Eric Van Nieuwkerk**, **Mr David Compton-Moen**, **Mr Kevin Bligh, and Mr Craig Stewart**.

17.3 Read the s42A reports authored by Ms Hannah Goslin, Ms Lisa Scott, and Mr Andrew Henderson.

17.4 Read my previous evidence and reports relating to the landuse consent applications (CRC181274 and RMA/2017/2111) by Road Metals Company Limited to extend quarry operations onto adjoining land and operate an aggregate processing activity.

17.5 Read previous evidence and reports on various plan changes relating to quarries (e.g. briefs of evidence of Messrs Robert Potts, William Hemming Field, Richard Spencer English presented at the Christchurch District Plan Independent Hearings Panel) and other quarry consent application proposals within Christchurch and Selwyn.

Overall Mechanism of Progressive Rehabilitation

18 Fulton Hogan propose to extract aggregate from the entire site, except from within the boundary setbacks. Development of the quarry will take place in a number of phases as follows:

18.1 Use of suitable on-site material (supplemented by imported topsoil) to create perimeter bunds.

18.2 Planting around bunds to establish boundary screening.

18.3 Development of quarry pit area – removal of topsoil and subsoil overburden material and initial extraction to develop a working pit.

18.4 Construction of the site infrastructure such as site entrances, haul roads, establish processing plant and field conveyors, sediment ponds, weighbridge, workshop and site offices etc.

18.5 Extraction of aggregate in stages.

18.6 Rehabilitation of worked out areas, also in stages.

19 The focus of my evidence is on rehabilitation of the worked-out areas.

20 The primary purpose of rehabilitation is to:

20.1 Minimise the extent of exposed areas and achieve soil stabilisation as soon as is practical after the completion of earthworks.

20.2 Maximise favourable environmental conditions for plant growth and hasten natural revegetation processes by controlling those factors that are able to be controlled, monitoring results, and where necessary, progressively adapting activities to improve results.

20.3 Blend the worked-out quarry faces and the fill area into the surrounding landscape.

20.4 Achieve an increase in long-term sustainability of various land uses of the site.

21 The most effective rehabilitation occurs when the work is integrated as part of the overall operation and is implemented progressively, as each section of the Quarry is completed.

22 A draft Rehabilitation Plan that outlines how progressive rehabilitation could occur has been developed and this was part of the consent application.

23 The proposed approach will allow for progressive rehabilitation to occur alongside excavation activities, resulting in vegetation being established in different areas of the site as areas become available following completion of excavation.

24 While timing of stage completion can adapt to fluctuations in aggregate demand, the sequence of extraction activity forms the basis for how rehabilitation efforts occur.

25 The rehabilitation programme will be carried out as follows:

25.1 Progressive rehabilitation of the site throughout the stages of extraction.

25.2 Stabilisation of quarry faces and ensuring any areas where works have been completed are left in a safe and stable condition.

25.3 Creation of a free draining and stable landform to ensure that any areas where work is completed has adequate stormwater drainage or soakage.

25.4 Reinstallation of topsoil to ensure the soil can be used for crop/plant establishment. This may require the soil to be mixed with organic material or a soil conditioner.

25.5 Selection of the appropriate vegetation cover.

25.6 Re-vegetation (e.g. re-grassing) after spreading the topsoil. This will involve replanting with suitable plant species as soon as practicable. Topsoil and re-vegetation is proposed to be undertaken during September to November, or March to May, to improve the plant establishment.

25.7 Maintaining the site through controlling weeds.

25.8 Monitoring and controlling plant and animal pests during rehabilitation works.

26 Rehabilitation planning that is integrated with extraction sequences will ensure rehabilitation can commence in areas where extraction activity has concluded. This will ensure that vegetation can be established, or a return to other land uses (e.g. pasture) achieved, as soon as practicable rather than leaving an exposed and disused quarry languishing for longer than it needs to and progressively getting larger over time. The rehabilitation planning minimises the rehabilitation burden at any one time.

27 Timeframes for rehabilitation of the site will be driven largely by the rate of extraction and will occur progressively over the site once filling in completed stages has been finished. It is anticipated that rehabilitation of each worked-out stage will be completed within 12 months of the stage being finished. This will also ensure that the maximum opened up areas stays within 10 ha. I have discussed the final rehabilitation in Paragraphs 35-40 below.

28 Given the proposed progressive rehabilitation, at the end of the quarry life the areas designated for production support and containing the quarrying infrastructure (which includes the crushing plant, administration and service areas etc) will be decommissioned and the final rehabilitation will be carried out. The task is more contained than would be the case if progressive rehabilitation did not occur.

Rehabilitation Considerations - Soils, Plant Species and Plant Management

29 A fundamental process of rehabilitating the site will be the preparation of the substrate and the quality of topsoil for all planting areas, including areas left to regenerate naturally. I consider the following to be the typical steps that are employed for successful rehabilitation:

29.1 Handle topsoil at an optimum moisture content to reduce damage to soil structure – this provides a higher standard of revegetation and lower maintenance requirements.

29.2 Endeavour to spread topsoil in the reverse sequence to its removal so that the organic layer, containing any seed or vegetation, is returned to the surface.

29.3 Spread topsoil at a minimum depth of 300 mm. This is done in a manner that aids runoff control, minimises erosion and increases moisture retention.

29.4 Level topsoil to an even surface and avoid a compacted or over-smooth finish.

29.5 Prevent vehicular movement on any areas where the topsoil has been spread to prevent soil compaction, which impacts plant growth and drainage issues.

29.6 In the event that compaction of the topsoil occurs, the soil should be ripped to maintain a friable soil state, which promotes normal soil infiltration and good crop/pasture establishment and growth.

30 Expedient planting of areas which have been top-soiled is important for erosion control, aesthetics and returning the land to a useful condition.

31 Species are chosen for rehabilitation depending on several factors that include tolerance to site conditions (such as moisture stress, wind effects, and soil substrate texture), soil characteristics (such as drainage, organic content,

structure and aggregation, soil-water relationships, mobilising of nutrients, and nitrogen fixation), and soil drainage conditions. I have discussed these in more detail in Paragraph 57.

32 Revegetation using seeding will take the following into consideration:

32.1 Planting using one or more of the following methods - broadcasting, drilling, or hydroseeding, all of which are common seeding methods.

32.2 The sowing rates adopted will ensure normal pasture establishment. The seed supplier's minimum recommendations should be adopted.

32.3 Fertiliser application is not considered necessary and may encourage proliferation of weeds. However, if the need arises, moderate application rates will be employed.

33 While re-grassing will be carried out, natural regeneration of grass and vegetation by providing suitable conditions for vegetation establishment will also expediate plant establishment.

34 Vegetation management will be carried out to promote rapid growth and development. On-going management will entail:

34.1 Monitoring of regrowth.

34.2 Fertilising as necessary, weed control and re-sowing of bare areas as necessary. However, fertiliser application will be avoided or kept to a minimum.

34.3 Grazing of newly established pastures should not be contemplated until plant establishment. By this time, plants are strong enough to resist trampling and their root systems are sufficiently developed to prevent plants being pulled completely out of the ground by grazing stock.

34.4 Total groundcover should not be reduced below 70 per cent, as this will increase erosion hazard.

34.5 The health and extent of revegetation efforts will be assessed regularly. Remedial works may include supplementary seed sowing (broad-cast application) or if necessary, the application of fertiliser (at very low rates) to promote native plant growth.

34.6 An annual monitoring inspection will be included within the rehabilitation management and associated reporting will cover:

(a) Identification of successes of past and previous year.

(b) Identification of deficiencies or inadequacies.

(c) Identification of opportunities.

(d) The programme for the coming year.

34.7 **Table 1** provides examples of the monitoring methods, the parameters to be monitored, and the frequency.

