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Amberfield - Peacocke Structure Plan

Terrestrial Ecological Assessment
Prepared for Weston Lea Ltd
15 May 2018

Boffa Miskell

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Cover photograph: Automatic bat detector located above the Waikato River within the Amberfield site. Georgia Cummings (2017)

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1.0 Executive Summary

Weston Lea Ltd propose to develop a subdivision at the Amberfield site which is located within the Peacocke structure plan area. The proposal is for up to 1000 dwelling units with a range of development densities. The site is located in the Hamilton South area on the western bank of the Waikato River.

The purpose of this report is to detail the findings of an ecological assessment of the present terrestrial ecological values, ecological context, provide an assessment of the potential ecological effects of the subdivision, and to identify opportunities to avoid, remedy, or mitigate any potential adverse ecological effects.

The Amberfield site is located in an area with several significant natural areas (SNA) associated with the Waikato river and associated gullies. With two identified SNAs occurring within the site on the Waikato River.

Within the Amberfield site areas of kānuka, planted natives, and mahoe dominated vegetation along the banks of the Waikato River were assessed as having high ecological value. The remaining majority of the vegetation on the site is grazed pasture of little ecological value with single trees, shelterbelts, hedgerows, plantings, and ornamental gardens of low ecological value scattered throughout the property. All native plant species identified are classified as 'Not Threatened'.

Although much of the vegetation is of low ecological value with regards to flora these areas provide habitat for several species of native fauna. Most notable of these species is the endemic, Threatened – Nationally Critical, long-tailed bat (*Chalinolobus tuberculatus*) which was identified as utilising the site for commuting, foraging, and potentially opportunistic roosting. Additional to the long-tailed bat there exists habitat for copper skink (*Oligosoma aeneum*) (Not Threatened) within much of the non-pasture vegetation present. The Amberfield site also provides habitat for a range of not threatened native bird species which are primarily associated with the riparian vegetation along the Waikato River. As well as the bird species identified onsite the riparian area of the Waikato River could also be utilised by several at-risk shag species for roosting and/or nesting.

The activities associated with subdivision of Amberfield site have the potential to result in:

- Loss of 0.019ha of high value (0.31% present onsite) and 5.3ha (47% present on site) of low value vegetation;
- The above vegetation loss will also result in the loss of 5.32ha (28.5% present onsite) of low ecological value copper skink habitat and 0.019ha (0.18% present onsite) of moderate-high value Avifauna habitat with the majority of the low value habitats lost (including grazed areas);
- Permanent increases of anthropogenic disturbance (lighting, roading, and residential housing). This will render the site to effectively impermeable to long-tailed bats preventing foraging, commuting, and potentially roosting in areas currently utilised by long-tailed bats;
- Development in this area also has the potential to indirectly impact on high value long-tailed bat commuting corridors and habitats adjacent to the site by way of lighting and noise disturbance reaching beyond the development footprint and boundary; and
- For all fauna present there is potential for construction activities to directly disturb, injure or kill individuals present.

The assessed potential level of ecological effects is summarised in Table 1.

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Strategies that will be implemented with the Amberfield site to avoid, remedy, mitigate and offset these potential effects include:

- Avoid where practicable removal of vegetation of high ecological value;
- Plant 13.79ha (consisting of buffer and amenity planting along the Waikato River, planting in the southern gully, and riparian planting along watercourses) of predominately native vegetation to enhance and supplement existing habitats and create additional habitats onsite for long-tailed bats, copper skinks, and avifauna; and
- Develop management plans to manage the temporary effects of construction activities on fauna species present.

To manage impacts on long tailed bats specifically:

- Maintain or establish a vegetated set back from high value habitats and potential commuting corridors (such as the Waikato River) that will maximise the screening of anthropogenic disturbance (such as lighting);
- Retain and enhance the minor gully to provide an alternative commuting corridor that will be protected in perpetuity;
- Avoid lighting where practicable and follow bat sensitive lighting guidelines where lighting is required; and
- Include tall stature native and exotic trees in plantings to provide roost habitat in the long term.

The assessed potential level of ecological effects post mitigation is summarised in Table 1.

Table 1: Summary of significance of ecological effect as a result of the proposed Amberfield development.

