Item 2: Draft Te Kararo Queenstown Gardens Tree Succession Plan

SESSION TYPE: Workshop

PURPOSE/DESIRED OUTCOME:

To provide the Community & Services Committee with an overview of the Draft Te Kararo Queenstown Gardens Tree Succession Plan and seek input from Councillors on the plan.

The draft succession plan will be shared with the Queenstown Gardens stakeholders and wider community for feedback, before being presented to the Community & Services Committee for adoption in August 2025.

DATE/TIME:

Thursday, 3 April 2025 at 11.30AM

TIME BREAKDOWN:

Presentation: 20 mins
Questions and discussion: 25 mins

Prepared by:

Name: Briana Pringle
Title: Parks Planning Manager
18 March 2025

Reviewed and Authorised by:

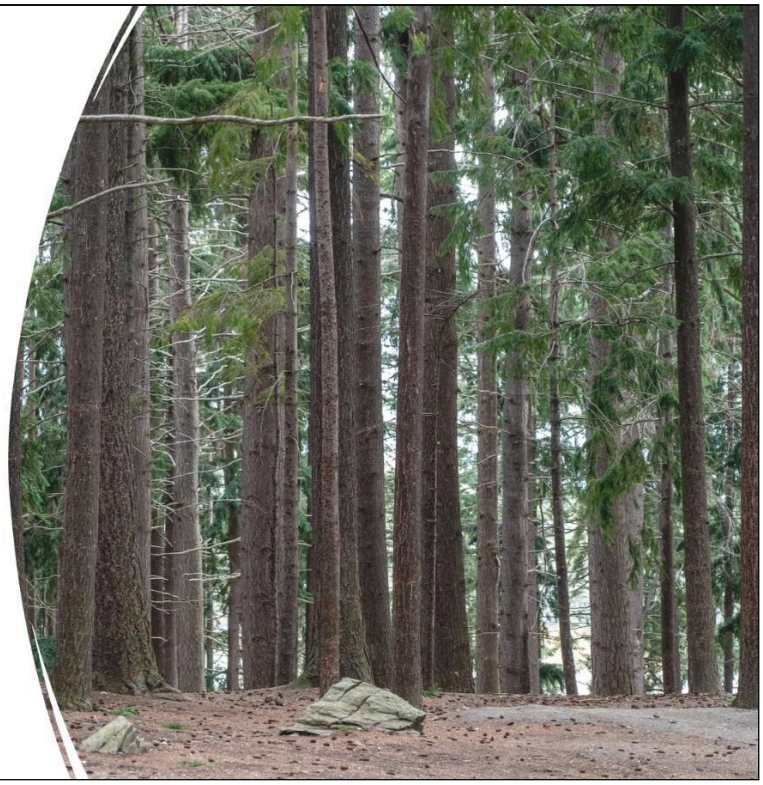
Name: Kenneth Bailey
Title: General Manager Community Services
26 March 2025

ATTACHMENTS:

A	Presentation – Draft Te Kararo Queenstown Gardens Tree Succession Plan
B	Te Kararo Queenstown Gardens Conifer Succession Plan - December 2024 – DRAFT

Te Kararo Queenstown Gardens

Tree Succession Plan



Why are we doing this?

Te Kararo Queenstown Gardens is a cherished public space. The Gardens offer a peaceful environment while preserving a large array of plant life

While the conifer-dominated landscape has protected the Gardens, these conifers are now considered an invasive species and dominating feature of the Gardens

The Queenstown Gardens Reserve Management Plan requires the development of a tree succession plan for the gradual replacement of the Douglas fir within the Gardens

Engagement:

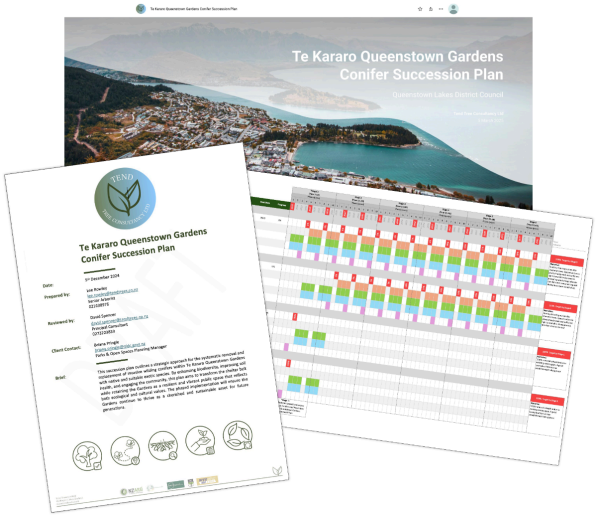
- We have shared the plan with the Friends of the Wakatipu Gardens (FOG).

Next Steps:

April	Draft plan shared with the Community and Services Committee at a public workshop. *April 3rd*
April – May	Draft plan shared with the Queenstown Gardens stakeholders and wider community for feedback. *14th April – 12th May*
April	Public stakeholder workshops to answer questions about the plan. *12pm 16th & 6pm 18th April*
August	Draft Te Kararo Queenstown Gardens Tree Succession Plan will be presented to the Community and Services Committee for adoption

~60-80 Years of Succession

Report Framework



Canopy Framework

LiDar Assessment

Canopy Structure & Profile

Invasive Conifers

33% Coverage

Predominantly Douglas Fir

Tallest trees up to 54m

Age ~120yr

Benefits

Provide shelter for park users & activities

Protects internal trees & plant

Provides habitat & shelter

Creates a micro-climate

Sequesters Carbon

Specimen Conifers, i.e. 5 Sisters, Ponderosa Pines

Without this shelter, the Gardens wouldn't be what it is today

Zoning

Allows for smaller focus areas

Zones are based on observations:

- LiDar Assessment
- Canopy Gaps/Edge Trees
- Adaptive Growth

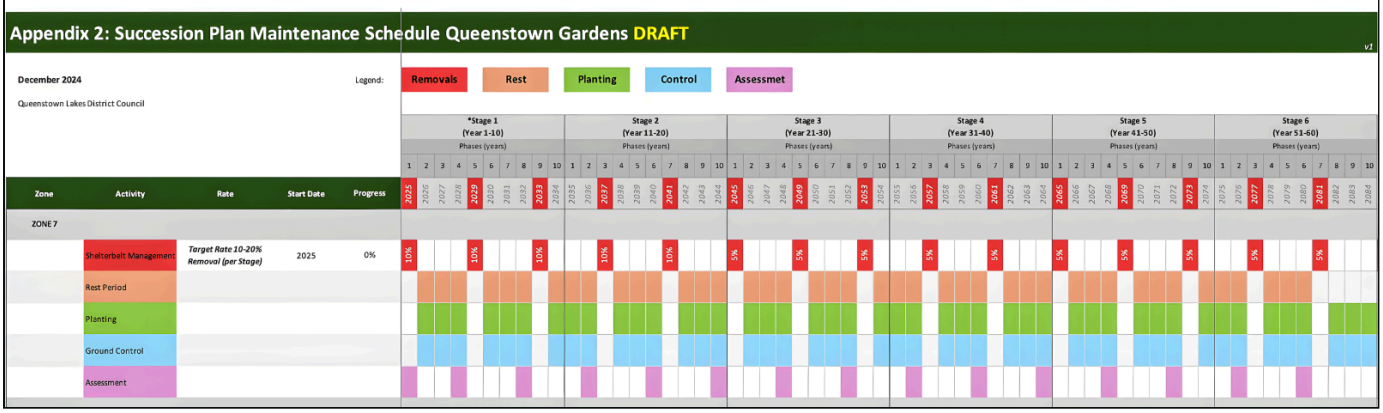
What is Adaptive Growth?

How trees adjust their growth & development in response to varying environmental conditions

LINZ, Stats NZ, Esri, TomTom, Garmin, METI/NASA, U… Powered by Esri

Maintenance Schedule Framework

	Stage 1 (Years 1-10)										Stage 2 (Years 11-20) *etc...*									
	Phases (years)										Phases (years) *etc...*									
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
ZONE 1																				
ZONE 2																				
ZONE 3 *etc..*																				



Succession Planting

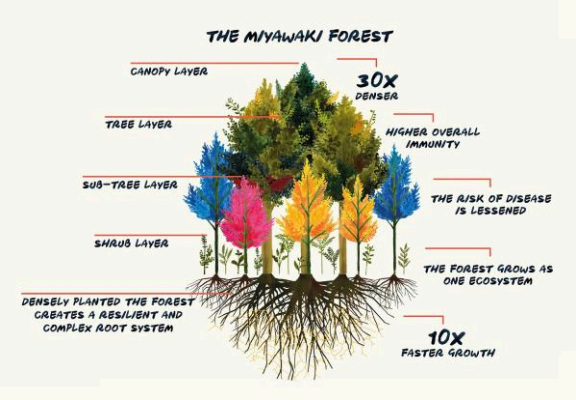
Planting

Planting Methodologies

Mixed Native & Exotic Species Selection:

- 40 Native Trees & Large Shrubs
- 18 Suitable Conifer & Deciduous Trees

Replace vertical structure with Suitable Conifers



Soil

The key to success is **healthy soil**

Soil amendments & conditioning *(site prep, mulching, compost, irrigation, water retention, nutrients)*

Initial Focus (Years 1-5)

No budget in 2024 LTP

Zone 1 *(40% thin)*
Zone 3 *(100% Removal)*

Individual Conifers

Focal Areas Zone 2 & 4
(as per the Development Plan)

Proposed Operational Access Trails

Start planting season after removals

Questions?

