

Erosion and Sediment Control Assessment

Remarkables Ski Area Upgrades and Doolans Expansion Project

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Suitably Qualified and Experienced Professional

This Erosion and Sediment Control Assessment (ERSCAR) has been prepared by Tom Grandiek and Katy Bonacci and reviewed by Elisa Chillingworth, all of Enviroscope.

Katy holds two Bachelor of Science degrees, majoring in Environmental Science and Geography. Katy has experience preparing Environmental Management Plans and Erosion and Sediment Control Plans within the Queenstown Lakes District and wider Otago Region.

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Tom and Elisa meet the criteria of a Suitably Qualified and Experienced Professional (SQEP) for the purposes of preparing and reviewing this EMP and overseeing the environmental aspects of this project.

We confirm that we have read the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2023. This report has been prepared in compliance with that Code, as if it was expert evidence presented in proceedings before the Environment Court. Unless we state otherwise, this report is within my area of expertise, and we have not omitted to consider material facts known to us that might alter or detract from the opinions expressed in this report.

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Appendix 1	Universal Soil Loss Calculations
Appendix 2	Construction Environmental Management Plan

1.0 INTRODUCTION

1.1 Purpose

Enviroscope has prepared this Erosion and Sediment Control Assessment Report (ESCAR), on behalf of NZSki Limited to support the Fast Track Application for the Remarkables Ski Area Upgrades and Doolans Expansion Project (the Project). This assessment considers the following matters associated with earthworks for the Ski Area Expansion:

- Overarching erosion and sediment control principles and procedures relevant to the Project.
- Suitable erosion and sediment control measures to minimise erosion and manage sediment-laden runoff.
- An assessment of the effectiveness of those erosion and sediment control (ESC) principles and procedures in minimising potential sediment discharges to an acceptable level.
- Assessment of the receiving environment.

The purpose of this assessment is to consider the likely methods and practices that can be implemented during construction. Implementation of environmental controls during operations is aimed at avoiding and mitigating potential adverse effects on the receiving environment, with specific reference to freshwater waterbodies in the vicinity of the proposed expansion areas.

This report is to be read in conjunction with the following supporting documents, which provide detail in respect of the specific management measures and their implementation:

- **Appendix 2:** Construction Environmental Management Plan

1.2 Site Overview

The Remarkables Ski Area, located within the Rastus Burn Recreation Reserve, was established in 1985 and sits at an elevation of approximately 1,600 -1,940 m a.s.l. The ski area adjoins the Remarkables Conservation Area, and the access road traverses portions of Conservation Land. The ski area comprises three alpine cirques or bowls, covering approximately 540 ha, with around 385 ha of skiable terrain. Existing operations include eight lifts, four chairlifts and four surface conveyor lifts.

Access to the ski area is via the Remarkables Ski Field Access Road, which consists of approximately nine kilometres of sealed road and three kilometres of unsealed road. Both the existing Remarkables Ski Area and the proposed Doolans expansion are held within conservation estate.

The Doolans site is an alpine, backcountry basin located within the Doolans Creek Right Branch, to the east and south-east of the existing Remarkables Ski Area. This basin comprises a series of interconnected south orientating cirques, shelves, boulder fields and faces and has historically been used for outdoor recreation, including backcountry skiing and hunting.

The proposed Project extends from the base of the ski area access road, incorporating works associated with State Highway 6 and carpark upgrades, through to upgrades within the existing base building, and expansion into the Doolans Basin to create more skiable terrain. Works within the Doolans Basin will include new, ski trail development, access tracks, a reservoir, infrastructure upgrades, snowmaking, and associated facilities and services, which are outlined in greater detail in **Section 1.3**.

Although the proposed works are located on land managed by the Department of Conservation (DOC), land use and development activities are subject to the relevant zoning and district wide provisions under the Queenstown Lakes District Council (QLDC) and Central Otago District Council (CODC) District Plans, alongside the requirements of the Otago Regional Council (ORC) Regional Plan. Site characteristics are summarised in **Table 2,** and the subject site is shown in **Figure 1** below.

Table 2: Site Characteristics

Remarkables Ski Area Upgrades and Doolans Expansion Project		
Legal Description	Part Section 1 Block X Kawarau SD Ratus Burn Recreational Reserve Section 2 SO 22561 Ratus Burn Recreational Reserve Section 1 SO 22561 Ratus Burn Recreational Reserve Lot 2 DP 17411 Access Road and Carpark	Section 1 SO 24738 Conservation Land Section 12 SO 24636 Conservation Land Section 8 SO 24742 Conservation Land
Territorial Authority	QLDC and CODC	
Regional Authority	ORC	
Topography (site area)	The wider site is characterised by steep, high-alpine topography typical of the Remarkables, with elevation ranging from approximately 1,100 m a.s.l at the lower access road interfaces to over 1,940 m a.s.l across the upper cirques and proposed Doolans expansion area. The landscape comprises a sequence of glacially-formed cirques, tarns and over-steepened faces. Slopes commonly range between 25° and 45°, with localised terrain exceeding these gradients where schist bedrock outcrops and talus slopes dominate. The Doolans Basin consists of interconnected south to south-east facing bowls, benches and moraines, exhibiting pronounced alpine geomorphic features shaped by historic glaciation and ongoing freeze–thaw processes.	

Geology and Soils	A geological risk assessment report prepared by Stantec, dated 31 March 2023, reported on the geotechnical conditions of the Shadow Basin, within the Remarkables Ski Area and provides a reliable insight into the subsoil ground conditions of the site. The report notes that fluctuating glaciation within the Remarkables over the past 18,000 years has resulted in significant areas of exposed glacially eroded bedrock and areas of moraine. The report notes that the underlying rock on the Remarkables Range lies within the Caples terrane and consists of chlorite schist. Stantec have noted that this underlying rock is exposed in many locations. The report notes that both over-compacted moraine debris and blocky colluvium overlay the schist bedrock. They note that blocky colluvium extends down the Shadow Basin Cirque side along the Shadow lift alignment and that the depth of the surficial colluvium material is variable, and the overlying colluvium is often shallow with rock immediately below the surface. The growOtago ORC database classifies the soil group of the area as upland alpine shallow soil type. The soil profile is dominated by a shallow topsoil layer, overlying weathered schist rock. Narrow-leaved and slim snow tussock and shrubland overly the soil.
Waterbodies	The freshwater ecological characteristics of the receiving environments are described in detail within the Ecological Assessment prepared by e3scientific and should be read in conjunction with this report. The headwaters and upper tributaries of the Rastus Burn and Doolans Creek Right Branch are located throughout the respective upper basins where the ski area expansion works are proposed to occur. There are also Natural Inland Wetlands and Alpine Tarns present within both upper basins. Groundwater and aquifers are largely absent below the Rastus Burn Basin and Doolans Basin, due to the elevated nature of the subject site and relative depth of mapped aquifers in the area. However, perched groundwater and seepages are expected to be encountered during earthworks.

Climate (Wind, precipitation, temperature)	***It should be noted that the closest weather station to the Project is at Queenstown Airport, therefore climate data has been sourced from Queenstown Airport Data and the National Institute of Water and Atmospheric Research (NIWA).*** **Queenstown** It should be noted that as the subject site is located between 1,100 – 1,940 m a.s.l, m a.s.l, climatic variations are more severe at this altitude. The site is subjected to frequent strong winds from north-west to south-west quarter, sub -zero temperatures and permanent snow cover from early June until late October. The majority of the information within this section was taken from NIWA's The Climate and Weather of Otago 2nd Edition (2015)[1]. The data and figures were compiled from observations over a 30-year period from 1981-2010. It is likely that present-day weather patterns have a slightly larger range and scale due to climate shifts. Unless otherwise noted, Queenstown specific data was taken from readings at the Queenstown Airport. **Wind** The prevailing wind direction to be predominantly from the west and the north-east with a yearly average windspeed of approximately 10.5 km/hr in Autumn and Winter, and 13.3 km/hr in Spring and Summer. Wind velocity is typically highest in the late afternoon, and lowest in the early morning. Additionally, Queenstown Airport only experiences approximately two days per Summer and Spring season where average windspeeds exceed 30 km/hr; although, gusts exceeding 61 km/hr are experienced approximately 30 days per year. **Precipitation** Queenstown receives fairly steady moisture accumulation throughout its seasons. The seasonal average ranges from approximately 61 mm/month in Autumn and Winter to 64 mm/month in Summer and Spring. The wettest month is December, with a 76 mm/month average rainfall. **Temperature** Queenstown typically records a highly daily average temperature through the summer and a lower daily average through the winter due to its elevation and inland location. According to the Remarkables Skifield Expansion Project Ecological Assessment prepared by e3 Scientific in May 2026, the mean monthly temperature in Queenstown is 15.9°C in July to 3.8°C in July. At elevations of approximately 1,500 m on the Remarkables, mean temperatures are expected to be 10-12°C lower than those recorded in Queenstown, consistent with altitudinal temperature gradients described by Meurk (1982).

[1] Macara, G. R. (2015). Climate and weather of Otago (2nd ed.). National Institute of Water and Atmospheric Research (NIWA). https://webstatic.niwa.co.nz/library/NIWAsts67.pdf

Vegetation	Vegetation across the Remarkables Ski Area and Doolans Basin represents a largely intact high-alpine ecosystem. The landscape is dominated by snow tussock grassland, with slim snow tussock (*Chionochloa macra*) occupying higher elevations and narrow-leaved snow tussock (*C. rigida*) more common on lower slopes and terraces. These tussocklands are interspersed with a diverse assemblage of native herbs, alpine grasses, and low-growing forbs. On exposed ridgelines, upper cirque faces, and wind-scoured knolls, vegetation transitions to cushionfield communities, including *Dracophyllum muscoides*, *Phyllachne rubra*, and other stress-tolerant alpine specialists. Rockfield and outcrop habitats are widespread on steeper slopes, where vegetation is sparse and confined to pockets of shallow fine material. Lower slopes and basin floors within the Doolans contain a mosaic of wetland and seepage environments. These wetland communities support dense cover of obligate wetland species such as *Oreobolus pectinatus*, *Schoenus pauciflorus*, *Caltha obtusa*, and *Carex gaudichaudiana*, and occur in depressions, drainage lines, and areas with sustained saturation or perched hydrology. (Assessment courtesy of e3scientific ecological assessment).
Contaminated Land	Two existing HAIL sites exist within the Remarkables Ski Area and are listed below. At the time of preparing this report, there are no other known sites of known contaminants, within the proposed Ski Area Upgrades. HAIL.00485.01 – Remarkables Maintenance Yard Diesel Tank HAIL.00771.01 – Shadow Basin Chairlift Diesel Tank

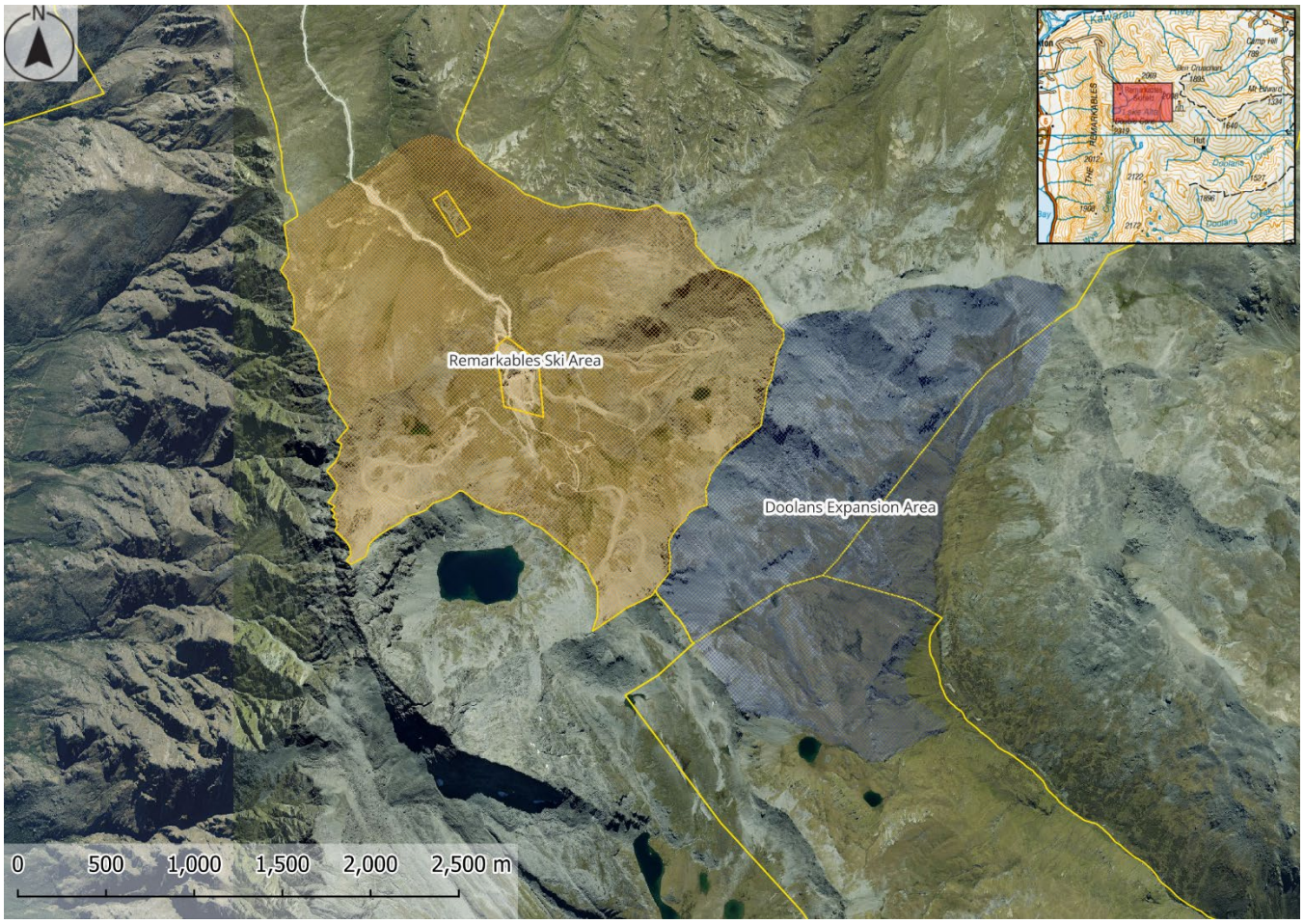


Figure 1: Location of the Site (Source: QGIS)