34.8 Table 1 – Plant Monitoring Requirements

Method	Monitoring	Parameter	Frequency
Photo Points	▪ Seedlings ▪ Weeds ▪ Regeneration	▪ Assess the condition of the vegetation	▪ At regular intervals as a visual record of the improvements and/or changes
Transect	▪ Planted seedlings	▪ %age coverage and this should be >70%	▪ 3-4 weeks after planting. ▪ Annually.

34.9 Fulton Hogan is committed to record keeping, which will be important to ensure the accumulation of knowledge and will result in increased efficiency and reduced costs over the life of the rehabilitation project. Progress photographs, taken at key vantage points, should be used as a valuable monitoring tool. I understand Fulton Hogan has staff that can undertake these requirements in-house.

The Final, Rehabilitated Outcome

35 The final outcome for the perimeter landscaping around the quarry is discussed in **Mr David Compton-Moen's** evidence. His evidence provides the cross-sectional diagrams of the final landscaping plans for the area around the quarry.

36 Based on the evidence of **Mr Don Chittock** and that of **Mr Craig Stewart,** Fulton Hogan sees the Roydon site as providing the potential to be an exemplar in terms of site rehabilitation. This is also confirmed by the measures I have outlined in Paragraphs 34.1-34.7 above.

37 The following is expected of the rehabilitated site:

37.1 An appropriate mix of cleanfill and adequate layers of permeable subsoil and healthy productive topsoil will be used to achieve the

finished ground levels. The cleanfill materials will be deposited in a manner that encourages free draining of stormwater runoff into the permeable ground as recommended in Section 4.6 of the Draft Cleanfill Management Plan for the proposal.

37.2 Topsoil will not be compacted when being used to raise the quarry floor. It will be loosely placed and spread by appropriate machinery e.g. grading to address high and low points.

37.3 The minimum finished floor level for the site, following operational rehabilitation activities, will be at least 1.3 metres (m) (this includes a minimum topsoil of 300 mm) above highest recorded ground water levels in the vicinity of the site, at the time of backfilling occurring. Where cleanfilling occurs the minimum depth above the groundwater will be greater than 1.3 metres. The proposed buffer including the 0.3 metres topsoil will ensure that:

(a) There is sufficient buffer to allow any of the land uses listed in **Attachment 1** to be undertaken.

(b) There is sufficient protection of the groundwater as highlighted in Paragraph 60-107.

(c) There is sufficient soil depth for root establishment and sustainable plant growth as discussed in Paragraph 57-59

38 My description of the rehabilitation above has focused on restoring pasture/grass, however the land can be used for several different activities. The focus on grassing and vegetation is because the initial restoration to stabilise the site and mitigate erosion, dust etc needs the site to be grassed or vegetated in some way. .

39 The final rehabilitated site may include:

39.1 A reduced unsaturated zone thickness. The buffer between the soil surface and the underlying groundwater is reduced, potentially increasing the groundwater susceptibility to the activities associated with the final land use.

39.2 Ponding of surface waters – this potentially increases the potential for contamination to enter groundwater and increase surface water runoff or recharge depending upon local topography.

39.3 Soil contamination e.g. from vehicle use and refuelling.

40 I have discussed the actual and potential effects in Paragraphs 60-107 of my evidence. **Mr Eric Van Nieuwkerk** discusses the actual and potential effects on groundwater as a result of the reduced unsaturated zone thickness.

Current and Potential Land uses

41 In the next section (from Paragraph 50) I discuss the possible land uses post quarrying. However, before I do this, it is important to also highlight the current and potential current land uses at the site without the quarry. This will help demonstrate what impact, if any, the proposed quarrying will have on future land uses.

42 The site and the surrounding area is a combination of farming (consisting of pastoral), rural residential, residential, commercial, and community land uses.

43 I have listed the current and potential uses in **Attachment 1** at the end of my evidence.

44 The rural residential, community land uses, and some light farming activities can be carried out as permitted activities under the current district and regional planning provisions.

45 Commercial uses and some farming activities would be discretionary or restricted discretionary activities under the Selwyn District Plan and the regional planning provisions would therefore require consent.

46 Intensive farming on the property is constrained by a number of factors, including:

46.1 Availability of irrigation water.

(a) The existing consent CRC182422 permits the take and use of groundwater at a rate not exceeding 9.5 L/s, with a volume not exceeding 6,772 m^3 in any period of nine consecutive days. The consented irrigated areas is 32 ha. Any changes to the consent resulting in a reduction in the abstraction rate and/or the annual volume may limit the potential irrigation area post quarrying.

(b) The likelihood of getting more water is very low because it is in a fully allocated groundwater zone, which means applying

for an increased or new groundwater allocation will not be possible.

46.2 Current and future regional planning rules:

(a) The Canterbury Land and Water Regional Plan (CLWRP)'s Selwyn Te Waihora Sub-regional plan has limits on the discharge of nitrates and phosphorus from various farming activities. For example, according to the plan, if the nitrogen loss for a property is more than 15 kgN/ha/yr, further reductions are required by 2022. These reductions are sector specific, with dairy farmers being required to reduce by 30%, dairy support by 22%, pigs by 20%, irrigated sheep, beef or deer by 5%, dryland sheep and beef by 2%, arable by 7%, fruit, viticulture or vegetables by 8% and all other sectors 0%. Properties do not need to reduce if their nitrogen loss is below 15kgN/ha/yr.

(b) The proposed CLWRP Plan Change 7 will also limit some more farming activities (e.g. commercial vegetable growing operations) due to the proposed nutrient limits.

(c) This means that some farming activities would not be economically feasible due to nutrient limits.

47 The Selwyn District Plan zones the site as Rural. This zoning restricts the type and nature of commercial and industrial activities that can be undertaken. The site would have to be rezoned to allow a broader range of activities.

48 Current and future district planning rules; or example, in the district plan rural residential properties with a density ≥ 4 ha/dwelling fall under the permitted activity status. On the other hand, lots that <4 ha require a wastewater discharge consent under the CLWRP. I do note that none of these are fatal flaws under these plans, and activities can be granted consents provided the actual and potential adverse effects are fully addressed.

49 Some current and future land uses at the site are limited by activities beyond the site such as the airport activities. For example, with regards to the airport possible land uses would be affected by:

49.1 The noise contour zoning.

49.2 Activities that could potentially encourage birds, which would cause bird strike risks are controlled activities.

Possible Post Rehabilitation Land uses

50 The final land use is unlikely to be determined until sometime in the future. In the meantime, it is proposed Fulton Hogan will restore the site to a form such that it can be available for a variety of activities.

51 **Attachment 1** identifies many possible land uses post-rehabilitation. Some of the likely land uses may require consenting before they can be implemented.

52 **Attachment 1** demonstrates that the existing and potential land uses (i.e. pre-quarrying) right now are much the same as the potential land uses post-quarrying and after rehabilitation.

53 I understand Fulton Hogan uses and will continue to use an external farm advisor to provide advice and audits on compliance with the relevant regional and district planning requirements. Therefore, Fulton Hogan is able to ensure that the correct farming practices are maintained both pre and post quarrying.

54 In conclusion, I note that:

54.1 Many of the land uses in **Attachment 1** are similar as between the pre-quarrying and post-quarrying scenarios as I discussed in Paragraphs 46-48 above. However, under either scenario many of these would require plan changes or resource consents before they could be implemented.

54.2 Intensive farming activities are already constrained by a number of factors, most of which I have discussed in Paragraphs 46-48 above.

54.3 I, therefore, conclude that:

(a) Quarrying will not by and large limit the range of potential future land uses. This means that same type of activities that are possible before the quarrying will also be possible after quarrying.

