GEOG309 Project Report

School of Earth and Environment - University of Canterbury

Establishing Authentic and Representative Indigenous Ecosystems in the Pūharakekenui-Styx River Catchment

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Executive Summary

- This project aims to quantify the current distribution of indigenous vegetation in the Pūharakekenui–Styx River catchment in relation to the Lucas Associates Indigenous Ecosystems and propose barriers and solutions to achieving 10% cover, as required by the 2023 National Policy Statement for Indigenous Biodiversity (NPS-IB).

- Indigenous vegetation is critical for sustaining biodiversity, ecological function, and cultural values in Ōtautahi Christchurch.

- Vector overlay analyses in ArcGIS Pro determined that indigenous vegetation currently covers 7.29% ± 0.16% of the catchment, which is 140 ± 3 hectares short of the 10% cover goal.

- Theory relating to edge effects was used to describe limitations associated with standard 20 m riparian buffers in new developments and recommended wider buffers.

- ArcGIS Pro was used to model varying riparian buffer sizes to quantify the additional coverage wider buffers could add to each indigenous ecosystem.

- Physical characteristics surveying and scenario-based analyses were conducted to identify the best methods to address ecosystems underrepresented by indigenous vegetation cover and increase overall cover in the catchment.

- Potential planting scenarios included combinations of encouraging developers to increase riparian buffer widths, increase indigenous plantings on public parks and reserves, acquiring land for native reserves, and stormwater ponds in new developments.

- An online survey (*n* = 354) distributed via Christchurch Facebook community groups informed potential barriers and solutions to increasing indigenous vegetation cover. The survey revealed strong public support for doing so, and that the major barriers were the cost of plants, growing space, and time.

- Future research is needed to explore rates being utilised to fund indigenous vegetation planting initiatives and establish the authentic and representative Lucas Associate Indigenous Ecosystems.

1.0 Introduction

The Earth lost 1.5 million km² of forest between 2000 and 2012, which is approximately six times the size of New Zealand (Hansen et al., 2013). By 2019, an estimated one million plant and animal species were on track for extinction due to human activity (Tollefson, 2019). The largest global drivers of this land-use change are agricultural and urban expansion, made necessary by the global human population doubling in the last 50 years (Díaz et al., 2019). As the demand for food and housing continues to grow, it is crucial to find sustainable ways to restore vegetation without compromising essential resources. Urban areas present one such opportunity.

New Zealand (NZ) is no exception to green cover loss, having lost roughly three-quarters of its forests since human colonisation (Ewers et al., 2006). Urbanisation has further erased important natural heritage, contributing to the cultural and spiritual disconnection between the Indigenous Māori people and the land (Rodgers et al., 2023). In 2023, the National Policy Statement for Indigenous Biodiversity (NPS-IB) was introduced to provide policymakers with evidence to rebuild NZ's ecosystems (Ministry for the Environment, 2023). Subpart 3.22(a) requires regional councils to aim for at least 10% indigenous vegetation cover in all urban and non-urban environments (Ministry for the Environment, 2023). While *native* vegetation refers to species originating from within a country, *indigenous* vegetation refers to species native to specific ecological districts. The NPS-IB adopts definitions of ecological districts from McEwen (1987), such as the Canterbury low plains, to determine the spatial scale of indigenous vegetation. Many past conservation efforts have focused on planting native rather than the indigenous ecosystems that would not only grow better but rekindle the connection between Māori and their land (Rodgers et al., 2023).

The Pūharakekenui-Styx River is one of three major urban rivers in Ōtautahi Christchurch (Figure 1). The Styx Living Laboratory Trust (hereafter the Trust), a local river care organisation, was established in 2001, and is associated with the Christchurch City Council. The Trust has acquired large parcels of land along the Styx River to create conservation reserves and improve the river's health. To ensure its plantings are authentic and representative of the land before human interference, the Trust draws on planting guides from Lucas Associates (2021). The planting guides were created by analysing remnants of historical vegetation across Christchurch, allowing a city-wide map of indigenous ecosystems to be created (Figure 2) (Lucas Associates, 2021).

The Trust proposed five research questions, broadly aiming to quantify current vegetation cover and investigate how to increase it.

1. What is the current percentage of the Pūharakekenui-Styx River catchment covered with indigenous vegetation?
2. What proportion of each ecosystem is covered with indigenous vegetation?
3. Are some ecosystems significantly less represented than others?
4. What are the most suitable areas to prioritise for future planting to achieve 10% indigenous vegetation coverage across the catchment while ensuring proportional representation across ecosystems?
5. What might be the key barriers to achieving the NPS-IB targets of 10% indigenous vegetation cover, and how might these be overcome?

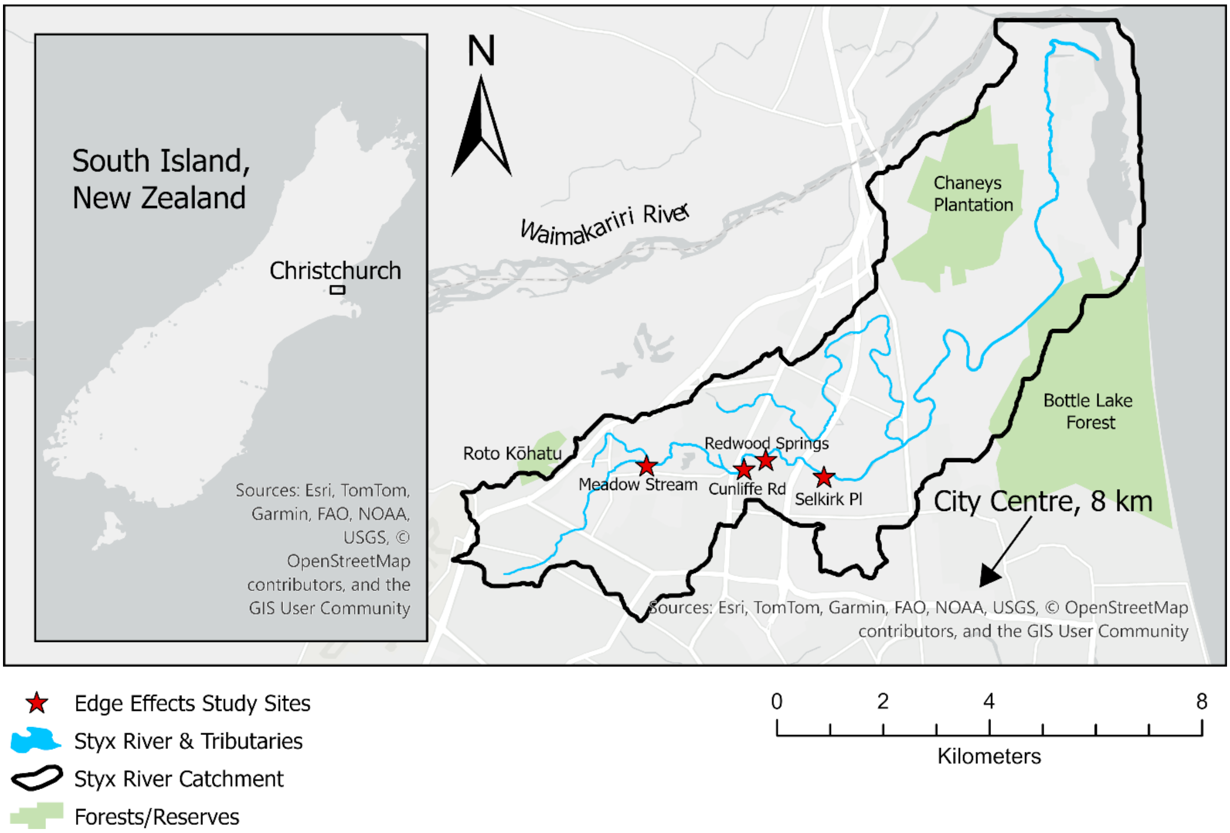

Figure 1: Map of the Pūharakekenui-Styx River catchment study site. Extent of the study site is shown in relation to the South Island of New Zealand. Areas shown where edge effects of riparian planting buffers were studied.

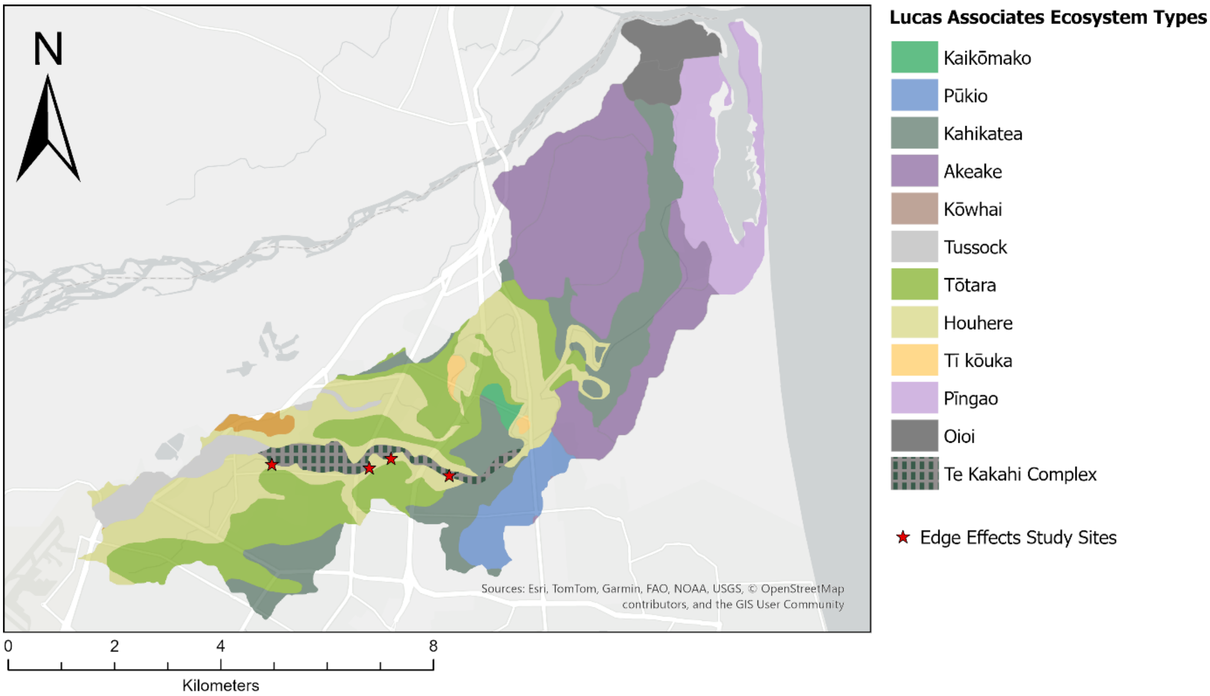

Figure 2: Indigenous ecosystems of the Pūharakekenui-Styx River catchment as defined by Lucas Associates (2021).

