



Rastus Burn Wastewater Freshwater Ecological Impact Assessment

NZSki Limited

May 2026



Arrow Lane Arrowtown 9302

www.e3scientific.co.nz

Rastus Burn Wastewater Freshwater Ecological Impact Assessment

Prepared by e3Scientific for NZSki Limited

Document Status

Version 1



TABLE OF CONTENTS

1	Introduction	1
1.1	Overview	1
1.2	Ecological Report Structure	3
1.3	Scope of Work	3
1.4	Limitations	3
1.5	Code of Conduct	4
2	Activity Description and Environmental Context	6
2.1	Description of Activity	6
2.1.1	Wastewater Treatment	6
2.2	Environmental Context	9
2.2.1	Rastus Burn	9
2.2.2	Lake Alta Headwaters	9
2.2.3	Regional Plan	11
3	Methods	12
3.1	Desktop Review	12
3.2	Site Visit	12
3.3	Physio-Chemical Parameters	13
3.4	Habitat	14
3.5	Periphyton	14
3.6	Macroinvertebrates	14
3.6.1	Macroinvertebrate Metrics	15
3.7	Fish	16
3.8	Wetlands	16
4	Results	17
4.1	Surface Water Results	17
4.2	Habitat	18
4.3	Periphyton	20
4.4	Macroinvertebrates	23
4.5	Fish	26
4.6	Wetlands	27
5	Ecological Values	29
5.1	Assessment of Ecological Value following the EIANZ Guidelines	29
5.2	Summary of Ecological Values	31
6	Ecological Impact Assessment	33
6.1	Ecological Impact Assessment Methodology	33



6.1.1	Assigning Magnitude of Effect	33
6.1.2	Assigning Level of Effect	34
6.1.3	Residual Impact	34
6.2	Wastewater Discharge Effects	35
6.2.1	Nutrient Enrichment	36
6.2.2	Reduced Dissolved Oxygen	37
6.2.3	Thermal Change	37
6.2.4	Wetland Hydrology	38
7	Conclusions and Recommendations	39
8	References	41



LIST OF FIGURES

Figure 1: Site overview showing the Rastus Burn and existing wastewater treatment land dispersal site.....	2
Figure 2: Wastewater treatment system locations (Source: e3Scientific 2026a).	8
Figure 3: Site Sampling overview.	13
Figure 4: Compliance Monitoring point Habitat (Source: SLR 2026).	19
Figure 5: Lake Alta outlet sampling within the Rastus Burn with didymo present (13/4/2025).	20
Figure 6: Stylised periphyton growth potential in alpine streams (Uehlinger <i>et al.</i> , 2010).	22
Figure 7: Flow paths near the dispersal field and potential wetland areas within 100 m marked with blue rectangles and likely wetland areas within orange shapes.	28
Figure 8: Example images of wet areas found within Area A.	28

LIST OF TABLES

Table 1: Macroinvertebrate Metric Attribute Bands (Source; Boothroyd & Stark, 2000; Stark & Maxted, 2007).	15
Table 2: Physico-chemical results for the Rastus Burn at the Lake Alta outlet on 13/4/2025 and the DGV (ANZG, 2018) values for sites with a cool wet climate and mountain source of flow. .	17
Table 3: Rastus Burn habitat at the Lake Alta Outlet.	20
Table 4: Summary of compliance ecological monitoring (Sources: Ludgate, <i>et al.</i> , 2014; Ludgate, <i>et al.</i> , 2017; SLR, 2023; SLR, 2026; e3Scientific, 2026a).	24
Table 5: Macroinvertebrate raw data.	25
Table 6: Assessment of the Rastus Burn habitat using the ecological criteria in the EIANZ Guidelines.	30
Table 7: Criteria for describing magnitude of effect (Roper-Lindsay, <i>et al.</i> , 2018).	33
Table 8: Criteria for describing level of effect (Roper-Lindsay, <i>et al.</i> , 2018).	34

LIST OF APPENDICES

Appendix A: Wetlands mapped in upper catchment (Source Wildlands Accessed 2026).
Appendix B: Proposed Performance Criteria (Source: e3Scientific, 2026a).
Appendix C: Proposed Nutrient Performance Criteria (Source Stantec 2026).



Executive Summary

NZSki Ltd is planning upgrades to the wastewater treatment system at the Remarkables Ski Area to accommodate increased visitor numbers and the associated rise in domestic wastewater volumes to 204 m³/day. The proposal involves directing additional wastewater into a wastewater treatment plant located near the Remarkables Base and existing dispersal field, which discharges to land within the Rastus Burn catchment.

e3Scientific Ltd was engaged by NZSki to assess the freshwater ecological values of the nearby Rastus Burn and evaluate the potential effects of increased wastewater volumes being discharged to land within the catchment. The Rastus Burn is a small, steep alpine stream draining from Lake Alta through a high-elevation tussock and shrubland catchment before flowing to the Kawarau River. The stream is characterised by cold, clear, well-oxygenated water, stable rocky substrates, and naturally low nutrient concentrations.

Ecological surveys and previous monitoring show that the stream supports an algal community typical of alpine environments, with low biomass and dominance by diatoms and filamentous red algae. Macroinvertebrate communities are of "good to excellent" quality and dominated by pollution-sensitive taxa adapted to cool, oligotrophic conditions. The reach near the ski field is naturally fishless due to downstream waterfalls that prevent fish passage.

The wastewater treatment plant will be upgraded to accommodate the increased wastewater volumes, although nutrient loads are expected to remain stable due to improved treatment performance.

The Rastus Burn has been assessed as having **Moderate** overall ecological value, reflecting high representativeness, moderate ecological context and rarity values, and naturally low diversity. The key potential effect of increased wastewater discharge is nutrient enrichment, which could alter algal and macroinvertebrate communities if nutrient levels rise. However, the proposals treatment system is to be designed to maintain the existing freshwater ecological communities in their current state by meeting proposed performance criteria. Therefore, the increase in wastewater discharge volume with a lower nutrient



concentration (stable nutrient load) results in a Low magnitude of effect, resulting in a **Low** level of ecological effect.

The management approach provides strong ecological safeguards by ensuring a commitment to achieve the proposed wastewater performance criteria, controlled discharge volumes, and seasonal timing that avoids sensitive low-flow periods. Land-based infiltration and robust operational, maintenance and risk-management planning further protect Rastus Burn water quality. A comprehensive monitoring programme across periphyton, macroinvertebrates, and downstream wetlands supports early detection of change helping to avoid and mitigate adverse effects and protect overall stream health.

Monitoring is proposed to confirm the potential effects on the freshwater ecological values present. The recommended monitoring actions are summarised below:

- Monitoring of periphyton composition and biomass within the Rastus Burn upstream and downstream of the infiltration dispersal fields is recommended.
- Monitoring of macroinvertebrate taxa densities, community composition and EPT, MCI, SQMCI metrics within the Rastus Burn upstream and downstream of the infiltration dispersal fields is recommended.
- Wetland delineation of area downgradient and within 100m of the land dispersal field.
- Monitoring of any delineated wetlands downgradient (within 100 m) of the land dispersal field for wetland hydrological regime and vegetation community to ensure wetlands remain healthy every two years.



1 Introduction

1.1 Overview

NZSki are anticipating an increase in customers and therefore an increase in the volume of wastewater requiring treatment and discharge to land at the Remarkables Ski field area. NZSki intend to pump the wastewater into the existing Remarkables wastewater management system for treatment and discharge to the existing dispersal field in the Rastus Burn catchment (Figure 1).

The project proposes wastewater treatment upgrades to achieve performance criteria. e3Scientific Limited (e3s) was commissioned by NZSki to complete a Freshwater Ecological Assessment (FEcIA) of the increased wastewater discharge on the Rastus Burn stream habitat and freshwater ecology. This report provides the methodology, results, ecological value and impact assessment of the FEcIA where ecological assessments have been undertaken. Fieldwork associated with this FEcIA was completed on 27th February, 2026.



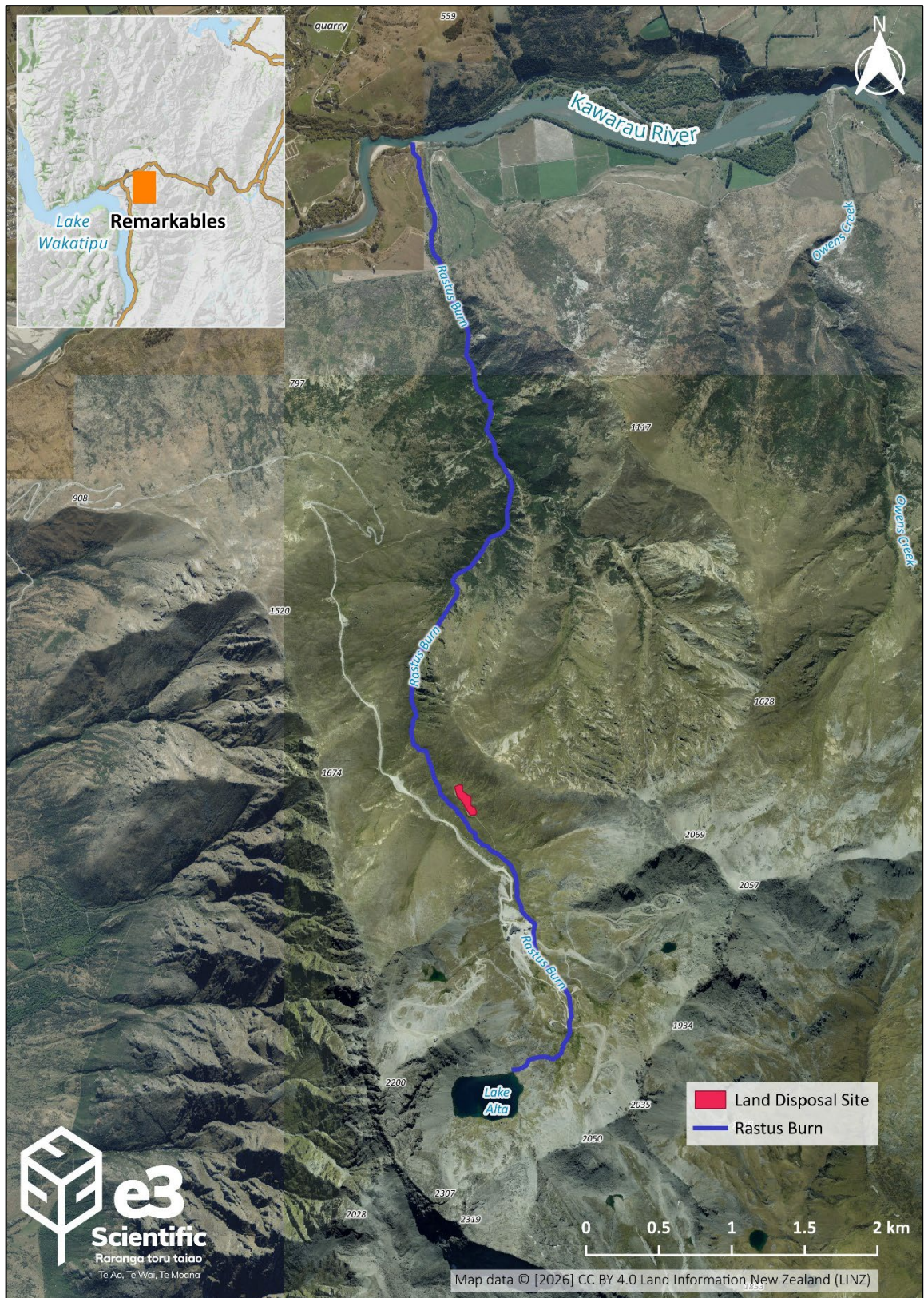


Figure 1: Site overview showing the Rastus Burn and existing wastewater treatment land dispersal site.



