

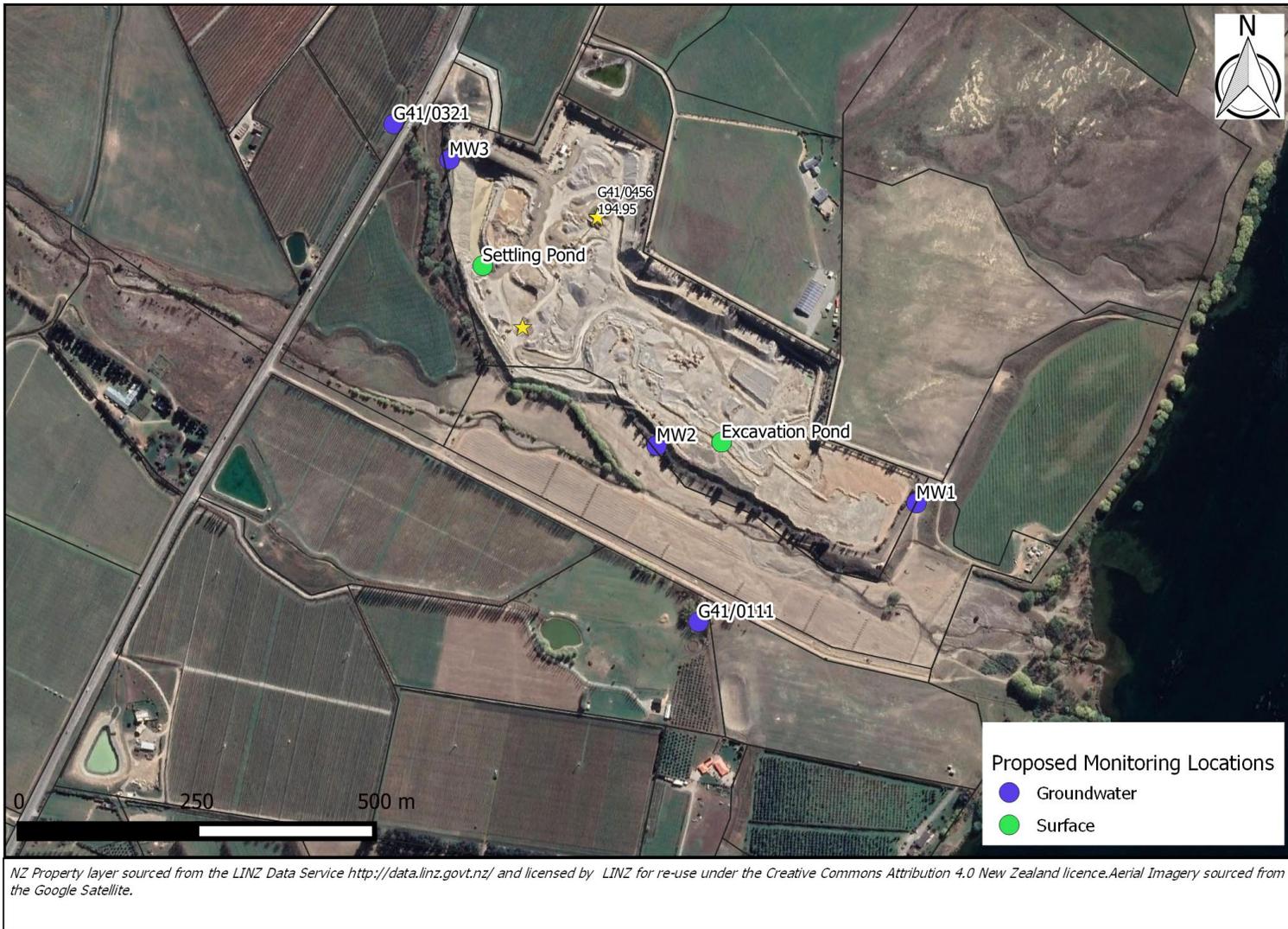
SUMMARY STATEMENT OF ALEXANDRA BADENHOP (GROUNDWATER)

17TH DECEMBER, 2021

1. This summary statement reflects only the points that differ from those stated in previous evidence and joint witness statements or that require particular emphasis, and are focussed on review of the draft conditions circulated by the Applicant on 15th December.
2. I have discussed with Dr. Freeman the need for groundwater monitoring conditions to reflect our joint witness statement, which stated that water quality impacts from the Quarry should be assessed by sampling from a dedicated groundwater monitoring network.
3. I agree with Point 37 a) of Ms Irving's submission on behalf of Amisfield Estate Society. The groundwater monitoring programme should take into account all of the site works and reporting for the land use consent (bore) and discharge consent should be integrated. This could be achieved by specifying the monitoring programme in the discharge consent, and referring to these conditions in the land use (bore) consent.
4. The groundwater monitoring programme should enable understanding of groundwater flow paths and groundwater quality across the site. This requires at least three monitoring wells screened across the water table, and all monitoring wells need to be surveyed so that groundwater elevations can be calculated from groundwater level measurements. Best practice groundwater monitoring should always include monitoring of an upgradient control bore that is not impacted by quarry operations.
5. New groundwater monitoring locations should consist of dedicated sets of nested piezometers with one screened across the water table and one at 10 m below the water table in each set. Samples should also be taken from:
 - a. the settling pond and the exposed area of groundwater (to assess discharge water quality).
 - b. sensitive bores (G41/0321 and G41/0111), and
 - c. G41/0319 to represent an upgradient (control) bore.

Note:

- i. Proposed monitoring locations are provided as Figure 1. I recognise that the exact locations of monitoring bores will be constrained by drill rig access and agreement from bore owners, and therefore final locations will need to be confirmed.
 - ii. G41/0456 is not recommended as a monitoring bore due to deeper screen depth.
 - iii. Specifications for new monitoring bores should be relative to the groundwater table, not the land surface.
6. Sampling parameters and methodology: Field parameters (temperature, pH, Dissolved Oxygen, Electrical Conductivity and Oxidation Reduction Potential) should be measured at the time of sampling using a calibrated water quality meter in a flow cell. Samples should be collected after field parameters have stabilised to within 5% of the previous three measurements. Field filtering of samples must be completed for dissolved metals analysis. Samples should be analysed for Total petroleum hydrocarbons, total suspended solids, turbidity, and the routine drinking water profile including major ions (sodium, potassium, calcium, magnesium, alkalinity, chloride, sulphate, nitrate), copper, zinc, lead, Arsenic and E-coli, iron and manganese. Samples should be analysed for both total and dissolved metals.
7. The consent holder should submit an annual report on the results of water quality sampling and groundwater flow paths to the Consent Authority and the owners of sampled bores.
8. The discharge permit currently does not specify a location for the discharge. This means that the monitoring programme needs to be extensive enough to account for the fact that the settling pond can be moved, or the location of the discharge needs to be specified and the proposed monitoring locations need to be reviewed to reflect this decision.
9. Given the location of the excavation will move across the site, quarterly monitoring should be continued throughout the term of the consent.
10. Impacts on G41/0346, G41/0340 are unlikely due to their location 60 m from Lake Dunstan which means that groundwater quality is likely to be strongly affected by the lake. The location of monitoring bores should provide early warning for possible effects.



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