2.0 Literature Review

2.1 Ecosystem Services and Indigenous Perspectives

The resilience of human communities is linked to the resilience of local ecosystems (Andersson et al., 2014). Ecosystem services provide human communities with food, seed dispersal, pollination, pest control, and recreation & health (Andersson et al., 2014). Human populations strain ecosystems when environmental limits are approached (Rockström et al., 2009), but engage in stewardship when best practice is modelled (Andersson et al., 2014). Ecosystem service function is correlated with habitat connectivity, and therefore presents the necessity for appropriate planning across urban landscapes (Andersson et al., 2014). Nature-based Solutions (NbS) and Traditional Ecological Knowledge (TEK) both use the ecosystem as a reference for environmental planning (Kiddle et al., 2021). NbS has the same objective as TEK: To respect ecosystem services and increase ecological resilience (Pinto et al., 2025). TEK is grounded in Indigenous perspective, representing knowledge that has been collected over many generations, such as mātauranga Māori. Although it cannot be explicitly defined, mātauranga Māori encompasses oral traditions as guiding principles for sustainable ecological restoration in NZ (Kiddle et al., 2021).

2.2 Policies and Regulations on Indigenous Vegetation in Urban Environments

The National Policy Statement on Urban Development (Ministry for the Environment (2020) encourages higher-density housing and smarter urban growth. When paired with the NPS-IB (Ministry for the Environment, 2023), these policies aim to balance city development with biodiversity protection. The Christchurch District Plan (Christchurch City Council, 2017, p. 71) accompanies this by requiring a 20 m landscape buffer along certain zone boundaries. This buffer must be vegetated, maintained, and kept free of buildings or infrastructure. While the plan doesn't specify indigenous species, planting indigenous species would directly support NPS-IB goals, further enhancing habitat quality, ecological connectivity, and ecological resilience. Varshney et al. (2024) highlight that NZ's planning policies tend to focus on protecting significant native habitats but lack measurable outcomes for improving biodiversity within urban areas. These gaps are particularly relevant to the Styx River catchment, where housing continues to expand near ecologically sensitive zones.

2.3 Barriers

Social, institutional, and economic factors often hinder indigenous vegetation reestablishment in urban and semi urban areas, as residents tend to prioritise function and aesthetics over ecological value (Jay & Stolte, 2011). Fragmented ownership, unclear responsibilities, and disputes between public and private landowners further limit the efficiency and success of restoration projects (Bell-James et al., 2023). Landowners are more likely to invest in native plantings when policies or financial incentives align with their values (Norton et al., 2020; Potter et al., 2023). Building partnerships based on trust and long-term collaboration among councils, landowners, and communities can create co-benefits while enhancing equity and environmental outcomes (Febria et al., 2020; Norton et al., 2020; Schindler, 2025). Although institutional systems and technology provide valuable guidance, restoration success ultimately hinges on human behaviour, compliance, and continued management (McKergow et al., 2016; Meurk & Swaffield, 2000). Visible landscape features such as shelterbelts, riparian zones, verges, and medians offer socially acceptable entry points for native planting (McKergow et al., 2016; Meurk & Swaffield, 2000).

2.4 Riparian Zones and Edge Effects

Riparian zones are areas beside streams that interact with runoff from hillslopes and floodplain overflow (Parkyn, 2004). Vegetation within these zones improves water quality and filtration, provides shade, and stabilises stream banks (Parkyn, 2004). The 20 m riparian buffer required by the Christchurch District Plan (Christchurch City Council, 2017, p. 71) is likely insufficient to sustain riparian ecosystems in the Styx River due to edge effects. Edge effects are changes in resource availability and physical or biological conditions occurring at ecosystem boundaries (Biasotto & Kindel, 2018), identified through visual differences in canopy cover, vegetation, light, temperature, and species abundance across site edges (Norton (2002). An Australian study found that narrow buffers (< 10 m) failed to protect stream ecosystems, whereas wider buffers (> 30 m) provided effective short-term protection across diverse environments (Davies & Nelson, 1994).

3.0 Methods

3.1 Q1 – 3: GIS Methods

To determine the current indigenous coverage of the catchment and each ecosystem (Questions 1-3), a vector overlay analysis was conducted in ArcGIS Pro 3.5 by intersecting ecosystem type and vegetation cover data. Most of the vegetation cover data was provided as polygons by Dr. Antony Shadbolt, the representative of our community partner. Shadbolt included remnant vegetation, areas planted by the Trust, areas planted by the New Zealand Transport Agency Waka Kotahi, and areas that are to be planted within the next five years. The inclusion of the near-future plantings aimed to ensure our research's relevance beyond the near future. A small polygon dataset from Land Information New Zealand (LINZ) was also included (Toitū Te Whenua Land Information New Zealand, 2015). The Lucas Associates ecosystems of Ōtautahi Christchurch were imported from the Christchurch City Council website (Lucas Associates, 2021). Finally, a polygon defining the Styx River catchment was imported from ArcGIS Online (Doscher, 2020). To calculate the indigenous vegetation cover of each ecosystem in the catchment (Question 2) and determine the underrepresented Ecosystems (Question 3), the vegetation data was intersected with the ecosystems. The sum of these values gave the total indigenous vegetation cover of the catchment (Question 1).

3.2 Q4: Edge Effect Methods

The ecological integrity of the Styx River corridor was assessed to determine whether the 20 m minimum landscape buffer (Christchurch City Council, 2017) adequately protects ecological communities from urban development pressures. Edge effects were evaluated by comparing habitat continuity and biodiversity across varying riparian buffer widths and conditions. Four sites (Selkirk Place, Meadow Stream, Cunliffe Road, and Redwood Springs) were examined (Figures 1 and 2). These were selected in consultation with a community partner who emphasised the value of buffers ≥20 m, plus an additional 5 m pathway zone. An Edge Effects Field Data Sheet (Table 2), adapted from ecological monitoring sources and Norton et al. (2020), guided data collection on canopy cover, native vs non-native vegetation, and site observations. Measurements were taken at fixed distances of 0 m and 20 m from the buffer edge, with all quadrats sized 2 × 2 m.

Table 1: Edge effects field data sheet template. 2 m^2 quadrat used.

Site	Quadrat	Canopy cover (%)	Native ground cover (%)	Non-native ground cover (%)	Observations
1					
2					

3.3 Q4: GIS Methods for Scenario Modelling

To identify suitable planting areas (Question 4), a multifaceted approach combining vector overlay and scenario-based analyses was used. Five polygon layers – river channel, riparian buffers (20, 25, 40, and 80 m), urban/road cover, indigenous vegetation, and unplantable areas like beaches – were overlaid to calculate developable land within each buffer size. All layers except vegetation cover were created manually using 2025 satellite imagery. The resulting developable land polygons were intersected with the Lucas Associates (2021) ecosystem map to quantify developable land in each ecosystem for each buffer size.

Digitisation error for each layer was calculated using Equation 1, as described by Carisio (2012, as cited in Ghilani, 2000).

$$Digitisation\ Error = \sqrt{A_i} \times (\Delta p + \Delta u) \times \sqrt{2} \tag{1}$$

A_i is polygon area, p is pixel accuracy of the imagery, and u is user accuracy of vertex placement. Vertex accuracy was determined from the standard deviation of ~50 measurements per layer, recording the horizontal difference between placed and true vertices along clear borders like rivers, lakes, and roads. Pixel accuracy was obtained from the satellite metadata. The Lucas Associates (2021) Ecosystems map had a recommended viewing scale of 1:50,000. LINZ states that their printed 1:50,000 topographic maps have a planimetric accuracy of ±22 metres (Toitū Te Whenua - Land Information New Zealand, 2022). Therefore, the 22 m accuracy was used in place of the pixel and user accuracy for this layer. The error was propagated through intersecting layers using Equation 2.

$$\frac{\delta_z}{z} = \sqrt{\frac{\delta_x}{x} + \frac{\delta_y}{y} + \dots} \tag{2}$$

3.4 Q4: Scenario Modelling Methods

Scenario-modelling, a method used to address uncertainty in ecological restoration to enable flexible, evidence-based decision-making (Metzger et al., 2017; Moore et al., 2022), was utilised to assess methods of increasing indigenous vegetation in the catchment and ensuring equal representation of each ecosystem. We utilised scenario modelling to assess methods of increasing indigenous vegetation in the catchment and equally representing each ecosystem. A 10% quantitative target boundary was set to ensure equal representation for the identified underrepresented Lucas Associates ecosystems. The following land-use scenarios were developed to test pathways for achieving these targets by selecting parameters to reflect practical management options, spatial feasibility, and policy relevance (Metzger et al., 2017):

- Riparian buffer expansion: Buffer widths selection was guided by Christchurch City District Plan guidelines (Christchurch City Council, 2017), community partner recommendations, and edge effect findings.
- Public planting increases**:** Increasing indigenous vegetation planting within public parks, reserves, limited road verges, and stormwater facilities by 1% and 5%. Percentages were selected based on trade-offs between recreation and biodiversity gains.
- Areas of future development: Our community partner suggested a rule of thumb that 10% of urban developments are allocated for stormwater facilities.

- Ecosystem-specific interventions: Land acquisition and vegetation conversion to indigenous vegetation cover within Roto Kōhatu (recreation reserve), Chaneys Plantation, and Bottle Lake Forest (pine forests).

Each scenario was spatially modelled by overlaying the developable land within each riparian buffer size, land ownership (Canterbury Maps, 2025), and ecosystems (Lucas Associates, 2021). Public parks, reserves, limited road verges, and stormwater facilities were manually identified through a systematic visual search using Canterbury Map Viewer satellite data (Canterbury Maps, 2025). An analysis was then performed to calculate the total potential restoration area within each Ecosystem.