1.3 Description of Activities

NZSki is seeking all the requisite approvals under the Fast-Track Approvals Act to remove and modify indigenous vegetation, complete earthworks, and construct and operate additional ski area infrastructure within the Remarkables Ski Area and Doolans Basin. The proposed scope of the Project will be undertaken in a phased manner. The Project's phasing is indicative and subject to change. The phasing outlined below provides a general framework for the order of operations:

Construction Season 2026 - 2027

- Base Area Excavations and Services Diversions
- Base Building and Gondola Foundations (1-7)
- Midstation / Rastus Burn Access Roads and Services
- Ratus Burn Temporary Access Roads, Laydown Areas and Construction Platforms
- Ratus Burn Gondola Towers
- Doolans Access and Services
- Rastus Burn Wastewater Investigations

Construction Season 2027 - 2028

- 33KV Power Upgrade
- Superstructure Base Building and Gondola
- Mid Station Earthworks and Foundations
- Doolans Gondola Towers
- Doolans Access and Services (Continued)
- Reservoir and Pump Shed
- Doolans Ski Trails and Snowmaking Infrastructure
- Doolans Base Area Earthworks and Water Storage Tanks

Construction Season 2028 - 2029

- Lower Carpark Expansions
- Superstructure Base Building and Gondola (Continued)
- Mid Station Gondola and Patrol Hut
- Doolans Gondola and Cabin Building
- Water Storage Tanks
- Water Intake Access Road and Infrastructure
- Reservoir, Water Intake and Snowmaking Commissioning
- Ratus Burn Wastewater Onsite Disposal

Construction Season 2029 - 2030

- State Highway 6 Intersection
- Doolans Cabin Food and Beverage
- Snow Play Zone, Conveyor and Snowmaking Infrastructure
- Trail Development and Operational Improvements
- Rastus Burn Wastewater Onsite Disposal

The most up-to-date earthworks areas and volumes for each construction season of works are detailed in **Table 3** below.

Table 3: Earthworks Quantities

Description	Volume m^3	Area m^2
Construction Season 2026-2027 (Season 1)		
Cut	37,284	-
Fill	37,802	-
Season 1 Total	**75,086**	**45,603**
Construction Season 2027-2028 (Season 2)		
Cut	66,466	**-**
Fill	59,399	**-**

Season 2 Total	**125,865**	**44,390**
Construction Season 2028-2029 (Season 3)		
Cut	49,593	-
Fill	74,485	-
Season 3 Total	**124,078**	**59,550**
Construction Season 2029-2030 (Season 4)		
Cut	44,797	-
Fill	79,410	-
Season 4 Total	**124,207**	**62,500**

2.0 STATUTORY CONSIDERATIONS

2.1 Fast-Track Approvals Act 2024

The Project is being progressed under the Fast-track Approvals Act 2024 (FTAA), which establishes a consolidated approvals regime for nationally or regionally significant projects.

The Act establishes the expert-panel process, which must evaluate whether the environmental effects of the Project; including erosion and sediment generation and discharges have been sufficiently avoided, remedied, or mitigated within the context of the streamlined approvals system.

2.2 Resource Management Act 1991

Under the RMA 1991, land-disturbing activities are managed through Section 9 of the Act, and any discharge of contaminants, including sediment to land or water is regulated under Section 15 of the Act. National Environmental Standards, National Policy Statements, and regional and district plans give practical effect to these requirements.

Section 105 of the RMA requires that any discharge application considers the nature of the discharge, the sensitivity of the receiving environment, the reasons for choosing the proposed discharge method, and any feasible alternatives. The ESCAR has been undertaken with these considerations in mind.

2.3 National Environmental Standards for Freshwater (NES-F, 2020)

These standards regulate activities that may affect freshwater bodies, including earthworks that generate sediment-laden runoff. Controls and design measures must ensure that sediment discharges are minimised to protect receiving environments.

2.4 National Policy Statement for Freshwater Management (NPS-FM, 2020)

The NPS-FM requires the protection and improvement of freshwater health. This includes managing sediment generation from land-disturbing activities to avoid adverse effects on aquatic ecosystems. The ORC has proposed a progressive implementation plan for meeting the NPS-FM 2017 and includes objectives and targets for FMUs in accordance with the requirements of the NPS-FM. However, it is noted that this process has been required by the current government to be ceased.

2.5 Department of Conservation (DOC)

The DOC remains a key stakeholder for any works occurring within the Remarkables Ski Area, Doolans Basin and Public Conservation land. The Project is required to operate in accordance with the established *Alpine Works and Rehabilitation Protocol* agreed between DOC and NZSki as well as any necessary Wildlife Act Permits or concessions issued by DOC. The protocol outlines DOC's expectations for environmental protection, vegetation handling, erosion and sediment control, and post-construction rehabilitation in the alpine environment.

2.6 Regional Plan: Water for Otago (Otago Regional Council)

While consents are not issued under the standard Otago Regional Plan: Water for Otago, the expert panel must still consult with and assess effects against this, ensuring earthworks-related sediment risks are appropriately managed. This includes alignment with regional or nationally recognised erosion and sediment control (ESC) best-practice guidance.

2.7 District Plan Provisions (Central Otago District Council and Queenstown Lakes District Council)

Across both districts, the respective district plan provisions seek to ensure that land disturbance is carried out in a manner that maintains slope stability, avoids excessive sediment generation, protects natural character, and minimises adverse effects on waterbodies, indigenous vegetation, people and culturally significant landscapes. The Expert Panel must still have regard to the relevant district plan objectives and policies when considering the scale and nature of environmental effects.

The ESCAR responds directly to these policy directions by assessing and providing best practice management measures that prioritise erosion prevention, progressive rehabilitation, and minimal-disturbance techniques, consistent with both CODC's and QLDC's expectations.

2.8 Water Conservation (Kawarau) Order 1997

The Kawarau River is the predominant receptor for both the Rastus Burn and Doolans Creek Right Branch catchments, where some of the proposed upgrades are occurring. The Kawarau River has outstanding values recognised by a water conservation order under the Resource Management Act. The order protects the Kawarau River and its tributaries, including Lake Wakatipu, for their outstanding natural characteristics and cultural, recreational, and ecological values. Key points include:

- **Protection of Natural Characteristics:** The Order recognises the river system's scenic beauty, clear waters, and unique biodiversity, safeguarding these features from significant alterations.
- **Recreational and Cultural Significance:** It protects the river's value for activities like fishing, kayaking, jet boating, and its importance to local Māori for cultural practices.
- **Flow and Water Quality Standards:** The Order sets specific water quality standards, flow requirements, and water use restrictions to maintain ecological health and prevent degradation from activities such as damming or pollution.
- **Restrictions on Water Use and Development:** Limitations are placed on water rights and activities that could negatively affect the river's flow, quality, or character, ensuring sustainable management aligned with conservation priorities.

2.9 Industry Best Practice Guidelines

Erosion and sediment controls shall be designed and installed in accordance with current best practice guidelines (see **Figure 2**, **to the extent practicable**, recognising the site's unique characteristics. Generally, this is:

- Erosion and Sediment Control Guidelines for Land Disturbing Activities in the Auckland Region 2016 (Auckland Council Guideline Document GD2016/005).
- QLDC Guidelines for Environmental Management Plans, June 2019 (The Guidelines).

- Department of Conservation and NZSKI Ltd. Protocol for the Rehabilitation of Natural Alpine Environments Following Ski Area Development.
- Ministry for the Environment (MfE), National works in waterways guideline-best practice guide for civil infrastructure works and maintenance.

GD05 ARC Guidelines

QLDC Environmental Guidelines

Figure 2: QR Codes

3.0 EROSION AND SEDIMENT CONTROL

3.1 Objectives

Due to the alpine environment, the practical installation of GD05 design sediment controls is not always feasible and ultimately incurs greater disturbance of the local flora and fauna. Therefore, a focus on proactive erosion control is adopted to minimise erosion occurring in this first instance and reduce sedimentation. Erosion and sediment control provided for in this assessment and the CEMP and ESCPs is adopted to provide low-impact design, whilst minimising potential adverse effects on surrounding receptors.

In line with The Remarkables Ski Area Upgrade & Doolans Expansion Project- Stormwater Concept Report (Stantec 2026a), existing sheet flow and natural surface water pathways have been retained wherever practicable across trails and roads within the Rastus Burn Basin and the proposed access and ski trail in the Doolans basin. This has been achieved by avoiding the construction of swales and channels that would otherwise intercept, divert, and concentrate flow.

Instead, existing sheet flow patterns and ephemeral watercourse pathways have been preserved to maintain their natural function. Surface water is encouraged to disperse and pass across roads and trails, rather than being collected in swales and channels. This approach maintains, as closely as practicable, the original natural surface sheet flow regime and reduces alteration to the existing hydrological processes.

3.2 Erosion and Sediment Control Principles

ESC devices shall be installed, maintained and decommissioned in accordance with the following principles:

- To ensure that there is a minimum of interference with the natural environment, and avoidance of disturbance to areas outside approved work areas.
- Culverts will only be installed where splash crossings or sheet flow are impracticable due to topography, safety, or environmental constraints.
- Where culverts are required, inlet and outlet scour protection.
- To ensure that any indigenous vegetation disturbed by development is restored as near as possible to its original density and diversity, within the shortest practical timeframe.
- To minimise the erosion and sedimentation of exposed soils (and soil among transplanted vegetation), optimising the long-term regeneration of indigenous vegetation through natural dispersal.
- Erosion and sediment controls are integrated with construction planning.
- Construction is staged to minimise the duration and area of exposed soil open at any one time.
- A ‘treatment train’ approach is used so that the sediment retention devices operate as efficiently and effectively as possible.
- Separation of ‘clean’ and ‘dirty’ water with clean water to be diverted around the site to minimise the volume of dirty water needing management onsite.
- The duration of soil exposure is minimised.
- Controls are always maintained in proper working order.
- Progressively stabilise and revegetate disturbed or completed areas.
- The site is monitored, and erosion and sediment control practices are adjusted to maintain the required performance standard.

- Soil erosion is minimised as far as reasonable and practical.
- Avoidance of sediment discharge off-site and protection of receiving environments.

3.3 Erosion and Sediment Control Devices

The following provides a high-level overview of the erosion and sediment controls that will be utilised across the Project area. Specific detail with respect to each control measure, along with, where, when, what and how they will be utilised is provided in the overarching CEMP and project specific ESCPs, attached as **Appendix 2.**

3.4 Erosion Control Practices

3.4.1 Non-Structural Controls

The key principles of erosion control are outlined below. These principles and concepts provide guidance for ESC throughout the planning, construction and maintenance phases of a project. Construction activities are typically concentrated within the spring, summer and autumn construction period, reflecting alpine access constraints and the operational requirements of the ski season. Where works are not completed within a single construction season, work areas will be stabilised and left in a safe condition, including, where necessary, temporary reinstatement or protection measures, to enable safe transition into winter ski area operations and Doolan's Basin winter recreational access.

Staging

Only by exposing those areas that are required for active earthworks, the duration of exposure and risk of erosion and sedimentation can be minimised. 'Earthworks staging', where the site has earthworks undertaken in smaller units over time, limits erosion. Staging is demonstrated in the Erosion and Sediment Control plans attached as **Appendix 2** and has been outlined in **Section 1.3.**

Timing

It is recommended that works are undertaken outside of significant or adverse weather events (e.g. during sustained periods of rainfall, or snow and ice, or dry and windy periods that are conducive to exacerbated rates of erosion and sedimentation).

Progressive Rehabilitation

A focus on progressive rehabilitation is necessary to reduce the exposed catchments and reduce the possibility of erosion and sedimentation from occurring. Rehabilitation measures are outlined below:

- Existing vegetation is initially stripped and located above the cut batters to form clean water diversion bunds and dirty water diversion bunds downslope of excavations.
- Existing vegetation and topsoil are immediately placed over cut and fill batters to stabilise the works area, once design levels have been reached.
- In areas where vegetation is sparse, reinstating with rocks and boulders provides rapid rehabilitation.

3.4.2 Stabilisation Measures

Revegetation

- Vegetation along with the topsoil and roots will be carefully excavated to keep the roots intact so it can be reinstated back with the plants (e.g. tussock) intact to enable quick re-establishment.

- In some areas at lower elevations, an alpine mix of seed, previously harvested from the site, is recommended to be hand-sown where vegetation re-establishment is struggling.