Te Kararo Queenstown Gardens Conifer Succession Plan

Date: 5th December 2024

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Brief: This succession plan outlines a strategic approach for the systematic removal and replacement of invasive wilding conifers within Te Kararo Queenstown Gardens with native and suitable exotic species. By enhancing biodiversity, improving soil health, and engaging the community, this plan aims to transform the shelter belt while retaining the Gardens as a resilient and vibrant public space that reflects both ecological and cultural values. The phased implementation will ensure the Gardens continue to thrive as a cherished and sustainable asset for future generations.

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1. Introduction

The establishment of conifers around the peninsula of Te Kararo Queenstown Gardens has served a functional purpose, acting as a windbreak that provided critical shelter for planted amenity trees and supported the establishment of the Gardens as a valued public space. This wind shelter allowed the successful growth of diverse tree species within the Gardens, contributing to the early landscape development. However, over time, these conifers have become an invasive and dominating feature of the Gardens, and their advancing age requires careful management and transition to a more sustainable and ecologically diverse shelterbelt.

Current Role of the Conifer Plantation

The conifer plantation covers approximately 5 hectares, about 33% of the Gardens total 15 hectares (152,400 m²). The conifer trees serve as a windbreak, sheltering other trees and providing a more comfortable environment for recreational activities within the Gardens. This protective function is critical in maintaining the usability of the Gardens, particularly in exposed areas where strong winds can deter visitors and damage other vegetation.

The mature conifer plantation is estimated to sequester approximately 51 metric tonnes of CO_2 per year[1]. Although beneficial, this contribution to carbon capture does not offset the long-term ecological damage caused by these invasive species.

Ecological Impact of Invasive Conifers

The spread of wilding conifers within the Queenstown Lakes District has led to significant ecological imbalances through soil degradation, biodiversity loss and seed spread risks. The dense canopy of these trees blocks sunlight, suppresses understory growth and disrupts natural regeneration processes, significantly reducing native flora and fauna. Their needle litter contributes to soil acidification and reduces nutrient availability, resulting in poor soil health that challenges the establishment of other plant species. Additionally, the monoculture created by these conifers increases fire risk, posing further environmental threats.

Seed sources, such as the protruding peninsula of Te Kararo Queenstown Gardens, enable the spread of wilding species into surrounding natural areas, compounding the ecological challenges and threatening local ecosystems. Previous conifer control measures within Te Kararo Queenstown Gardens have been inconsistent and reactive, lacking a comprehensive strategy to systematically remove and replace these invasive species.

[1] based on an assumed density of 500 trees per hectare and an average sequestration rate of 20 kilograms of CO_2 per tree annually

Purpose of the Succession Plan

The primary purpose of this succession plan is to provide a clear, actionable framework for the systematic removal of invasive conifers from Te Kararo Queenstown Gardens and their replacement with suitable species. The plan outlines specific actions, timelines, responsibilities and resources required to achieve project goals over the coming decades.

A strategic approach involving Zones, Stages and Phases has been developed to gradually remove conifers and reintroduce a diverse range of plant species to enhance the Gardens' ecological resilience. By replanting with a mix of native and suitable exotic species, the plan aims to restore ecological balance, improve soil health and create a sustainable landscape that provides aesthetic, recreational and cultural benefits.

This succession plan is aligned with regional and national strategies, such as the New Zealand Wilding Conifer Management Strategy and the Queenstown Gardens Reserve Management Plan (2011), both of which advocate for the removal of invasive conifers to protect ecosystems. Additionally, the plan supports the broader environmental goals of Queenstown Lakes District Council (QLDC), including enhancing public spaces and ensuring the sustainable management of natural resources for future generations.

Importantly, the plan recognises the need for a gradual, carefully managed removal process to mitigate the risks associated with sudden wind load changes, ensuring that the overall landscape and the framework of highly valued tree assets within the Gardens remain stable throughout the transition.

Immediate Need for Action

Immediate action is required to prevent further ecological degradation and restore Te Kararo Queenstown Gardens to a more natural and resilient state. The invasive conifers are damaging the Gardens' current landscape and threatening the broader ecological integrity of the region.

The phased approach detailed in this succession plan spans several decades, making timely action crucial. Delaying the start will exacerbate the existing issues and heighten risks to garden visitors as the maturing conifer trees approach the end of their Safe Useful Life.

2. Key Challenges

Gradual vs. Large-Scale Removal Approaches

One of the primary challenges facing the succession plan is balancing the need for conifer removal with the potential impacts on the Gardens' existing trees and public safety. Large-scale removal poses risks, such as sudden changes in wind dynamics, which can destabilise remaining trees and expose them to damage. While trees naturally adapt their structure to withstand wind over time, through a process called thigmomorphogenesis[2], sudden exposure to increased wind can result in branch or complete tree failure. A gradual, staged approach mitigates these risks by allowing trees and landscapes to adapt over time while transitioning to a more diverse shelterbelt canopy.

The staged removal approach also helps manage water retention, as trees play a crucial role in intercepting rainfall through their canopies. This slows down the rate of rainfall, allowing water to gradually infiltrate the soil and reduce the risk of soil erosion and surface flooding. When large numbers of trees are removed all at once, this natural water interception is lost, leading to increased surface runoff, potentially overwhelming stormwater systems. Furthermore, removing many trees, particularly those providing wind protection, may temporarily affect the gardens' usability.

Planting Conditions and Soil Challenge

The monoculture established by the conifers has significantly impacted biodiversity, the dense canopy restricts understory growth and contributes to soil degradation, leading to poor soil structure, nutrient deficiencies and increased soil acidity from needle litter. These factors present a challenge for the establishment of new trees and the reintroduction of diverse plant species.

Compacted, nutrient-poor soils need significant enhancement through the application of organic amendments, such as compost, mulch or biochar, to improve soil quality. These interventions will help restore soil structure, boost microbial activity and increase nutrient availability.

Reinvasion Risks

The Gardens' location on a peninsula, coupled with its conifer seed source, increases the risk of reinvasion both within the Gardens and into surrounding natural areas. Conifer seeds can travel significant distances, spreading rapidly and undermining control efforts. Continuous monitoring of the Gardens will be essential to identify new seedling growth quickly.

Public Perception

Managing public perception of the succession plan is essential, particularly when visible changes, such as extensive tree removals are taking place. The public may have emotional or cultural connections to the existing landscape, so communicating the project's long-term benefits is important.

Funding and Resource Limitations

Securing sustainable funding is vital for the continued implementation of the succession plan. The project's long-term nature, with removal and replanting occurring over multiple decades, requires consistent financial resources.

[2] the response of plant cells to mechanical stimulation. For example, the thigmomorphogenetic response of trees in windy environments is to grow shorter, with thicker trunks and stronger roots.

3. Succession Plan Outline

The succession plan prioritises the systematic removal and thinning of invasive conifers from Te Kararo Queenstown Gardens through a structured approach involving distinct **Zones**, **Stages**, and **Phases**. This gradual approach ensures that wind protection for amenity and heritage trees within the Gardens and public safety is carefully managed, mitigating the risks associated with increased wind exposure.

A key focus of the plan is to reintroduce a diverse mix of native and exotic species to enhance biodiversity and create a more resilient, ecologically balanced landscape. Additionally, tall-growing, non-invasive conifers will be strategically planted to preserve the crucial windbreak function currently provided by the existing invasive conifer stands. The wind shelter properties of the existing conifers, particularly the edge trees, will be leveraged to protect and support the establishment of new plantings during the transition.

Continuous monitoring of wind impacts, tree health, stability and the establishment of new plantings will guide adaptive management decisions. Ongoing assessments will inform necessary adjustments to both removal and planting strategies as required, ensuring the plan remains flexible and responsive to evolving conditions.

Zoning, Stages and Phases

Using LiDAR mapping and site assessments the conifer removal strategy has been divided into 12 distinct **Zones** based on existing canopy gaps, groupings and their role in providing wind protection. Each Zone is then assigned **Stages** and **Phases** to determine the sequence of removal and replanting efforts.