3.5 Q5: Survey Methods

To investigate potential barriers to increasing indigenous vegetation cover in the Styx River catchment (Question 5), an online survey was designed using Qualtrics XM, which sampled the Greater Christchurch community. The survey collected perspectives based on three main themes: benefits of native vegetation, barriers to planting, and significance of community planting and native reserves. A mixture of 34 multiple-choice and free-text questions were asked, including 6 demographic questions. Facebook community groups were selected with the aim to achieve a balanced spread of the individual suburbs that constitute Christchurch. Data collection ran for three weeks, and in the final week, we sent it to our friends and family who lived within our area of interest. Chi-square and analysis of variance (ANOVA) tests were run in Qualtrics XM to test for statistical significance.

4.0 Results

4.1 Q1 – 3: GIS Results

The total indigenous vegetation cover in the catchment was 7.29% ± 0.16%, short of the 10% cover goal by 140 ± 3 ha (Table 2). Eight out of twelve ecosystems contained less than 10% indigenous vegetation cover. Kaikōmako was the most underrepresented ecosystem, followed by Pūkio. For every ecosystem to reach 10% cover, 271 ± 6 ha of new plantings would be required.

Table 2: Absolute indigenous vegetation cover, percent cover, and area needed to reach 10% cover for each of the Lucas Associates Indigenous Ecosystems in the Pūharakekenui-Styx River catchment.

Ecosystem	Vegetation cover (ha)	Cover of ecosystem (%)	Area needed for 10% (ha)
Kaikōmako	0.00852 ± 0.00019	0.0323 ± 0.0007	2.63 ± 0.06
Pūkio	0.875 ± 0.02	0.428 ± 0.010	19.6 ± 0.4
Kahikatea	13.5 ± 0.3	1.64 ± 0.04	68.4 ± 1.5
Akeake	34.3 ± 0.8	2.85 ± 0.06	86.3 ± 1.9
Kōwhai	1.31 ± 0.03	3.09 ± 0.07	2.92 ± 0.07
Tussock	5.66 ± 0.13	3.74 ± 0.08	9.47 ± 0.21
Tōtara	33.2 ± 0.7	3.81 ± 0.09	53.8 ± 1.2
Houhere	73.8 ± 1.7	7.28 ± 0.16	27.6 ± 0.6
Tī kōuka	9.06 ± 0.2	14.1 ± 0.3	0
Pīngao	65.7 ± 1.5	14.5 ± 0.3	0
Oioi	69.7 ± 1.6	37.3 ± 0.8	0
Te Kakahi Complex	69.2 ± 1.6	53.8 ± 1.2	0
Total	376 ± 8	7.29 ± 0.16	140 ± 3

4.2 Q4: Edge Effects Results

Edge effects were assessed across four riparian sites in the Styx catchment, varying in buffer width and vegetation establishment. Quadrat data and field observations are summarised below.

4.21 Selkirk Place

Figure 3: Riparian buffer at Selkirk Place study site.

Figure 4: Poor vegetation health/cover on the other side of Selkirk Place.

Table 3*:* Edge effects field data sheet for Selkirk Place. 2 m^2 quadrat used.

Site	Quadrat	Canopy cover (%)	Native ground cover (%)	Non-native ground cover (%)	Observations
1	River edge	0	10	90	No bird activity observed; all shrubs <2m in height; minimum vertical structure
2	Fence area	0	0	100	Sparse ground cover; dry substrate; dominated by exotic species

Note: No canopy cover on the future development side of the stream.

4.22 Cunliffe Road

Figure 5: Cunliffe Road, showing the minimal area that the riparian buffer covers between the new housing sections.

Figure 6: Cunliffe Road riparian buffer from another angle, showing new plantings.

Table 4. Edge effects field data sheet for Cunliffe Road. 2 m^2 quadrat used.

Site	Quadrat	Canopy cover (%)	Native ground cover (%)	Non-native ground cover (%)	Observations
1	River edge	0%	30%	50%	Recent plantings; weed invasion; patchy ground cover with bare areas
2	New development area (grass)	0%	5%	10%	Dominated by bare soils and weeds; low vegetation diversity

4.23 Meadow Stream

Figure 7: Well-maintained buffer at Meadow Stream study site.

Figure 8: Pathway between riparian buffer and houses at Meadow Stream study site, with additional vegetation separating pathway from housing, making this buffer 25m.

Table 5: Edge effects field data collection sheet for Meadow Stream. 2 m^2 quadrat used.

Site	Quadrat	Canopy cover (%)	Native ground cover (%)	Non-native ground cover (%)	Observations
1	River edge	60%	80%	20%	Dense native vegetation; tall shrubs and canopy cover; clear stream flow
2	Path side	0%	20%	80%	Ornamental grasses and tussocks adjacent to path; low native cover

4.24 Redwood Springs

Figure 9: Grass separating riparian buffer from the road at Redwood Springs study site.

Figure 10: Well-maintained recreational side of riparian buffer at Redwood Springs study site.

Figure 11: Dense riparian buffer at the water's edge of Redwood Springs study site.

Table 6: Edge effects field data sheet for Redwood Springs study site. 2 m^2 quadrat used.

Site	Quadrat	Canopy cover (%)	Native ground cover (%)	Non-native ground cover (%)	Observations
1	River edge	20%	50%	50%	Bird activity; mature native species including cabbage trees and flax; canopy cover present
2	Path side	0%	10%	90%	Weed invasion; dry conditions; low structural diversity; adjacent to mown grass

4.3 Q4: Scenario Modelling Results

Scenario-based modelling identified a range of spatially feasible planting strategies across the Styx catchment that contribute towards the 271 ± 6 ha required to reach 10% cover for all underrepresented ecosystems (Table 7). The scenarios highlighted differences in restoration potential depending on land availability, ecosystem distribution, buffer widths, public green space availability, and the influence of future development areas.

Table 7: Land required for underrepresented Lucas Associates Indigenous Ecosystems in the Pūharakekenui-Styx River catchment to reach 10% equal representation.

Ecosystem	Total area of ecosystem (ha)	Current indigenous coverage (ha)	Area required to reach 10% (ha)
Kaikōmako	26	0	2.63
Pūkio	204	1	19.6
Kahikatea	819	13	68.4
Akeake	1206	4	86.3
Kōwhai	42	1	2.92
Tussock	151	6	9.47
Tōtara	869	33	53.8
Houhere	1014	74	27.6
Total	4331	132	271

A 20 m riparian buffer provided a moderate gain of ~56 ha. Wider buffers of 40 m and 80 m captured larger portions, particularly of Kahikatea and Houhere, contributing approximately 135 and 321 ha respectively (Figure 12). The 25 m buffer contributed ~75 ha and provided a balance between ecological gain and fiscal feasibility. At this width, Houhere achieved 10.4% cover. Despite the 80 m buffer providing the highest overall vegetation coverage, it enabled only Houhere to achieve 10% cover.

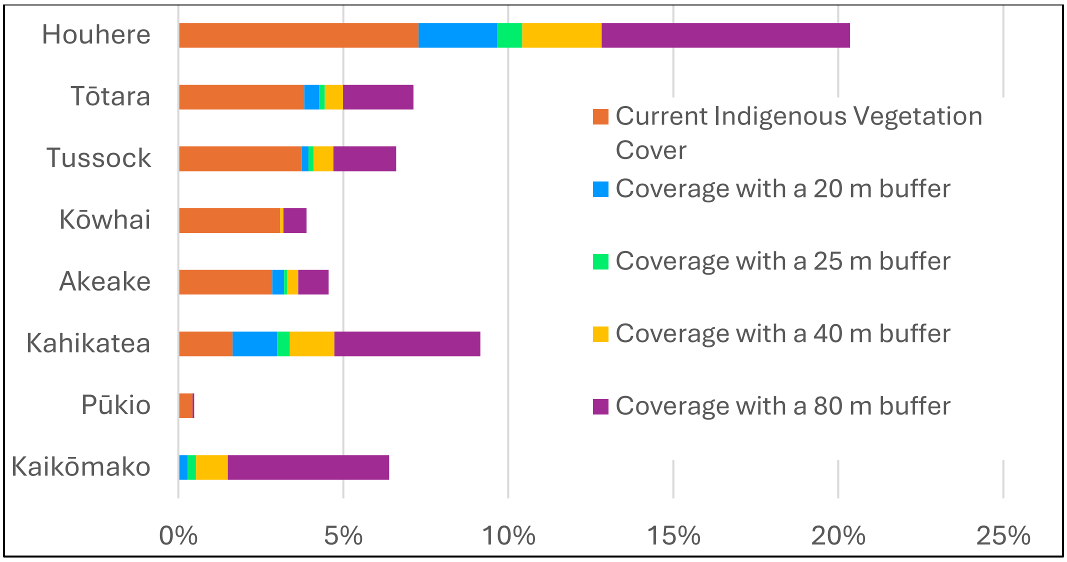

Figure 12: Percentage of Lucas Associates Indigenous Ecosystems in the Pūharakekenui-Styx River Catchment after Scenario Buffer Extensions.

Increasing indigenous planting in public spaces provided modest but spatially valuable gains (Table 8). A 1% increase provided 7.63 ha (0.15%), and a 5% increase provided 37.05 ha (0.72%) with noticeable gains identified within the Akeake, Tōtara, and Tussocks ecosystems, which contain pine forests, concentrated public open spaces, and an unutilised 6.79 ha of Roto Kōhatu (Modelled public spaces shown in Appendix B4-8). When modelled together with a 25m buffer, the scenario reduced the required land area to meet targets by 76.31 ha, showing strong additive effects (Table 9).

Table 8: Indigenous planting scenarios for public parks and reserve increases within underrepresented Lucas Associates Ecosystems in the Pūharakekenui-Styx River catchment.

Ecosystem	1% increase (ha)	1% increase (%)	5% increase (ha)	5% increase (%)
Kaikōmako	N/A	N/A	N/A	N/A
Pūkio	0.0592	0.029	0.296	0.145
Kahikatea	0.26	0.032	0.32	0.16
Akeake	6.621	0.55	33.11	2.75
Kōwhai	N/A	N/A	N/A	N/A
Tussock	0.1222	0.081	0.611	0.405
Tōtara	0.5725	0.066	2.869	0.33
Houhere	N/A	N/A	N/A	N/A
Total	7.63	-	37.05	-

Table 9: Scenario Modelling of indigenous vegetation gains with 25m buffers and increased public park planting.