Access Tracks and Ski Trails

- Road and trail surfaces will be armoured using well-graded granular material to resist erosion under sheet flow conditions.
- Localised rock armouring will be provided at flow transition points, splash crossings, culvert outlets, and roof runoff discharge areas as required.

Erosion Matting

- There are many different types of erosion matting, and the product selected should be done so under the direction of an appropriately qualified person.
- Biodegradable erosion matting like coconut fibre or wool matting material can be utilised on lower-grade slopes and actively promote revegetation, subject to DOC approval.
- A more robust geotextile erosion matting may be required on high-grade batters with higher susceptibility to further mobilisation of material, or areas subject to fluvial undermining. Geofabric lining is to be installed as per Geotechnical recommendations. Efforts should be made to source erosion matting with neutral colour tones that will blend with the existing catchment tones to reduce visual effects.
- Where and when erosion matting is utilised needs to be undertaken per the direction of the Geotechnical Engineer and Environmental Consultant.

Soil Stabilising Polymers

- Erosion control, soil binders or polymers may be utilised as a short-term ground protection agent (generally less than 6 months) on exposed surfaces prior to final shaping and treatment. Polymers help bind soil particles and produce a 'laminated' surface area, reducing susceptibility to erosion. A proven, environmentally safe product should be utilised under the direction of the project SQEP and subject to DOC approval.
- Use of soil binders is not considered appropriate where the established soil crust is likely to be damaged, or within areas of concentrated flow or where periodic inundation is likely to occur. It is also emphasised that the use of soil binders does not constitute stabilisation of the site, but rather as a temporary mitigation measure against the potential effects of raindrop and/or windborne erosion.

3.4.3 Site Access

The Remarkables Ski Area has multiple existing stabilised access points, and machinery and plant will be confined to the consented earthworks footprints. Existing access tracks will be utilised to access the proposed earthworks areas to reduce impacts on the existing flora and fauna.

Any tracking over the site shall follow the path of least disturbance and/or the nominated access tracks as shown in the site-specific erosion and sediment control plans. Protective matting, or site won rock, can be utilised in areas within direct proximity of critical source areas, as directed by the project ecologist and where they can safely be deployed without causing a slipping hazard.

3.4.4 "Clean Water" Diversion Channels and Bunds

Clean water diversion channels and bunds (CWDC/CWDB) will be used to capture and divert clean water from the undisturbed surfaces above the exposed works site. The purpose of these devices is to separate clean and dirty water and minimise the size of the contributing catchment.

Due to the steep slopes, as well as a requirement to avoid damaging indigenous vegetation as far as reasonably possible, the vegetative layer of topsoil and root zone should be pushed upwards above the intended cut area to form a vegetated earth bund. Where possible, the topsoil will be carefully lifted and folded over to keep roots intact so it can be folded back with plants (e.g. tussock) intact to enable quick re-establishment. The clean water diversion bund shall be installed on contour and direct upslope sheet flows to the adjoining flow paths.

3.4.5 "Dirty Water" Diversion Channels and Bunds

Dirty water diversion channels and bunds (DWDC/DWDB) will be installed to capture and carry sediment-laden stormwater to the respective sediment control device.

Concentrated flows in the steep alpine environment are generally not advantageous, and with limited areas for sediment attenuation devices, implementing DWDCs is not always feasible. Due to the nature of the proposed earthworks to form ski trails that largely match the existing terrain and trenching, which is excavated and backfilled in a staged manner, there is limited opportunities to effectively install DWDCs.

Dirty water diversion bunds can be used to good effect at the base of excavations to attenuate surface water sheet flows from upslope. The use of heavily vegetated dirty water diversion bunds at the base of excavations has been successfully implemented during earlier phases of development across other projects within the Remarkables Ski Area, as well as other ski areas in the district, overseen by Enviroscope.

3.4.6 Contour Drain

Contour drains will be installed to reduce the slope length and thereby reduce the velocity and erosive power of dirty water runoff. Flows caught by the contour drains will be directed into the nearest sediment control measure, before out letting towards an appropriate flow path or a water body.

3.4.7 Check Dams

Rock check dams will be deployed primarily to reduce the velocity of concentrated flows in the DWDCs and DWDBs. They will also act to capture some coarse sediment. Surrounding rock won during excavations can be utilised to form the check dams, reducing the necessity to transport rock to the site.

3.4.8 Drop-Out Pits

Drop-out pits can be used within the DWDCs and DWDBs to good effect as they:

- Allow the heavier coarse sediments to drop out, preventing them from entering the sediment retention devices, and reducing loads on these devices.
- To act as a sump joining two intersection channels or bunds.

3.4.9 Pipe-Drop Structures

Pipe drop structures shall be used to transport clean water that may terminate from waterbodies or ephemeral flow paths without causing erosion through works areas. Due to the alpine environment, it is common to encounter clean water seepages or flows generated from flow paths during rainfall events and/or snow and ice melt. While care has been taken to avoid all prominent waterbodies and flow paths, the proposed earthworks will encounter some areas of clean water that will need to be conveyed around, or over the works area safely.

3.4.10 Culverts

Culverts shall be used onsite to transport 'clean' or 'dirty' water under ski trails and access tracks. Culverts shall consist of a PVC culvert, and follow the detailed design provided in Stantec's Stormwater Concept Report (Stantec 2026a). Geofabric and rock shall be placed at the inlet and outlet to prevent scour from the higher velocity water exiting the culvert.

3.4.11 Trafficable Swales

Trafficable swales will be installed at low points in the access tracks and ski trails, to provide sheet flow to flow across the trail surfaces, mimicking sheet flows, as designed in (Stantec 2026a). Trafficable swales shall have a drop out pit and coconut coir log installed at the outlet during construction, to reduce water velocities and capture sediments.

3.4.12 Splash Crossings

Splash crossings will be used preferentially over culverts for water body crossings where traffic volumes and gradients allow. Splash crossings maintain hydrological continuity, reduce blockage risk, and minimise long-term maintenance requirements in alpine conditions. Splash crossings will be rock lined.

3.4.13 Level Spreader

Level spreaders are commonly utilised in alpine environments to convert concentrated flows into sheet flows. The use of a level spreader assists in dissipating flows before directing via a suitable sediment control before being routed into adjoining waterbodies or overland flow paths.

3.4.14 Stockpiles

Stockpiling of materials on site will be required for stripped topsoil/vegetation/rock stockpiled for respreading across the site, suitable cut materials stockpiled for filling other areas of the site and imported fill materials stockpiled for sequenced filling works.

Ensuring they are placed on stable ground away from critical source areas is key. Employing sediment controls downslope of stockpiles is critical, as well as active stabilisation of stockpiles that may be present for some time. Stockpile locations will be carefully considered and demonstrated in the erosion and sediment control plans.

3.5 Sediment Control Practices

3.5.1 Decanting Earth Bund

Decanting earth bunds (DEBs) are to be used to capture flows from larger earthworks extents and allow sediment to settle out of the water column. These are initially earmarked to be utilised at the base of larger earthworks extents, where gradient permits their installation, like the base building, lower gondola terminal in the Doolans Basin, and any other viable locations along the ski trails or access tracks.

Due to the steep and sensitive alpine environment, the ability to excavate areas to form GD05 design DEBs may not be feasible, but every effort should be made to construct them to their maximum size. If, through bench testing, it is determined that chemical treatment of the soils can provide tangible environmental benefit, then the DEBs will be chemically treated in accordance with an approved Chemical Treatment Management Plan (CTMP).

3.5.2 Sediment Sumps

Sediment sumps or small sediment basins will be excavated at the termination of the 'dirty' water diversion channels or bunds to manage smaller catchments ≤2000 m^2, where fall cannot reach more formalised retention devices or the topography does not support the construction of more formalised retention devices. Sediment sumps function as an important element of the 'treatment train' approach, whereby flow velocity is reduced, and sediment can settle out of suspension before overflowing into adjoining overland flow paths or waterbodies.

Sediment sumps shall typically be formed to dimensions of 2.0 m W x 2.0 m L x 1.0 m D, though depth should vary depending on the subsoil media. It is important that sediment deposits are regularly cleared from the sump to maintain exposure of these free-draining soils. A spillway should be constructed and lined on the downslope wall of the sediment sump, ensuring the lining is secured in place to avoid erosion and undercutting.

3.5.3 Chemical Treatment

Chemical treatment is not initially proposed for this project due to the difficulties of implementing in the alpine environment, particularly the inability to practically install sediment retention ponds (SRPs) and DEBs. Snow and ice encountered throughout the year traditionally inhibit effective dosing of coagulants and flocculants.

If chemical treatment is deemed necessary based on daily, weekly and monthly environmental inspections as defined in the CEMP, a CTMP shall be prepared by Enviroscope. Bench testing will be undertaken to confirm chemical treatment requirements. This will ensure that the selected flocculant or coagulant is dosed at appropriate rates to cause efficient coagulation whilst avoiding potential contamination in receiving waterways.

3.5.4 Standard Silt Fence

A silt fence (SF) is a temporary barrier of woven geotextile fabric that is used to capture mainly coarse sediments carried in sheet flow. Its purpose is to detain runoff flows so that deposition of transported sediment can occur through settlement. They are not used to filter sediment out of runoff.

SFs are appropriate where there is a need to control sediment by intercepting sheet flow, where a site is low gradient, or is confined with a small contributing catchment, such as short batter fills and around watercourses, to delineate the limit of disturbance on an earthworks site, such as riparian areas or bush reserves, or where installation of an earth or topsoil bund would impact sensitive areas, such as indigenous flora, fauna or waterbodies.

A standard SF can be used to capture potential sheet flows from smaller catchment areas, and in sheltered areas, unlikely to be exposed to severe winds and snow. Exact SF locations are to be confirmed by the environmental consultant and ecologist subject to ground conditions during initial excavations. This is to ensure best practice control with the least ecological impact is selected.

3.5.5 Super Silt Fence

Super silt fences (SSF) temporarily impound sediment-laden runoff, reduce velocities and allow sediment to settle out of the water. The use of SSFs is like that of SFs. However, SSFs are more robust devices that are appropriate to control runoff from steeper or larger catchments than SFs. SSFs can be utilised to greater effect in the alpine environment as they provide a greater level of tensile strength. SSFs are to be utilised below any fill areas within direct proximity of waterbodies.

The anchoring of the SSF will ensure stability, and the double-layered geotextile will ensure that finer grades of sediments will be captured prior to any water filtering through the fabric. This solution will be adopted in a restricted manner, as the nature of the alpine environment makes erecting and maintaining SSFs in wind zones very difficult. As a staged approach is being undertaken along with progressive rehabilitation, contributing exposed works areas are limited as far as reasonably practicable. Exact SSF locations are to be confirmed by the environmental consultant and ecologist, subject to ground conditions during initial excavations. This is to ensure best practice control with the least ecological impact is selected.

3.5.6 Turkey Nest

A turkey nest is typically constructed using a physical structure wrapped in a layer of permeable geotextile matting to act as a means of filtration via dewatering. The turkey nest should be constructed utilising hessian sack sandbags wrapped in geotextile material with the dimensions of 2000 x 1500 x 500 mm (L x W x H). The geotextile should consist of non-woven needle-punched geotextiles and be manufactured from the extrusion of polymer fibres which are then laid down on a manufacturing ‘bed’. They are then needle punched to entangle the threads, resulting in a permeable, yet dimensionally stable product which provides filtration. Spare geotextile matting should be readily available on-site to replace the used matting, which will lose its filtration capabilities after use.

3.5.7 Coconut Coir Log

Coconut coir logs can be considered both an erosion and sediment control. Coconut coir logs will act to reduce the slope length and thereby reduce the velocity and erosive power of dirty water sheet flows, whilst capturing entrained sediment. During excavations, if exposed areas cannot be quickly stabilised prior to forecast rainfall events, coconut coir logs shall be installed below excavated areas, and on contour across excavated slopes to reduce slope length and capture entrained sediments, subject to DOC approval.

The use of coconut coir logs is technically outside of the GD05 specifications due to the slope and extent of some of the contributing catchments, however there are mitigating factors that justify their use, as explained below.

- They can be utilised in exposed, high wind and snow zones without becoming severely damaged, unlike silt fences.
- Coconut coir logs have a reduced effect on local biota as they do not require machinery to disturb ground by digging/trenching them into place. They can be robustly secured utilising pegs and rope.

- They are constructed with a biodegradable product that does not bioaccumulate or produce waste in the sensitive alpine environment. They provide short- and long-term erosion and sediment mitigation, as well as a suitable medium for vegetation to bind to and reestablish.
- They can be deployed and decommissioned rapidly to allow for works to be staged and rehabilitated as required by this plan. They are also reusable and can be utilised on a continuous basis across independent stages.
- They do not pose a health and safety risk for recreational users of the ski trails if they become enveloped by snow.

3.6 Works in Waterbodies

Some earthworks associated with the Remarkables Ski Area Expansion occurs within waterbodies such as wetlands, cushion bogs, ephemeral overland flow paths and alpine streams and tarns.

Temporary waterway diversions enable works to be undertaken without working in wet conditions and without displacing excessive loads of sediment into the waterbodies. These measures seek to divert all flow via a stabilised system around the area of works and discharge it back into the waterbody, below the works to avoid scour of the channel bed, whilst maintaining the hydrological neutrality and integrity. This is to be completed using the methodology outlined below, which has been prepared in accordance with Section G4 of GD05 best-practice methodology for works within a watercourse. The Remarkables Ski Area Upgrade & Doolans Expansion Roading, Stream Crossings and Stormwater Freshwater Ecological and Hydrological Impact Assessment, prepared by e3Scientific Limited for NZSki Limited (e3 scientific 2026b), has been adopted for works within waterbodies and recommendations adopted in this report and **Appendix 2**.

