

Appendix 5: Ecological Impact Assessment

TĪTOKI LANDCARE

Specialist Ecological Restoration

Ecological Assessment: Rider Park Proposed Private Plan Change FINAL

November 2025



PROJECT NUMBER	0316			
PROJECT NAME	Ecological Assessment: Rider Park Proposed Private Plan Change			
PROJECT ADDRESS	37 Maungatautari Road			
PREPARED FOR	Powerup Business Consulting Limited			
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REVIEW	Technical	QA	Version	Date to client
	T. Connolly	T. Connolly	Draft1	18/8/2025
			Draft2	8/9/2025
			Draft3	7/10/2025
	G. Cumming	G. Cumming	Draft4	12/11/2025
	T. Connolly	T. Connolly	Final	19/11/2025

This report should be cited as: ‘Titoki Landcare (2024). *Ecological Assessment: Rider Park Proposed Private Plan Change*. Prepared for *Powerup Business Consulting Limited*.’

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Contents

Executive summary	1
1 Introduction	5
1.1 Site summary	5
1.2 Proposed plan change and development.....	6
1.3 Assessment of ecological effects of the proposed development.....	8
2 Vegetation assessment	9
2.1 Vegetation assessment methods	9
2.2 Vegetation description and value.....	9
2.3 Potential effects of the PPC on vegetation	13
2.4 Assessment of effects on vegetation.....	13
2.4.1 Overall level of effect on vegetation.....	13
3 Long-tailed bat assessment	14
3.1 Long-tailed bat assessment methods.....	14
3.1.1 Desktop assessment.....	14
3.1.2 Acoustic surveys.....	14
3.1.3 Bat habitat assessment	15
3.2 Long-tailed bat description and value	16
3.3 Long-tailed bat activity in the surrounding landscape	17
3.4 Long-tailed bats on the Site.....	17
3.5 Long-tailed bat habitat assessment.....	20
3.5.1 Commuting habitat	20
3.5.2 Foraging habitat	20
3.5.3 Roosting habitat	20
3.6 Ecological value of the Site as habitat for long-tailed bats	20
3.6.1 Foraging and commuting habitat.....	20
3.6.2 Roosting habitat	21
3.7 Potential effects of the PPC on long-tailed bats.....	21
3.8 Assessment of effects on long-tailed bats.....	21
3.8.1 Mortality, injury, and/or disturbance during potential roost removal.....	21
3.8.2 Permanent loss of commuting and foraging habitat	21
3.8.3 Loss of available roosting habitat.....	22
3.8.4 Degradation of adjacent habitat due to increased levels of lighting	23
3.8.5 Overall level of effect on long-tailed bats.....	25

4	Bird assessment	26
4.1	Bird assessment methods.....	26
4.2	Bird community description and value.....	26
4.3	Potential effects of the PPC on birds.....	27
4.4	Assessment of effects on birds.....	27
4.4.1	Mortality, injury, and/or disturbance to birds during vegetation clearance and earthworks	27
4.4.2	Permanent loss and modification of pasture, exotic specimen trees, and hedgerow habitats	28
4.4.3	Post-construction degradation of habitats due to increased levels of lighting and noise .	28
4.4.4	Enhancement of gully and river embankment habitats through restorative actions.....	28
4.4.5	Overall level of effect on birds	28
5	Lizard assessment	30
5.1	Lizard assessment methods.....	30
5.2	Lizard species potentially present onsite and value.....	30
5.3	Copper skink habitat onsite and value	30
5.4	Potential effects on lizards	31
5.5	Assessment of effects on lizards	31
5.5.1	Mortality of copper skinks during vegetation clearance and earthworks of gardens around dwellings.....	31
5.5.2	Temporary loss of 0.16 ha of low value habitat.....	31
5.5.3	Enhancement of c. 11.7 ha of gully, river embankment and escarpment habitats.....	31
5.5.4	Overall level of effect on lizards.....	32
6	Wetland assessment.....	33
6.1	Wetland assessment methods	33
6.2	Wetland descriptions and value.....	33
6.3	Potential effects on wetlands.....	36
6.4	Assessment of effects on wetlands	36
6.4.1	Loss of c. 800 m ² of seepage wetland through the alteration of stormwater drainage .	36
6.4.2	Contamination and pollution of gully wetlands from stormwater drainage	36
6.4.3	Enhancement through proposed restorative actions within gully and escarpment	36
6.4.4	Overall level of effect on wetlands	37
7	Freshwater assessment.....	38
7.1	Freshwater assessment methods.....	38

7.1.1	March 2022 stream assessments	38
7.2	Watercourse descriptions	39
7.2.1	Water quality.....	42
7.2.2	Macroinvertebrates	42
7.2.3	Fish	42
7.2.4	Ecological value of freshwater features.....	42
7.3	Potential effect on freshwater	43
7.4	Assessment of effects on freshwater features.....	43
7.4.1	Contamination and pollution from stormwater drainage	43
7.4.2	Enhancement through proposed restorative actions along the riparian margins within the gully.....	43
7.4.3	Overall level of effect on freshwater features	43
8	Summary of effects assessments.....	45
9	Effects management recommendations.....	47
9.1	Measures proposed to avoid, minimise, remedy, offset, and compensate effects on ecological features	47
9.2	Compensation for adverse effects on long-tailed bats	49
9.2.1	Reasoning for compensation instead of offsetting.....	49
9.2.2	Compensation recommendations.....	49
9.2.3	Principles for biodiversity compensation.....	50
10	Conclusion.....	53
Appendix A	Weather data during acoustic surveys	54
Appendix B	Wetland delineation plot data.....	69

Executive summary

Titoki Landcare has been engaged by Powerup Business Consulting Limited to identify the ecological values present at the rural zoned property at 37 Maungatautari Road, Leamington (the Site) and assess the ecological effects of a proposed plan change for the Site.

The Site covers 98.65 ha (more or less) on the south-eastern perimeter of Cambridge township, spanning from the Waikato River to Maungatautari Road. Most of the Site is covered in pasture (c. 82.42 ha) and used for equine and dry stock farming. The river embankment along the northern boundary is covered predominantly with weedy exotic trees such as privets and black locusts. There is a wide gully area covering approximately 8.9 ha through the northern half of the Site which consists of several wetland areas and watercourses through its basin. The gully is predominantly covered in herbaceous vegetation but also has some trees and shrubs, most of which are exotic.

The proposed plan change seeks to change the zoning of the property from Deferred Residential and Rural Zone to a mix of residential, commercial and reserve zones. Approximately half of the Site is currently identified in the Waipā District Plan as a Future Growth Cell for Cambridge township.

Vegetation

Most of the vegetation is pasture (c. 82.42 ha). Other common vegetation includes rank grass (c. 4.88 ha), tree privet-black locust forest (c. 2.11 ha), and sedgeland (c. 2.37 ha). There are also gardens, hedgerows, shelterbelts, raupō reedland (c. 0.43 ha), and watercress herbfields.

Most of the vegetation to be removed is exotic pasture (c. 80.5 ha) with Negligible vegetative value. Approximately 2.67 ha of willow-oak treeland, 0.19 ha of shelterbelt and 0.86 ha of hedgerows and gardens will also be removed. The remaining vegetation is expected to be enhanced through restorative actions.

The overall level effect of the proposed plan change on vegetation is assessed as Very Low and no mitigation actions are considered necessary to balance this effect.

Long-tailed bats

Long-tailed bats are Threatened – Nationally Critical species and are assigned a Very High ecological value. They are known to be present around the periphery of Cambridge township and have been confirmed to commute and forage across the Site via acoustic surveys in 2021 and 2022.

Bat activity was detected by all monitors deployed within the Site with the number of bat echolocation calls (passes) per night ranging between 0.7 and 21.4 passes per night. This is a relatively high level of activity in most landscapes, but it is relatively low compared to other acoustic surveys undertaken locally. Notwithstanding, the Site is an important habitat for this Nationally Critical species as the bats are regularly present and are confirmed to forage in the area.

Potential effects of the land use change within the Site include:

- Mortality, injury, and/or disturbance of long-tailed bats during the removal of potential roost trees. Long-tailed bats as a species are considered Very High value due to their Threatened - Nationally Critical conservation status;
- Permanent loss of 2.86 ha of Moderate value foraging habitat (primarily willow-oak treeland), and 81.36 ha of Low value commuting and foraging habitat (pasture, hedgerows and gardens);
- Loss of approximately 120 potential roost trees assessed as High value habitat; and
- Degradation of habitat adjacent to the Site and within the gully and river embankment onsite due to increased levels of lighting.

With the exception of the permanent loss of commuting and foraging habitat, these effects can be adequately addressed through avoidance, minimisation, and mitigation measures. The permanent loss of 2.86 ha of Moderate value and 81.36 ha of Low value foraging and commuting habitat is assessed as a Moderate magnitude of effect on a Very High value species and therefore a High level of effect that will need to be addressed through compensation that is commensurate to this effect.

Birds

A total of 25 bird species have been recorded at the Site, including 12 native species and 13 exotic species. All of the native species recorded at the Site are common Not Threatened species, except for kākā (At Risk - Recovering) which was observed flying over the Site in August 2025.

Other At Risk bird species that may be present on the Site include four species of shag which may periodically utilise the vegetation along the river embankment. This habitat however is not expected to be negatively impacted by the proposed plan change. It is possible that bellbird also utilise the Site periodically and they are considered regionally rare. It is highly unlikely that bellbirds roost or nest within the Site.

Kākā and bellbird are assigned a Moderate ecological value. The remaining native bird species recorded onsite or potentially onsite and impacted for the proposed land use change are assigned a Low ecological value.

The potential effects on birds from the proposed land use changes include:

- Mortality, injury, and/or disturbance to common Not Threatened nesting or roosting birds during vegetation clearance and earthworks.
- Permanent loss and modification of pasture, exotic specimen trees, and hedgerow habitats.
- Post-construction degradation of habitats adjacent to residential land uses due to increased levels of lighting and noise.
- Enhancement of gully and river embankment habitats i.e. rank grass, privet-black locust forest, sedgelands, raupō reedland, watercress herbfields due to restorative actions e.g. native revegetation, and weed and pest animal management.

Each of these effects can be managed appropriately through avoidance, minimisation, and mitigation measures resulting in a Low overall level of effect on native birds from the proposed land use changes.

Herpetofauna (lizards)

No formal surveys have been undertaken for herpetofauna. However, numerous exotic plague skinks have been observed in the gully area. The native At Risk – Declining copper skink may also be present within the gully or river embankment. Copper skinks are assigned a high ecological value due to their conservation status.

The proposed level of effect of the proposed land use change is assessed as a Net Gain for native skinks due to the proposed enhancement of the gully area within the Site as part of the mitigation package.

Wetlands and freshwater

Approximately 3.19 ha of natural wetland habitat has been identified within the Site. Approximately 3.11 ha of the wetlands are within the gully area and the remaining 800 m² of wetland are seepage wetlands on an escarpment in the northern corner of the Site. Several watercourses run through the gully including two permanent streams, two intermittent streams, and one ephemeral stream.

The wetlands are a mix of vegetation types including rautahi sedgelands, raupō reedlands, and watercress herbfields. The sedgelands and raupō reedlands are assigned a Very High ecological value. The watercress herbfields and seepage wetlands are assigned a Moderate ecological value.

Three watercourses were assessed using Rapid Habitat Assessments. The two permanent streams were assessed as ‘Good’ condition and the intermittent stream that was surveyed was assessed as ‘Fair’ condition.

Adverse effects on the wetlands and streams will largely be avoided. However, stormwater infrastructure has the potential to adversely affect the wetlands and streams. Appropriate design and construction of stormwater infrastructure will therefore be essential to avoid adverse effects on the wetlands and streams. Enhancement actions across the gully and escarpment have been proposed as part of the plan change and these will have a positive effect on the ecological value of the wetlands and streams.

If stormwater infrastructure is designed and constructed appropriately and gully and escarpment enhancement works are undertaken as proposed, the magnitude of the effects on the wetlands and streams is assessed as Positive and the overall level of effect on the wetlands due to the proposed land use change is assessed as a Net Gain.

Compensation recommendations

A variety of measures have been proposed and mentioned throughout this assessment to avoid, minimise, and remedy the actual and potential ecological effects on the features identified on the Site. These largely include avoiding and minimising effects by avoiding areas with high value features such as the gully area as per the effects management hierarchy.

Compensation is required to balance the potential effects from the proposed plan change on long-tailed bats due to the permanent loss of 2.86 ha of moderate value and 81.36 ha of low value commuting and foraging habitat having a high level of effect.

The proposed compensations actions include:

- Plant 8,420 long-lived tree species (150+ years) known to be used by long-tailed bats for roosting within the proposed reserves and along the western boundary of the site.
- Plant an additional 20,000 native trees, shrubs and herbaceous plants to encourage foraging and commuting within the proposed reserves.
- Undertake predator control and monitoring across the proposed reserves onsite, targeting possums, rats, mustelids, and cats until the land is vested with Waipa District Council.
- Provide a \$200,000 contribution for predator control in the wider landscape to Waipa District Council or a local community trust with the necessary knowledge and skill set.

If these measures to avoid, minimise, mitigate, and compensate the actual and potential effects of the proposed plan change are carried out in full, it is considered that the potential ecological effects of the proposed changes in land use will be appropriately addressed.

1 Introduction

Titoki Landcare was engaged by Powerup Business Consulting Limited to identify the ecological values present at the rural zoned property at 37 Maungatautari Road, Leamington (the Site) and thereafter to assess the ecological effects of a proposed plan change (PPC) for the Site.

This report provides:

- A summary of the proposed plan change;
- Identification of the existing natural features on the Site;
- Assessments of the ecological impacts of the proposed plan change and residential development;
- Recommendations to avoid, minimise, and remedy any effects assessed as moderate or higher; and
- Compensation recommendations to manage any residual ecological effects that cannot be avoided, minimised, or remedied.

1.1 Site summary

The Site is approximately 98.65 hectares and between 1800-1900 m long and 270-750 m wide. It is located on the south-eastern fringe of Cambridge town on the northern side of Maungatautari Road (Figure 1).

The Site is located in the Hamilton Ecological District. This is a highly degraded ecological district with less than 2% of indigenous ecosystems remaining. Landforms present within the Site include alluvial plains, river terraces, gully embankments and gully floors. The Site would have naturally been covered with native vegetation types as per Clarkson *et al.* (2007)¹.

The Site was cleared and converted to pasture prior to 1939² and is currently used for equine and dry stock farming. Most of the Site is currently pasture (c. 82.42 ha), but there is also a large gully area (8.90 ha) through the northern half of the Site, and a river embankment covered predominantly with weedy exotic trees such as privets and black locusts. The gully area includes several wetland areas and watercourses through its basin. The gully is predominantly covered in herbaceous vegetation but also has some trees and shrubs, most of which are exotic.

The northern boundary of the Site includes c. 525 m of the true left bank of the Waikato River. On the opposite side of the river is the Cambridge Golf Club. Along the western boundary of the property is the designated Cambridge greenbelt, a c. 200 m wide strip of open space through the town. The stretch of the greenbelt adjacent to the Site includes a nature reserve, a dog park, the Leamington Rugby Sports Club, and the Leamington Pony Club.

No areas on the Site are identified as Significant Natural Areas in the Waipā District Plan. However, northern parts of the Site along the Waikato River are within the 'Biodiversity Corridor – 750m River Stream Corridor' identified in the Waipā District Plan maps.

¹ Clarkson, B. D., Clarkson B. R., & Downs, T. M. (2007). Indigenous Vegetation Types of the Hamilton Ecological District. CBER Contract Report 58.

² Based on a 1939 aerial image sourced from <http://retrolens.co.nz>.

The land contains well-drained orthic allophanic soil³.



Figure 1. Site location and extent of the proposed plan change.

1.2 Proposed plan change and development

The proposed plan change seeks to change the zoning of the property from Deferred Residential and Rural Zone to a mix of residential, commercial and reserve zones (Figure 2). Approximately half of the Site is currently Deferred Residential Zone and identified in the Waipā District Plan as a Future Growth Cell for Cambridge township. The remaining land is currently Rural Zone.

Medium Density Residential Zones are proposed to cover most of the site. A new network of roads will connect the residential areas. Two commercial zones are proposed as neighbourhood centres with one commercial zone off the proposed extension of Wordsworth Street and the second towards the southern end of the Site near Maungatautari Road.

Local purpose reserves are proposed for stormwater management, ecological maintenance and enhancement, amenity, and recreation. Stormwater infrastructure will be constructed through the Site as required. Ecological maintenance and enhancement is proposed across an area of approximately 11.7 ha of local purpose reserve and residential zone. These areas include the central gully and surrounding terrace, a terrace escarpment towards the northern end of the Site (within the proposed residential zone), and the river embankment along the northern boundary of the Site.

³ Landcare Research. (2025). S-Map Online. Sourced from <https://smap.landcareresearch.co.nz/maps-and-tools/app>.

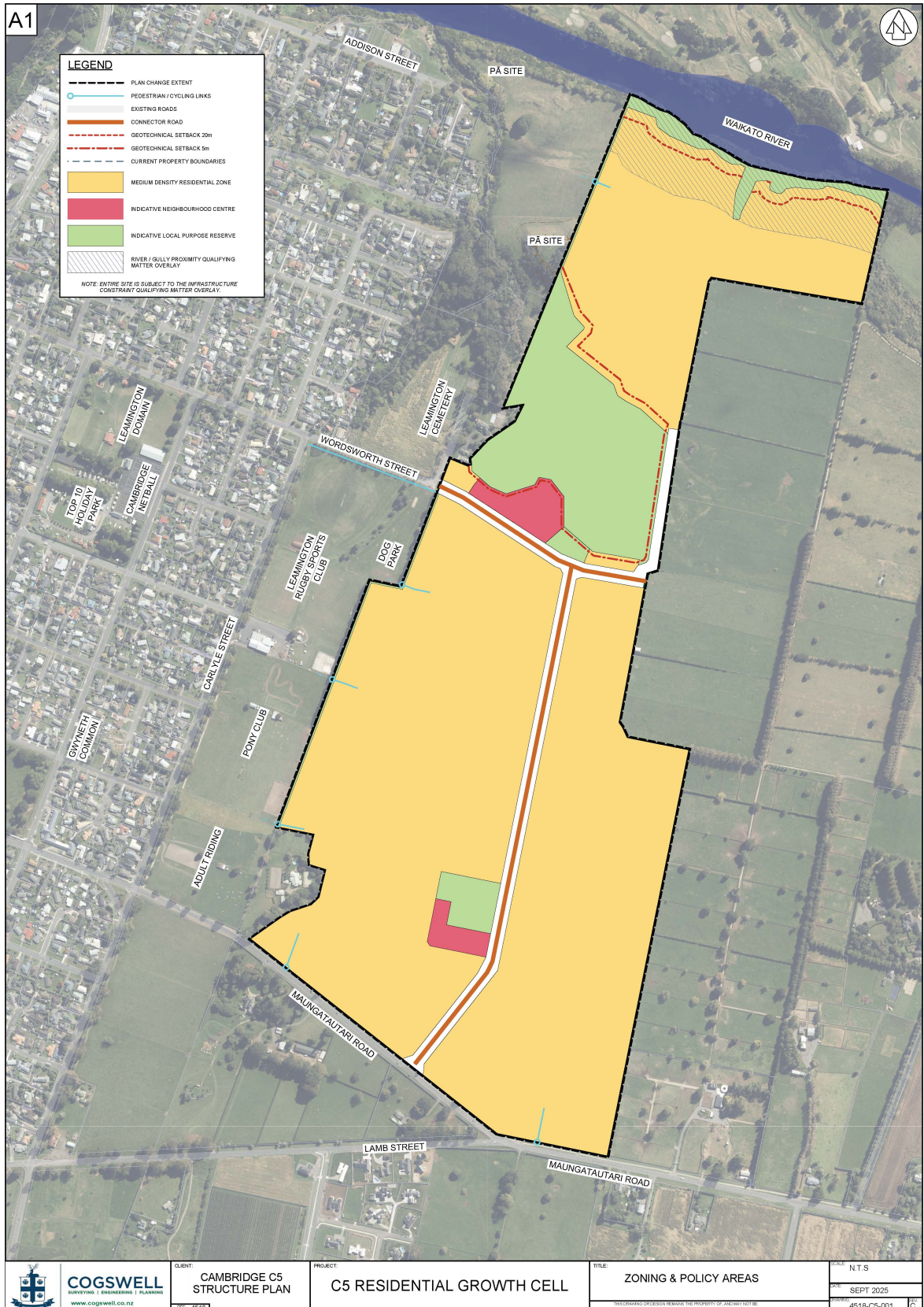


Figure 2. Structure Plan of proposed private plan change.