Ecosystem	Indigenous vegetation coverage after 25m buffer + 1% increase on public park/reserve (%)	Indigenous vegetation coverage after 25m buffer + 5% increase on Public Park/Reserve (%)	Land required (ha) after 25m buffer + 1% Public Park/Reserves	Land required (ha) after 25m buffer + 5% Public Park/Reserve
Kaikōmako	0.5	0.5	2.5	2.5
Pūkio	0.5	0.6	19.5	19.3
Kahikatea	3.4	3.6	68.1	68.1
Akeake	3.8	6.0	74.2	47.7
Kōwhai	3.1	3.1	2.9	2.9
Tussock	4.2	4.5	8.8	8.4
Tōtara	4.5	4.8	47.8	45.5
Houhere	10.4	10.4	0	0
Total	N/A	N/A	224.0	194.4

Modelling potential development zones using the 10% stormwater area rule of thumb identified strong opportunities to align stormwater management with indigenous restoration, particularly in the northern catchment where greater equality in representation could be achieved. Notably, two large developments in the Akeake ecosystem could gain up to 8 ha of stormwater facilities. The Kahikatea ecosystem relies on seven key properties that could provide 0.8 – 40.4 ha. Kaikōmako, limited to 12 properties, requires 3 ha to achieve its 10% goal, but its fiscally unfeasible due to land value ($1 million per ha), yet it could achieve 0.7 – 1.9 ha through stormwater facilities, if the land were developed. Kōwhai provides ~1.5 ha through stormwater facilities, while Pūkio remains the most responsive to future development, with ~184 ha achievable for stormwater retention and restoration if 90% of the remaining ecosystem is developed (Appendix B9-10). Targeted vegetation conversion in Chaneys Plantation and Bottle Lake Forest land parcels (Akeake ecosystem) contributes 6.1 - 122.3 ha of additional indigenous vegetation (Table 10). Achieving 10% target scenarios are detail in Table 11 and 12.

Table 10: Indigenous vegetation cover gains in the Pūharakekenui-Styx River catchment from different Conversion Scenarios of Chaneys Plantation and Bottle Lake Forest.

Location	(ha)	1% (ha)	5% (ha)	10% (ha)	15% (ha)	20% (ha)
Chaneys Plantation	434.4	4.3	21.8	43.4	65.2	86.9
Bottle Lake Forest	177.0	1.8	8.9	17.7	26.6	35.4
Total	611.5	6.1	30.6	61.1	91.7	122.3

Table 11: Most effective modelled scenarios for achieving 10% indigenous vegetation coverage across underrepresented Lucas Associates ecosystems.

Ecosystem	Scenario Type	Key Constraints
Houhere	25m buffer	Most achievable
Kōwhai	Motorway planting + future development	Small ecosystem, one key property for development, doesn't contain river or tributaries
Tussocks	25m buffer + 5% planting increase + 6.79ha Roto Kōhatu conversion	Private parcel overlap for wider buffers
Akeake	40m buffer + 10% conversion Chanley's and Bottle Lake + future development	Rural area, private ownership
Kahikatea	40m buffer + future development + 4 – 20ha Reserve	Reserve size dependent on the level of future development

Kaikōmako	40m buffer + future development	Small ecosystem, high land value
Pūkio	10% stormwater from 70% development of remaining ecosystem + 8ha Reserve	Limited public land, reliant on future development, doesn't contain river or tributaries, land acquisition costs
Tōtara	5% planting increase + small scale future development + 40ha Reserve	Highly urbanised, Land acquisition, Private parcel overlap for wider buffers, Hardest to achieve

Table 12: Modelled scenarios for achieving 10% indigenous vegetation coverage for Pūharakekenui-Styx River catchment

Scenario Type	Indigenous Coverage (%)
40m buffer + future development	>10.00
40m buffer + 1% planting increase	10.5
25m buffer + 20% conversion of Chanleys Plantation and Bottle Lake Forrest	11.10
80m buffer	13.50

4.4 Question 5 Results

Survey response (*N* = 354) was relatively well distributed throughout Christchurch suburbs, with 49% of the respondents not belonging to the top 10 most common suburbs (Figures 13, 16, and 17; Table 14; Appendix A1). Participants living within the catchment were fewer compared to those outside, but within-catchment suburbs made up 53% of the top 10 suburbs (Figure 14; Table 14). The friends and family sample population was too small (*N* = 16) to conduct statistical tests, so they were included in the data analysis except Figures 20, 21, 22, Table 13, and statistical significance tests. Each age bracket was almost equally represented (Figure 15). Female participants were 65% (*n* = 219) of the dataset and males were 31% (*n* = 104). Urban homeowners constituted 60% of the sample (*n* = 214), rural/semi-rural homeowners 20% (*n* = 71), and renters 14% (*n* = 49).

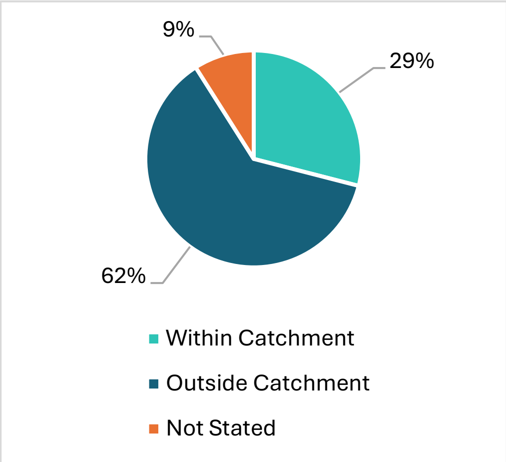

Figure 13: Proportion of participants within and outside Styx-Pūharakekenui catchment.

Option	Responses	%
Within	104	29.38
Outside	218	61.58
Not Stated	32	9.04
Total	354	

Table 14: Top 10 most frequently reported suburb of residence.

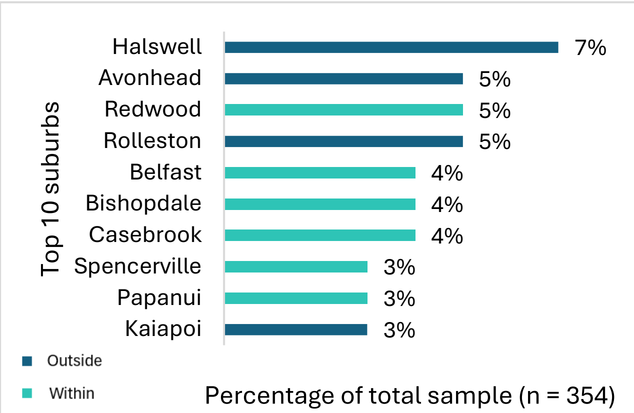

Figure 14: Top 10 most frequently reported suburb of residence.

Suburb	Participants	%
Halswell	24	6.78
Avonhead	19	5.37
Redwood	17	4.80
Rolleston	16	4.52
Belfast	14	3.95
Bishopdale	14	3.95
Casebrook	14	3.95
Kaiapoi	12	3.39
Spencerville	10	2.82
Papanui	10	2.82
Not Stated	32	9.04
Top 10	150	42.37
Remaining Suburbs (67)	172	48.59
Total Participants	354	

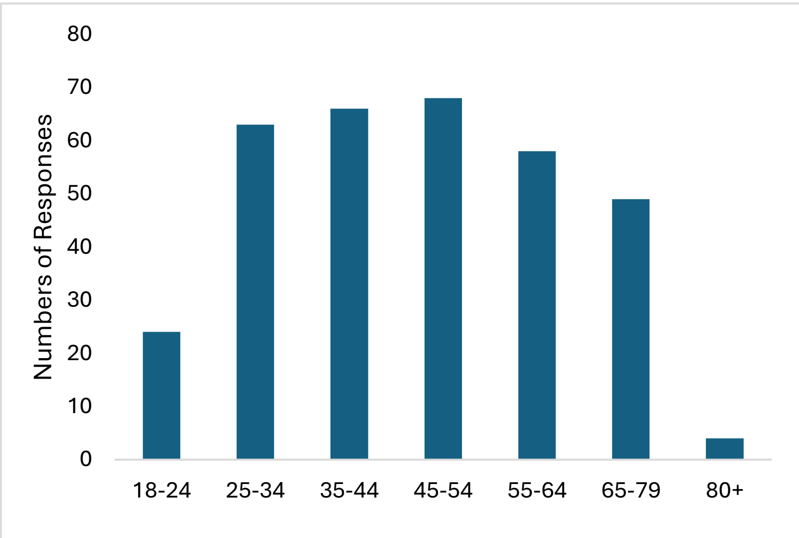

Figure 15: Distribution of survey respondents in 7 age brackets

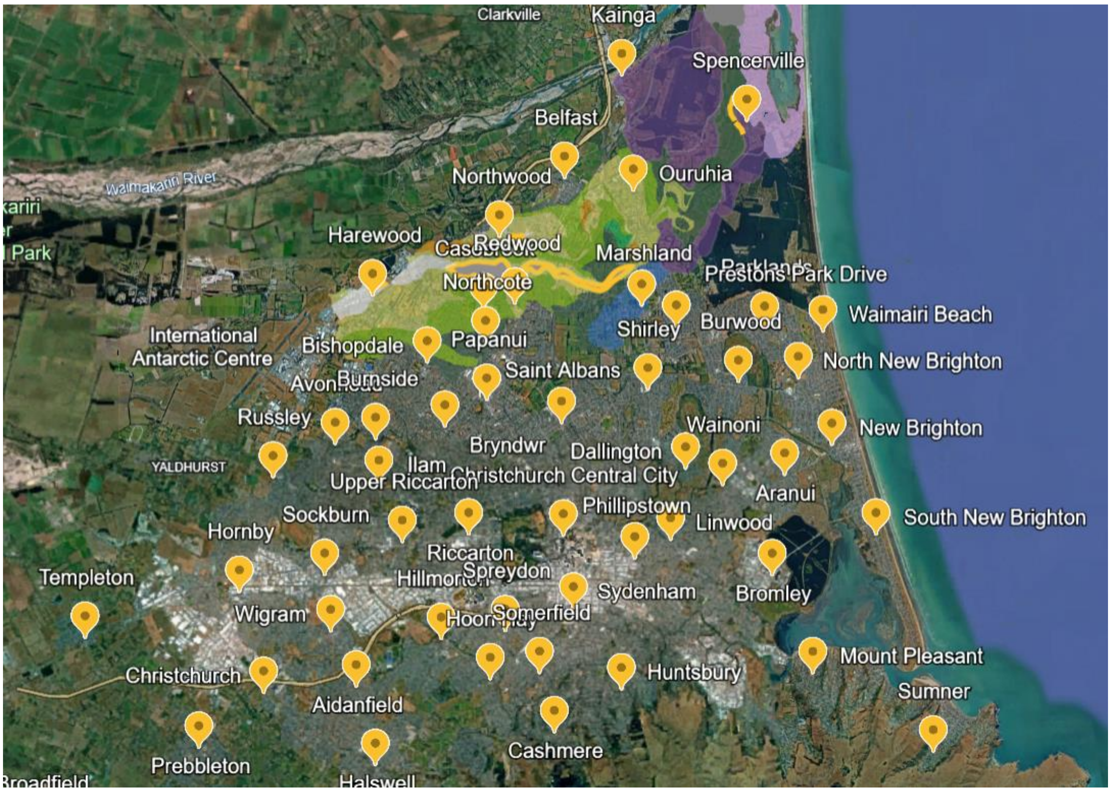

Figure 16: Google Earth map displaying Christchurch suburbs sampled from Facebook community groups, as stated in Appendix 1.1.