(b) Quarrying will not result in the loss of productive agricultural land or investment as similar activities (**Attachment 1**) will be able to be undertaken post quarrying. There may be some reductions required in terms of stocking rates and/or the application of fertilisers, but that will be managed by Regional

Council rules and will depend largely on outputs from nutrient loss modelling tools (which will take account of the irrigation applications, depth and type of soils remaining post-rehabilitation).

(c) There are minimal opportunity costs with regards to land uses as a result of the decision to develop the quarry and the consequent rehabilitation.

(d) While the potential land uses pre and post quarrying might be similar subject to the constraints I have highlighted above (and in **Attachment 1**), I do note that the productive potential of some of the agricultural activities may be reduced due to a number of factors such as the recommended reduced fertiliser applications I have made in Paragraphs 32.3 and 34.2.

(e) The available irrigation water would pose the same constraints as it did under the pre-quarrying. However, any changes to the conditions of the consent to take water (CRC182422) that restrict the annual volume abstracted as part of the quarrying consent application may result in a smaller volume of water available for the comparable post quarrying land uses.

(f) On current trends (e.g. growth, land use preferences), the most likely land uses post quarrying will be rural residential (as per the current district plan zoning) with some light pastoral farming. However, any of the options in **Attachment 1** are possible in the medium to long term, provided the requirements (e.g. consenting) constraints (if any e,g, as per Paragraph 54.3(e)) to the activities are addressed.

(g) Therefore, I see no need for conditions restricting the land use on the site post quarrying. There are sufficient provisions within the current and proposed statutory plans to ensure that the land use will be matched to the productive potential of the land and the prevailing environmental (climate, soils, available water etc) conditions.

Whether the Proposal Offers Certainty as to Rehabilitated Outcomes

55 In this part of my evidence I discuss how the proposal offers certainty of a rehabilitated outcome. To achieve this:

55.1 I outline how the rehabilitation should be managed and monitored to achieve the desired outcomes.

55.2 I describe the effectiveness of the proposed minimum 300 mm to sustain plant growth and of the at least 1.3 m unsaturated soil matrix in reducing the potential contamination of the underlying groundwater.

55.3 I confirm that further certainty comes from the proposed consent conditions.

56 To ensure certainty as to the rehabilitated outcomes:

56.1 Appropriate monitoring is proposed. For example, the planting monitoring proposed in **Table 1** should be implemented.

56.2 The overall management of site rehabilitation will be the responsibility of the Roydon Quarry Manager or by delegated authority. Responsibilities include:

(a) Managing daily quarry operations – extraction and manufacturing of aggregates to supply orders.

(b) Ensuring compliance with the conditions of all resource consents pertaining to the site.

(c) Communicating resource consent requirements to staff, contractors and all other relevant parties.

(d) Overseeing compliant implementation of the Quarry Rehabilitation Plan and other management plans.

57 The proposed minimum 300 mm topsoil will enhance the desired rehabilitated outcomes as it will be able to sustain plant growth. However, there are a number of factors that determine the extent to which this is achieved. These are:

57.1 The topsoil's biological, chemical and physical characteristics determine the soil fertility.

57.2 The key chemical properties are pH, electrical conductivity, phosphorus and exchangeable sodium percentage (ESP). Physical properties include permeability, water holding capacity, soil density and drainage characteristics. Soil profile characteristics such as soil structure, soil texture, stoniness, soil depth, depth to rock, observed

root depth, colour and mottling provide an indication of the soil fertility and usefulness for plant growth.

57.3 Appropriate use of inorganic fertilisers, which will be in accordance with Good Farm Management Practices[1] and the Code of Practice for Fertiliser Use[2]. This will provide mitigation against any potential adverse effects on both the soils and groundwater. Use of organic fertilisers will enhance both the physical and biological properties of the soils to ensure optimum plant grown. Use of fertilisers will be controlled via the existing planning provisions limiting nutrient loss to ensure minimum leaching of nutrients. Therefore, there will be no need for any conditions relating to fertiliser applications.

57.4 Having been to some of the current sites operated by Fulton Hogan, I note that Fulton Hogan has gained considerable experience in managing rehabilitated areas to enhance the above soil properties and consequent plant growth. I am, therefore confident that the rehabilitation processes and the rehabilitated areas will be managed and operated to ensure that the minimum 300 mm of soil will have good soil health and will enhance optimal plant growth.

57.5 The observed sites show that the rehabilitated land seems to be sustainably growing grass over the topsoil that is similar to what is proposed under this proposal.

58 Both the applicant and the s42A report offered possible conditions of consent to achieve the desired rehabilitated outcomes. I have discussed the proposed conditions in Paragraphs 114-115. Consent conditions can be used to ensure that the outcomes from the desired rehabilitated sites can be achieved.

59 From the foregoing and as noted in Paragraph 54.3, it is my opinion that the situation of the site following restoration will be very similar to that at present and will achieve the desired rehabilitated outcomes.

Assessment of Potential Adverse Effects

General

60 As discussed in Paragraph 38, there are some potential adverse effects arising from the reduced depth to the groundwater. The following paragraphs of my

[1] *http://www.fedfarm.org.nz/FFPublic/Policy2/National/Good_Farming_Practice-Action_Plan_for_Water_Quality_2018.aspx*
[2] *https://www.ecan.govt.nz/document/download?uri=3137827*

evidence discuss the actual and potential adverse effects arising from the proposal.

61 I should note that my assessment of effects focusses on the effects on the soil. **Mr Eric Van Nieuwkerk** discusses the effects on groundwater after the actual and potential contaminants have reached the groundwater.

Effects of Stormwater from Buildings

62 Roof stormwater is considered to be “clean” and will be conveyed via a sealed system designed to prevent the entry of surface stormwater runoff. Consideration will be given to the possible use of roof stormwater for onsite use e.g. irrigation and dust suppression.

63 The normal concentrations of contaminants, such as zinc and organic matter in roofing stormwater, are such that there are not usually any meaningful adverse effects on the groundwater quality.

64 Therefore, the actual and potential effects on groundwater quality arising from stormwater discharge from the roof areas will be negligible.

Effects of Hardstanding Stormwater

65 Hardstanding stormwater from the trafficable and car parking areas will be conveyed to dry ponds to remove sediment prior to infiltration to ground. The ponds will be lined with soils to ensure the removal of possible contaminants, before the water infiltrates to groundwater. Water would pond for no longer than 48 hours. Runoff from road surfaces will infiltrate to ground along the road edges.

66 The estimated mean contaminant loadings for urban stormwater sources based on Event Median Concentration (EMC) are summarised in **Table 2** below. Given the lower traffic volumes, the limited operational hours etc. the quarry contaminant levels have been conservatively assumed to be at least 50% less than the urban concentrations.

Table 2 - Estimated Mean Contaminant Loadings

Contaminant	TSS (mg/L)	BOD (mg/L)	Zn (mg/L)	Cu (mg/L)	Pb (mg/L)	Hydrocarbons (mg/L)
Urban Areas	170[2][1]	9[3]	0.19[2]	0.023[2]	0.095[2]	2[3]
Suggested for the Quarry (at least 50% less than Urban	85	4.5	0.1	0.012	0.043	1[3]

[1] *Kingett Mitchell Ltd (2005))*[3]
[2] *NZTA (2009)*[4]
[3] *Williamson (1993)*[5]

67 The proposed stormwater management system (detailed in the application) will ensure treatment and removal of contaminants. The dry ponds will be installed which will be lined with soils. **Table 3** includes a summary of the efficiency of contaminant removal through the ponds (refer to as 'soakage pit and underlying soil treatment' in **Table 3**) and the expected performance. The removal efficiencies cited are taken from the Ministry for the Environment (MfE) On-Site Stormwater Management Guideline (NZWERF, 2004).