1.2 Ecological Report Structure

The FEClA is structured as follows:

- Section 2: Site location and description of the proposed activity.
- Section 3: Methodology employed during the ecological assessment.
- Section 4: Results
- Section 5: Ecological values
- Section 6: Ecological impact assessment.
- Section 7: Conclusions and recommendations.

1.3 Scope of Work

The scope of work to complete this FEClA report included a desktop review of available information including monitoring reports associated with the existing wastewater discharge consent. A field site visit was also undertaken to assess and characterise the ecological values of further downstream on the Rastus Burn near the confluence with the Kawarau River to determine if fish were present in the lower reaches of the waterway.

1.4 Limitations

The findings of this report are based on the Scope of Work outlined above. e3Scientific Limited (e3s) performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environmental science profession. No warranties, express or implied, are made. Subject to the Scope of Work, e3s's assessment is limited to a desktop review of the existing information, eDNA and macroinvertebrate sample collection and a freshwater ecological impact assessment following EIANZ guidelines. The confidence in the findings is limited by the Scope of Work.

The results of this assessment are based upon site inspections conducted by e3s personnel, information from interviews with people who have knowledge of site conditions and information provided in previous reports. All conclusions and recommendations regarding the properties are the professional opinions of e3s personnel involved with the project, subject to the qualifications made above. While normal assessments of data reliability have been made, e3s assumes no responsibility or liability for errors in any data obtained from regulatory agencies,



statements from sources outside e3s, or developments resulting from situations outside the scope of this project.

The confidence in the findings is limited by the Scope of Work, and limited data due to the singular site visit at one time of year. A full range of biota that are present at this site may not have been seen or recorded; however, desktop research was utilised to aid the assessment.

1.5 Code of Conduct

The authors of this report are Mark Hamer and reviewer Bryony Miller. Bryony Miller is the Technical Director of Marine and Freshwater Ecology at e3Scientific and is a professional ecologist with over 15 years' experience. She regularly completes freshwater and marine ecological impact assessments on behalf of regional and district councils, private companies, national governmental organisations, not-for-profit and research groups. She has been an expert witness at Environment Court and hearings and has been involved in mediation and expert caucusing. She currently is a member of the NZ Freshwater Science Society, NZ Marine Science Society, NZ Science Diving Committee and is an executive committee board member of the NZ Coastal Society.

Mark Hamer is a professional freshwater ecologist with over 17 years' experience working in the freshwater ecology and monitoring industry. Freshwater biomonitoring proficiency and experience includes wetland delineation, water and sediment quality assessments, eDNA, river periphyton, aquatic plant identification, riparian habitat assessment, macroinvertebrate collection and analysis. Freshwater fish monitoring using electric fishing, netting or spotlighting methods along with associated fish handling, analysis and fish passage assessments. At e3scientific for the past 3 years Mark's focus has been on ecological value assessments and reviewing and producing ecological impact assessments in the consenting process. He has been an expert witness at consent hearings and is a current member of the New Zealand Freshwater Sciences Society.

We confirm that we both 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 our area of expertise, and we have not omitted to consider



material facts known to either of us that might alter or detract from the opinions expressed in this report.



2 Activity Description and Environmental Context

2.1 Description of Activity

2.1.1 Wastewater Treatment

The proposed Remarkables ski field expansion will increase operational capacity and visitor numbers, resulting in higher wastewater loads. Upgrades to the existing wastewater infrastructure are therefore required to accommodate increased volumes and loads associated with this growth (Mitchell-Daysh, 2026). The current wastewater treatment plant is located near the base building at 1600 m above sea level (a.s.l.) with the dispersal fields at a lower elevation of 1440 m a.s.l. The wastewater dispersal field comprises of a series of three bunded depressions that extend for 300 m along a colluvial deposit elevated 50 m above the true right bank of the Rastus Burn. The dispersal fields are oblong and are located approximately 50 – 100 m north-east of the Rastus Burn. The dispersal fields cover approximately 0.61 ha and are 2 – 3 m deep which provides enough storage for the estimated annual flows (MWH, 2014), including precipitation.

The proposed volume of wastewater is estimated to be 204 m³/day during the ski season. The current wastewater treatment process includes primary screening and settlement treatment. The wastewater management system includes a 35 m³ pre-settlement tank in Car Park 1 that receives toilet and greywater from the staff and base buildings and the public toilets. Flows are then directed to twin 75 m³ septic tanks with outlet filters before the partially treated effluent is conveyed via a buried 100 mm PVC pipeline—crossing the Rastus Burn on insulated steel bridges—to a 31 m³ belowground sedimentation tank. From there, flow is measured and split three ways to the infiltration basins, which operate in parallel and discharge wastewater to land through infiltration.

Sludge from the pre-settlement and septic tanks is removed twice yearly. The basins were refurbished in 2014 by excavating and replacing the base material to restore infiltration, and the three dispersal fields provide a combined dispersal area of 6,100 m² with a conservative maximum application rate of 20 mm/day for primary treated effluent (Figure 2). The daily wastewater volume is expected to increase by 77 m³/day, from 127 m³/day to 204 m³/day (e3Scientific, 2026a).



An options report and water quality assessment for this proposal has been undertaken and recommended an upgrade to the wastewater treatment system is needed to achieve the performance criteria (e3Scientific, 2026a; Stantec, 2026).

The secondary treatment components typically include primary sedimentation tanks with effluent filter, nitrification chambers, aeration chamber, clarifier, sludge return system from base of clarifier into primary tank, anoxic tanks, treated effluent pump station and effluent disc filters (Stantec, 2026).

The tertiary treatment typically includes primary sedimentation tanks with effluent filter, the secondary treatment stages with additional carbon and alkalinity dosing systems (Stantec, 2026).

The treatment and nutrient load management are to be designed to meet the performance criteria. So, while the wastewater volume is to increase, the additional treatment provided is expected to ensure there is no increase in annual nutrient loads.



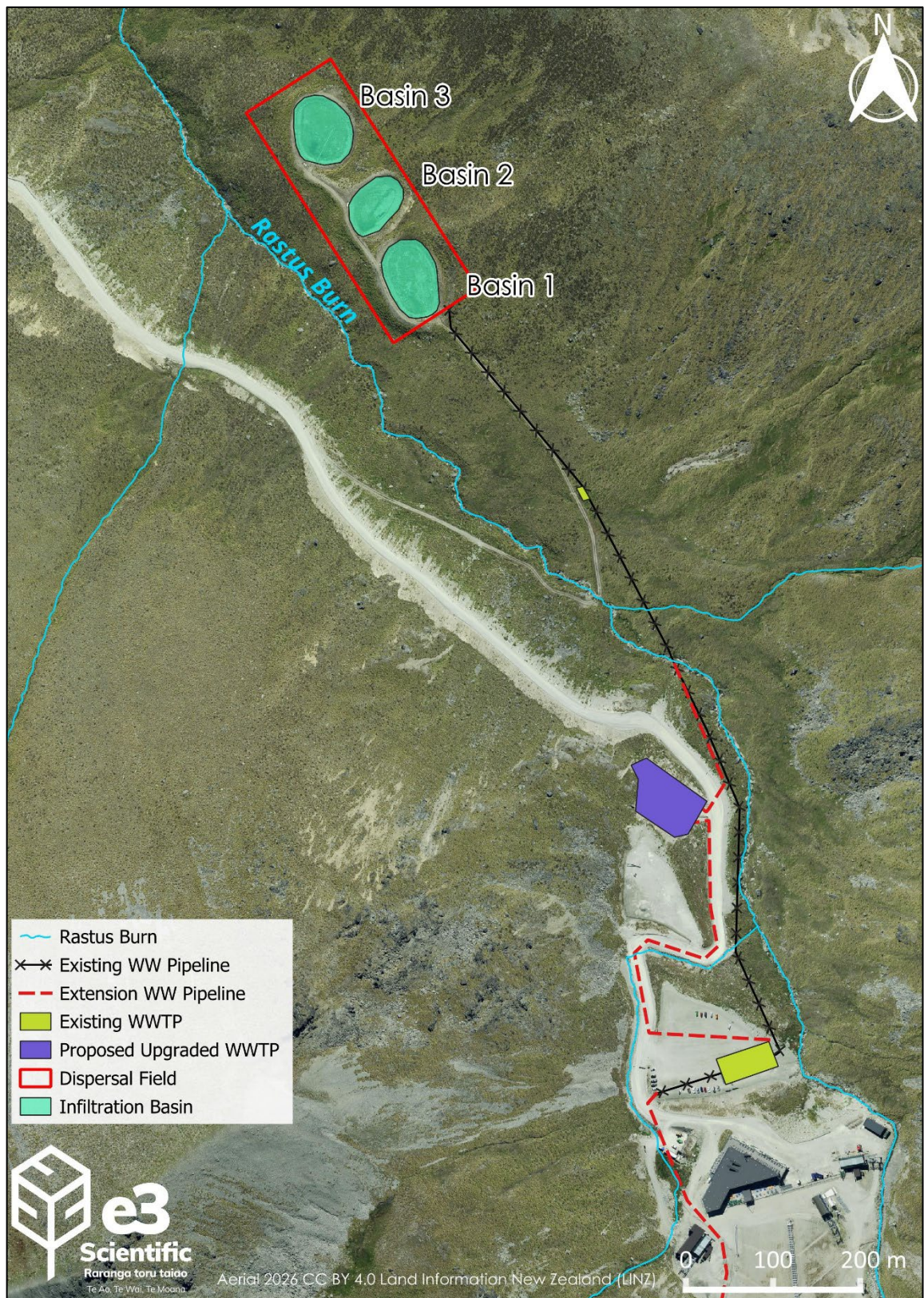


Figure 2: Wastewater treatment system locations (Source: e3Scientific 2026a).



2.2 Environmental Context

2.2.1 Rastus Burn

The catchment has been developed to support the Remarkables ski field with ski lifts, roading, car parks, and associated ski field buildings however there are still areas of undisturbed wetlands, lakes, and alpine terrain. The Remarkables ski field is located in the upper basin of the Rastus Burn which has its headwaters in three small cirque basins. The catchment elevation ranges from 2,300 m a.s.l. at the highest peaks down to 315 m a.s.l. at the confluence with the Kawarau River (e3Scientific, 2025).

The Rastus Burn is a small (~2 m wide), steep mountain stream with a low flow of 25 L/s and a median flow predicted to be approximately 70 L/s. The catchment upstream of the wastewater treatment plant site is 581 ha and drains the northern end of the Remarkables Range. The upper catchment is alpine, so much of the winter precipitation falls as snow. The landcover comprises predominately of tussocks and bare rock although the upper catchment has small wetlands present in summer once the snow has melted. The stream gradient changes from reasonably low gradient in the headwater cirques and past the Remarkables Base to then a much steeper gorge section from 1400 m a.s.l down to 400 m a.s.l. before levelling out 1 km upstream from the confluence with the Kawarau River.