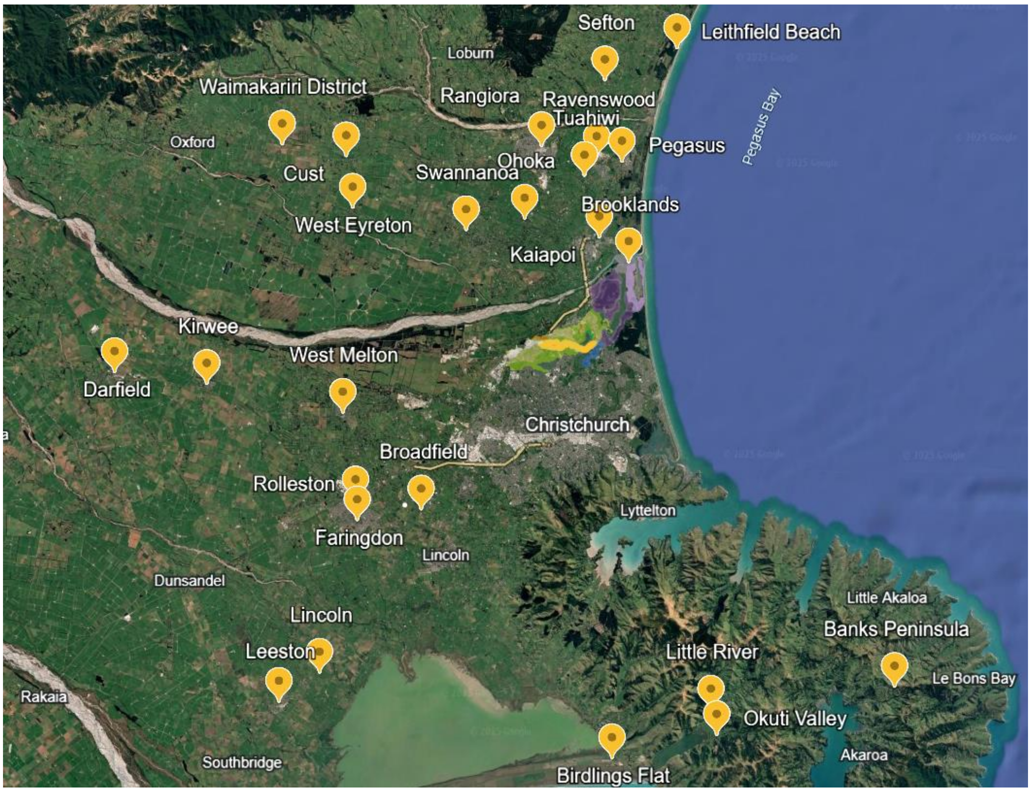

Figure 17: Google Earth map displaying Greater Christchurch suburbs sampled from Facebook community groups, as stated in Appendix 1.1.

Participants (*n* = 353) responded to how important increasing indigenous vegetation in their community was to them, holding similar perspectives regardless of their proximity to the catchment (Figure 18, Appendix A2). Responses in the 'Very Important' category composed 87% of the 'Strongly Support' rates for the native vegetation category (Figure 19, Appendix A4). The position on this question held similar trends regardless of participant proximity to the catchment (Appendix A3). Of the 8 people in the 'Not at all Important' category, 7 were in the 'Strongly Don't Support' group. Of the 'Very Important' category, 77% preferred native plant species even when told that the non-native species were perceived as more aesthetic (Figure 20, Appendix A5). Of the 'Not at all Important' group, <1% preferred native over perceivably more aesthetic non-native plants.

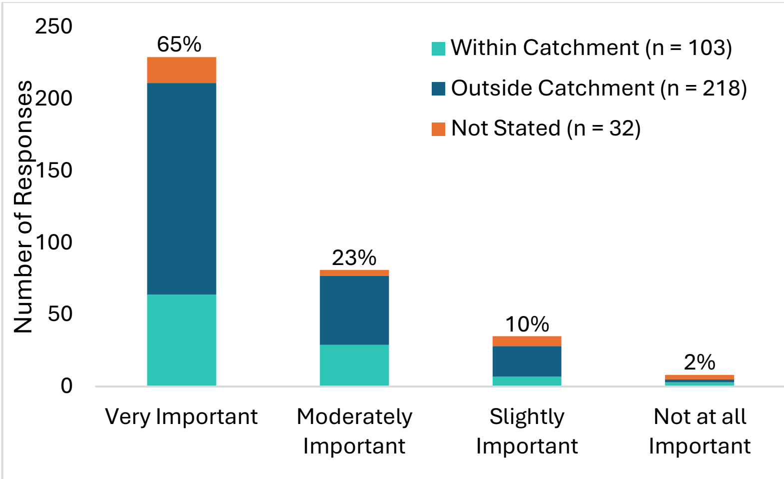

Figure 18: Participant opinion on the importance of increasing indigenous vegetation in the community, highlighting residential suburbs as within or outside the Pūharakekenui-Styx River catchment.

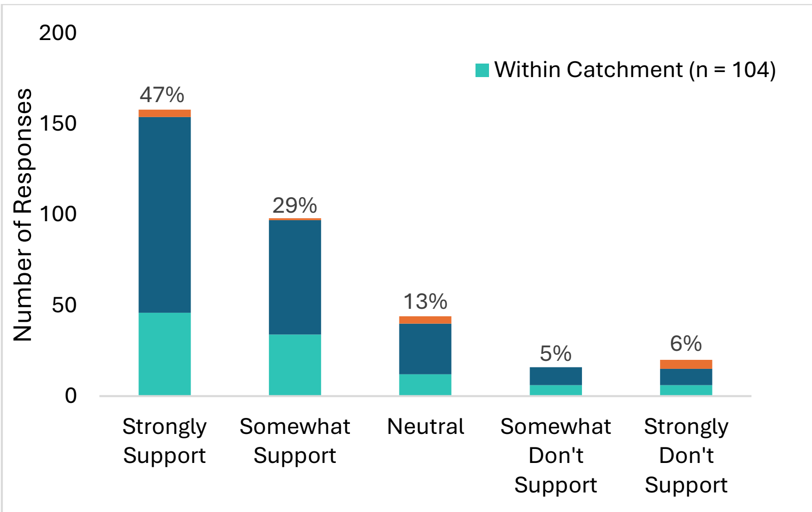

Figure 19: Participant opinion on utilising rates or levies to fund increasing indigenous vegetation cover in the community, relative to suburbs within or outside the Pūharakekenui-Styx River catchment, highlighting percentages alongside response numbers.

There is a strong statistical relationship between the *importance of increasing native vegetation* variable and the participants' support for rates to be used to increase native vegetation cover χ^2 (12, *N* = 319) = 153, *p* = < 0.001 (Figure 20, Appendix 1.4). It was unlikely that urban homeowner status affected participants' responses to the rates question χ^2 (*p* = 0.102). An ANOVA test determined strong statistical significance between participants' beliefs in importance of native vegetation and their preferences of native plants vs specifically aesthetic plants χ^2 (6, *N* = 336) = 83.7, *p* = < 0.001 (Figure 21, Appendix 1.5). ANOVA tests identified no statistical significance between personal importance of increasing native vegetation and the demographic variables of age (*p* = 0.277), gender (*p* = 0.383), and homeownership status (*p* = 0.573), however the effect sizes were all no greater than 0.185 so this would need to be repeated. The top three barriers which emerged were the cost of plants (54%), growing space (45%), and time (31%) (Figure 22, Table 13). Third to last (14%) was personal motivation to plant.

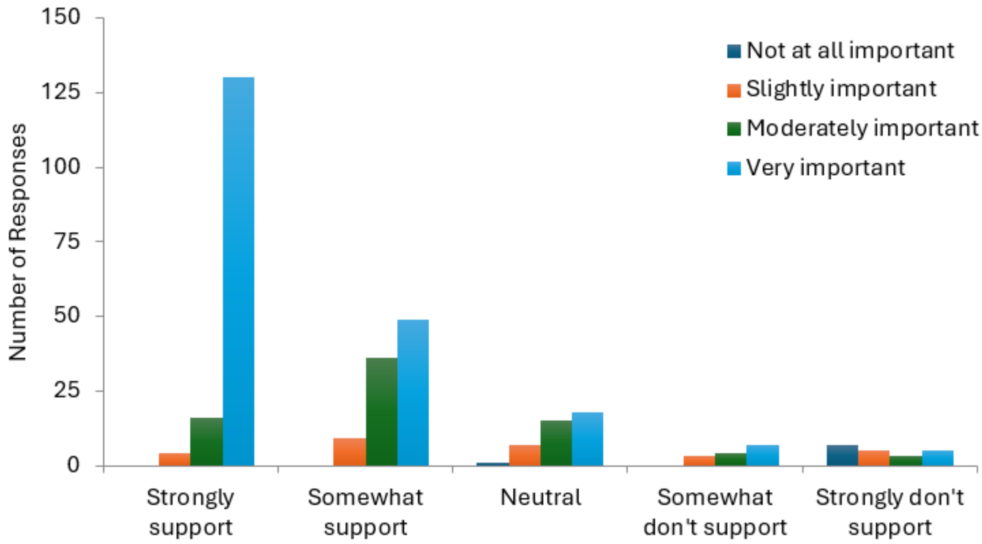

Figure 20: Relationship between personal importance of increasing native vegetation in the community and utilising rates or levies to increase native vegetation in the community, highlighting percentages alongside response numbers.