Table 3 - Estimated Treatment and Water Quality Outcome

Parameter	Stormwater Concentration (mg/L)	Sumps and the Oil & Grit Interceptor (%)	Soakage Pit and underlying Soil Treatment (%)	Minimum Treatment Outcome (mg/L)	Guideline Values (mg/L)
TSS	85	40	90	5.1	50
BOD	4.5	20	90	0.36	-
Zn	0.1	N/A	85	0.015	30
Cu	0.012	N/A	85	0.0018	40
Pb	0.043	N/A	85	0.00645	0.2
Hydro-carbons	1	>75	>75	0.0625	TPH C_7-C_9 = 360 TPH C_{10}-C_{14} = 7

68 Further polishing of the stormwater will occur through the rehabilitated minimum 300 mm topsoil matrix and the minimum 1 m of unsaturated material above the groundwater table.

69 Given the low contaminant concentrations after treatment, it is considered that the impact on groundwater will be less than minor.

Effects of Nitrates

70 During quarrying there will be little or no sources of nitrates as the existing land use (animal grazing) will be discontinued within the working quarry area, which means there will be no nitrate fertiliser applications or nitrogen fixation. During

[3] *Kingett Mitchell Ltd (2005). Aquatic ecology and stream management groups for urban streams in the Wellington Region. Report prepared by Kingett Mitchell Ltd for Wellington Regional Council.*
[4] *NZTA (2009); Workbook for Workshop Participants on the Stormwater Treatment Standard for State Highway Infrastructure. NZ Transport Agency April, May, June, July, August 2009.*
[5] *Williamson RB (1992) Urban Runoff Data Book Water Quality Centre Publication No. 20*

rehabilitation, fertiliser applications will be based on good practices (Paragraph 57.3) and at application rates:

70.1 Appropriate for the rehabilitated land taking into account the depth to groundwater and based on best practices as I discussed in Paragraph 57.3.

70.2 The CLWRP nutrient limit controls.

70.3 Recommended by the seed suppliers for the crop cultivar. This will ensure full plant uptake and minimal leaching and within the nutrient limits set out in the CWLRP.

71 There will also be little or no vegetation that could potentially fix nitrogen. The concentration of nitrates reaching groundwater is expected to be even lower as various nitrogen cycle processes (e.g. denitrification and volatilization) will also reduce the concentrations.

72 Therefore, I expect that the nitrogen concentrations will be negligible and will not add to the baseline groundwater nitrogen concentration of 8.4 g/m^3 obtained from groundwater sampling undertaken by the applicant.

73 I therefore conclude that nitrogen discharge as a result of the activity will not be of any concern.

Effects of Pathogens

74 **Table 4** contains median ranges of concentrations of common pathogenic indicator organisms in urban stormwater runoff derived from data collected in New Zealand (NZWERF (2004)), Australia Canada and the USA.

75 There is no specific data for quarries and therefore these median values have been adopted as a proxy. It is expected that the applicant's operations will be of a lower contaminant nature.

Table 4 - Median concentrations of Faecal Coliforms and Streptococci in Stormwater[6]

Faecal Coliforms MPN/100 ml	Faecal Streptococci MPN/100 ml
4,200	11,000

76 According to a study by the Florida University (IFAS)[7]:

[6] https://www.tandfonline.com/doi/pdf/10.1080/00288330.1985.9516106

[7] *IFAS, 1984. Impact of On-Site Sewage Disposal Systems on Surface and Ground Water Quality, November 1984. Prepared by the Institute of Food and Agricultural Sciences Soil Science Department, University of Florida, Gainesville, FL for Florida Department of Health and Rehabilitative Services (HRS)*

"*..when at least two feet of unsaturated soil exist between the infiltration system and the water table, BOD_5 removals of >90%, TSS removals of >95% and faecal coliform reductions of > 99% can be expected for a functional and properly maintained septic tank. Bacteria and viruses are effectively removed by adsorption and sorption processes in the ground water and are not transported far from the source*"

77 In addition to the IFAS study noted above, a number of studies also show that:

77.1 The passage of treated wastewater through the soil at a low rate and intermittently will enhance the natural pathogen die-off and reduce the number eventually transported into ground/surface water.

77.2 The main mechanisms that operate within the soil matrix to ensure pathogen removal are filtration, adsorption and natural attrition.

77.3 Results from various studies show virus reductions of 99.99% through 0.6 m of 0.12 mm diameter sand and bacteria reductions of 99.998% through 0.9 m of 0.15 mm diameter dune sand, with 92% to 97% reduction occurring in the top one centimetre.[8,9]

77.4 NZWERF (2004) suggests a pathogen removal rate of 90% through soakage system with the removal primarily taking place in the upper soil layers. Generally, there is 1 log reduction for every 100 mm of soil.

78 Overall, I consider that the effects of pathogens within the stormwater discharge will be negligible.

Effects of Hazardous Substances Storage on Groundwater

79 There will be some fuel storage within the site. The fuel tanks will be bunded with refuelling to occur adjacent to this tank on a covered concrete refuelling pad.

80 Futon Hogan will prepare a spill management plan for the site, which will incorporate the management and inspection of the fuel tank (including fuel reconciliation, spill management and containment and visual inspection of the tank) as well mobile refuelling processes.

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[8] *Crane S.R. and Moore J.A., (1984): Bacterial Pollution of Groundwater: A Review. Water Air & Soil Pollution 22: 67-83*
[9] *Gunn I., (1997): On-site wastewater systems and bacterial reduction in sub-soil disposal areas: A review. On-Site NewZ Special Report 97/2.*

81 Therefore, there will be measures in place to prevent fuel and hydrocarbons from discharging onto the soil and movement through the unsaturated soil into the groundwater system.

82 In the event of a spill, the response plan and clean up protocol in the Spill Management Plan will be implemented. This is standard procedure across all Fulton Hogan sites.

83 The resulting groundwater contaminant impact will be similar to what will likely occur in case of contamination caused by the use of machinery and this is discussed in detail in Paragraphs 84-86 below. The actual and potential impact on the groundwater is discussed in more detail in the brief of evidence of **Mr Eric Van Nieuwkerk.** However, from my assessment, I conclude that effects as a result of the reduced unsaturated depth to groundwater will be less than minor.

Effects of Machinery

84 Use of machinery has a potential effect on the soils and ultimately on the groundwater due to the reduce saturated zone during and after extraction.

85 The applicant will:

85.1 Store fuel in bunded containers and will check for (and if necessary clean up) any spillages (e.g. during plant fuelling activities).

85.2 The site plant will be maintained to a high level.

85.3 All earthmoving machinery, pumps, generators and ancillary equipment will be operated in a manner, which ensures spillages of fuel, oil and similar contaminants are prevented, particularly during refuelling and machinery servicing and maintenance.

85.4 These mitigatory measures will reduce the possible source component of the source-pathway-receptor linkage.

86 Any spillage on to the surface of the quarry, either during extraction or post rehabilitation, still has to travel through at least 1.3 m of topsoil and in-situ gravel matrix before it reaches the unconfined groundwater system.

86.1 The soil and gravel matrix will likely provide some attenuation, although it is likely there could be some direct pathways to groundwater or leaching will occur over time if the contaminants are

not removed in time, resulting in the possible contamination of the groundwater.

86.2 Generally, soils are known to have a hydrocarbon retention capacity of 5-20 L/m^3 in gravels and 40-80 L/m^3 in silts (Pastrovich et al., 1979)[10].

87 Given the comprehensive spill management plan proposed, and the operation and maintenance of the equipment, spill and leakage volumes are expected to be small and will likely be retained in the soil. Contaminated soils resulting from spills will be removed.