The stream has a distinct seasonal flow pattern of very low flows in winter due to freezing in the upper catchment, a late-spring peak from snowmelt and westerly storms, and a lower summer minimum in February–March. Mean annual low flow at the ski area pumphouse is estimated at 26 L/s (7-day average).

The surrounding terrain is steep and dominated by large snow tussock, spear grass, and an understorey of native herbs and sedges. Low shrubs, mainly *Dracophyllum* species, occur in drier areas, while boggy zones support extensive turf and mound communities (Ludgate, *et al.*, 2014).

2.2.2 Lake Alta Headwaters

Lake Alta sits on Department of Conservation (DOC) land within an area managed as the Remarkables Ski Field by NZSki. The 13 hectare (ha) lake is approximately 34.45 m deep (Figure 1) (Clarke Fortune McDonald & Associates.,



2011). The lake drains from an outlet to the Rastus Burn that flows to the Kawarau River which then converges to the Clutha River 55 km downstream.

Lake Alta was assessed as part of the Lakes 380 project between 2018 and 2021. This study suggests that Lake Alta is considered to have “Very poor” water quality with a “Supertrophic”, status (Lakes 380, Accessed 2025). However, the lakes 380 assessment was estimated based on bacteria present in lakebed sediment rather than actually based on regular water quality, clarity and Chlorophyll *a* samples (Pearman, *et al.*, 2022).

Previous surveys have demonstrated that fish are absent from the lake, most likely due to the high altitude and harsh (cold) conditions (Ryder Consulting, 2012) but also likely due to being naturally excluded by multiple chutes and waterfalls downstream. The Rastus Burn has been monitored as part of the previous NZSki resource consent. This has outlined a benthic macroinvertebrate community dominated by *Deleatidium* and *Nesameletus* mayfly larvae, Elmidae beetles and Chironomid (non-biting midge) larvae, along with a relatively high proportion of stonefly larvae (Ryder Consulting, 2012). Alpine lake benthic communities are primarily influenced by the limited availability of food, the high radiation intensities during the ice-free summer period promoting algal growth and by the winter cover of ice, with lakeside tussock contributing allochthonous plant material to littoral habitat (Fureder, *et al.*, 2006). The macroinvertebrate community is considered likely to have low diversity due to the high elevation, and relatively short season for macroinvertebrate colonisation and growth between winter freeze over events. Internationally alpine lakes are dominated by chironomid larvae with low numbers of EPT taxa present (Fureder, *et al.*, 2006).

There are no known macrophyte records for Lake Alta. The boulder substrate appears to be not ideal for macrophyte colonisation along with the harsh seasonal conditions with the lake freezing over in winter. Small amounts of filamentous green algae are present within the surface 1 m around the littoral edge and at the outlet to the Rastus Burn (Ryder Consulting, 2012). Benthic algae is a food source for higher trophic levels such as grazing macroinvertebrates. *Didymo* (*Didymosphenia geminata*) has been confirmed as present by eDNA analysis in the lake outlet channel (D. Jack, *pers. comm.*, 2025).

The Lake Alta zooplankton community was sampled in 2002 (Shallenberg, 2002) and 2011 (Ryder Consulting, 2012) where a limited zooplankton fauna typical of



alpine lakes was present with *Boeckella dilatata*, *Ceriodaphnia dubia*, *Alona sp.* and *Chydorus sp.* present.

2.2.3 Regional Plan

Regional Plan: Water for Otago

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 F41:8066 4100.
- Presence of significant fish spawning areas.
- A high degree of naturalness above 900 metres asl.

The Rastus Burn includes most of these ecosystem values, however, is unlikely to have significant fish spawning areas particularly in the upper reaches as it is fishless above the gorge. The location identified as the area of threatened invertebrates is upgradient of the NZSki base and includes a small headwater area upstream of the reach and is largely due to rare moths, beetles, a cave weta and land snail (Patrick, *et al.*, 1992). Although the Rastus Burn is fishless and weed free, we note didymo has been identified recently in the upper Rastus Burn (Figure 5).

The ORC Regional Plan: Water for Otago (2025) does not explicitly provide water quality limits for the Rastus Burn but it does outline in Schedule 15 that the Kawarau River downstream of the Shotover River confluence is in receiving water group 2. The waterway should therefore meet 0.075 mg/l for Nitrate-nitrite nitrogen, 0.1 mg/l for ammoniacal nitrogen, 0.01 for dissolved reactive phosphorus, 260 cfu/100ml and 5 NTU to achieve good water quality (Otago Regional Council, 2025).



3 Methods

3.1 Desktop Review

A desktop review of relevant databases including monitoring reports associated with the existing wastewater discharge consent was undertaken.

The desktop study included a review of existing ecological and water quality information to determine habitats and species likely present on the site.

The desktop assessment included:

- A review of the Land and Water Aotearoa (LAWA) website to access water quality and macroinvertebrate records;
- A review of the New Zealand Freshwater Fish Database (NZFFDB) and Wilderlab eDNA database for historic fish records; and
- Determination of the threat status of the species records by using the New Zealand Fish Threat Classifications as outlined in (Dunn, *et al.*, 2025) and (Grainger, *et al.*, 2018).
- A review of relevant literature including previous consent monitoring reports related to the discharge of wastewater to the Rastus Burn (Ludgate, *et al.*, 2014; Ludgate, 2017; SLR, 2023; SLR, 2026).
- A review of the Otago Regional Plan for known Rastus Burn natural values and expected water quality.

These aspects are then considered against the Otago Regional Council (ORC) Regional Plan: Water for Otago, Schedules 1A and 15. Then the ecological values and impact of the activity are assessed following the methods outlined in the EIANZ Guidelines (Roper-Lindsay, *et al.*, 2018).

3.2 Site Visit

On 13 April 2025, e3scientific freshwater ecologists carried out a site visit at Lake Alta outlet to sample the Rastus Burn upstream of the wastewater discharge. A further site visit was undertaken on 27 February 2026 to collect eDNA samples downstream of the Rastus Burn Gorge to determine if fish were present within the lower reaches of the stream near the confluence with the Kawarau River.



Consent monitoring largely used to assess the ecological values present was undertaken in 2014, 2017, 2023 and 2025. The consent monitoring sites comprise of one upstream control site and 3 downstream impact sites. The upstream site is approximately 400 m upstream of the wastewater dispersal fields. The impact sites were monitored 50 m, 200 m and 1500 m downstream of the wastewater dispersal field (SLR, 2026) (Figure 3).



Figure 3: Site Sampling overview.

3.3 Physio-Chemical Parameters

The properties of the water in the Rastus Burn immediately below Lake Alta were assessed on 30 April 2025 using a calibrated YSI ProDSS multiparameter meter that measured water temperature, dissolved oxygen, total dissolved solids, conductivity, pH and turbidity. The meter was deployed mid water and allowed to stabilise for 1 minute before the readings were recorded. The data gathered was then assessed against recognised guideline values for the various relevant parameters. The default guideline values (DGV)(ANZG, 2018) have been developed for different waterway types based on the River Environmental



Classification (REC). This section of the Rastus Burn is considered in the REC to have a cool wet climate and a mountain source of flow (Snelder, *et al.*, 2010), therefore the DGV (See Table 2) for this river type was used to produce guideline values (ANZG, 2018).

3.4 Habitat

Four compliance monitoring sites and the Lake Alta Rastus Burn outlet had habitat observations completed (Figure 4 & 5). The compliance monitoring reports were used to describe the instream and riparian habitat present at the consent compliance monitoring sites. During the April 2025 survey, habitat characteristics of the Rastus Burn at the Lake Alta outlet were assessed and used to describe the instream habitat conditions at this site.

3.5 Periphyton

Periphyton monitoring undertaken as part of the compliance monitoring to assess the existing wastewater discharge was reviewed and periphyton type and abundance over time described. No further periphyton monitoring was completed in April 2025 or February 2026 as part of this assessment.

As per existing compliance monitoring conditions, periphyton was visually assessed at each of the four sites and different substrates available for periphyton growth (e.g., gravels, cobbles) were inspected. Samples of representative algal cover were collected from each site and returned to the laboratory for further identification (SLR, 2026). Samples were inspected under 200-400x magnification to identify algal species present using the keys of Biggs & Kilroy (2000), Entwisle *et al.* (1988) and Moore (2000). Algae were given an abundance score using the reduced ranks scheme, with 1 representing rare, 2 representing common and 3 representing abundant (SLR, 2026).

3.6 Macroinvertebrates

Macroinvertebrate sampling within the Rastus Burn Stream was completed on 13 April 2025 by e3scientific freshwater ecologists. The sample was collected upstream of the wastewater outlet and the compliance monitoring sites (Figure 3). As some elevated water parameter levels have been recorded at the



upstream compliance monitoring site (e3Scientific, 2026a) it was decided an additional sample recently collected further upstream at the Lake Alta outflow would be useful within this context.

A 0.4 m wide, 500 micron mesh kicknet was used following the C1 hard bottomed protocol (Stark, *et al.*, 2001) to obtain a macroinvertebrate sample in order to identify the values present within the Rastus Burn near the outlet of Lake Alta. This involved collecting five subsamples across the assessment reach that are combined into one composite sample. Habitat types were sampled in proportion to their presence with 100% of the sample effort involved sampling cobble riffles. Ethanol was added to a concentration of 70% to preserve the sample. The sample was then transported to e3s laboratory for identification, full count enumeration and metric calculation.

The consent monitoring reports utilised the same kicknet field method and equipment following the C1 protocol (Stark, *et al.*, 2001). The samples were then processed using the full count P3 protocol (Stark, *et al.*, 2001; Ludgate, *et al.*, 2014; Ludgate, 2017; SLR, 2023; SLR, 2026).

3.6.1 Macroinvertebrate Metrics

Macroinvertebrate metrics (taxa richness, MCI, QMCI, EPT taxa, % EPT Taxa, % EPT Abundance and ASPM) were calculated for the Rastus Burn Lake Outlet sample. The compliance monitoring reports also produced MCI, SQMCI and EPT% following the same methods. The MCI, QMCI and SQMCI metrics were compared against quality classes reported in Boothroyd & Stark (2000) and Stark & Maxted (2007) in Table 1. Using these quality classes rather than the more recent NPS-FM (2020) classes is considered appropriate as the macroinvertebrate monitoring occurs at the end of the ski season and prior to the end of November whereas the NPS-FM requires sampling to occur December to April (Ministry for the Environment, 2020). Additionally, EPT is used to assess the community diversity and sensitivity.

Table 1: Macroinvertebrate Metric Attribute Bands (Source; Boothroyd & Stark, 2000; Stark & Maxted, 2007).

Quality Class (2000)	Quality Class (2007)	MCI	QMCI
Clean water	Excellent	≥ 120	≥ 6.00
Doubtful quality	Good	100 – 119	5.00 – 5.99
Probable moderate pollution	Fair	80 – 99	4.00 – 4.99



Probable severe pollution	Poor	< 80	< 4.00
----------------------------------	------	------	--------

3.7 Fish

Electric fishing of the Rastus Burn was undertaken in October 2014 over a 2 km reach from 1500 m downstream of the dispersal field to 400 m upstream (Ludgate, *et al.*, 2014). During this survey Ludgate *et al.*, (2014) noted the presence of waterfalls likely to preclude fish from accessing the upper Rastus Burn.