Each Stage represents a ten-year cycle, while each Phase corresponds to one year. This structured approach allows for gradual, manageable progress and monitoring and reassessment. The table below shows the **Zone**, **Stage** and **Phasing** structure used to form the Maintenance Schedule. The overlay map, *Figure 1* shows the 12 Zoning areas:

Table 1: Succession Plan Maintenance Schedule

	Stage 1 (Years 1-10)										Stage 2 (Years 11-20) *etc...*									
	Phases (years)										Phases (years) *etc...*									
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
ZONE 1																				
ZONE 2																				
ZONE 3 *etc..*																				

Figure 1: Zoning Overview

The detailed maintenance schedule, including specific removal and replanting timelines, can be found in ***Appendix 2 – Succession Plan Maintenance Schedule***. This schedule outlines key milestones and indicative dates, with initial removals planned to begin in 2025 and extend over a 60-year period, concluding in the late 2080's.

While the proposed timeline is flexible and can be adjusted to accommodate budgetary constraints or other considerations, the overall structure of the schedule should be adhered to. This phased approach allows sufficient time for newly planted shelter species to establish and mature, ensuring that replacement trees provide adequate cover before subsequent removals.

By staggering activities across multiple zones, the Gardens will maintain a continuous flow of operations. This approach ensures that as trees in one Zone adapt to increased wind exposure, work can progress in other areas, balancing the landscape's transition.

The 60-year timeframe is considered the minimum duration required to balance the removal of invasive conifers and the establishment of an effective replacement shelter. Accelerating the process could compromise the Gardens' ability to maintain windbreak functions and damage the internal framework of trees within the Gardens.

Activity by Zone

Each Zone will undergo a structured sequence of activities designed to manage conifer removal, replanting and long-term management. Description of activities are identified in the following table:

Table 2: Maintenance Schedule Activities

Activity	Description	Timeline	Key Activities	Monitoring & Evaluation
Shelterbelt Management	Systematically thin out shelterbelt wilding conifers in phases to reduce wind load gradually.	Start 2025. Estimated duration: 50-80 years.	Select trees for thinning; leave some to acclimate to new wind exposure; ensure safe public access during operations.	Inspect trees for wind damage; adjust thinning strategy if needed; monitor soil erosion; reevaluate shelterbelt effectiveness.
Rest Period	Pause operations to allow remaining trees to adapt to new conditions.	Minimum three years rest between removal phases.	Minimal intervention; inspect tree health regularly.	Record tree health; plan for the next removal phase based on tree response.
Planting	Introduce native and exotic species in cleared areas, ensuring suitability to local conditions.	During rest periods.	Prepare soil; plant tree species; install protective measures for young plants.	Monitor plant growth; replace failed plants; evaluate the success of species establishment.
Ground Control	Regularly manage and remove new wilding seedlings; maintain newly planted areas.	During rest periods.	Identify and remove new seedlings; inspect plant health; manage invasive species.	Track seedling recurrence; evaluate the success of new tree plantings; adjust management as needed.
Assessment/Monitoring	Evaluate overall success and plan next phase removal and long-term maintenance.	Prior to each removal phase.	Conduct comprehensive reviews; plan for ongoing maintenance.	Document long-term outcomes; adjust management strategies based on data and feedback.

Initial Focus and Early Stages

The first stage (*Stage 1: Years 1-10*) of the succession plan will focus on critical goals, including establishing Operational Access, Focal Areas and Individual Conifers removals. These early stages are identified on the map below, *Figure 2*.

Operational Access

Operational access trails have been selected based on the natural contours of the land and existing entry points, forming these access trails early will streamline removal and planting operations throughout subsequent Stages. A large portion of tree removals may occur in the early stages to allow for the construction of these access trails.

Focal Areas

Removing trees in these areas will align with the *Te Kararo Queenstown Gardens Development Plan*, creating viewshafts to connect visitors with the surrounding landscape and recreational spaces to relax.

Individual Conifers

Throughout the main Gardens, individual conifers can be removed at any time during the process since their presence does not significantly impact wind dynamics. Arborist crews should carry out the removal in a controlled manner to minimise damage to the surrounding landscape. It is crucial to highlight that only Individual Douglas Fir or low-value/poor-health conifers have been identified for removal in this initial stage. Trees like the 'Five Sisters' and Ponderosa Pines offer substantial amenity value due to their presence in the landscape, and the community may wish to retain certain trees even though they are classified as invasive pest species.

Figure 2: Initial Focus & Early Stages

4. Removal and Control Strategy

Methods of Tree Removal

The removal of conifers within Te Kararo Queenstown Gardens will employ a combination of mechanical felling and arboricultural dismantling. This approach ensures safe and efficient removal while minimising environmental impacts and maintaining public safety.

5.1.1 Mechanical Felling

Conifers will be felled using mechanised equipment in low public use zones where access allows, and large quantities of trees can be removed quickly. Felling will be staged carefully to avoid damaging nearby trees and vegetation.

5.1.2 Arboricultural Dismantling

Arboricultural dismantling will be employed in sensitive zones near high-value trees, public areas, or structures. This method involves manually sectioning trees in a controlled manner, reducing the risk of collateral damage and ensuring precision in constrained spaces.

5.1.3 Materials and Debris

Timber will be removed from the site. Branches will be processed into wood mulch of appropriate grade to assist with replanting efforts. The mulch will either be spread directly around planting areas to enhance soil moisture retention and suppress weeds or left in piles to age before further use. Any excess mulch that exceeds on-site requirements will be transported offsite.

5.1.4 Tree Stumps

In high-visibility or heavily frequented public areas, tree stumps will be either ground down or mechanically removed to improve aesthetics and ensure safe access for both users and equipment. In lower-priority zones, stumps will be cut low to the ground, and planting will be established around them, allowing for natural decomposition over time.

Ground Control

Ongoing efforts after the initial removal will focus on managing regrowth and preventing reinvasion of wilding conifers. Ground crews will conduct regular inspections of replanting zones to identify and promptly remove new seedlings.

Targeted herbicide treatments or manual control methods will be employed to prevent conifer re-establishment. Herbicide applications will be carefully managed to minimise environmental impacts, with applications timed for optimal weather conditions. Regular follow-up treatments will address any regrowth, with the frequency of treatment adjusted based on monitoring results. The goal is to reduce herbicide use over time while maintaining effective control.

Control measures and strategies will be adjusted as needed to ensure the long-term success of restoration efforts. Engaging the community in reinvasion prevention through initiatives and volunteer seedling removal days will provide additional support and increase awareness of the importance of ongoing conifer control.

Timing and Safety Considerations

The timing of removals will be critical to minimise disruption and ensure public safety. Operations will be scheduled during off-peak times, such as early mornings, weekdays, or low-tourism seasons, to reduce impacts on park users and QLDC Field Staff.

Removal activities in the *Succession Plan Maintenance Schedule* have been aligned into four-year cycles. This approach ensures efficient execution of removal operations within designated periods while providing intervals of rest and minimising disruption within the Gardens.

To ensure safety, protocols will include path closures, clear signage, and barriers to restrict public access to active work areas. Protective measures, such as barriers around sensitive vegetation and waterways, will also be in place. Low-impact machinery will be prioritised, and pre-removal assessments will identify and mitigate potential risks or challenges. Regular communication will keep park visitors informed about the schedule and purpose of removal operations.

5. Replanting Strategy

Replanting will commence in the planting season following tree removals and maintain consistency throughout the duration of the project. The primary focus will be on the rapid introduction of new plants and organic matter to enhance soil conditions, create shelter and establish microenvironments that support further ecological restoration. Opportunities for early planting in several zones already exist and have been identified in the *Succession Plan Maintenance Schedule*, it is encouraged to start planting these zones as soon as possible.

Site preparation and replanting will be aligned with optimal seasonal conditions, aiming to plant primarily in Autumn and Spring when the climate is most conducive to successful establishment.

The replanting process typically begins with introducing pioneer species such as grasses, ferns and early colonisers like *Mānuka*. These species are resilient, adaptable to poor soils, and thrive in challenging conditions. They play a crucial role in restoring soil structure, improving nutrient cycling and creating microenvironments supporting other species' growth.

However, given the success of planting at reserves such as Jardine Park, this strategy can be advanced by introducing secondary and taller native tree species, such as *Kōwhai*, *Beech,* and *Southern rātā*. Planting these secondary species concurrently with pioneers will help expedite the development of canopy layers. These trees are specifically chosen for their ability to provide wind shelter, enhance the reserve's visual appeal, and create habitats for wildlife. Carefully selected exotic species will also be planted early in the process.