The predominant methodology when crossing waterbodies to undertake earthworks will be the temporary diversion of the waterbody by utilising a pipe-drop structure and installation of culverts. This will ensure the least disturbance to flora and fauna and a practical measure that enables earthworks to be undertaken quickly, in a dry environment. The following measures should be undertaken when crossing waterbodies:

- Apply MfE (2021) in-water works guidance, minimising the active works footprint.
- Prior to construction, the boundaries of wetlands within 10 m of the planned road should be marked out to ensure that all contractors are aware of the location of wetlands and to ensure they are not damaged.
- Soil binding polymers are not to be used, in direct proximity to water bodies.
- Dewater works areas using short diversions and pump sediment laden water to appropriate control devices.
- Stabilise disturbed streambanks with geotextile matting and eco sourced native tussock plantings.
- Include cement use management procedures in the CEMP.
- Biosecurity measures are in place after the last Rastus Burn stream Crossing to ensure didymo is not transferred to Doolans Basin tributary streams.
- Undertake works, as far as practicable, when flows in the waterbody or wetland are low.
- Where possible, undertake works in the dry bed.
- Ensure the sediment losses to water are avoided.
- Ensure machinery used within the waterbody or wetland boundaries is cleaned prior to entering the area.
- Have general purpose and hydrocarbon spill kits on hand.
- Ensure that fuel storage tanks and machinery stored in the construction area are always maintained to prevent leakage of oil and other contaminants into the waterbody.
- No refuelling of machinery must occur within the waterbody.

- Any wetland being temporarily removed must be removed in a way that it retains as much of the vegetation, roots, and topsoil as possible.
- Ensure the consented structures in the bed are stabilised and/or armoured to prevent scouring and erosion.

3.7 Dust Control Practices

Dust from construction activities, vehicle movements and stockpiles can create a nuisance to local flora and fauna, contractors and staff. The key risks associated with dust occur during the bulk earthworks phase of the project.

There are a range of activities that may produce dust onsite including:

- General disturbance of soil (particularly during drier months).
- Inappropriate staging that does not seek to minimise the extent of exposed soil.
- Vehicle movements along access tracks.
- Stockpiling of vegetation, topsoil or subsoil.
- Slow or ineffective revegetation procedures.

The following measures will be deployed to ensure dust generation onsite is minimised:

- Stage works where possible to minimise soil exposure extents and timeframes.
- Stabilise disturbed areas progressively throughout construction.
- Dust suppression of exposed areas and stockpiles by sprinklers, k-lines, approved by the Environmental Representative.
- If dust activities cannot be controlled during high winds, works will cease until favourable conditions return.
- Only designated access tracks are to be used.
- A speed limit will be posted as 20 km/hr.
- To avoid spillage risks, trucks will not be overloaded.
- Stockpile heights are to be minimised where possible (< two metres) and should be temporarily stabilised (e.g. a biodegradable erosion matting, soil stabilising polymer).
- Long-standing topsoil stockpiles shall be stabilised and cleanfill or aggregate stockpiles that are easily erodible should have erosion matting or soil stabilising polymer applied to them.

3.8 Maintenance of Erosion and Sediment Control Devices

Ongoing maintenance of the site shall be undertaken as follows and as summarised in **Table 4**:

Regular and Weather-Responsive Inspections

- Daily visual checks during active earthworks.
- Prior to and Post-Rainfall Inspections: Mandatory within 24 hours before or after rainfall events.
- Weekly formal inspections by the Environmental Representative.

Prompt Corrective Action

- Address any identified damage, blockage, or failure immediately and always before the next forecasted rainfall.
- Sediment removal and maintenance must prevent any reduction in treatment capacity.

Structural Integrity

- Check for scouring, undercutting, collapsed batters, or overtopping.
- Ensure all outlet structures, spillways, and decant systems remain stable and functioning as per design specifications.

Access and Health & Safety

- Maintain safe access routes for inspection and maintenance crews.
- Ensure no instability or unsafe conditions develop around ESC devices.

Table 4: Typical Maintenance Requirements

ESC Device	Maintenance Requirements
Sediment Sumps	Remove sediment at 20% capacity and inspect spillways and emergency overflow pathways.
Silt Fences / Super Silt Fences	Clear trapped sediment before it reaches 1/3 height, repair rips or leaning posts, ensure toe-in is maintained.
Diversion Channels and bunds	Remove sediment buildup, repair erosion or bank failures, keep linings (if any) secure.
Decanting Earth Bunds (DEBs)	Maintain decant system, clear sediment as per thresholds, repair structural damage.
Check Dams / Level Spreaders	Remove sediment buildup, repair armouring (rock or geotextile) to avoid scour.

3.9 Rapid Response Procedure for Significant or Adverse Weather Events

The Environmental Representative (ER) will maintain active and ongoing monitoring of weather forecasts from reliable sources (e.g., MetService, NIWA) throughout the duration of earthworks. The ER will ensure that sufficient preparation time is allowed for site crews to inspect, maintain, and reinforce erosion and sediment control (ESC) measures prior to any significant or adverse weather event.

Weather Forecast Monitoring

- The ER will check and document daily weather forecasts, including short-term severe weather warnings.

Pre-Rainfall ESC Inspections

- Conduct thorough inspections of all ESC devices (e.g., DEBs, silt fences, diversion channels/bunds, check dams) at least 24 hours prior to the forecast event to confirm functionality and available capacity.

Stabilisation of Exposed Areas

- Apply temporary stabilisation measures (e.g., vegetation, site won rock, polymers/soil binders, erosion/geotextile matting) to exposed, inactive, or at-risk areas.

Suspension of Earthworks

- Temporarily cease earthworks activities on vulnerable areas prior to and during the forecast event to minimise active soil exposure.

ESC Maintenance

- Undertake any necessary sediment removal (e.g., from DEBs, sediment sumps, or silt fences) and repair any structural damage or undercutting identified.

Spare erosion and sediment control products should be stored onsite at all times including but not limited to:

- Silt fencing (x5).
- Waratahs (x50).
- Spare high tensile wire.
- 110 mm Novacoil pipe (at least 50m).
- Silt fence clips (x50).
- Pump and generator.
- Rock rip rap for check dams and culvert inlets and outlets.
- Geofabric x 4 rolls.
- Coconut coir logs (x20)
- Sandbags (x10)

Active Monitoring During Rainfall (Where Safe)

- During prolonged rainfall events, and where safe to do so, the ER or delegated site personnel will monitor key ESC measures for overtopping, bypassing, or failure.

Emergency Repairs

- Be prepared to undertake immediate reactive maintenance if any ESC device shows signs of failure during the event.

Snow and Ice

- Remain vigilant of the forecast and inspect ESC devices prior to forecast snow events, during thaws.
- Where possible, avoid starting new earthworks just before snow or icy conditions.
- Direct meltwater away from exposed soil and toward the DEB or sediment sump.
- Ensure ongoing maintenance of the drop-out pits, sediment sumps and check dams to slow down meltwater flow to reduce erosion and promote sediment settlement.
- As soon as conditions allow, repair any damaged ESC devices and reapply mulch or geotextile fabric where needed.

Record Keeping and Reporting

All pre- and post-weather event inspections, maintenance actions, and site observations shall be recorded in the site's ESC inspection and maintenance logs provided in the CEMP. Where required by consent conditions, notifications and significant event reporting (e.g., turbidity exceedances or ESC failures) will be provided to the relevant District and

Regional Council Compliance Monitoring staff (e.g., ORC, CODC, QLDC) in accordance with consent condition timeframes.

3.10 Decommissioning and Removal

Erosion and sediment control devices will remain in place until 'stabilisation' of the site has been achieved. This is generally defined as 80% vegetative cover. Within the alpine environment, site 'stabilisation' will focus on reinstatement of vegetation initially stripped from the works area, with cut-and-cover techniques employed to retain topsoil, organic matter, and the indigenous vegetation present, thereby supporting natural regeneration and long-term surface stability. Due to the presence of extensive rock at higher elevations, replacing rock over disturbed surfaces also provides a suitable level of stabilisation and will be adopted extensively. Examples of these is depicted in **Figure 3.**

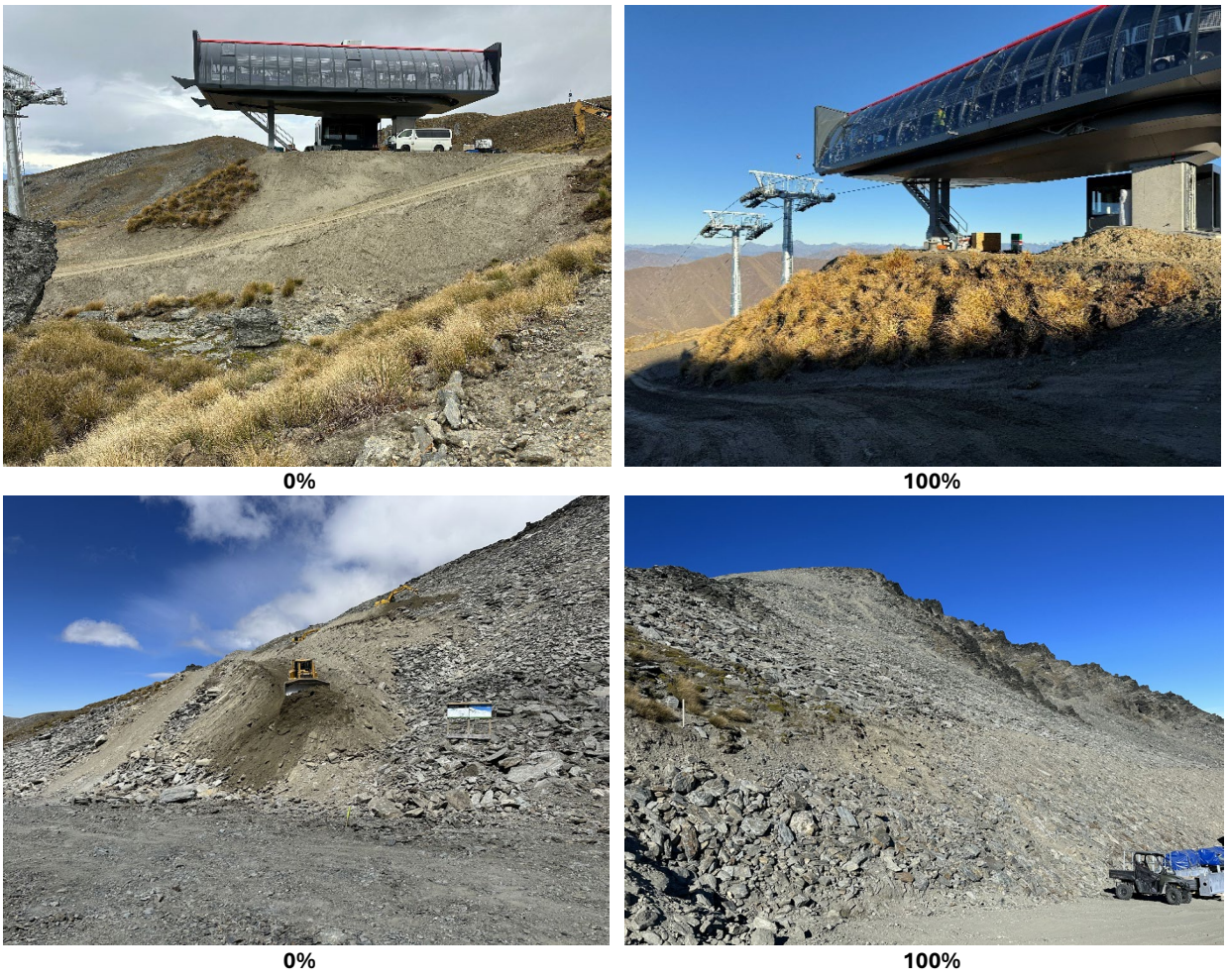


Figure 3: Visual Cover

3.11 Inspections and Monitoring

Monitoring of erosion and sediment controls will be undertaken in accordance with the ESCP provided in the Construction Environmental Management Plan (CEMP), **Appendix 2**. The CEMP outlines the monitoring programme

and methodology to confirm that controls are correctly designed, installed, and maintained throughout the works. It also provides the framework for assessing how effectively the erosion and sediment control measures are performing over the duration of the construction phases. Types of inspections and monitoring will be as follows:

- Daily visual checks during active earthworks.
- Prior to and Post-Rainfall Inspections: Mandatory within 24 hours before or after rainfall events.
- Weekly formal inspections by the Environmental Representative.
- As-Built inspections of ESCs undertaken by the SQEP.
- Monthly environmental inspections undertaken by the SQEP.

3.12 Contingency Measures

The following contingency measures in **Table 5** shall be deployed as required.

Table 5: Erosion and Sediment Control Contingency Measures

Issue	Contingency Measure
Sediment-laden stormwater flowing across the site boundary	• Cease all earthworks immediately in the contributing catchment. • Deploy sandbags, silt socks, or bunding to redirect and contain overland flow. • Install emergency silt fence or geofabric barriers where practical. • Divert clean water away from disturbed areas to reduce further mobilisation. • Notify the Environmental Consultant (SQEP) and initiate a site-specific incident response plan. • Conduct incident documentation (location, cause, volume, response time). Submit to regulatory authority.
Controls do not appear to be working as intended	• Undertake immediate inspection of failed controls (e.g., collapsed silt fence, overtopped basin). • Reinstate or upgrade the control using materials on-site (e.g., double silt fence, reinforce batter). • Assess whether additional or alternative measures are required (e.g., temporary stabilisation, chemical treatment). • Environmental Consultant (SQEP) to update the ESCP and record actions taken. • Notify QLDC, CODC and ORC.