The ORC Regional Plan suggests that the Rastus Burn provides spawning habitat for trout (Otago Regional Council, 2025). It is assumed this could only possibly occur in the lower reaches near the confluence with the Kawarau River. Therefore, eDNA was collected on 27 February 2026 within the Rastus Burn approximately 4.5 km downstream of the wastewater dispersal field and approximately 600 m upstream from the confluence with the Kawarau River.

Six replicate eDNA samples were collected following Wilderlab sample collection guidance notes and NIWA replicate recommendations (Melchior & Baker, 2023; Smith, *et al.*, 2024). Where 1 litre of stream water was filtered and the filter preserved and labelled and sent to Wilderlab for genetic analysis to identify the species with eDNA within the samples.

The NZFFD and eDNA databases were also reviewed to ascertain if more recent assessments or fish records were present (Figure 3).

3.8 Wetlands

Historical reports were reviewed to ascertain if there were any wetlands near and downgradient of the wastewater dispersal field and discharge. Additionally, aerial imagery was assessed to identify any potential wetland areas near and down gradient of the wastewater dispersal field.



4 Results

4.1 Surface Water Results

Rastus Burn physico-chemical parameters are consistent with those expected for a cool, clear alpine stream in late summer (Table 2). The high dissolved oxygen levels are likely driven by strong re-aeration as water cascades over bouldery habitat, and may also reflect phytoplankton activity in Lake Alta, which could contribute to the slightly lower-than-expected pH. Turbidity and total suspended solids are generally low, although occasional increases occur during snowmelt or when fine material is mobilised from the rocky upper basins or from access-track runoff upstream.

According to Ludgate *et al.*, (2014), the Rastus Burn at the compliance monitoring sites contains cool, well-oxygenated, low-nutrient water, with temperatures typically between 1.7°C and 5.1°C and a normal pH range. Faecal contamination is very low and usually below detection limits upstream of the wastewater dispersal field.

Table 2: Physico-chemical results for the Rastus Burn at the Lake Alta outlet on 13/4/2025 and the DGV (ANZG, 2018) values for sites with a cool wet climate and mountain source of flow.

Site	Rastus Burn	DGV
Temperature (°C)	7.6	N/A
Dissolved Oxygen %	107	93 - 103
Conductivity (µS/cm)	16.3	87
pH	7.31	7.39 – 7.8
Turbidity (NTU)	0	4.6
Water Clarity (m)	Clear	1

Note: values in bold if outside the recommended DGV range.

Overall, the current discharge of wastewater to land has been considered to have a slight but measurable increase in nutrient concentrations in the Rastus Burn above baseline levels but remains below the 99% DGV (e3Scientific, 2026a). It is expected that the proposed increase in wastewater volume with improved quality will ensure the existing nutrient load will remain and effects on water quality will be consistent with the current situation.



4.2 Habitat

Streambed habitat in the Rastus Burn consists of bedrock chutes and waterfalls in the steeper reaches, transitioning to cobbles, boulders, and gravel free of fine sediment in the flatter sections. The steep gradient creates cascading reaches with a bed dominated by cobbles and boulders, and pockets of smaller gravels in slower areas (Ludgate, *et al.*, 2014). The Rastus Burn is fed by lake water and the Lake Alta Outlet comprised primarily of cobbles and large gravels smothered in didymo (Table 3; Figure 5).

At the upstream compliance site the riparian zone was dominated by large *Chionochloa* (snow tussock) and *Aciphylla* (spaniard), with scattered low shrubs such as *Dracophyllum* and *Veronica* species, along with small alpine herbs. Moss occurred along the stream margins and on instream rocks. The channel featured tumbling flow over medium boulders, interspersed with small pockets of lower-velocity water where the substrate comprised flat cobbles and medium gravels (SLR, 2026)(Figure 4).

The compliance monitoring site 50 m downstream has riparian vegetation similar to the upstream reach, with snow tussock, spaniard, low shrubs, alpine herbs, and moss on stream edges and boulders. The instream habitat had a noticeably steeper gradient than the upstream and 200 m downstream sites. Large boulders created abrupt drops, and a major cascading waterfall occurred immediately upstream of the sampling area (SLR, 2026)(Figure 4).

At the site 200 m downstream, the riparian vegetation remained dominated by tussock, spaniard, and low alpine shrubs, with moss present on shaded margins and instream surfaces. The stream flowed through a confined channel with a long run, and the bed was composed of small boulders, medium to large cobbles, and intermittent patches of coarse gravel (SLR, 2026)(Figure 4).

At the site 1500 m downstream, the site supported a more diverse and taller riparian vegetation assemblage, including *Phormium cookianum* (mountain flax), taller *Coprosma* species, and scattered *Discaria* (matagouri) and *Carmichaelia* (native broom), with vegetation overhanging the channel in places. The instream habitat had a very steep gradient and consisted of continuous cascade and waterfall-type flow with very high velocities. Substrates were dominated by large



boulders and bedrock, with only occasional small patches of finer gravel (SLR, 2026)(Figure 4).



Figure 4: Compliance Monitoring point Habitat (Source: SLR 2026).





Figure 5: Lake Alta outlet sampling within the Rastus Burn with didymo present (13/4/2025).

Table 3: Rastus Burn habitat at the Lake Alta Outlet.

Site	Rastus Burn
Boulder	-
Cobble	40
Gravel	60
Filamentous algae %	60 (didymo)
Macrophyte cover %	0
Moss cover %	0
Habitat assessment (RHA) 0-100	62

4.3 Periphyton

Periphyton growth has been assessed as minimal upstream and downstream of the current wastewater treatment plant infiltration dispersal field, with any periphyton community present dominated by red filamentous algae at less than guideline values (SLR, 2023). The monitoring site 50 m downstream typically has the lowest algal diversity of the four sites, while the upstream control generally has



the greatest diversity. This low algal cover is considered largely due to the cold, water temperatures, snow and ice limiting light at times and high water velocities preventing excessive algal biomass (Ludgate, *et al.*, 2014).

Of the algal taxa reported as present in the 2025 consent monitoring report (SLR, 2026), *Audouinella* is considered an oligotrophic taxa, *Cocconeis* more a generalist, *Cymbella* mesotrophic, *Gomphonema* varies depending on the species, *Naviculoid* oligotrophic to mesotrophic, *Pinnularia* mesotrophic to oligotrophic (Biggs, 2000). While a dissolved inorganic nitrogen (DIN) level of < 10 mg/m³ and dissolved reactive phosphorus (DRP) level of < 1 mg/m³ have been suggested to maintain benthic biodiversity in New Zealand (Biggs, 2000) these levels are considerably higher than what is currently present at this low nutrient alpine location.

Periphyton cover in alpine streams is generally low during the summer snow melt phase and highest in more favourable stable autumn conditions. Spring low flow does not generally demonstrate an increase in periphyton biomass (Figure 6) (Uehlinger, *et al.*, 2010). Low temperatures slow down algal growth rates, but periphyton biomass reaches higher levels if discharge and turbidity are low and snow cover is lacking (Uehlinger, *et al.*, 2010). The Rastus Burn currently has low nutrient concentrations recorded upstream of the wastewater dispersal fields although seasonal patterns are apparent with higher nutrient levels recorded in winter than summer and an apparent phosphorus source upstream (e3scientific 2026a).

Didymo (*Didymosphenia geminata*) is known to have been in the Rastus Burn since 2023 and has been observed at the headwaters at the Lake Alta outlet during summer 2025 (Figure 5). This lake outlet provides stable flow and it appears that didymo biomass can reach high levels here. Once introduced to a new waterway, didymo blooms are known to occur in high light conditions and very oligotrophic water with low mean dissolved reactive phosphorus levels e.g. <2 mg/m³ (Bothwell, *et al.*, 2014). Didymo stalk production (blooms) are in response to very low DRP and is a strategy to move cells out of the benthic boundary layer and into the water column where there is greater delivery of phosphorus (Bothwell, *et al.*, 2014). Didymo is known to tend to bloom downstream of lake outlets where high light, low turbidity, stable substrate and stable flow are present along with low DRP levels (Bothwell, *et al.*, 2014). Therefore, as didymo has newly arrived in the catchment and the Rastus Burn is downstream from Lake Alta with



relatively stable flows, high light levels in summer and low phosphorus (DRP) levels, didymo blooms may potentially occur in the Rastus Burn in the future and this would be unrelated to the wastewater discharge. As yet, didymo has only been recorded in consent monitoring 200 m downstream of the wastewater dispersal field in November 2025 and was considered “rare” at that time (SLR, 2026). It is expected that with suitable wastewater treatment, phosphorus levels will remain low (<2 mg/m³) and didymo blooms may become an issue within the catchment.

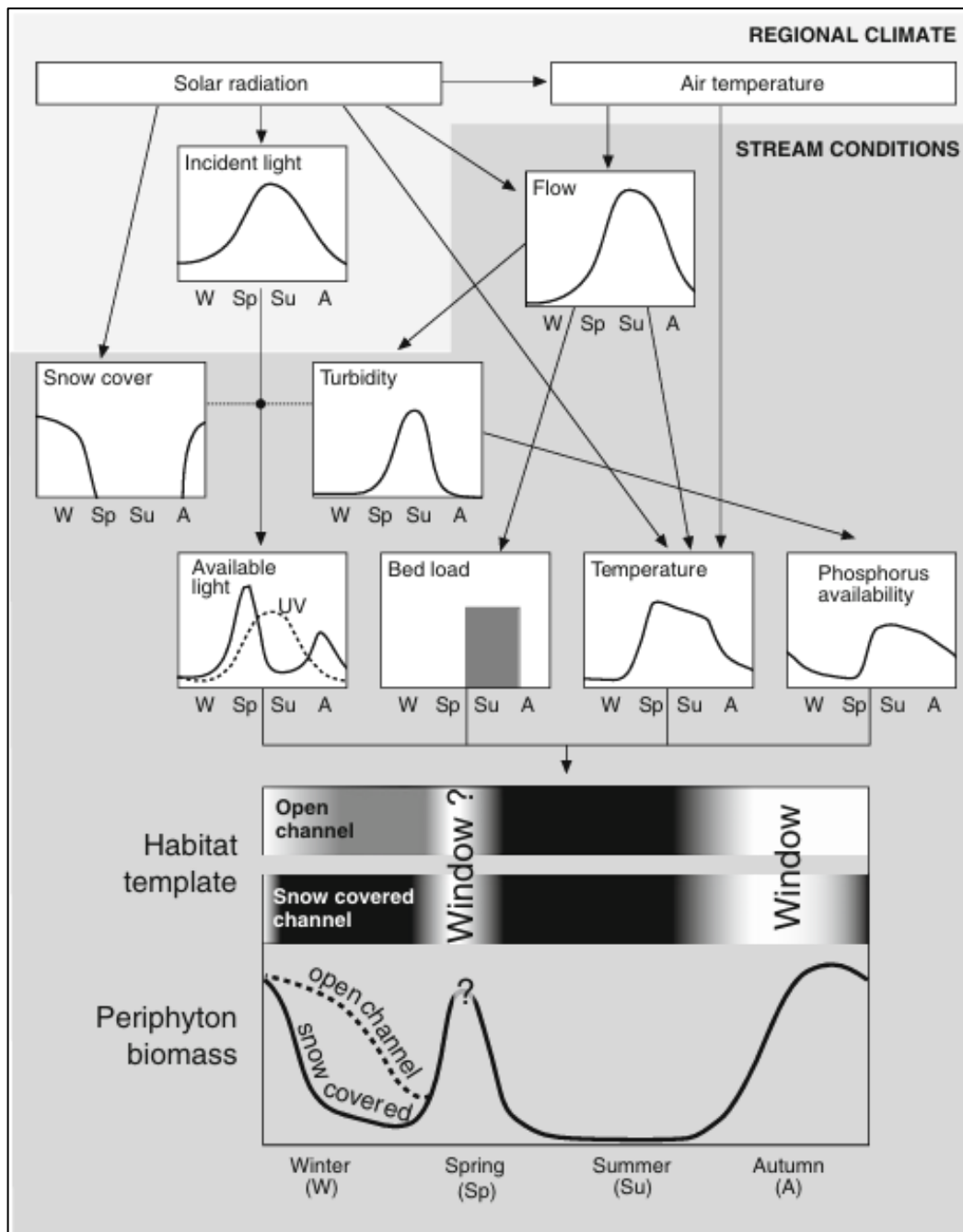


Figure 6: Stylised periphyton growth potential in alpine streams (Uehlinger *et al.*, 2010).