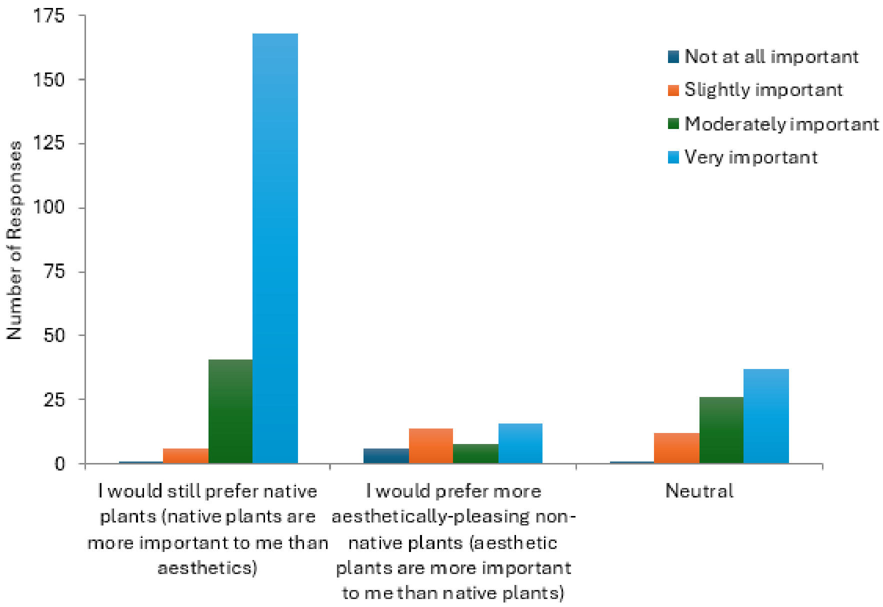

Figure 21: Relationship between personal importance of increasing native vegetation in the community and preference over native or aesthetic plants, highlighting percentages alongside response numbers.

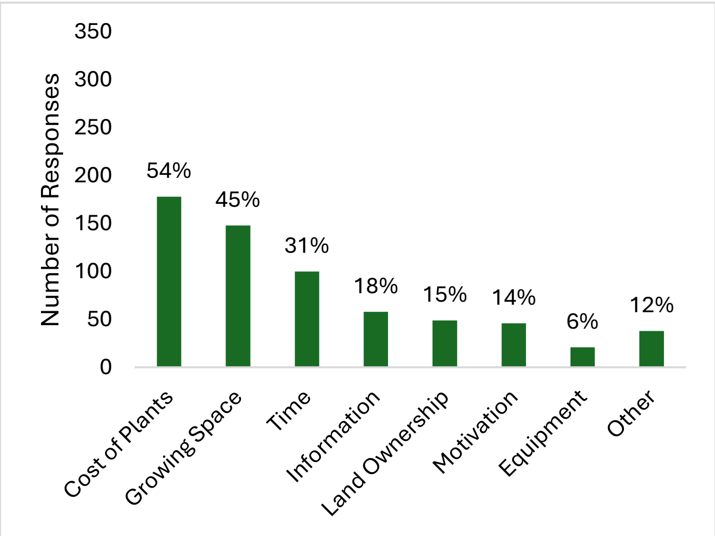

Table 15: Barriers to planting more native vegetation around

Option	Responses	%
Cost of Plants	178	54.43
Growing Space	148	45.26
Time	100	30.58
Information	58	17.74
Land Ownership	49	14.99
Motivation	46	14.07
Equipment	21	6.42
Other	38	11.62
Total	327	

Figure 22: Barriers to planting more native vegetation around home properties. **Note:** Percentages do not add to 100% as the question was of 'select all that apply' design.

5.0 Discussion

5.1 Q1 – 4: GIS

A major limitation in quantifying indigenous vegetation in the Styx River catchment was the absence of data for private properties. Using LiDAR for unsupervised classification was considered but disregarded due to limited available methodology. Another limitation was the accuracy of vegetation polygons provided by our community partner. Vertex analysis indicated the digitisation was accurate, with minimal spatial error. However, polygons were assumed to represent 100% indigenous cover. Ground truthing showed this was not entirely accurate but reliable enough to justify continuing its use. Creating a polygon layer of all developable land within river buffers involved subjectivity. Properties with large, high-value homes and gardens were classified as unlikely to be subdivided due to the value of the house compared to the land. If this assumption proved untrue, the effect on the accuracy of the results would be insignificant.

5.2 Q4: Edge Effects

The results indicate that both riparian buffer width and vegetation maturity are essential for reducing ecological edge effects. Narrow, poorly established buffers such as Selkirk Place (Figures 3 and 4) and Cunliffe Road (Figures 5 and 6) showed reduced canopy cover, minimal native ground vegetation, and had more exotic species dominating (Tables 3 and 4). All those characteristics exhibit stronger edge effects, where environmental conditions such as temperature, light, and moisture cause changes in resource availability that occur at ecosystem boundaries (Biasotto & Kindel, 2018). In comparison, wider and well-established buffers at Meadow Stream (Figures 7 and 8) and Redwood Springs (Figures 9 - 11) supported denser native vegetations, greater structural diversity, and higher bird activity, reflecting improved ecological integrity (Tables 5 and 6).

Selkirk Place and Cunliffe Road represent areas of future development, both having poorly maintained buffers lacking pathway or space separating them from new housing. In contrast, Meadow Stream and Redwood Springs feature wide, well-vegetated buffers with pathways and high biodiversity, highlighting the value of extended buffers that Selkirk and Cunliffe Road should aim to achieve. These findings align with research indicating that buffers narrower than 30 m are often inadequate for mitigating edge effects and maintaining healthy habitat conditions (Norton et al., 2020; Parkyn, 2004). The 20 m minimum buffer under the

Christchurch City Council (2017) therefore, seems insufficient for long-term ecological resilience. Wider buffers, especially those including pathways or planting zones, helped reduce the impact of surrounding urban areas on the river environment. However, this part of the study was limited by a small sample size and single time-point data collection, reducing statistical certainty and excluding seasonal variation. Site variability and reliance on visual observations may also have introduced bias.

5.3 Q4: Scenario Modelling

Scenario-based modelling showed that achieving equal ecosystem representation requires a combination of moderate buffer expansions (25 - 40 m), targeted planting, and selective land acquisition, as no single intervention can meet the target. Scenario design parameters prioritised public and council-owned land, as these areas present fewer socially, regulatory, and logistical barriers than private parcels (McKergow et al., 2016; Meurk & Swaffield, 2000; Schindler, 2025). Implementing an 80 m buffer highlighted the potential for feasibility limitations due to potential overlapping with private parcels and urban development. The model is heavily assumption-based and reliant on the accuracy of secondary data. Small changes in these assumptions can produce varying results (Metzger et al., 2017). Additionally, the model cannot fully capture or predict variability in future land-use zoning, exclusion of private land opportunities, manual identification processes, or inherent spatial inaccuracies associated with digitisation and data resolution. All of which can alter the practicality of recommended suitable planting areas (Durrant et al., 2023). Small scale factors such as species migrations, soil composition, hydrology, and vegetation health may be overlooked as ecological conditions were simplified at polygon scale. Lastly, with the research's limited timeframe, there is a lack of direct stakeholder integration (mana whenua, council planners, or developers) which limited our potential to capture on-ground constraints. In turn, this restricted analysis of the social and practical factors of the modelled recommendations to the Trust. (Durrant et al., 2023; Metzger et al., 2017)

5.4 Q5: Survey

We considered that participants living within the Styx River catchment may be more passionate about increasing vegetation in the area, but very similar perspectives and response patterns presented regardless of proximity to the catchment, gender, age, living situation, urban/rural homeowner status. This observation is supported by the notion that people who prioritise native plantings and ecological value over aesthetic and functional plantings, are self-motivated to do so through values and education (Jay and Stolte (2011). Given that majority of our survey respondents value environmental matters, their own awareness of environmental issues may act as motivators for their behaviour. Any existing social barriers to increasing native vegetation in the community may be due to lack of awareness around the biodiversity crisis NZ is facing (Rodgers et al., 2023). People are motivated to plant native plants around their properties but are inhibited by the high cost of plants (Figure 22, Appendix 1.4). Personal values support sustainable initiatives if individuals can financially afford them, but once costs exceed a certain extent, individuals revert to unsustainable initiatives (Phillips et al., 2019). Personal values were associated with participants' choices to use rates for native planting and whether participants preferred native plants over aesthetic non-native plants, as their motivation was with native species rather than aesthetics (Figure 21). It was not clear whether people believed that native plants are more expensive than exotic plants, or if the cost-of-living crisis (RNZ, 2025)places home gardening amenities further down priority lists. Council rates are 12% higher on average (Ricketts, 2025), so a review of what rates are currently spent on would be necessary before considering that Indigenous Ecosystem restoration be included in them.

Our sample was likely large enough to be representative of the underlying Christchurch population, but it was no less subject to social desirability bias, which did not change between in-person and online surveys (Gnambs and Kaspar (2017). The underlying pro-native perspective in the sample population may indicate social desirability, where participants felt more inclined to complete the survey because the cause aligned with common social beliefs. Additional limitations were in survey distribution. Several community pages declined our entry if we did not state that we lived there, and some pages accepted our request to join but declined the survey post. Delays in survey post times meant many groups did not have the same amount of collection time as others. We distributed the survey via Facebook community groups for convenience; however, this self-selection sampling risks collecting a sample that is not representative of the population (Harrison et al., 2023).