A critical element of this replanting strategy is establishing new shelter to replace the existing conifer windbreak function. This will be achieved by selecting tall, fast-growing, non-invasive conifer species that will establish shelter early in the process. ***Appendix 3 – Species Selection Guide*** contains a list of potential species. The map below shows how strategic placement of non-invasive conifers could be established to create new functional but less intrusive shelter:

Replanting Strategy (cont.)

Although some early plantings may be affected by subsequent tree removals, strategic planning aims to minimise these impacts. It is essential to recognise that the primary role of early planting is to improve soil conditions and support long-term restoration. Even if trees are damaged or lost during later removal phases, the soil and ecological benefits from the initial plantings remain intact, ensuring continued progress. Where damage is anticipated and unavoidable, lower-value pioneer species should be prioritised over secondary species.

Strategically, some existing conifer groups, particularly those along the lakeshore, will be retained to provide shelter and protection for new plantings until they are fully established. These retained trees will offer essential windbreak support during the early stages of plant establishment.

Native trees thrive when planted in close proximity. Larger trees, such as Beech, tend to dominate areas and will be planted in groups 2-3 meters apart. Shrubs and smaller trees are best spaced around 1 meter apart; Mānuka will be planted in clusters to establish their presence more effectively. For smaller plants, grasses and ground covers, 500-800mm spacing is recommended to ensure quick coverage.

Where possible, new plantings should be eco-sourced, meaning they are naturally found within the Queenstown region and possess local provenance. A comprehensive list of suitable native species, ranging from large trees to understorey vegetation, can be found in ***Appendix 3 – Species Selection Guide***.

Replanting Strategy Summary:

6.1.1 **Initial and Secondary Planting (Early to Mid-Stages)**

Planting will commence immediately after conifer removal in designated zones, incorporating both pioneer and secondary species. Pioneer species, such as *Mānuka, Kānuka*, and selected grasses, will stabilise soil, improve nutrient cycling, and create microenvironments to support restoration efforts. Concurrently, secondary planting will introduce taller native trees, including *Kōwhai, Beech*, and *Southern Rātā*, along with carefully selected exotic species. These secondary trees will contribute vertical structure, accelerate canopy development, and establish shelters to replace the ageing invasive Conifers.

6.1.2 **Final Planting (Later Stages)**

In this phase, the focus will be on filling gaps, introducing additional species to boost habitat value and replacing failed plantings. The aim is to ensure that the restored zones are dense and ecologically diverse, offering the necessary wind protection and fully functioning ecosystems.



Soil Enhancement and Preparation

Improving soil conditions is essential for the successful establishment of new plantings. Applying organic materials such as mulch, compost, biochar and mycorrhizal inoculation will enhance soil structure, improve water retention and increase nutrient availability. These amendments will help neutralise soil acidity caused by conifer needle litter and create a more hospitable environment for new plantings.

Soil conditioning will involve tilling or screefing to break up compacted layers. This process will be followed by incorporating organic matter and applying mulch around plant bases to conserve moisture, suppress weeds, and regulate soil temperature. These practices are essential for improving root establishment and promoting overall plant health.

Soil nutrient levels will be monitored throughout the replanting phases to identify deficiencies. Based on these assessments, targeted applications of fertilisers or additional organic amendments will be made to optimise plant growth conditions. For guidelines and best practices related to soil conditioning and nutrient management, refer to ***Appendix 4—Soil Enhancement Techniques and Best Practices***.

Long-Term Maintenance and Monitoring

Ensuring the success of replanting efforts requires consistent monitoring and adaptive management to respond to challenges as they arise. This adaptive approach ensures that replanting efforts remain resilient and effective, supporting the long-term restoration goals.

Newly planted areas will be inspected regularly to monitor plant health, check for signs of stress or failure and manage invasive species that may compete with new growth. Maintenance will include watering, mulching and replacing any failed plants.

Protective measures, such as tree guards, plant shelters, targeted pest control and public awareness, will safeguard young plants from damage and activities like frisbee golf. Adjustments will be made based on observed impacts to ensure plant survival and success.

Alternative Planting Methodologies

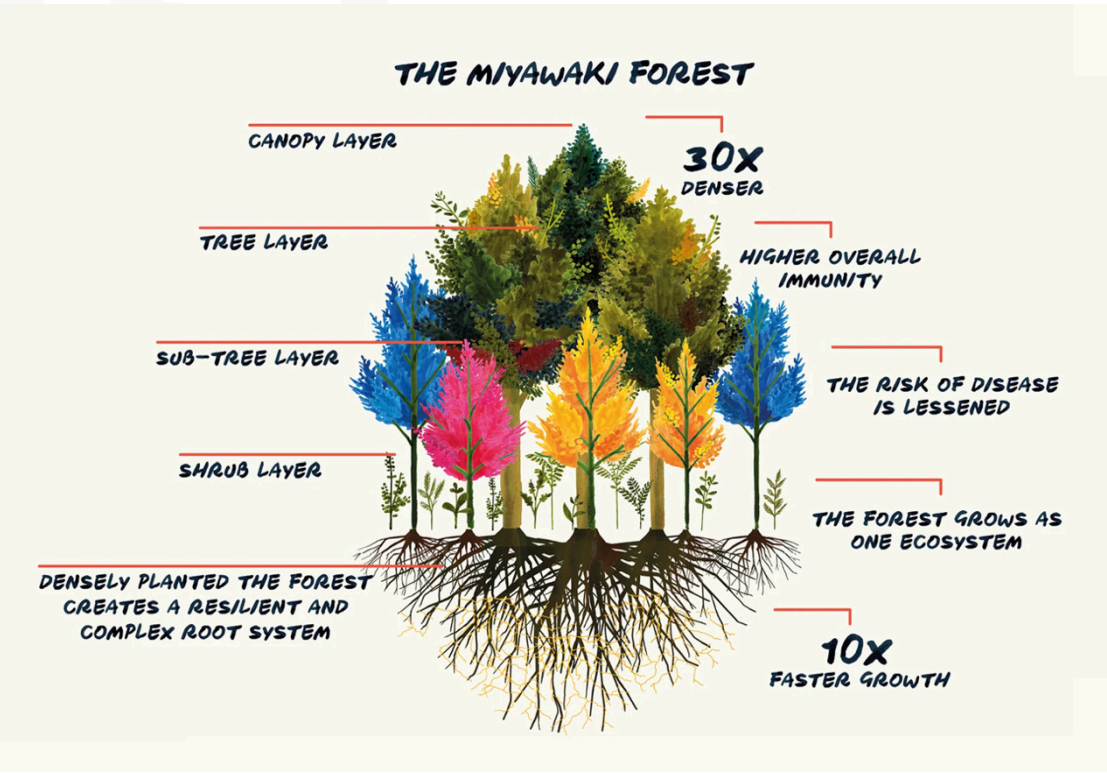
One potential approach to enhance the replanting strategy within the Gardens is the **Miyawaki method**, a technique for creating dense, fast-growing and ecologically resilient forests. This method involves planting native species in close proximity, closely mimicking natural forest regeneration processes.

The Miyawaki method encourages plant growth much faster than traditional planting techniques, with vegetation maturing up to 10 times quicker. This acceleration can significantly reduce the time needed to establish functional shelter and achieve soil restoration.

A critical element of this method is **thorough site preparation**, which involves digging deep and wide pits and enriching the soil with biomass such as compost and biochar before planting. These organic additions enhance soil fertility, promote microbial activity and improve soil structure. By enriching the soil beforehand, the root systems of newly planted species benefit from optimal conditions for rapid growth, efficient water retention and improved nutrient absorption. The close planting means plants grow taller quicker as they compete for available light.

Once established, Miyawaki forests require less maintenance due to their density. The compact planting improves moisture retention, suppresses weed growth and provides resistance to environmental stressors, such as drought, pests or vandalism. This self-sustaining characteristic makes the Miyawaki method a cost-effective and efficient solution when combined with more conventional planting techniques.

The benefits of using the Miyawaki method can be seen in this video by Kent County Council (UK), where they explored techniques to improve tree establishment and survival rates, supporting the expansion of urban tree cover: https://www.youtube.com/watch?v=0VizWfEIW1U



6. Monitoring and Adaptive Management Strategy

The success of the Te Kararo Queenstown Gardens Succession Plan relies on a robust monitoring and adaptive management strategy. This approach ensures flexibility and responsiveness as conditions change throughout the conifer removal, replanting and restoration efforts. Progress will be tracked using technologies like Geographic Information Systems (GIS) and LiDAR, providing critical data to inform decisions about removals and planting.

Key metrics, including tree health, growth rates, soil quality and the effectiveness of conifer control, will inform necessary adjustments to ensure the plan's objectives are met. Wind load impacts will be closely monitored throughout each stage to assess whether more extensive or cautious removal strategies are appropriate.