88 As discussed above, small spills will be retained in the quarry floor gravels and the rehabilitation soil. Large spills are unlikely given the mitigation measures and the operational procedures proposed for the quarry.

89 It is my conclusion that effects on groundwater arising from spills are likely to be less than minor given the mitigation measures proposed and also the attenuation through the soils in the event of a spillage.

Effects Associated with the Proposed Truckwash

90 The proposal includes a truck washdown area. A truck washdown location will be established on site, which will consist of be a concrete and bunded truck wash pad close to the site workshop. In the paragraphs below I assess the effects associated with this activity.

91 The truck washdown area will be designed and built such that all wastewater from the truck was is collected in an appropriately sized holding tank.

92 An oil/water separator will be installed to provide pre-treatment. Both the oil and separated water will be treated as trade waste. As such, the oil and water will be collected in holding tanks and trucked off site, where it can be disposed in appropriately at an approved location.

93 Therefore, the effects associated with the truck washdown area are less than minor as no discharges from this activity will enter the soil or flow freely on the soil surface.

[10] *De Pastrovich, T.L., Y. Baradat, R. Barthel, A. Chiarelli, and D.R. Fussell, 1979. Protection of Ground Water From Oil Pollution, CONCAWE, The Hague, 61 pp.*

Effects from the Human Effluent Systems

94 Fulton Hogan propose to convey all human effluent generated from the site to holding tanks.

95 The effluent systems will be regularly cleaned by hydro trucks, consistent with Fulton Hogan's current practices at other quarry sites in Canterbury. The wastewater will be trucked off site and disposed of in accordance with environmental regulations.

96 In the unlikely event that effluent get onto or into the soil, the assessment of effects associated with nitrates (Paragraphs 70-73), pathogens (Paragraphs 74-78 and spills demonstrate that the effects will be less than minor.

97 Therefore, there will be no effects associated with the effluent wastewater generated from the site as this will primarily be dealt with off-site.

Effects of Sediments

98 During the excavation works fine sediments may become unbound and mobilise during the excavation works. Fine sediments will also potentially be generated by vehicles and other physical works on the site.

99 I expect sediment, as with metals, hydrocarbons, pathogens, to be attenuated by the topsoil and the unsaturated matrix above the groundwater through the two processes of filtration and adsorption.

100 Once adsorbed, I expect some of this sediment to start building up within the topsoil or the unsaturated matrix. In the topsoil, the sediment will contribute to the clay and silt content of the soils, which in time can improves the soil structure. If trapped below the topsoil the sediment will start to build up some imperviousness of the underlying layers below the topsoil and this will serve as a sieve, which will help reduce the potential soil contamination.

101 Based on the foregoing, I consider the effects of sediments on the soils to be less than minor. This conclusion is also confirmed by the s42A Report in Paragraph 286.

Effects of the Post Rehabilitation Land use

102 A range of post quarrying land uses are discussed in Paragraph 51.

103 Any intentions to intensify would require various consents under the Canterbury Regional Land and Water Plan (LWRP) and/or the Selwyn District

Plan. The plans have rules around what is and is not permissible, e.g. rules around the quantities of fuel and hazardous substances that can be stored.

104 The highest risk rural activity would be dairying, which is well known for its potential adverse effects on groundwater due to nitrate leaching. Intensive dairying is unlikely to be a feasible land use option on this land for the following reasons:

104.1 The stock carrying capacity will be very low based on the soil pasture yield making dairy an uneconomic option for the site as the Dry Matter yields (DM) will be low.

104.2 If the pasture demand is 600 kg DM per year per stock unit then the carrying capacity would be 6-15 stock units/ha or a maximum of 2 dairy cows/ha. The only time the rate would be increased was if supplementary feed was provided, which again makes the site unsuitable for dairying given the small number of animals that it would be able to accommodate.

104.3 It is unlikely that dairying would comply with the LWRP rules and more specifically with the rules in the Selwyn Waihora Plan.

105 The most likely land use post quarrying based on the current planning framework would be lifestyle blocks:

105.1 These are typically accompanied by small animal (e.g. sheep, goats and pigs) rearing and possibly horticultural activities via glasshouses etc. The main risk to groundwater under the circumstances would be nitrates and pathogens depending on the farming practices.

105.2 The effects of these on the soils and groundwater has been discussed above. A more detailed consideration of the potential impacts to groundwater is discussed in **Mr Eric Van Nieuwkerk**'**s** brief of evidence.

106 In my view, the likely land uses post rehabilitation will, therefore, not have any more adverse effects on the soils and the groundwater under the site than the pre-quarrying state.

Summary of the Assessment of the Potential Adverse Effects

107 Based on the assessment of environmental effects, the cleanfill methodology (as proposed in the Draft Cleanfill Management Plan – discussed briefly in

Paragraph 37.1) and management proposed (as in the Draft Rehabilitation Plan – discussed briefly in Paragraph 22), limits to the depth of excavation (Paragraph 37.3), management of hazardous substances (Paragraph 79-83), stormwater management (Paragraph 62-69), restrictions of the planning frameworks on nutrient discharges (Paragraphs 102-105) and monitoring and mitigation proposed (in my Paragraphs 34.6-34.8 and **Mr Eric Van Nieuwkerk**'s evidence which discussed groundwater monitoring), it is considered that the any adverse effects on groundwater from removal of large areas of topsoil and of unsaturated zone above groundwater will be less than minor.

Issues Raised by The S42a Reports

108 I have read the s42a Reports prepared by Ms Hannah Goslin, Ms Lisa Scott and Mr Andrew Henderson and other experts.

109 From the submissions filed I have discerned the following matters of concern:

110 Paragraphs 248-267 of the s42A report discusses the potential effects of the proposal on groundwater and other groundwater uses. **Mr Eric Van Nieuwkerk's** brief of evidence addresses the potential impacts on groundwater. In my brief of evidence I discuss the potential effects arising from the reduction in the unsaturated soil depth in Paragraphs 60-107 above. In my opinion the potential effects of various contaminants resulting from the reduced soil depth are less than minor. I note the following from the s42A report:

110.1 In Paragraph 258 the Officer acknowledges the adequacy of the proposed minimum separation distance of 1m. The report states that: *"On the basis of advice from Dr Scott, I agree that maintaining a one metre separation to seasonal highest groundwater at the site will provide adequate protection to groundwater during excavation and note such a restriction is typical of other resource consents for quarrying activities in the Canterbury Region*".

110.2 Paragraph 262 provides some possible mitigation measures to manage spills such as hydrocarbons or oils. The reports states that: "*The applicant does not propose a location for the permanent tank or drive through area as mentioned in the excerpt above. To minimise the potential for any spills and the impact they may have, Dr Scott recommends that no refuelling of vehicles should take place within the excavated quarry pit and the use of catch trays under refuelling*

connectors over unsealed ground. The applicant proposes to periodically refuel fixed and mobile plant in the quarry pit."

I have discussed the potential effects of the use of machinery and spills in Paragraphs 79-88 above. In my assessment I have concluded in Paragraph 107 that the effects on groundwater resulting from the reduced soil matrix will be minor. I recommend acceptance of the proposed condition suggested by the Officer in Paragraph 262 and 266 of their report as reasonable.

110.3 The Officer concludes in Paragraph 267 that provided the measures suggested in their Paragraphs 262-266 are adopted as conditions then they: "*..consider the adverse effects arising from the excavation of aggregate material to be less than minor*".

I agree with the conclusions. I also support that suggested conditions arising from the Officer's analyses in Paragraphs 262-266 as this assessment is a reflection of what Fulton Hogan has proposed in the application.