6.0 Conclusion

The Trust should prioritise future plantings in areas with narrow or degraded buffers, especially where development directly borders the Styx River. Wider, well-vegetated buffers improve ecological quality and can inform restoration priorities within the Styx River corridor. Restoration should focus on widening buffers beyond 20 m, enhancing native canopy cover, and managing invasive species to strengthen ecological connectivity and sustainability. The 25 m and 40 m buffer scenarios were identified as the most practical for implementation as these widths align more favourably with existing riparian patterns, minimise overlap with built infrastructure, and are mostly compatible with adjacent land uses. Achieving the 10% indigenous vegetation cover target is unlikely to be inhibited by community belief, but rather the practicalities of funding. Future surveying is needed to explore how council rates could be used to plant more indigenous vegetation in the community. The barriers identified in the survey were likely perceived barriers for people, so to truly investigate the planting barriers the Trust may experience, a survey could be distributed to similar community organisations to collect their experiences on the matter. Successful indigenous ecosystem restoration depends on ecological cover expansion, strong governance, and community commitment. It is vital for restoration planning to address stakeholder benefits, aesthetics preference, and to utilise tailored incentives to increase adoption of indigenous restoration rather than focusing purely on ecological benefits.

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Appendices

Appendix A1.1 Facebook Community Groups.

Aranui/Wainoni/New Brighton Community Page
Avonhead/Russley Community page
Burwood Community Support - Christchurch
Burwood, Shirley, Mariehau and Surrounding Areas - Support Local
Belfast NZ Community Page
Bishopdale/Papanui/Bryndwr & Surroundings Community
Bishopdale/Burnside/Casebrook Community Group
Bishopdale Community Group
Beckenham Business Community (Christchurch NZ)
Bromley Residents Group - Christchurch, NZ
Birdlings Flat Community Page
Christchurch Central
Christchurch Community Watch & Information
Christchurch Community Group
Redwood, Belfast and Northwood Community Group
Northwood, Redwood, Northcote Casebrook & Surrounds
Waimakariri Community
St Albans, Edgeware, Mariehau & Merivale Area Community Group
North Canterbury Local
St Albans - Mariehau Residents
Prestons & Marshlands Community Social Group
Halswell Businesses
Halswell Community Group
Kainga Residents Association
Kaiapoi Community Page
Hoon Hay Community Association Noticeboard
Hillmorton - Spreydon - Hoonhay Community Page
Riccarton Neighbourhood Updates
Spreydon/Somerfield/Sydenham Community Page's
Prestons & Marshlands Community Social Group
Rolleston Community Page
Rangiora Community Page
Rangiora Community & Business (Local Community & Business Posts Welcome)
Peoples Independent Republic of New Brighton
New Brighton Community
Parklands Community - Christchurch
Waikuku Beach Fan Club
Lincoln Community Page
Halswell/Westlake/Wigram/Aidanfield/Kennedys Bush Community Group

Prebbleton/Hornby/Wigram Community Group
Prebbleton Community Group
Templeton (N.Z) Community & Residents Page
Russley/Avonhead/Yaldhurst Community Group

Appendix A2. Participant perception of the importance of increasing indigenous vegetation in the community relative to within-catchment and outside-catchment suburbs.

Option	Within	%	Outside	%	Not Stated	%	Total	%
Very Important	64	62.75	147	69.12	18	64.87	229	64.87
Moderately Important	29	28.43	48	21.08	4	22.95	81	22.95
Slightly Important	7	5.88	21	8.82	7	9.92	35	9.92
Not at all Important	3	2.94	2	0.98	3	2.27	8	2.27
Total	103		218		32		353	

Appendix A3. Participant opinion on utilising rates or levies to fund indigenous vegetation plantings in the community, relative to within-catchment and outside-catchment suburbs.

Option	Within	%	Outside	%	Not Stated	%	Total	%
Strongly Support	46	44.66	108	49.51	4	28.57	158	47.02
Somewhat Support	34	33.01	63	30.88	1	7.14	98	29.17
Neutral	12	11.65	28	12.75	4	28.57	44	13.10
Somewhat Don't Support	6	4.85	10	2.45	0	0.00	16	4.76
Strongly Don't Support	6	5.83	9	4.41	5	35.71	20	5.95
Total	104		218		14		336	

Appendix A4. Pairwise table showing relationship between the perception of importance of increasing indigenous vegetation in the community and utilising rates or levies to fund indigenous vegetation plantings in the community, relative to within-catchment and outside-catchment suburbs.

Option	Strongly Support	%	Somewhat Support	%	Neutral	%	Somewhat Don't Support	%	Strongly Don't Support	%	Total	%
Very Important	130	86.67	49	52.13	18	43.90	7	50.00	5	25.00	209	65.52
Moderately Important	16	10.67	36	38.30	15	36.59	4	28.57	3	15.00	74	23.20
Slightly Important	4	2.67	9	9.57	7	17.07	3	21.43	5	25.00	28	8.78
Not at all Important	0	0.00	0	0.00	1	2.44	0	0.00	7	35.00	8	2.51
Total	150		94		41		14		20		319	

Appendix A5. Pairwise table showing relationship between the perception of importance and whether participants preferred non-aesthetic native or aesthetic non-native plants.

Option	Native Plants	%	Aesthetic Plants	%	Neutral	%	Total	%
Very Important	168	77.78	16	36.36	37	48.68	221	65.77
Moderately Important	41	18.98	8	18.18	26	34.21	75	22.32
Slightly Important	6	2.78	14	31.82	12	15.79	32	9.52
Not at all Important	1	0.46	6	13.64	1	1.32	8	2.38
Total	216		44		76		336	

Appendix B1. Indigenous vegetation percentage for underrepresented Lucas Associates Ecosystems in the Pūharakekenui-Styx River catchment under 20 m buffer and increased public park planting scenarios.

Ecosystem	Indigenous vegetation cover after 20 m buffer + 1% increase on public parks/reserves (%)	Indigenous vegetation cover after 20 m buffer + 5% increase on public parks/reserves (%)	Land required after 20 m buffer + 1% increase on public parks/reserves (ha)	Land required after 20 m buffer + 5% increase on public parks/reserves (ha)
Kaikōmako	0.28	0.28	2.53	2.53
Pūkio	0.459	0.145	19.54	19.30
Kahikatea	3.032	3.16	57.04	55.98
Akeake	3.76	5.96	75.28	48.79
Kōwhai	3.09	3.09	2.92	2.92
Tussock	4.051	4.375	9.05	8.56
Tōtara	4.316	4.58	49.23	46.93
Houhere	9.66	9.66	3.5	3.5
Total	-	-	219.09	188.51

Appendix B2. Indigenous vegetation percentage for underrepresented Lucas Associates Ecosystems in the Pūharakekenui-Styx River catchment under 40 m buffer and increased public park planting scenarios.

Ecosystem	Indigenous vegetation coverage after 40 m buffer + 1% increase on public parks/reserves (%)	Indigenous vegetation coverage after 40 m buffer + 5% increase on public parks/reserves (%)	Land required after 40 m buffer + 1% increase on public parks/reserves (ha)	Land required after 40 m buffer + 5% increase on public parks/reserves (ha)
Kaikōmako	1.50	1.50	2.23	2.23
Pūkio	0.46	0.56	19.54	19.30
Kahikatea	5.05	4.89	42.84	42.78
Akeake	4.18	6.05	70.18	43.69
Kōwhai	3.09	3.09	2.92	2.92
Tussock	4.78	5.11	7.85	7.36
Tōtara	5.06	5.32	43.03	40.73
Houhere	12.38	12.38	0	0
Total	-	-	188.59	159.01

Appendix B3. Indigenous vegetation percentage for underrepresented Lucas Associates Ecosystems in the Pūharakekenui-Styx River Catchment under 80 m buffer and increased public park planting scenarios.

Ecosystem	Indigenous vegetation coverage after 80 m buffer + 1% increase on public parks/reserves (%)	Indigenous vegetation coverage after 80 m buffer + 5% increase on public parks/reserves (%)	Land required after 80 m buffer + 1% public parks/reserves (ha)	Land required after 80 m buffer + 5% public parks/reserves (ha)
Kaikōmako	6.39	6.39	1.7	1.7
Pūkio	0.51	0.63	19.44	19.20
Kahikatea	9.182	9.31	6.64	6.58
Akeake	5.1	7.3	59.08	32.59
Kōwhai	3.88	3.88	2.62	2.62
Tussock	6.68	7.01	5.05	4.56
Tōtara	7.19	7.45	24.43	22.13
Houhere	20.36	20.36	0	0
Total	-	-	118.96	89.38

Appendix B4. Planting scenarios within Lucas Associates Pūkio Ecosystem: Public parks, reserves, and storm water facilities planting increases.

Location	Total area (ha)	1% (ha)	% of ecosystem	5% (ha)	% of ecosystem
Stormwater Facility, 40R Raranga Street	1.50	0.015	0.007	0.075	0.037
Stormwater Facility, 44R Lower Styx Road	4.42	0.0442	0.022	0.221	0.108
Total	-	0.0592	0.029	0.296	0.145

Appendix B5. Planting scenarios within Lucas Associates Kahikatea Ecosystem: Public parks, reserves, and storm water facilities planting increases.

Location	Total area (ha)	1% (ha)	% of ecosystem	5% (ha)	% of ecosystem
Shepards Stream Reserve, 224R Lower Styx Road	3.51	0.0351	0.004	0.1755	0.021
Shepards Stream Reserve, 214 Lower Styx Road	1.97	0.0197	0.002	0.0985	0.012

Shepards Stream Reserve, ID-6927696	0.5016	0.005016	0.0006	0.02508	0.031
Styx Loop conservation Park, 64R Turners Road	2.77	0.0277	0.003	0.1385	0.017
Styx River Reserve no.2, 303 Radcliffe Road	8.09	0.0809	0.009	0.4045	0.049
Redwood Park, 339 Main North Road	6.81	0.0681	0.008	0.3405	0.042
Paddington Playground, 21 Paddington Street	1.34	0.0134	0.002	0.067	0.008
Larch Reserve, 20 Larch Place	0.45	0.0045	0.0005	0.0225	0.003
Craighead Reserve, 117 Northcote Road	0.92	0.0092	0.001	0.046	0.006
Total	-	0.26	0.032	1.32	0.16

Appendix B6. Planting scenarios within Lucas Associates Akeake Ecosystem: Public parks, reserves, and storm water facilities planting increases.