Overall, the current discharge of wastewater to land has been considered to maintain a low cover of periphyton near baseline levels. It is envisaged that the proposed increase in wastewater volume at reduced nutrient concentrations will continue to ensure low/rare cover of periphyton that prefer oligotrophic conditions. Noting there may be blooms of didymo that are unrelated to this activity.

4.4 Macroinvertebrates

The Rastus Burn macroinvertebrate compliance monitoring has demonstrated the stream is numerically dominated by *Deleatidium* mayflies, predatory flatworms and worms with a variety of stonefly and true fly larvae with the occasional beetle and caddisfly present (Ludgate, *et al.*, 2014). The species present are generally considered to represent cool clear well oxygenated water and are indicative of 'good to excellent' conditions in 2014 (Ryder 2014; Ludgate *et al.*, 2014), 'good to excellent' in 2017 (Ludgate, 2017), 'fair to good' in 2023 (SLR, 2023) and 'excellent' (SLR, 2026).

The stream ecology based on the macroinvertebrate community is considered a "healthy and diverse benthic macroinvertebrate communities typical of high gradient alpine streams" (Ludgate, 2017). Monitoring results supporting this opinion are provided in Table 4. The 2013/14 samples demonstrate "excellent" MCI and QMCI metric scores down gradient of the land dispersal site with the 2016/17 demonstrating "good" to "excellent" MCI scores. The 2022/23 results showed a decline in MCI and QMCI values before rising to "excellent" 1500 m downstream of the land dispersal site.

This decline in 2022/23 is likely to be related to elevated nutrient loads at that time although an effluent spill also occurred in 2023 (e3Scientific, 2026a). The results in 2024/25 demonstrate a return to metrics indicative of a macroinvertebrate community in "excellent" condition. In summary, if the increase in wastewater can be managed and treated to ensure there is no increase in total nutrient (nitrogen and phosphorus) load the macroinvertebrate community should remain in "excellent" condition and indicative of a healthy alpine stream.



Table 4: Summary of compliance ecological monitoring (Sources: Ludgate, et al., 2014; Ludgate, et al., 2017; SLR, 2023; SLR, 2026; e3Scientific, 2026a).

Table 4b: Ecological Monitoring		2013-2014	2016-2017	2022-2023	2024-2025	Average
Periphyton	All sites	Absent or rare across all sites	Absent or rare across all sites	Absent or rare across all sites	Absent or rare across all sites, didymo detected at 200 DS for the first time.	-
EPT Taxa%	Upstream	51	44	49	63	52
	50m DS	47	52	39	48	46
	200m DS	49	43	36	60	47
	1500m DS	-	49	54	54	52
MCI Score	Upstream	114	119	99	123	114
	50m DS	125	130	105	130	123
	200m DS	129	117	96	132	119
	1500m DS	-	116	118	134	123
SQMCI Score	Upstream	7.3	7.4	5.6	7.4	7
	50m DS	6.9	7.3	4.9	7.6	7
	200m DS	7.1	6.3	5.2	7.3	6.5
	1500m DS	-	7.1	7.2	7.9	7

Didymo blooms have the potential to alter the macroinvertebrate community present by shifting the species composition from that of larger bodied mayflies and stoneflies to a predominance of smaller bodied diptera larvae and worms (Kilroy, et al., 2009). This can lead to increased macroinvertebrate relative abundance (Bray et al., 2019) but a lowering of the macroinvertebrate metric scores.

Due to the low algal biomass (and low palatability, in the case of didymo) the sparse macroinvertebrate grazer community consists of macroinvertebrates sensitive to organic pollution and those that prefer cool well oxygenated water. The algal food resource will be supplemented with plant material such as tussock leaves that some macroinvertebrate shredders will be able to utilise. In the absence of fish, stonefly and flatworm predators comprise the top trophic level as the dominant macroinvertebrate predators. The macroinvertebrate community has consistently been considered to be representative of a "good to excellent" macroinvertebrate community although there was a decline in 2023 to "fair to good" before recovering in 2025 to 'excellent' again based on MCI and SQMCI results (SLR, 2023; SLR, 2026).

The ORC Schedule 1A ascertainment that rare macroinvertebrates are present above the NZski base building (1600 m a.s.l.) appears to be based on a study undertaken by Patrick, et al., (1992) that found *Tiphobiosis childi*, *T. montana*, *Hydrobiosis kiddi* and *Costachorema hebdomon* as present and considered them local species with aquatic larvae that are not often collected. *Hydrobiosis sp. aff. chalcodes*, which replaces the widespread and common *H. parumbripennis* in the South Island high country, was also found by Patrick, et al., (1992). However, the New



Zealand Threat Classification for Freshwater Invertebrates (Grainger, *et al.*, 2018) does not consider any of these taxa threatened, with only *C. hebdomon* considered At Risk - Naturally Uncommon. Naturally Uncommon taxa are those “whose distribution is confined to a specific geographical area or which occur within naturally small and widely scattered populations, where this distribution is not the result of human disturbance” (Grainger, *et al.*, 2018). However, it is also possible that other data deficient taxa are also present within the waterway.

The instream ecological metrics were low (Fair MCI and Poor QMCI) for the Rastus Burn at the Lake Alta Outlet upstream of the wastewater discharge to land (Table 5) but this is largely driven by the low density and diversity community present in alpine lake outlets (Harding, 1994). Alpine environments have lower diversity due to limited dispersal by adult (flying insect) life stages of the instream macroinvertebrate larvae. Didymo is also known to influence benthic macroinvertebrate communities by increasing species richness (Bray, *et al.*, 2019) and altering the size and type of organisms present to smaller taxa (Kilroy, *et al.*, 2009; Ladrera, *et al.*, 2018). The didymo bloom at the Lake Alta outlet overrides the natural low diversity EPT dominated community that would otherwise be present. Whereas, the macroinvertebrate community present nearer the wastewater land dispersal field is still intact and considered “excellent” in 2025 (Table 4).

Table 5: Macroinvertebrate raw data.

Macroinvertebrates	Rastus Burn Lake Outlet
Diptera	
<i>Chironomus</i>	3
<i>Maoridiamesa</i>	2
<i>Orthoclaadiinae</i>	1
<i>Limonia</i>	17
Ephemeroptera	
<i>Deleatidium</i>	17
Plecoptera	
<i>Acroperla</i>	1
<i>Zelandobius</i>	1
Trichoptera	
<i>Hydrobiosis</i>	2
<i>Hudsonema</i>	13
Oligochaeta	64



Macroinvertebrates	Rastus Burn Lake Outlet
Abundance	121
Taxa Richness	10
EPT % Abundance	28.1
EPT %Taxa Richness	50
EPT Richness	5
MCI	84
QMCI	3.4
ASPM	0.29
Shannon Diversity Index	1.47
Shannon Evenness	0.64

Overall, the current discharge of wastewater to land is considered to maintain a macroinvertebrate community considered indicative of “excellent” health. It is envisaged that the proposed increase in wastewater volume at reduced nutrient concentrations will continue to ensure macroinvertebrate community considered indicative of “excellent” health. At this altitude the Rastus Burn has a low diversity and abundance of algae and macroinvertebrates. We note that didymo blooms that are unrelated to this activity could alter the macroinvertebrate community at times in the future.

4.5 Fish

Fish have not been recorded in surveys undertaken in the Rastus Burn from 2006 to 2024. Ludgate *et al.* (2014) considered the lower 1 km of the Rastus Burn upstream of the confluence with the Kawarau River to be the only section potentially suitable for colonisation and use by fish. Spatial analysis suggests the lower 1.7 km (to approximately 450 m a.s.l.) is accessible for fish from the Kawarau River but beyond this point waterfalls and bedrock chutes would exclude upstream fish access (Figure 3).

eDNA data from the Kawarau River at Chards farm collected in April 2025 by the ORC shows the presence of rainbow (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*), perch (*Perca fluviatilis*) and common bully (*Gobiomorphus cotidianus*) (Figure 3). Kōaro (*Galaxias brevipinnis*) and longfin eel (*Anguilla dieffenbachii*) are also known from Lake Whakatipu. eDNA results in this study collected from the lower Rastus Burn below the gorge sections in February 2026 identified the eDNA of kōaro, brown trout and rainbow trout. Trout are unable to



pass the waterfalls and chutes within the Rastus Burn without human assistance, while kōaro are the only fish potentially able to migrate upstream past waterfalls and bedrock chutes. Notwithstanding this point it is very unlikely that kōaro would be present in the upper Rastus Burn due to the number waterfalls and the lack of kōaro recorded in the area above 1100 m a.s.l.

The absence of fish above the Rastus Burn Gorge and including Lake Alta is confirmed by reviewing nearby fish survey records from the NZFFDB and Wilderlab eDNA records.

4.6 Wetlands

Based on aerial photograph analysis two seepage wetlands are present in close proximity to the wastewater dispersal field. The potential wetlands are situated 32 and 80 metres down gradient and at distance of 130 and 250 m north-west of the wastewater dispersal fields in area A and potentially closer if identified in Area C (Figure 7). On a separate flow gauging trip e3s staff noticed wet areas (no wetland delineation was undertaken to confirm if they were natural inland wetlands) within area A approximately 130 m north-west of the dispersal fields (Figure 8). The hydraulic connection of the wetlands to groundwater is unclear. However, if connected, it is possible wetlands will experience a slight increase in flow in response to the proposed increase in wastewater volume.

Given the proposed nutrient loadings are similar to the current situation and only a slight increase in flow predicted, e3scientific would not expect to see a measurable effect on these wetlands.