Ecological value being assessed	Pre-mitigation level of ecological effect	Post-proposed mitigation level of ecological effect.
Vegetation	Very Low	Likely net benefit
Bats	Very high	Very high – requires additional offsite mitigation strategy.
Herpetofauna	Very Low	Likely net benefit
Avifauna	Low	Neutral or slightly beneficial

It was identified that there are limited opportunities to mitigate the effects on long-tailed bats onsite for the subdivision and urbanisation of the Amberfield site. The context of the site within the wider Peacocke Structure Plan area (and the subsequent urbanisation of this area) severely restricts options for meaningful mitigation. To mitigate for the residual ecological effects an offsite mitigation strategy is needed. We have recommended a trust be established that will fund conservation activities relevant to the Hamilton south long-tailed bat population (activities to be defined by funding parameters). The purpose of this would be to hold financial contributions from developers in a fund that would be used to mitigate for those effects on long-tailed bats which cannot be managed within the development context in the Peacocke Structure Plan area as a whole. It would seek to ensure a cohesive, long-term approach to long-tailed bat conservation that will have a greater benefit than disparate and project-specific responses across the Peacocke Structure Plan area.

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2.0 Introduction

The Weston Lea Ltd (WLL) engaged Boffa Miskell Ltd (BML) to undertake a terrestrial ecology assessment for the proposed subdivision and development of the Amberfield site in the Peacocke Structure Plan area, Hamilton (Figure 1 & Figure 2).

As part of the proposal, WLL intends to urbanise what is currently a dairy farm that borders on its east side of the Waikato River. This will require the modification of the vegetation and habitats that are within the construction/subdivision footprint and has the potential to have indirect offsite impacts on nearby habitats.

This report details the in-depth terrestrial ecology assessment carried out across the Amberfield site and will be used to inform the Assessment of Environmental Effects (AEE) and Integrated Catchment Management Plan (ICMP) and the management of the potential effects of this development.

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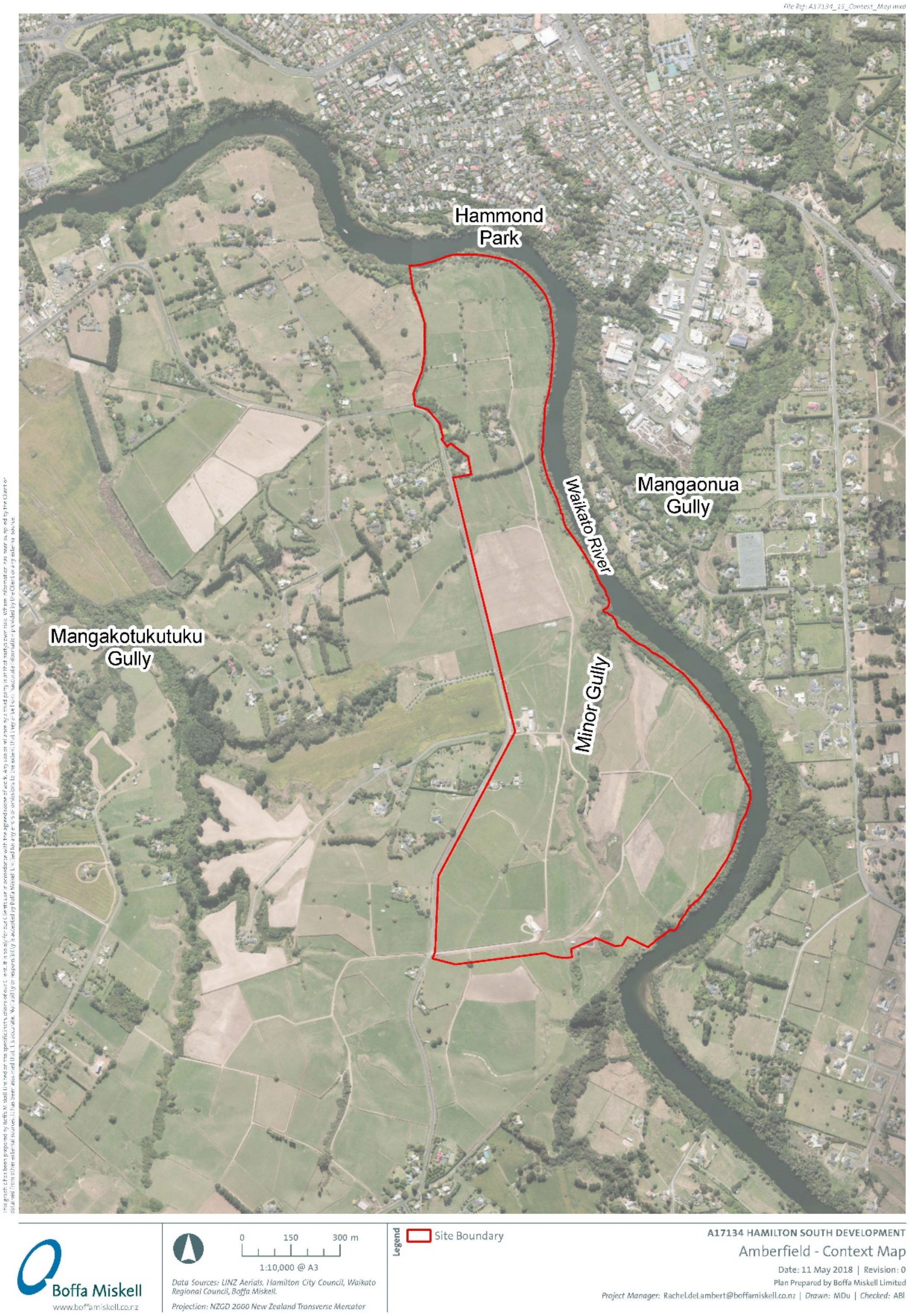