Location	Total area (ha)	1% (ha)	% of ecosystem	5% (ha)	% of ecosystem
Kainga Park, 162 Kainga Road	4.68	0.0468	0.0039	0.234	0.019
Kainga forest parcel, ID-3524541	42.89	0.4289	0.356	2.1445	0.177
Chaneys Plantation, 27 Spencerville Road	434.43	4.3443	0.3602	21.7215	1.801
Styx Riverbank Reserve, ID-3564438	0.7878	0.007878	0.0007	0.03939	0.003
Unnamed playground, 11 Nautilus Place	0.68	0.0068	0.0006	0.034	0.003
Spencerville Reserve, 6A Heyders Road	0.70	0.007	0.0005	0.035	0.0029
Spencerville Reserve, 25 Styx River Place	0.49	0.0049	0.0004	0.0245	0.0020
Bottle Lake plot, ID-3427151	35.812	0.35812	0.0296	1.7906	0.1484
Bottle Lake plot, ID-3510222	11.25	0.1125	0.0093	0.5625	0.0466
Bottle Lake plot, 240 Lower Styx Road	64.99	0.6499	0.0538	3.2495	0.2694
Bottle Lake plot, 168 Lower Styx Road	64.99	0.6499	0.0538	3.2495	0.2694

Unnamed Park, 110R Te Korari Street	0.40	0.004	0.003	0.02	0.0016
Total	-	6.621	0.55	33.11	2.75

Appendix B7. Planting scenarios within Lucas Associates Tussocks Ecosystem: Public parks, reserves, and storm water facilities planting increases.

Location	Total area (ha)	1% (ha)	% of ecosystem	5% (ha)	% of ecosystem
Smacks Creek Riverbank reserve, 336 Gardiners Road	1.02	0.0102	0.0067	0.051	0.0337
Smacks creek, 30R Wilkinsons Road	0.64	0.0064	0.0042	0.032	0.0211
Springvale Garden Reserve, 9 Springvale Gardens	0.50	0.005	0.0033	0.025	0.0165
Portion of Roto Kohato, 550 Sawyers Arms Road	6.79	0.0679	0.0449	0.3395	0.2248
Rindle Reserve, 100 Northwood Boulevard	0.06	0.0006	0.0003	0.003	0.0019
Kaputone Headwaters Reserve, 173R Johns Road	0.20	0.002	0.0013	0.010	0.0066
Kaputone Headwaters Reserve, 26 Springwater Avenue	0.47	0.0047	0.0031	0.0235	0.0015
Kaputone Springs Reserve, 30 Springwater Avenue	0.19	0.0019	0.0012	0.0095	0.0062
Portion of Englefield Reserve	1.4	0.014	0.0092	0.070	0.0463
Northwood Park, 35 Crombie Green	0.95	0.0095	0.0062	0.0475	0.0314
Total	-	0.1222	0.081	0.611	0.405

Appendix B8. Planting scenarios within Lucas Associates Tōtara Ecosystem: Public parks, reserves, and storm water facilities planting increases.

Location	Total area (ha)	1% (ha)	% of ecosystem	5% (ha)	% of ecosystem
Ballymena Reserve, 18A Belfast Road	0.08	0.0008	0.00009	0.004	0.00046

Unnamed green area, 67 Belfast Road (unsuitable for development, potential stormwater)	1.70	0.017	0.00196	0.085	0.00978
Castile Reserve, ID-3579803, (Castile Place)	0.50	0.005	0.00058	0.025	0.00288
Recreation Reserve, 30 Northwood Boulevard	0.12	0.0012	0.00014	0.006	0.00069
Mounter Reserve, 26 Northwood Boulevard	0.13	0.0013	0.00015	0.0065	0.00075
Northwood Boulevard, ID-6508449 (streetside verges)	2.08	0.0208	0.00239	0.104	0.01197
Northwood Boulevard, ID-3592188 (streetside verges)	0.11	0.0011	0.00013	0.0055	0.00063
Northwood Boulevard, ID-3592189 (streetside verges)	0.08	0.0008	0.00009	0.004	0.00046
Northwood Boulevard, ID-3592190 (streetside verges)	0.11	0.0011	0.00013	0.0055	0.00063
Northwood Boulevard, ID-3592198 (streetside verges)	0.41	0.0041	0.00047	0.0205	0.00236
Northwood Boulevard, ID-3592201 (streetside verges)	0.59	0.0059	0.00068	0.0295	0.00339
Anglem Reserve, 17 Anglem Way	0.02	0.0002	0.00002	0.001	0.00012
Beechwood Reserve, 15 Amamoor Street	0.05	0.0005	0.00006	0.0025	0.00029
Waterford Reserve, 27 Northwood Boulevard	1.67	0.0167	0.00192	0.0835	0.00961
Unnamed Park, 6 Lassiter Green	0.22	0.0022	0.00025	0.011	0.00127
Unnamed Park, henley green	0.13	0.0013	0.00015	0.0065	0.00075
Vaughan Reserve, 34 Coolspring Way	0.12	0.0012	0.00014	0.006	0.00069
Murchison Park, 46 Lowry Avenue	4.11	0.0411	0.00473	0.2055	0.02365
Murchison Park, 47D Solomon Avenue	0.11	0.0011	0.00013	0.0055	0.00063
Alwyn Park, 70 Dunbarton Street	0.59	0.0059	0.00068	0.0295	0.00339
Sharnbrook Reserve, 120 Regent's Park Drive	0.80	0.008	0.00092	0.04	0.00460

Aylsham Reserve, 169R Regent's Park Drive	0.83	0.0083	0.00096	0.0415	0.00478
Barnes Reserve, 65 Barnes Road	1.39	0.0139	0.00160	0.0696	0.00801
Marlene Reserve, 33 Royleen Street	0.20	0.002	0.00023	0.01	0.00115
Redwood Park, 339 Main North Road	6.81	0.0681	0.00784	0.3405	0.03918
Millhaven Park, 8R Millhaven Place	0.30	0.003	0.00035	0.015	0.00173
Stormwater, 10R Millhaven Place	0.17	0.0017	0.00020	0.0085	0.00098
Stormwater, 9R Redbrook Road	0.40	0.004	0.00046	0.02	0.00230
Stormwater, 11R Redbrook Road	0.57	0.0057	0.00066	0.0285	0.00328
Stormwater, 149R Cavendish Road	1.99	0.0199	0.00229	0.0995	0.01145
Grampain Reserve, 68 Grampain Street	1	0.01	0.00115	0.05	0.00575
Mendip Reserve, 19 Mendip Place	0.19	0.0019	0.00022	0.0095	0.00109
Tullet Park, 99 Claridges Road	6.09	0.0609	0.00701	0.3045	0.03504
Tullet Park, 93 Claridges Road	0.62	0.0062	0.00071	0.031	0.00357
Tullet Park, 39 Glasnevin Drive	0.30	0.003	0.00035	0.015	0.00173
Tullet Park, 5 Glasnevin Drive	0.93	0.0093	0.00107	0.0465	0.00535
Paprika Reserve, 20 Tivoli Place	0.14	0.0014	0.00016	0.007	0.00081
Paprika Reserve, 10 Paprika Place	0.10	0.001	0.00012	0.005	0.00058
Tralee Reserve, 19 Tralee Place	0.36	0.0036	0.00041	0.018	0.00207
Stretton Reserve, 10A Stretton Street	0.30	0.003	0.00035	0.015	0.00173
Natalie Reserve, 21 Natalie Place	0.06	0.0006	0.00007	0.003	0.00035
Crofton Reserve, 51 Crofton Road	0.17	0.0017	0.00020	0.0085	0.00098
Pasadena Reserve	0.08	0.0008	0.00009	0.004	0.00046
Becmead Reserve,	0.10	0.001	0.00012	0.005	0.00058

12 Trafford Street					
Becmead Reserve, 11 Becmead Drive	0.14	0.0014	0.00016	0.007	0.00081
Benmore Gardens Reserve, 8 Benmore Gardens	0.49	0.0049	0.00056	0.0245	0.00282
Styx River Reserve, 24 Skyedale Drive	0.46	0.0046	0.00053	0.023	0.00265
Styx River Reserve, ID-3368993	0.11	0.0011	0.00013	0.0055	0.00063
Styx River Reserve, 563R Harewood Road	0.07	0.0007	0.00008	0.0035	0.00040
Styx River Reserve, 541R Harewood Road	0.05	0.0005	0.00006	0.0025	0.00029
Nunweek Park, 240 Wooldridge Road	19.22	0.1922	0.02212	0.961	0.11059
Total	-	0.5725	0.066	2.869	0.33

Appendix B9: 10% Stormwater retention vegetation potential based on assumed future development sites.

Location	Land area (ha)	10% Stormwater (ha)
Kahikatea		
12 Earlham street	134.49	13.4
2 Earlham street	8.09	0.81
287 Spencerville Road	75.08	7.51
266 Spencerville Road	35.00	3.50
240 Spencerville Road	63.79	6.38
144 Turners Road	47.32	4.43
165 Turners Road	40.43	4.04
Total		40.42
Kaikōmako		
196 Belfast Road	2.64	0.26
24 Crawford Road	4.28	0.43
22 Crawford Road	4.19	0.42
184 Belfast Road	3.59	0.36
Total		1.47
Kōwhai		
333 Johns Road	14.75	1.48
Total		1.48
Akeake		
Enough land for large subdivision Potential (500-1000+ homes)	60 - 80	6 - 8

Enough land for large subdivision Potential (500-1000+ homes)	60 – 80	6 - 8
Total		12 – 16

Note: Large subdivision based on 500 homes → ~33 ha just for housing lots + parks, roads, schools, buffer lands etc. might double that.

Appendix B10: 10% Stormwater vegetation potential based on assumed future development sites of Pūkio Lucas Associates Indigenous Ecosystem.

Ecosystem	Remaining developable land area (ha)	20% Development (ha)	10% Stormwater (ha)	50% Development (ha)	10% Stormwater (ha)
Pūkio	183.92	36.78	3.68	91.96	9.16

Ecosystem	Remaining developable land area (ha)	70% Development (ha)	10% Stormwater (ha)	90% Development (ha)	10% Stormwater (ha)
Pūkio	183.92	128.74	12.87	183.92	16.55