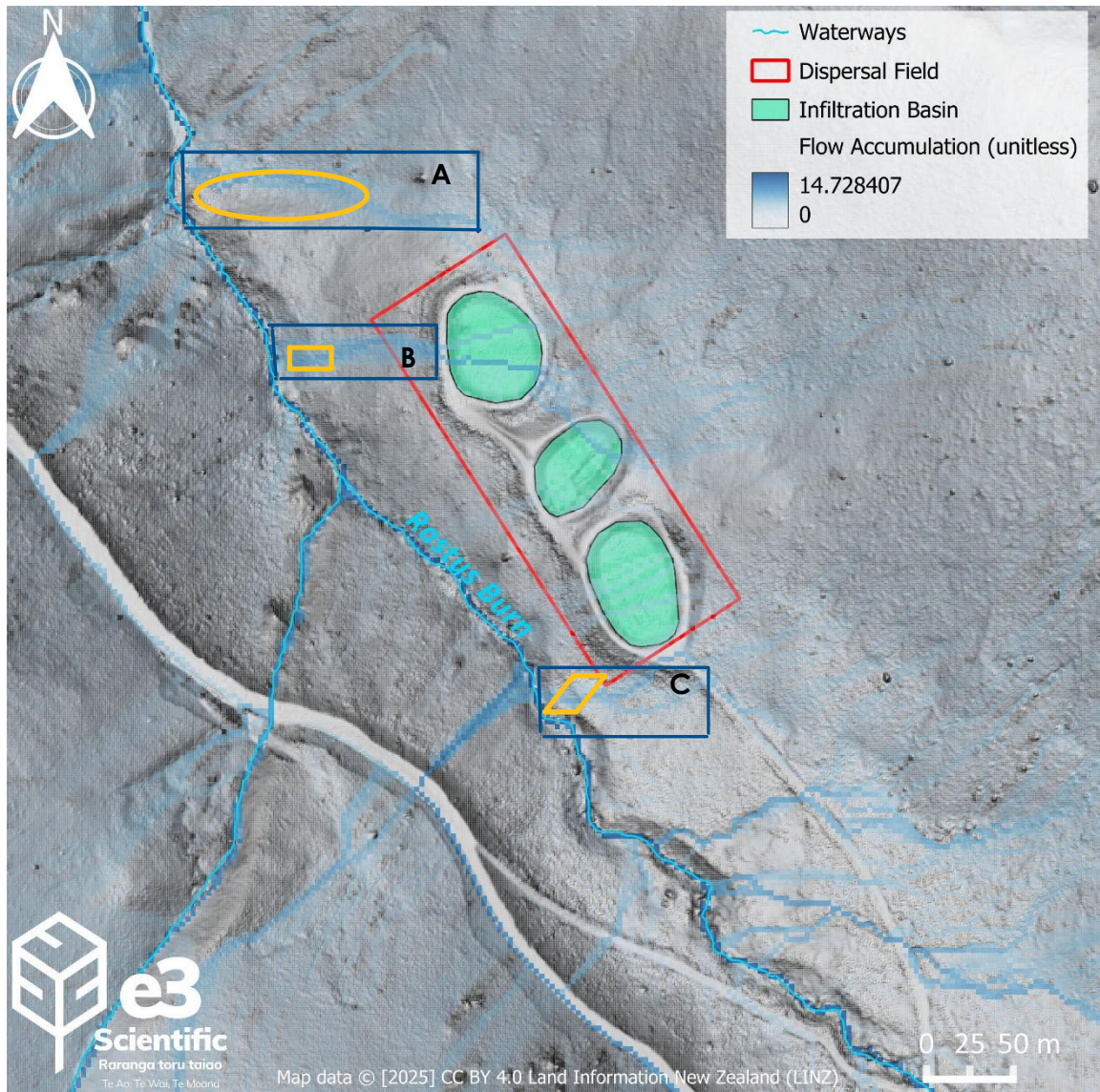


Figure 7: Flow paths near the dispersal field and potential wetland areas within 100 m marked with blue rectangles and likely wetland areas within orange shapes.



Figure 8: Example images of wet areas found within Area A.



5 Ecological Values

5.1 Assessment of Ecological Value following the EIANZ Guidelines

Under the EIANZ guidelines (Roper-Lindsay, 2018) ecological value is assigned based on the following assessment matters as summarised in Table 6 below:

- Representativeness
- Rarity and Distinctiveness
- Diversity and Pattern
- Ecological Context

The representative criteria is more difficult to utilise within the freshwater environment as it relies on a range of information to support the assessment. More easily incorporated into the EIANZ criteria are rarity, diversity and ecological context in the freshwater environment which is utilised to support an assessment of ecological value. These matters are each assessed on a five point scale from Negligible to Very High.

Representativeness

The representativeness value for the freshwater environment includes the extent to which the site is typical of the natural characteristics, catchment size, stream order, standing water characteristics and taxa present. Therefore, it is considered appropriate that sites classified as unmodified or representative are recognised with a higher value under the Representative criteria. An unmodified or more natural site or area is likely to be a better representative example than a more modified one; some people consider that representativeness is broadly equivalent to "naturalness".

Rarity / Distinctiveness

The New Zealand Threat Classification System (NZTCS) is used to assess the threat status of fish (Dunn, et al., 2025), freshwater macroinvertebrates (Grainger, et al., 2018), terrestrial and aquatic plants (de Lange, et al., 2023) and birds (Robertson, et al., 2021). This impact assessment has utilised these NZTCS reports to inform an assessment of rarity. However, rare habitats, communities or ecosystem types should also be considered.



Diversity and Pattern

The desktop research undertaken within this report of the NZFFD, Shannon Diversity Index and Richardson & Jowett (1996) provide the basis for an assessment of diversity at the proposed site. Diversity and pattern can include physical and biological diversity. Underlying physical patterns such as lower fish diversity at greater altitude or temporal gradients. Long-term trends and taxa density can also be considered.

Ecological Context

Ecological context describes an ecosystem's role in ecosystem functioning. Examples may include:

- freshwater and terrestrial habitat may provide an important food source for fish and/or birds.
- freshwater and terrestrial habitat may play an important part in the lifecycle of a species e.g. breeding or spawning locations for macroinvertebrate, bird or fish species.
- Macroinvertebrate metrics or TICl scores.

For the purpose of this assessment habitats that support Threatened and At - Risk species, are biologically diverse, provide an important food source or play a critical role in the lifecycle of a species are considered to have a high ecological value.

Table 6: Assessment of the Rastus Burn habitat using the ecological criteria in the EIANZ Guidelines.

Matter	Criteria	Score
Representativeness	The Rastus Burn is typical of an alpine stream in Otago with a steep rocky catchment. Permanent flow with a tarn in the headwaters. An algal and macroinvertebrate community representative of cool, clear water, where indigenous species dominate is present. Expected guilds and species assemblage present for this altitude. Reasonably low taxa richness due to the	High



Matter	Criteria	Score
	alpine cold conditions with snow covering the ground for at least 4 months of the year. Community likely to be very similar to 1840 baseline community.	
Rarity/distinctiveness	The Rastus Burn does not support any rare or threatened fish. It does support a population of At Risk - Naturally uncommon caddisfly upstream of the wastewater discharge site. High macroinvertebrate predator numbers due to the lack of fish.	Moderate
Diversity and pattern	There is naturally low diversity in the algal and macroinvertebrate community present instream and an absence of fish. Alpine stream environments have lower diversity due to limited dispersal by adult (flying insect) macroinvertebrate life stages.	Low
Ecological context	The harsh alpine environment limits the community able to reach the upper Rastus Burn, and the growth rates and survivorship of those that do. This leads to low instream productivity with a low diversity and abundance of instream algae and macroinvertebrates and a community that is fishless. This is similar to other alpine streams in the region.	Moderate

5.2 Summary of Ecological Values

In summary the cold, clear, well oxygenated water of the Rastus Burn and stable rock substrates free of fine sediment provide for an algal community typical of alpine environments with low cover of a few species including diatoms and filamentous red algae. The low algal biomass and allochthonous tussock leaves in turn provide a constrained food resource for the limited macroinvertebrate



community present that comprises of taxa sensitive to organic pollution and that prefer cool well oxygenated water.

The macroinvertebrate community has consistently been considered to be representative of a “good to excellent” macroinvertebrate community through consent monitoring downstream of the wastewater dispersal field. The recent introduction of didymo to the Rastus Burn catchment headwaters (Lake Alta outlet) could mean that blooms may occur in the future throughout the Rastus Burn and this could alter the macroinvertebrate community composition during didymo bloom events.

The EIANZ Guidelines provide guidance on how to combine the 4 matters assessed above. Combining the 1 High, 2 Moderate and 1 Low matter results in an overall **Moderate Ecological value** for the Rastus Burn near the NZSki site and wastewater dispersal fields.



6 Ecological Impact Assessment

6.1 Ecological Impact Assessment Methodology

This ecological impact assessment (FEcIA) follows the EIANZ Ecological Impact Assessment Guidelines for New Zealand. The guidelines are based on the assessment of the ecological values present within the disturbance area of the proposed wastewater dispersal field (see Section 2). The magnitude of the effect within the zone of influence and the wider context of species populations and extent of remaining freshwater habitat is then considered to establish the level of ecological effect.

The FEcIA guidelines provide a series of tables that assist with the assignment of value to the ecological features that will be disturbed and the magnitude of the activity. These tables are provided in Table 7 & 8 and referred to in the discussion below. A summary of the ecological effects and the measures employed to avoid and mitigate the ecological effects of the proposed works are presented in Table 9.

6.1.1 Assigning Magnitude of Effect

The EIANZ guidelines provide criteria for assigning the extent of the effects on the ecological values within the area that may be disturbed by the activity. This assessment adopts the criteria for describing magnitude of effect and is provided in 7 below.

Table 7: Criteria for describing magnitude of effect (Roper-Lindsay, *et al.*, 2018).

Magnitude	Description
Very High	Total loss of, or very major alteration to, key elements/features/ of the existing baseline conditions, such that the post-development character, composition and/or attributes will be fundamentally changed and may be lost from the site altogether; AND/OR Loss of a very high proportion of the known population or range of the element/feature.
High	Major loss or major alteration to key elements/features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed; AND/OR Loss of a high proportion of the known population or range of the element/feature
Moderate	Loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed; AND/OR Loss of a moderate proportion of the known population or range of the element/feature



Magnitude	Description
Low	Minor shift away from existing baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances or patterns; AND/OR having a minor effect on the known population or range of the element/feature
Negligible	Very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation; AND/OR having negligible effect on the known population or range of the element/feature

6.1.2 Assigning Level of Effect

The level of ecological effect is based on combining the ecological value of an environment that may be impacted by the proposed activities and the magnitude of the effect.

Table 8 is adapted from the EIANZ guidelines to provide a level of effect matrix. For the purpose of this assessment, where the level of effect is moderate or above, a management response is required to ensure potential environmental effects are managed appropriately. An effect level of Low or Very Low indicate the effect is ecologically less than minor.

Table 8: Criteria for describing level of effect (Roper-Lindsay, et al., 2018).

		Ecological Value			
		Very High	High	Moderate	Low
Magnitude	Very High	Very High	Very High	High	Moderate
	High	Very High	Very High	Moderate	Low
	Moderate	High	High	Moderate	Low
	Low	Moderate	Low	Low	Very Low
	Negligible	Low	Very Low	Very Low	Very Low
	Positive	Net Gain	Net Gain	Net Gain	Net Gain

6.1.3 Residual Impact

The residual impact is the final impact level assigned to the proposed activity and potential effects once proposed mitigation/remediation options have been applied and is outlined in Table 8.