Issue	Contingency Measure

The site is inappropriately exposed prior to imminent rain event	• Suspend further soil disturbance activities immediately.
	• Prioritise stabilisation of exposed areas using:
	  ○ Vegetative or rock cover.
	  ○ Polymer if < 48 hours (subject to ground conditions).
	  ○ Geofabric or jute matting for slopes and channels.
	• Inspect and reinforce existing ESC devices before rainfall.
	• Activate **Section 3.9** Rapid Response Procedure.

Sediment retention devices are near capacity and more rain is forecast	• Check decants heights, primary spillway and emergency spillway functionality. • Temporarily reduce contributing catchment using diversion bunds if feasible. • Begin chemical treatment (e.g., PAC, flocculant dosing) to accelerate sediment settlement and increase capacity. • Document actions and notify the Environmental Consultant (SQEP) and Council.

4.0 UNIVERSAL SOIL LOSS EQUATION

4.1 Overview

The Universal Soil Loss Equation (USLE) is the principal methodology employed in New Zealand for quantifying anticipated sediment yields associated with earthworks activities. It is adopted as a planning level tool to approximate the potential magnitude of sediment discharge. However, due to the inherent variability and assumptions embedded within the USLE parameters, it is not intended to provide a precise measurement of actual sediment yield.

Rather, the USLE serves to inform the development of ESCPs, delineate spatial variability in erosion risk across a site, and facilitate comparative assessment of sediment generation potential under different land disturbance scenarios. The estimate of sediment yield generated by the USLE considers of the following variables:

A – Soil Loss

- The predicted amount of soil lost (tonnes/hectare/year). In this case, 6-month durations were utilised to reflect the 6-month construction seasons undertaken in the alpine environment.

R – Rainfall Erosivity

- R measures the erosive power of rainfall at a site, combining rainfall energy and intensity to represent how capable the local rainfall regime is of causing soil erosion.
- A representative 2-year ARI rainfall event was adopted to characterise rainfall erosivity for the purposes of the USLE assessment. A 6-hour duration was selected as a pragmatic representation of erosion-effective rainfall for the Queenstown Lakes/Central Otago area. Rainfall depth was derived from NIWA's High Intensity Rainfall Design System (HIRDS v4). The selected event is intended to provide a measure of erosion potential and has been applied consistently across all site conditions.

K – Soil Erodibility

- Describes how easily soil particles are detached and moved, which depends on soil type and structure.
- A soil erodibility factor (K) of 0.3 was adopted based on the interpretation of the USLE nomograph, assuming a silty clay to silty clay loam soil texture. This value represents a conservative estimate of soil erodibility. Field observations indicate a high proportion of rock and coarse material across both the Doolans and Rastus Burn catchments, which would be expected to result in a lower effective erodibility. However, the standard USLE nomograph does not account for rock-dominated soils, and therefore a conservative K value has been utilised.

LS – Slope Length and Steepness

- Combines the effect of how long and steep the slope is. Steeper and longer slopes = more erosion.
- For calculation of the LS factor, a conservative average slope ratio was adopted for each catchment, derived from the elevation difference between the highest and lowest points within the catchment.

C – Ground Cover Factor

- Reflects how ground cover (like vegetation or mulch) reduces erosion.
- Bare soil has a high C value; vegetated areas have a low C value.

- A ground cover factor (C) value of 0.01 has been adopted to represent the pre-earthworks conditions, reflecting the existing, largely undisturbed, native vegetation cover. A C value of 1.0 was applied to earthworked areas, representing the rough and irregular exposed soil surfaces during construction. This approach was conservative, noting that the rough and irregular nature of the earthworked surface may reduce the erosive potential of the surface.

P – Roughness Factor

- Represents the degree to which surface roughness affects the erosion of sediment from a catchment.
- A roughness factor (P) value of 1.0 was adopted to represent the pre-earthworks conditions, reflecting the natural surface roughness does not materially increase or decrease the runoff velocity of erosive potential. A P value of 0.9 was adopted to represent earthworked conditions given the rough and irregular landscape the works are within.

Sediment Delivery Ratio

- The sediment delivery ratio accounts for the likely ratio of sediment retained on site, within depressions, rough surfaces and vegetation.
- A sediment delivery ratio of 0.7 was chosen given the Doolans and Rastus Burn catchments steep and variable topography.

The USLE is conservative as it assumes that the earthworks stages will be exposed to erosion for the full duration of construction across the respective construction season, whereas in practice, those areas will be staged, progressively stripped and rehabilitated.

The USLE has been applied to the two respective sub-catchments in which the proposed earthworks are located. The Rastus Burn catchment (331.15 ha) and the Doolans Basin catchment (300.32 ha), refer to **Figure 4**. The analysis was undertaken for both the full extent of each sub-catchment and the proposed earthworks footprints within them. The locations are shown in **Figure 5**, **Figure 6, Figure 7** and **Figure 8** below.

Appendix 1 of this report provides a summary of the estimated sediment yields (tonnes per hectare per construction season), derived from the USLE for the proposed earthworks, within the Rastus Burn and Doolans sub catchments, across the four-year construction timeline.

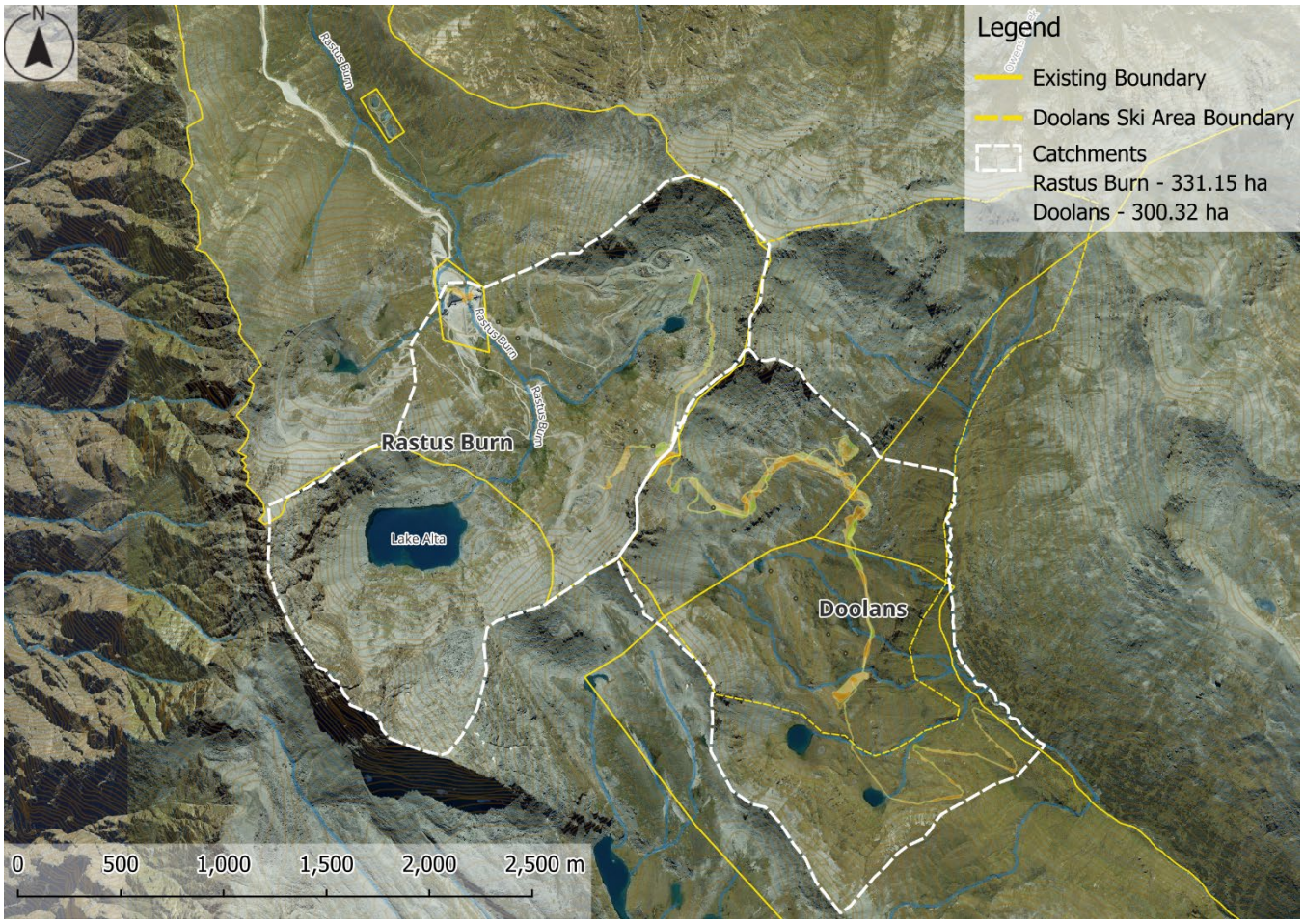


Figure 4: Sub catchments (Source: QGIS)

4.2 Results

4.2.1 Baseline (Pre-Earthworks) Sediment Yield

USLE modelling was undertaken to quantify existing sediment generation within the Rastus Burn and Doolans Basin catchments under current undisturbed conditions. The assessment indicates:

- **Rastus Burn Catchment:** Estimated sediment yield of **167.74 t** per six-month period (**0.51 t/ha**).
- **Doolans Basin Catchment:** Estimated sediment yield of **239.62 t** per six-month period (**0.80 t/ha**).

These values represent natural background erosion rates prior to the commencement of bulk earthworks.

4.2.2 Construction Season 2026-2027

Bulk earthworks during the 2026–2027 season include the Base Building platform, Rastus Burn Gondola Towers, and the Doolans Access. Disturbance areas comprise approximately **3.61 ha** in the Rastus Burn catchment and **0.96 ha** in the Doolans Basin catchment (**Figure 5**).

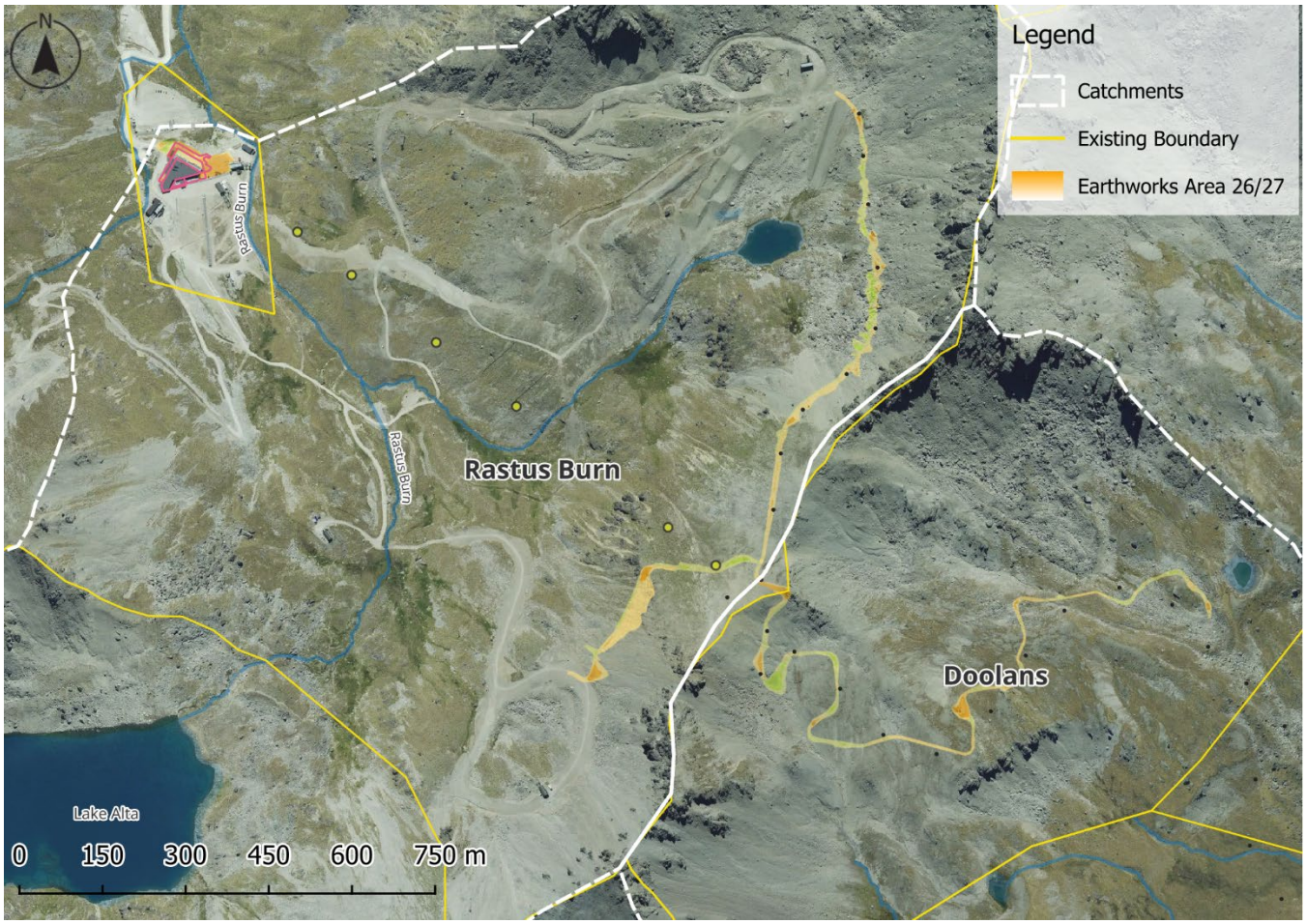


Figure 5: Construction Season 26-27

Predicted sediment yield (no controls):

- Rastus Burn: **164.36 t** or **45.59 t/ha**
- Doolans Basin: **68.58 t** or **71.81 t/ha**

Predicted sediment yield (with controls):

Implementation of progressive stabilisation, clean-water diversions, decanting earth bunds, sediment sumps, coconut coir logs, and drop-out pits predicted yields to:

- Rastus Burn: **49.31 t** or **13.68 t/ha**
- Doolans Basin: **34.29 t** or **35.90 t/ha**

4.2.3 Construction Season 2027-2028

During the 2027-2028 construction season, bulk earthworks within the Rastus Burn catchment are expected to be largely completed, while major works within the Doolans will be underway. Activities include the Doolans Gondola Towers, access and services, Water Reservoir and pump shed, Doolans ski trails and snow making infrastructure, and

the Doolans Base Area earthworks and water storage tanks. Disturbance areas total **3.654 ha** in the Doolans catchment and **0.785 ha** in the Rastus Burn catchment (**Figure 6**).