111 Paragraphs 278-290 of the s42A report discusses the actual and potential adverse effects on groundwater quality arising from the discharge of stormwater and other contaminants into land (excluding the discharge of contaminants arising from the deposition of cleanfill into land). I note the following:

111.1 The Officer's report is in general agreement with my assessment in Paragraphs 62-83 above.

111.2 However, the s42A report does highlight concerns about my use of the microbial concentrations in **Table 4** of my evidence above. I have searched for similar data in and around Canterbury and New Zealand in general. I can confirm that the microbial concentrations are conservative and, in some cases, not too dissimilar to reported concentrations from around New Zealand.

111.3 The Officer concludes in their Paragraph 290 that: "*On the basis of advice provided by Dr Scott, I consider the discharge of stormwater and aggregate wash water[11] at the site could have an effect on groundwater quality and users that is minor*".

[11] *Note – there is no aggregate washwater produced at this site.*

I have discussed the effects in Paragraphs 62-69 above. Based on my detailed assessment, I consider that the effects will be less than minor rather than minor .

112 Paragraphs 291-306 of the s42A report discuss the potential adverse effects on groundwater quality arising from site remediation at the conclusion of cleanfilling and future land use. I note:

112.1 In Paragraph 305 of her report Ms Gosling notes that "*there is potential for future land uses which could result in unacceptable risk to the groundwater long term*". Ms Goslin recommends a covenant on each land title to exclude high intensity land uses.

112.2 I agree with Ms Goslin that there are some activities that at high intensity have potential to cause adverse groundwater effects given the reduce soil matrix post rehabilitation. I have highlighted this in Paragraph 104 of my evidence.

112.3 However, I do not see the need for covenants to be placed on titles as I consider the existing LWRP (The Selwyn Te Waihora Sub regional chapter) and planned statutory provisions (e.g. the Proposed Plan Change 7 to the CLWRP) and the district planning rules, provide sufficient restrictions to such intensified land uses. It is, therefore, unlikely that such developments would be proposed, let alone consented. For this reason, I do not see a need for the suggested covenants given what I have assessed to less than minor effects.

113 Paragraphs 340-345 of the s42A report discuss the actual and potential adverse effects on soil resources after quarrying. I note:

113.1 The report concludes that "*Subject to compliance with the conditions as recommended, I consider the actual and potential adverse effects on soil resources are likely to be less than minor*". I have reviewed these conditions:

(a) I can confirm that they are generally aligned with the applicant's proposal and the conditions offered by the applicant.

(b) My assessment of effects in Paragraphs 60-107 above has concluded that the effects will be less than minor. This is consistent with the s42A conclusions in Paragraphs 258, 262 and 305 of the report.

114 The proposed conditions for CRC192408 and CRC192409 (Land use consent to excavate material and deposit cleanfill material over an unconfined/semi-confined aquifer) relating to rehabilitation and spill management are Conditions 26-32 in Appendix 7 of the s42A report. My comments relating to these are:

114.1 I am in general agreement with the proposed consent conditions and the suggested changes by the reporting Officer.

114.2 In Condition 29, the Officer suggests that the entire site be rehabilitated prior to the expiry of the consents. I do not think that this practical as Fulton Hogan may want to extract product right up to the expiry of the consent. The last sections to be quarried at the expiry of the consent will then be rehabilitated a process, which could take 12-24 months given the monitoring suggested by the Officer in Condition 28. There will also be the rehabilitation of the areas where the processing infrastructure is decommissioned. I recommend a period of up to 5 years after the expiry of the consent for final rehabilitation to be completed. This will provide enough time to decommission the processing infrastructure and carry out the final rehabilitation.

114.3 The Officer recommends additional conditions, one of which seeks to restrict intensive farming by stating that: "*Once all extraction and rehabilitation activities are complete, the land shall not be used for the following activities.*"

As I noted in Paragraph 112.3, I do not see the need for such a condition or for covenants to be placed on titles. There are sufficient statutory tools (e.g. the CLWRP, The Selwyn Te Waihora Sub regional chapter) and planned (e.g. the Proposed Plan Change 7 to the CLWRP) to manage the future land uses at the site. The proposed condition as worded is vague as it may in future limit genuine low intensity land use activities. The existing (e.g. CLWRP, District Plan) and proposed statutory instruments (e.g. Plan Chan 7 of the CLWRP) provide and will provide sufficient controls to such intensified land uses. It is therefore unlikely that such developments will be consented. For this reason, I recommend that the suggested covenants are not included on the titles.

115 I have reviewed the proposed conditions relating to CRC192411 and CRC192412 (*Discharge permit to discharge stormwater to land where contaminants may enter groundwater and discharge contaminants which may enter water from an industrial or trade process*). My comments are:

115.1 For the proposed Condition 3 the Officer suggests that: "*to limit the scope of this discharge permit I recommend a maximum area of stormwater basins should be included. To improve the enforceability of this condition, I recommend a condition is included that specifies the required depth of soil at the basin invert to enable the removal of contaminants*."

In my opinion these are not practical suggestions as the volume of the stormwater to remove first flush contaminants is based on a predetermined depth of the first flush. For example, Canterbury Regional Council requires a first flush treatment depth of 25 mm for stormwater consents. Christchurch City Council permits a depth that ranges from 12.5-25 mm. By limiting the maximum area of the basins, the Officer is either requiring Fulton Hogan to design the basins based on a small first flush treatment depth, or limiting the areas that will be discharging into the basins thereby limiting the potential working areas. The suggested changes are inconsistent with the Canterbury Regional Council best practices. I recommend that a minimum first flush depth (of 15-25 mm) be adopted instead.

The proposed conditions relating to CRC192413 (Discharge permit to discharge contaminants to land that may enter groundwater associated with the deposition of cleanfill for site rehabilitation) that are relevant to my brief of evidence are Conditions 1-12. I have no specific concerns with regards to the proposed conditions or the suggested changes by the Officer.

Rehabilitation Issues Raised by Submitters

116 I have reviewed summaries of the various submissions and read approximately 170 of the ones who wish to be heard and the approximately 22 of those that have expressed concerns on the matters covered by my evidence (rehabilitation).

117 Below I offer comments on some of the submissions relating to the proposed rehabilitation. The submissions that I have directly responded to below are a representative sample of the common themes relating to my brief of evidence. The issues raised in other submissions that I have not directly responded to are captured by my response to the submitters below.

Anuschka Reich-Topp

118 The submission by Ms Reich-Topp expressed concerns regarding discharge of stormwater to ground. My comments in Paragraphs 62-69 have specifically addressed the effects of discharge of stormwater and concluded that effect will be less than minor. My conclusion is supported by the s42A report which, in Paragraphs 278-289, discusses the effects of stormwater discharge. The s42A report concludes in Paragraph 289 that the effects of stormwater discharges will be less than minor.

Barbra Mary Ann Wade

119 The submission by Ms Wade also discusses stormwater discharges and offers some possible consent conditions. My comments in response to Ms Reich-Topp in Paragraph 118 also address Ms Wade's concerns.

120 The concerns regarding spill management and containment expressed in Ms Wade's submission have been addressed in more detail in Paragraphs 84-88.

Christine Fox

121 Among other comments, the submission by Ms Fox expresses concern regarding the proposed 1.3 m unsaturated matrix and the potential impact on groundwater.

122 **Mr Eric Van Nieuwkerk**'s evidence discusses the impact on groundwater in more detail. However, in Paragraphs 62-106 I have provided an assessment of environmental effects relating to reduced soil matrix above the groundwater. The s42A report by and large supports the general conclusions.

123 Paragraph 90 of the s42A reports conclude that the effect of stormwater discharges on groundwater could be less than minor. The submission by Ms Wade also discusses stormwater discharges and offers some possible consent conditions. My comments in response to Ms Reich-Topp in Paragraph 118 also address Ms Wade's concerns.