Regular evaluations, including in-depth assessments every three years, will track biodiversity gains, soil improvements, and the overall success of replanting phases.

Effective communication strategies, such as visual examples and signage, will educate the community about the plan’s ecological benefits. Emphasis will be on the importance of conifer removal for the Gardens’ long-term health and sustainability.

Ongoing stakeholder consultation will ensure the plan reflects community values and responds to public feedback. By involving stakeholders in the decision-making process, the project can build a broad base of support that helps drive its success, fostering a sense of ownership and stewardship within the community.

7. Conclusion and Recommendations

The succession plan for Te Kararo Queenstown Gardens offers a comprehensive framework for systematically removing invasive conifers and re-establishing native and suitable exotic species.

Success hinges on a well-coordinated approach incorporating thorough planning, robust stakeholder engagement, ongoing monitoring, and adaptive management practices. With effective implementation, the Gardens will evolve into a thriving, biodiverse landscape, reflecting the area's natural beauty and cultural significance, leaving a lasting legacy by safeguarding the Gardens for future generations.

Expected Outcomes

7.1.1 Restoration of Biodiversity

The systematic removal of conifers will facilitate the re-establishment of native plant species, enhance habitat for local fauna, and promote biodiversity. This will create a more balanced and thriving ecosystem aligned with regional conservation goals. To complement the restoration, select exotic species will also be introduced to maintain diversity and colour and continue the botanical theme within the Gardens' existing character.

7.1.2 Improved Soil Health and Landscape Function

Soil enhancement measures will rehabilitate the degraded soil conditions caused by decades of conifer dominance. Improved soil health will support the successful establishment of new plantings and contribute to a more resilient landscape.

7.1.3 Enhanced Recreational and Aesthetic Value

The transformation of the Gardens will improve their visual appeal, providing a more diverse and dynamic landscape that enhances the visitor experience. New plantings will create further seasonal interest, enhance the aesthetic appeal and provide natural windbreaks that will protect the Gardens, its heritage trees and other key amenities.

7.1.4 Strengthened Community Engagement and Stewardship

The project will foster a sense of ownership and stewardship by involving the community and key stakeholders. This inclusive approach will ensure that the Gardens remain a cherished public asset that reflects community values and priorities.

7.1.5 Adaptive Management for Long-Term Success

Ongoing monitoring and adaptive management will ensure the plan remains responsive to new challenges and opportunities. This approach will allow for continuous refinement of management practices, ensuring that the Gardens are resilient to changing environmental conditions and can thrive well into the future.

Key Recommendations for Plan Implementation

7.2.1 Secure Funding for Long-Term Implementation

The plan's success depends on securing sustainable funding sources. It is recommended that QLDC pursue a multifaceted approach to funding, including government grants, local fundraising initiatives, and partnerships with businesses and community organisations. Contingency plans should be established to address potential funding gaps, ensuring continuous progress.

7.2.2 Plan for Long-Term Maintenance and Adaptive Management

To ensure the Gardens' transformation is sustainable, long-term maintenance plans must be established, with adaptive management strategies that can respond to changing conditions. A dedicated team should oversee the project, adjusting the plan as needed.

7.2.3 Implement Robust Monitoring and Reporting Mechanisms

Effective monitoring and reporting are essential to tracking progress, measuring success, and guiding management decisions. Monitoring protocols should be established, utilising GIS and LiDAR mapping, site evaluations, and regular stakeholder feedback sessions.

7.2.4 Develop a Public Communication Strategy

A clear and proactive communication strategy should be developed to manage public perception and educate the community on the plan's benefits. This strategy should include regular updates and educational materials that highlight the ecological, cultural, and recreational improvements resulting from the project.

7.2.5 Promote Community Involvement in Planting and Maintenance Activities

Encouraging community participation in planting days and ongoing maintenance activities will enhance public support and contribute valuable volunteer resources. Educational programs that involve schools and youth groups should be considered to inspire the next generation of environmental stewards.

Recommendations for Broader Application and Future Projects

7.3.1 Apply Lessons Learned to Similar Projects in the Region

The insights gained from the Te Kararo Queenstown Gardens succession plan should be documented and shared to guide future restoration projects throughout the Queenstown Lakes District. This unique and complex project will offer valuable lessons, such as the effectiveness of conifer removal and replanting techniques and soil enhancement strategies.

7.3.2 Expansion of the Botanical Gardens

The removal of conifers will create an opportunity to expand the Botanical Gardens into the upper plateau of Zones 5, 7, and 8. Engaging landscape designers early in the project will be key to realising this vision.

7.3.3 Explore Opportunities for Ecological Education

This project provides a unique opportunity to educate the public about native biodiversity, the impacts of invasive species and the importance of sustainable landscape management. Interpretive signage can be developed to showcase the Gardens as a living example of ecological restoration.

8. Appendices

Appendix 1 – StoryMap https://storymaps.arcgis.com/stories/2349d5ec9ba54679ae48e75cab49551e
Appendix 2 - Succession Plan Maintenance Schedule *(Spreadsheet)*
Appendix 3 - Species Selection Guide
Appendix 4 - Soil Enhancement Techniques and Best Practices

References and Supporting Documentation

1. Te Kararo Queenstown Gardens Development Plan
   A comprehensive plan detailing the long-term vision for Te Kararo Queenstown Gardens, including landscape enhancements, historical considerations, and environmental management strategies that align with the goals of the succession plan.

2. Queenstown Gardens Reserve Management Plan 2011
   This document provides the foundational guidelines for managing Te Kararo Queenstown Gardens, including policies on tree management, landscape preservation, and community engagement. It supports the alignment of the succession plan with existing management frameworks.

3. New Zealand Wilding Conifer Management Strategy 2014
   A national strategy that outlines best practices for wilding conifer control across New Zealand, emphasising collaborative approaches, funding mechanisms, and long-term management goals.

Appendix 2: Succession Plan Maintenance Schedule Te Kararo Queenstown Gardens DRAFT

v1

December 2024

Queenstown Lakes District Council

Legend: **Removals** | **Rest** | **Planting** | **Control** | **Assessmet**

Zone	Activity	Rate	Start Date	Progress	*Stage 1 (Year 1-10) Phases (years) 1 2 3 4 5 6 7 8 9 10	Stage 2 (Year 11-20) Phases (years) 1 2 3 4 5 6 7 8 9 10	Stage 3 (Year 21-30) Phases (years) 1 2 3 4 5 6 7 8 9 10	Stage 4 (Year 31-40) Phases (years) 1 2 3 4 5 6 7 8 9 10	Stage 5 (Year 41-50) Phases (years) 1 2 3 4 5 6 7 8 9 10	Stage 6 (Year 51-60) Phases (years) 1 2 3 4 5 6 7 8 9 10	Years indicative
					2025 2026 2027 2028 2029 2030 2031 2032 2033 2034	2035 2036 2037 2038 2039 2040 2041 2042 2043 2044	2045 2046 2047 2048 2049 2050 2051 2052 2053 2054	2055 2056 2057 2058 2059 2060 2061 2062 2063 2064	2065 2066 2067 2068 2069 2070 2071 2072 2073 2074	2075 2076 2077 2078 2079 2080 2081 2082 2083 2084	
ZONE 1											
	Shelterbelt Management	***Target Rate 40% Removal (First Stage)***	2025	0%	20% 20% 20%	40%					100% Target by Stage 2
	Rest Period										**Narrative**: Start on the upper bank, beside the skate park and work back towards the lake, retaining lakeside trees for planting establishment. Consider height reductions as necessary based on windy dynamic assessments.
	Planting										
	Ground Control										
	Assessment										
ZONE 2											
	Shelterbelt Management	***Target Rate 80% Removal (First Stage)***	2029	0%	40% 40%	20%					100% Target by Stage 2
	Rest Period										**Narrative**: Opportunity to plant now. Thining smaller diameter trees in the first instances. Consider height reductions as necessary based on windy dynamic assessments.
	Planting										
	Ground Control										
	Assessment										
ZONE 3											
	Shelterbelt Management	***Rate 100% Removal***	2025	0%	100%						100% Target by Stage 1
	Rest Period										**Narrative:** Complete removal, with select removal of exposed trees in Zone 4.
	Planting										
	Ground Control										
	Assessment										
ZONE 4											
	Shelterbelt Management	***Target Rate 25-45% Removal (per Stage)***	2029	0%	10% 5%	10% 15%	15% 20% 25%				100% Target by Stage 3
	Rest Period										**Narrative**: Early stages to establish access road and removal for Focal Area. Retain portions of lakeside trees for planting establishment shelter
	Planting										
	Ground Control										
	Assessment										