Figure 1: Amberfield site in context of surrounding features.

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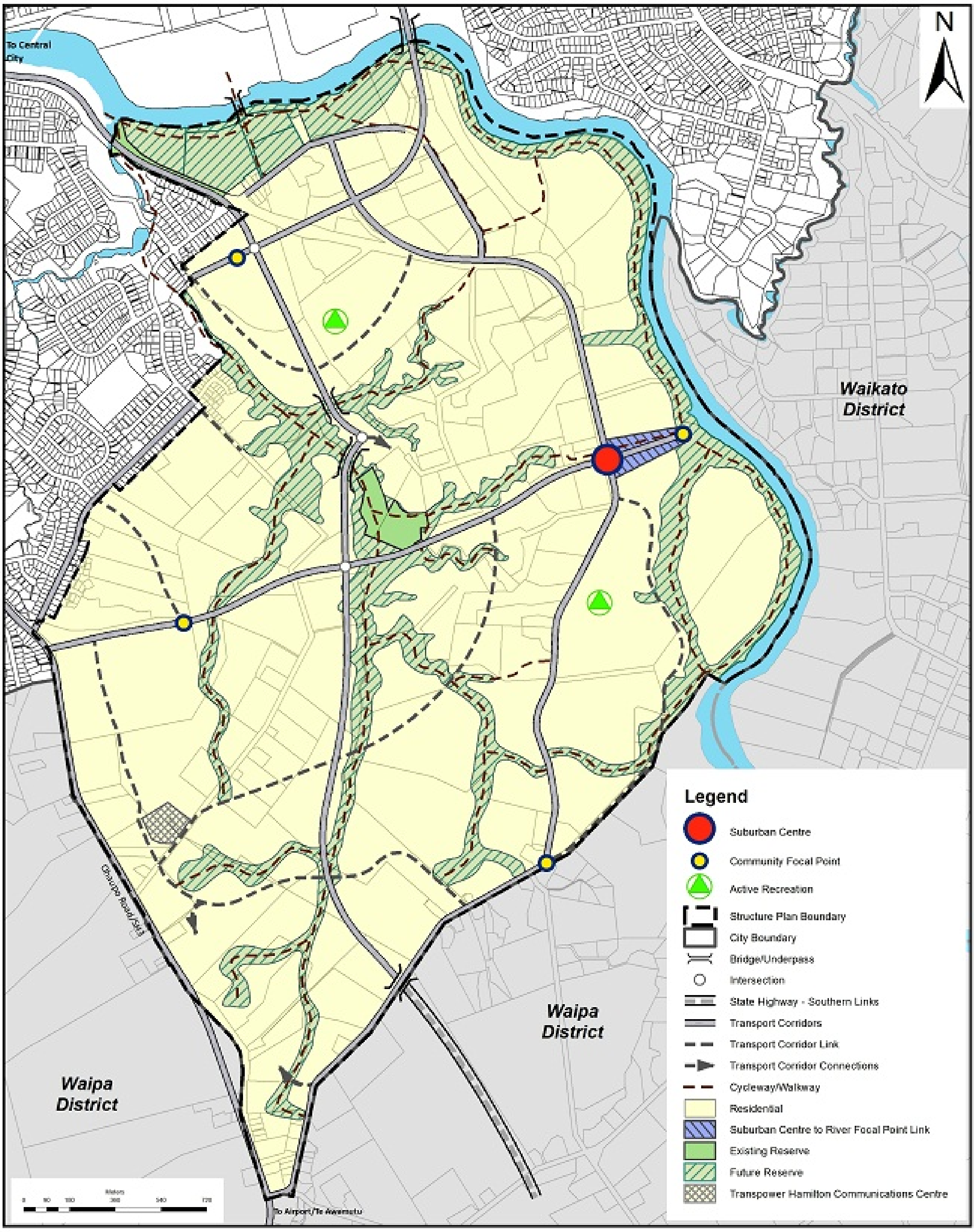