6.2 Wastewater Discharge Effects

The activity considered is the increase in wastewater volume from 127 m³/day to 204 m³/day discharged to a land infiltration system near the Rastus Burn Stream an increase of 77 m³/day. Although it should be noted that further work is proposed to be undertaken to confirm the volume of wastewater and associated nutrient loads more accurately (e3Scientific, 2026a). E3s and Stantec have both proposed nutrient load performance criteria to maintain ecological values, there are known issues with bywash and the magflow meter that may explain the differences between the e3s and Stantec annual nutrient loads. The e3scientific performance criteria for nutrient loads are based on a current average annual load of 498 kg/N/Yr and 64 kg/P/Yr (e3Scientific, 2026a). However, the actual mean nutrient load may be as high as 750kg/N/yr or higher based on other modelled methods (Stantec, 2026). Further investigation is proposed to reconcile these numbers.

It is proposed that the wastewater treatment system will be upgraded to maintain water quality. This will enable the greater volume of wastewater to be treated and disposed to land without increasing the annual nutrient load above current levels. The current nutrient loads have been assessed to not be adversely affecting the freshwater ecology of the Rastus Burn (provided there are no discharges of untreated wastewater directly to the stream).

Wastewater discharges can pose a particular risk to alpine streams because small increases in nutrient concentrations can cause large ecological responses in these naturally oligotrophic systems. Inputs of nitrogen and phosphorus can stimulate algal growth, shift periphyton communities toward nutrient-tolerant species, and alter food-web structure in streams that typically support very low productivity. These nutrient-driven changes may be compounded by associated stressors such as elevated water temperatures, reduced dissolved oxygen associated with microbial contamination, and the introduction of trace contaminants including pharmaceutical products. Alpine biota are poorly adapted to such changes, meaning wastewater discharges can influence ecological condition at relatively low loading rates and the potential effects of these are considered for the Rastus Burn in Sections 6.2.1 to 6.2.3.



6.2.1 Nutrient Enrichment

A potential effect of the discharge of wastewater to is to increase nutrient levels in the Rastus Burn and the downstream aquatic habitats. Increased nutrient loads have been shown to generally influence algal community growth rates and composition. Nitrogen and phosphorus have both been found to limit overall algal growth at low concentrations in streams although algal taxa vary in their nutrient requirements. In turn algae can have strong effects on the invertebrate community present. The Rastus Burn has a low diversity macroinvertebrate community dominated by pollution sensitive mayflies and is naturally fishless at this location. Small nutrient increases may increase algal growth rates and associated macroinvertebrate grazer densities as the system becomes more productive. A minor shift in in macroinvertebrate densities would suggest the ecosystem is absorbing the increased productivity. A shift in the spring or autumn algal composition and biomass and an associated shift in the macroinvertebrate composition would be indicative of a more degraded ecosystem.

It is proposed that the wastewater treatment system will be upgraded to provide enhanced treatment over the existing system. This will enable the greater volume of wastewater to be treated and disposed to land without increasing the annual nutrient load above the design levels of wastewater as per the currently proposed performance criteria (e3Scientific, 2026a; Stantec, 2026, Appendix B and C). The current nutrient loads have been assessed to not be adversely affecting the freshwater ecology of the Rastus Burn (provided nutrient loads remain below 2023 levels and there are no discharges of untreated wastewater directly to the stream). There are complexities with the wastewater volumes, nutrient loads and compliance monitoring data utilised and uncertainties with ecological impacts present in 2023, as such further investigations are recommended.

The Rastus Burn currently has low nutrient concentrations recorded near the wastewater dispersal field but typically slightly elevated above background levels. Therefore, the predicted increase in wastewater volume to a maximum of 204 m³/day and stable nutrient load maintained no greater than the proposed performance criteria (Appendix B and C) will equate to a Low magnitude and a Low level of effect.

However, continued monitoring is recommended and outlined below to ensure the level of effect is confirmed as Low;



- Monitoring of periphyton composition and biomass within the Rastus Burn upstream and downstream of the infiltration dispersal fields is recommended.
- Monitoring of macroinvertebrate taxa densities, community composition and EPT, MCI, SQMCI metrics within the Rastus Burn upstream and downstream of the infiltration dispersal field is recommended.

6.2.2 Reduced Dissolved Oxygen

The Rastus Burn is well oxygenated (near 100%) and a reduction to even 90% may be ecologically meaningful at this location. However, the wastewater discharge is to land via dispersal field soakage, and as such instead of organic material entering the Rastus Burn water column directly, it is intercepted by soil filtering and microbes. This strips out the organic matter that drive biological oxygen demand (BOD) before the water reaches the Rastus Burn. So, while a potential effect of the discharge of wastewater is reduced oxygen levels due to high oxygen demand of the wastewater. This is unlikely provided the wastewater treatment system and infrastructure is installed and maintained to design specifications.

Therefore, the magnitude of effect is considered Negligible. The Moderate ecological value of the stream combined with the Negligible magnitude of effect results in a Very Low level of effect. Therefore, no management actions are recommended.

6.2.3 Thermal Change

The wastewater piping is to be thermally protected to protect against freezing. The treated wastewater is then pumped to the land infiltration site and the wastewater will approximate air temperature before soaking into the infiltration field and soils. The wastewater is expected to mix with cool groundwater before upwelling and entering the Rastus Burn.

The Rastus Burn is a cold water stream with low thermal buffering capacity. If the wastewater entering the stream was much warmer than the stream this can lead to thermal shock of cold adapted taxa. Warmer water may hold less oxygen and disrupt reproductive success of alpine adapted species with reduced egg viability or higher larval mortality in favour of more generalist taxa (Werry, *et al.*, 2026). The likelihood of thermal shock is considered extremely low due to the wastewater acclimatizing to air temperature in the infiltration field at the land dispersal site and mixing with cool groundwater prior to entering the stream.



The predicted temperature change equates to a Negligible magnitude and a Very Low level of effect. Therefore, no management actions are required.

6.2.4 Wetland Hydrology

The proposed increased wastewater discharge volume has potential to alter receiving wetland hydrology. It is likely this will provide a positive effect to the wetlands with a greater stable winter supply of groundwater. However, it is recommended that the areas outlined in Figure 7 are delineated for the presence of wetlands. If present and within 100 m of the dispersal fields the wetlands should have their current status (wetland type, hydrology and vegetation community) characterised and be monitored (wetland hydrological regime and vegetation) to assess the potential effects of the increased wastewater discharge on the wetlands.



7 Conclusions and Recommendations

NZSki are anticipating an increase in customers and therefore an increase in the volume of domestic wastewater requiring treatment and discharge to land at the Remarkables Ski field area. The wastewater currently undergoes primary treatment and screening before being disposed to 3 dispersal fields for land infiltration. The nearby Rastus Burn has Moderate ecological values. The existing wastewater discharge to land has resulted in stable periphyton and macroinvertebrate communities, excluding the elevated loads and a systems failure in 2023. The proposed activity is for an increase in wastewater volume to 204 m³/day. It is proposed that this increased volume of wastewater will have an enhanced treatment system underpinned by discharge performance criteria before discharging to land in the current location. Further work is proposed to be undertaken to confirm the volume of wastewater and associated nutrient loads more accurately. The performance criteria currently proposed are based on the best information currently available.

The proposed increased wastewater discharge is considered to have a “Low” level of effect on the aquatic ecology values (e.g. instream algae, alpine invertebrate community and ecological processes) present. However, monitoring is proposed to help ensure potential effects on the ecological values present are “Low” for the increased wastewater volume.

The management framework provides strong ecological safeguards by ensuring wastewater treatment to meet performance criteria and control discharge volumes. Land-based infiltration further reduces contaminant loading to the Rastus Burn, while robust operation, maintenance, and risk-management planning to meet defined performance criteria enables environmental protection thresholds to be met. A comprehensive monitoring programme covering periphyton, macroinvertebrates, and downstream wetland condition provides early detection of ecological change. The proposal promotes the avoidance and mitigation of adverse effects to protect stream health.

The recommended monitoring actions are summarised below:

- Monitoring of periphyton composition and biomass within the Rastus Burn upstream and downstream of the infiltration dispersal field is recommended.



- Monitoring of macroinvertebrate taxa densities, community composition and EPT, MCI, SQMCI metrics within the Rastus Burn upstream and downstream of the infiltration dispersal field is recommended.
- Wetland delineation of area downgradient and within 100 m of the land dispersal field.
- Monitoring of any delineated wetlands downgradient (within 100 m) of the land dispersal field for wetland hydrological regime and vegetation community to ensure wetlands remain healthy every two years.



8 References

- ANZG. (2018). *Australian & New Zealand Guidelines for Fresh and Marine Water Quality*. Canberra: Australian Government.
- Biggs, B. J. (2000). *New Zealand Periphyton Guideline: Detecting, Monitoring and Managing Enrichment of Streams*. Christchurch: Prepared for the Ministry for the Environment by NIWA.
- Biggs, B. J., & Kilroy, C. (2000). *Stream Periphyton Monitoring Manual*. Christchurch: NIWA for the Ministry for the Environment.
- Boothroyd, I. G., & Stark, J. D. (2000). Chapter 14 Use of invertebrates in monitoring. In K. J. Collier, & M. J. Winterbourn, *New Zealand stream invertebrates: ecology and implications for management*. (pp. 344-373). Christchurch: New Zealand Limnological Society.
- Bray, J. P., Kilroy, C., Gerbeaux, P., Burdon, F. J., & Harding, J. S. (2019). Ecological processes mediate the effects of the invasive bloom-forming diatom *Didymosphenia geminata* on stream algal and invertebrate assemblages. *Hydrobiologia*, 847: 177- 190.
- Clarke Fortune McDonald & Associates. (2011). Survey data.
- Dunn, N., Closs, G., Crow, S., David, B., Goodman, J., Griffiths, M., . . . Makan, T. (2025). *Conservation status of New Zealand freshwater fishes, 2023*. Wellington: Department of Conservation. New Zealand Threat Classification Series 46.
- e3Scientific. (2025). *Desktop Review of Rastus Burn WWTP discharge*. Christchurch: Prepared by e3Scientific for NZSki.
- e3Scientific. (2026a). *Doolans Extension - Rastus Burn Wastewater Discharge Impact Assessment*. Arrowtown: Prepared by e3Scientific for NZSki Remarkables.
- Fureder, L., Ettinger, R., Boggero, A., Thaler, B., & Theis, H. (2006). Macroinvertebrate diversity in Alpine lakes: effects of altitude and catchment properties. *Hydrobiologia*, 562: 123-144.
- Grainger, N., Harding, J., Drinan, T., Collier, K., Smith, B., Death, R., . . . Rolfe, J. (2018). *Conservation status of New Zealand freshwater invertebrates*. Wellington: Department of Conservation NZ Threat Classification Series 28.