124 Paragraph 313 of the s42A report concludes that "*Based on the advice of Dr Scott, I consider there is no requirement for targeted mitigation of the effects for well M36/7575. Given this, I consider the actual and potential adverse effects on community supply well M36/7575 is less than minor*. "

Davina Penny

125 The submission by Ms Penny highlights rehabilitation as an issue. However, the specific concerns are not highlighted.

126 I consider that my assessment in the preceding sections have demonstrated how the proposed rehabilitation is based on best practices.

Carole Greenfield

127 The submission by Ms Greenfield discusses a number of matters relating to the proposed rehabilitation. These include weeds control, drainage issues, management of hazardous materials, final site clean-up.

128 I have specifically addressed all the concerns discussed in Ms Greenfield's submission in the preceding sections of my evidence. The concerns addressed have also been specifically discussed in the s42A report.

129 The general conclusion is that the effects on the issues of concern arising from the proposal are less than minor.

Conclusions

130 I have outlined the proposed rehabilitation strategy and assessed whether or not the proposed rehabilitation depth of 300 mm can sustain plant growth and the actual and potential environmental effects. The following is a summary of my review and assessment:

130.1 The proposed rehabilitation is based not just on current best practices, but intends to set the baseline for future best practices. The applicant also intends to make this site an exemplar project, which will demonstrate the basis for effective and sustainable rehabilitation post quarrying.

130.2 The proposed minimum 300 mm topsoil depth and a resulting depth to groundwater of at least 1.3 m will provide for sustainable plant grown enabling a variety of future land uses to be adopted on the site.

130.3 The resulting landform and unsaturated zone above the highest groundwater level will ensure that contaminants from future land uses are attenuated or removed reducing the actual and potential impacts on groundwater. I also note that the Officer's s42A report comes to the same conclusions and the suggested conditions also support this.

131 I also concluded that:

131.1 Statutory planning provisions already impact significantly on what land uses could establish on the site – both pre and post quarrying.

131.2 Quarrying will not impact on the potential land uses that may establish, except to a minor degree (in terms of - potentially - stocking rates or fertiliser application).

131.3 There are minimal opportunity costs with regards to land uses as a result of the decision to develop the quarry and the consequent rehabilitation.

131.4 While the land uses pre and post quarrying might be similar, I do note that the productive potential of some of the agricultural activities may be reduced. This means that while the same activities can be undertaken, the intensity might be lower post quarrying potentially due to fertiliser application.

131.5 The most likely land uses post quarrying will be rural residential with some light pastoral farming. However, any of the options in **Attachment 1** are possible in the medium to long term provided the constraints (e.g. existing and future planning provisions for example) to the activities are addressed.

132 I am in general agreement with the proposed s42A report conditions pertaining to rehabilitation.

133 I am also in general agreement with the proposed changes to the conditions relating to rehabilitation. However, the suggested new condition for covenants on titles is, in my view, superfluous as there are enough statutory planning tools to ensure the way future land uses are conducted on the site are appropriate in light of any changes to substrate composition and depth. The existing instruments are precise and based on science to determine the nitrate or phosphorous loading rates and will inherently manage certain types of activities or the stock rates on the site based on nitrate or phosphorous limits.

134 In my evidence, I also reviewed the submissions by various affected parties. I have offered comments on the concerns relating to groundwater contamination resulting from the reduced distance between the groundwater and the final rehabilitated surface. In summary:

134.1 The activities over these areas post rehabilitation are unlikely to introduce new risk of contamination.

134.2 It appears to me the most likely land use over these areas will be rural residential (based on current trends in the area) and any intentions to intensify would require various consents under the CLWRP – now or after quarrying. The CLWRP has rules around what is and is not permissible e.g. rules around the nutrient limits, water abstractions, quantities of fuel and hazardous substances that can be stored.

135 It is my conclusion that the proposed rehabilitation will be effective and will allow for sustainable use of the land post quarrying to suit a variety of land uses.

Dated 23 September 2019

Victor Mthamo
Environmental Consultant

ATTACHMENT 1 – EXISTING AND POTENTIAL LAND USES

Land Use	Pre-Quarry Actual and Potential Land Uses	Post-Quarry Potential Uses	Comparison of Pre and Post Quarrying
Peri-Urban Development	▪ Rural residential possible. SDC Rural residential zoning limits this to 4 ha blocks. ▪ 1 dwelling per 4ha is permitted but subdivision for 4ha blocks needs consent as a controlled activity	▪ Post quarrying the rehabilitated site (minus buffer strip) can be divided into 40 x 4 ha rural residential lifestyle blocks. ▪ Proximity to city and proven demand for such typology. ▪ 1 dwelling per 4ha is permitted but subdivision for 4ha blocks needs consent as a controlled activity ▪	▪ Both pre and post-quarrying scenarios can accommodate this type of use ▪ However, the post quarrying area will yield less number of sites as the post quarrying areas will be reduced by the area used for battering slopes and landscaping.
Rural Agricultural/ Horticultural	▪ Large scale sheep farming is not economical possible given the size of the land (only 170 ha blocks). However, sheep fattening and finishing would be viable.	▪ Sheep farming is possible under the post quarrying environment subject to the nutrient limits in the CLWRP. ▪ There could be a reduced stocking rate due: ○ To the nutrient limit controls under the plan as the lowering of the unsaturated zone may have an effect on the nutrient modelling. ○ The desire to minimise the soil compaction risk and impact on the topsoil (which would affect the soil drainage and soil structure).	▪ Both pre and post-quarrying scenarios can accommodate this type of use ▪
	▪ There are no dairy or dairy support farms in the area. While the district planning rules permit dairying, under the current regional planning rules dairy farms would not be possible because of the nutrient limits. Dairy support is unlikely to be viable because of (i) the distance to the nearest dairy farms and (ii) there is not sufficient irrigation water for the full 170 ha to economically produce feed.	▪ The same restrictions would apply post quarrying.	▪ Both pre and post-quarrying scenarios can accommodate this type of use
	▪ Crop farming is possible in the area. There are no crop farms in and around the area. Plan Change 7 will restrict some the farming practices and some cropping options.	▪ The post quarrying land use, advantages and disadvantages will be similar to the pre-quarrying state.	▪ Both pre and post-quarrying scenarios can accommodate this type of use. ▪ However, there could some differences in productivity as the post quarrying scenario may have reduced fertiliser inputs.

Land Use	Pre-Quarry Actual and Potential Land Uses	Post-Quarry Potential Uses	Comparison of Pre and Post Quarrying
		○ To the nutrient limit controls under the plan as the lowering of the unsaturated zone may have an effect on the nutrient modelling.	
	▪ Greenhouse glass production of various crops is possible. There are similar operations within 1 km of the site. ▪ Application of fertilisers and chemicals will be better controlled in glass houses as precise applications rate via engineered chemigation and fertigation systems. This will produce better outcomes than comparative open farming systems.	▪ Greenhouse production will be possible under the post quarry final landform. The visual effects post quarrying will be lower as the bunding will provide screening. ▪ Application of fertilisers and chemicals will be better controlled in glass house as precise applications rate via engineered chemigation and fertigation systems. This will produce better outcomes than comparative open farming systems.	▪ Greenhouse glass production is possible under both scenarios. ▪ The post quarrying glass house production will have fewer visual effects than under the pre-quarrying scenario because of better screening.
	▪ While not commonly a horticultural (market gardens, orchards, vineyards) area these potential current land uses e.g. Larcomb Vineyards is a short distance from the site, there are also a number of poultry farms near the site. ▪ However, any proposals for any of these activities would be subject to the CLWRP proposed Plan Change 7 which limits nutrient discharges from commercial horticultural activities.	▪ Any restriction post quarrying will not be different to those the site and will also be subject to current and proposed planning requirements.	▪ Both pre and post-quarrying scenarios can accommodate this type of use ▪ However, there could some differences in productivity as the post quarrying scenario may have reduced fertiliser inputs.
	▪ Large-scale poultry farming operation. There are a number of poultry farms in the general area. There are no restrictions beyond normal compliance with the various district council requirements.	▪ There are no restrictions anticipated. ▪ There will be some positive benefits post quarrying as the poultry infrastructure will not have any visual amnesty effects as it benefits from the bundling and planting around the site perimeter.	▪ Poultry farming options will be the same pre and post quarrying. ▪ There are some positive benefits with the post quarrying scenario.
	▪ Equine, large equestrian or bloodstock centre. There are a number of small-scale equine operations around the area. There are no restrictions to this activity.	▪ Equine, equestrian or bloodstock centre can also be carried out post quarrying. As with the pre-quarrying scenario, there are no restrictions.	▪ There are no restrictions to this type of activity under both the pre and post quarrying scenarios.
Animal Boarding	▪ Animal Boarding is also an option for the site. ▪ There is one such operation down Jones Road close to Weedons.	▪ Animal boarding is also a possible option post quarrying. ▪ The bunding and landscaping will offer positive benefits as these will reduce the visual effects	▪ Animal boarding is possible under both scenarios.