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Zone	Activity	Rate	Start Date	Progress	*Stage 1 (Year 1-10) Phases (years) 1 2 3 4 5 6 7 8 9 10	Stage 2 (Year 11-20) Phases (years) 1 2 3 4 5 6 7 8 9 10	Stage 3 (Year 21-30) Phases (years) 1 2 3 4 5 6 7 8 9 10	Stage 4 (Year 31-40) Phases (years) 1 2 3 4 5 6 7 8 9 10	Stage 5 (Year 41-50) Phases (years) 1 2 3 4 5 6 7 8 9 10	Stage 6 (Year 51-60) Phases (years) 1 2 3 4 5 6 7 8 9 10	
					2025 2026 2027 2028 2029 2030 2031 2032 2033 2034	2035 2036 2037 2038 2039 2040 2041 2042 2043 2044	2045 2046 2047 2048 2049 2050 2051 2052 2053 2054	2055 2056 2057 2058 2059 2060 2061 2062 2063 2064	2065 2066 2067 2068 2069 2070 2071 2072 2073 2074	2075 2076 2077 2078 2079 2080 2081 2082 2083 2084	*Years indicative*
ZONE 5											
	Shelterbelt Management	***Target Rate 20-30% Removal (per Stage)***	2029	0%	10% 5%	10% 5%	10% 5% 10%	15% 15%	15%		100% Target by Stage 5
	Rest Period										**Narrative**: This Zone has the tallest trees within the shelter belt. Start by establishing the access road and thinning the tallest trees closest to the Gardens, focusing on the gradual removal of vertical structure.
	Planting										
	Ground Control										
	Assessment										
ZONE 6											
	Shelterbelt Management	***Target Rate 15-20% Removal (per Stage)***	2029	0%	10% 5%	10% 5%	10% 5% 10%	5% 10%	5% 10% 5%	5% 5% 5%	100% Target by Stage 6
	Rest Period										**Narrative**: Early stages to establish access road and removal of groups to establish ligthwells. Retain portions of lakeside trees for planting establishment shelter
	Planting										
	Ground Control										
	Assessment										
ZONE 7											
	Shelterbelt Management	***Target Rate 10-20% Removal (per Stage)***	2025	0%	10% 10% 10%	10% 10%	5% 5% 5%	5% 5%	5% 5% 5%	5% 5% 5%	100% Target by Stage 6
	Rest Period										**Narrative**: Early stages to establish access roads and focal area. Gradually thin & remove from the Garden out towards the Lake. Retain portions of lakeside trees for planting establishment shelter. Some opportunities to plant now exist
	Planting										
	Ground Control										
	Assessment										
ZONE 8											
	Shelterbelt Management	***Target Rate 10-15% Removal (per Stage)***	2029	0%	10% 10%	10% 10%	10% 10% 5%	5% 5%	5% 5% 5%	5% 5% 5%	100% Target by Stage 6
	Rest Period										**Narrative**: Establish access roads and remove smaller diameter trees in the early stages. Retain portions of lakeside trees for planting establishment shelter
	Planting										
	Ground Control										
	Assessment										

Queenstown Lakes District Council

Zone	Activity	Rate	Start Date	Progress	*Stage 1 (Year 1-10) Phases (years) 1 2 3 4 5 6 7 8 9 10	Stage 2 (Year 11-20) Phases (years) 1 2 3 4 5 6 7 8 9 10	Stage 3 (Year 21-30) Phases (years) 1 2 3 4 5 6 7 8 9 10	Stage 4 (Year 31-40) Phases (years) 1 2 3 4 5 6 7 8 9 10	Stage 5 (Year 41-50) Phases (years) 1 2 3 4 5 6 7 8 9 10	Stage 6 (Year 51-60) Phases (years) 1 2 3 4 5 6 7 8 9 10	Years indicative
					2025 2026 2027 2028 2029 2030 2031 2032 2033 2034	2035 2036 2037 2038 2039 2040 2041 2042 2043 2044	2045 2046 2047 2048 2049 2050 2051 2052 2053 2054	2055 2056 2057 2058 2059 2060 2061 2062 2063 2064	2065 2066 2067 2068 2069 2070 2071 2072 2073 2074	2075 2076 2077 2078 2079 2080 2081 2082 2083 2084	
ZONE 9											
	Shelterbelt Management	***Target Rate 10-15% Removal (per Stage)***	2029	0%	5% 5%	5% 5%	5% 5% 5%	5% 10%	10% 10% 10%	10% 10%	100% Target by Stage 6
	Rest Period										**Narrative**: Start by thinning out smaller diameter trees. Opportunities to plant already exist and sufficient light is available. Exposed to prevailing winds, keep lakeside Conifers until new planting and shelter have been established.
	Planting										
	Ground Control										
	Assessment										
ZONE 10											
	Shelterbelt Management	***Target Rate 10-20% Removal (per Stage)***	2037	0%	5% 5%	5% 5% 10%	10% 10%	10% 10%	10% 10% 10%	10% 10%	100% Target by Stage 6
	Rest Period										**Narrative**: Start by thinning out smaller diameter trees. Opportunities to plant already exist and sufficient light is available. Steep ground, monitor erosion control
	Planting										
	Ground Control										
	Assessment										
ZONE 11											
	Shelterbelt Management	***Rate 100% Removal***	2029	0%	100%						100% Target by Stage 1
	Rest Period										**Narrative**: 100% removal is feasible due to existing canopy gaps. A good example of Native tree establishment taking place
	Planting										
	Ground Control										
	Assessment										
ZONE 12											
	Shelterbelt Management	***Rate 100% Removal***	2029	0%	100%						100% Target by Stage 1
	Rest Period										**Narrative**: 100% removal is feasible due to existing canopy gaps. A good example of Native tree establishment taking place
	Planting										
	Ground Control										
	Assessment										

***Stage 1**:
Priortise removals for operational access roads, Individual Conifers and Focal Area identified in Queenstown Gardens Development Plan

Appendix 3 -Species Selection Guide

A comprehensive guide to the native and suitable exotic species that will be used in replanting efforts, including information on their ecological roles, growth characteristics, and suitability for different conditions within Te Kararo Queenstown Gardens. Including a complete list of native species from *Growing Native Plants in the Wakatipu* by Wakatipu Reforestation Trust.

Species	Type	Ecological Role	Growth Characteristics	Suitability
Pioneer Species				
Leptospermum scoparium (Mānuka)	Native	Improves soil conditions and supports the establishment of other plants	Grows 5-6m; tolerant of poor soils and drought	Ideal for initial restoration phases due to its hardiness
Kunzea ericoides (Kānuka)	Native	Provides early shelter, creates microenvironments for other species	Grows 10-15m; thrives in dry, low-nutrient soils	Excellent for stabilizing soil and long-term ecological succession
Pittosporum tenuifolium (Kohuhu)	Native	Helps create microclimates for later plantings, stabilises soil	Grows 5-10m; tolerates wind and poor soils	Provides shelter and protection for more delicate species
Coprosma robusta (Karamu)	Native	Improves soil structure and attracts birds with its berries	Grows 5-7m; fast-growing and tolerant of a wide range of conditions	Ideal for fast-growing shelter in exposed or degraded areas
Secondary and Tertiary Species				
Sophora microphylla (Kowhai)	Native	Attracts native birds, provides habitat and visual interest	Grows 10-12m; prefers well-drained soils	Enhances biodiversity and offers medium canopy cover
Metrosideros umbellata (Southern Rata)	Native	Supports native fauna, provides nectar and habitat	Grows 15-20m; suited to moist, cooler climates	Ideal for wetter areas, contributes to canopy formation
Aristotelia serrata (Wineberry/Makomako)	Native	Provides food for native birds with its berries, adds medium canopy cover	Grows 5-10m; prefers moist, well-drained soils	Excellent for forest margins or understory planting; attracts wildlife
Carpodetus serratus (Putaputaweta)	Native	Contributes to biodiversity and habitat creation; tolerates shaded areas	Grows 6-10m; thrives in moist, well-drained soils	Ideal for secondary planting in moist, shady spots
Griselinia littoralis (Kapuka/Broadleaf)	Native	Provides medium canopy cover and habitat for birds	Grows 6-10m; tolerates wind-exposed environments.	Great for filling gaps in the canopy, hardy against wind
Pittosporum eugenioides (Tarata/Lemonwood)	Native	Adds to biodiversity, supports bird life with its fruit, provides dense foliage	Grows 10-15m; prefers well-drained soils	Ideal for wind-exposed areas or as a visual screen in medium shelterbelts
Elaeocarpus hookerianus (Pōkākā)	Native	Provides habitat for birds and insects; improves biodiversity	Grows 10-15m; tolerates a range of conditions from lowland to upland forests	Ideal for damp, semi-shaded areas, particularly effective in mixed native plantings to add structural diversity
Plagianthus regius (Manatu, Lowland Ribbonwood)	Native	Fast-growing; provides early shade and habitat, excellent for soil stabilisation	Grows 10-20m; prefers moist, fertile soils	Ideal for riparian zones or as part of early successional planting in wetter areas; provides quick shelter and habitat for native fauna
Melicytus ramiflorus (Māhoe)	Native	Improves soil conditions, attracts birds with berries, forms a dense canopy	Grows 5-10m; fast-growing	Provides dense cover in sheltered or semi-shaded areas
Exotic Species				
Platanus x acerifolia (London Plane)	Exotic Deciduous	Provides broad canopy cover, aesthetic and structural balance	Grows up to 30m	Ideal for shade and structure in high-use public areas
Tilia x europaea (Lime)	Exotic Deciduous	Adds seasonal interest and shelter	Grows up to 25m	Suitable for aesthetic value and providing valuable shelter
Quercus robur ‘Fastigiata’ (English Oak)	Exotic Deciduous	Provides structural form and wind resistance	Grows up to 20m; fastigiate form	Ideal for exposed areas, offering wind tolerance and visual appeal
Ulmus procera (English Elm)	Exotic Deciduous	Provides wind tolerance and broad canopy	Grows up to 35m	Suitable for large areas where shade and shelter are needed
Fagus sylvatica (European Beech)	Exotic Deciduous	Adds structural diversity and dense shade	Grows 25-30m; slow-growing	Ideal for adding long-term shade and visual structure
Carpinus betulus (European Hornbeam)	Exotic Deciduous	Provides dense hedge and structural shelter	Grows 20-25m; dense foliage	Suitable for structured hedges and windbreaks in urban gardens
Betula utilis (Himalayan Birch)	Exotic Deciduous	Tolerates a range of soils and conditions, provides fast-growing shelter	Grows 15-20m; fast-growing	Ideal for open areas requiring quick canopy cover and soil stabilisation, it does not appear to have an allergenic effect on humans, such as the variety Betula pendula.