Figure 2: Peacock Structure Plan Area showing future land use. Direct excerpt from Hamilton City Operative District Plan – Section 3.4 -Figure 3.4a: Peacocke Structure Plan – Land Use.

2.1 Project scope

This report is one of a suite of technical reports that has been prepared to inform the AEE & ICMP for the Amberfield.

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The particular focus of this report is an assessment of the potential effects of the project on terrestrial ecology. A freshwater ecological assessment was not part of the scope of this report. Its purpose is to:

- describe the results of the ecological investigations and the existing terrestrial environment;
- assess the ecological significance of the existing features of the site with reference to the Operative Waikato Regional Policy Statement (WRPS);
- verify the extent and significance of the previously identified Significant Natural Areas (SNA) within the proposed project area;
- provide an assessment of the potential effects of the proposed works on terrestrial ecological values and;
- identify ecological constraints and enhancement opportunities, as well as opportunities and strategies to avoid, remedy or mitigate any potential adverse effects on the terrestrial ecology of the area.

2.2 Report Structure

This ecological assessment:

- describes the project and its ecological context (Sections 3.0 & 4.0);
- outlines the methodology used to undertake the assessment (Section 5.0);
- describes the results of the assessment (Sections 6.0 & 7.0);
- provides a summary of the ecological values (Section 8.0);
- assesses the ecological effects of the project (Section 9.0);
- provides recommendations to avoid, remedy or mitigate effects (Section 10.0); and
- lastly, provides conclusions and recommendations (Section 11.0).

3.0 Project description

Weston Lea Limited, representing the Peacocke family, proposes to develop a major new settlement within the Peacocke Structure Plan area of Hamilton City.

The proposal is for up to 1000 dwelling units incorporating a range of development densities on land situated between Peacockes Road and the Waikato River. Lot sizes will vary from over 700m^2 down to 200m^2, and building heights will vary from one storey to two storeys. A neighbourhood centre, accommodating between 5,000m^2 and 10,000m^2 of retail or employment uses, is also provided for, consistent with the Peacocke Structure Plan.

The riparian margins of the Waikato River are retained and a network of open spaces including neighbourhood parks, amenity open space, shared walking and cycling pathways, and an archaeological / heritage reserve are proposed.

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A new local roading network based on an upgraded Peacockes Road and incorporating north-south spine roads and east-west connector roads providing access to the riparian margin will serve the development. Extensions to be both the water and wastewater networks will also be provided to serve the development. Stormwater management will incorporate re-use by individual households and rely largely on on-site and public soakage systems for disposal.

The application also includes bulk earthworks to enable the development with earthworks design that minimises overall volumes and retains the natural river terraces of the site.