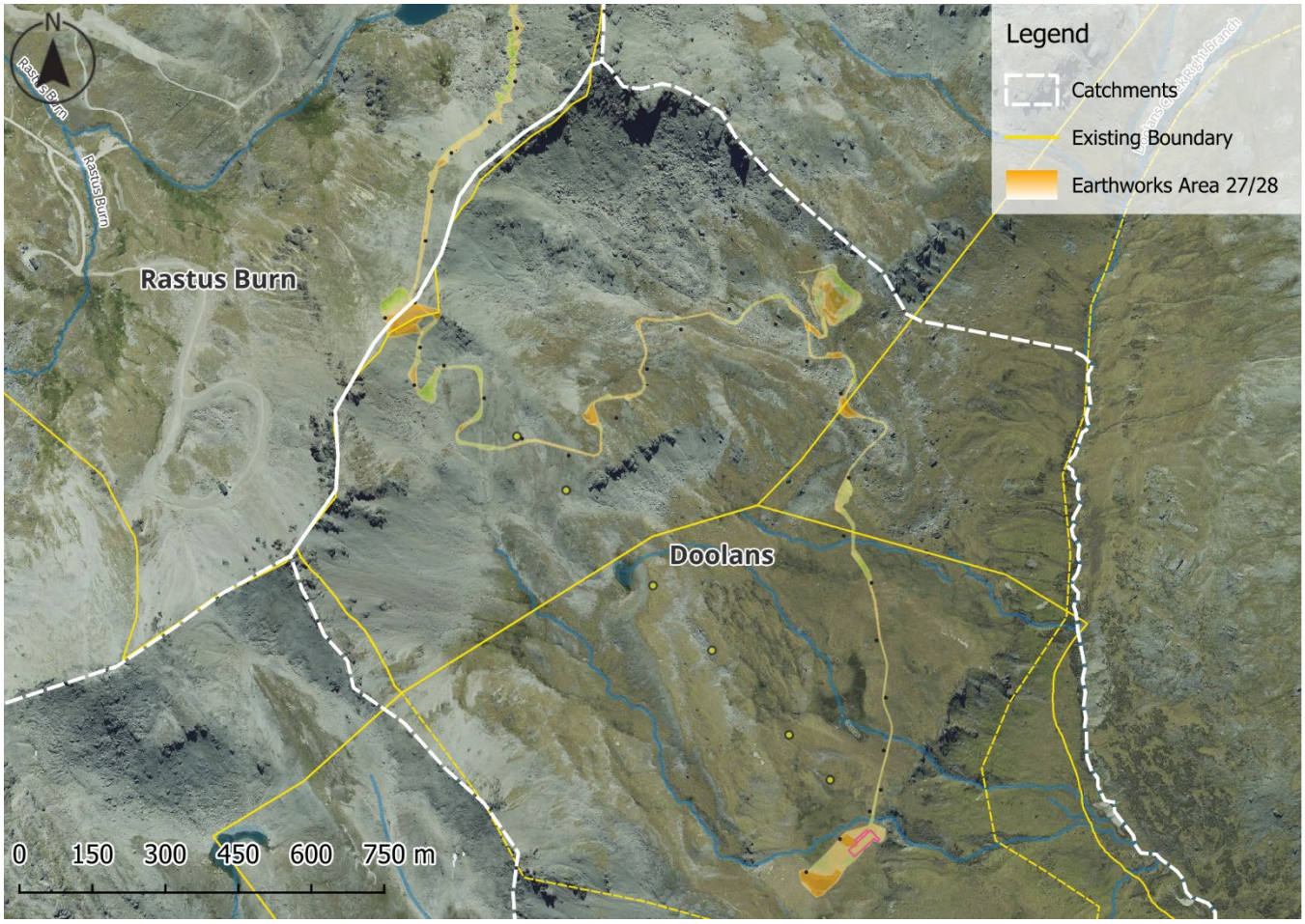


Figure 6: Construction Season 27-28

Predicted sediment yield (no controls):

- Rastus Burn: **35.79 t** or **45.59 t/ha**
- Doolans Basin: **262.39 t** or **71.81 t/ha**

Predicted sediment yield (with controls):

Implementation of progressive stabilisation, clean-water diversions, decanting earth bunds, sediment sumps, coconut coir logs, and drop-out pits predicted yields to:

- Rastus Burn: **10.74 t** or **13.68 t/ha**
- Doolans Basin: **131.20 t** or **35.90 t/ha**

4.2.4 Construction Season 2028-2029

Earthworks during the 2028 season focus on the Car Park 3 expansion within the Rastus Burn catchment, and the water intake and access works within the Doolans. Disturbance areas comprise **2.28 ha** in the Doolans catchment and **0.78 ha** in the Rastus Burn catchment (**Figure 7**). It is important to note that Car Park B earthworks have been excluded from this calculation, as these works occur outside both the Doolans and Rastus Burn catchments. Carpark B is located beside State Highway 6, beside the Remarkables Road access.

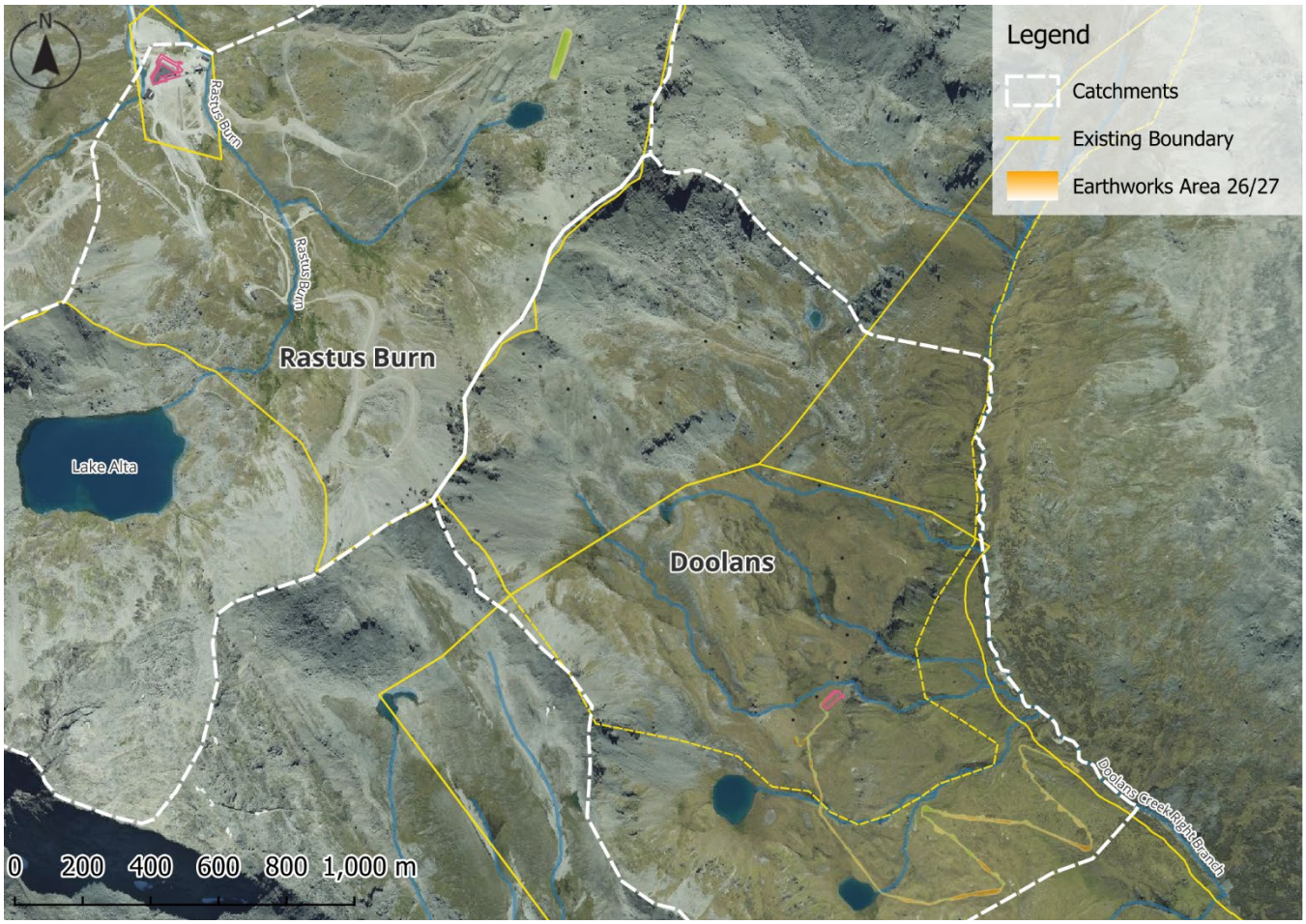


Figure 7: Construction Season 28-29

Predicted sediment yield (no controls):

- Rastus Burn: **35.69 t** or **45.59 t/ha**
- Doolans Basin: **163.51 t** or **71.81 t/ha**

Predicted sediment yield (with controls):

Implementation of progressive stabilisation, clean-water diversions, decanting earth bunds, sediment sumps, coconut coir logs, and drop-out pits predicted yields to:

- Rastus Burn: **10.71 t** or **13.68 t/ha**

- Doolans Basin: **49.05 t** or **35.90 t/ha**

4.2.5 Construction Season 2029-2030

Bulk earthworks withing the Rastus Burn catchment are proposed to be completed during the 2029-2030 construction season. Works within the Doolans catchment will focus on the Blue Ski Trail, with a proposed disturbance area of **6.25 ha** (**Figure 8**).

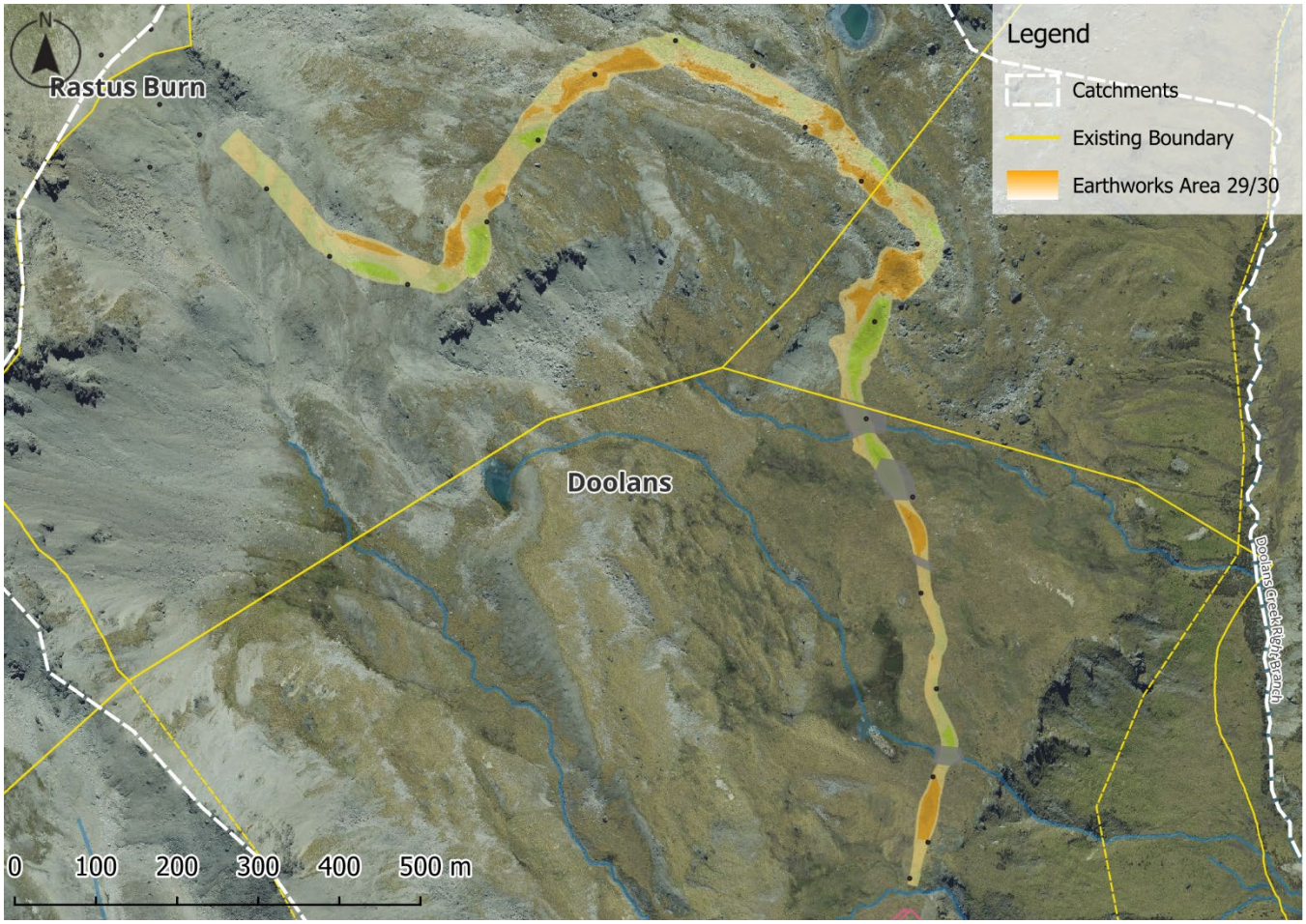


Figure 8: Construction Season 29-30

Predicted sediment yield (no controls):