Appendix 3 -Species Selection Guide

Species	Type	Ecological Role	Growth Characteristics	Suitability
Native Shelter Species				
Fuscospora cliffortioides (Mountain Beech)	Native	Provides canopy cover and habitat for fauna	Grows 15-20m; prefers well-drained soils	Excellent for exposed, high-altitude areas requiring wind tolerance
Podocarpus totara (Tōtara)	Native	Dense foliage for windbreaks and biodiversity enhancement	Slow-growing; can reach up to 30m	Adaptable, long-lived species for creating strong shelter
Lophozonia menziesii (Tawhai, Silver Beech)	Native	Provides long-term, dense canopy cover, offering excellent protection against wind	Grows 20-30m; thrives in cooler, moist environments, making it highly suitable for shelter planting	Ideal for exposed, moist, or cooler locations where wind shelter is necessary
Fuscospora fusca (Tawhai Raunui, Red Beech)	Native	Contributes to long-term canopy formation and offers dense foliage, which provides excellent wind shelter	Grows 25-35m, making it ideal for tall shelter purposes	Perfect for creating a wind-resistant canopy in exposed areas
Prumnopitys taxifolia (Matai, Black Pine)	Native	Dense, long-lived tree, providing strong windbreak and habitat	Grows 20-25m; slow-growing but creates a durable, dense shelter once mature	Adaptable to various conditions, offering a long-term solution for wind protection, especially in lowland areas
Suitable Exotic Shelter Species				
Metasequoia glyptostroboides (Dawn Redwood)	Exotic Shelter Tree	Fast-growing windbreak species, provides seasonal interest	Grows up to 35m; deciduous	Suitable for creating quick wind protection and adding visual diversity
Sequoiadendron giganteum (Giant Redwood)	Exotic Shelter Tree	Creates iconic, towering landscape features, provides strong wind protection	Grows over 60m; highly wind-tolerant	Ideal for creating iconic and functional shelter in large open areas
Sequoia sempervirens (Coast Redwood)	Exotic Shelter Tree	Provides wind protection, grows rapidly in suitable conditions	Grows 50-70m; very long-lived	Suitable for large spaces where fast-growing, tall windbreaks are needed
Abies grandis (Grand fir)	Exotic Shelter Tree	Strong windbreak species with symmetrical, tall structure	Grows up to 75m	Ideal for large landscape areas requiring dense, tall shelter
Picea abies (Norway Spruce)	Exotic Shelter Tree	Provides dense shelter and is effective at blocking wind	Grows up to 35-55m; prefers cooler climates and well-drained soils, fast-growing	Excellent for areas requiring fast-growing, high shelter, especially in cooler regions
Cedrus deodara (Deodar Cedar)	Exotic Shelter Tree	Fast-growing, evergreen, coniferous tree that provides excellent wind shelter	Grows 40-50m	Ideal for wide open areas requiring strong shelter
Eucalyptus regnans (Mountain Ash)	Exotic Shelter Tree	Rapid growth and dense canopy provide excellent shelter and wind resistance	Grows up to 40-60m, making it one of the tallest shelter species; thrives in moist, well-drained soils	Suitable for areas requiring very tall shelter, especially in moist environments
Cupressus × leylandii (Leyland Cypress)	Exotic Shelter Tree	Provides fast-growing, dense shelter and wind protection	Grows up to 20-30m; very fast-growing and adaptable to a range of soils and climates	Ideal for quick shelterbelt establishment, though may require regular pruning to maintain size and density
Chamaecyparis lawsoniana (Lawson's Cypress)	Exotic Shelter Tree	Creates dense foliage suitable for wind protection and screening	Grows up to 30-50m; prefers well-drained soils and cooler, moist environments	Great for providing a tall, dense windbreak in areas that experience cooler, moist climates
Cupressus macrocarpa (Monterey Cypress)	Exotic Shelter Tree	Fast-growing, tall, and hardy windbreak species	Grows up to 30m	Perfect for exposed windy areas
Cupressus arizonica (Arizona Cypress)	Exotic Shelter Tree	Offers good wind resistance and dense foliage for shelter	Grows up to 15-20m; drought-tolerant, thriving in dry soils and hot climates	Best for dry, arid regions where strong windbreaks are required

Growing Native Plants in the Wakatipu by Wakatipu Reforestation Trust

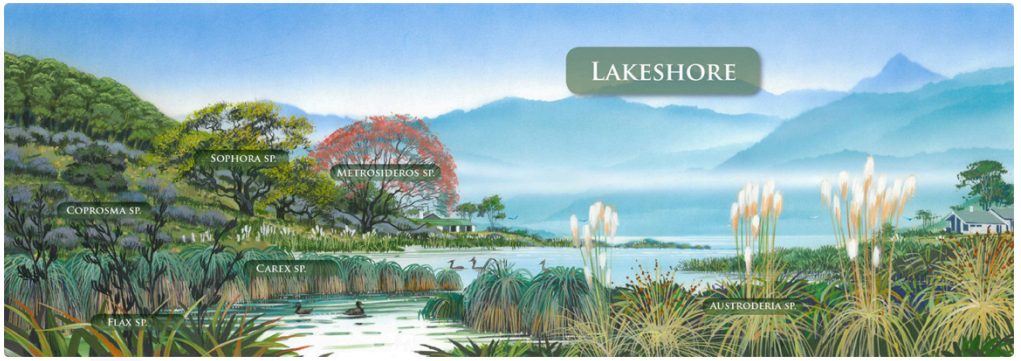
Tall Trees 15m to 25m
Elaeocarpus hookerianus (pōkākā)
Fuscospora cliffortioides (tawhai rauriki, mountain beech)
Fuscospora fusca (tawhai raunui, red beech)
Lophozonia menziesii (tawhai, silver beech)
Plagianthus regius (manatu, lowland ribbonwood)
Prumnopitys taxifolia (matai, black pine)
Metrosideros umbellata (southern rātā)
Podocarpus totara (tōtara)

Medium size trees 8m to 10m
Aristotelia serrata (makomako, wineberry)
Carpodetus serratus (putaputaweta, marble leaf)
Coprosma linariifolia (mikimiki yellow wood)
Cordyline australis (tī kōuka, cabbage tree)
Fuchsia excorticata (kōtukutuku, konini, tree fuchsia)
Griselinia littoralis (kapuka, broadleaf)
Hoheria sexstylosa (houhere, lacebark, ribbonwood)
Melicytus ramiflorus (māhoe, whitey wood)
Pennantia corymbosa (kaikomako)
Pittosporum tenuifolium (kōhūhū)
Sophora microphylla (South Island kōwhai)