1.3 Assessment of ecological effects of the proposed development

The Environment Institute of Australia and New Zealand (EIANZ) Ecological Impact Assessment Guidelines (EclAG) for undertaking assessments of ecological effects in New Zealand defines a standard method of determining the impact of an activity in New Zealand⁴. This method involves three steps:

Step one - assigning ecological value

Ecological values are assigned one of five value categories - Negligible, Low, Moderate, High or Very High, with consideration to four 'matters':

- Representativeness;
- Rarity/distinctiveness;
- Diversity and pattern; and
- Ecological context.

Step two - assess magnitude of effect

The magnitude of an effect is measured according to five categories - Negligible, Low, Moderate, High or Very High.

Step three - assessment of the overall level of effects

The overall level of effect is established using a matrix based on the ecological values and the magnitude of effects on these values after measures to avoid, remedy or mitigate have been carried out. Categories include Positive, Negligible, Low, Moderate, High and Very High.

The overall level-of-effect categories are then used to determine if residual effects management is required over and above measures to reduce the severity of effects through efforts to avoid, remedy or mitigate adverse effects with the intention to achieve 'no net loss', and preferably a 'net gain', in biodiversity values.

A level of residual effect assessed as Moderate or greater usually requires efforts to offset or compensate for these effects.

A description of the ecological values of the Site and an assessment of the potential ecological effects of this plan change are detailed in the following sections of this report.

⁴ Roper-Lindsay, J., Fuller, S. A., Hooson, S., Sanders, M. D., & Ussher, G. T. (2018). Ecological impact assessment. EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd edition (Issue May).

2 Vegetation assessment

2.1 Vegetation assessment methods

Rapid vegetation assessments were carried out on 21, 23 and 24 July 2025 by Titoki Landcare ecologists, building on the information collected on 1 March 2022 by Boffa Miskell ecologists. Rapid vegetation assessments included broad vegetation classification based on the dominant species.

Descriptions of the vegetation classifications identified are provided in Section 2.2 below.

The vegetation is assigned a value based on its representativeness, rarity/distinctiveness, diversity and pattern, and ecological context. Value as habitat for fauna is excluded from this Section and is covered by the assessments in Section 3 to Section 5.

Vegetation classifications (excluding pasture) were mapped using geographic information software (GIS).

2.2 Vegetation description and value

A total of 10 broad vegetation classifications have been identified across the 98.65 ha Site. These are predominantly exotic, with pasture covering c. 82.42 ha. Exotic specimen trees within pasture have been included in the pasture classification, unless they provide more than 20% cover on the landscape.

Descriptions of each classification and the ecological value assigned to each are provided in Table 1.

Table 1. Vegetation classification descriptions and ecological value.

Vegetation classification	Area (ha)	Description and consideration	Ecological value
Pasture	82.42	Most of the Site is covered in highly managed exotic pasture with occasional exotic specimen trees such as oaks (<i>Quercus</i> spp.), willows (<i>Salix</i> spp.), and poplars (<i>Populus</i> spp.). This vegetation is not representative of the historical vegetation, it is not rare or distinctive, and doesn't contain any level of native diversity.	Negligible
Willow-oak treeland	3.22	Several paddocks towards the south of the Site and an area east of the horse stables have a higher density of trees. The trees are mostly willows and oaks and a variety of fruit trees are present near the stables. Under and between the trees is lawn, pasture and pavement. Tree cover is approximately 25%. This vegetation is not representative of the historical vegetation, it is not rare or distinctive, and doesn't contain any level of native diversity.	Negligible
Hedgerows	1.29	Hedgerows c. 1-3 m high of barberry (<i>Berberis glaucocarpa</i>) and broadleaf (<i>Griselinia littoralis</i>).	Negligible

		This vegetation is not representative of the historical vegetation. It is not rare or distinctive, but it contains one common native species.	
Amenity gardens	0.16	Amenity gardens are present around the existing dwellings on the property. These largely consist of small non-native ornamental shrubs and hedges. This vegetation is not representative of the historical vegetation, it is not rare or distinctive, and doesn't contain any native diversity.	Negligible
Tree privet-black locust forest	2.11	Forested areas are present along the river and in parts of the gully embankment. These areas are mostly dominated by tree privet (<i>Ligustrum lucidum</i>) and black locusts (<i>Robinia pseudoacacia</i>). Some native plants are present such as tree ferns, māhoe (<i>Melicytus ramiflorus</i>), and kānuka (<i>Kunzea robusta</i>). The vegetation isn't representative of historical vegetation being dominated by exotic trees. It isn't rare or distinctive. Kānuka is present which is classified as a Threatened species although it is a very common species. It contains a low level of native diversity. This exotic forest has naturally regenerated and includes shade-tolerant exotic trees which will likely continue to dominate the plant community for the long-term without intervention.	Low
Rautahi sedgeland	2.37	A mix of native and exotic herbaceous plants. Common species include rautahi (<i>Carex geminata</i>), swamp millet (<i>Isachne globosa</i>), sharp spike sedge (<i>Eleocharis acuta</i>), Yorkshire fog (<i>Holcus lanatus</i>), creeping buttercup (<i>Ranunculus repens</i>), and mercer grass (<i>Paspalum distichum</i>). This vegetation is partially representative of an early successional native wetland plant community. It has a high representation of native plants, but exotic plants are also common. It is a rare vegetation type due to 90% of historical wetlands being drained and degradation of remaining wetlands from introduced species. It has a moderate level of diversity and pattern with a mosaic of different species dominating the plant community in patches. It is considered to have a moderate level of resilience and functionality but is impacted by grazing and susceptible to invasion by willows if left unmanaged.	Moderate
Raupō reedland	0.43	Reedland dominated by raupō (<i>Typha orientalis</i>). Grey willows (<i>Salix cinerea</i>) are establishing through the reedland and cover approximately 25% of the reedland. This vegetation is representative of vegetation that may have naturally occurred in the wetlands on the Site. It is a rare vegetation that has largely been cleared for agriculture. It contains a low level of native diversity because it is heavily dominated by one native species. This vegetation has naturally regenerated following	High

		historical clearance and is at risk of being replaced by willow wetland if left unmanaged.	
Watercress herbfields	0.39	Several wetland and stream areas in the gully are covered with watercress (<i>Nasturtium officinale</i>). This vegetation is not representative of historical vegetation, it is not rare or distinctive, and doesn't contain any native plant species. Although this vegetation contains negligible ecological value, it is valued as a food source and for its medicinal properties.	Negligible
Rank grass	4.88	Overgrown pasture (rank grass) covers most of the gully embankments and areas of the gully basin, particularly where vehicle tracks have been established in the past. It includes grass species such as <i>Paspalum dilatatum</i> and cocksfoot (<i>Dactylis glomerata</i>) as well as a range of other species such as wild carrot. At the time of the rapid vegetation assessment, the Site had recently been sprayed targeting pampas grass (<i>Cortaderia selloana</i>) and blackberry (<i>Rubus fruticosus</i> agg.) which were previously common. This vegetation is not representative of historical vegetation, and it is not rare or distinctive. Native species were not encountered during the rapid vegetation assessment. Large parts of the vegetation had recently been sprayed including considerable areas of gully embankment which may negatively affect bank stability, particularly given the high sand content of the soil.	Negligible
Exotic shelterbelts	0.28	Several exotic shelterbelts are present on the property. These are dominated by Lombardy poplars (<i>Populus nigra</i>) and Japanese cedar (<i>Cryptomeria japonica</i>). Damage from Cyclone Gabrielle in February 2023 resulted in the removal of a Eucalyptus shelterbelt and some <i>Cryptomeria</i> and willows. This vegetation is not representative of historical vegetation, it is not rare or distinctive, and doesn't contain any native plant species.	Negligible



Figure 3. Vegetation distribution across the Site. Pasture areas are not mapped.

2.3 Potential effects of the PPC on vegetation

The land use changes proposed in the plan change will permanently remove approximately 85.93 ha of negligible and low value vegetation, including:

- 80.5 ha of pasture;
- 2.67 ha of willow-oak treeland;
- 0.70 ha of hedgerows;
- 0.19 ha of shelterbelt; and
- 0.16 ha of gardens.

This vegetation will primarily be replaced with residential dwellings and gardens, roads, and other infrastructure (including stormwater swales).

Additional proposed changes to vegetation include permanent enhancements to approximately 11.71 ha of reserve, which currently consists of:

- 2.11 ha of tree privet-black locust forest;
- 2.37 ha of rautahi sedgeland;
- 0.43 ha of raupō reedland;
- 4.88 ha of rank grass; and
- 1.92 ha of pasture.

2.4 Assessment of effects on vegetation

Only vegetation types with Negligible ecological value are expected to be adversely impacted by the change in land use i.e. pasture, willow-oak treeland, shelterbelts, hedgerows, and gardens. Adverse effects on features of Negligible value will only ever be Low or Very Low, regardless of the magnitude of the effect.

The enhancement of 11.71 ha of vegetation is assessed as a Net Gain.

2.4.1 Overall level of effect on vegetation

The overall level effect of the proposed plan change on vegetation is assessed as very low (Table 2).

Table 2. Summary of actual and potential effects on vegetation from the proposed plan change.

Vegetation type	Area (ha)	Value	Magnitude	Level of effect
Pasture	80.5	Negligible	Low	Very low
Willow-oak treeland	2.67	Negligible	Low	Very low
Hedgerows	0.70	Negligible	Moderate	Low
Exotic shelterbelts	0.19	Negligible	Low	Very low
Amenity gardens	0.16	Negligible	Low	Very low
Tree privet-black locust forest	2.11	Low	Positive	Net gain
Rautahi sedgeland	2.37	Moderate	Positive	Net gain
Raupo reedland	0.43	Moderate	Positive	Net gain
Rank grass	4.88	Negligible	Positive	Net gain
Pasture	1.92	Negligible	Positive	Net gain
Overall				Very low

3 Long-tailed bat assessment

Long-tailed bats (*Chalinolobus tuberculatus*) are currently classified as Threatened – Nationally Critical⁵, and are known to be present in highly modified landscapes within Waikato, including in and around Cambridge. As they are a Nationally Threatened species, they are assigned an ecological value of Very High and require management at any magnitude of effect from Low to Very High.

3.1 Long-tailed bat assessment methods

An assessment of the value of the Site as habitat for long-tailed bats was undertaken via:

1. A desktop assessment of previous survey information on long-tailed bats in the area;
2. Acoustic surveys across the Site and in the surrounding landscape in 2021 and 2022 by Boffa Miskell ecologists to detect the presence and relative activity levels of long-tailed bats within the Site; and
3. Habitat assessments to evaluate the suitability of the Site as commuting, foraging and roosting habitat.

3.1.1 Desktop assessment

The Department of Conservation's national bat database⁶ was reviewed for previous records of long-tailed bats within proximity of the Site. Publicly available and relevant literature was also reviewed, in particular the information collected as part of the State Highway 1 Cambridge to Piarere long-term improvements fast track resource consent application⁷.

3.1.2 Acoustic surveys

Two acoustic bat surveys were undertaken across the Site and surrounding landscape in 2021 and 2022 by Boffa Miskell ecologists. The surveys were undertaken using DOC-manufactured automatic bat monitors (ABMs) to record echolocation calls. The raw acoustic data collected in those surveys has been reanalysed for this assessment.

The first survey was conducted over 14 nights during April 2021 using 20 ABMs deployed within the Site. The second survey was conducted over 30 nights from December 2021 to January 2022 using 37 ABMs and surveyed the Site and the surrounding landscape. ABMs were deployed in locations targeting features preferred by long-tailed bats for commuting, foraging, and/or roosting.

ABMs were set to record bat echolocation calls from one hour before sunset to one hour after sunrise. The data collected from the ABMs was analysed using BatSearch 3.12 software. Each echolocation call identified was recorded as one bat 'pass' and is evidence of bats being active in the vicinity of the ABM⁸. The average number of passes per night on nights with optimal weather conditions (see Section 3.1.2.1) was calculated for each ABM to provide an index of bat activity in

⁵ O'Donnell, C.F.J., Borkin, K.M., Christie, J., Davidson-Watts, I., Dennis, G., Pryde, M., & Michel, P. (2023). Conservation status of bats in Aotearoa New Zealand, 2022. *New Zealand Threat Classification Series 41*. Department of Conservation, Wellington. 18 p.

⁶ National bat database sourced in June 2025 from the Department of Conservation.

⁷ Dodunski, C. (2024). SH1 Cambridge to Piarere Long Term Improvements Ecology: Long-tailed bat assessment. Technical report prepared for Waka Kotahi by WSP.

⁸ The range of an automatic bat monitor is approximately 50 m, and the microphones are omni-directional.

different areas of the Site and wider landscape, and to compare the results of the surveys with previous surveys in the wider landscape.

Echolocation calls made while foraging show a distinct pattern referred to as a 'feeding buzz' which can be identified within the data collected by the ABMs. If feeding buzzes are recorded by an ABM, it is evidence that bats are feeding within the vicinity of the ABM, and the area can be considered foraging habitat.

Acoustic monitoring with ABMs cannot be used to confirm if an area is roosting habitat for long-tailed bats.

3.1.2.1 Optimal weather conditions for acoustic surveys of long-tailed bats

Long-tailed bat activity is influenced by on overnight weather conditions such as temperature, rainfall, and wind speed. Overnight weather data through the survey periods was reviewed to identify any periods when weather was not optimal for bat activity.

Optimal weather conditions for monitoring long-tailed bats in this location are considered to be:

- Air temperature above 8 °C within the first four hours after sunset;
- Less than 5 mm of precipitation within the first four hours after sunset;
- Mean wind speed does not exceed 10 km/h in the first four hours after sunset;

Hourly weather data through the survey periods was sourced from the Hamilton station (ID: 26117) of New Zealand's National Climate database as this was the nearest weather station available.

3.1.3 Bat habitat assessment

A habitat assessment was conducted across the Site, considering potential commuting, foraging, and roosting habitat.

The foraging and commuting assessments were supported by the results of the acoustic surveys undertaken onsite.

A Titoki Landcare ecologist undertook a visual assessment of potential bat roosting habitat in July and August 2025. The assessment covered the proposed development footprint of the Site, i.e. it excluded trees in the gully and along the river embankment which are proposed to be new reserve areas. The assessment included a visual inspection of trees from the ground using binoculars for any features that could be used by long-tailed bats for roosting, including:

- Cavities;
- Hollows;
- Knot holes;
- Cracks;
- Flaking and peeling of bark;
- Epiphytes; and/or
- Broken or dead branches or trunk.

It was not possible to visually assess every tree due to some accessibility constraints around horses or foliage obscuring views. A conservative approach has been taken for any tree that could not be satisfactorily assessed.

Any tree with potential roost habitat identified was recorded and assessed as either a high, medium or low suitability for roosting based on the experience of ecologists and studies that have been undertaken on roost selection by long-tailed bats^{9,10,11}. Some areas contained clusters of potential roost trees and, where appropriate, these were assessed as a group rather than individually.

3.2 Long-tailed bat description and value

Long-tailed bats are a highly mobile microbat species endemic to New Zealand and are present across New Zealand. They are currently classified as Threatened – Nationally Critical due to monitored populations declining at a rate of 5-9% each year and the assumption that unmonitored populations are declining at similar rates⁵.

Long-tailed bats populations have large home ranges but have much smaller core areas where they spend the majority of their time. The home range of a well-studied population in Eglinton Valley, Fiordland is known to cover more than 10,000 ha and a radio-tracking survey of the population of bats around the south of Hamilton identified that local population had a home range of at least 5,278 ha^{12,13}. The bats spend most of their time however in core areas that are 5-10% of their full home range^{12,13}.

Long-tailed bats roost almost exclusively in trees during the day and emerge around sunset, primarily to forage (feed). They forage on flying insects on the wing. They are considered an edge adapted species and use the edges of vegetation and linear features such as streams, rivers, and shelterbelts to help them navigate their way around the landscape.

Long-tailed bats live in social groups, particular females and juveniles, who gather in communal (maternity) roosts to give birth and care for young pups¹⁴. Research indicates that there is little movement of individuals between social groups and that knowledge around foraging and roosting is passed down from mothers to young. In practical management terms, this means that different bat populations will behave differently from one another so what we know about the behaviour of one population should be treated with caution when considering other populations.

Being a Threatened - Nationally Critical species, long-tailed bats are assigned an ecological value of Very High.

⁹ O'Donnell, C. F. J. & Sedgely, J. A. (1999). Use of Roosts by the Long-Tailed Bat, *Chalinolobus tuberculatus*, in Temperate Rainforest in New Zealand. *Journal of Mammalogy*, 80(3), 913-923.

¹⁰ Sedgely, J. A., & O'Donnell, C. F. J. (1999). Roost selection by the long-tailed bat, *Chalinolobus tuberculatus*, in temperate New Zealand rainforest and its implications for the conservation of bats in managed forests. *Biological Conservation*, 88(2), 261-276.

¹¹ Sedgely, J. A. & O'Donnell, C. F. J. (2004). Roost use by long-tailed bats in South Canterbury: examining predictions of roost-site selection in a highly fragmented landscape. *New Zealand Journal of Ecology*, 28(1), 1-18.

¹² O'Donnell, C. F. J. (2001). Home range and use of space by *Chalinolobus tuberculatus*, a temperate rainforest bat from New Zealand. *Journal of Zoology*, 253, 253-264.

¹³ Davidson-Watts Ecology (Pacific). (2019). Long-tailed Bat Trapping and Radio Tracking Baseline Report 2018 and 2019 Southern Links, Hamilton. Prepared for AECOM.

¹⁴ O'Donnell, C. F. J. (2001) Advances in New Zealand mammalogy 1990-2000: Long - tailed bat, *Journal of the Royal Society of New Zealand*, 31:1, 43-57,

3.3 Long-tailed bat activity in the surrounding landscape

A total of 602 survey records exist within the national bat database between Hautapu and Piarere as of June 2025. Bats were recorded at varying levels of activity in 548 of these records (91%) and are therefore considered to be very commonly present across the wider landscape. Of the 54 records with no bats detected, 21 of them were within the boundaries of Cambridge town and this is the only area that has been monitored in the wider landscape that bats appear to mostly avoid.

The level of bat activity detected between Cambridge and Piarere is some of the highest activity recorded in New Zealand. Of the records in the national bat database with the necessary information, only two monitors have recorded higher average passes per night – one near a permanent maternity roost in Sandford Park, Hamilton, and the second near Taunoko in Manawātū-Whanganui Region.

The highest activity recorded in the wider landscape is around and south of Whitehall Quarry where surveys in 2021 and 2023 recorded an average of between 18.2 and 168.7 passes per night with the median survey recording 58 passes per night. A further 20 surveys within 20 km of the Site have recorded an average of more than 100 passes per night since 2020 (Figure 4).

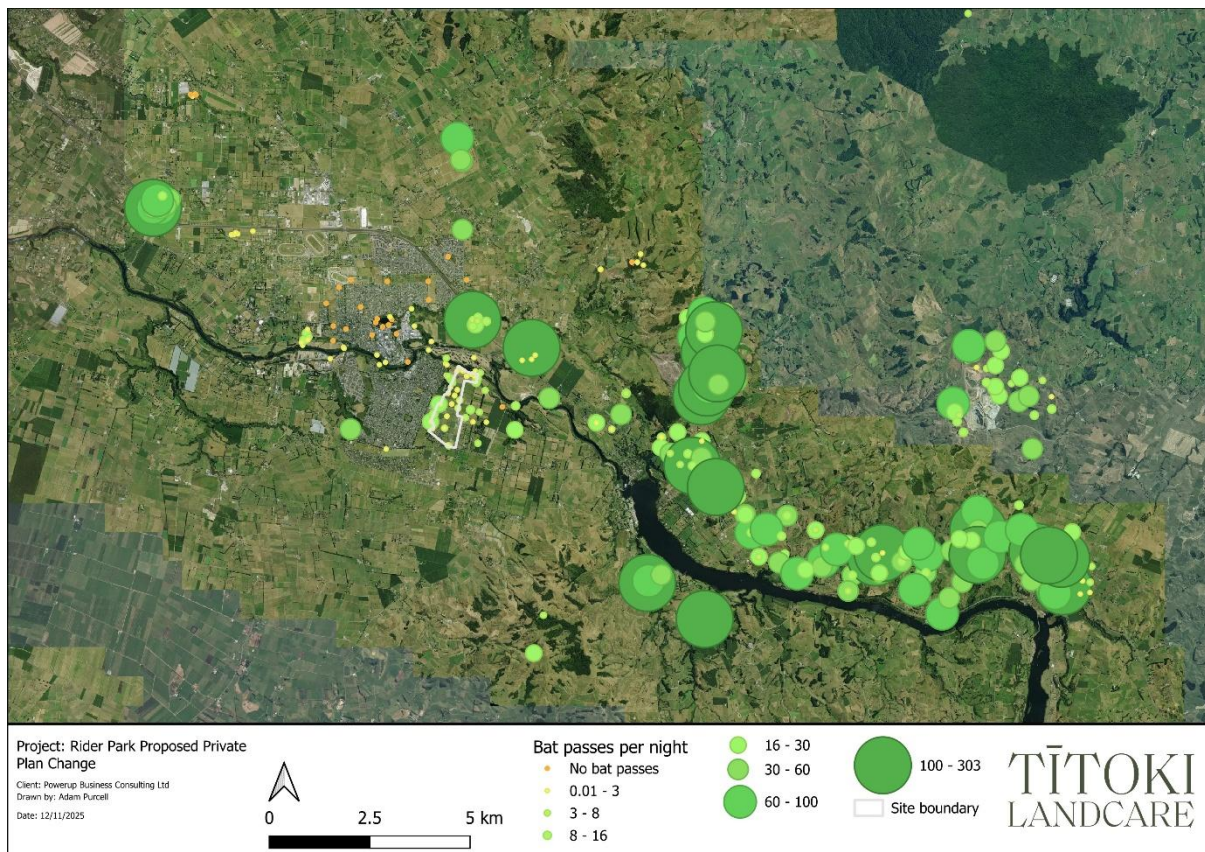


Figure 4. Records of long-tailed bat activity within the wider landscape from the national bat database and measured as mean passes per night.

3.4 Long-tailed bats on the Site

Bat activity was detected by all monitors deployed within the Site during the acoustic surveys conducted in 2021 and 2022. The number of bat passes per night ranged between 0.07 and 21.4 passes per night, with most ABMs (70%) detecting less than 3 passes per night (Figure 5).

Bat activity was highest along the shelterbelt that was present on the western boundary of the Site adjacent to the Cambridge greenbelt. The three detectors along this shelterbelt detected 14.0, 16.1, and 21.4 passes per night during the first survey in April 2021. Peak activity for each of these detectors was 107, 37, and 55 passes in a single night, respectively. Activity was lower in this area during the second survey (December 2021 - January 2022) during which activity at the same three sites was 10.5, 2.1, and 1.2, respectively (Figure 5). This shelterbelt provided a linear feature from the southern end of the forested gully that is contiguous with the Waikato River corridor. The shelterbelt was likely a useful navigational feature for long-tailed bats dispersing south of the Waikato River via the gully. Many of the trees along the shelterbelt were damaged during Cyclone Gabrielle and subsequently removed. The area has not been surveyed since to assess for changes in bat activity.

Other areas with higher bat activity included:

- The north-eastern boundary of the Site near the Waikato River – two ABMs recorded 10.9 and 11.0 passes per night in the first survey and 0.4 and 3.4, respectively, over the second survey;
- The willow-oak treeland towards the southern end of the Site – 7.2 passes per night in the first survey and 1.0 in the second; and
- Along a short shelterbelt at the top of the gully – 5.3 passes per night in the first survey and 0.9 in the second.

The activity at the remaining 13 monitoring sites ranged between 0.07 and 4.4 passes per night for both surveys.

Feeding buzzes were recorded at six monitoring locations across the Site with the level of foraging ranging between two and five feeding buzzes over both surveys at each of the six monitoring locations.

Multiple ABM locations recorded calls within the first hour after sunset, and often within the first 30 minutes during the December 2021/January 2022 survey. This could suggest that long-tailed bats were roosting nearby, although they are able to travel several kilometres in a few minutes.

Weather was optimal for all survey nights for both surveys (Appendix A).



Figure 5. Mean number of bat passes per night recorded by each ABM during the 2021 and 2022 acoustic surveys completed by Boffa Miskell ecologists.

3.5 Long-tailed bat habitat assessment

The Site contains a range of habitats used by long-tailed bats for varying activities as described below.

3.5.1 Commuting habitat

The entire Site in its current state can be considered commuting habitat for long-tailed bats of varying quality. Linear features such as shelterbelts, the river embankment, and terrace escarpments are likely preferred commuting pathways, but bats will travel across open pasture (as shown by the acoustic survey results) and around dwellings if the density of dwellings is not too high.

The recently removed shelterbelt along the western boundary of the Site was a 750 m long linear feature that provided a connection to the Cambridge greenbelt, including a forested gully area to the north. This feature recorded the highest levels of bat activity within the site during both acoustic surveys, and was likely used as a dispersal corridor facilitating access of long-tailed bats into the Site and the Cambridge greenbelt. Only eight trees remain of this feature along approximately 150 m since being removed post Cyclone Gabrielle.

3.5.2 Foraging habitat

The entire Site is potentially foraging habitat for long-tailed bats, although certain features are more likely to encourage foraging within the Site. The willow-oak treeland, tree privet-black locust forests, wetlands, and streams are thought to likely provide the best foraging habitat on the Site. Several feeding buzzes were recorded in these areas in the acoustic surveys, particularly in the willow-oak treeland. Hedgerows and shelterbelts are also considered better foraging habitat than the pasture as long-tailed bats are generally considered edge-adapted foragers.

3.5.3 Roosting habitat

The visual assessment of trees within the proposed development footprint of the Site (i.e. excluding proposed reserve areas) identified approximately 120 trees that contain or might contain features suitable for roosting. These are almost exclusively exotic trees except for one native tītoki (*Alectryon excelsus* subsp. *excelsus*). Approximately 50 trees are within a Lombardy poplar shelterbelt off Maungatautari Road.

Of the c. 120 trees identified as potential roost habitat, c. 20 were assessed as having features of high suitability for long-tailed bat roosting, c. 70 had features that are moderately suitable for long-tailed bat roosting, and c. 30 had features of low suitability for long-tailed bat roosting.

3.6 Ecological value of the Site as habitat for long-tailed bats

Bat activity was detected by all monitors deployed within the Site with the number of bat passes per night ranging between 0.07 and 21.4 passes per night. This is a relatively high level of activity in most landscapes, but it is relatively low compared to other surveying undertaken locally (Figure 4).

3.6.1 Foraging and commuting habitat

The detection of bat activity and feeding buzzes within the Site confirms the Site is commuting and foraging habitat for long-tailed bats. The exotic shelterbelts, tree privet-black locust forests, willow-oak treelands, wetlands, and stream areas are considered to be of higher value as commuting and foraging habitat for long-tailed bats than pasture, rank grass, gardens and hedgerows. Given the frequency of bat activity detected in the wider landscape, and the wide ranging behaviour of long-

tailed bats, most if not all of the rural areas around Cambridge are likely to be used by bats for foraging and commuting. The exotic shelterbelts, treelands, wetlands, and streams within the Site are assessed as being of Moderate ecological value as foraging and commuting habitat for long-tailed bats. The remaining areas within the Site are assessed as being of Low ecological value as foraging and commuting habitat for long-tailed bats.

3.6.2 Roosting habitat

Roosting habitat is a key factor limiting the abundance of long-tailed bats in modified landscapes, alongside predation by introduced mammals. Approximately 120 trees have been identified within the development footprint of the site as potential roosting habitat. Given the possibility of long-tailed bats utilising the trees for roosting, the potential roosting trees are assessed as having a High ecological value.

3.7 Potential effects of the PPC on long-tailed bats

The change in land use within the Site has several potential adverse effects on long-tailed bats, including:

- Mortality, injury, and/or disturbance of long-tailed bats during the removal of potential roost trees;
- Permanent loss of 2.86 ha of Moderate value and 81.36 ha of Low value commuting and foraging habitat;
- Loss of approximately 120 potential roost trees assessed as High value habitat; and
- Degradation of habitat adjacent to the Site and within the proposed reserves onsite due to increased levels of lighting.

There are also potential positive impacts through the creation of new suitable roosting habitat in the medium to long term via planting within proposed reserves, an escarpment within a residential zone, and along the western boundary, replacing trees lost from the shelterbelt following Cyclone Gabrielle.

3.8 Assessment of effects on long-tailed bats

3.8.1 Mortality, injury, and/or disturbance during potential roost removal

There is potential for long-tailed bats to be killed, injured and/or disturbed during the removal of potential roost trees.

The risk of mortality, injury and/or disturbance to bats can be minimised by avoiding the removal of the roost trees where possible and following established protocols for minimising the risk of felling active bat roosts. If the necessary protocols are followed, no long-tailed bats should be killed, injured, or disturbed during the removal of trees and the magnitude of this effect will be Negligible. A Negligible magnitude of effect on Very High value long-tailed bats is an overall Low level of effect.

3.8.2 Permanent loss of commuting and foraging habitat

Given the general avoidance of urban areas around Cambridge town by long-tailed bats, the proposed plan change is expected to result in bats generally avoiding the proposed residential and commercial areas within Site. The loss of Moderate value foraging habitat is expected primarily from the partial removal of the willow-oak treeland plus the isolation of the remaining willow-oak treeland from suitable bat habitat. Low value habitat is expected to be lost through the conversion

of pasture to residential and commercial land uses. This has been calculated as a loss of 2.86 ha of Moderate value and 81.36 ha of Low value commuting and foraging habitat for long-tailed bats.

Assessing the magnitude of this effect is dependent on understanding the home range and behaviour of the bats on the Site e.g. what other areas do they visit, where do they spend most of their time (i.e. where are their core areas), and where do they roost. However, we have minimal understanding of the home range for this population as no radio-tracking has been carried out which creates difficulty in assessing the magnitude of effects of the loss of habitat.

As such, we have assumed that the home range of the bats present on the Site is at a similar scale to the home ranges and core areas identified through radio-tracking studies undertaken and reported in Hamilton¹³. Aside from Cambridge township, the roughly 5,000 ha area around the Site is almost entirely characterised by pastoral land very similar to the site and the removal of 84.22 ha is a small alteration from baseline conditions. Given we have no information of their core areas, we have been conservative and assessed the loss of 84.22 ha of commuting and foraging habitat as a Moderate magnitude of effect on the local population of long-tailed bats. A Moderate magnitude of effect on the Very High value long-tailed bats is assessed as a High level of effect.

This High level of effect will require compensation either onsite and/or offsite to appropriately address the impacts on the bat population. Compensation options are provided in more detail in Section 9 and include:

- Enhancement of commuting and foraging habitat inside and outside of the development footprint e.g. planting trees and shrubs for commuting and foraging, or creating meadows and wetlands as foraging habitat;
- Enhancement of existing potential roosting habitat e.g. predator control around potential roost trees; and
- Creation of new roosting habitat e.g. planting tree species known to be used for roosting, installing artificial roost boxes, cutting cavities into exotic trees.

3.8.3 Loss of available roosting habitat

Approximately 120 potential roosting trees have been identified within the Site that are likely to be removed as part of the proposed plan change. This will result in a loss of potential roosting habitat for long-tailed bats.

Considering there are substantially more potential roost trees in the surrounding landscape e.g. the gully area immediately west of the site and Waikato River corridor, the magnitude of effect of removing of approximately 120 potential roosting trees on the availability of roosting habitat for the local population of long-tailed bats is assessed as Low. A Low magnitude of effect on the Very High value long-tailed bats is a Moderate level of effect.

In the short to medium-term, artificial roost boxes are an option to mitigate the temporary loss of roosting habitat. These have been shown to be regularly used by the Hamilton long-tailed bat population at 24 sites across eight parks in the city¹⁵. Short-term and medium-term loss of potential

¹⁵ Robinson, H., Ling, N., Tempero, G.W. (2024). Occupation of artificial roosts by long-tailed bats (*Chalinolobus tuberculatus*) in Hamilton City, New Zealand. New Zealand Journal of Zoology. Vol. 51, No. 2, pp. 186–199.

roosting trees can also be partially mitigated by increasing the suitability of roosting habitat within existing weedy tree species (e.g. tree privet and grey willows) on the Site by artificially creating cavities or poisoning the trees and leaving them standing to the development cavities naturally. Planting trees known to be used for roosting by long-tailed bats can mitigate the effect in the long-term.

Through a combination of planting trees, installing artificial roost boxes, and treating weedy trees, the magnitude of effect from removing 120 potential roost trees is assessed as Negligible and the level of effect on long-tailed bats is assessed as Low.

3.8.4 Degradation of adjacent habitat due to increased levels of lighting

Light pollution from the proposed residential and commercial areas has the potential to reduce the quality of habitat in the proposed reserves and neighbouring areas¹⁶, i.e. the gully, river embankment, escarpment to be enhanced, Cambridge greenbelt and neighbouring farm, causing bats to potentially avoid using those areas.

This can be avoided and/or minimised through:

- Establishing a tall hedge, shelterbelt, or other buffer around the boundary of the Site, particularly in spots where car lights will be directed along roads (Figure 6). Broadleaf hedges exist along much suggested 'Hedge/fence' areas and should be retained as much as possible;
- Restricting outdoor lighting on the edge of the Site and near reserve areas where restorative works are proposed within the Site to ensure added illuminance from fixed artificial outdoor lighting shall not exceed 0.3 lux (horizontal and vertical) at any height at the external boundary of any Light Management Area. Lighting attached to a vehicle is not considered to be fixed. A 20 m Light Management Area is suggested around these areas where lighting should be restricted to:
 - Fixed artificial lighting being installed as low as is practical and with the light emitting downwards.
 - Have a maximum colour temperature of 2700K.
 - Outdoor security lighting controlled with a motion sensor and set to a short duration e.g. five minutes or less.
- Designing the subdivision layout to minimise roads within Light Management Areas. Where roads cannot be avoided within Light Management Areas, street lighting should be designed to ensure light levels immediately outside the Site boundary and within reserves is minimised. The stretches of the Site boundary and reserves where car lights are directed into should receive additional screening if necessary to ensure light levels immediately outside the Site boundary and within the reserves do not exceed 0.3 lux.

If lighting is managed effectively, then it is expected that the bats will continue to use the green areas as they do through southern Hamilton and Karapiro Gully in Cambridge East⁶. If light is managed effectively around the boundary of the Site and the proposed reserve within the Site, the

¹⁶ Schamhart, T., Browne, C., Borkin, K. M., Ling, N., Pattemore, D. E., & Tempero, G. W. (2023). Detection rates of long-tailed bats (*Chalinolobus tuberculatus*) decline in the presence of artificial light. *New Zealand Journal of Zoology*, 51(2), 200–210.

magnitude of the effect of lighting on adjacent habitat is assessed as Negligible. A Negligible magnitude of effect on Very High value bats is a Low level of effect.



Figure 6. Proposed mitigation areas within Rider Park including proposed locations of hedges/fences, shelterbelts and Light Management Areas to minimise the impact of light on bat activity in land immediately adjacent to the Site.

3.8.5 Overall level of effect on long-tailed bats

Considering the above, the overall level of effect on long-tailed bats from the proposed plan change is assessed as **High**. This effect will require further mitigation, offsetting and/or compensation to ensure the effects are reduced. Recommendations for further mitigation, offsetting and/or compensation are provided in Section 9.

A summary of the actual and potential effects on long-tailed bats is presented in Table 3.

Table 3. Summary of actual and potential effects on long-tailed bats.

Actual or potential effect on long-tailed bats	Level of effect
Mortality, injury, and/or disturbance of very high value long-tailed bats during the removal of potential roost trees	Low
Permanent loss of 2.86 ha of moderate value and 81.36 ha of low value commuting and foraging habitat	High
Loss of available roosting habitat	Low
Degradation of habitat adjacent to the Site due to increased levels of lighting	Low
Overall	High

4 Bird assessment

4.1 Bird assessment methods

The actual and potential native bird species present on the Site were assessed using a combination of opportunistic observations of birds seen or heard during site visits in July and August 2025 and a review of bird database records in the area. Databases reviewed included:

- New Zealand Bird Atlas;
- iNaturalist; and
- eBird

4.2 Bird community description and value

Twelve native bird species and 13 exotic species were observed during site visits in 2025 (Table 4). All of the native species recorded at the Site are common Not Threatened species, except for kākā (*Nestor meridionalis*; At Risk - Recovering) which was observed flying over the Site in August 2025. It is possible that kākā utilise the Site periodically for foraging in the mature trees, but it is highly unlikely that they roost or nest within the Site.

A list of additional native species that may inhabit the Site is provided in Table 5. Other At Risk bird species that may be present on the Site include four species of shag which may periodically utilise the vegetation along the river embankment. This habitat however is not expected to be negatively impacted by the proposed plan change. It is possible that bellbird also utilise the Site periodically and they are considered regionally rare. It is highly unlikely that bellbirds roost or nest within the Site.

Kākā and bellbird are assigned a moderate ecological value. The remaining native bird species recorded onsite or potentially onsite and impacted for the proposed land use change are assigned a low ecological value.

Table 4. A list of bird species observed onsite in July and August 2025 and the threat status.

Common name	Species name	Threat status
Fantail	<i>Rhipidura fuliginosa</i>	Not Threatened
Grey warbler	<i>Gerygone igata</i>	Not Threatened
Kākā	<i>Nestor meridionalis</i>	At Risk - Recovering
Kingfisher	<i>Todiramphus sanctus</i>	Not Threatened
Paradise shelduck	<i>Tadorna variegata</i>	Not Threatened
Pūkeko	<i>Porphyrio melanotus melanotus</i>	Not Threatened
Silvereye	<i>Zosterops lateralis</i>	Not Threatened
Spur-winged plover	<i>Vanellus miles</i>	Not Threatened
Swamp harrier	<i>Circus approximans</i>	Not Threatened
Tūi	<i>Prosthemadera novaeseelandiae</i>	Not Threatened
Welcome swallow	<i>Hirundo neoxena</i>	Not Threatened
Chaffinch	<i>Fringilla coelebs</i>	Introduced and naturalised
Common pheasant	<i>Phasianus colchicus</i>	Introduced and naturalised
Eurasian blackbird	<i>Turdus merula</i>	Introduced and naturalised

Goldfinch	<i>Carduelis carduelis</i>	Introduced and naturalised
House sparrow	<i>Passer domesticus</i>	Introduced and naturalised
Magpie	<i>Gymnorhina tibicen</i>	Introduced and naturalised
Mallard	<i>Anas platyrhynchos</i>	Introduced and naturalised
Myna	<i>Acridotheres tristis</i>	Introduced and naturalised
Redpoll	<i>Carduelis flammea</i>	Introduced and naturalised
Rock pigeon	<i>Columba livia</i>	Introduced and naturalised
Song thrush	<i>Turdus philomelos</i>	Introduced and naturalised
Skylark	<i>Alauda arvensis</i>	Introduced and naturalised
Spotted dove	<i>Streptopelia chinensis</i>	Introduced and naturalised
Starling	<i>Sturnus vulgaris</i>	Introduced and naturalised

Table 5. Native bird species not observed onsite but potentially present.

Common name	Species name	Threat status
Black shag	<i>Phalacrocorax carbo novaehollandiae</i>	At Risk - Relict
Little shag	<i>Phalacrocorax melanoleucos brevirostris</i>	At Risk - Relict
Little black shag	<i>Phalacrocorax sulcirostris</i>	At Risk – Naturally Uncommon
Pied shag	<i>Phalacrocorax varius</i>	At Risk - Recovering
Bellbird	<i>Anthornis melanura</i>	Not Threatened (regionally rare)
Kererū	<i>Hemiphaga novaeseelandiae</i>	Not Threatened
Morepork	<i>Ninox novaeseelandiae</i>	Not Threatened
Pied stilt	<i>Himantopus himantopus</i>	Not Threatened
Shining cuckoo	<i>Chrysococcyx lucidus</i>	Not Threatened
White-faced heron	<i>Egretta novaehollandiae</i>	Not Threatened

4.3 Potential effects of the PPC on birds

The potential effects on birds from the proposed land use changes include:

- Mortality, injury, and/or disturbance to common Not Threatened nesting or roosting birds during vegetation clearance and earthworks.
- Permanent loss and modification of pasture, exotic specimen trees, and hedgerow habitats.
- Post-construction degradation of habitats adjacent to residential land uses due to increased levels of lighting and noise.
- Enhancement of gully and river embankment habitats i.e. rank grass, privet-black locust forest, sedgeland, raupō reedland, watercress herbfields through restorative actions e.g. native revegetation, and weed and pest animal management.

4.4 Assessment of effects on birds

4.4.1 Mortality, injury, and/or disturbance to birds during vegetation clearance and earthworks

The magnitude of the effect of mortality, injury and/or disturbance to common Not Threatened bird species is considered Moderate on these Low value bird species. A Moderate magnitude of effect on Low value species is a Low level of effect.

As the risk of injury or mortality is considered highly unlikely to any At Risk or regionally rare species, the magnitude of effect on these species is considered Negligible.

4.4.2 Permanent loss and modification of pasture, exotic specimen trees, and hedgerow habitats

The permanent loss and modification of pasture, exotic specimen trees, and hedgerow habitats will have an impact on the bird community at the Site. The loss of this habitat is considered a minor shift away from the current conditions for the wider landscape.

Of the native bird species present in the Site, the conversion of pasture to residential land use will likely adversely affect paradise shelducks, pūkeko, swamp harriers, and welcome swallows, and potentially white-faced herons which haven't been recorded onsite but potentially do use it. All of these species are Not Threatened and many of their populations are larger now than historically due to the conversion of land to pasture. Other native species will likely continue to inhabit the Site once it has been developed into mostly residential land use.

The magnitude of effect from the loss of these habitats is assessed as Low. A Low magnitude of effect on Low value species is assessed as a Very Low level of effect.

4.4.3 Post-construction degradation of habitats due to increased levels of lighting and noise

The potential degradation of habitats adjacent to residential land uses would impact species adapted to living in modified landscapes with humans present i.e. pūkeko, swamp harriers, welcome swallows, white-faced herons.

The magnitude of effect of the habitat degradation due to increased light and noise is assessed as Low. A Low magnitude of effect on Low value species is assessed as a Very Low level of effect.

4.4.4 Enhancement of gully and river embankment habitats through restorative actions

Restorative actions within the gully and along the river embankment such as native planting and pest animal control will enhance the habitat quality for several native species. It will also provide more suitable habitat for higher value species such as bellbirds, kākā, and shags.

The magnitude of effect of gully and river enhancements is assessed as Positive. A Positive magnitude of effect on Low and Moderate value species is assessed as a Net Gain.

4.4.5 Overall level of effect on birds

In consideration of the above factors, we have assessed the overall level of effect on birds from the proposed land use changes as **Low**. A summary of the actual and potential effects on birds is provided in Table 6.

Table 6. Summary of the actual or potential effects on birds.

Actual or potential effect on birds	Level of effect
Mortality, injury, and/or disturbance to common Not Threatened nesting or roosting birds during vegetation clearance and earthworks	Low
Permanent loss and modification of pasture, exotic specimen trees, and hedgerow habitats	Very low

Post-construction degradation of habitats adjacent to residential land uses due to increased levels of lighting and noise	Very low
Enhancement of gully and river embankment through restorative actions	Net gain
Overall	Low

5 Lizard assessment

5.1 Lizard assessment methods

No formal surveys were carried out onsite for lizards due to detection rates for New Zealand lizards during surveys being generally poor and the requirement for a Department of Conservation Wildlife Act Authority to catch lizards and confirm their species.

A review of relevant literature and recorded observations of native lizards in the area was undertaken to identify what native lizard species might be present within the Site. This included a review of database such as the Department of Conservation Herpetofauna Bioweb database and iNaturalist.

A qualitative habitat assessment was carried out across the Site to identify potential habitat for native lizards potentially in the Site in July and August 2025.

5.2 Lizard species potentially present onsite and value

Based on records of native lizards¹⁷ within the area and the experience and knowledge of Titoki Landcare ecologists, the only native species considered potentially present on the Site is the copper skink (*Oligosoma aeneum*; At Risk – Declining¹⁸). Two observations of this species have been recorded in Cambridge in 2025 on iNaturalist¹⁹. Any copper skinks present in the area are expected to be at low densities due to predation by mammalian predators and the Site's long history of disturbance including ongoing maintenance/modification of pastoral grazing. As copper skinks are classified as At Risk – Declining they are assigned a high ecological value.

Ornate skink (*Oligosoma ornatum*; At Risk – Declining) is the only other native skink known to be present in the local area in lowland habitats similar to this site, but is only known to be present in one location in Hamilton (21 km north of the Site). Given the rarity of this species in the area and the unsuitable habitat available on the Site, it is highly unlikely that ornate skinks are present.

The invasive plague skink (*Lampropholis delicata*) was observed several times within the gully onsite during July 2025 and there is likely a considerable population of this species in this area. The population of plague skinks would be competing for resources with native copper skinks if they are present.

5.3 Copper skink habitat onsite and value

Habitat assessments on the Site focused on identifying ground-level habitats that might provide suitable refugia for copper skinks such as dense vegetation and leaf litter, rotting logs, and other natural or artificial objects providing cover.

¹⁷ DOC BioWeb herpetofauna database

¹⁸ Hitchmough, R., Barr, B., Knox, C., Lettink, M., Monks, J., Patterson, G., Reardon, J., van Winkel, D., Rolfe, J. & Pascale, M. (2021). *Conservation status of New Zealand reptiles, 2021*. New Zealand Threat Classification Series 35. Department of Conservation, Wellington.

¹⁹ https://www.inaturalist.org/observations?subview=map&taxon_id=146313

Most of the Site is not considered suitable habitat for copper skinks, but various areas do provide potential habitat. Potentially suitable habitats include:

- Rank grass, wetlands, and exotic forest areas within the gully and along the river embankment; and
- Gardens around dwellings.

The gully and river embankment areas are larger and contain more potential habitat for copper skinks. They are also better connected to other potential habitats for copper skinks. These areas are therefore considered higher quality habitat than the gardens around dwellings. They are assigned a Moderate value as habitat for copper skinks.

The gardens around houses are small and isolated and are assigned a Low value as habitat for copper skinks.

5.4 Potential effects on lizards

The potential effects on lizards from the proposed plan change include:

1. Mortality of copper skinks during vegetation clearance and earthworks of gardens around dwellings;
2. Temporary loss of 0.16 ha of low value habitat; and
3. Enhancement of c. 11.7 ha of gully, river embankment and escarpment habitats.

5.5 Assessment of effects on lizards

5.5.1 Mortality of copper skinks during vegetation clearance and earthworks of gardens around dwellings

There is a small possibility that copper skinks are present and at risk of mortality during the clearance and earthworks of low quality habitat within the proposed residential and commercial development footprint.

Given the small possibility and the minor effect it would have on the population, this is assessed a Negligible magnitude of effect. A Negligible magnitude of effect on High value copper skinks is a Very Low level of effect.

5.5.2 Temporary loss of 0.16 ha of low value habitat

The clearance of 0.16 ha of low value amenity garden habitat is considered temporary as it is expected that considerably more garden habitats of similar value as habitat for copper skinks would be established with the conversion of the land into predominantly residential use.

The magnitude of this effect is assessed as Negligible. A Negligible magnitude of effect on High value copper skinks is a Very Low level of effect.

5.5.3 Enhancement of c. 11.7 ha of gully, river embankment and escarpment habitats

As the gully and river embankment areas are within the identified reserve zones of the proposed plan change and are proposed to be ecologically enhanced to compensate for effects on long-tailed bats, this is expected to result in an enhancement of these areas as habitat for copper skinks. In

particular, predator control and planting of ground cover plants will facilitate the enhancement of these areas as habitat for copper skinks.

The magnitude of effect these enhancements is assessed as Positive. A Positive magnitude of effect on High value copper skinks is a Net Gain.

5.5.4 Overall level of effect on lizards

In consideration of the above factors, we have assessed the overall level of effect on lizards from the proposed land use changes as a **Net Gain**. A summary of the effects on lizards in provided in Table 7.

Table 7. Summary of the actual or potential effects on lizards.

Actual or potential effect on lizards	Level of effect
Mortality of copper skinks during vegetation clearance and earthworks of gardens around dwellings	Very low
Temporary loss of 0.16 ha of low value habitat	Very low
Enhancement of c. 11.7 ha of gully, river embankment and escarpment habitats	Net gain
Overall	Net gain

6 Wetland assessment

6.1 Wetland assessment methods

Wetland habitats within the Site were identified in general accordance with the 'Wetland delineation protocols'²⁰ using the vegetation tool for delineating wetlands²¹, the hydric soils field guide²², and wetland hydrology tool²³ on July 23 and 24, 2025. A further visit was undertaken on October 3, 2025, to assess potential seepage wetland on an escarpment towards the northern end of the Site.

Where vegetation was clearly hydrophytic (i.e. all dominant species in the vegetation type have wetland indicator status rating of 'obligate' or 'facultative wetland'²⁴) and passed the rapid hydrophytic vegetation test, the area was identified as wetland habitat. If vegetation was not clearly hydrophytic, the dominance and prevalence tests were completed.

If the results of the dominance and prevalence tests were uncertain (i.e. prevalence index score between 2.5 and 3.5), soil and hydrology indicators were assessed.

Additional soil and hydrology tests were undertaken around the margins of wetlands in areas with uncertain vegetation (i.e. a dominance of facultative species e.g. Yorkshire fog and/or buttercup).

The boundaries of identified wetlands were walked with two handheld GPS units. GPX files from the GPS units were extracted and uploaded to GIS software. The average of the two GPX tracks was used in GIS to map the extent of each wetland.

Additional spot soil samples and hydrology assessments were used to verify/amend the boundaries of the wetland in areas where there was a gradual change in composition of the plant community.

6.2 Wetland descriptions and value

Approximately 3.19 ha of wetlands have been identified within the Site. This includes c. 3.11 ha in the gully area and c. 0.08 ha of seepage wetland on an escarpment in the northern part of the site (Figure 8).

The gully wetlands appear to have been subject to historical modifications and earthworks for the construction of tracks through the base of the gully. This has led to the creation of several hydrologically disconnected wetlands which would have historically been connected. The wetlands

²⁰ Ministry for the Environment. (2024). Wetland delineation protocols. Wellington: Ministry for the Environment.

²¹ Clarkson, B. (2013). A vegetation tool for wetland delineation in New Zealand. Prepared by Landcare Research for Meridian Energy Ltd

²² Fraser, S., Singleton, P. & Clarkson, B. (2018). Hydric soils – field identification guide. Contract report prepared for Tasman District Council by Manaaki Whenua Landcare Research.

²³ Ministry for the Environment. (2021). Wetland delineation hydrology tool for Aotearoa New Zealand. Wellington: Ministry for the Environment.

²⁴ A component of the vegetation tool for wetland delineation in New Zealand is to assign plants with a 'wetland indicator status rating'. Ratings are split into five categories of obligate (plants species occurring in wetlands >99%), facultative wetland (plant species occurring in wetlands c. 67-99% of the time), facultative (plant species occurring in wetlands c. 34-66% of the time), facultative upland (plants occurring in wetlands 1-33% of the time); upland (plants occurring in wetlands <1% of the time).

are unfenced and are exposed to grazing by stock. The identified wetlands within the gully have been split into three vegetation classifications – rautahi sedgeland (c. 2.37 ha), raupō reedland (c. 0.43 ha), and watercress herbfield (c. 0.39 ha) as described in Section 2.2.

The seepage wetlands on the escarpment include a collection of nine small wet areas (between c. 10 m² and 180 m²) dominated by a mix of herbaceous plants. Common species include yorkshire fog, rautahi, *Juncus bufonius*, kuawa (*Schoenoplectus tabernaemontani*), and mercer grass.

Wetlands are valuable for the range of services they provide such as water storage and filtration, flood protection, and habitat and food provision. Additionally, 90% of wetlands have been lost nationally so all remaining wetlands are significant. The dominance of native plants within the wetlands on the Site adds to their value, but this has been considered in Section 2.2.

The wetlands within the gully have been assigned a High ecological value due to their size, rarity, and the ecosystem services they provide. The wetlands on the escarpment have been assigned a Moderate ecological value due to their small size but still providing ecosystem services and supporting several native plant species.



Figure 7. Wetland extent within the boundaries of the Rider Park proposed plan change.

6.3 Potential effects on wetlands

The wetlands within the gully are within a proposed reserve and the escarpment area with the seepage wetlands has been identified as an additional area for protection and enhancement. The avoidance of these areas will allow potential adverse effects on the wetland areas to largely be avoided. However, stormwater management from the proposed land use changes has the potential to drain and/or degrade the wetlands if not designed and constructed adequately.

Actual or potential effects on the wetlands include:

- Loss of c. 800 m² of seepage wetland through the alteration of stormwater drainage;
- Contamination and pollution of the gully wetlands from stormwater drainage; and
- Enhancement through proposed restorative actions within the gully and escarpment.

6.4 Assessment of effects on wetlands

6.4.1 Loss of c. 800 m² of seepage wetland through the alteration of stormwater drainage

If stormwater infrastructure is constructed in a way that prevents the soakage of water through permeable surfaces and into groundwater, the seepage wetlands on the escarpment may be completely or partially lost. If stormwater infrastructure is designed to allow drainage of stormwater into groundwater (as is expected), the groundwater seepage through to the wetlands is likely to be maintained.

If stormwater infrastructure is designed and constructed appropriately, the effect on the seepage wetlands from stormwater drainage is assessed as a Negligible magnitude of effect. A Negligible magnitude of effect on the Moderate value wetlands is a Very Low level of effect.

6.4.2 Contamination and pollution of gully wetlands from stormwater drainage

Inadequate capacity and/or construction protocols of stormwater infrastructure for the proposed plan change have the potential to impact the wetlands by allowing untreated stormwater to enter the wetlands and/or allowing sediment run-off into the wetlands during construction. Appropriate design and construction of stormwater infrastructure will therefore be essential to avoid adverse effects on the wetlands.

If stormwater infrastructure is designed and constructed appropriately, the effect on the wetlands from stormwater drainage is assessed as a Low magnitude of effect. A Low magnitude of effect on the High value wetlands is a Low level of effect.

6.4.3 Enhancement through proposed restorative actions within gully and escarpment

Ecological enhancement of the wetlands is proposed as part of the compensation recommendations for effects on long-tailed bats and will include weed management, native planting, and pest animal control. Assuming this is carried out, the magnitude of the effect of enhancing the wetlands is positive and provides a Net Gain level of effect.

If enhancement works within the wetland are undertaken as proposed, the magnitude of the effects on the wetlands is assessed as Positive and the overall level of effect on the wetlands due to the proposed land use change is assessed as a Net Gain.

6.4.4 Overall level of effect on wetlands

In consideration of the above factors, we have assessed the overall level of effect on wetlands from the proposed land use changes as a **Net Gain**. A summary of the actual and potential effects on wetlands is provided in Table 8.

Table 8. Summary of the actual or potential effects on wetlands.

Actual or potential effect on wetlands	Level of effect
Loss of c. 800 m2 of seepage wetland through the alteration of stormwater drainage	Low
Contamination and pollution from stormwater drainage	Low
Enhancement through proposed restorative actions within the gully reserve and escarpment	Net gain
Overall	Net gain

7 Freshwater assessment

7.1 Freshwater assessment methods

Watercourses onsite were identified during Site walkovers in July 2025 and mapped in GIS software. Streams were classified as either permanent, intermittent, or ephemeral based on appropriate stream definitions in the Auckland Unitary Plan because they are not defined in the Waikato Regional Plan.

The intermittent and permanent watercourses identified onsite were assessed with rapid habitat qualitative assessments on 4 August 2025 following the National Rapid Habitat Assessment for Streams and Rivers²⁵. This assessment scores 10 habitat parameters out of 10 for a total possible score out of 100. Total scores are categorised into one of four condition classes being:

- Excellent – 76-100
- Good – 50-75
- Fair – 25-49
- Poor – 0-24

Weather during the freshwater assessments was fine and there had been no precipitation in the previous 48 hours. There had been heavy rain (48.2 mm) six days earlier on 29 July and a total of 59.4 mm was recorded in the two weeks prior to the habitat assessments.

7.1.1 March 2022 stream assessments

More detailed stream assessments were carried out in 2022 by Boffa Miskell ecologists on two watercourses on the Site and two watercourses downstream of the Site following the Waikato Regional Ecological Monitoring of Streams methods²⁶. For each watercourse, an assessment of habitat values was carried out including:

- Physical stream characteristics and riparian zones;
- Macrophyte and periphyton cover following the Waikato Regional Council guidelines²⁷;
- A rapid qualitative habitat assessment following the REMS methods; and
- Macroinvertebrate sampling following Protocol C2 for sampling and Protocol P1 for analysis to provide macroinvertebrate community indices as a measure of water and habitat quality^{28,29}.

Water quality spot measurements and water grab samples for chemical analysis were collected at three sites – one within downstream receiving environment of the gully, outside of the Site; and two

²⁵ Clapcott, J. (2015). National rapid habitat assessment protocol development for streams and rivers. Prepared for Northland Regional Council. Cawthron Report No. 2649. 29 p. plus appendices.

²⁶ Collier, K.J. & Kelly, J. (2005). *Regional guidelines for ecological assessments of freshwater environments: macroinvertebrate sampling in wadeable streams*. Environment Waikato Technical Report 2005/02.

²⁷ Environment Waikato. (2009). *Regional Guidelines for Ecological Assessments of Freshwater Environments – Aquatic Plant Cover in Wadeable Streams*. Technical Report 2006/47.

²⁸ Stark, J. D., Boothroyd, I. K. G., Harding, J. S., Maxted, J. R., & Scarsbrook, M. R. (2001). *Protocols for sampling macroinvertebrates in wadeable streams* (p. 65). Prepared for the Ministry for the Environment.

²⁹ Stark, J. D., & Maxted, J. R. (2007). *A user guide for the Macroinvertebrate Community Index* (Cawthron Report 1166). Prepared by Cawthron Institute for the Ministry for the Environment.

from two watercourses reach near the north-eastern corner of the property. Water quality data was compared against the Australian and New Zealand Guidelines for Freshwater and Marine Water Quality Guidelines³⁰.

Fish surveys were done along reaches within the same two sites. Fish surveys were undertaken with electric fishing machine following the New Zealand freshwater fish sampling protocols³¹. All species caught were identified to species level if possible and measured. The Fish Index of Biotic Integrity (Fish IBI) was calculated from the results of the surveys and used to help assess stream condition based on the composition of the fish community in the watercourses.

In addition to electric fish surveys, environmental DNA (eDNA) samples were collected at the same sites as the water samples, providing further information about the fish communities within the watercourses. The New Zealand Freshwater Fish Database was also reviewed for records of native fish nearby that may be present within the watercourses on the Site.

As the watercourses on the Site are within proposed reserve areas and outside of the primary development areas, it was not considered necessary to repeat this level of assessment in 2025.

7.2 Watercourse descriptions

Five watercourses were identified within the gully area in the Site (Figure 8). These include two permanent streams, two intermittent streams, and one ephemeral stream. Two watercourses around the outer edge of the gully basin are potentially artificially induced following historical track construction.

All of the watercourses in the gully drain into the forested gully habitat within the Cambridge greenbelt on the western boundary of the property which then drains into the Waikato River approximately 700 m to the north. Four of the watercourses merge before they exit the property.

The streams all have wide riparian margins that are vegetated with short stature, herbaceous riparian vegetation such as rautahi and Yorkshire fog. However, the streams are unfenced and are accessible to stock.

Rapid habitat assessments along the two permanent streams and the longer intermittent stream resulted in 'Good' score for the two permanent streams (55/100 and 54/100), and a 'Fair' score for the intermittent stream (46/100) (Table 9). They generally score high in the rapid habitat assessments for riparian width and shading, bank stability, and fish cover abundance. They score low for deposited sediment, invertebrate habitat, and hydraulic heterogeneity. The Boffa Miskell assessment of the primary stream through the gully (Watercourse 1) in 2022 assessed it as 'Optimal' in the REMS assessment with a score of 136 out of 180.

Two culverts were observed along the streams, including one perched culvert which may be impacting upstream migration of fish.

³⁰ ANZECC. (2000). *Australian and New Zealand guidelines for fresh and marine water quality*. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

³¹ Joy, M. K., David, B., & Lake, M. D. (2013). *New Zealand freshwater fish sampling protocols*. Part 1: Wadeable rivers and streams [New Zealand Freshwater Fish Sampling Protocols]. Massey University.

Table 9. Rapid habitat assessment scores for the three main watercourses in the gully and the filled watercourse in the north-eastern corner.

Habitat parameter	Watercourse 1	Watercourse 2	Watercourse 3
Deposited sediment	1	2	2
Invertebrate habitat diversity	6	8	8
Invertebrate habitat abundance	2	2	2
Fish cover diversity	2	4	4
Fish cover abundance	8	9	7
Hydraulic heterogeneity	5	5	2
Bank erosion	10	7	8
Bank vegetation	3	3	4
Riparian width	10	6	2
Riparian shade	8	8	7
Overall	55/100	54/100	46/100

Table 10. Stream habitat assessment results conducted by Boffa Miskell in 2022.

Habitat parameter	Watercourse 1	Forested gully site (offsite)
Riparian vegetation zone width	Optimal	Marginal
Vegetation protection	Optimal	Marginal
Bank stability	Optimal	Suboptimal
Channel sinuosity	Marginal	Poor
Channel alteration	Optimal	Poor
Sediment deposition	Optimal	Poor
Pool variability	Poor	Poor
Abundance & diversity of habitat	Optimal	Poor
Periphyton	Optimal	Marginal
Overall	Optimal	Marginal



Figure 8. Stream extent and classification on the Site.

7.2.1 Water quality

Water quality within the forested gully downstream of the site was unsatisfactory for multiple parameters (Table 11). Dissolved oxygen levels were low, specific conductivity and faecal coliforms were high, and nitrogen parameters were very high.

Table 11. Spot water quality measurements and chemical analysis from samples collected in March 2022.

Parameter	Forested gully	Guideline values
Dissolved oxygen (mg/L)	6.18	
Dissolved oxygen (%)	57.4	< 80%: unsatisfactory
Specific conductivity (µS/cm)	300	115
pH	7.2	<6.5: unsatisfactory
Temperature (°C)	12.1	>20°C: unsatisfactory
Turbidity (NTU)	0.9	>5: unsatisfactory
Total suspended solids (g/m ³)	<3	
Total nitrogen (g/m ³)	9.1	>0.5: unsatisfactory
Total ammoniacal nitrogen (g/m ³)	<0.010	0.01
Nitrate-N (g/m ³)	8.8	0.065
Nitrite-N + Nitrate-N (g/m ³)	8.8	0.04-0.1
Total kjeldahl nitrogen (g/m ³)	0.21	0.04-0.1
Dissolved reactive phosphorus (g/m ³)	0.011	0.014
Total phosphorus (g/m ³)	0.017	>0.04: unsatisfactory
Faecal coliforms (cfu/100 ml)	1,200	550

7.2.2 Macroinvertebrates

Pollution tolerant taxa dominated the macroinvertebrate samples collected from the gully watercourse in March 2023. The sample had an MCI_{sb} score less than 80 and SQMCI_{sb} score less than 4.00 indicating poor quality and probable severe pollution in the watercourse.

7.2.3 Fish

Three native fish species were captured during the electric fishing survey – shortfin eel (*Anguilla australis*; Not Threatened³²), longfin eel (*Anguilla dieffenbachii*; At Risk - Declining³²), and banded kokopū (*galaxias fasciatus*; Not Threatened). No introduced fish species were caught.

Two banded kokopū and 10 longfin eels were caught in the gully fishing site which returned an 'Excellent' rating for the Fish IBI.

eDNA samples detected these same three species plus the non-resident native Australian speckled longfin eel (*Anguilla reinhardtii*)³².

7.2.4 Ecological value of freshwater features

The ecological value of longfin eels is high due to it being classified as At Risk – Declining. The Australian speckled longfin eel is also assessed high ecological value due to it being a non-resident

³² Dunn, N.R., Allibone, R.M., Closs, G.P., Crow, S.K., David, B.O., Goodman, J.M., Griffiths, M., Jack, D.C., Ling, N., Waters, J.M., Rolfe, J.R. (2018). Conservation status of New Zealand freshwater fish, 2017. New Zealand Threat Classification Series 24. Department of Conservation, Wellington.

native. Shortfin eels and banded kokopū are assigned a low ecological value as they are Not Threatened species.

The watercourses within the gully are assigned a moderate to high ecological value due to their connectivity to the surrounding wetland gully system and downstream forested stream system and providing habitat for a high value fish community. There are however considerable opportunities for improvement, particularly in reducing nitrogen and faecal coliform pollution and improving stream riparian habitats.

7.3 Potential effect on freshwater

The actual and potential effects on the freshwater features on the Site include:

- Contamination and pollution of the waterways from stormwater drainage; and
- Enhancement through proposed restorative actions along the riparian margins within the gully.

7.4 Assessment of effects on freshwater features

7.4.1 Contamination and pollution from stormwater drainage

Inadequate capacity and/or construction protocols of stormwater infrastructure for the proposed plan change have the potential to impact the watercourses within the gully by allowing untreated stormwater to enter watercourses and/or allowing sediment run-off into the watercourses during construction. Appropriate design and construction of stormwater infrastructure will therefore be essential to avoid adverse effects on the wetlands. This will be addressed via resource consents at the time of development.

Given the existing water quality issues, if stormwater infrastructure is designed and constructed appropriately, the effect on the watercourses from stormwater drainage is assessed as a Negligible magnitude of effect. A Negligible magnitude of effect on the moderate to high value watercourses is a Very Low level of effect.

7.4.2 Enhancement through proposed restorative actions along the riparian margins within the gully

Ecological enhancement of the gully including riparian margins of the watercourses is proposed as part of the compensation package for long-tailed bats via weed management, native planting, and pest animal control. Likewise, the change in land use will remove stock access from the gully and watercourses. The magnitude of the effect of enhancing the stream riparian areas is positive and provides a Net Gain level of effect.

If riparian enhancements are undertaken as proposed, the magnitude of the effects on the watercourses is assessed as Positive and the overall level of effect is assessed as a Net Gain.

7.4.3 Overall level of effect on freshwater features

In consideration of the above factors, we have assessed the overall level of effect on freshwater features from the proposed land use changes as **Net Gain**. A summary of the actual and potential effects on freshwater features is provided in Table 8.

Table 12. Summary of the actual or potential effects on wetlands.

Actual or potential effect on freshwater features	Level of effect
Contamination and pollution from stormwater drainage	Very low
Enhancement through proposed restorative actions along the riparian margins within the gully	Net gain
Overall	Net Gain

8 Summary of effects assessments

Table 13 provides a summary of the actual and potential effects of the proposed plan change on the ecological features identified within the Site.

Effects on long-tailed bats are assessed as High and therefore require further mitigation, offsetting and/or compensation. The level of effect on all other features is assessed as less than Moderate and therefore do not require any further mitigation, offsetting or compensation.

Table 13. Summary of actual and potential effects on the ecological features identified on the Site.

Actual or potential effect	Level of effect
Vegetation	
Removal of 84.92 ha of pasture	Very low
Removal of 0.96 ha of hedging	Low
Removal of 0.16 ha of gardens	Very low
Removal of 2.11 ha of tree privet-black locust forest	Net gain
Enhancement of 2.37 ha of rautahi sedgeland	Net gain
Enhancement of 0.43 ha of raupō reedland	Net gain
Enhancement of 4.88 ha of rank grass	Net gain
Enhancement of 1.04 ha of pasture	Net gain
Overall level of effect on vegetation	Very low
Long-tailed bats	
Mortality, injury, and/or disturbance of very high value long-tailed bats during the removal of potential roost trees	Low
Permanent loss of 2.86 ha of moderate value and 81.36 ha of low value commuting and foraging habitat	High
Loss of available roosting habitat	Low
Degradation of habitat adjacent to the Site due to increased levels of lighting	Low
Overall level of effect on long-tailed bats	High
Birds	
Mortality, injury, and/or disturbance to common Not Threatened nesting or roosting birds during vegetation clearance and earthworks	Low
Permanent loss and modification of pasture, exotic specimen trees, and hedgerow habitats	Very low
Post-construction degradation of habitats adjacent to residential land uses due to increased levels of lighting and noise	Very low
Enhancement of gully and river embankment through restorative actions	Net gain
Overall level of effect on birds	Low
Lizards	
Mortality of copper skinks during vegetation clearance and earthworks of gardens around dwellings	Very low
Temporary loss of 0.16 ha of low value habitat	Very low
Enhancement of c. 11.7 ha of gully, river embankment, and escarpment habitats	Net gain
Overall level of effect on lizards	Net gain
Wetlands	
Contamination and pollution from stormwater drainage	Low
Enhancement through proposed restorative actions within the gully and escarpment	Net gain
Overall level of effect on wetlands	Net gain
Freshwater features	
Contamination and pollution from stormwater drainage	Very low

Enhancement through proposed restorative actions along the riparian margins within the gully	Net gain
Overall level of effect on freshwater features	Net gain

9 Effects management recommendations

The effects management hierarchy has been applied to the proposed plan change as per the National Policy Statement for Indigenous Biodiversity 2023 (NPS-IB)³³.

9.1 Measures proposed to avoid, minimise, remedy, offset, and compensate effects on ecological features

A variety of measures have been proposed throughout this assessment to avoid, minimise, remedy and compensate the actual and potential ecological effects on the features identified on the Site.

More than minor effects on vegetation, birds, lizards, wetlands, and freshwater values are avoided and minimised through measures such as avoiding residential and commercial land use in higher value areas (Table 14).

Additional measures are required to manage the potential effects on long-tailed bats as they are classified as Threatened – Nationally Critical, and the removal of trees and conversion of pasture to residential and commercial land uses (activities that are required for urban growth around Cambridge) will result in a more than minor effects on this Very High value species.

The removal of potential roosting habitat for long-tailed bats is assessed as a Moderate level of effect and recommendations are made to remedy this effect through the creation of new suitable roosting habitat within the Site to reduce the level of effect to Low.

The loss of foraging and commuting habitat through the conversion of agricultural land use to urban land use (commercial and residential) is unable to be replaced onsite (remediation) or offsite (offsetting) and therefore compensation is the only option available to balance the residual effects on long-tailed bats from this change in land use. Given the highly mobile nature of long-tailed bats, compensation has recently been agreed upon as an appropriate approach to effects management on similar projects within the Waipa District when the effects on long-tailed bats cannot be avoided, minimised, or remedied^{34,35}.

Table 14. Outline of measures to avoid, minimise, remedy, and compensate effects on ecological features for the Rider Park proposed plan change.

Ecological feature	Avoidance, minimisation, remediation, offset and mitigation measures
Vegetation	Avoidance – vegetation with moderate or high value (i.e. rautahi sedgeland and raupō reedland) is being excluded from residential or commercial areas and is included in proposed reserve zones. Only vegetation with negligible or low value will be within the residential and commercial development footprint.

³³ Ministry for the Environment. (2023). National Policy Statement for Indigenous Biodiversity 2023

³⁴ Berry, S., Manukau, T. & Hikuroa, A. (2025). Record of Decision of the Expert Consenting Panel Under Clause 36 of Schedule 10 of The Act. In the Matter of an Application by the New Zealand Transport Agency to the Environmental Protection Authority under the National Built Environment Act 2023 to authorise the State Highway 1 Cambridge to Piarere Long Term Improvement Project.

³⁵ Tepania, S. M. (2024). Consent Order. Decision [2024] NZEnvC 107. In the Matter of an Appeal under Clause 14 of the First Schedule of the Resource Management Act 1991 between Royal Forest And Bird Protection Society Of New Zealand Incorporated and Waipā District Council and Rukuhia Properties Limited and Titanium Park Limited.

Long-tailed bats	Avoidance – most of the highest value foraging, commuting, and roosting habitats (e.g. shelterbelts, wetlands, tree privet-black locust forests) are being retained. Some of these habitats will be removed however e.g. c. 120 potential roost trees and foraging habitat across pasture and willow-oak treeland. Minimisation – the risk of mortality, injury and disturbance to long-tailed bats during tree removal and earthworks will be minimised by following established protocols for minimising the risk of felling active bat roosts. The degradation of habitat adjacent to the Site due to increased levels of lighting can be minimised by: • Restricting outdoor lighting on the edge of the Site and near reserves; • Retaining/establishing a tall hedge, fence, shelterbelt or other buffer on the boundary of the Site and reserves; and • Minimising the presence of roads immediately adjacent to proposed reserves and the Rider Park boundary. Remediation – the loss of c. 120 potential roost trees is proposed to be remedied through a combination of short to medium-term remediation measures and long-term remediation measures. Recommended short to medium-term measures include the installation of artificial bats boxes and poisoning weedy trees (e.g. tree privets and black locusts) and leaving them <i>in-situ</i> to encourage the development of potential roosting habitat within the site. Given that we consider it unlikely but possible that bats could utilise these 120 trees for roosting, we recommend the installation and maintenance of 30 artificial bat boxes and poisoning of at least 120 weedy trees with a DHB ≥ 15 cm. The poisoning of weedy trees will need to be undertaken with consideration to the impact on bank stability and other bank stabilisation measures will need to be undertaken (e.g. planting) if the poisoning of a tree will potentially compromise bank stability. Installation of artificial roost boxes and poisoning of weedy trees can be undertaken in the existing forested gully and river embankment habitats onsite. Planting trees known to provide roosting habitat for long-tailed bats can mitigate the effects from the loss of potential roosting trees in the long-term. We recommend planting 360 trees of species known to provide roosting habitat for long-tailed bats within the gully, river embankment, and/or terrace escarpments onsite to address the loss of c. 120 potential roost trees. Compensation – the permanent loss of 2.86 ha of moderate value and 81.36 ha of low value commuting and foraging habitat is proposed to be compensated through a combination of actions as per below and detailed further in Section 9.2. • Plant 8,420 long-lived trees (150+ years) known to be used by long-tailed bats for roosting within the gully, river embankment and escarpment within the site. • Plant an additional 20,000 native trees, shrubs and herbaceous plants to encourage foraging and commuting within and along the gully, river embankment and escarpment. • Undertake predator control and monitoring across the gully, river embankment, and escarpment targeting possums, rats, mustelids, and cats until the land is vested with Waipa District Council. • Provide a \$200,000 contribution for predator control in the wider landscape to Waipa District Council or a local community trust with the necessary knowledge and skill set. It is recommended that the minimisation, mitigation and compensation activities for long-tailed bats be detailed in a Bat Management Plan for the proposed plan change.
Birds	Avoidance – the removal of the highest quality habitats for birds is being avoided i.e. wetlands and tree privet-black locust forest in the gully and along the river

	embankment. This will minimise the impact on the higher value species potentially present in the Site e.g. shags and bellbirds.
Lizards	Avoidance – the removal of the highest quality habitats for copper skinks are being avoided i.e. the gully area and river embankment.
Wetlands and freshwater features	Avoidance – the wetland areas and watercourses currently within the Site are all within proposed reserve areas or ecological enhancement areas within residential zone (i.e. the escarpment) and outside of the primary development footprint and therefore avoid most potential adverse effects. Minimisation – appropriate design and construction of stormwater infrastructure will ensure adverse effects on wetlands and watercourses from stormwater drainage are minimised. Stormwater infrastructure will need to be designed to have the capacity to manage heavy rainfall events to avoid the high value wetlands and moderate value watercourses being adversely affected from untreated stormwater. Stormwater infrastructure will need to be constructed following protocols that minimise the deposition of sediment into the wetlands and watercourses while soil is exposed during construction e.g. silt fences construction around earthworks sites as appropriate.

9.2 Compensation for adverse effects on long-tailed bats

Compensation is required to address the potential effects from the proposed plan change on long-tailed bats due to the permanent loss of 2.86 ha of Moderate value and 81.36 ha of Low value commuting and foraging habitat having a High level of effect.

9.2.1 Reasoning for compensation instead of offsetting

Loss of habitat for long-tailed bats is unavoidable for any urban development around Cambridge as bats are present all around the periphery of the town. Loss of roosting habitat can be replaced with new roosting habitat and can therefore be remedied or offset. Yet, the loss of 81.36 ha of pasture that is currently used by bats for foraging and commuting habitat cannot be replaced. This is because most of the surrounding landscape is already in this pastoral land use. Hence recreating pasture would require either removing forest and treeland (creating a perverse outcome of removing high value habitat to create lower value habitat), or by reverting urbanised areas back to pasture (which is not feasible for obvious reasons). However, existing low value foraging and commuting habitat can be improved.

The key threats to the survival of long-tailed bats are predation by introduced mammals and lack of roosting habitat, rather than foraging and commuting habitat availability. Focusing mitigation efforts on reducing predation threat and increasing roosting habitat availability through compensation is therefore expected to provide greater benefits for long-tailed bats than focusing solely on improving foraging and commuting habitat.

9.2.2 Compensation recommendations

Compensation actions could target the following components of long-tailed bat habitat for the local population:

1. Increase the amount of potential roosting habitat available;
2. Reduce predation pressure within their home range;
3. Improve the quality of foraging habitat within their home range; and/or

4. Improve connectivity across different parts of their home range.

The recommended compensation actions are outlined in Table 15. These are currently high-level recommendations, and the details of how these measures shall be implemented, along with the minimisation and mitigation measures outlined above, should be included in a Bat Management Plan developed and approved prior to site works commencing. The extent of the compensation action recommended is consistent with other recent local land developments of similar size and effect e.g. Waipa District Private Plan Change 20 - Airport Northern Precinct Extension and the Amberfield Subdivision. Most of the compensation recommendations are expected to be implemented onsite, with the exception being predator control in the wider landscape.

Table 15. Recommended compensation package for the loss of 2.86 ha of moderate value and 81.36 ha of low value commuting and foraging habitat for long-tailed bats.

Enhancement opportunity for the local long-tailed bats population	Recommendations
Increase the amount of potential roosting habitat	Plant 8,420 long-lived trees (150+ years) known to be used by long-tailed bats for roosting within the gully, river embankment, and escarpment areas within the site. This equates to 100 trees per hectare of commuting and foraging habitat lost.
Improve the quality of foraging and commuting habitat	Plant an additional 20,000 native trees, shrubs and herbaceous plants to encourage foraging and commuting within and along the gully, river embankment, and escarpment areas. These plants can be planted together with the 8,420 long-lived trees. Designing the layout of these trees to incorporate linear arrangements with a mix of short and tall statured vegetation will encourage bats to travel into the areas and utilise the foraging habitat. Planting along the western boundary of the site will encourage commuting through the Cambridge greenbelt immediately west of the site and encourage connectivity for long-tailed bats across the neighbouring landscape.
Reduce predation pressure within their home range	Undertake predator control and monitoring across the gully, river embankment, and escarpment areas onsite targeting possums, rats, mustelids, and cats until the land is vested with Waipa District Council. Provide a \$200,000 contribution to Waipa District Council or a local community trust for predator control and monitoring within the potential home range of the local long-tailed bat population.

9.2.3 Principles for biodiversity compensation

The compensation recommendations are in general accordance with the 'Principles for biodiversity offsetting' provided in Appendix 4 of the NPS-IB³³. A commentary on how these principles have been followed with the compensation recommendations is provided in Table 16.

Table 16. A commentary on the alignment of the compensation recommendations with the 'Principles for biodiversity offsetting'.

Principles for biodiversity compensation	Comment
Adherence to effects management hierarchy: Biodiversity compensation is a commitment to redress more than minor residual adverse effects, and should	The effects management hierarchy has been implemented throughout the project. Effects have been avoided and minimised where possible, then

be contemplated only after steps to avoid, minimise, remedy, and offset adverse effects are demonstrated to have been sequentially exhausted.	remedied. Residual effects have been compensated as offsetting is not possible for this effect.
When biodiversity compensation is not appropriate: Biodiversity compensation is not appropriate where indigenous biodiversity values are not able to be compensated for. Examples of biodiversity compensation not being appropriate include where: - the indigenous biodiversity affected is irreplaceable or vulnerable; - effects on indigenous biodiversity are uncertain, unknown, or little understood, but potential effects are significantly adverse or irreversible; - there are no technically feasible options by which to secure a proposed net gain within acceptable timeframes.	The loss of foraging and commuting habitat can be appropriately compensated because the loss of Low to Moderate value habitat at the scale proposed for this Project are unlikely to be limiting factors for the survival of the long-tailed bat population in question. Focusing management recommendations on increasing roosting habitat, reducing predation pressure, and improving existing commuting and foraging habitat can lead to better outcomes for long-tailed bats than attempting to recreate lost commuting and foraging habitat.
Scale of biodiversity compensation: The indigenous biodiversity values lost through the activity to which the biodiversity compensation applies are addressed by positive effects to indigenous biodiversity (including when indigenous species depend on introduced species for their persistence), that outweigh the adverse effects.	The planting of 28,420 trees, predator control across the gully, river embankment, and escarpment habitats, and a \$200,000 contribution to predator control in the wider landscape will outweigh the loss of 2.86 ha of treeland and shelterbelts and 81.36 ha of pasture and gardens (i.e. commuting and foraging habitat).
Additionality: Biodiversity compensation achieves gains in indigenous biodiversity above and beyond gains that would have occurred in the absence of the compensation, such as gains that are additional to any minimisation and remediation or offsetting undertaken in relation to the adverse effects of the activity.	The proposed compensation actions are all additional.
Leakage: Biodiversity compensation design and implementation avoids displacing harm to other indigenous biodiversity in the same or any other location.	Other indigenous biodiversity benefits will come from the proposed compensation actions beyond benefit to long-tailed bats e.g. increased indigenous vegetation cover, and increased habitat for birds, skinks and invertebrates.
Long-term outcomes: Biodiversity compensation is managed to secure outcomes of the activity that last at least as long as the impacts, and preferably in perpetuity. Consideration must be given to long-term issues around funding, location, management, and monitoring.	The proposed compensation actions includes planting a large number of long-lived native trees along with 20,000 additional native plants to form a perpetual native forest in the compensation areas.
Landscape context: Biodiversity compensation is undertaken where this will result in the best ecological outcome, preferably close to the impact site or within the same ecological district. The action considers the landscape context of both the impact site and the compensation site, taking into account interactions between species, habitats and ecosystems, spatial connections, and ecosystem function.	The compensation actions are largely taken within the Site, plus providing funding for pest animal control in the wider landscape.
Time lags: The delay between loss of, or effects on, indigenous biodiversity values at the impact site and the gain or maturity of indigenous biodiversity at the compensation site is minimised so that the calculated gains are achieved within the consent period or, as	The development of the land is likely to take several years, and the compensation planting should be completed well in advance of the change in land for the entire site. In which case, there will be improvements in habitat quality and

appropriate, a longer period (but not more than 35 years).	availability prior to the loss of foraging and commuting habitat.
Trading up: When trading up forms part of biodiversity compensation, the proposal demonstrates that the indigenous biodiversity gains are demonstrably greater or higher than those lost. The proposal also shows the values lost are not to Threatened or At Risk (declining) species or to species considered vulnerable or irreplaceable.	The values lost are to a Threatened species, and compensation is almost exclusively required for a species that are either Threatened or At Risk. The compensation is for the loss of low value habitat for a species widely dispersed across highly modified landscapes, hence avoidance of effects is not possible and compensation is standard practice for this species for land developments of this size. Reducing predation pressure and increasing roosting habitat are the two most valuable actions for managing long-tailed bat habitat. The recommended compensation equates to one additional potential roost tree per 100 m ² of foraging and commuting habitat lost (i.e. one tree every 10 m), plus 20,000 additional trees and shrubs, plus predator control across gully, river embankment, and escarpment areas and the wider landscape which is greater than the loss of foraging and commuting habitat from the removal of pasture, exotic treelands and household gardens.
Financial contributions: A financial contribution is only considered if: (a) there is no effective option available for delivering biodiversity gains on the ground; and (b) it directly funds an intended biodiversity gain or benefit that complies with the rest of these principles.	A financial contribution is offered for predator control in the wider landscape because long-tailed bats are highly mobile animals with a home range significantly larger than the habitats within the site so undertaking predator control on a larger scale is necessary to protect the animals from predation by introduced mammals.
Science and mātauranga Māori: The design and implementation of biodiversity compensation is a documented process informed by science, and mātauranga Māori.	Biodiversity compensation recommendations and rationale are documented in assessment. The detailed design of the compensation actions will be provided in a Bat Management Plan which will be informed by science and mātauranga Māori
Tangata whenua and stakeholder participation: Opportunity for the effective and early participation of tangata whenua and stakeholders is demonstrated when planning for biodiversity compensation, including its evaluation, selection, design, implementation, and monitoring.	Tangata whenua and stakeholders have not yet been involved in the development of compensation recommendations but will have the opportunity to review and pass comment on these recommendations. Tangata whenua will be involved through the development of the Bat Management Plan which will provide specific details for the compensation action e.g. planting lists and species, planting schedules, maintenance requirements, and predator control programme.
Transparency: The design and implementation of biodiversity compensation, and communication of its results to the public, is undertaken in a transparent and timely manner.	These recommendations will be made public through the public notice for the proposed private plan change.

10 Conclusion

There are a number of features of ecological value within the Site and several actual and potential effects of the proposed plan change on those features. Various measures have been proposed to avoid, minimise, remedy, and compensate actual and potential effects of the proposed changes in land use.

The effects on long-tailed bats from the proposed plan change are assessed as High after measures to avoid, minimise and remedy due to the permanent loss of foraging and commuting habitat. The level of effect on all other features is assessed as less than Moderate and therefore doesn't require any further mitigation.

To appropriately address the effects on long-tailed bats, the following compensation is proposed:

- Plant 8,420 long-lived trees (150+ years) known to be used by long-tailed bats for roosting within the proposed gully, river embankment, and escarpment areas within the site.
- Plant an additional 20,000 native trees, shrubs and herbaceous plants to encourage foraging and commuting within and along the gully, river embankment, and escarpment areas.
- Undertake predator control and monitoring across the gully, river embankment, and escarpment areas onsite targeting possums, rats, mustelids, and cats until the land is vested with Waipa District Council.
- Provide a \$200,000 contribution to Waipa District Council or a local community trust for predator control in the wider landscape.

If these measures are carried out in full, it is considered that the potential ecological effects of the proposed changes in land use will be appropriately addressed.

Appendix A Weather data during acoustic surveys

Date	Time	Min. temperature (°C)	Precipitation (mm)	Surface wind speed (km/hr)	Max. wind gust (km/hr)
9/04/2021	17:00	17.8	0	2.2	9
	18:00	17.2	0	5.4	11.2
	19:00	16.6	0	10.1	25.2
	20:00	16.6	0	6.5	16.6
	21:00	16.8	0	6.8	13.7
	22:00	17.2	0	4.7	12.2
	23:00	17.1	0	2.5	8.3
10/04/2021	0:00	17	0	1.8	5
	1:00	17.1	0	5.4	16.2
	2:00	18	0	6.1	14.4
	3:00	17.8	0.4	4.3	11.5
	4:00	16.9	1.9	10.4	17.3
	5:00	16.7	1.4	7.2	21.6
	6:00	16.8	0	2.9	7.9
	7:00	16.7	0	3.6	13.3
10/04/2021	17:00	19.1	0	2.5	9.7
	18:00	19.3	0	3.2	12.2
	19:00	18.8	0	2.9	8.3
	20:00	18.9	0	5	11.9
	21:00	19.2	0	4.7	13.3
	22:00	19	0	7.2	17.6
	23:00	18.5	0	6.8	15.8
11/04/2021	0:00	18.5	0	8.6	19.1
	1:00	18.4	0	6.8	12.2
	2:00	18.6	0	3.2	13.3
	3:00	19.6	0	2.9	10.1
	4:00	19.6	0	3.2	7.9
	5:00	19.2	0.1	3.6	9
	6:00	19	0	8.6	12.2
	7:00	18.9	0	4	9
11/04/2021	17:00	24.4	0	4.3	13.7
	18:00	21.2	0	2.2	6.8
	19:00	18.8	0	1.4	5.4
	20:00	17.5	0	1.1	4.3
	21:00	16.6	0	1.1	4.7
	22:00	16.3	0	2.2	6.8
	23:00	15.8	0	2.9	5.4
12/04/2021	0:00	15.3	0	3.6	6.8
	1:00	15.1	0	4.7	9.4
	2:00	14.8	0	6.1	10.1
	3:00	14.9	0	6.8	11.2
	4:00	15	0	6.1	11.2
	5:00	15	0	5.4	10.8

	6:00	15.1	0	5.4	10.1
	7:00	15.1	0	4.7	7.6
12/04/2021	17:00	23.7	0	4.7	15.1
	18:00	22.2	0	4	14.4
	19:00	21.3	0	2.2	7.6
	20:00	20.7	0	1.4	4.7
	21:00	20.1	0	1.1	5
	22:00	19.8	0	1.1	4.7
	23:00	19.3	0	1.4	4.3
13/04/2021	0:00	18.9	0	1.8	5.4
	1:00	18.4	0	1.1	6.5
	2:00	18.3	0	1.8	12.6
	3:00	18.3	0	2.5	6.8
	4:00	18.3	0	0.7	3.6
	5:00	18.2	0	1.4	3.2
	6:00	17.9	0	1.1	3.6
	7:00	17.7	0	2.9	8.6
13/04/2021	17:00	20.9	0	12.6	32.8
	18:00	19.4	0	7.2	22.7
	19:00	18	0	2.2	10.1
	20:00	17.4	0	2.2	9.4
	21:00	16.3	0.5	2.9	14.8
	22:00	15	0	1.1	5.4
	23:00	14.5	0	1.4	4.7
14/04/2021	0:00	14.3	0	1.1	3.6
	1:00	13.8	0	1.1	4
	2:00	13.6	0	1.4	5.4
	3:00	13.7	0.3	2.2	5.4
	4:00	13.4	0	2.2	6.5
	5:00	13.2	0	3.2	9
	6:00	12.6	0	4	8.6
	7:00	12.3	0	4.3	7.6
14/04/2021	17:00	13.5	0.3	5	15.5
	18:00	13.5	0	9.4	14.8
	19:00	13.1	0	4	15.5
	20:00	12.6	0	2.2	6.8
	21:00	11.9	0	2.2	7.9
	22:00	11.4	0	1.8	7.6
	23:00	10.6	0	3.2	13
15/04/2021	0:00	10.2	0	3.2	14.4
	1:00	10	0	1.1	5
	2:00	10.1	0	1.4	5.4
	3:00	9.8	0	1.4	6.1
	4:00	9.8	0	3.6	7.9
	5:00	9.7	0	2.2	5.8
	6:00	9	0	2.5	11.5
	7:00	8.8	0	1.4	4.7
	17:00	17.5	0	10.4	23
	18:00	16.9	0	7.9	18.7

15/04/2021	19:00	16.3	0	7.6	21.2
	20:00	15.3	0	2.2	11.2
	21:00	15.2	0	4.3	18.7
	22:00	15.3	0.1	3.2	13.7
	23:00	14.8	0	2.2	8.3
16/04/2021	0:00	14.4	0	1.8	7.2
	1:00	14	0	1.8	9
	2:00	13.7	0	1.8	6.5
	3:00	13.5	0	1.8	7.2
	4:00	13.2	0	1.8	10.4
	5:00	13	0	2.2	9.7
	6:00	12.9	0	1.8	7.2
	7:00	12.2	0	1.1	5.8
16/04/2021	17:00	20.1	0	8.6	24.8
	18:00	17.9	0	6.5	18.4
	19:00	17.1	0	5.4	17.3
	20:00	16.1	0	5	18.7
	21:00	15.2	0	1.8	7.2
	22:00	14.8	0	1.1	4.7
	23:00	14.7	0	0.7	4.3
17/04/2021	0:00	14.8	0	0.7	3.2
	1:00	15.2	2.3	3.2	15.1
	2:00	15.6	1.8	4.7	19.4
	3:00	15.2	0	1.4	6.5
	4:00	14.8	0	1.1	4.7
	5:00	14.9	0	2.5	9.7
	6:00	14.8	0.4	2.2	8.6
	7:00	14.5	1.4	3.2	7.9
17/04/2021	17:00	16.9	0	5	15.1
	18:00	15.2	0	6.5	22.7
	19:00	14.1	0	2.5	10.8
	20:00	13.1	0	2.9	10.4
	21:00	11.3	0	3.2	14.8
	22:00	10.4	0	2.2	11.5
	23:00	9.6	0	1.8	6.1
18/04/2021	0:00	9.1	0	1.8	9.4
	1:00	8.4	0	1.8	7.6
	2:00	8	0	1.4	5.8
	3:00	7.7	0	1.4	5.8
	4:00	7.6	0	2.9	8.6
	5:00	7.9	0	4.3	8.3
	6:00	7.4	0	5	10.8
	7:00	7.4	0	6.1	15.5
18/04/2021	17:00	16.4	0	6.8	22.3
	18:00	15.5	0	3.2	15.8
	19:00	14.8	0	1.4	5.4
	20:00	13.8	0	1.4	10.8
	21:00	13.4	0	2.2	7.2
	22:00	13.4	0	1.8	7.2

	23:00	13.2	0	2.9	9.7
19/04/2021	0:00	13.2	0	1.4	5.8
	1:00	13.1	0	1.1	3.6
	2:00	12.1	0	1.8	7.6
	3:00	12.4	0	1.4	5.8
	4:00	12.6	0	1.4	6.1
	5:00	12.6	0	2.2	8.3
	6:00	12.5	0	2.5	8.3
	7:00	12.5	0	2.2	7.9
19/04/2021	17:00	18.3	0	3.2	15.5
	18:00	16.8	0	2.2	7.6
	19:00	14.6	0	1.8	4.7
	20:00	13.5	0	1.1	5
	21:00	12.6	0	1.4	3.6
	22:00	12.2	0	2.2	5.4
	23:00	12	0	4	8.6
20/04/2021	0:00	11.3	0	4.7	8.6
	1:00	11.3	0	6.1	11.5
	2:00	11.6	0	7.2	11.9
	3:00	11.7	0	9.4	13.3
	4:00	11.5	0	9	13
	5:00	11.6	0	9.7	15.1
	6:00	11.5	0	9.4	15.1
	7:00	11.3	0	9.4	13.7
20/04/2021	17:00	18	0	6.1	16.6
	18:00	17	0.3	5.8	16.6
	19:00	17.1	0	6.5	18.4
	20:00	17.6	0.5	4.3	14.8
	21:00	17.6	2.6	7.6	21.2
	22:00	16.6	3.3	7.6	19.1
	23:00	16.6	0.1	14.4	32
21/04/2021	0:00	16.9	0	18.4	24.8
	1:00	16.3	0.7	8.3	28.4
	2:00	15.7	0	2.9	6.5
	3:00	15.5	0	6.1	12.2
	4:00	15.3	0	6.5	12.6
	5:00	15.2	0	3.6	9.4
	6:00	15.5	0	3.2	8.3
	7:00	14.6	0	4	15.5
21/04/2021	17:00	18.8	1.2	5	17.3
	18:00	18.2	0	4	14.8
	19:00	16.7	0	1.8	9
	20:00	15.5	0	1.1	4
	21:00	15.4	0.2	0.7	3.2
	22:00	16	0	2.2	8.3
	23:00	15.3	0	4.3	16.2
22/04/2021	0:00	15.1	0	4.7	17.3
	1:00	14.2	0	3.6	11.9
	2:00	13.5	0	1.8	9.7

	3:00	12.9	0	2.5	8.3
	4:00	12.2	0	1.4	5
	5:00	11.7	0	1.4	6.1
	6:00	11.3	0	1.4	5
	7:00	10.7	0	1.4	5.8
22/04/2021	17:00	19.6	0	4.7	13.7
	18:00	17.6	0	2.9	10.1
	19:00	15.6	0	2.2	6.5
	20:00	14.2	0	1.8	7.2
	21:00	13	0	1.4	5
	22:00	12.2	0	1.1	3.6
	23:00	11.8	0	1.1	3.6
23/04/2021	0:00	11.3	0	1.4	6.5
	1:00	11.1	0	3.2	11.5
	2:00	11.5	0	10.1	16.6
	3:00	11.5	0	9	16.6
	4:00	11.2	0	4.3	12.6
	5:00	10.1	0	2.9	11.5
	6:00	10.1	0	2.2	9.4
	7:00	9.6	0	2.9	9.7
21/12/2021	18:00	21.3	0	10.8	33.5
	19:00	20.4	0	8.6	29.5
	20:00	19.6	0	9.4	29.9
	21:00	18.6	0	8.6	25.6
	22:00	18.5	0	4.3	13
	23:00	18.7	0	6.1	16.2
	0:00	19	0	4.7	15.5
22/12/2021	1:00	18.8	0	4.3	14
	2:00	18.5	0	3.6	10.8
	3:00	17.7	0	2.2	8.3
	4:00	16.3	0	1.4	8.3
	5:00	15.2	0	1.1	3.6
	6:00	15	0	1.4	8.3
	7:00	16.2	0	3.2	10.8
	8:00	17.8	0	4	16.6
	9:00	19.3	0	7.9	24.1
22/12/2021	18:00	23.6	0	7.9	23.8
	19:00	22.5	0	5.8	20.9
	20:00	20.6	0	5.8	17.6
	21:00	19.7	0	3.6	13.7
	22:00	19	0	1.8	7.9
	23:00	18.2	0	1.1	4.7
	0:00	17.7	0	2.5	11.5
	1:00	17.7	0	4.7	15.8
23/12/2021	2:00	16.8	0	4	15.1
	3:00	16.5	0	4.3	13.3
	4:00	16.3	0	6.1	12.2
	5:00	16.2	0	4	11.2
	6:00	16.1	0	5.4	15.5

	7:00	16.7	0	5.8	13.3
	8:00	18.7	0	5.4	16.9
	9:00	20	0	7.2	22.7
23/12/2021	18:00	25.5	0	7.9	21.2
	19:00	23.9	0	6.8	22
	20:00	21.5	0	6.5	20.2
	21:00	20.5	0	4.7	14.4
	22:00	19.7	0	2.2	9.4
	23:00	18.9	0	1.4	9.7
	0:00	18.5	0	2.2	10.1
24/12/2021	1:00	18.5	0	4	15.5
	2:00	17.8	0	2.2	10.4
	3:00	17.2	0	2.9	12.2
	4:00	16.5	0	2.5	10.1
	5:00	16.1	0	1.4	6.1
	6:00	16	0	1.4	5
	7:00	17	0	6.1	12.2
	8:00	17.3	0	5.8	8.6
	9:00	19.2	0	6.8	19.8
24/12/2021	18:00	24.7	0	7.2	21.2
	19:00	23.7	0	6.1	22
	20:00	19.9	0	6.1	20.5
	21:00	18.8	0	4	16.2
	22:00	17.8	0	4.7	18.4
	23:00	17	0	2.5	12.6
	0:00	16.2	0	2.5	14.4
25/12/2021	1:00	15.3	0	1.1	4.7
	2:00	14.7	0	1.1	5
	3:00	14.7	0	1.8	7.2
	4:00	14.6	0	2.2	5.8
	5:00	14.4	0	2.5	7.6
	6:00	14.1	0	3.6	9.7
	7:00	15.3	0	3.6	10.4
	8:00	17.9	0	4.3	9.4
	9:00	19.3	0	3.6	8.3
25/12/2021	18:00	27.3	0	7.2	24.8
	19:00	25	0	8.6	27
	20:00	22.4	0	5	16.9
	21:00	20.2	0	1.1	6.5
	22:00	18.4	0	1.1	4.3
	23:00	18.2	0	0.7	4.3
	0:00	18.9	0	1.1	4
26/12/2021	1:00	19.4	0	1.1	4
	2:00	19.2	0	1.1	5
	3:00	18.6	0	1.4	5
	4:00	18.1	0	1.1	3.6
	5:00	18	0	0.7	3.6
	6:00	17.8	0	0.7	4.7
	7:00	18.4	0	2.2	6.1

	8:00	19.4	0	4.3	12.2
	9:00	20.8	0	3.2	15.1
26/12/2021	18:00	27.3	0	6.8	19.4
	19:00	26	0	4	17.6
	20:00	21.7	0	2.2	9.4
	21:00	19.4	0	1.4	4.7
	22:00	18.2	0	1.4	6.1
	23:00	17.1	0	1.1	4.3
	0:00	16.3	0	1.1	4.3
27/12/2021	1:00	15.7	0	1.4	4.7
	2:00	15.4	0	2.9	6.5
	3:00	15.2	0	4	6.5
	4:00	14.6	0	4	7.6
	5:00	14.6	0	5	10.4
	6:00	14.7	0	5.4	9
	7:00	15.3	0	7.2	11.2
	8:00	16.6	0	6.1	13
	9:00	19.3	0	4.3	8.3
27/12/2021	18:00	25.7	0	3.6	19.4
	19:00	25.3	0	2.9	10.4
	20:00	22.8	0	1.4	6.1
	21:00	21.8	0	2.2	11.5
	22:00	20.8	0	1.4	6.1
	23:00	19.6	0	2.2	6.1
	0:00	19.6	0	4	7.6
28/12/2021	1:00	19.4	0	3.6	9.4
	2:00	19.3	0	4.3	8.6
	3:00	19.3	0	3.6	7.6
	4:00	19.6	0	2.2	6.1
	5:00	19.6	0	4.3	9.4
	6:00	19.7	0	4	7.6
	7:00	19.9	0	9	13.7
	8:00	20.1	0	8.3	14
	9:00	20.8	0	7.2	14.4
28/12/2021	18:00	20	18.1	6.1	19.8
	19:00	20	0	2.5	7.9
	20:00	19.9	0	2.2	6.8
	21:00	19.7	0	5.4	10.1
	22:00	19.4	0	5	9.7
	23:00	19.3	0	3.2	8.3
	0:00	19.5	0	0.7	4.7
29/12/2021	1:00	19.5	0	1.1	4.7
	2:00	19.2	0	2.9	9
	3:00	19.2	0	2.2	9
	4:00	18.4	0	4	14
	5:00	18	0	4.3	16.2
	6:00	17.4	0	4	16.2
	7:00	17.2	0	5	18
	8:00	17.5	0	5	17.6

	9:00	18.3	0	7.6	20.9
29/12/2021	18:00	21.9	0	11.5	26.6
	19:00	21.6	0	6.8	23
	20:00	19.2	0	4.3	16.6
	21:00	17.9	0	2.9	9.4
	22:00	17.4	0	2.9	11.5
	23:00	17.5	0	2.2	11.9
	0:00	17.4	0	3.2	11.2
30/12/2021	1:00	17.2	0	2.2	8.6
	2:00	16.7	0	3.2	15.1
	3:00	16.3	0	4.3	14.8
	4:00	15.9	0	4	13
	5:00	15.5	0	2.9	11.2
	6:00	15.4	0	2.5	12.2
	7:00	15.3	0	6.5	14.4
	8:00	16.5	0	3.6	11.9
	9:00	18.7	0	7.2	20.5
30/12/2021	18:00	21	0	9.4	29.9
	19:00	20.4	0	6.8	23.8
	20:00	18.1	0	4.3	19.1
	21:00	16.8	0	2.2	10.1
	22:00	16	0	1.4	7.2
	23:00	15.4	0	2.2	6.8
	0:00	14.7	0	1.1	6.1
31/12/2021	1:00	14.1	0	1.1	6.5
	2:00	14	0	1.4	5
	3:00	13.4	0	1.8	9.7
	4:00	13	0	4.3	12.6
	5:00	13	0	2.2	8.6
	6:00	13.4	0	1.8	7.6
	7:00	14.4	0	3.6	10.4
	8:00	16.1	0	4	14.4
	9:00	17.9	0	6.1	19.4
31/12/2021	18:00	22.7	0	8.6	25.2
	19:00	21.1	0	8.3	24.8
	20:00	18.8	0	5	21.6
	21:00	17.7	0	3.6	14.4
	22:00	16.9	0	2.9	11.5
	23:00	16.3	0	2.2	9.7
	0:00	15.5	0	1.8	8.6
1/01/2022	1:00	15.1	0	2.2	11.2
	2:00	14.7	0	1.4	8.3
	3:00	14.3	0	1.4	5
	4:00	13.7	0	1.4	7.9
	5:00	13.6	0	1.1	5.8
	6:00	13.6	0	1.4	6.1
	7:00	14.9	0	3.6	10.4
	8:00	16.8	0	5	15.1
	9:00	18.1	0	6.5	17.6

1/01/2022	18:00	27.4	0	5.8	18
	19:00	25.5	0	5.8	16.6
	20:00	22.7	0	4	13.3
	21:00	21.4	0	1.8	6.1
	22:00	20.4	0	1.8	7.6
	23:00	20	0	6.5	16.6
	0:00	19.5	0	5.8	11.2
2/01/2022	1:00	18.7	0	4	9.7
	2:00	17.6	0	1.8	5.8
	3:00	17	0	3.2	7.2
	4:00	16.4	0	3.6	7.2
	5:00	15.8	0	2.9	6.8
	6:00	15.7	0	3.6	7.9
	7:00	17.2	0	5.8	10.4
	8:00	19.3	0	7.2	14
	9:00	20.6	0	10.1	19.1
2/01/2022	18:00	27.1	0	5.4	16.6
	19:00	25.3	0	3.2	16.6
	20:00	22.5	0	2.5	9.4
	21:00	21.2	0	5.8	13.3
	22:00	20.1	0	4	11.5
	23:00	19.3	0	4.7	9.7
	0:00	18.3	0	2.2	6.5
3/01/2022	1:00	17.5	0	2.2	5
	2:00	16.6	0	2.9	8.6
	3:00	16.4	0	3.2	9
	4:00	16.2	0	2.9	7.6
	5:00	15.4	0	2.2	7.2
	6:00	15.3	0	3.6	9.4
	7:00	16.7	0	4.7	8.3
	8:00	18	0	3.6	9
	9:00	20.4	0	2.5	5.8
3/01/2022	18:00	29.9	0	3.6	15.1
	19:00	27.9	0	3.2	10.1
	20:00	25.1	0	2.9	13.3
	21:00	22.8	0	1.4	5.8
	22:00	21.6	0	1.4	6.8
	23:00	20.9	0	1.1	6.1
	0:00	20.4	0	5	12.6
4/01/2022	1:00	19.6	0	7.2	13.3
	2:00	19.2	0	5	10.4
	3:00	18.4	0	7.2	15.8
	4:00	17.5	0	2.9	7.9
	5:00	16.8	0	6.5	12.6
	6:00	16.4	0	7.9	14.4
	7:00	17	0	4.7	10.8
	8:00	19.3	0	2.9	7.9
	9:00	20.6	0	3.2	6.8
	18:00	29.6	0	5	20.2

4/01/2022	19:00	28.9	0	2.9	11.2
	20:00	24.7	0	2.2	6.8
	21:00	23.2	0	4.3	10.8
	22:00	21.9	0	1.4	4.3
	23:00	21.8	0	2.2	6.5
	0:00	21.1	0	1.8	5.8
5/01/2022	1:00	20.2	0	4	10.8
	2:00	19.6	0	3.2	8.6
	3:00	19.3	0	2.2	5.4
	4:00	18.5	0	1.4	6.1
	5:00	18	0	1.4	5
	6:00	17.8	0	0.7	4
	7:00	19.4	0	1.8	5
	8:00	21.6	0	2.2	9
	9:00	22.7	0	2.9	11.2
5/01/2022	18:00	23.6	0	10.1	26.6
	19:00	23.4	0	4	16.2
	20:00	21.5	0	4	14.4
	21:00	20.2	0	5.4	15.8
	22:00	19.3	0	4.7	14.8
	23:00	18.6	0	2.5	10.4
	0:00	17.9	0	2.2	10.1
6/01/2022	1:00	17.3	0	1.4	6.5
	2:00	17.1	0	1.4	6.1
	3:00	16.5	0	1.4	7.6
	4:00	16.5	0	2.2	7.2
	5:00	17.1	0	2.5	8.3
	6:00	17.4	0	2.9	9.4
	7:00	17.6	0	5	10.4
	8:00	18.3	0	6.1	11.2
	9:00	18.6	0	3.6	11.2
6/01/2022	18:00	23.7	0	10.4	53.3
	19:00	19.8	4.2	18.4	34.9
	20:00	19.7	0.7	14.4	24.5
	21:00	19.9	0	12.2	25.2
	22:00	19.8	0	10.4	16.9
	23:00	19.7	0	12.6	22
	0:00	19.1	0	17.6	27.7
7/01/2022	1:00	18.5	0	22.7	32.4
	2:00	18.3	0	24.5	35.6
	3:00	18.1	0	25.2	36
	4:00	16.9	0.2	26.6	38.5
	5:00	16.7	0	24.8	37.4
	6:00	16.6	0	27.4	43.6
	7:00	16	0	22	38.5
	8:00	16.1	0	15.5	33.5
	9:00	16.8	0	16.2	34.9
	18:00	24.3	0	6.8	20.2
	19:00	23.6	0	9	23

7/01/2022	20:00	21.5	0	5.4	18.4
	21:00	20.1	0	2.2	9
	22:00	18.6	0	1.4	6.5
	23:00	17.5	0	0.7	5.4
	0:00	16.7	0	1.4	7.2
8/01/2022	1:00	16.1	0	1.8	7.2
	2:00	15.6	0	3.2	8.6
	3:00	15.4	0	4.3	9.4
	4:00	14.8	0	3.6	10.4
	5:00	14.5	0	3.6	10.8
	6:00	14.3	0	2.2	5.4
	7:00	15.8	0	4.3	8.3
	8:00	16.9	0	5	10.1
	9:00	17.9	0	6.5	10.8
8/01/2022	18:00	25.9	0	8.3	22.7
	19:00	24.8	0	5	19.1
	20:00	21.6	0	3.6	14
	21:00	19.9	0	2.9	13.7
	22:00	18.6	0	1.1	6.1
	23:00	17.8	0	1.4	5.4
	0:00	17.1	0	0.7	4
9/01/2022	1:00	16.6	0	1.1	5
	2:00	16.1	0	0.7	4.3
	3:00	16	0	1.1	4
	4:00	16.1	0	3.2	7.2
	5:00	15.9	0	5.4	9.7
	6:00	15.9	0	7.2	11.2
	7:00	16.4	0	6.5	11.5
	8:00	17.2	0	3.6	7.9
	9:00	18.7	0	2.5	9
9/01/2022	18:00	24.6	0	7.9	27
	19:00	23.2	0	5.8	17.6
	20:00	20.6	0	5	15.8
	21:00	20.5	0	1.1	5.4
	22:00	19.5	0	1.1	4.3
	23:00	18.8	0	1.1	6.1
	0:00	18.1	0	0.7	3.6
10/01/2022	1:00	17.6	0	1.1	6.5
	2:00	17.1	0	0.7	6.1
	3:00	16.7	0	0.7	4.7
	4:00	16.7	0	1.4	6.5
	5:00	17.5	0	0.7	4
	6:00	17.5	0	1.8	6.5
	7:00	17.6	0	1.1	6.5
	8:00	18.7	0	1.4	7.2
	9:00	20	0	2.9	11.9
	18:00	24.1	0	8.3	31
	19:00	23.6	0	6.1	18.4
	20:00	22.2	0	4	11.5

10/01/2022	21:00	21.1	0	2.5	10.4
	22:00	20.1	0	1.4	7.6
	23:00	19.3	0	0.7	4
	0:00	18.8	0	1.1	5.4
11/01/2022	1:00	18.1	0	1.1	6.1
	2:00	17.7	0	1.1	4.7
	3:00	17.1	0	1.1	4.3
	4:00	16.6	0	0.7	5
	5:00	16.3	0	0.7	4.3
	6:00	16.2	0	0.7	5.4
	7:00	16.4	0	1.8	6.8
	8:00	17.5	0	2.9	7.9
	9:00	19.2	0	3.6	10.8
11/01/2022	18:00	26.4	0	7.6	22.7
	19:00	25	0	6.1	23.8
	20:00	22.1	0	3.6	14.8
	21:00	20.7	0	2.2	9.4
	22:00	19.8	0	1.4	6.8
	23:00	19.1	0	1.1	5
	0:00	19.1	0	1.1	7.6
12/01/2022	1:00	18.8	0	1.1	5.4
	2:00	18.1	0	1.8	9.7
	3:00	17.8	0	1.8	9
	4:00	17.9	0	2.2	8.6
	5:00	17.1	0	1.1	4
	6:00	16.9	0	1.1	6.8
	7:00	17.4	0	2.2	10.1
	8:00	18.9	0	4.3	14
	9:00	20.7	0	6.5	20.2
12/01/2022	18:00	22.9	0	9.7	26.6
	19:00	21.2	0	9.7	29.5
	20:00	19.5	0	4.3	17.6
	21:00	18.4	0	3.2	12.6
	22:00	17.7	0	1.8	9.4
	23:00	17.2	0	0.7	4.3
	0:00	16.7	0	1.4	10.1
13/01/2022	1:00	16.3	0	1.4	4
	2:00	15.7	0	1.4	5.8
	3:00	14.9	0	1.8	11.9
	4:00	14.9	0	1.8	7.2
	5:00	14.5	0	1.4	6.5
	6:00	14.2	0	2.2	7.9
	7:00	15.2	0	2.9	7.9
	8:00	16.7	0	3.6	9
	9:00	18.1	0	13.7	27.4
	18:00	25	0	5.8	14.8
	19:00	22.9	0	6.5	17.3
	20:00	21.5	0	7.2	19.8
	21:00	19	0	17.3	29.9

13/01/2022	22:00	17.6	0	19.8	27.7
	23:00	16.6	0	17.6	26.6
	0:00	16.2	0	16.6	25.2
14/01/2022	1:00	16	0	19.8	28.8
	2:00	15.5	0	20.2	27
	3:00	15.1	0	20.9	29.2
	4:00	14.5	0	18.7	28.8
	5:00	14.2	0	13.7	22.7
	6:00	14.4	0	20.5	31
	7:00	15	0	18	28.8
	8:00	15.4	0	17.3	28.4
	9:00	16.4	0	13.7	27
14/01/2022	18:00	23.8	0	5.8	14.8
	19:00	22.7	0	5	11.9
	20:00	20.6	0	4.3	11.9
	21:00	19.5	0	4.3	14
	22:00	18.5	0	8.6	15.5
	23:00	17.6	0	10.4	18.4
	0:00	17.2	0	13.3	20.9
15/01/2022	1:00	16.9	0	14.8	23.4
	2:00	16.1	0	14.4	22
	3:00	16.2	0	15.8	25.9
	4:00	16.3	0	15.8	24.5
	5:00	16.3	0	13.7	27.7
	6:00	16.1	0	14.4	27.4
	7:00	16.2	0	13.7	29.9
	8:00	17	0	16.2	29.2
	9:00	18.7	0	18.7	32
15/01/2022	18:00	24.2	0	5.8	13.3
	19:00	22.9	0	5	12.6
	20:00	21.2	0	3.2	13
	21:00	20.4	0	7.2	12.6
	22:00	19.9	0	7.6	16.6
	23:00	18.3	0	9.4	18.7
	0:00	16.7	0	4.3	10.8
16/01/2022	1:00	16.5	0	12.6	22.3
	2:00	17	0	13.3	22.3
	3:00	15.6	0	5	12.6
	4:00	15.2	0	3.6	11.2
	5:00	14.9	0	2.9	15.1
	6:00	14.8	0	2.5	8.3
	7:00	16.3	0	7.6	18.7
	8:00	17.9	0	13.7	28.1
	9:00	19	0	22	33.5
16/01/2022	18:00	25.8	0	20.9	31
	19:00	24.8	0	13	33.1
	20:00	22.8	0	14.4	25.9
	21:00	21.2	0	19.1	28.8
	22:00	20.2	0	24.1	36

	23:00	19.2	0	19.4	32
	0:00	18.2	0	13.7	22
17/01/2022	1:00	17.8	0	10.4	20.2
	2:00	16.9	0	4.7	18.7
	3:00	15.6	0	1.8	7.9
	4:00	15.2	0	2.5	13
	5:00	15	0	3.2	15.5
	6:00	16.9	0	8.3	22.3
	7:00	16.5	0	4.7	19.4
	8:00	19.7	0	20.5	30.6
	9:00	20.5	0	8.6	25.6
17/01/2022	18:00	26.2	0	12.6	34.2
	19:00	25.4	0	5.8	19.4
	20:00	22.3	0	5	18
	21:00	20.2	0	1.8	6.8
	22:00	18.9	0	2.2	9.4
	23:00	18.1	0	2.5	12.6
	0:00	17.4	0	3.2	16.2
18/01/2022	1:00	16.7	0	1.1	4.3
	2:00	16	0	1.4	5.8
	3:00	15.4	0	1.4	5.4
	4:00	15.2	0	5	13.7
	5:00	15	0	3.6	8.6
	6:00	14.1	0	2.5	6.1
	7:00	14.9	0	2.2	6.8
	8:00	17.3	0	3.6	16.9
	9:00	18.4	0	5.8	15.8
18/01/2022	18:00	27.1	0	11.2	27.7
	19:00	24.4	0	10.1	31
	20:00	21.7	0	6.5	24.5
	21:00	19.9	0	2.2	11.5
	22:00	19.1	0	2.2	11.2
	23:00	18.2	0	1.1	5.4
	0:00	17.5	0	1.1	6.1
19/01/2022	1:00	17	0	1.4	6.1
	2:00	17.1	0	1.4	7.6
	3:00	16.5	0	1.8	6.5
	4:00	16	0	1.8	4.7
	5:00	15.7	0	2.2	5.4
	6:00	15.6	0	3.2	8.3
	7:00	15.8	0	5.8	10.1
	8:00	16.3	0	3.2	6.8
	9:00	18	0	2.5	9
19/01/2022	18:00	23.7	0	10.4	27.4
	19:00	22.9	0	8.3	26.3
	20:00	21.2	0	5.8	24.8
	21:00	20	0	4	10.4
	22:00	19.1	0	1.8	10.8
	23:00	18.4	0	1.4	6.5

	0:00	17.6	0	1.1	7.6
20/01/2022	1:00	17.6	0	0.7	4
	2:00	17.7	0	0.7	3.6
	3:00	17.9	0	1.1	4.3
	4:00	18.2	0	1.4	5
	5:00	18.2	0	1.4	6.1
	6:00	18.3	0	2.2	11.2
	7:00	18.2	0.7	5.4	17.6
	8:00	18.3	0	4.7	16.2
	9:00	20.4	0	5.8	21.6

Appendix B Wetland delineation plot data

Date	23/07/2025	Plot	1		East	1819011E
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	5801664N
Yes	0	No	Yes	1.72	Hydrology indicator	No
Pasture	Code	Common Name	Status	Cover (%)		
	ranrep	<i>Creeping buttercup</i>	FAC	12		
	hollan	<i>Yorkshire fog</i>	FAC	30		
	lotped	<i>Lotus</i>	FAC	1		
	eleacu	<i>Sharp spike-sedge</i>	OBL	1		
	isaglo	<i>Swamp millet</i>	OBL	15		
	schtap	<i>Lake sedge, kuta</i>	OBL	60		
	verame	<i>Brooklime</i>	OBL	1		
Notes						

Date	23/07/2025	Plot	2		East	1819011E
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	5801668N
No	0	No	No	4.10	Hydrology indicator	No
Pasture	Code	Common Name	Status	Cover (%)		
	trirep	<i>White clover</i>	FACU	30		
	ranrep	<i>Creeping buttercup</i>	FAC	5		
	plamaj	<i>Broad-leaved plantain</i>	FACU	5		
	pasdil	<i>Paspalum</i>	FACU	10		
	rumcri	<i>Curled dock</i>	FAC	2		
	dacglo	<i>Cocksfoot</i>	FACU	1		
	hollan	<i>Yorkshire fog</i>	FAC	3		
		<i>Sonchus sp.</i>		1		
	crecap	<i>Hawksbeard</i>	FACU	5		
	solses	<i>Soliva sessilis</i>	FACU	1		
	germol	<i>Geranium molle</i>	FACU	2		
	tripra	<i>Red clover</i>	FACU	10		
	lotped	<i>Lotus</i>	FAC	1		
	browil	<i>Prairie grass</i>	UPL	25		
	stemed	<i>Chickweed, Kohukohu</i>	FACU	1		
Notes						

Date	23/07/2025	Plot	4		East	1818980E
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	5801758N
No	0	No	Yes	3.05		
Pasture	Code	Common Name	Status	Cover (%)		

	HOLLAN	<i>Yorkshire fog</i>	FAC	93
	SONOLE	<i>Sonchus olerachus</i>	UPL	1
	PHYOCT	<i>Phytolacca octandra</i>	FACU	2
	cargem	<i>Carex geminata</i>	FACW	1
	RUBFRU	<i>Blackberry</i>	FAC	1
	CALYSTEGIA	<i>Bindweed spp.</i>	FACU	2
Notes	Soil chart 5/3. Mild mottling and slightly gleyed below 25 cm. Water table not reached			

Date	23/07/2025	Plot	4		East	175.49125E
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	37.90575S
Yes	0	No	Yes	3.08	Hydrology indicator	No
Pasture	Code	Common Name	Status	Cover (%)		
	HOLLAN	Yorkshire fog	FAC	95		
	GERMOL	Geranium molle	FACU	3		
	DAUCAR	wild carrot	FACU	5		
Notes	Soil chart: 7/2. Water table not reached					

Date	23/07/2025	Plot	6		East	1818963E
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	5801803N
No	1	No	No	3.35	Hydrology indicator	No
Pasture	Code	Common Name	Status	Cover (%)		
	DACGLO	Cocksfoot	FACU	35		
	HOLLAN	Yorkshire fog	FAC	60		
	RANREP	Creeping buttercup	FAC	1		
Yes	TRIREP	White clover	FACU	1		
	CRECAP	Hawksbeard	FACU	2		
	Agrostis			1		
Notes	Water table not reached at 1.2m depth. No hydrology indicators. Borderline soil colour of 3/3.					

Date	23/07/2025	Plot	7		East	
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	
Yes		No			Hydrology indicator	No
Notes	Soil sample only. Soil chart: 2/2					

Date	23/07/2025	Plot	8		East	
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	
No		No			Hydrology indicator	No
Notes	Soil & hydrology only. No hydrology indicators. Soil colour 6/3.					

Date	23/07/2025	Plot	9		East	
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	

Yes	No	Hydrology indicator	No
Notes	Soil chart: 8/2, sandy		

Date	23/07/2025	Plot	9		East	175.49078E
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	37.90462S
No		No			Hydrology indicator	No
Notes	Water table 45 cm					

Date	24/07/2025	Plot	11		East	175.49122E
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	37.90439S
Yes	0	No	Yes	2.85	Hydrology indicator	Yes
Pasture	Code	Common Name	Status	Cover (%)		
	ELEACU	Sharp spike-sedge	OBL	4		
	RANREP	Creeping buttercup	FAC	2		
	DAUCAR	wild carrot	FACU	1		
	PLALAN	Narrow-leaved plantain	FACU	1		
	HYPRAD	Catsear	FACU	1		
	HOLLAN	Yorkshire fog	FAC	25		
Notes	Water table has risen to 20 cm on 24 July. Muddy ground from vehicles.					

Date	24/07/2025	Plot	12		East	175.49081E
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	37.90426S
Yes	0	No	Yes	2.88	Hydrology indicator	No
Pasture	Code	Common Name	Status	Cover (%)		
	Dacglo	Cocksfoot	FACU	30		
	Ranrep	Creeping buttercup	FAC	40		
	Plalan	Narrow-leaved plantain	FACU	1		
	Cargem	Carex geminata	FACW	40		
	Hollan	Yorkshire fog	FAC	35		
	Sonasp	Prickly sowthistle	FACU	1		
	Eleacu	Sharp spike-sedge	OBL	5		
				152		
Notes	Sandy soil with clay starting to appear approximately 60 cm from the surface, quite wet sand & clay. Darker shade in the beginning, changing to lighter shade around 15 cm, going back to darker shade from 40 cm.					

Date	24/07/2025	Plot	12		East	175.49088E
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	37.90494S
Yes	0	No	Yes	2.40	Hydrology indicator	Yes

Pasture	Code	Common Name	Status	Cover (%)
	Cargem	<i>Rautahi</i>	FACW	60
	Ranrep	<i>Creeping buttercup</i>	FAC	15
	Hollan	<i>Yorkshire fog</i>	FAC	25
	Eleacu	<i>Sharp spike-sedge</i>	OBL	2
	Cyndac	<i>Indian doab</i>	FACU	2
Notes	Soil chart 10YR 2/1, organic matter present, light clay texture, damp			

Date	24/07/2025	Plot	13		East	175.49065E
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	37.90456S
No	0	No		3.05	Hydrology indicator	No
Pasture	Code	Common Name	Status	Cover (%)		
	Pasdis	<i>Mercer grass</i>	FACW	10		
	Daucar	<i>wild carrot</i>	FACU	15		
	Cyndac	<i>Indian doab</i>	FACU	10		
	Hyprad	<i>Catsear</i>	FACU	10		
	Axofis	<i>Carpet grass</i>	FACU	10		
	Hollan	<i>Yorkshire fog</i>	FAC	20		
	Isaglo	<i>Swamp millet</i>	OBL	20		
	Pruvul	<i>Self-heal</i>	FACU	10		
Notes	Soil sandy, yellow and small amount of mottling					

Date	24/07/2025	Plot	15		East	175.49120E
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	37.90457S
No	0	No	Yes	3.00	Hydrology indicator	No
Pasture	Code	Common Name	Status	Cover (%)		
	Hollan	Yorkshire fog	FAC	100		
	Corsel	Pampas	FAC	1		
	Rubfru	Blackberry	FAC	1		
Notes	Soil sandy 10RY 5/3					

Date	24/07/2025	Plot	16		East	175.49100E
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	37.90441S
No	0	No	No	3.13	Hydrology indicator	No
Pasture	Code	Common Name	Status	Cover (%)		

	Ranrep	<i>Creeping buttercup</i>	FAC	30
	Eleacu	<i>Sharp spike-sedge</i>	OBL	25
	Hollan	<i>Yorkshire fog</i>	FAC	20
	Daucar	<i>wild carrot</i>	FACU	5
	Pasdil	<i>Paspalum</i>	FACU	8
	Cyndac	<i>Indian doab</i>	FACU	60
	Lotped	<i>Lotus</i>	FAC	2
	Zoymin			1

Notes	Soil 10RY 4/3			
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Date	24/07/2025	Plot	17		East	175.49034E
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	37.90407S
Yes		No			Hydrology indicator	No
Notes	Soil sample only, mottling at 25cm and gley like sandy soil from 25cm					

Date	24/07/2025	Plot	18		East	
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	
	0	No	Yes	3.08	Hydrology indicator	No
Pasture	Code	Common Name	Status	Cover (%)		
	Ranrep	Creeping buttercup	FAC	30		
	Hollan	Yorkshire fog	FAC	40		
	Lotped	Lotus	FAC	2		
	Verame	Brooklime	OBL	1		
	Zoymin			5		
	Eleacu	Sharp spike-sedge	OBL	2		
	Cyndac	Indian doab	FACU	30		
Notes						

Date	24/07/2025	Plot	19		East	175.48980E
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	37.90433S
Yes		No			Hydrology indicator	No
Notes	Soil only, sandy gley soil from 5cm. 10RY 4/1					

Date	24/07/2025	Plot	20		East	175.49138E
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	37.90433S
Yes	0	No	Yes	2.91	Hydrology indicator	No
Pasture	Code	Common Name	Status	Cover (%)		
	Ranrep	<i>Creeping buttercup</i>	FAC	90		
	Eleacu	<i>Sharp spike-sedge</i>	OBL	10		
	Cyndac	<i>Indian doab</i>	FACU	10		

Notes	Soil, small amount of mottling, 10YR 4/2				
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Date	24/07/2025	Plot	21		East	175.48918E
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	37.90233S
Yes		No			Hydrology indicator	No
Notes	Soil sample only, lots of mottling and gley 10RY 5/1					

Date	24/07/2025	Plot	22		East	175.48953E
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	37.90240S
No	0	No	Yes	3.07	Hydrology indicator	No
Pasture	Code	Common Name	Status	Cover (%)		
	Ranrep	<i>Creeping buttercup</i>	FAC	15		
	Cargem	-	FACW	20		
	Hollan	<i>Yorkshire fog</i>	FAC	50		
	Cyndac	<i>Indian doab</i>	FACU	5		
	Pasdil	<i>Paspalum</i>	FACU	15		
	Pruvul	<i>Self-heal</i>	FACU	5		
	Plalan	<i>Narrow-leaved plantain</i>	FACU	2		
	Eleacu	<i>Sharp spike-sedge</i>	OBL	1		
	Lotped	<i>Lotus</i>	FAC	5		
	Antodo	<i>Sweet vernal</i>	FACU	2		
	Sonasp	<i>Prickly sowthistle</i>	FACU	1		
Notes	10YR 5/6. Water table not reached.					

Date	24/07/2025	Plot	23		East	175.48977E
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	37.90236S
No	47		No	3.54	Hydrology indicator	No
Pasture	Code	Common Name	Status	Cover (%)		
	Rubfru	<i>Blackberry</i>	FAC	10		
	Hollan	<i>Yorkshire fog</i>	FAC	30		
	Daucar	<i>wild carrot</i>	FACU	2		
	Plamaj	<i>Broad-leaved plantain</i>	FACU	5		
	Hyprad	<i>Catsear</i>	FACU	2		
Yes	Trirep	<i>White clover</i>	FACU	2		
	Eleacu	<i>Sharp spike-sedge</i>	OBL	2		
	Plalan	<i>Narrow-leaved plantain</i>	FACU	2		
	Pasdil	<i>Paspalum</i>	FACU	1		
	Rumobt	<i>Broad-leaved dock</i>	FAC	1		
	Lotped	<i>Lotus</i>	FAC	5		

	Pruvul	<i>Self-heal</i>	FACU	5	
Yes	Lolper	<i>Perennial ryegrass</i>	FACU	45	
Notes	Soil sample 10YR 4/2 some gley soil				

Date	24/07/2025	Plot	24		East	175.48945E
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	37.90225S
Yes		No			Hydrology indicator	No
Notes	Soil sample only. Gley from 5cm 10RY 5/2					

Date	24/07/2025	Plot	24		East	175.48913E
Wetland	Pasture (%)	Rapid	Dominance	Prevalence	South	37.90308S
No		No			Hydrology indicator	No
Notes	Sandy soil, small amount of mottling, no hydrology indicators 10RY 6/4					