- Harding, J. S. (1994). Variations in benthic fauna between differing lake outlet types in New Zealand. *New Zealand Journal of Marine and Freshwater Research*, 28(4): 417-427.
- Holdaway, R. J., Wiser, S. K., & Williams, P. A. (2012). Status Assessment of New Zealand's Naturally Uncommon Ecosystems. *Conservation Biology*, 26(4):619-629.
- Kilroy, C., Larned, S. T., & Biggs, B. J. (2009). The non-indigenous diatom *Didymosphenia geminata* alters benthic communities in New Zealand rivers. *Freshwater Biology*, <https://doi.org/10.1111/j.1365-2427.2009.02247.x>.
- Ladrera, L., Goma, J., & Prat, N. (2018). Effects of *Didymosphenia geminata* massive growth on stream communities: Smaller organisms and simplified food web structure. *Public Library of Science (PLOS)*, 13(3): 1-18.
- Lakes 380. (Accessed 2025, 06 16). *Lakes 380*. Retrieved from Lake Alta: <https://ourlakesourfuture.co.nz/lakes/lake-alta/>
- Ludgate, B. (2017). *Remarkables Ski Area - Biological survey of the Rastus Burn*. Dunedin: Prepared for NZSki Ltd by Ryder Environmental Ltd.
- Ludgate, B., Arthur, J., & Ryder, G. (2014). *Remarkables Ski Area Wastewater System - Assessment of Environmental Effects November 2014*. Dunedin: Prepared for NZSki by Ryder Consulting Ltd.
- Melchior, M., & Baker, C. (2023). *eDNA Guidelines and field protocols for lotic systems*. Hamilton: NIWA.
- MfE. (2021). *National works in waterways guideline - Best practice guide for civil infrastructure works and maintainance*. Wellington: Ministry for the Environment.
- Ministry for the Environment. (2020). *National Policy Statement for Freshwater Management*. Wellington: Ministry for the Environment.
- Mitchell-Daysh. (2026). *Remarkables Ski Field Expansion Project - Project Description*. Queenstown: Prepared by Mitchel-Daysh for NZ Ski Ltd.
- Otago Regional Council. (2025). *Regional Plan: Water for Otago*. Dunedin: Otago Regional Council, Updated 21 August 2025.
- Patrick, B. H., Lyford, B. M., Ward, J. B., & Barratt, B. I. (1992). Lepidoptera and other insects of the Rastus Burn Basin, The Remarkables, Otago. *Journal of the Royal Society of New Zealand*, 22(4): 265-278.
- Pearman, J. K., Wood, S. A., Vandergoes, M. J., Atalah, J., Waters, S., Adamson, J., . . . Tibby, J. (2022). A bacterial index to estimate late trophic level: National scale validation. *Science of the Total Environment*, 812:152385.
- Robertson, H. A., Baird, K. A., Elliot, G. P., Hitchmough, R. A., McArthur, N. J., Makan, T. D., . . . Michel, P. (2021). *NEW ZEALAND THREAT CLASSIFICATION SERIES 36*:

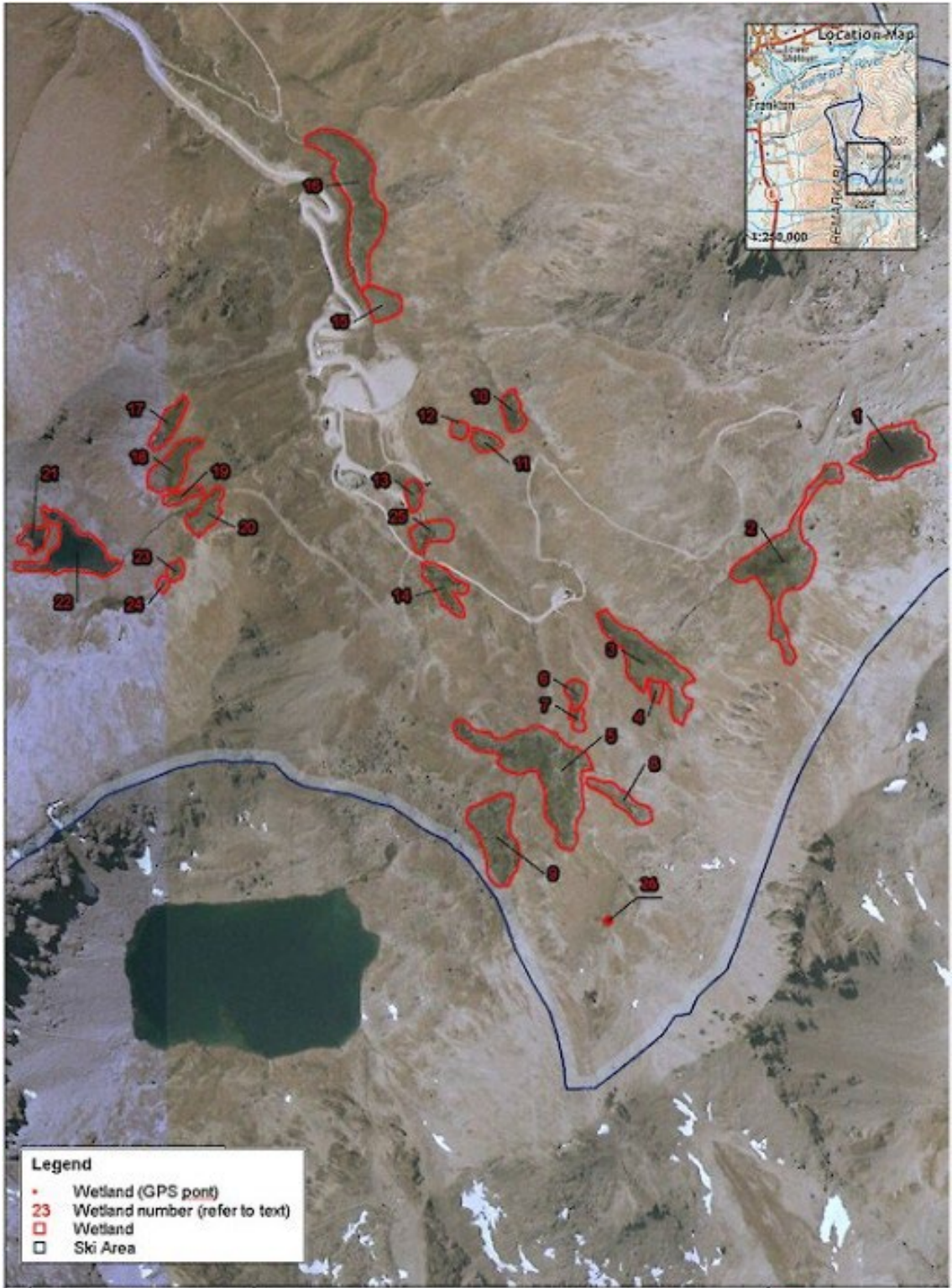


- Conservation status of birds in Aotearoa New Zealand, 2021*. Wellington: Department of Conservation.
- Ryder Consulting. (2012). *NZSki - Lake Alta. Effects of Abstraction on Aquatic Ecology*. Dunedin: Ryder Consulting Limited.
- Shallenberg, M. (2002). *Report on the zooplankton composition and distribution in Lake Alta in early 2002*. Dunedin: Report Prepared for Ryder Consulting Limited.
- SLR. (2023). *Remarkables Ski Area - Biological survey of the Rastus Burn*. Dunedin: Prepared for NZSki Ltd by SLR Consulting New Zealand.
- SLR. (2026). *Remarkables Ski Area: Biological Survey of the Rastus Burn*. Dunedin: Prepared by SLR Consulting Lts for NZSki Ltd.
- Smith, J., David, B., Hicks, A., Wilkinson, S., Ling, N., Fake, D., . . . Gault, A. (2024). Optimizing eDNA Replication for Standardized Application in Lotic Systems in Aotearoa, New Zealand. *Environmental DNA*, 1-27.
- Stantec. (2026). *Remarkables Ski Area Expansion Project - Wastewater Treatment and Disposal Feasibility Report*. Queenstown: Prepared for ZNSki by Stantec New Zealand.
- Stark, J. D., & Maxted, J. R. (2007). *A user guide for the Macroinvertebrate Community Index*. Nelson: Prepared for the Ministry for the Environment. Cawthron Report No.1166.
- Stark, J. D., Boothroyd, I. K., Harding, J. S., Maxted, J., & Scarsbrook, M. R. (2001). *Protocols for sampling macroinvertebrates in wadeable streams*. New Zealand macroinvertebrate working group (Report 1). Prepared for the Ministry for the Environment.
- Uehlinger, U., Robinson, C. T., Hieber, M., & Zah, R. (2010). The physico-chemical habitat template for periphyton in alpine glacial streams under a changing climate. *Hydrobiologia*, 657: 107-121.
- Werry, L., Mitrovic, S., Lim, R., Rohlf, A. M., & Kefford, B. (2026). Elevational and seasonal differences in macroinvertebrate community structure in alpine streams. *Marine and Freshwater Research*, <https://doi.org/10.1071/MF25065>.
- Wildlands. (Accessed 10/2/2026). *Assessment of wetlands at the Remarkables Ski Area, Queenstown*. Retrieved from Wildlands: www.wildlands.co.nz/projects/assessment-of-wetlands-at-the-remarkables-ski-area-queenstown/



Appendices

**Appendix A: Wetlands mapped in upper catchment (Source: Wildlands
Accessed 2026).**



Data Acknowledgment	
Aerial photos: MFE 2001	
Report Date:	
Client:	
Ref:	04/01/11
Path:	E:\proj\remarkables\mfe\landinfo\ub
File:	Remarkables Wetlands_Figure.mxd

Remarkables Ski Area wetlands

0 250 500
m

Wildlands
www.wildlands.co.nz, 0709 962092

Scale: 1:10,000
Date: 30/03/2011
Cartographer: FM
Format: A4

Appendix B: Proposed Performance Criteria (Source: e3Scientific, 2026a)

Parameter	Criteria	Rationale
Nitrogen Load	Five-year rolling mean is ≤ 500 kg nitrogen/year	The average value (rounded) of reported loads
	Must not exceed 600 kg nitrogen/year in any calendar year	Potential threshold from lower of values reported for 2022/2023
Phosphorus Load	Five-year rolling mean is ≤ 65 kg phosphorus/year	The average value (rounded) of reported loads
	Must not exceed 85 kg phosphorus/year in any calendar year	Halfway between the average value and the maximum possible load as per Table 13.
TSS Concentration	Five year rolling mean is ≤ 40 mg/L TSS	Average concentration (rounded) of the compliance monitoring dataset at the discharge pipe
	Five year rolling 95%ile is ≤ 110 mg/L TSS	95%ile value (rounded) of the compliance monitoring dataset at the discharge pipe
BOD Concentration	Five year rolling mean is ≤ 80 mg O ₂ /L (BOD ₅)	The average value (rounded) of reported loads
	Five year rolling 95%ile is ≤ 320 mg O ₂ /L (BOD ₅)	95%ile value (rounded) of the compliance monitoring data
E. coli	No criterion	A performance criterion for human faecal pathogens is not required as the natural die-off rates are high, and there are no sensitive receptors in the affected downstream reach.

Appendix C: Proposed Performance Criteria (Source: Stantec 2026)

Appendix C: Proposed Nutrient Load Performance Criteria (Stantec 2026).

Parameter	Limit
Total Nitrogen	Must not exceed an annual maximum load of 750 kg in any calendar year
Total Phosphorus	Must not exceed an annual maximum load of 155 kg in any calendar year