Land Use	Pre-Quarry Actual and Potential Land Uses	Post-Quarry Potential Uses	Comparison of Pre and Post Quarrying
	▪ There will be consents required from the regional council for wastewater discharges, water supply etc. ▪ This is not a permitted activity and so consent from the district council would be required under Rule 9.9.1.	and possibly noise from the operation post quarrying. ▪ The consent requirements will be the same. The consents to discharge wastewater to ground would be subject to a few more restrictions due to the unsaturated zone. However, there is the option to irrigate the bunds using secondary treated effluent. ▪ This is not a permitted activity and so consent from the district council would be required under Rule 9.9.1.	
Other Rural Activities	▪ Forestry. This would consist of approved plant species being planted on the land. ▪ Given the other options available for the land use, the opportunity costs associated with forestry are to high for the option to be possible.	▪ Forestry is also possible. There would be no restrictions under the current planning rules.	▪ Both pre and post-quarrying scenarios can accommodate this type of use. ▪
	▪ A plant nursery is a viable option for the site. Southern Woods less than 1 km from the site had demonstrates how this is possible.	▪ A plant nursery can also be established at the site post quarrying. ▪ There might be concerns regarding the reduced unsaturated soil matrix. However, with appropriate Good Practice Management there will be appropriate mitigation to allay the concerns.	▪ Nurseries are possible both pre and post quarrying.
Commercial/ Industrial	▪ There is likely to be appropriate roading infrastructure, following the motorway extension etc. ▪ Market appetite for business premises in that location e.g. there are already at least 3 industrial commercial activities between Johns Road and SH1. ▪ However, a plan change process would be necessary to enable these types of developments to go ahead. ▪ The SDC rural zoning does permit some commercial enterprises. Less than 100 m from the is a agricultural machinery enterprise. This has operated successfully for at least 6 years.	▪ Commercial and industrial activities are possible under the post quarrying scenario. ▪ The establishment of the would be subject to the same statutory requirements as the pre-quarrying environment. ▪ The landscaping and screening provided by the quarry will offer some positive benefits from a visual amenity point of view.	▪ Both pre and post-quarrying scenarios can accommodate this type of use. ▪ The post quarrying scenario may have positive benefits as the area will be screened giving better visual amenities.

Land Use	Pre-Quarry Actual and Potential Land Uses	Post-Quarry Potential Uses	Comparison of Pre and Post Quarrying
	▪ Composting and Mushroom Farming ▪ Mushroom farming and composting. Examples of this within the district include Meadow Mushrooms (at 578/606 Springs Road, Prebbleton), Broadfields Mushrooms (Waterholes Road). ▪ Composting facilities – examples of these within the district include Southern Horticultural Products, (Manion Road), Rolleston Resource Recovery Park. ▪ Under the current SDC plan this is discretionary activity. It could be undertaken on the site provided a consent was sought and granted. The proposed district plan seeks to defined permitted activities and discretionary and non-complying activities.	▪ These activities could be carried out at the site post quarrying under the current district plan provisions. ▪ It is not clear what the requirements for a permitted or discretionary activity would be under the proposed district plan. It is also no clear what the non-complying activities would be.	▪ Both pre and post-quarrying scenarios can accommodate this type of use. ▪ It is likely that the changes to the district plan will impact the pre and post quarrying to the same extent as the main consideration is usually around air quality. The plan does give some considerations to the effect in groundwater quality but not to the same extent that the regional council does.
Nature Ecological Reserve, Wetlands	▪ The site is unlikely to ever be used for ecological restoration as there are no inherent features that lend the site to this type of activity. ▪ There are also no natural waterways that could help enhance and sustain any ecological restoration project.	▪ Post quarrying the final landform lends itself to a possible ecological activity. ▪ Vegetation bunds would be well established, providing initial fauna habitat. ▪ A remediated stormwater pond to serve Templeton could serve as aquatic area with riparian planting. ▪ Such a use will provide a benefit that the community will not have under the existing landuse options for the site.	▪ The post quarrying scenario offers a land use that is not currently likely under the existing state (pre-quarrying) as the pre-quarrying land can be put to other more productive uses and so is unlikely to be used for ecological purposes.
Recreational Purpose	▪ Facilities would be near to State Highway One and Christchurch Southern Motorway.	Limited travel modes – is not served by public transport and too distant for walking/biking.	▪ The post quarrying scenario offers a land use that is not currently likely under the existing state (pre-quarrying) as the pre-quarrying land can be put to other more productive uses and so is unlikely to be used for recreational purposes.
	▪ Golf Course. Could support a sizeable golf course development. An example of this is the Templeton Golf course nearby.	▪ This use is an option post quarrying.	▪ The post quarrying scenario offers a land use that is not currently likely under the existing state (pre-quarrying) as the pre-quarrying land can be put to other more productive uses and

Land Use	Pre-Quarry Actual and Potential Land Uses	Post-Quarry Potential Uses	Comparison of Pre and Post Quarrying
			so is unlikely to be used for golf course purposes.
	▪ Velodrome. This not really an option pre-quarrying as there are other sites within the region that would have a lower opportunity cost.	▪ This use is an option post quarrying as it is pre-quarrying. ▪ Sufficient area for a South Island cycling velodrome post quarrying.	▪ The post quarrying scenario offers a land use that is not currently likely under the existing state (pre-quarrying) as the pre-quarrying land can be put to other more productive uses and so is unlikely to be used for a velodrome.
	▪ Parks/Reserves. This is not reasonable use of the land under the current state.	▪ This use is an option post quarrying as it is pre-quarrying.	▪ The post quarrying scenario offers a land use that is not currently likely under the existing state (pre-quarrying) as the pre-quarrying land can be put to other more productive uses and so is unlikely to be used for as a park/reserve.
	▪ Nature Trails. This not really an option pre-quarrying as there are other sites within the region that would have a lower opportunity cost.	▪ This use is an option post quarrying as it is pre-quarrying.	▪ The post quarrying scenario offers a land use that is not currently likely under the existing state (pre-quarrying) as the pre-quarrying land can be put to other more productive uses and so is unlikely to be used for nature trails.
	▪ Race Track. This not really an option pre-quarrying as there are other sites within the region that would have a lower opportunity cost.	▪ This use is an option post quarrying as it is pre-quarrying.	▪ The post quarrying scenario offers a land use that is not currently likely under the existing state (pre-quarrying) as the pre-quarrying land can be put to other more productive uses and so is unlikely to be used for a race track.