- Doolans Basin: **448.81 t** or **71.81 t/ha**

Predicted sediment yield (with controls):

Implementation of progressive stabilisation, clean-water diversions, decanting earth bunds, sediment sumps, coconut coir logs, and drop-out pits predicted yields to:

- Doolans Basin: **134.64 t** or **21.54 t/ha**

4.3 USLE Conclusion

The USLE modelling demonstrates that, without erosion and sediment controls, sediment generation from the proposed earthworks would exceed the natural background levels, particularly within the Doolans catchment during peak construction years. Through the application of erosion and sediment controls – including progressive stabilisation, the use of clean-water diversions, DEBs, sediment sumps, coconut coir logs, and drop-out pits – results in significant reductions in the predicted sediment yield across all construction seasons.

These findings highlight the importance of staged earthworks, timely stabilisation, and the consistent implementation of erosion and sediment control measures to minimise sediment discharge risk through the proposed construction programme.

5.0 RECEIVING ENVIRONMENTS

5.1 Waterbodies

Surface water bodies (rivers, streams, lakes and wetlands) provide important habitats for many species of plants, fish, birds and animals, some of which are endemic and/or threatened. To protect these values, water quality must be safeguarded, and the natural flow of the watercourse maintained to the greatest possible extent. An increase in suspended sediment within the water column can degrade water quality and sediment deposition can adversely affect benthic habitat for macroinvertebrate communities. Where flow must be reduced or diverted, mitigation is required to ensure the values of the waterbodies are not degraded.

5.2 Identified Waterbodies

The freshwater ecological characteristics of the receiving environments are described in detail within the Ecological Assessment prepared by e3 Scientific and should be read in conjunction with this report. To support wetland mapping across the study area, e3 Scientific have undertaken hydrological analysis to model likely flow paths and water accumulation. Surface waterbodies, flow paths and wetlands identified within and in proximity to the site are provided in **Figure 8** and **Figure 9** below.

The headwaters and upper tributaries of the Rastus Burn and Doolans Creek Right Branch are located throughout the respective upper basins and faces where the ski area expansion works are proposed to occur. There are also Natural Inland Wetlands and Alpine Tarns present within both upper basins.

Rastus Burn

The greater Rastus Burn watershed covers an area of 1,460 hectares and is fed by Lake Alta and two prominent tributaries. Lake Alta is located at the head of a cirque basin, and its overflow feeds the Rastus Burn. The Rastus Burn and its tributaries are shaped by glacial, periglacial, channel erosion and mass-movement processes, typical of the steep alpine environment. The Rastus Burn flows into the Kawarau River, opposite Hayes Creek, which in turn feeds into the wider Clutha River Matau Branch.

The Rastus Burn catchment is influenced by rapid runoff due to its steep slopes and shallow soils. Seasonal snowfall and subsequent melt contribute significantly to baseflow patterns. NIWA's NZ River Maps indicates that the upper portion of the Rastus Burn generates up to 382.6 tonnes/year of suspended sediment.

The Rastus Burn has been modified in areas within the Remarkables Ski Area via re-diversion and culverting in areas of ski trails and associated infrastructure. Downslope of the Rastus Burn Recreation Reserve; agricultural activities have also modified the Rastus Burn tributaries to some degree. Water is taken from the Rastus Burn for the purposes of snow making in the Remarkables Ski Area.

Schedule 1A of the Regional Plan: Water for Otago (2020) identifies the natural and human use values of Otago's surface water bodies. The Rastus Burn is listed in Schedule 1A. The listed ecosystem values of the Rastus Burn include:

- Free from aquatic pest plants.
- Presence of riparian vegetation of significance to aquatic habitats.
- Presence of a boulder bed composition of importance for resident biota.
- Presence of indigenous invertebrates threatened with extinction upstream of NZMS 260 F41:806641.

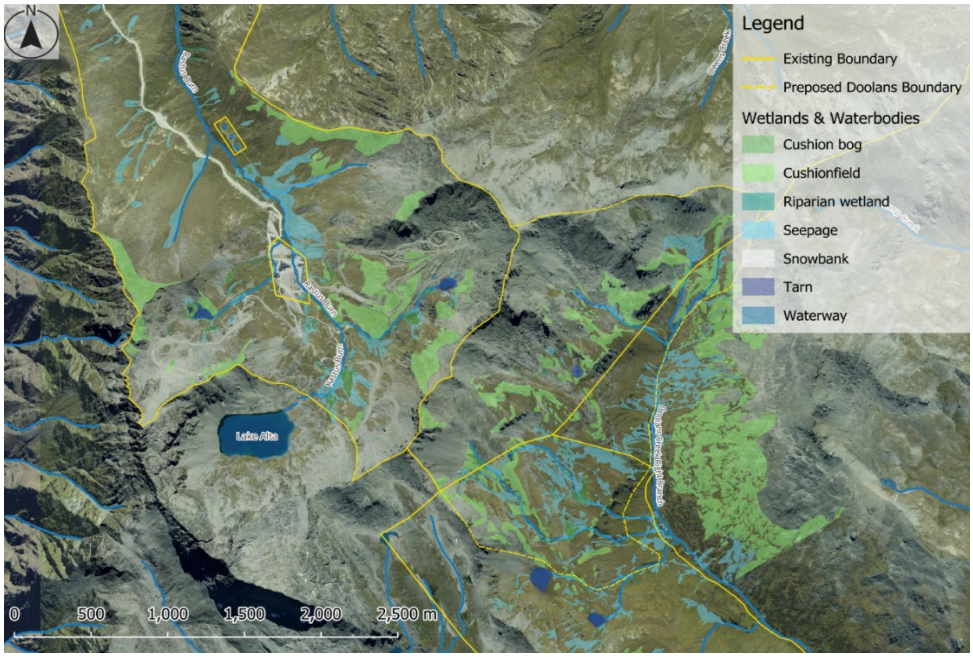
Doolans Creek Right Branch

The Doolans Creek Right Branch drains a large watershed, including the upper Doolans Basin, an extensive alpine catchment located on the south-east side of The Remarkables within the Hector Mountains. The Doolans Creek Right Branch flows into the Kawarau River below Victoria Flats and Victoria Bridge, ultimately contributing to the wider Clutha River Matau Branch. The Doolans upper faces and basin associated with the Project, are a glacially and fluvially derived alpine environment, containing numerous cirques, tarns, boulder fields, and alpine snow tussock and herbfield environments.

The Doolans Creek Right Branch can be characterised as a high-energy fluvial erosion catchment, with boulder and rock dominated channels typical of steep alpine waterbodies. These characteristics indicate a naturally high erosion environment, with coarse sediment supply from scree and over steepened hillslopes delivering material directly to the Creek network. NIWA's NZ River Maps indicates that the upper portion of the Doolans Creek Right Branch generates up to 586.5 tonnes/year of suspended sediment.

Groundwater

Significant ground water and aquifers are largely absent across the Rastus Basin and Doolans Basin, due to the elevated nature of the subject site and relative depth of mapped aquifers in the area[2]. Typically, groundwater occurs only as shallow, discontinuous, low volume storage in fractured rock, colluvium, talus, and local moraine pockets. Perched groundwater and seepages are expected to be encountered during earthworks, and the management of these localised flows are provided for in the CEMP and ESCP.



[2] https://www.orc.govt.nz/environment/water-care/groundwater/#aquifers

Figure 9: Waterbodies within and in proximity to the Site (Source: e3 Scientific)

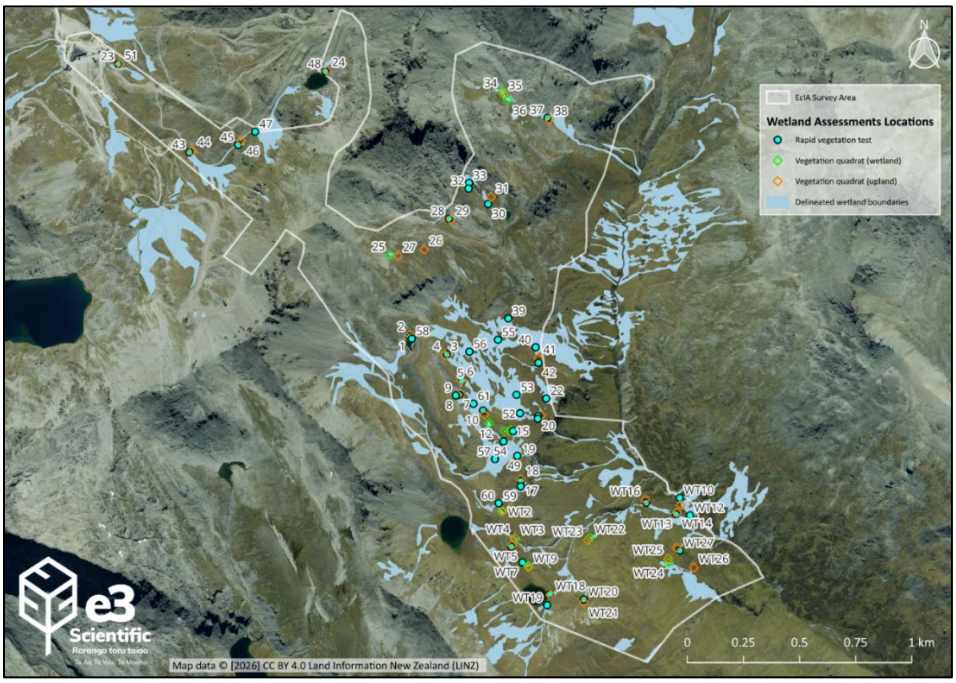


Figure 10: Wetland assessment results and delineated wetland boundaries (Source: e3 Scientific)

5.3 Performance Criteria

The recommended water quality performance criteria have been proposed following current accepted industry best practice, assessment of the proposed works and the characteristics of the receiving environment.

Key considerations include:

- The existing environment/watershed and related water quality of adjoining waterbodies.
- Staged earthworks sequencing over a four-year construction window.
- Progressive rehabilitation of disturbed surfaces.
- Variations in the sediment retention efficiency of commonly used erosion and sediment control practices, including differing ground covers, silt fences, SRPs and DEBs[3].

The assumed efficiencies of sediment control devices represent average performance across a range of rainfall/snow and ice melt conditions. Unless turbidity or Total Suspended Solids (TSS) limits are set at relatively high levels, exceedances may occur at certain points during storm events due to natural fluctuations, even when overall effects remain within acceptable limits.

[3] https://www.landcareresearch.co.nz/assets/Events/Remote-sensing/2022/RA1.2_Review_final_2020_LC3761.pdf

Turbidity and/or visual clarity has been proposed for on-site water quality monitoring, consistent with the Erosion and Sediment Control Guide for Land Disturbing Activities (GD05), Otago Regional Council, Land and Water Regional Plan (LWRP) and the QLDC EMP Guidelines.

GD05 identifies visual clarity (mm) and turbidity (NTU), as a practical and responsive indicator of suspended sediment during construction, as it provides immediate results suitable for operational monitoring. While GD05 recognises TSS as the benchmark parameter for quantifying suspended sediment, it also notes the limitations of TSS for day-to-day monitoring due to sampling and laboratory processing time, which is acutely relevant due to the isolated alpine environment of the site. Accordingly, GD05 supports using visual clarity/turbidity-based trigger levels to guide site management responses during earthworks.

Given these considerations, any discharge from the sites' boundaries, or sediment control devices should set out to meet the criteria in **Table 6**.

Table 6: Water Quality Discharge Criteria

Parameter	Discharge Criteria
Receiving waterbodies	No conspicuous change in colour or visual clarity
Turbidity[4] - Sediment control devices	≤ 150 NTU
Visual clarity (mm) - Sediment control devices	≥ 100 mm (As per GD05)
If Turbidity or Visual Clarity are exceeded, test TSS…	
Total Suspended Sediment (TSS)	≤ 50 mg/L
pH[7]	5.5 – 8.5
Hydrocarbons or tannins	No visible trace
Waste	No waste or litter is visible

5.4 Management Measures

The following measures will be deployed to ensure the protection of receiving waterbodies:

- Erosion and sediment controls will be implemented and maintained in accordance with the site-specific ESCP.
- Ministry for the Environment (MfE) 2021, National works in waterways guideline-best practice guide for civil infrastructure works and maintenance.
- Undertake earthworks during spring, summer and autumn, when fine weather is more frequent, to reduce the risk of weather-related erosion and sedimentation.
- Undertake vegetation removal and rehabilitation in accordance with the following approved plans:
    - *Remarkables Skifield Doolans Expansion Project Terrestrial Ecological Management Plan*, prepared by EMM Consulting Pty Ltd, May 2026.