4.0 Ecological site context

The site is situated within the Hamilton Ecological District (McEwen, 1987) on a low terrace adjacent to the Waikato River. The Waikato River runs along the eastern side of the site with stepped terraces giving way to steep banks to the river. In the south, a minor gully separates an island of river terrace. On the opposite side of the river to the site is the Mangaonua Gully and Hammond Park (Figure 1). The surface geology consists of alluvial loose sedimentary and weak igneous rocks[1].

The land use is predominately agricultural with some rural lifestyle dwellings. Historic clearance has removed almost all of the original indigenous vegetation and indigenous vegetation is now restricted to the steep river and gully banks and some isolated plantings. Prior to human settlement low terraces adjacent to the Waikato River, and river terrace and gully scarps, were once characterised by totara-matai-kowhai forest. Gully floors may have once been kahikatea-pukatea-swamp maire forest (Clarkson, Clarkson, & Downs, 2007).

The site falls within the threatened environment classification[2] category 1 where <10% indigenous vegetation cover is left nationally, however there are very small areas that have 10-20% indigenous cover left. These small areas of threat category 2 are likely an artefact of mapping scale and a category 1 classification of the entire site is appropriate given less than 2% of all indigenous ecosystems remain in the Hamilton Ecological District (Clarkson et al., 2007). This means that any remaining indigenous vegetation cover is a high priority for protection due to its rarity (Ministry for the Environment & Department of Conservation, 2007).

Within the site there are two SNAs (Cornes, Thomson, & Clarkson, 2012a, 2012b; *Hamilton City Council Operative District Plan*, 2017) (refer to Figure 3):

1. SNA 54 (16.13 in Cornes et al. 2012a&b) Riverside Kānuka, Peacocke: a 3.3 ha kānuka/mahoe-privet forest that runs 1.2km along the Waikato River. This SNA is described as having moderate ecological value (ecological rank 3).
2. SNA 48 (16.6 in Cornes et al. 2012a&b) Riverside Kānuka, Peacocke: a 2.4ha kānuka-privet-mamaku forest described as having high ecological value (ecological rank 2).

As most of the SNAs in the area are associated with the Waikato River and Mangakotukutuku and Mangaonua gullies, the site is close to several SNAs associated with Mangaonua Gully and

[1] New Zealand Land Resource Inventory – Soil – Landcare Research. Data accessed via Our Environment mapping portal (http://ourenvironment.scinfo.org.nz/home)

[2] From the Land Environments New Zealand (LENZ) Threatened Environment Classification (2012).

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Hammond Park, which along with the SNAs onsite, provide linkages and corridors between the major gullies (Mangakotukutuku and Mangaonua) and the Waikato River (Figure 3).

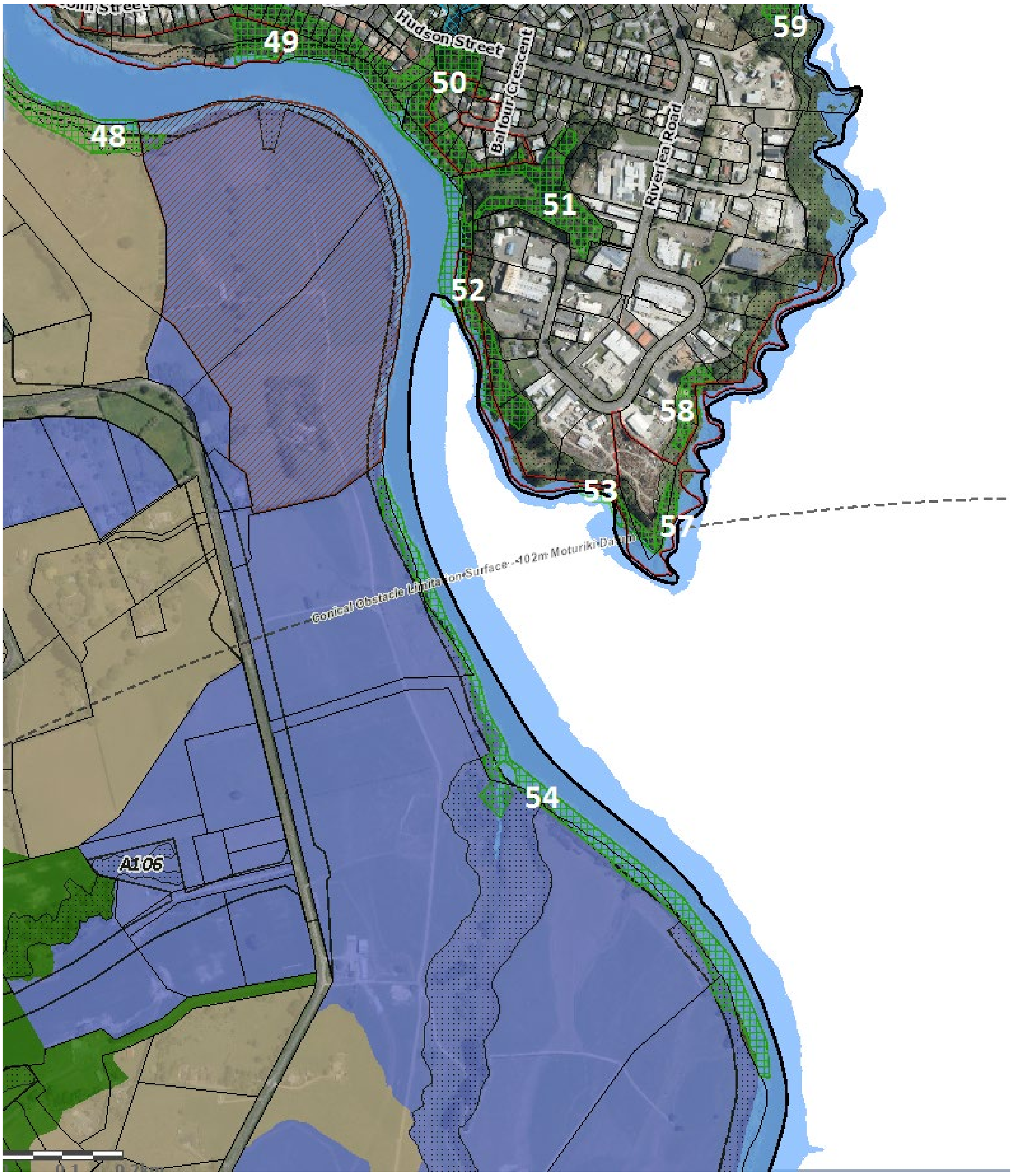

Figure 3: Amberfield site in context. Operative District Plan Map[3] - green hashed areas are defined Significant Natural Areas and white numbers are their site numbers as defined within the Hamilton City Council Operative District Plan.

[3] Accessed via Hamilton City Council Operative District Plan map portal: http://gisviewer.hcc.govt.nz/Templates/PropQueryCompare/ on 16/01/2018.

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5.0 Methods

5.1 Desktop review

The existing information relating to this area was reviewed to inform the methodology and approach to ecological assessment and determine the wider ecological context of the site.

Key sources of information reviewed involved:

- Ecological expert evidence statements related to the NZTA Waikato Expressway and Southern Links roading projects;
- Hamilton City SNA descriptions (Cornes et al., 2012a, 2012b), associated District Plan policies (*Hamilton City Council Operative District Plan*, 2017), and the Waikato Regional Council's (WRC) Regional Policy Statement (RPS) (Waikato Regional Council, 2016);
- New Zealand Herpetological Database (Department of Conservation – Bioweb Database);
- New Zealand Plant Conservation Network plant distribution database information (New Zealand Plant Conservation Network, 2017) drawn from the National Vegetation Survey Database (NVS)[4] and;
- Summaries of Hamilton City biennial bird counts (Fitzgerald & Innes, 2013) and Ornithological Society of New Zealand census summaries (Cornes et al., 2012a).

Additionally, Hamilton City is one of the few cities in New Zealand that supports a population of long-tailed bats. Long-tailed bats (*Chalinolobus tuberculatus*) are listed as Threatened - Nationally Critical (O'Donnell et al., 2018). Multiple studies have been undertaken on this population in order to increase understanding of an important aspect of Hamilton's urban ecology. These previous studies were reviewed to gain a preliminary understanding of bat activity around the site, including known and/or likely roosting areas. Studies reviewed include:

- Hamilton City Bat Survey 2011 - 2012 (Kessels & Associates Ltd., 2012);
- Southern Links NOR Ecological Assessment: Supplementary Long-tailed Bat Survey Report (Opus International Consultants Ltd., 2014);
- Hamilton Section Long-tailed Bat Surveys 2016: Pre-construction Baseline Surveys 3 & 4 (Opus International Consultants Ltd., 2016);
- Hamilton City Long-tailed Bat Survey 2016 – 2017 (Kessels & Associates Ltd., 2017); and
- Ecological expert evidence statements related to the NZTA Waikato Expressway and Southern Links roading projects.

5.2 Terrestrial vegetation

We carried out a survey of the vegetation onsite on 5 & 6 October 2017. The site was walked using geo-referenced aerial maps on a tablet to navigate to areas that appeared to have

[4] We Boffa Miskell Ltd acknowledge the use of species occurrence data drawn from the National Vegetation Survey Database (NVS)

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vegetation other than pasture (based on aerial maps). We searched for and recorded the plant species in all areas surveyed. Potential locations of rare taxa and areas previously identified as significant ecological areas were targeted. No quantitative vegetation studies were undertaken (i.e. transects or quadrats) as the vegetation found was low in species diversity, dominated by exotic pest plants, and the assessment did not require such data.

Vegetation was broadly grouped into Waikato River riparian vegetation, gully scarps, and then other vegetation. Vegetation descriptions were qualitative and described based on dominant canopy species and understory species. This approach was followed as the highly modified nature and dominance of pest plants onsite meant that an approach such as applied within Atkinson (1985) we considered may have not have captured native vegetative values where present (as these often contribute <20% of the species composition).

During this survey we also verified the extent, condition, and location of the values described in the two previously identified SNA features. As the vegetation survey included the full extent of the vegetation on the Waikato River banks the total surveyed area was approximately 121.5 ha.

5.3 Bats

5.3.1 Introduction

Hamilton is one of the few cities in New Zealand that supports a population of Threatened - Nationally Critical long-tailed bats within its city limits. Long-tailed bats are not often found in densely populated areas as they are highly sensitive to mammalian predators and anthropogenic disturbance, particularly light and noise. Previous long-tailed bat research around Hamilton has shown that the bats are largely limited to the less developed areas in the southern extent of the city but use the Waikato River and associated tributaries to disperse through more built-up areas.

The Peacocke Structure Plan area, within which the site is located, is bounded by the Waikato River, the Manganoa Gully and Hammond Park to the east and the Mangakotukutuku gully to the west. These are all key landscape features for the Hamilton south long-tailed bat population.

The objective of the long-tailed bat surveys was to:

a) Determine key habitat features for bats on the site;

b) Ascertain how bats are interacting with the site i.e., commuting, foraging and/or roosting and therefore understand the importance of the site for the population; and

c) Gain an understanding of the relative importance of the site compared to the Waikato River which flows along the eastern boundary.

5.3.2 Acoustic Activity Surveys

Bat surveys were undertaken using automatic bat monitors (ABMs) which passively record both long-tailed bat (40 kHz) and lesser short-tailed bat (28 kHz) echolocation calls on two concurrently operating frequency channels. They operate remotely by recording and storing each echolocation call (bat pass), along with the date and time of occurrence. Multiple versions of ABMs, all produced by the Department of Conservation, were used.

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5.3.2.1 Timing

Two bat surveys were undertaken, the first during the breeding season and the second in autumn when the new season's pups are flying and establishing core habitats.

The first survey ran from 20 November 2017 to 4 December 2017, totalling 15 survey nights. This monitoring period was chosen as during the breeding season, breeding female bats and their dependant young are occupying maternity roosts that generally occur in the most productive habitat within their colony's range (Pryde, O'Donnell, & Barker, 2005). Consequently, if high levels of bat activity are recorded in the project area during this period it is likely the project area is in the vicinity of core habitat for a bat colony.

The second survey ran from 7 to 22 March 2018, totalling 16 survey nights. The second survey period was chosen as this is generally considered a time when the home range of young bats is at its largest and therefore surveying during this period will maximise the likelihood of detecting bats (C. O'Donnell pers. comm. 2017).

During both survey periods recorders were programmed to record from one hour before sunset[5] to one hour after sunrise each night[6].