Small Trees to large shrubs 4m to 6m	
Coprosma crassifolius	Olearia aviceniifolia
Coprosma, intertexta	Olearia bullata (swamp tree daisy)
Coprosma lucida (karamū)	Olearia fimbriata (robust tree daisy)
Coprosma propinqua (mingimingi, mikimiki)	Olearia lineata (narrow-leaved tree daisy)
Coprosma virescens	Olearia odorata (scented tree daisy)
Corokia cotoneaster (korokia)	Phyllocladus alpinus (mountain toatoa)
Hebe salicifolia (koromiko)	Pseudopanax colensoi var. ternatus (orihou, three finger)
Leptospermum scoparium (mānuka)	Pseudopanax ferox (fierce lancewood)
Lophomyrtus obcordata (rahotu)	Myrsine australis (mapou, red matipo)
Melicope simplex (poataniwha, wharangi)	Myrsine divaricata (weeping mapou)

Small Shrubs
Carmichaelia petriei (native broom)
Coprosmas acerosa & brunnea (dwarf coprosmas)
Hebe biggarii
Hebe buchananii
Hebe hectori (whipchord hebe)
Hebe pimeleoides var. faucicola
Hebe pimeleoides var. pimeleoides
Heliohebe cupressoides
Melicytus alpinus (porcupine shrub)
Muehlenbeckia complexa (scrambling creeper)
Ozothamnus leptophyllus var vauvilliersii
Podocarpus nivalis (snow tōtara)

Flaxes, Ferns, grasses, sedges and other plants
Phormium cookianum (whaririki, mountain flax)
Phormium tenax (harakiki swamp flax)
Astelia fragrans (bush lily)
Austroderia richardii (toi toi)
Chionochloa rigida (narrow-leaved snow tussock)
Festuca novaezelandiae (hard tussock)
Poa colensoi (blue tussock)
Carex buchananii
Carex secta (makura, oio)
Asplenium gracillimum
Blechnum pennamarina
Polystichum vestitum (prickly shield fern)



This appendix outlines the soil enhancement techniques that will be employed throughout the restoration process in Te Kararo Queenstown Gardens, focusing on reversing the negative impacts caused by long-term conifer dominance. Best practices are included for improving soil health, addressing nutrient deficiencies, and preventing soil erosion to support the successful establishment of new plantings.

1.1 Soil Amendments

Amending the soil is a critical step in restoring the fertility and structure needed for successful plant growth. The following guidelines provide recommendations for organic amendments, including compost, mulch, and biochar.

Compost

Timing: Applied during early planting phases to enhance soil structure and moisture retention.
Benefits: Improves aeration, water retention, and nutrient availability, particularly in soils degraded by conifer needle litter.

Compost improves soil structure, increases organic matter, and promotes microbial activity. Application rates should range from 10-20cm in depth, applied across planting zones. Compost should be incorporated into the soil during initial site preparation, especially in areas where soil compaction or low organic content is evident.

Mulch

Timing: Applied after planting to maintain moisture and reduce temperature fluctuations.
Benefits: Helps maintain soil temperature, improves water retention, and protects soil from erosion.

Mulch provides soil insulation, reduces water evaporation, and suppresses weed growth. A layer of mulch (5-10cm deep) should be applied around new plantings but kept clear from the plant stem to prevent rot.

Biochar

Timing: Incorporated into soil during the preparation of planting zones.
Benefits: Increases water-holding capacity, enhances soil microbial diversity, and provides a long-term carbon sink.

Biochar is a long-lasting carbon-rich material that improves nutrient retention and microbial health in soils. It should be mixed with compost at a rate of 5-10% by volume.

1.2 Soil Conditioning

Soil conditioning is an essential part of site preparation for planting, ensuring that the ground is adequately prepared to support root establishment and overall plant health. The following protocols outline the key steps in soil conditioning.

Tilling and Screefing

Tilling: Mechanical tilling will break up compacted layers of soil, enhancing aeration and improving water infiltration.
Screefing: Involves removing the surface cover to expose the soil, allowing for better root penetration and nutrient absorption. This method is particularly useful in areas that have accumulated heavy organic debris or conifer needle litter.

Soil conditioning involves both tilling, which breaks up compacted soil and incorporates organic matter and screefing, which clears surface vegetation or organic debris (needles and cones) to expose the soil. Organic matter such as compost and biochar should be incorporated into the soil during tilling to improve soil structure, nutrient levels and microbial activity. This provides a more favourable environment for plant roots to establish and grow.

1.3 Nutrient Management

Nutrient management is essential to counteract the nutrient depletion caused by years of conifer dominance. The following strategies will support plant establishment by addressing soil nutrient deficiencies:

Slow-Release Fertilisers

Application Rates: Based on soil testing, slow-release fertilisers should be applied at 50-100g per square metre, depending on the species being planted.
Monitoring: Soil nutrient levels should be monitored every 6-12 months to track the progress of soil fertility recovery. Soil samples should be analysed for macronutrients (N, P, K) and micronutrients such as calcium, magnesium, and sulphur.
Corrective Actions: If soil testing reveals deficiencies in key nutrients, targeted amendments such as lime for pH adjustment or organic matter for improving microbial activity should be implemented.

Organic or slow-release fertilisers will be applied to provide essential nutrients gradually over time. Nitrogen, phosphorus, and potassium (NPK) fertilisers should be used based on soil test results, with applications tailored to meet the needs of different species.

Cover Crops

Benefits: Increases organic matter, improves soil structure, and prevents nutrient leaching during periods of soil disturbance.

Planting cover crops such as clover or grasses can improve soil fertility by fixing nitrogen and preventing erosion. These crops should be sown during rest periods between tree removals and replanting phases.

1.4 Watering and Irrigation

Proper watering and irrigation are crucial for the successful establishment of new plantings, particularly in the early stages of restoration. The following strategies ensure optimal moisture levels for plant growth while conserving water resources:

Drip or Irrigation Lines

Timing: Where practical, Drip irrigation systems will be used regularly during the first 2-3 years of establishment, especially during dry periods.
Benefits: Provides targeted watering, reduces water waste, and ensures that young plants receive the moisture they need to establish strong root systems.

Drip irrigation systems will be installed where feasible and existing water supplies exist, delivering water directly to the roots of newly planted species. This method reduces water loss from evaporation and ensures efficient use of water.

Watering Schedule

Timing: Watering should be done early in the morning or late in the afternoon to minimise water loss through evaporation.
Monitoring: Soil moisture sensors can be used to monitor the effectiveness of the watering schedule and prevent overwatering.

A regular watering schedule will be maintained for newly planted trees and shrubs, particularly during the first two growing seasons. Watering should be more frequent during the dry summer months, with adjustments made based on weather patterns and soil moisture levels.

Mulching for Moisture Retention

Benefits: Reduces the frequency of irrigation, improves water retention in the soil, and provides additional protection against temperature fluctuations.

The application of mulch around new planting areas will help retain soil moisture and reduce the need for frequent watering. Organic mulches, such as wood chips, can slow the evaporation of water from the soil.

Water-Saving Measures

Benefits: Minimises water usage while ensuring plant health and resilience in drier areas.

Drought-resistant and native species that are adapted to local moisture conditions will be prioritised for planting in areas with limited water availability. This reduces the need for extensive irrigation and ensures long-term sustainability.

1.5 Erosion Control Measures

Preventing soil erosion is crucial during tree removal and replanting phases. Erosion not only depletes soil nutrients but also damages the landscape, making it difficult for new plantings to establish. The following techniques will ensure soil stability throughout the restoration process:

Temporary Ground Covers

Timing: Applied immediately after tree removal and before new plantings to stabilise the soil surface.
Benefits: Provides temporary protection against erosion while improving soil health through root development.

Planting quick-growing grasses or using biodegradable mats will help stabilise soil during periods of tree removal. These ground covers prevent soil displacement from wind and rain, reducing erosion risks while allowing for future replanting.

Silt Fences and Erosion Barriers

Application: Installed in areas prone to soil displacement or runoff, particularly on slopes or near water bodies.
Benefits: Keeps soil on-site and prevents it from being washed into surrounding areas, thus protecting local ecosystems and water quality.

These barriers should be installed around areas where heavy machinery is used or where soil is likely to be disturbed during removal activities. Silt fences prevent soil runoff into waterways or adjacent areas. Erosion Barriers could consist of felled logs strategically place and backfilled with soil/mulch and planted.

Stabilisation Plantings

Timing: Planted as soon as possible after tree removal to stabilise soil before other species are introduced.
Benefits: Provides long-term erosion control and improves soil structure, ensuring successful establishment of subsequent plantings.

Early-stage pioneer species (e.g., Mānuka, Kānuka) or erosion-resistant grasses should be planted in areas susceptible to soil erosion. These plants are quick to establish and help anchor the soil with their root systems.