[4] Turbidity and or visual clarity can provide a practical, real-time measure on site. If the specified turbidity or visual clarity value is not met, a water sample will be collected and sent for TSS laboratory testing.

- *A Protocol for the Rehabilitation of Natural Alpine Environments Following Ski Area Development (Alpine Works and Rehabilitation Protocol)*, prepared by the Department of Conservation and NZSki Ltd.

- Ensure that no vegetation is disturbed or removed beyond the defined consented works area, to prevent undue degradation of the site and instream habitats.
- All wetlands, flow paths, boulder fields, snow tussock grassland and shrublands are to be avoided, except for consented areas.
- Refuelling, servicing and storage of hydrocarbons will be in accordance with the relevant procedures in the Chemicals and Fuels Management set out within the CEMP.
- All concrete washing is to be undertaken in the designated concrete wash-out pit.
- All plant and equipment on-site will be inspected regularly to ensure they are of an acceptable standard.
- Stockpiling of any organic, erodible or hazardous material onsite is not to be placed within close proximity of a watercourse/major drainage lines.
- All chemical treatment of sediment-laden water will be undertaken in accordance with an approved Chemical Treatment Management Plan.

5.5 Water Quality Monitoring Plan

Water quality will be monitored in accordance with **Table 7**.

Table 7: Water Quality Monitoring Measures

Sampling Scope	
Objective	To assess whether controlled and uncontrolled discharge, meets the Discharge Criteria referred to in **Section 5.3, Table 6.**
Responsibility	On-site water quality sampling is to be completed by the nominated Environmental Representative.
Spatial boundaries	Discharges from within the sites' boundaries, receiving waterbodies and/or sediment control devices.
Frequency	When there is a discharge of water across the site boundary or from a decanting earth bund, and where a Significant Rain Event occurs through the night, monitoring must be undertaken the following day. A significant rain event is defined as any forecast/actual rain event of 20 mm within a 12-hour period or a rain event that can generate overland flow, noting that this varies seasonally.
Sampling Design	
Water quality criteria	As outlined in the Discharge Criteria referred to in **Section 5.3, Table 6.**
Sampling locations	At boundaries of the site where any water is flowing into receiving waterbodies and/or sediment control devices.

Sampling method	• TSS – Registered laboratory. • Turbidity (NTU) – Nephelometer. • Visual clarity – Clarity tube/Secchi disk. • pH – pH meter, only if utilising chemical treatment. • Gross pollutants – visual observations. • Tannins – visual observations (any unusual darkening of waters). • Hydrocarbons – visual observations (is there any oily film[5] on surface or smell).
Quality control	Any water quality meters will be calibrated according to the manufacturer's instructions.
Recording	
Recording results	All results will be entered into a spreadsheet and kept onsite provided in the site Construction Environmental Management Plan.
Actions	
Non-conformances	Any exceedances observed will be reported to the Project Manager/ Environmental Consultant who will investigate and ensure appropriate corrective actions are implemented immediately.

5.6 Contingency Measures

The following contingency measures in **Table 8** shall be adopted if required.

Table 8: Water Quality Contingency Measures

Issue	Contingency Measure
Exceedance of water quality criteria	• Contact the Project Manager and Environmental Consultant (SQEP) immediately. • Works will cease or be modified to remove further risk of contamination. • **QLDC, CODC and ORC** will be verbally notified. • The Environmental Incident procedure provided in the site Construction Environmental Management Plan will commence. • Remedial measures will be implemented, and the Environmental Incident will be closed out by the Environmental Representative with a copy of an Environmental Incident report to the Project Manager and **QLDC, CODC and ORC**.

[5] Some bacteria produce a naturally occurring film on the water surface. Bacteria films breaks apart in angular shapes when disturbed whereas hydrocarbon film separates as globules.

6.0 ASSESSMENT OF EFFECTS

6.1 Actual or Potential Effects on Receiving Environment

The Remarkables Ski Area Expansion Project has the potential to generate short-term changes to water quality during construction, primarily through the disturbance of soils and the mobilisation of sediment during rainfall, snowmelt, and freeze thaw events.

The USLE assessment presented in **Appendix 1**, and discussed in **Section 4.2**, demonstrates that predicted sediment yields from each construction stage are modest when considered at the catchment scale.

The staged construction approach and reduced construction season durations, further reduces erosion and sedimentation effects. By limiting the spatial and temporal extent of the disturbed surfaces at any one-time, sequencing work to avoid concurrent high-risk areas, and immediately rehabilitating completed surfaces, the project materially lowers the magnitude and duration of potential sediment mobilisation.

6.2 Cumulative Effects on Waterbodies

The proposed earthworks are inherently temporary and staged, with disturbance limited to defined work areas during shorter alpine construction seasons. As such, the works are not expected to result in any persistent, or long-term changes to the quality or quantity of water entering the receiving environments.

At the time of preparing this ESCAR, there are no known concurrent earthworks activities occurring within the surrounding catchments that would combine with the Project to elevate cumulative sediment or contaminant loads. Should other works occur within the broader catchment, these would be subject to their own consents, erosion and sediment control requirements, and monitoring frameworks.

Given the staged extents of exposed soils at any one time, the strong emphasis on erosion prevention, any sediment discharges from the site are expected to be small-scale and short-duration. The effects will be appropriately managed to minimise potential cumulative effects on waterbodies.

6.3 Kai Tahu Tikanga and Natural Values

The Remarkables, Rastus Burn and Doolans Basin hold recognised natural and cultural values for Kāi Tahu, including areas identified as Wāhi Tūpuna (as set out in the Queenstown Lakes District Plan). These alpine environments support high-value indigenous vegetation, wetlands, and waterbodies that contribute to the cultural identity and ecological integrity of the landscape.

The erosion and sediment control approach has been developed to protect these values by avoiding sediment-laden discharges, maintaining natural flow paths, and minimising disturbance to sensitive habitats. Kāi Tahu will ultimately speak to the extent to which these outcomes are achieved from a cultural perspective, and it is anticipated that further amendments can be made to the CEMP and ESCP reflective of those outcomes.

6.4 Conclusion

Overall, the anticipated effects of the Remarkables Ski Area Upgrades and Doolans Expansion Project on the receiving environment are expected to be effectively managed through the implementation of the proposed environmental management and erosion and sediment control measures. Estimated sediment generation associated with construction activities is temporary in duration, staged construction, shorter construction seasons, and an emphasis on erosion prevention and progressive stabilisation of disturbed areas.

The erosion and sediment control framework has been developed to protect downstream waterbodies, ecological values, and the recognised natural and cultural values of the area, including those of significance to Kāi Tahu.

Overall, it is anticipated that the proposed environmental management and erosion and sediment control measures, will ensure the earthworks are appropriately managed and sediment yield from the expansion works will be minimised to acceptable levels. Any adverse residual sediment related effects will be temporary and minor in nature, and consistent with the intent of the NPS-FM, Regional Plan: Water for Otago, and relevant QLDC and CODC district plan objectives and policies.

7.0 REFERENCES

- Auckland Council, 2016, Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region - GD05 (Revised 2023), June.
- Ministry for the Environment (MfE), 2011, Contaminated Land Management Guidelines No. 2: Hierarchy and Application in New Zealand of Environmental Guideline Values (Revised 2011), October.
- Otago Regional Council, 2023, Residential Earthworks in Otago, A guide for developers, landowners, contractors and service providers, March.
- Queenstown Lakes District Council (QLDC), 2019, Guidelines for Environmental Management Plans, June.
- Department of Conservation and NZSKI Ltd. Protocol for the Rehabilitation of Natural Alpine Environments Following Ski Area Development.
- Ministry for the Environment (MfE), National works in waterways guideline-best practice guide for civil infrastructure works and maintenance.
- The Remarkables Ski Area Upgrade & Doolans Expansion Roading, Stream Crossings and Stormwater Freshwater Ecological and Hydrological Impact Assessment, prepared by e3Scientific Limited for NZSki Limited (e3 scientific 2026b).
- The Remarkables Ski Area Upgrade & Doolans Expansion Project - Stormwater Concept Report (Stantec 2026a).
- e3Scientific. (2026a). Doolans Creek Water Take Assessment of Effects. Arrowtown: Prepared for NZSki.
- e3Scientific. (2026b). Doolans Basin Access Tracking Stormwater, earthworks and crossing FEcIA. Arrowtown: Prepared by e3Scientific for NZSki.
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- e3Scientific Ltd. (2026). Remarkables Ski Area Upgrade and Doolans Expansion Terrestrial Ecological Impact Assessment. Arrowtown: e3Scientific Ltd.
- e3Scientific Ltd. (2026a). Remarkables Ski Area Upgrade and Doolans Expansion - Doolans Creek Water Take Assessment of Effects. May 2026.

APPENDIX 1 UNIVERSAL SOIL LOSS CALCULATIONS

UNIVERSAL SOIL LOSS EQUATION (USLE) - REMARKABLES SKI AREA UPGRADES AND DOOLANS EXPANSION

Section of Site	Catchment Area (ha)	Earthworks Area (ha)	R	K	LS	Earthworks C	Earthworks P	Duration (yrs)	Sediment Delivery Ratio	Sediment Generation (tonnes)	t/ha
Catchment A - Rastus Burn	331.15	0	26.09	0.3	18.49	0.01	1	0.5	0.7	167.74	0.51
Catchment B - Doolans	300.32	0	23.68	0.3	32.09	0.01	1	0.5	0.7	239.62	0.80
Total	631.47	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**407.36**	**0.65**

2026/2027 Construction Season										**No E&SC Treatment**		**Erosion & Sediment Control**		
Site	Catchment Area (ha)	Earthworks Area (ha)	R	K	LS	Earthworks C	Earthworks P	Earthworks Duration (yrs)	Sediment Delivery Ratio	Sediment Generation (tonnes) From Earthworked Area	t/ha	Sediment Control Efficiency (%)	Net Sediment Yeild (tonnes) From Earthworked Area	t/ha
Catchment A - Rastus Burn	331.15	3.61	26.09	0.3	18.49	1	0.9	0.5	0.7	164.36	45.59	70%	49.31	13.68
Catchment B - Doolans	300.32	0.96	23.68	0.3	32.09	1	0.9	0.5	0.7	68.58	71.81	50%	34.29	35.90
Total	631.47	4.56	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**232.93**	**51.08**	N/A	**83.60**	**18.33**

2027/2028 Construction Season										**No E&SC Treatment**		**Erosion & Sediment Control**		
Site	Catchment Area (ha)	Earthworks Area (ha)	R	K	LS	Earthworks C	Earthworks P	Earthworks Duration (yrs)	Sediment Delivery Ratio	Sediment Generation (tonnes) From Earthworked Area	t/ha	Sediment Control Efficiency (%)	Net Sediment Yeild (tonnes) From Earthworked Area	t/ha
Catchment A - Rastus Burn	331.15	0.785	26.09	0.3	18.49	1	0.9	0.5	0.7	35.79	45.59	70%	10.74	13.68
Catchment B - Doolans	300.32	3.654	23.68	0.3	32.09	1	0.9	0.5	0.7	262.39	71.81	50%	131.20	35.90
Total	631.47	4.439	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**298.18**	**67.17**	N/A	**141.93**	**31.97**

2028/2029 Construction Season										**No E&SC Treatment**		**Erosion & Sediment Control**		
Site	Catchment Area (ha)	Earthworks Area (ha)	R	K	LS	Earthworks C	Earthworks P	Earthworks Duration (yrs)	Sediment Delivery Ratio	Sediment Generation (tonnes) From Earthworked Area	t/ha	Sediment Control Efficiency (%)	Net Sediment Yeild (tonnes) From Earthworked Area	t/ha
Catchment A - Rastus Burn	331.15	0.783	26.09	0.3	18.49	1	0.9	0.5	0.7	35.69	45.59	70%	10.71	13.68
Catchment B - Doolans	300.32	2.28	23.68	0.3	32.09	1	0.9	0.5	0.7	163.51	71.81	70%	49.05	21.54
Total	631.47	3.06	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**199.21**	**65.10**	N/A	**59.76**	**19.53**

2029/2030 Construction Season										**No E&SC Treatment**		**Erosion & Sediment Control**		
Site	Catchment Area (ha)	Earthworks Area (ha)	R	K	LS	Earthworks C	Earthworks P	Earthworks Duration (yrs)	Sediment Delivery Ratio	Sediment Generation (tonnes) From Earthworked Area	t/ha/ye	Sediment Control Efficiency (%)	Net Sediment Yeild (tonnes) From Earthworked Area	t/ha
Catchment A - Rastus Burn	331.15	0.00	26.09	0.3	18.49	1	0.9	0.5	0.7	0.00	0.00	0%	0.00	0.00
Catchment B - Doolans	300.32	6.25	23.68	0.3	32.09	1	0.9	0.5	0.7	448.81	71.81	70%	134.64	21.54
Total	631.47	6.25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**448.81**	**0.00**	N/A	**134.64**	**0.00**

APPENDIX 2 CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN