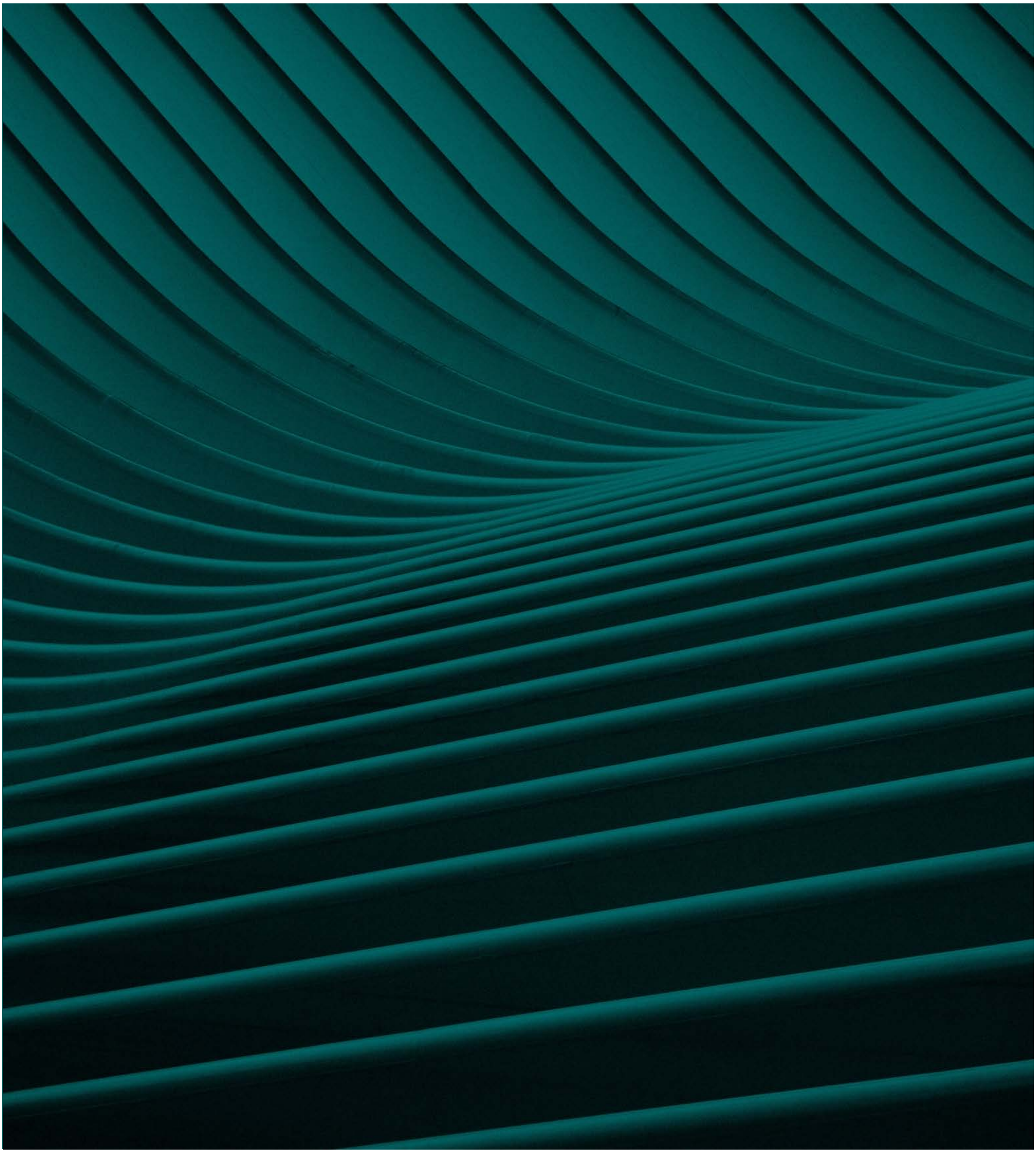
Boffa Miskell

Bendigo Ophir Gold Project

Freshwater Ecology Management and Monitoring Plan
Prepared for Matakanui Gold Limited

21 June 2026



Document Quality Assurance

This document may be cited as:
Boffa Miskell Limited 2026. *Bendigo Ophir Gold Project: Freshwater Ecology Management and Monitoring Plan*. Report prepared by Boffa Miskell Limited for Matakanui Gold Limited.

For any information regarding this report please contact:
Ian Boothroyd | Ecology | Partner | ian.boothroyd@boffamiskell.co.nz

Revision /version:	Issue date:	Prepared by:	Description:	Issued by:
Draft / Final V1	21 October 2025	Ian Boothroyd Senior Principal	Draft report issued to client	Ian Boothroyd Senior Principal
Final	23 October 2025	Ian Boothroyd Senior Principal	Final	Ian Boothroyd Senior Principal
Revised Final	21 June 2026	Ian Boothroyd Senior Principal	Final	Ian Boothroyd Senior Principal

Approved for issue:
Ian Boothroyd | Ecology | Partner | 21 June 2026

File name & Project number: BM250590

Template revision: 20250522 0000

CONTENTS

Appendices

1.0 Introduction

1.1 Background

Matakanui Gold Limited ("MGL") is seeking approvals for the Bendigo-Ophir Gold Project ("BOGP"), a new gold mine, ancillary facilities and environmental mitigation measures on Bendigo and Ardgour Stations in the Dunstan Mountains of Central Otago. The project site is located approximately 20 km north of Cromwell.

The BOGP is located within the footprint of Minerals Exploration Permit 60311, which overlays several pastoral stations that have grazed sheep and cattle in the area for over 100 years. MEP60311 is held by MGL under the Crown Minerals Act 1991. MGL has land access agreements with Bendigo and Ardgour Stations. The BOGP is located adjacent to land administered by the Department of Conservation ("DOC"), including the Bendigo Historic Reserve, the Bendigo Conservation Area and the Ardgour Conservation Area. BOGP mineral extraction activities will not occur in these areas.

Ecological work will include rehabilitation on direct disturbed areas, ecological uplift activities and pest exclusion area(s) adjacent to the footprint on nearby areas such as Ardgour and Bendigo Stations. A full description of the various activities comprising the establishment, operation and rehabilitation within the BOGP is provided in the Assessment of Environmental Effects prepared by Mitchell Daysh Limited.

To manage effects on freshwater values the BOGP will:

- realign watercourses to divert clean water from disturbed areas.
- monitor the ecological values above and below the treated water discharge.
- This Freshwater Ecology Management and Monitoring Plan (FEMMP) sets out the purpose, principles, design and monitoring of the diversion channels and monitoring of the treated water discharge.

1.2 Layout of the FEMMP

1.3 Objective

The objective of the Freshwater Ecology Management and Monitoring Plan (FEMMP) is to provide details of the:

Design and development of ecologically functional diversion channels as remedy for the loss of watercourses from the construction and operation of the BOGP.

Aquatic ecological monitoring of the treated water discharge.

Other aquatic ecological monitoring

1.4 Purpose

This management and monitoring plan is proposed for the construction and operation of the stream diversions and aquatic ecological monitoring. The purpose of the management and monitoring is to set out:

- Responsibilities and competencies.
- Protocol for effects minimisation.
- Diversion design principles.
- Diversion design.
- Protocols for aquatic ecological performance and confirmatory monitoring.
- Thresholds for actions where required.
- Hierarchy of responses.
- Reporting.

1.5 Information sources

This plan draws on the existing information set out in:

- Bendigo Ophir Gold Project: Assessment of Effects on Aquatic Habitat. Report prepared by Water Ways Consulting, June 2025.
- Bendigo Ophir Gold Project: Assessment of Freshwater Ecology Effects. Report prepared by Boffa Miskell, October 2025.

2.0 Responsibilities and Competencies

2.1 Purpose

The Environment Manager holds overall accountability for implementation of and compliance with all ecology management plans (including this freshwater plan) (Figure 1). Additional roles and responsibilities are detailed where relevant in the various individual plans. The Project Ecologist has specific responsibilities for the freshwater plan as set out below

2.2 Responsibilities

The responsibilities of the Project Ecologist are:

- Confirming and approving the FEMMP.
- Briefing contractors on the purpose and content of the FEMMP.

- Undertaking or contracting visual inspections and monitoring .
- FEMMP reporting.

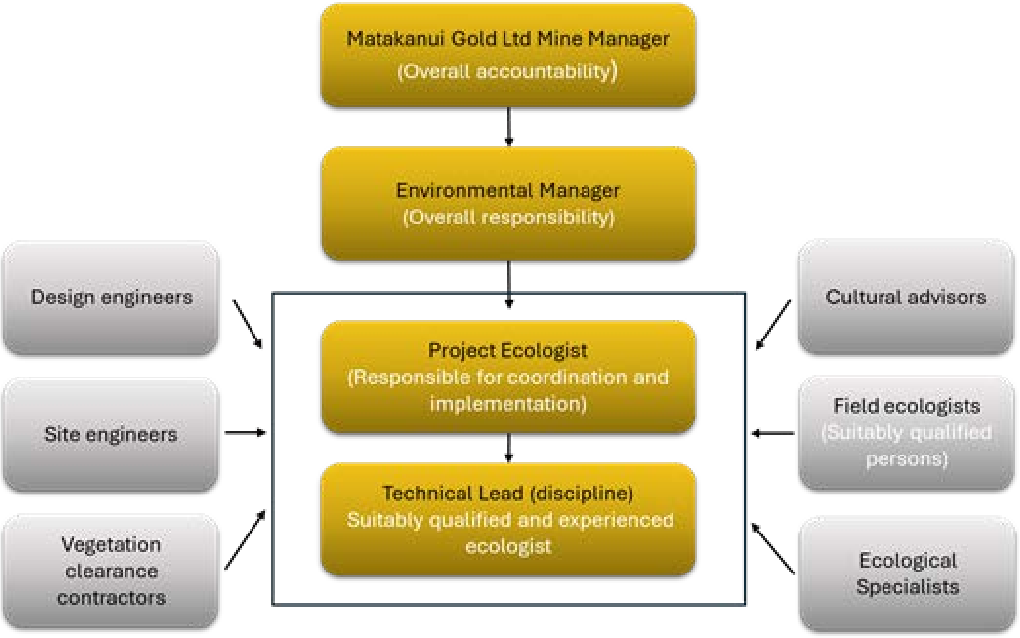


Figure 1. Overview of roles and responsibilities for the environment management at BOGP.

3.0 Existing Ecological Values

3.1 Overview

In their assessment of effects, Water Ways (2025) characterised each of the watercourses and their catchments, in particular Shepherds Creek and Rise and Shine Creek. In general, the study found that the ecological value of the Shepherds and Rise and Shine Creeks and associated tributaries varied from moderate-to-high in the upper reaches to moderate-to-low in the lower reaches. It is not our intention to repeat the findings here, but we summarise the ecological values below.

3.2 Shepherds Creek

The presence of the Ardgour Conservation Area in the headwaters provides a clean water supply to the stream and there is a low level of nitrogen increase in the farmed perennial reach of Shepherds Creek indicating that stock impacts are more limited to physical damage than to declines in water quality.

Shepherds Creek has several tributaries that, aside from Jean Creek, can be divided into two groups: the perennial flowing spring fed streams and the ephemeral streams that have very short duration flow periods. Shepherds Creek is considered representative of a low gradient

Dunstan Mountains perennial small stream. This assessment indicates that Shepherds Creek can be divided into reaches:

- The upper reaches of Shepherd Creek: moderate to high ecological value. From the Ardgour Conservation Area boundary to at least the downstream gorge section in the middle of the project area. This reach has good water quality, low to moderate habitat diversity and no introduced aquatic species.
- Downstream of the gorge section: moderate ecological value. Habitat modification increases with various impacts including water abstraction, channel modifications (e.g., the dam), crack willow, and stock impacts are evident.

Water Ways (2025) report that most of the main stem of Shepherds Creek is a gentle gradient single channel stream 0.5 - 1.0 m wide flowing along a 10 - 100 m wide valley floor.

No fish occur at the location of and upstream of the BOGP in the upper reaches of Shepherds Creek in the vicinity of the diversions.

3.3 Rise and Shine Creek

Water Ways (2025) report that the Rise and Shine Creek catchment has a range of ephemeral, intermittent and perennial streams that support a fauna of high to low ecological value:

- The stream draining Mt Moka in the upper Rise and Shine catchment is considered a high-quality habitat area, aside from the lower 200 m where historic and present modifications occur.
- Rise and Shine Creek downstream of the Mt Moka Stream confluence is a perennial stream and is considered to have low to moderate ecological value.
- Rise and Shine Creek and its tributaries upstream of the Mt Moka Stream confluence are intermittent and ephemeral water courses.

Water Ways (2025) report that none of the stream channels are large with a maximum width of 0.5 m and most less than 0.3 m wide.

None of the species occurring in the study samples are listed as threatened or of conservation interest. No fish occur at the location of and upstream of the BOGP in the upper reaches of Rise and Shine Creek.

3.4 Lindis River

The Lindis River rises in the low ranges to the north of the Lindis Pass and is bounded by the Ahuriri catchment and the Dunstan Ranges to the east and to the west by tributaries of Lake Hawea. Most of the Lindis River catchment consists of agricultural grasslands. As a result of the very dry climate in the lower catchment where much of the high-producing pasture and cropping is located there is heavy demand for water abstraction from the lower third of the Lindis River. Komanawa (2025) describe the hydrological characteristics of the downstream and surrounding catchments.

Five species of native fish and two sports fish have been recorded in the Lindis catchment. Native species recorded include[1]: longfin eel (Anguilla dieffenbachii), koaro (Galaxias brevipinnis), Clutha flathead galaxias (Galaxias sp. D), common bully (Gobiomorphus cotidianus) and upland bully (Gobiomorphus breviceps). The introduced species present are brown trout (Salmo trutta) and rainbow trout (Onchorhynchus mykiss).

Macroinvertebrate communities at sampled sites within the Lindis River are typically dominated by mayfly and are generally indicative of very good water quality and habitat. Periodic drying of the lower reaches of the Lindis River will contribute to fluctuations in the magnitude and quality of the ecological values.

In a study of the Lindis River by Otago Regional Council (ORC 2016), macroinvertebrate communities were found to comprise a mix of tolerant and sensitive species but made up of commonly occurring species. Although likely to be variable in abundance during different seasons and in variable river conditions, representatives of key feeding types[2] were apparent within the macroinvertebrate community reflecting a typical, if simplistic[3], natural ecosystem functionality. None of the macroinvertebrate species occurring in the study samples are listed as threatened or of conservation interest.

4.0 Stream Diversions as Effects Management

The assessment of effects of the BOGP on aquatic ecological values is set out in Waterways (2025) and the aquatic effects management in Boffa Miskell (2025). The outcome of the effects management is set out in Table 1. The main outcome is the development of ecologically functional diversions of the watercourses.

Boffa Miskell (2025) confirms that the functional need of the proposed BOGP activities means that the loss of watercourses is unavoidable. Although loss will be minimised as much as possible, the proposed mine activities will result in the loss of **7,139 m of permanent stream** length whilst **1,631 m of intermittent stream** length will be modified in Shepherd Creek.

Effects management provides **remedy of 9,558 m (9,558 m^2 of stream area) of created permanent watercourse** through rehabilitation of the proposed diversion of Shepherd Creek, including the reinstated stream across the surface of the TSF at closure. A further 1,196 m length (~957 m^2 of stream area) of Shepherds Creek will be enhanced to improve aquatic ecological values. This amounts to a total enhancement of **10,754 m of stream length (~10,515 m^2 of stream area)** of stream values.

Estimates of stream loss and modification in Rise and Shine Creek suggest that some 1,483 m length of stream **(~741.5 m^2)** will be lost and approximately **1,600 m of stream length (800 m^2 of stream area) will be created** within the catchment, and the equivalent will apply for enhancement of aquatic ecological values.

[1]Otago Regional Council (2008) Management Flows for Aquatic Ecosystems in the Lindis River. Otago Regional Council, Dunedin.

[2] Variety of different gazing types, filter feeders and predators.

[3] Simplistic = only few species and levels of feeding structure, as opposed to a more multi-level complex trophic structure.at each

Table 1: *Effects management hierarchy applied to freshwater values for the BOGP.*

Effects management		
	Shepherd Creek	**Rise and Shine Creek**
Ecological values	Moderate to high	Low to moderate
Avoid	Options to locate the project elsewhere are not available due to the location of the gold resource. Unavoidable reclamation of some 7,799 m of perennial and intermittent stream length. This equates to approximately 7,000 m^2 of stream area.	Options to locate the project elsewhere are not available due to the location of the gold resource. Unavoidable reclamation of some 1,483 m of perennial stream length (741.5 m^2) and no loss of intermittent stream. Temporary diversion of some 880 m (440 m^2) of perennial Mt. Mocha stream is unavoidable. This amounts to a total of approximately 1,181 m^2 of stream area.
Minimise	Diversions to capture water from ephemeral watercourses and transfer it back into the creeks.	Diversions to capture water and transfer it back into the creeks.
Remedy	Creation of some 7,643 m rehabilitated stream diversion (7,643 m^2). Diversion channel to be created in year 1 ahead or at same time as the reclamation of Shepherds Creek. Rehabilitation of 1,196 m of Shepherds Creek retained in existing bed above gorge. Reinstatement of some 1,915 m of stream on surface of TSF at mine closure.	At the completion of mining the temporary diversion of 880 m of the Mt. Mocha Creek line will be remedied and rehabilitated, and with other diversion design requirements leads to creation of some 1,599 m (800 m^2) of stream. Remediation of the connected flow between the SRX pit and SRX ELF.
Offset	Principles of offset cannot be fully satisfied due to lag time from full loss to full gain in values.	Principles of offset cannot be fully satisfied due to lag time from full loss to full gain in values.
Compensation	Additional compensation is proposed in the form of management of existing willows and transformation to native riparian vegetation over some 6,700 m of Bendigo and Clearwater Creeks (Willow concession area). Compensation completes the effects management by providing for the lag time to achieve ecological values.	

5.0 Design of Stream Diversion

5.1 Diversion design principles

The following high-level principles of design will be applied to the permanent and temporary diversion of the affected parts of Shepherds Creek and Rise and Shine Creek (as set out in Boffa Miskell 2025):

- As much as practicable, the diversion should be designed with an average width of no less than 0.8 m, and preferably 1 m for Shepherds Creek, and no less than 0.5 m for Rise and Shine Creek.
- As much as possible, the steam diversion channel must be a similar length and stream area than the channel to be reclaimed. This aims to ensure that there is no loss of extent and values of the watercourse.
- The channel design does not have to replicate the form of the channel to be reclaimed but would benefit from a low-flow (or baseflow) channel, a bank full channel and where available, a floodplain area.
- As much as possible, water flow should mimic the hydrology of the existing watercourse (i.e., flows intermittently or permanently same as existing channel).
- The channel should mimic, as much as practicable, the natural meanders of the stream to be reclaimed.
- Hydrologic heterogeneity and instream habitat complexity can be achieved through the creation of natural features such as runs, riffles and small and large pools.

In addition, we recommend the following:

- As far as is reasonably practicable, the habitat within the diversion is of a similar form and structure to the stream to be reclaimed (and like neighbouring tributaries). The final substrate present should mimic that naturally occurring in similar sized tributaries in the wider catchment to the extent that this is practicable.
- The stream profile should allow the planting of riparian vegetation close to and extending over and into the water surface at the margins to create ample stream edge habitat. This can be low stature planting that provides vegetation overhang over and into the watercourse and to enhance habitat for the aquatic ecosystem.
- To the extent practicable, riparian vegetation is to be planted along the length of the stream diversion. Riparian vegetation plays an important role in the ecological success of a stream diversion. Appropriate riparian species selection will enhance stream ecology through providing shade to the stream, reducing water temperature, producing habitat and providing a food source. As much as possible, riparian vegetation should extend along either side of the diversion channel.

When implemented the recommended principles and actions will provide acceptable remediation for the loss of the extent and values of Shepherds Creek and Rise and Shine Creek.

5.2 Diversion design guidelines

5.2.1 Overview

The design of the stream diversion must be fit for purpose and ensure that stream ecological functions are maintained or improved on. The diversion channels must provide appropriate aquatic habitat for macroinvertebrates and plants, while conveying water. The below are a guideline for the design and construction of the diversion.

5.2.2 Channel length and meander

The steam diversion channel must be the same length, or longer, than the channel to be reclaimed to ensure no loss of stream length (stream extent). The channel should mimic and improve upon, as far as practicable, the natural meanders of the stream to be reclaimed. Where possible, the addition of boulders, submerged logs, etc. will be used to aid meander development and increase flow heterogeneity.

5.2.3 Habitat diversity and channel complexity

Hydrologic heterogeneity and instream habitat complexity can be improved through the creation of natural features such as runs, riffles and small and large pools. These features can be created utilising natural substrates such as rocks, logs and large boulders. Gravels, cobbles and boulders should be used to increase stream heterogeneity and stability.

These should be consistent with the habitat present in the stream to be reclaimed and similar to neighbouring natural tributaries. The final substrate present should mimic that naturally occurring in similar sized tributaries in the wider catchment. The channel complexity and availability will 'naturalise' over time as the new diversion channel becomes established.

We recommend the inclusion of a shallow low flow channel in the initial channel design. The purpose of a low flow channel is to provide flow when climate conditions typically result in dry conditions. The low flow channel extends the period of habitat availability should dry conditions persist.

5.2.4 Stream depth, wetted width and velocity

Stream depth and wetted width affect the total area of habitat that can be utilised by aquatic biota, and the volume of water conveyed during normal flows. Stream width, depth and should mimic that of the channel to be reclaimed. With the design seeking to create a stream that meets an average depth and width, with some localised variation for the creation of large and small pools and meanders. These depths and widths shall be established at the detailed design stage.

As much as practicable, the channel design must create a low flow or baseflow channel, a bank full channel and a floodplain area. The low flow must connect to the seasonal groundwater flow to ensure water flow mimics that of the existing stream (i.e., permanently same as existing channel).

The designed channel should be an average width of no less than 0.8 m, and preferably 1 m for Shepherds Creek, and no less than 0.5 m for Rise and Shine Creek.

5.2.5 Fish Passage

Fish have not been detected as present in the Upper Shepherds Creek or the Rise and Shine Creek and there are several barriers to fish passage upstream and downstream in both Creeks. No provision for fish passage is required.

5.2.6 Riparian Vegetation

Riparian vegetation is to be planted along the length of the stream diversion. Riparian vegetation plays an important role in the ecological success of a stream diversion. Appropriate riparian species selection will enhance stream ecology through providing shade to the stream, reducing water temperature, providing habitat and a food source. Riparian vegetation should mimic the local vegetation and be appropriate for the local bioclimatic conditions.

The stream profile should allow the planting of riparian vegetation close to and extending over the water surface to create ample stream edge habitat. This will provide shading to the water surface, detritus in the form of fallen leaves and potential habitat for macroinvertebrate species.

5.2.7 Key features of the diversion rehabilitation

The key features of the diversion rehabilitation are outlined below and in Table 2:

- Drop structures and/or weirs designed to create series of stream pools and habitat diversity.
- Tree trunks embedded in the stream to provide flow complexity and habitat diversity.
- Mixed substrate diversity (occasional large boulders along with large, moderate and small sized gravels).
- Bund or swale alongside road edge to prevent road silt and materials entering the diversion channel.
- Transplant of plants from Shepherds Creek to diversion channel via holding area.
- Engineered structures may be necessary in more complex or steeper reaches.

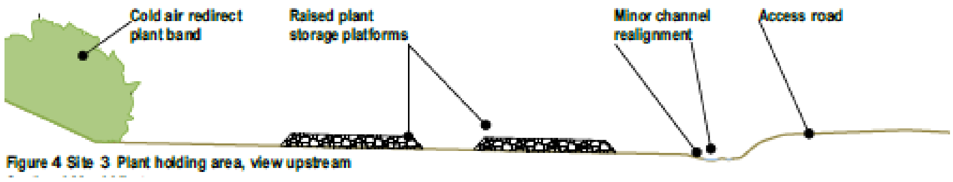
Access for maintenance and other purposes is required alongside the diversion. Example and indicative cross-sections of the proposed landscape diversion channel are shown in Figure 2 and drawn from the rehabilitation plan provided in Appendix 1.

5.3 Construction Principles

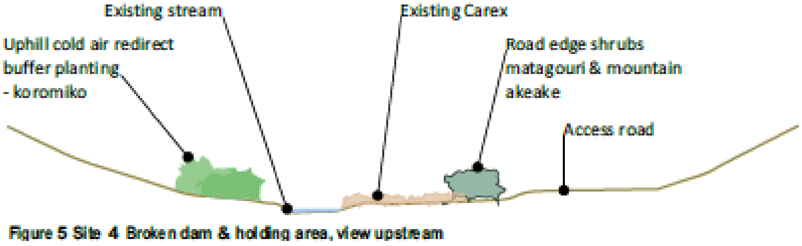
- As much as practicable, the stream diversion channel should be constructed offline and prior to any instream works within the channel to be reclaimed.
- During construction, and at completion of the diversion channel, it should be inspected by a Freshwater Ecologist to ensure ecological principals have been integrated.

Table 2: *Key features of the Shepherds Creek and Rise and Shine Creek diversions and applied to Diversion principles.*

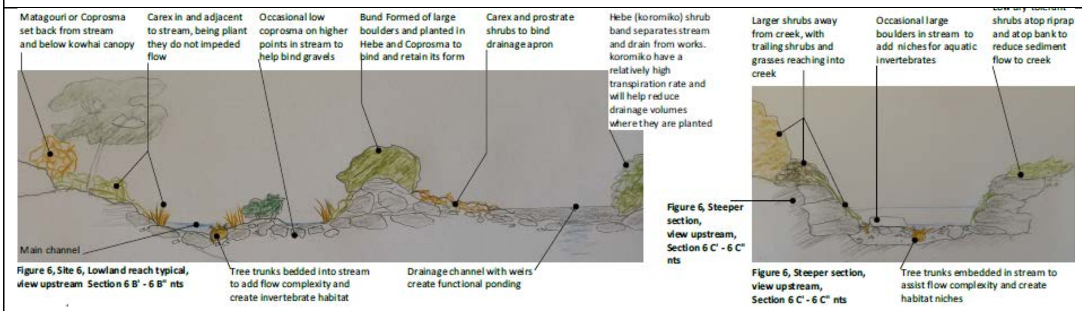
Diversion Principle	Shepherds Creek	Rise and Shine Creek
• To the extent practicable, the diversion should be designed with an average width of no less than 0.5 m, and preferably 1 m.	The diversion is expected to be formed with an average width of no less than 0.8 m, and preferably 1 m.	The diversion is expected to be formed with an average width of no less than 0.5 m, and preferably 1 m.
• To the extent practicable, the steam diversion channel must be a similar length and stream area than the channel to be reclaimed. This aims to ensure that there is no loss of extent and values of the watercourse.	The steam diversion channel length and stream area of the diversion does not meet the equivalent of loss and compensation is proposed.	The steam diversion channel length and stream area of the diversion does not meet the equivalent of loss and compensation is proposed.
• The channel design does not have to replicate the form of the channel to be reclaimed but would benefit from a low flow (or baseflow) channel, a bank full channel and where available, a floodplain area.	The proposed design features a low flow (or baseflow) channel, a bank full channel and where available, a floodplain area.	The proposed design features a low flow (or baseflow) channel, a bank full channel and where available, a floodplain area.
• To the extent practicable, water flow should mimic the hydrology of the existing watercourse (i.e., flows intermittently or permanently same as existing channel).	Hydrological conditions of the diversion channel are expected to mimic the hydrology of the existing watercourse, or features will be designed to accommodate modified hydrology.	Hydrological conditions of the diversion channel are expected to mimic the hydrology of the existing watercourse, or features will be designed to accommodate modified hydrology.
• The channel should mimic, as much as practicable, the natural meanders of the stream to be reclaimed.	The diversion channel will mimic natural stream character to the extent it is practicable.	The diversion channel will mimic natural stream character to the extent it is practicable.
• Hydrologic heterogeneity and instream habitat complexity can be achieved through the creation of natural features such as runs, riffles and small and large pools.	The diversion channel will mimic natural stream character.	The diversion channel will mimic natural stream character.



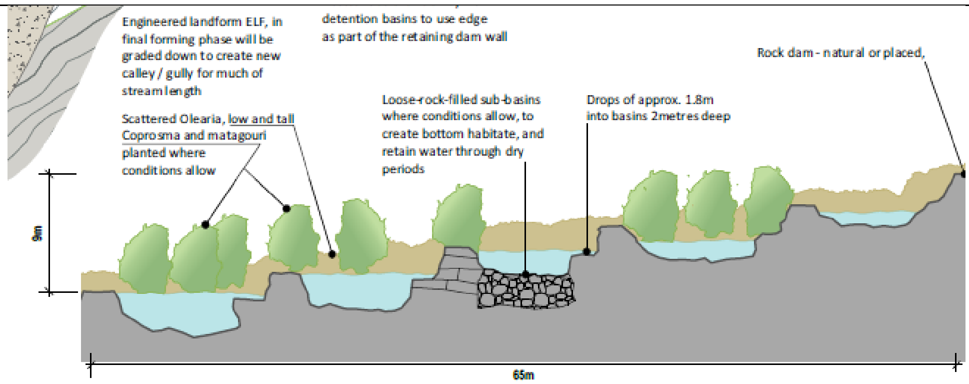
a) Plant holding area



b) Broken Dam and holding area



c) Indicative lowland and steeper sections



d) Drop series

Figure 2: *Indicative cross-sections of the proposed rehabilitated Shepherds Creek diversion (from Growplan, Appendix 1).*

5.4 Stream Ecological Valuation (SEV)

5.4.1 Consent condition

The resource consent requires that an SEV be carried out on the watercourses to be diverted, and for the design (on paper) of the final diversions to have a Stream Ecological Valuation (SEV) score equal to or greater than that measured in the corresponding diverted reaches prior to works commencing.

The stream ecological valuation of the existing streams and final diversion designs are to be calculated by a suitably qualified and experienced person in accordance with the methodologies set out the “Stream Ecological Valuation (SEV): A User’s Guide (Auckland Council Report No. GD2011/001). Auckland Council, Auckland, New Zealand”. For the avoidance of doubt, no further or additional SEVs need to be conducted for any other purpose in relation to this consent.

The following functions are not considered when calculating the SEV:

- Fish fauna intact.
- Invertebrate fauna intact.

Accordingly, an SEV assessments were undertaken of Shepherds and Rise and Shine Creek in April 2026 (Bioresearches 2026).

5.4.2 SEV scores

5.4.2.1 Shepherds Creek

SEV assessments were undertaken at two sites within the Shepherds Creek catchment:

- Within the central area of the of the proposed reach to be diverted. SEV score = 0.49.
- Upstream of the water take (and within the reach to be diverted). SEV score = 0.36.

Bioresearches (2026) attributed these relatively low scores to limited shading due to the pasture- dominated riparian margins and stock access, which has damaged stream banks and increased fine sediment loading, thereby reducing biogeochemical function.

A summary of the four ecological functions assessed are provided in Appendix 2. These descriptions indicate where an uplift in ecological function can be achieved.

5.4.2.2 Rise and Shine Creek

SEV assessments were undertaken at a single site within the Rise and Shine Creek:

- Immediately downstream of the proposed reach to be diverted. SEV score = 0.63.

Bioresearches (2026) attributed this relatively high score is largely attributed to the natural channel form, the presence of an indigenous, evergreen riparian zone extending more than 20 m from the stream banks, which provides consistent shading, and a predominantly hard-bottomed streambed supporting a healthy macroinvertebrate community.

A summary of the four ecological functions assessed are provided in Appendix 2. These descriptions indicate which features where an uplift in ecological function can be achieved.

5.5 Post-Construction Monitoring

5.5.1 Overview

Immediately following the livening of the diversion channel and inspection should be undertaken by a suitably qualified Freshwater Ecologist. It should ensure that the diversion channel is operating as intended. As noted above, SEV assessment of the constructed channel is not required by the resource consent.

To measure the overall success of the diversion channel continuing monitoring is required. The success is to be measured using habitat and macroinvertebrate community composition metrics. These are detailed below.

5.5.2 Monitoring parameters

The following monitoring parameters and methods will be undertaken as set out in Table 3.

***Table 3**. Proposed monitoring parameters and methods, BOGP.*

Monitoring attribute	Method	Metrics	Protocol (where appropriate)
Habitat	Rapid Habitat Assessment (RHA)	HQS	Clapcott et al. (2020)
Settled sediment	In-stream visual estimate of % sediment cover	Fine sediment cover (%)	Sediment Assessment Method 2 (Clapcott et al. 2011)
Algal cover	Periphyton cover (%)	• No algae • (bare substrate) • Films • Mats, • Filaments.	National Environmental Monitoring Standards for Periphyton (NEMS 2022a)
Macroinvertebrates	Benthic macroinvertebrates	• Taxa number • MCI, • EPT, • %EPT	Quantitative hardbottom protocols. (Stark et al. 2001)
Riparian planting	Cover% Planted success%	Cover% Planted success%	

5.5.3 Frequency of monitoring

Ecological Monitoring of the stream channel should be undertaken after years 1, 2 and 5 post-livening to ensure the channels are meeting ecological objectives.

5.5.4 Riparian Planting Monitoring

The riparian vegetation planting should be inspected at least every six months by a suitably qualified person in the year following the planting. The plants should be inspected to assess plant health. Where any plants appear to be in poor health or dying, the plants shall be removed and replanted, or care measures implemented as soon as is practicable.

Pest plants shall be assessed within the riparian planting. Where pest plants are considered to be dominating the vegetation and/or smothering desired plants then control activities shall be undertaken as soon as is practicable.

5.5.5 Indicative Performance Targets

The indicative targets for the performance of the diversions are set out in Table 4. These performance targets have been drawn from the existing ecological values as assessed by Waterways (2025) report, NOF from the NPS-FM and related metrics (i.e., RHA).

Table 4. *Indicative perfromance targets for diversions at BOGP.*

Diversion	**Shepherd's Diversion**	**Rise and Shine Diversion(s)**
Metric		
Habitat		
Habitat Quality Score band	Good	Good
Deposited fine sediments NOF Table 16	Band B	Band B
Macroinvertebrates		
Taxa number	10-13	8-10
MCI	>90	>90
EPT	5-7	3-5
MCI Band NOF Table 14	Band C	Band C

5.6 Hierarchy of response

Typically, the following steps would be applied to action a response:

1. Confirm if trigger breach is consistent (repeat monitoring and/or confirm observation).
2. Consider the nature of the change and likely cause or source.
3. Test the cause or source of the threshold breach as required and/or required.
4. Decide appropriate action if required (including no action).

5. Initiate action as required.
6. Continue monitoring as scheduled or at an appropriate revised frequency of all or specific metric.
7. Where recovery and/or return to accepted metric levels has not occurred consider whether further action is required.

6.0 Aquatic Ecological Performance Monitoring

6.1 Purpose

The purpose of the aquatic ecological monitoring is to confirm the protection afforded by the consented water quality limits of the treated water discharge, and no effects on the ecology the watercourses are occurring.

6.2 Consent condition

The consent condition requires that ‘Annual summer macroinvertebrate and periphyton monitoring should be undertaken in Shepherds Creek at sites located upstream and downstream of the treated seepage water discharge point as set out in the FEMMP’.

The frequency, location and methodology of the aquatic ecology monitoring is set out in this FEMMP, along with the threshold triggers where actions are required.

6.3 Monitoring locations

The aquatic ecological performance monitoring sites for the treated seepage water discharge will be located at:

- SC01 – Shepherds Creek Monitoring Site.
- RS03 – Rise and Shine Creek Monitoring Site.

Reference monitoring sites upstream of each of the performance monitoring sites on each of Shepherds, and Rise and Shine Creeks, will be selected to be comparative to the performance monitoring site locations. As much as possible the upstream control monitoring sites should reflect similar habitat, substrate and channel characteristics as those at the performance monitoring sites.

6.4 Monitoring parameters and methods

The monitoring methods, protocols and metrics for the aquatic ecological performance monitoring are set out in Table 5.

Table 5. *Proposed monitoring parameters and methods, and reporting metrics for BOGP.*

Monitoring attribute	Method	Metrics	Frequency	Protocol (where appropriate)
Habitat	Rapid Habitat Assessment (RHA)	• HQS	Annual	Clapcott et al. (2020)
Settled sediment	In-stream visual estimate of % sediment cover	• Fine sediment cover (%)	Monthly	Sediment Assessment Method 2 (Clapcott et al. 2011)
Periphyton cover	In-stream visual estimate of % periphyton cover	• No algae • (bare substrate) • Films • Mats, • Filaments.	Monthly	National Environmental Monitoring Standards for Periphyton (NEMS 2022a)
Periphyton productivity	Periphyton	• Chlorophyll a (CHLa)	Annual	National Environmental Monitoring Standards for Periphyton (NEMS 2022a)
Macroinvertebrates	Benthic macroinvertebrates	• Taxa number • MCI, • QMCI, • EPT, • %EPT	Annual	Quantitative hardbottom protocols. (Stark et al. 2001)

6.5 Performance monitoring thresholds

6.5.1 Overview

The performance monitoring thresholds requiring further attention and possible action are set out in Table 6.

Table 6. *Aquatic ecological performance monitoring thresholds, BOGP.*

Parameter	Metric	Threshold
Periphyton	CHLa (mg/m^2)	>200 mg/m^2 at performance monitoring site when <200 mg/m^2 at upstream reference site
Periphyton	Visual cover (%weighted composite periphyton cover)	>50% at downstream site than occurs at upstream reference site
Macroinvertebrates	QMCI and MCI scores	Score change of 20% or more above natural variation at downstream site than occurs at upstream reference site

6.5.2 Periphyton

The consent condition requires that should periphyton biomass exceeds 200 mg chlorophyll-a per m² and/or weighted composite periphyton cover exceeds 50% at the downstream site but not at the upstream site, the applicant shall engage a suitably qualified and experienced person (SQEP) to investigate the cause of the change and implement appropriate remedial actions as appropriate.

6.5.3 Macroinvertebrates

The consent condition requires that MCI and QMCI change of greater than 20% above natural variation between the upstream and downstream sites, the applicant shall engage a suitably qualified and experienced person (SQEP) to investigate the cause of the change and implement appropriate remedial actions as appropriate.

6.6 Hierarchy of response

The typical, responsible, and most important response when a performance threshold is met or breached is to repeat the monitoring or observation to confirm that the threshold truly has been met or breached, and that it is not a feature of a single unusual or inexplicable event, sampling error, or a broader effect occurring beyond the control of the consent holder.

Typically, the following steps would be applied to action a response:

1. Confirm if trigger breach is consistent (repeat monitoring and/or confirm observation).
2. Consider the nature of the change and likely cause or source.
3. Test the cause or source of the threshold breach as required and/or required.
4. Decide appropriate action if required (including no action).
5. Initiate action as required.
6. Continue monitoring as scheduled or at an appropriate revised frequency of all or specific metric.
7. Where recovery and/or return to accepted metric levels has not occurred consider whether further action is required.

7.0 Downstream Ecological Confirmatory Monitoring

7.1 Purpose

The purpose of the downstream aquatic ecological monitoring is to provide a confirmatory measure that no effects on the ecology the watercourses are occurring further in the receiving environment and provides an assessment of recovery if additional actions are required as set out in section 6 above.

No consent related compliance or performance thresholds or targets apply to these downstream locations.

7.2 Monitoring locations

The downstream confirmatory aquatic ecological monitoring sites will be located at:

- Lindis River at Ardgour Road (ORC SOE monitoring Site).
- Bendigo Creek at BSL Gauging Site (Bendigo Station).

7.3 Monitoring parameters and methods

The monitoring methods, protocols and metrics for the downstream confirmatory aquatic ecological monitoring locations are set out in Table 7.

Table 7. *Proposed parameters and methods, and reporting metrics for downstream confirmatory monitoring locations at BOGP. No threshold requirements apply to these sites.*

Monitoring attribute	Method	Metrics	Frequency	Protocol (where appropriate)
Habitat	Rapid Habitat Assessment (RHA)	• HQS	Annual	Clapcott et al. (2020)
Settled sediment	In-stream visual estimate of % sediment cover	• Fine sediment cover (%)	Monthly	Sediment Assessment Method 2 (Clapcott et al.
Periphyton cover	In-stream visual estimate of % periphyton cover	• No algae • (bare substrate) • Films • Mats, • Filaments.	Monthly	National Environmental Monitoring Standards for Periphyton (NEMS 2022a)
Periphyton productivity	Periphyton	• Chlorophyll a (CHLa)	Annual	National Environmental Monitoring Standards for Periphyton (NEMS 2022a)
Macroinvertebrates	Benthic macroinvertebrates	• Taxa number • MCI, • QMCI, • EPT, • %EPT	Annual	Quantitative hardbottom protocols. (Stark et al. 2001)

8.0 Reporting

A report summarising all of the ecological monitoring provided for in the FEMMP (diversion performance and confirmatory monitoring) will be prepared and submitted to Council in November in the year of sampling. The report will include:

- A summary all monitoring undertaken during the previous year, including diversion, performance and confirmatory monitoring (as set out above).
- The results of that monitoring including tables, graphs and summary data to describe the findings.
- A summary of the diversion and performance monitoring results.
- A summary of any actions or works that have been, or are proposed to be, undertaken to improve environmental performance.

9.0 References

Bioresearches (2026). Bendigo-Ophir Freshwater Ecological Valuation. Report prepared by Bioresearches for Matakanui Gold Limited, dated 16 April 2026.

Boffa Miskell (2025). Bendigo Ophir Gold Project: Assessment of Freshwater Ecological Effects. Report prepared by Boffa Miskell Ltd., October 2025.

Clapcott, J., Casanovas, P., & Doehring, K. (2020). Indicators of freshwater quality based on deposited sediment and rapid habitat assessment (3402). 31 p. https://environment.govt.nz/assets/Publications/Files/indicators-of-freshwater-quality.pdf

Clapcott, J., Young, R., Harding, J. S., Matthaei, C., Quinn, J., & Death, R. (2011). Sediment Assessment Methods: Protocols and guidelines for assessing the effects of deposited fine sediment on in-stream values. 108 p.

NEMS (2022a). National Environmental Monitoring Standards: Periphyton. Sampling and Measuring Periphyton from Wadeable Rivers and Streams. Version 1.0.0, July 2022. Ministry for the Environment. https://bucketeer-54c224c2-e505-4a32-a387-75720cbeb257.s3.amazonaws.com/public/Documents/Periphyton-v1.0.1.pdf

Stark, J.D.; Boothroyd, I.K.G.; Harding, J.S.; Maxted, J.R.; Scarsbrook, M.R. (2001): Protocols for sampling macroinvertebrates in wadeable streams. Prepared for the Ministry for the Environment, Sustainable Management Fund Project No. 5103. http://www.cawthron.org.nz/coastal-freshwater-resources/downloads/protocols-full-manual.pdf

Water Ways (2025). Bendigo Ophir Gold Project: Assessment of Effects on Aquatic Habitat. Report prepared by Water Ways Consulting, June 2025.

Appendix 1: Shepherd Creek Rehabilitation Plan (Growplan 2025)

Approach and outline

Plant selection and planting design is a combination of ecological function for the particularities of the site, with aesthetic elements primarily as cues for care

To increase understanding and valuing of the planted landscape it is essential planting makes sense and is not seen as 'just weeds'. Patterns and forms that look 'designed' are cues for care and inquisitiveness - this increases staff buy-in and can help toward having qualified staff to manage the two-decade closure phase

The overarching approach is to design, construct, revegetate and maintain for a no-net -loss outcome

Plant selection is based on several factors:

• Known to occur on-site now, or within circa 15Km from site, or known to have been present within the last 5000 years

• Beneficial to and supportive of wildlife - birds, skinks and geckos, and terrestrial and aquatic invertebrates

• Weighted towards aesthetic value

• Valued by Maori

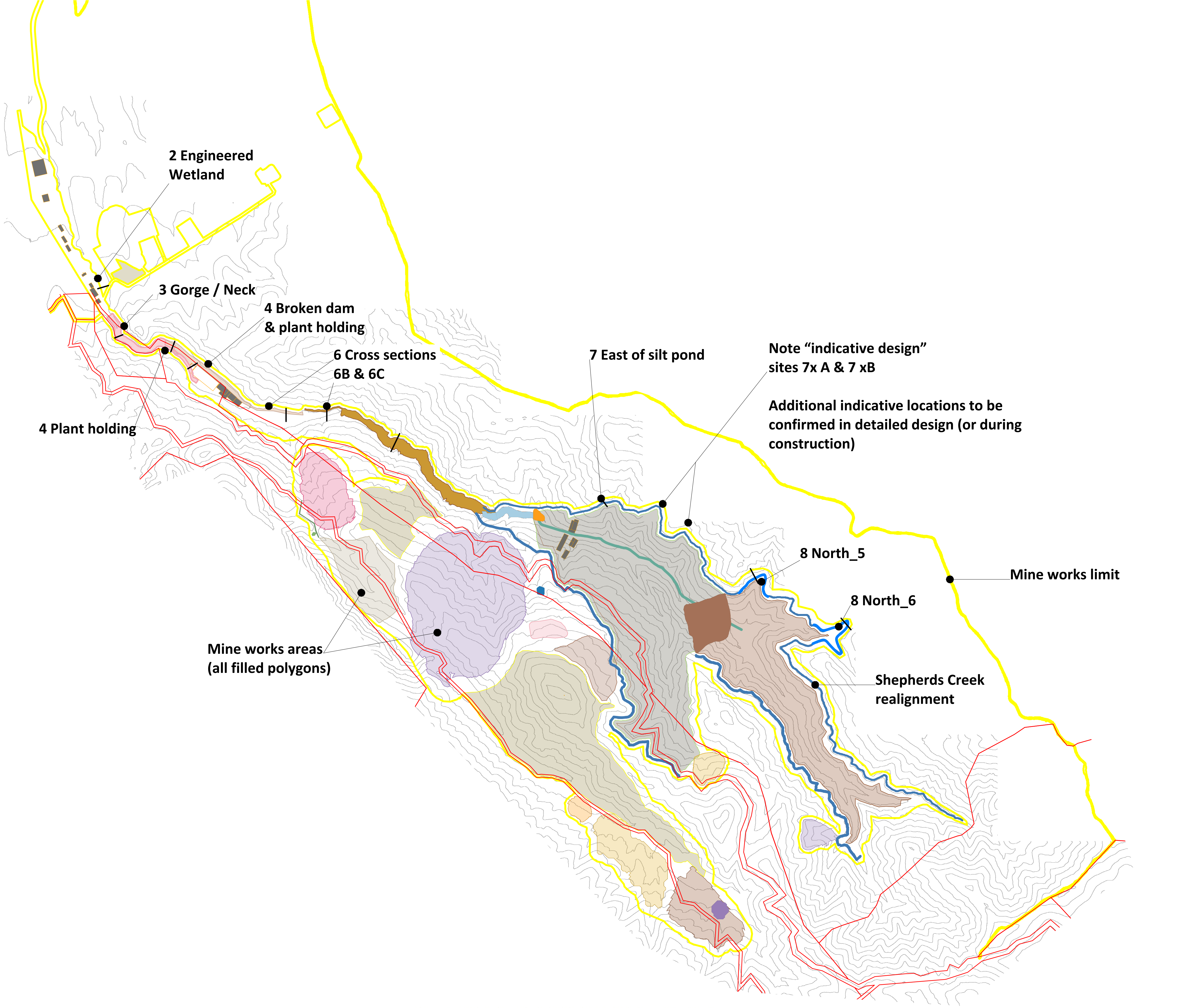
• Will withstand local climate and site conditions

• Lower palatability plants where possible to lessen effects of grazing pests, and eventually sheep post closure

Trees and/or shrubs overhanging creeks help sustain invertebrates via leaf breakdown products entering the water, shading also helps keep water cooler

Utilizing hard materials from site (or local area), and transplanting plants where practicable

Depending on site conditions and site context the water drop structures may be partly formed in basement rock, and constructed in boulders, sheet piling, or precast concrete, or a combination thereof and the forms naturalised



1
20250711
N

drawing **Overview**
location **Bendigo**
client **Santana Minerals**

scale **1:25000 @ A3**
www.growplan.co.nz
nigel@growplan.co.nz
027 214 7791

file **#_SantanaMin.277**
• **confirm services**
• **do not scale off plan**
• **verify all dimensions**

DRAFT

Nigel Cowburn
growplan ltd
west otago nz

GROWPLAN
People ∩ Plants ∩ Place

0 2000 m
Contour interval 20m this page only

Situation

Shepherd's Creek leaving the hills

Height change upstream to down approx. 8 metres

Approach

An engineered wetland as a final polishing and monitoring stage, including aquatic species as living sensors e.g koura (a forest fire-fighting pond practice) and *Daphnia* species

Channel enters and exits wetland in its natural position and flows through five detention basins / ponds

Stream realigned above existing ground and channel invert, with pond depth a maximum of 1.5 m above invert

Existing channel filled with loose angular rock to maintain some dry weather flow. This would also reduce the deep incision / erosion of this channel

Ponds lined with oxidized brown loess - a ubiquitous local soil mineral used to line local orchard irrigation ponds. Flow exits ponds over a low drop of approx. 1m on to a rock rubble base and exits pond into a slow flowing channel to the next basin

Plant selection for ability to thrive in riparian and wet zones of dryland areas

Planting layout and pattern leaves the channel and ponds in low grasses and sedges occasionaly planted to fenceline to enable views into the space

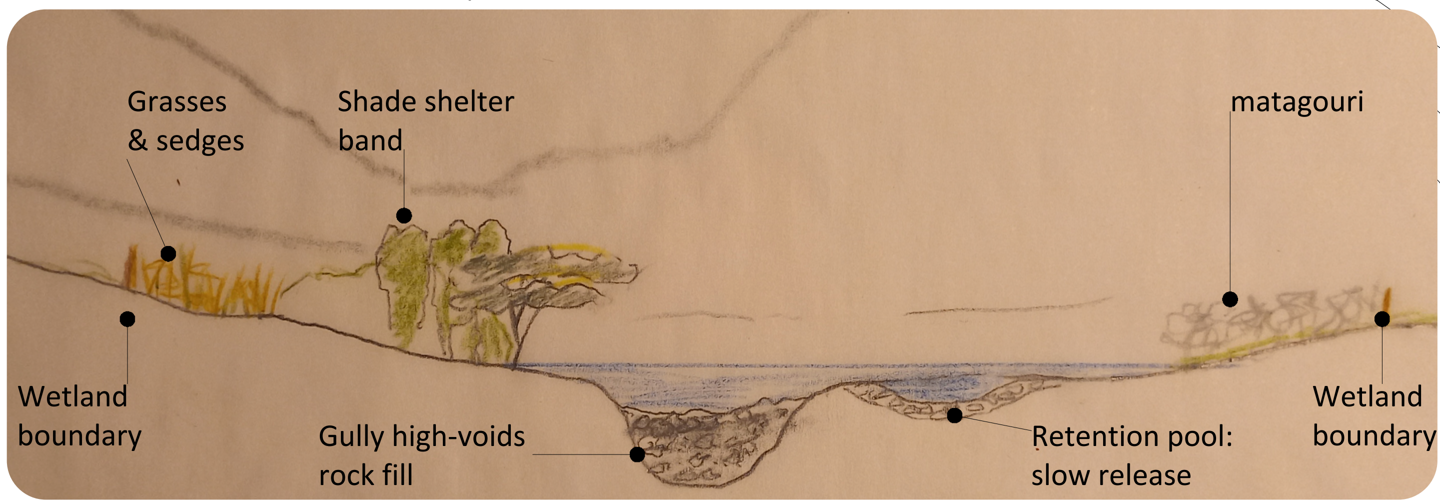
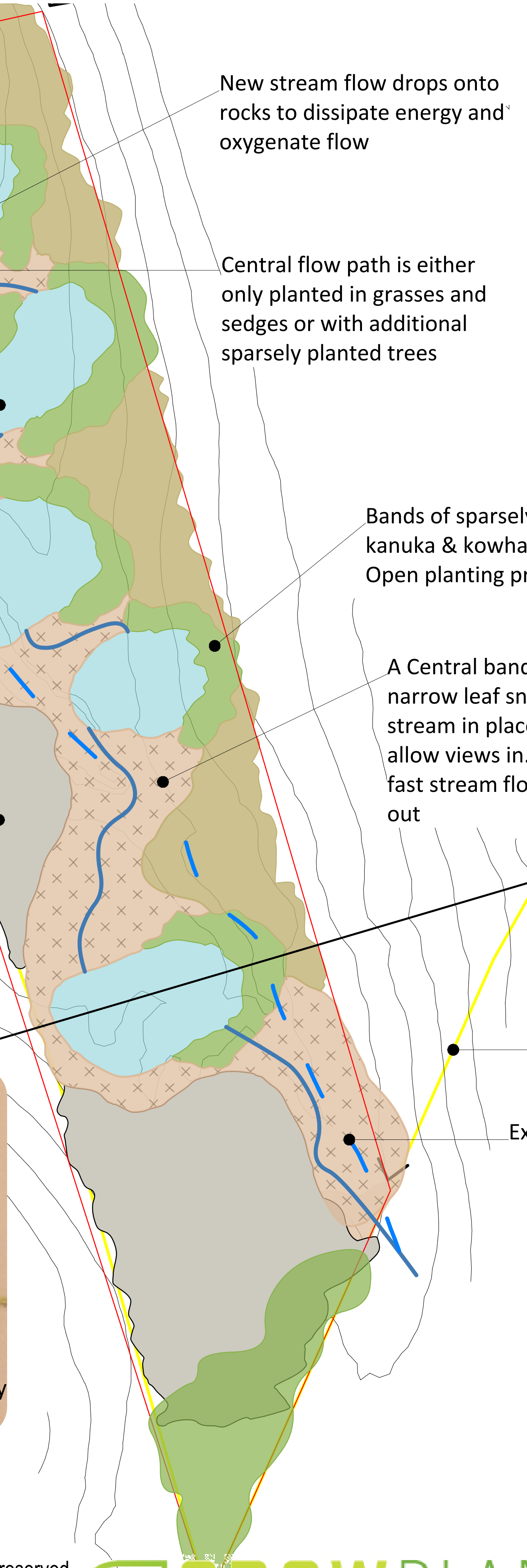
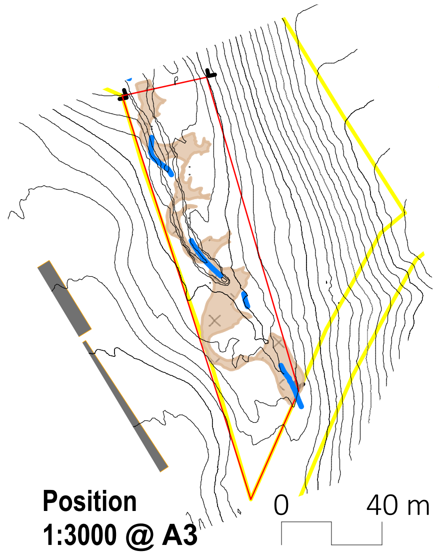
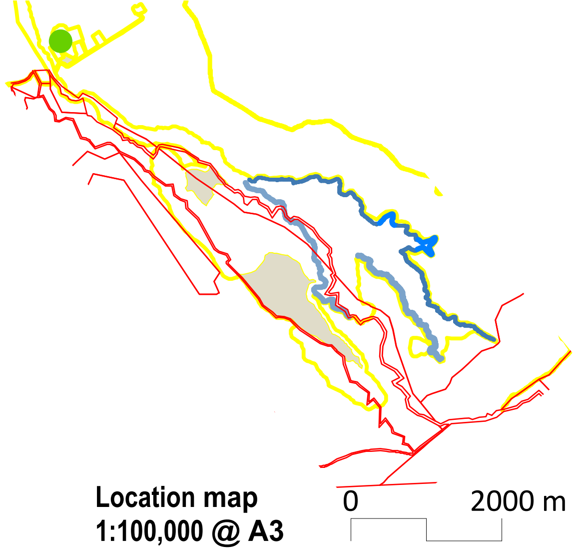


Figure 2, Site 1 Engineered Wetland, view upstream Section 1' - 1" nts







Plants for engineered wetland

Chionochloa rigida	narrow-leaf snow tussock
Carex coriacea	cutty grass
Discaria toumatou	matagouri
Halocarpus bidwilli	bog pine
Kunzea ericoides	kanuka
Sophora microphyla*	kowhai

Halocarpus bidwilli bog pine

Nigel Cowburn
growplan ltd
west otago nz

Situation

Shepherd's Creek passing through The Neck

Approach

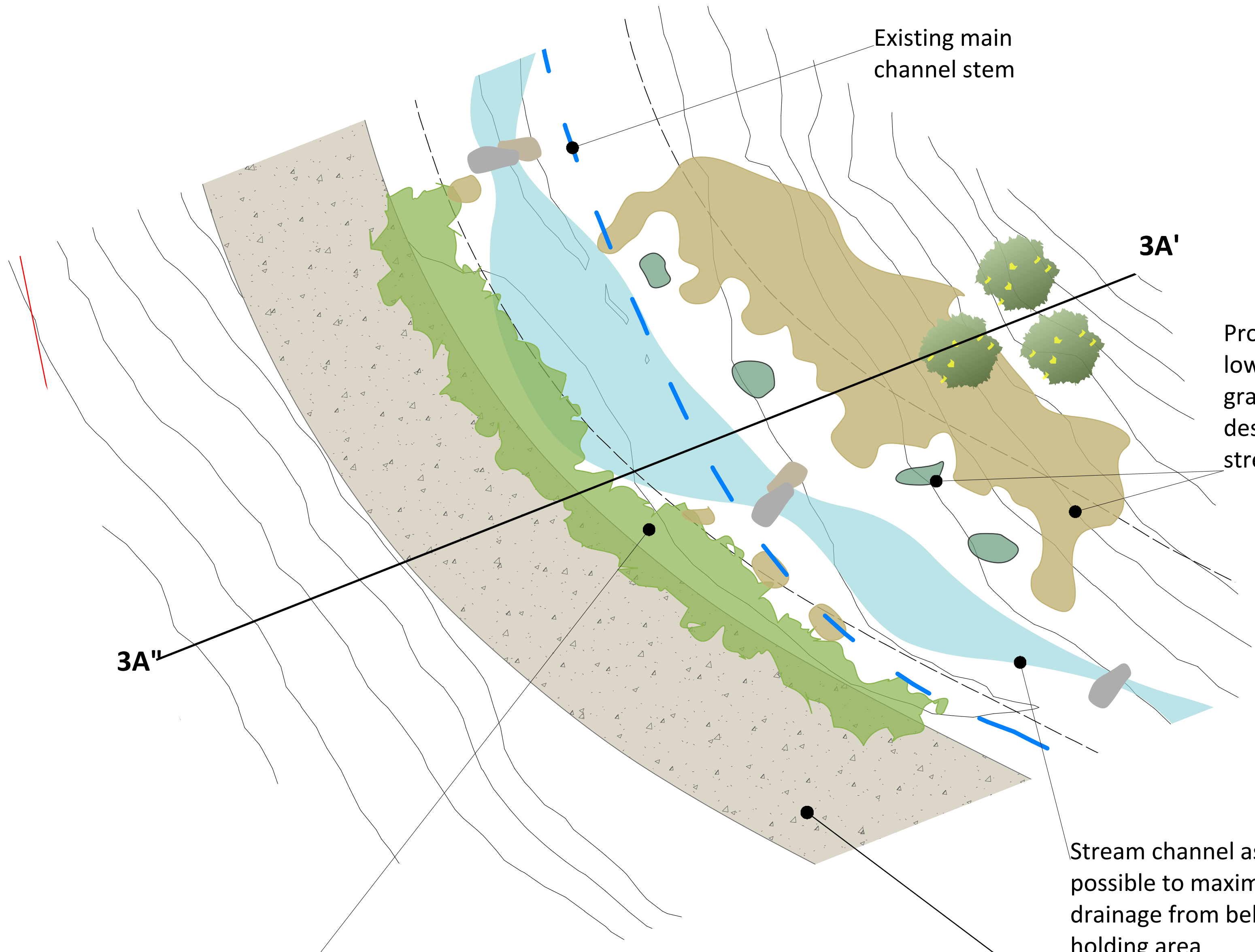
Channel remains at its existing height, but moved towards slope with some minor slope cut to facilitate this

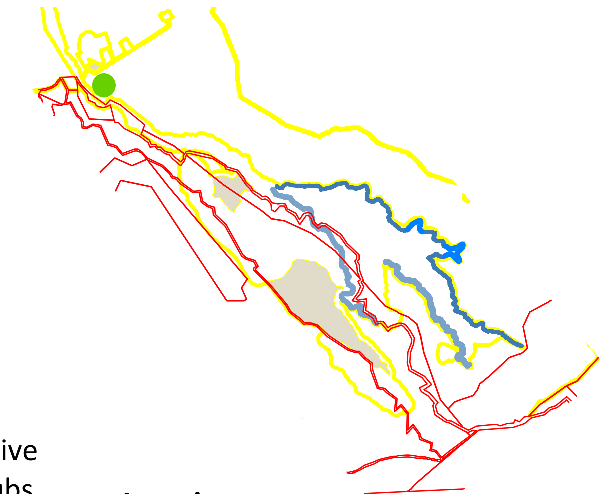
Continuation of pool rifle sequence as designed into reaches upstream

Low shrubland planting atop riprap adjacent access road

Planting able to thrive in riparian and wet zones of dryland areas

Planting is low and sparse to maximize stage flow





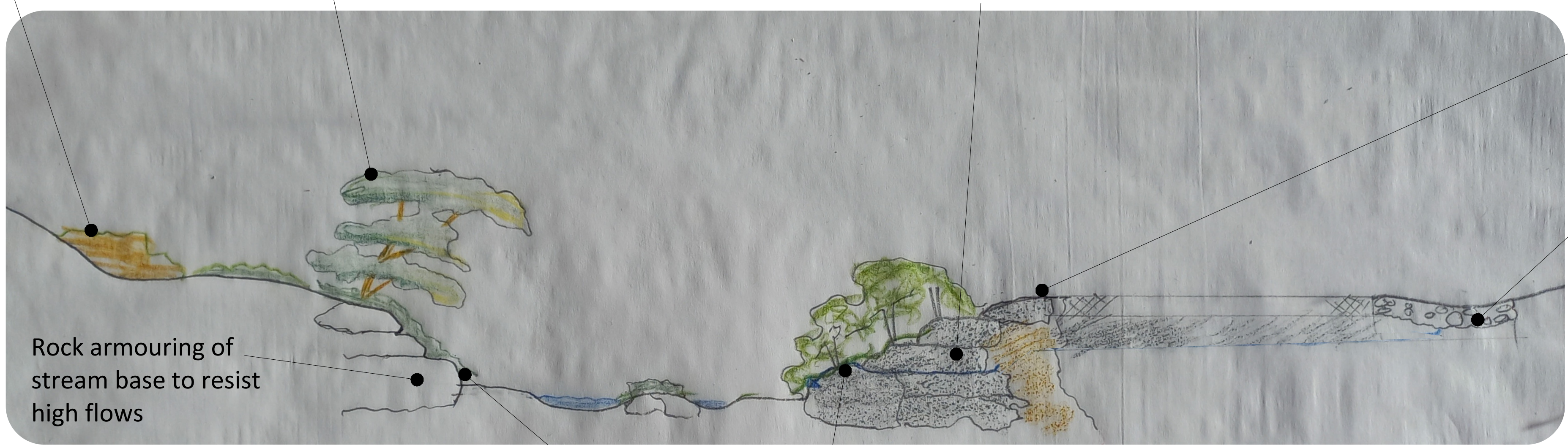


Figure 3 Site 2 Gorge at the Neck, view upstream
Section 3A' - 3A" nts

Plants for the Gorge at the Neck

Carex dipsacea
Carmichaelia sp.
Hebe salicifolia
Hebe subalpina
Pimelea notia
Sophora microphyla

Nigel Cowburn
growplan ltd
west otago nz

Situation

Shepherd's Creek plant transplant holding* and staging area, and for re-vegetation plant handling

Approach

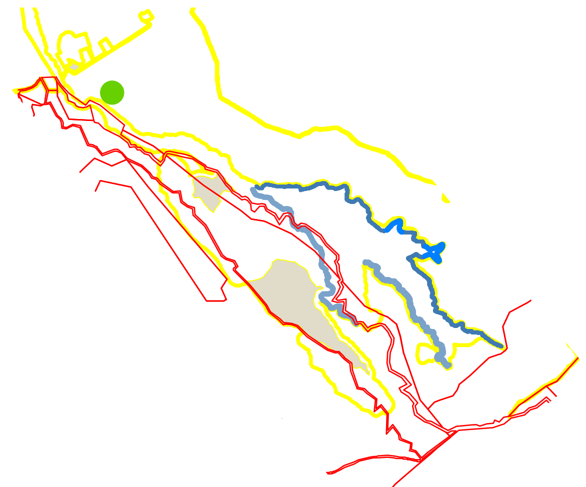
Plant storage planforms using a ridge and wide base 'furrow' for vehicle access and frost drainage, and to keep above high flow levels

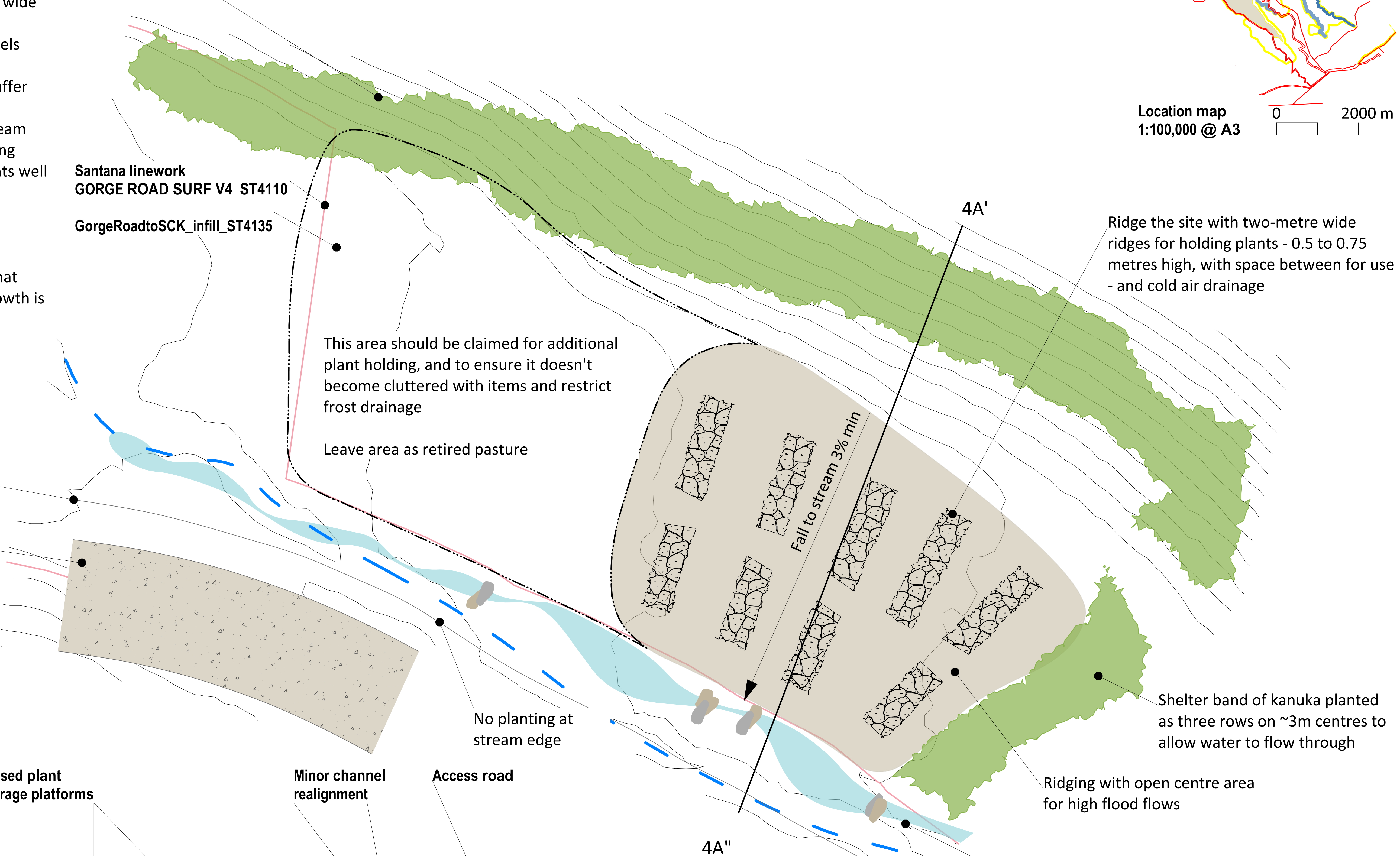
Create planted uphill cold air redirect / buffer

To maximise frost drainage limit downstream shrub planting to ground covers and trailing plants, with shrubs only as scattered plants well back from the main channel

<u>Site will require access - not shown</u>

* Not a nursery. A perception may exist that site-grown plants are more robust but growth is very slow with high mortality that it is not worthwhile





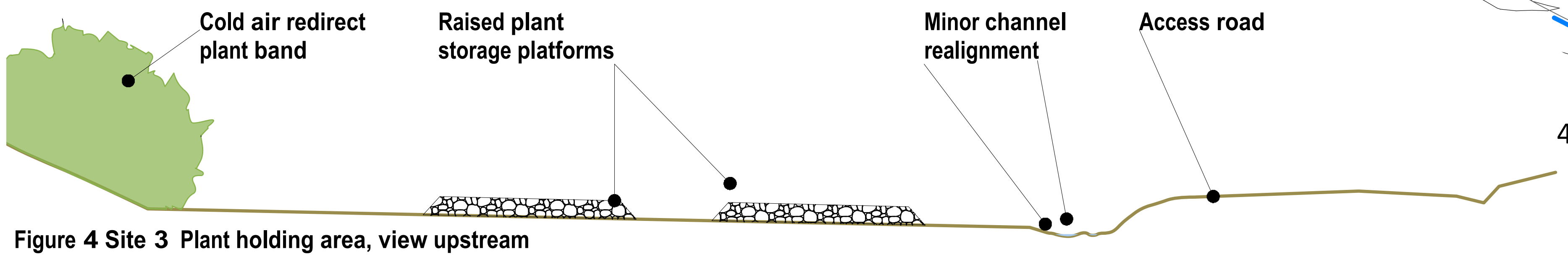


Figure 4 Site 3 Plant holding area, view upstream
Section 4A' - 4A" nts

4	drawing	Plant holding area	scale 1:400 @ A3	file #_SantanaMin.277
		Site 3	www.growplan.co.nz	• confirm services
N	location	Bendigo	nigel@growplan.co.nz	• do not scale off plan
20250711	client	Santana Minerals	027 214 7791	• verify all dimensions

DRAFT

Nigel Cowburn
growplan ltd
west otago nz

GROWPLAN
People ∩ Plants ∩ Place

0 20 m

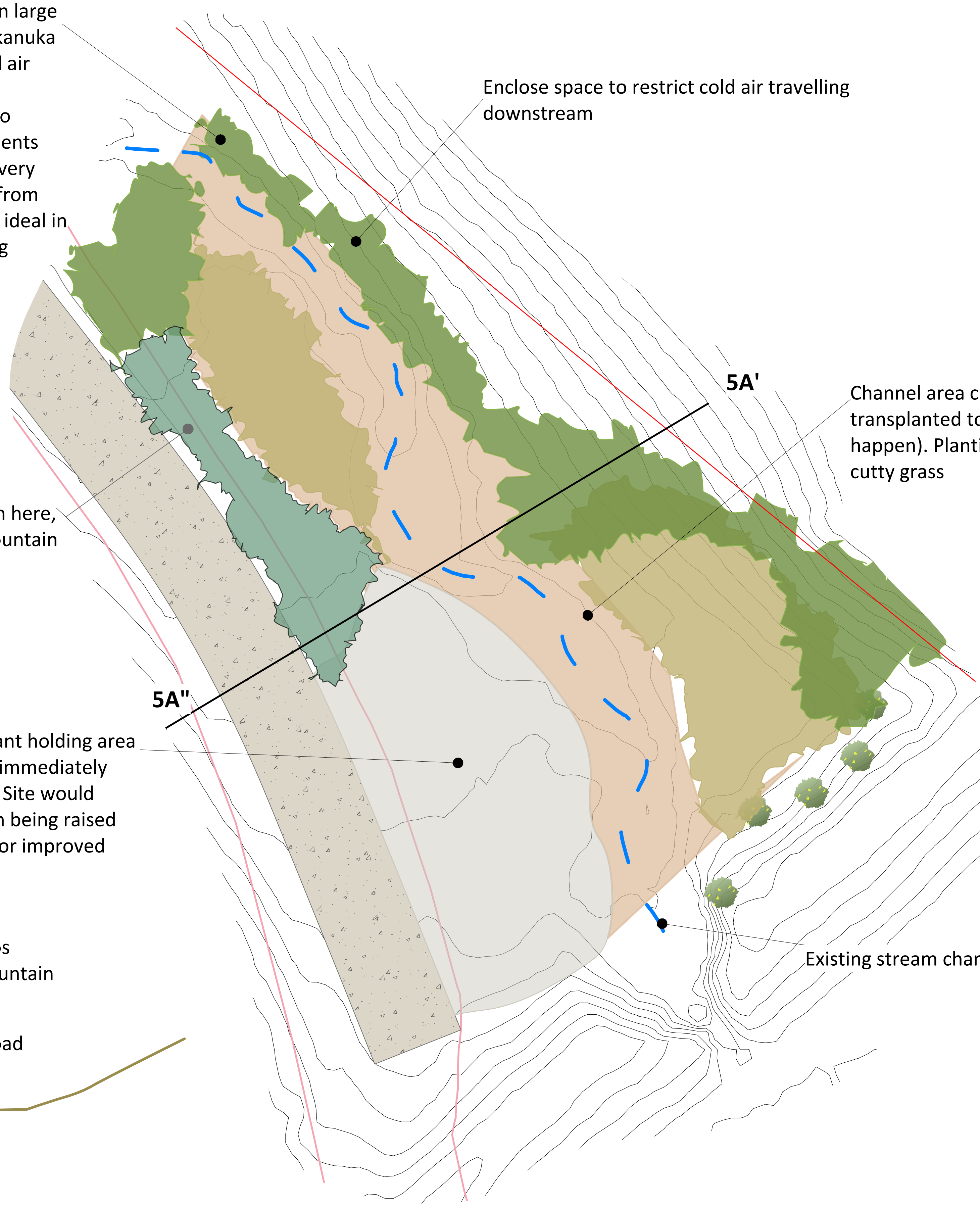
Contour interval **1** metre

Situation

Slow-moving sinuous stream immediately downstream from broken dam, and also need for a second plant holding area

Approach

In general work with slow moving stream and planting that is already here, especially cutty grass



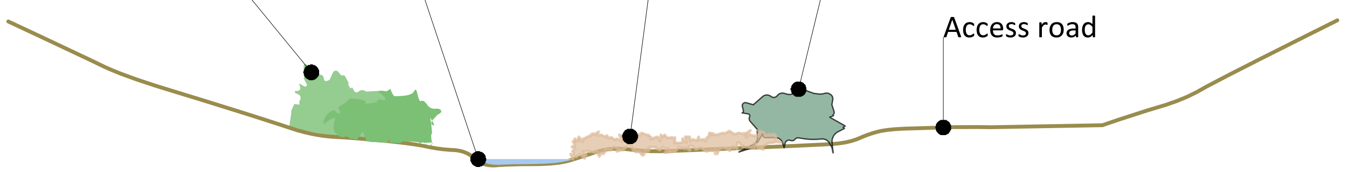


Figure 5 Site 4 Broken dam & plant holding area, view upstream
Section 5A' - 5A" nts

5 | drawing: Site 4 Broken dam & plant holding | location: Bendigo | client: Santana Minerals | 20250711 | N

scale 1:600 @ A3
www.growplan.co.nz
nigel@growplan.co.nz
027 214 7791

file #_SantanaMin.277
• confirm services
• do not scale off plan
• verify all dimensions

DRAFT

Nigel Cowburn
growplan ltd
west otago nz

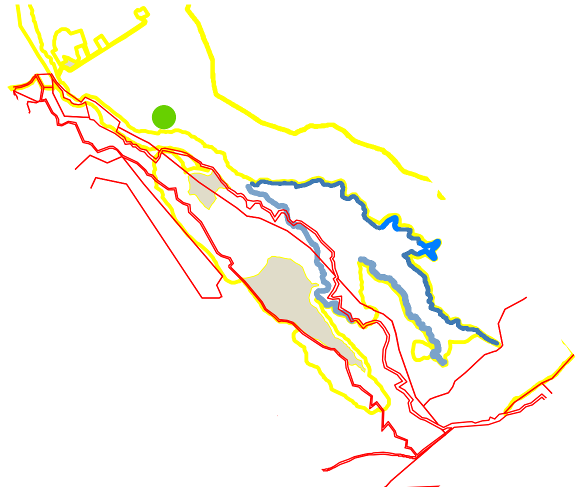
GROWPLAN
People ∩ Plants ∩ Place

0 40 m

Contour interval 1 metre

Situation

Shepherd's Creek lowland form (with adjacent dirty water channel) east of processing plant, and steeper section at Shepherd's Fill area



Location map 1:100,000 @ A3

Low water drop structures - approx. 1metre and rock armouring of outer stream curves

Kowhai clusters on true right at dams, and true right outer curves

Enclosing band of mingimingi, mountain akeake & koromiko

Stream

Ground cover Carex band lay flat in floods

Line of Coprosma on separating bund

Carex band on drainage apron

Strip of Koromiko and matagouri on bund separates channel from works area

Dirty water channel with detention weirs

Production / works area

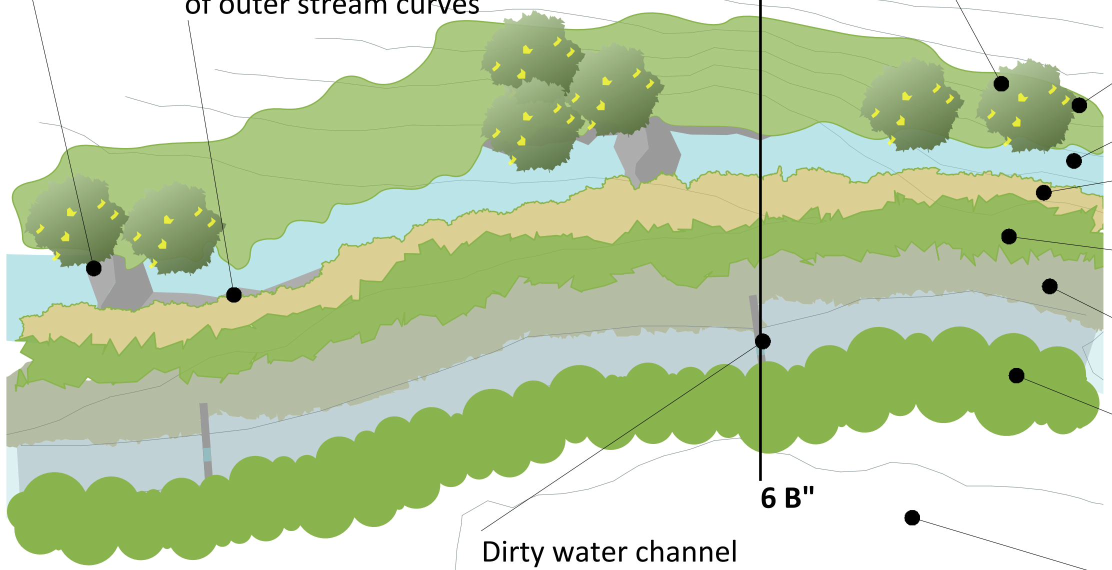


Figure 6, Site 6 B, Lowland reach plan typical, 1:300 @ A3

Scattered mingimingi, mountain akeake & koromiko, where planting allows

Carex band adjacent perennial flow

Kowhai clusters true right at dams, and true right outer curves

Water drop structures - < 2m, with rock riprap on outer stream curves

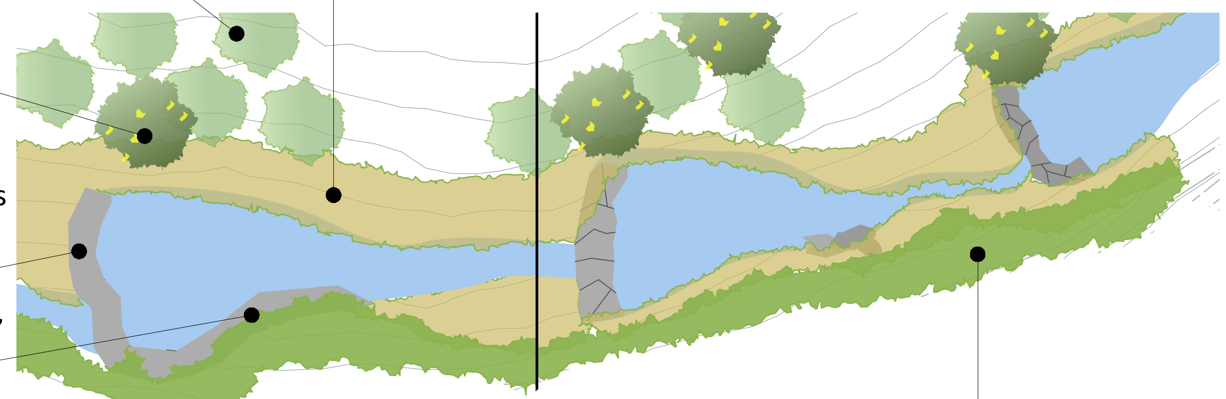


Figure 6, Site 6 C, steeper reach plan typical form, 1:300 @ A3

Matagouri or Coprosma set back from stream and below kowhai canopy

Carex in and adjacent to stream, being plaint they do not impeded flow

Occasional low coprosma on higher points in stream to help bind gravels

Bund Formed of large boulders and planted in Hebe and Coprosma to bind and retain its form

Carex and prostrate shrubs to bind drainage apron

Hebe (koromiko) shrub band separates stream and drain from works. koromiko have a relatively high transpiration rate and will help reduce drainage volumes where they are planted

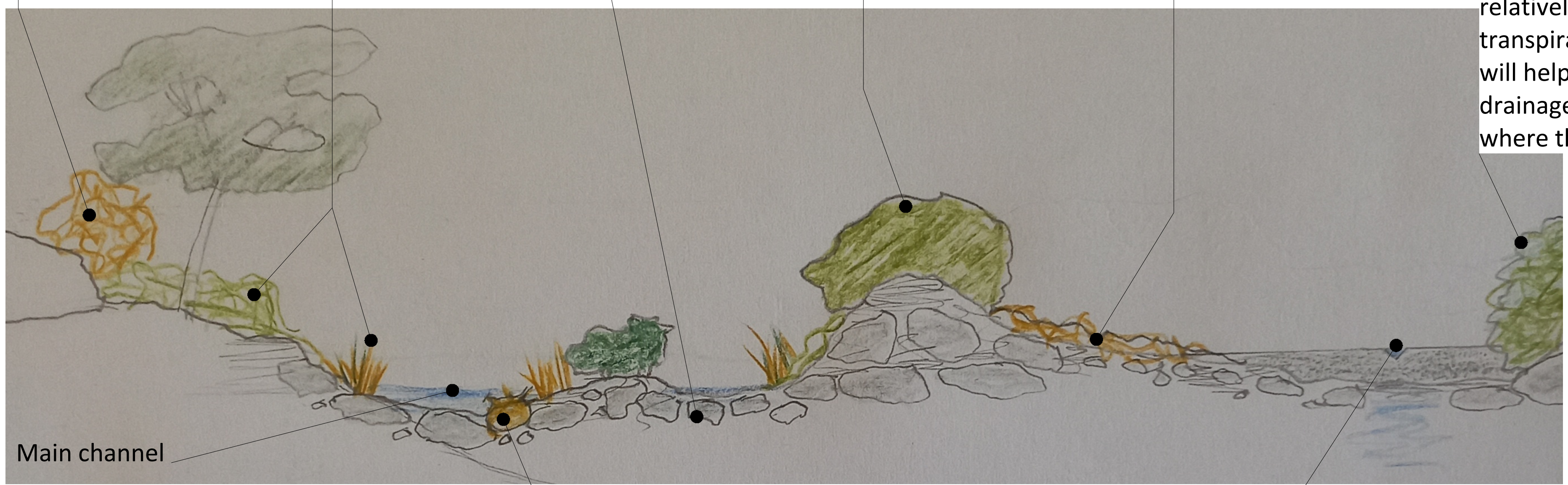


Figure 6, Site 6, Lowland reach typical, view upstream Section 6 B' - 6 B" nts

Tree trunks bedded into stream to add flow complexity and create invertebrate habitat

Drainage channel with weirs create functional ponding

Larger shrubs away from creek, with trailing shrubs and grasses reaching into creek

Occasional large boulders in stream to add niches for aquatic invertebrates

Low dry-tolerant shrubs atop riprap and atop bank to reduce sediment flow to creek

Figure 6, Steeper section, view upstream, Section 6 C' - 6 C" nts

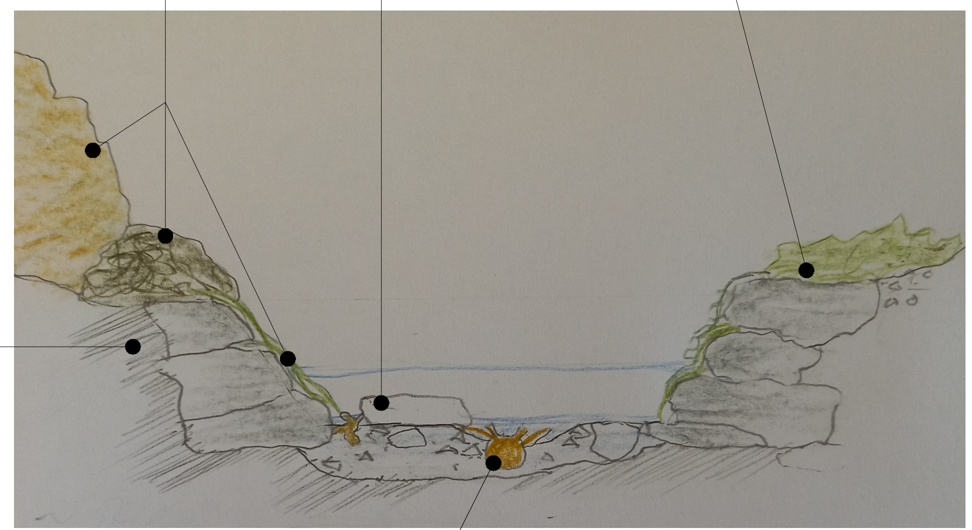


Figure 6, Steeper section, view upstream, Section 6 C' - 6 C" nts

Tree trunks embedded in stream to assist flow complexity and create habitat niches

0 20 m

Contour interval 1 metre

Title linework linz.data_CC_by_4.0

6
20250711

N

drawing **6 Shepherds Creek filled areas**
location **Bendigo**
client **Santana Minerals**

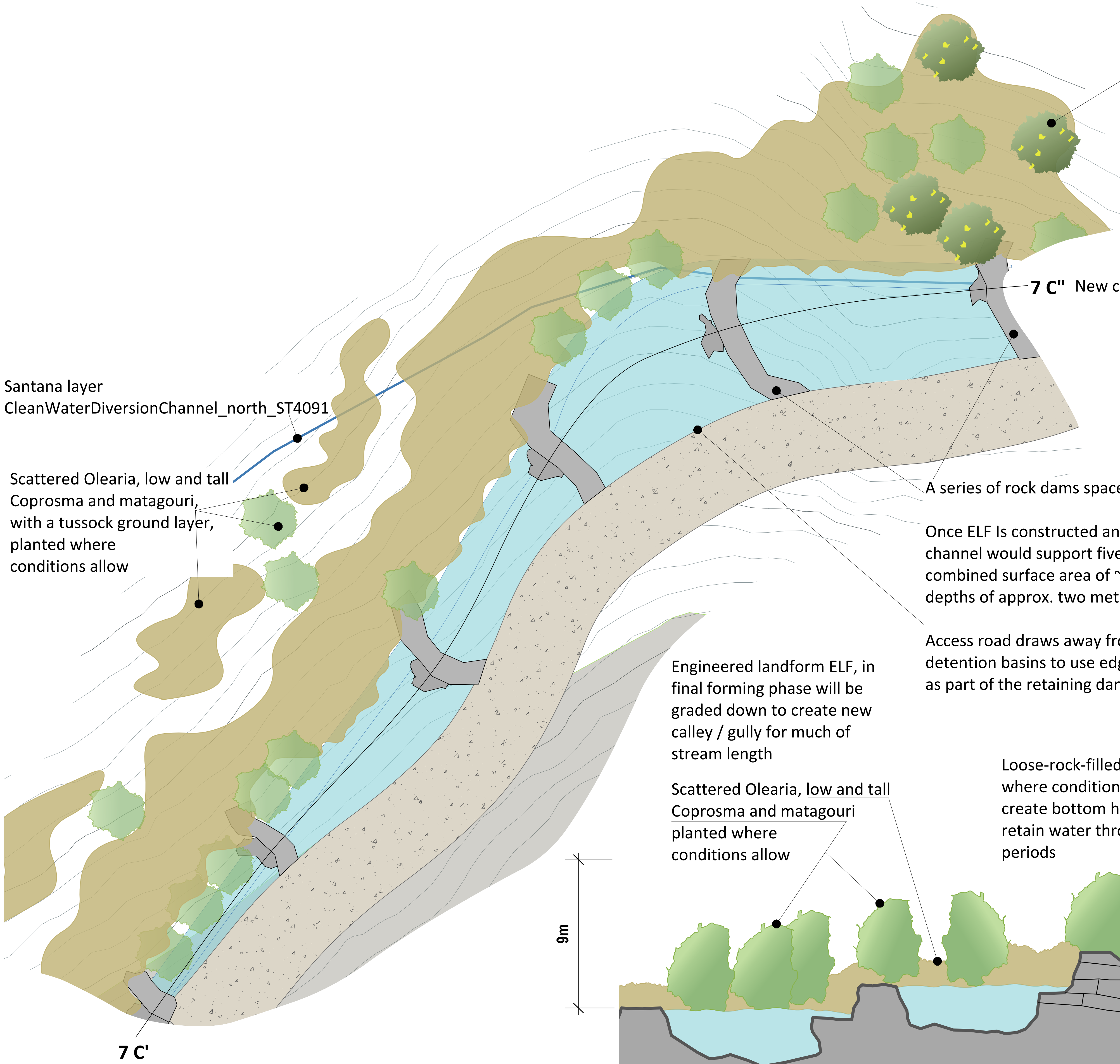
scale **1:300 @ A3**
www.growplan.co.nz
nigel@growplan.co.nz
027 214 7791

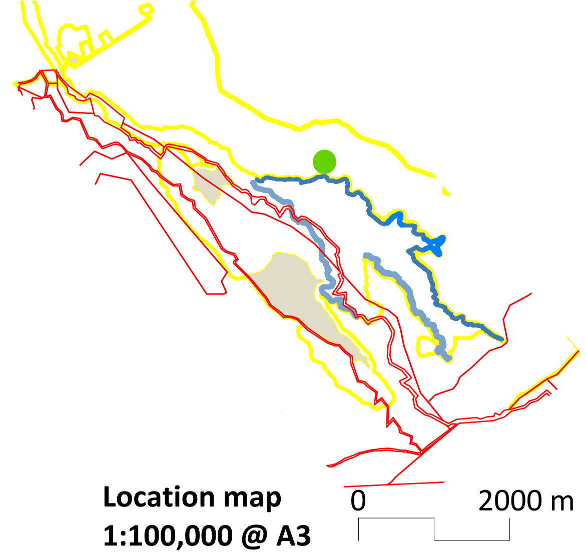
file **#_SantanaMin.277**
• confirm services
• do not scale off plan
• verify all dimensions

DRAFT

Nigel Cowburn
growplan ltd
west otago nz

GROWPLAN
People ∩ Plants ∩ Place





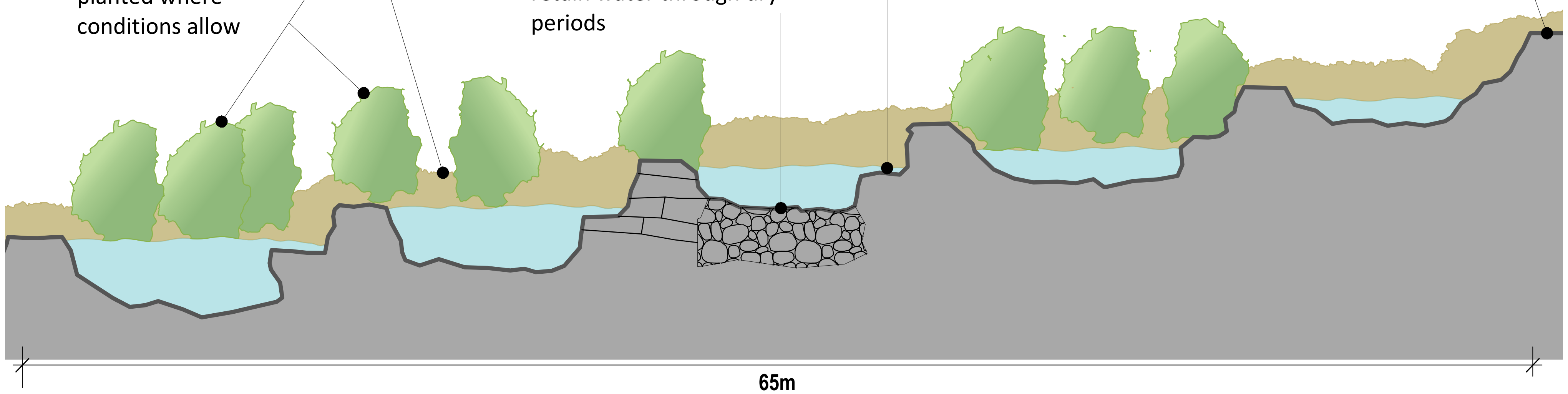


Figure 7, Site 7, drop series typical, view upstream - Long Section 7 B' - 7 B" nts, 1:250 @ A3

7
20250711

drawing Site 7, stream water drop series example
location Bendigo
client Santana Minerals

scale 1:250 @ A3
www.growplan.co.nz
nigel@growplan.co.nz
027 214 7791

file #_SantanaMin.277
• confirm services
• do not scale off plan
• verify all dimensions

DRAFT

GROWPLAN
People ∩ Plants ∩ Place

0 20 m

Contour interval 1 metre

North_5 Upper Shepherd Creek

Hillside and diversion channel detention basin and planting concept

Water flows in to basin in high flow state and detained to preserve minumum vernal state - a seasonal wet pond

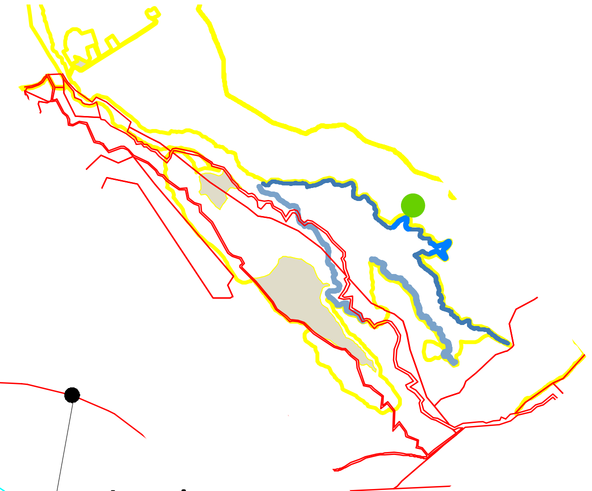
Porous in-flow wall (e.g. weeping wall) to take and release some low flow

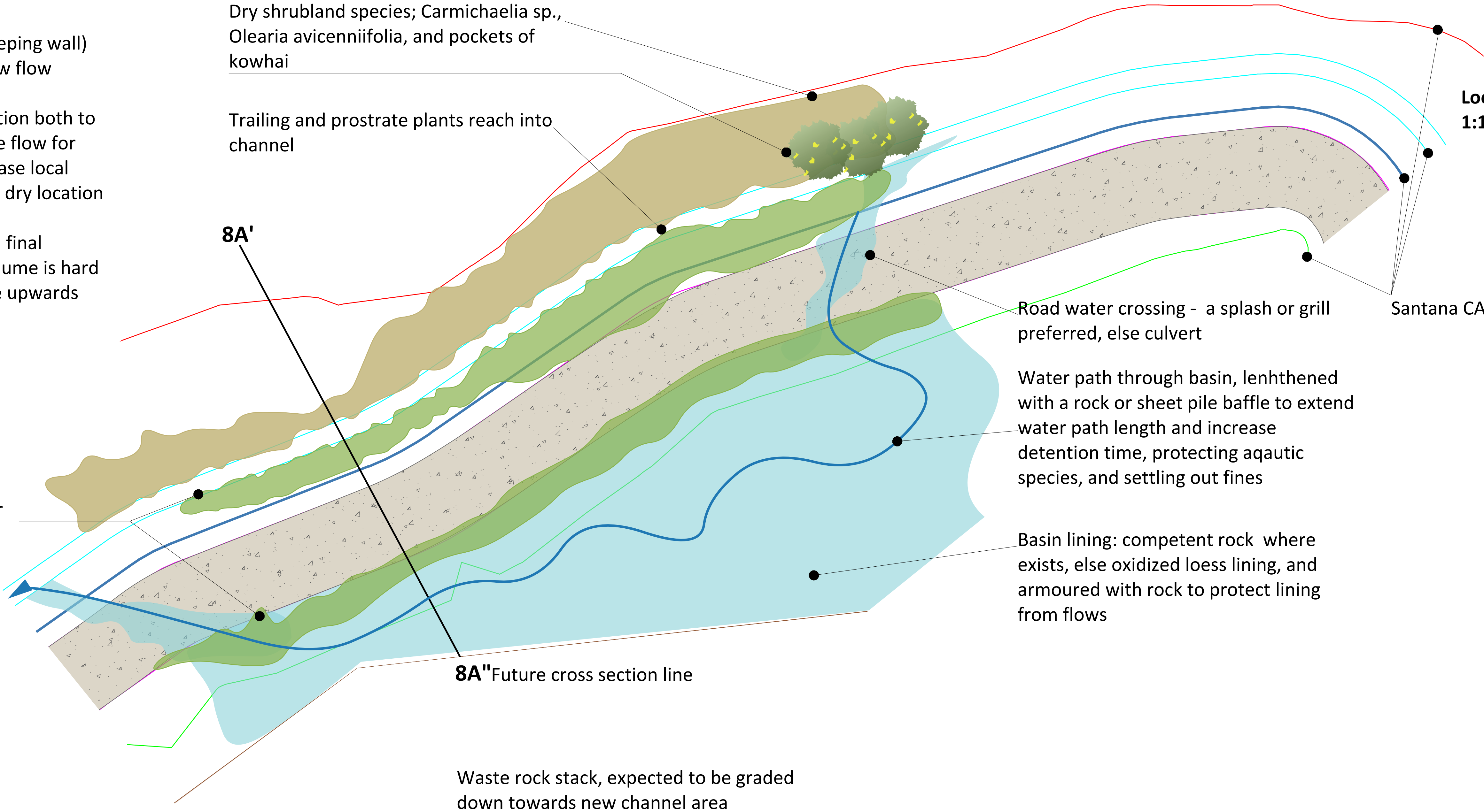
Detention basin would function both to detain flow, and retain some flow for aquatic species and to increase local humidity for plants in a very dry location

Due to uncertainties around final landform potential basin volume is hard to estimate but could range upwards from 400 cubic metres

Note

Indicative design and additional indicative locations to be confirmed in detailed design (or during construction)





Waste rock stack, expected to be graded down towards new channel area resulting in chanel area becoming a new gully

This could enable a larger dam than shown (and additional habitat), or a future dam expansion should precipitation increase

8 | drawing **Shepherds Creek site North_5** | location **Bendigo** | client **Santana Minerals**

20250711 | N

scale **1:300 @ A3**
www.growplan.co.nz
nigel@growplan.co.nz
027 214 7791

file **#_SantanaMin.277**
• confirm services
• do not scale off plan
• verify all dimensions

DRAFT

Nigel Cowburn
growplan ltd
west otago nz

GROWPLAN
People ∩ Plants ∩ Place

0 30 m

Title linework linz.data_CC_by_4.0
Contour interval 1 metre

North_6 Upper Shepherd Creek

Hillside and diversion channel detention basin and planting concept, also results in an easier and safer driving path

Water inflow to basin in high flow state and detained to preserve minimum vernal state - a seasonal wet pond

Basin is a run-of-stream approach with (anchored) boulder placement to direct flow
- not shown pending discussion

Detention basin would function both to detain flow, and retain some flow for aquatic species and to increase local humidity for plants in a very dry location

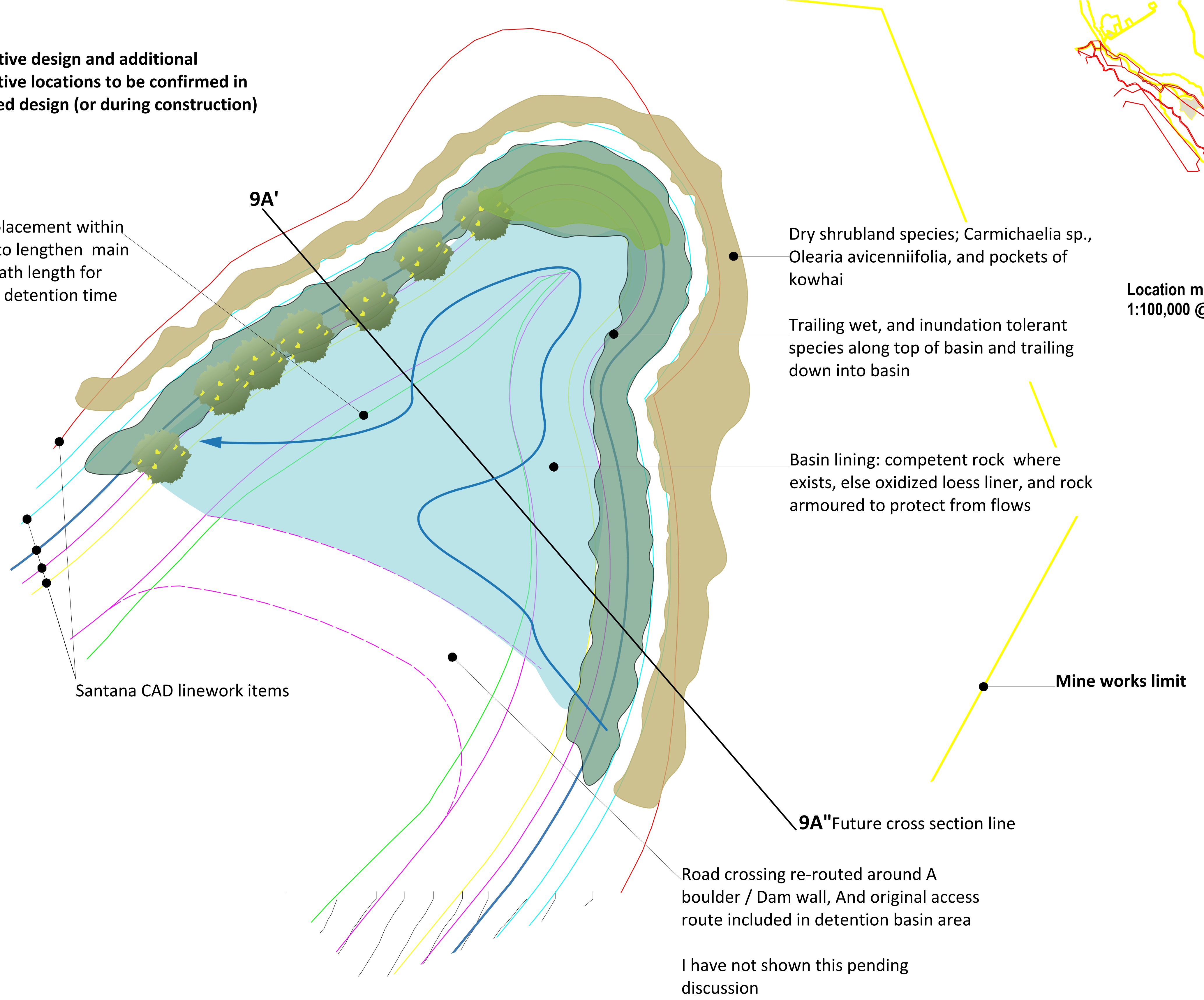
Volume would range upwards from 500 cubic metres

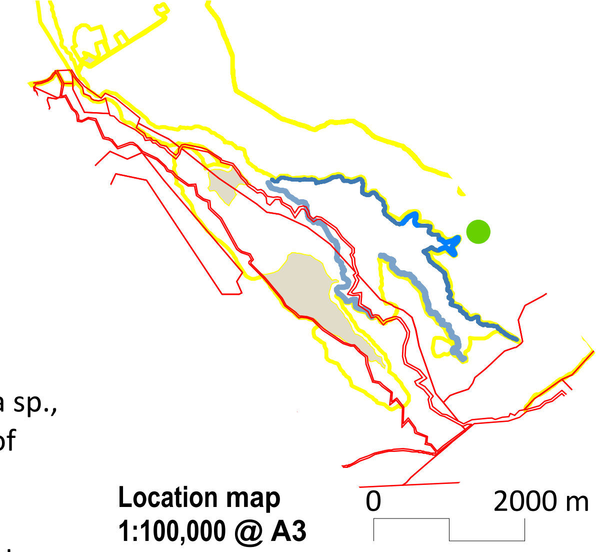
Data issue

No contours as data missing, need DEM file

Note

Indicative design and additional indicative locations to be confirmed in detailed design (or during construction)





9 20250711 N

drawing **Shepherds Creek site North_6**
location **Bendigo**
client **Santana Minerals**

scale **1:300 @ A3 main**
www.growplan.co.nz
nigel@growplan.co.nz
027 214 7791

file **#_SantanaMin.277**
- **confirm services**
- **do not scale off plan**
- **verify all dimensions**

DRAFT

Nigel Cowburn
growplan ltd
west otago nz

GROWPLAN
People ∩ Plants ∩ Place

0 30 m

Contour interval 1 metre

Height	botanical name	common name	Position	Wildlife	in cult.	Authority	Form & notes
1.0	*Carmichaelia compacta*	native broom	dry sites		Y	Walker 2004	
1.0	*Chionochloa rigida*	narrow-leaf snow tussock	wet tolerant		Y	Exists to North & South	
1.5	*Chionochloa rubra*	red tussock	stream margins		Y	Occurs on site	
0.7	*Coprosma cheesemanii*	-	-	birds	Y	Grove 2002	Spreads post grazing
2.0	*Coprosma propinqua**	mingimingi	-	skinks	Y	Walker 2004	Low palatability
0.5	*Carex dipsacea*	teasel sedge	stream sides		Y	Dunstan ED	
0.7	*Carex comans*	sedge	stream sides		Y	Dunstan ED	
0.7	*Carex coriacea*	cutty grass	wet tolerant		Y	Occurs on site	
2.0	*Discaria toumatou*	matagouri	-	inverts.[1]	Y	Occurs on site	1 - inverts. attract birds
7.0	*Festuca matthewsii**	southern blue fescue	wet edge		Y	Has existed in area	Size highly variable
4.0	*Halocarpus bidwilli*	bog pine	wet tolerant	birds	Y	Walker 2004	
1.5	*Hebe subalpina*	-	dryland wet flushes		Y	Walker 2004	Spreading farm avail.
1.5	*Hebe odora*	-	-		Y	Dunstan ED	
2.0	*Hebe salicifolia*	koromiko	wet tolerant		Y	Has existed in area	
5.0	*Kunzea ericoides*	kanuka	wet tolerant		Y	Occurs on site	
3.0	*Olearia avicenniifolia*	mountain akeake	-	inverts.	Y	Walker 2004	
0.5	*Pimelea aridula aridula*	pimelea	-	inverts.	Y	Exists in locale	Wide low shrub
0.3	*Pimelea oreophila lepta*	pimelea	stream sides	inverts.	Y	Exists in locale	Sprawls, low palat.
0.3	*Pimelea prostrata ssp. prostrata*	pinātoro / NZ daphne	stream sides	inverts.	Y	Exists in locale	Sprawls, low palat.
0.5	*Pimelea notia*	pimelea	stream sides	inverts.	N	Has existed in area	Sprawls, low palat.
4.0	*Pseudopanax ferox*	horoeka	-	inverts.	Y	Has existed, Pole 2022	
5.0	*Sophora microphyla**	kowhai	stream sides	birds	Y	Occurs on site	3 metre tall shrub forms exist
1.5	*Teucrium parviflorum*	teucridium	stream sides	inverts.	Y	Wardle 2001	

Table 4a Plant selection and information. *** Known Maori applications / value**

Plant authorities / references

Davies-Colley, R.J. & Payne G.W. 2023 Cooling streams with riparian trees: Thermal regime depends on total solar radiation penetrating the canopy. Austral Ecology, 48:1064–1073.
url: https://onlinelibrary.wiley.com/doi/10.1111/aec.13345

Pole, M. 2022 A vanished ecosystem: Sophora microphylla (Kōwhai) dominated forest recorded in mid-late Holocene rock shelters in Central Otago, New Zealand. Palaeontologia Electronica, 25(1):a1.
DOI: https://doi.org/10.26879/1169 and https://www.palaeo-electronica.org/content/2022/3503-vanished-ecosystem

Wardle, P. 2001 Distribution of native forest in the upper Clutha district, Otago, New Zealand, New Zealand Journal of Botany, 39:3, 435-446.
DOI: https://doi.org/10.1080/0028825X.2001.9512747

Grove P.B, Mark, A.F., Dickinson, K.J.M. 2002 Vegetation monitoring of recently protected tussock grasslands in the southern South Island, New Zealand. DOI: https://doi.org/10.1080/03014223.2002.9517700

Email me if a paper is difficult to obtain as I have pdfs of all

Plant authorities / references

Walker et 2014 Effects of secondary shrublands on bird, lizard and invertebrate faunas in a dryland landscape. J NZ Ecol. Soc
url: https://newzealandecology.org/system/files/articles/3123.pdf
- Has a useful Bendigo lizards study.

ED - Ecological District classification system

A number of studies note how impoverished native species are in the Bendigo area. Researchers including Pole have proved the existence of a number of species no longer growing here but that have grown at least to the North and South of site in the last two to five thousand years

Plants and wildlife values

All non-monocots ('grasses' rushes, sedges, tussocks and trrue grasses) Produce nectar and / or pollen, and produce seeds.

Every non-monocot is in a system that includes either invertebrates, birds or lizards, and sometime all three are attracted. Above instances are known and documented examples

Carex comans
Highly variable in form and colour

Carex coriacea
Perennial sedge - dies partly back in winter

Carmichaelia compacta
Cromwell broom, develops wide low clumps

Chionochloa macra
Slim snow tussock

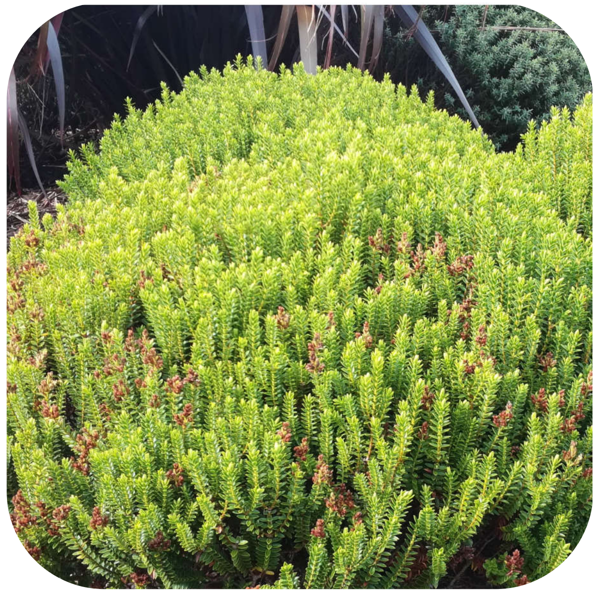
chionochloa rigida
Narrow-leaved snow tussock

Chionochloa rubra
Red tussock

Coprosma propinqua, mingimingi *
Especially of value to lizards

Discaria toumatou matagouri
An invertebrate essential

Halocarpus bidwillii
Wet tolerant, and when established dry too



Hebe odora
Garden example, in nature form more loose

Hebe salicifolia, koromiko *
* Plants with known use by Maori

Kunzea ericoides kanuka
Useful in removing excess nutrients, useful in seepage areas and gullies

Olearia avicenniifolia
Mountain akeake
Native tree daisy to 2-3 metres

Sophora microphylla, kowhai *
Highly variable form, several natural shrub and tree forms exist in Otago

Teucridium parvifolium
Deciduous shrub, attracts invertebrates

Plants without images:	Festuca matthewsii *
Carex dipsacea	Hebe subalpina
Coprosma cheesemanii	Pimelea species

3a
20250711

drawing **Plant selection images**
location **Bendigo**
client **Santana Minerals**

scale
www.growplan.co.nz
nigel@growplan.co.nz
027 214 7791

file **#_SantanaMin.277**
• **confirm services**
• **do not scale off plan**
• **verify all dimensions**

DRAFT

Nigel Cowburn
growplan ltd
west otago nz

GROWPLAN
People ∩ Plants ∩ Place

All plant images - Nigel Cowburn Growplan Ltd
 Contour interval 1 metre

Appendix 2: SEV descriptions of Shepherds Creek and Rise and Shine Creek (from Bioresearches 2026)

Shepherd’s Creek

Two SEV assessment was undertaken within Shephard’s Creek, each over a 100 m of stream reach. One assessment was conducted within the central area of the proposed permanent diversion channel (located around and downgradient of the Shepherd’s Engineered Landforms (ELF)).

The second SEV assessment was intended to be undertaken downstream of the diversion channel, within a reach unaffected by direct impacts, to act as a monitoring point for any changes in ecological value resulting from the permanent stream diversion. However, due to the presence of an existing water take, the streambed at this location was dry. Consequently, the second SEV was undertaken upstream of the water take, where permanent flow was present, although this reach is still within the section proposed for permanent diversion.

Shepherd’s Creek recorded an SEV score of 0.49 within the proposed diversion reach site and 0.36 at the water take site. These relatively low scores are primarily driven by limited shading due to the pasture-dominated riparian margins and stock access, which has damaged stream banks and increased fine sediment loading, thereby reducing biogeochemical function. Riparian vegetation is dominated by pasture species, with scattered mingimingi (*Coprosma propinqua*), matagouri (*Discaria toumatou*), sweet brier (*Rosa rubiginosa*), and thistles (*Carduus* sp.).

The sections below summarise the outcomes for each of the four ecological functions assessed across the two reaches of Shepherd’s Creek.

Hydraulic (Vchann, Vlining, Vpipe, Vbank, Vrough, Vbarr, Vchanshape, Vlining)

Overall, Shepherd’s Creek is a relatively natural channel with minimal modification. However high macrophyte growth and in-stream structures (such as the water take structure, road crossings) have modified approximately 30–40% of the channel. Despite this, overall bank condition is considered good, with no significant obstruction to floodplain connectivity.

Livestock pugging has widened the wetted channel, meaning that smaller flood events, which would typically be contained within the channel, are more likely to extend into the floodplain. The floodplain is predominantly vegetated with long and short grasses, with some low shrubs present. In addition to localised bank damage, it is estimated that up to 60% of the channel is affected by elevated fine sediment loading.

No piped inlets were identified within either representative reach; however, one barrier to fish passage is present in the lower section.

Biogeochemical (Vshade, Vdod, Vripar, Vdecid, Vmacro, Vretain, Vsurf, Vripfilt)

Shepherds Creek had an average depth of 0.06 m at the diversion reach and 0.09 m at the water take site. Substrates at both locations comprised a mix of gravels, cobbles, and organic material; however, stock access has increased the proportion of fine sediments, which account for approximately 53–71% of the substrate.

Macrophytes, primarily watercress (*Nasturtium officinale*), covered approximately 30–40% of the channel surface, with submerged macrophytes occupying 15–30% of the channel bed. Flow velocity was generally moderate across both reaches, although the lower reach exhibited slower flows than the upper reach. A small area of stagnant water was observed in the upper reach, likely resulting from streambed pugging. Evidence of bubbling was observed, and the high abundance of macrophytes suggests sub-optimal oxygen conditions, indicating some depletion of dissolved oxygen.

Riparian shading is generally low, with most shade provided by matagouri. Site topography provides some additional shading during the morning; however, overall shade is patchy. The limited extent of evergreen vegetation reduces the persistence of shading, and the riparian margin contains very little woody vegetation. As a result, organic matter inputs and filtration capacity are low.

Habitat Provision (Vgalspwn, Vgalqual, Vgobspwn)

Across both reaches, Shepherd's Creek has relatively low-gradient banks that are likely to be inundated during high flows, providing some potential spawning habitat. However, limited shading and sparse ground cover result in low-quality galaxiid spawning habitat. The limited presence of cobbles and larger woody debris also restricts the availability of suitable spawning habitat for bully species (*Gobiomorphus* spp.).

Biodiversity (Vfish, Vmci. Vept, Vinvert, Vripcond, Vripconn)

Aquatic habitat within both reaches is limited, consisting primarily of undercut banks, rooted aquatic vegetation, root mats, and minor riffles. These habitat features are sparse and limited in overall extent.

No fish were observed during electrofishing surveys, and no large macroinvertebrates (kōura or kākahi) were recorded. Macroinvertebrate communities included both pollution-tolerant and pollution-sensitive taxa, with the free-living caddisfly *Hydroboisella* and mayfly *Delatidium* identified.

Riparian vegetation across both reaches is dominated by pasture grasses and low-diversity shrubs, primarily matagouri. Bare and disturbed soils are present throughout. Due to low bank height and minimal incision, there is good connectivity between the stream and the adjacent floodplain/riparian zone.

Photo 1. Downstream reach of the Diversion Channel section of Shepherd's Creek

Photo 2. Upstream reach of the Diversion Channel section of Shepherd's Creek

Photo 3. Downstream reach of the water take section of Shepherd's Creek

Photo 4. Upstream reach of the water take section of Shepherd's Creek

Rise and Shine Creek

The representative reach of Rise and Shine Creek was assessed immediately downstream of the proposed permanent diversion channel around the Rise and Shine Pit. The assessed channel reach supported hydric vegetation, likely influenced by the presence of an upstream sediment retention pond within the reach.

The assessed section of Rise and Shine Creek contained a thick cover of matagouri and sweet brier, with a weedy understory and evidence of wild goat and/or pig tracks. Due to the dense vegetation, the SEV assessment was undertaken over a 70 m reach, with the upstream extent including a short section of willow-dominated vegetation. This reach is characterised by scrub vegetation similar to that present in the upper diversion reaches, and the selected length was considered appropriate to capture the baseline stream characteristics.

Rise and Shine Creek recorded an SEV score of 0.63. This relatively high score is largely attributed to the natural channel form, the presence of an indigenous, evergreen riparian zone extending more than 20 m from the stream banks, which provides consistent shading, and a predominantly hard-bottomed streambed supporting a healthy macroinvertebrate community.

The sections below summarise the outcomes for each of the four ecological functions assessed as part of the SEV methodology for Rise and Shine Creek.

Hydraulic (Vchann, Vlining, Vpipe, Vbank, Vrough, Vbarr, Vchanshape, Vlining)

Rise and Shine Creek comprise a largely natural channel with minimal modification to channel shape or lining. Minor inputs of fine sediment and some channel incision were observed. Although the channel remains relatively natural, incision of the banks may restrict flood flows from overtopping and connecting with the floodplain.

The floodplain is vegetated with low shrubs, predominantly matagouri and mingimingi, with some exotic willow present in the upper extent and patches of long grass. No barriers to fish migration or piped inflows were identified.

Biogeochemical (Vshade, Vdod, Vripar, Vdecid, Vmacro, Vretain, Vsurf, Vripfilt)

Rise and Shine Creek had an average depth of 0.10 m and contained a range of substrates, including gravels, cobbles, small woody material, and bedrock. Fine sediments (silt and sand) comprised approximately 20% of the substrate. Organic matter, such as leaf litter, was relatively low despite the well-vegetated riparian zone.

The riparian zone provides a high degree of shading, which in turn limits macrophyte growth. Flow velocity was generally good throughout the reach, with no areas of slow or stagnant flow observed. No factors indicating reduced stream oxygenation were identified.

Dense indigenous vegetation covers the majority of the 20 m riparian zone, providing consistent year-round shading. However, the relatively sparse understory limits the overall filtration function of the riparian margin.

Habitat Provision (Vgalspwn, Vgalqual, Vgobspwn)

At the assessed reach, Rise and Shine Creek has incised banks, which limit the availability of suitable galaxiid spawning habitat. Additionally, sloped banks and limited ground cover further reduce spawning suitability. Although cobbles are present within the stream, their overall abundance is relatively low, limiting the availability of suitable spawning habitat for bully species.

Biodiversity (Vfish, Vmci. Vept, Vinvert, Vripcond, Vripconn)

Aquatic habitat within the reach includes woody debris, undercut banks, rooted aquatic vegetation, and cobbles, with runs and short waterfalls also present. However, these habitat features are limited in extent and overall coverage within the reach.

No fish were observed during electrofishing surveys, and no large macroinvertebrates (kōura or kākahi) were recorded. Macroinvertebrate communities included both pollution-tolerant and pollution-sensitive taxa, including the swimming mayfly Oniscigaster and the green stonefly (Stenoperla), both of which are sensitive to environmental disturbance.

Riparian vegetation is dominated by dense matagouri, with some exotic species present. However, channel incision reduces connectivity between the stream and the floodplain.

Photo 5. Stream bed condition within Rise and Shine Creek

Photo 6. Riparian yard within Rise and Shine Creek.

Together. Shaping Better Places.

Boffa Miskell is a leading New Zealand environmental consultancy with nine offices throughout Aotearoa. We work with a wide range of local, international private and public sector clients in the areas of planning, urban design, landscape architecture, landscape planning, ecology, biosecurity, Te Hīhiri (cultural advisory), engagement, transport advisory, climate change, graphics, and mapping. Over the past five decades we have built a reputation for creativity, professionalism, innovation, and excellence by understanding each project's interconnections with the wider environmental, social, cultural, and economic context.

www.boffamiskell.co.nz

Whangarei	Auckland	Hamilton	Tauranga	Wellington	Nelson	Christchurch	Queenstown	Dunedin
09 358 2526	09 358 2526	07 960 0006	07 571 5511	04 385 9315	03 548 8551	03 366 8891	03 441 1670	03 470 0460