The timing of bat activity throughout the night and relative to sunrise/sunset was also analysed to provide an indication of bats roosting in close vicinity to the site.

5.3.2.2 Spatial survey design

During the first survey round, 30 ABMs (referred to also as units) were deployed across the Amberfield site and in the wider Peacockes Structure Plan Area to the west of the site (Appendix 3 – bat monitoring results map).

Within the project site, six transects of three ABMs (totalling 18 units) were set up running from the true left bank of the Waikato River west approximately 100 m into the interior of the site. The purpose of these transects was to capture the relative levels of bat activity within the project site in comparison to the edge of the Waikato River, a key commuting corridor for long-tailed bats.

A further seven ABMs were placed across the site targeting potential habitat features including: shelterbelts, stands of large trees and the minor gully in the southern extent of the site. The final five ABMs were deployed outside of the project site but within the wider Peacockes Structure Plan Area. These units targeted shelterbelts that potentially provide habitat connectivity beyond the project site for bats moving between the Waikato River and the Mangakotukutuku Gully to the west.

A further 19 ABMs were deployed during the second survey period, 18 of these were deployed along the same transects from the Waikato River discussed above. The final ABM targeted an area of tall-stature exotic trees close to the middle of the site.

5.3.2.3 Data analysis

Long-tailed bat activity is influenced by overnight temperatures and rainfall (O'Donnell, 2000). Weather data from the survey period was analysed to ensure conditions were suitable for bats to be active and therefore detectable via acoustic recordings. Suitable conditions are henceforth referred to as 'fine weather nights' and are defined for the purpose of this report as nights where the minimum overnight temperature was above 5°C and there was less than 5 mm

[5] Sunset and sunrise times were taken from the closest available location (Tauranga) on the LINZ Sunrise/Sunset tables, see https://www.linz.govt.nz/sea/nautical-information/astronomical-information).

[6] During the summer survey three units (A3, C3 and D2) were set-up incorrectly and only surveyed to one hour before sunrise as opposed to one hour after sunrise.

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of rainfall during the night. Weather data was taken from the “Ruakura 2 Ews” located approximately 4 km from the project site (www.cliflo.niwa.nz).

Acoustic data from fine weather nights was analysed using BatSearch versions 1.03 or 3.12, depending on the type of ABM used (see Table 8 and Table 9). The BatSearch programme is designed by the Department of Conservation for use with their ABMs. The software converts the bats echolocation calls (passes) into spectrograms that are visually analysed. Each spectrogram was recorded with the date and time which was then used to analyse the timing of activity across the site. The occurrence of feeding buzzes[7] within the spectrograms was also noted for later analysis.

5.3.3 Roost Habitat Assessment

During the site walkover and deployment of ABMs, any potential roost trees (trees more than 15 cm diameter at breast height (dbh), containing suitable roost features such as cavities, hollow limbs, loose bark and epiphytes were recorded using GPS and photos were taken. Evidence of use by bats such as staining, scratches and guano around cavities and at the base of the tree was also noted.

We also analysed the timing of bat passes recorded during the acoustic activity surveys as this can give an indication of whether bats are roosting in close vicinity to the site. During summer long-tailed bats emerge from roosts approximately 30 minutes after sunset (Griffiths, 2007) Consequently, if no bat passes are recorded across the site up to an hour after sunset, it is unlikely that bats are roosting, at least communally, within the site.

5.4 Herpetofauna

We carried out a qualitative assessment of habitat values for native herpetofauna (such as geckos and skinks) during the site walk over on 5 & 6 October 2017. The survey focused on identifying complex ground cover that would provide suitable habitat for copper skinks (*Oligosoma aeneum*) such as dense vegetation, rotting logs, leaf litter, and any other natural or artificial debris that may provide refugia (Peace, 2004).

Direct surveys for lizards were not undertaken as:

- detection rates for New Zealand herpetofauna during surveys are generally poor (Anderson, Bell, Chapman, & Corbett, 2012);
- previous experience has shown that in the Hamilton City area surveys rarely if ever detect native species other than copper skinks and often detect only plague skinks (*Lampropholis delicata*);
- most of the direct impacts of this development are limited to highly modified farmland, where (in the Hamilton area) habitat suitability means populations are likely restricted to occasional copper skinks; and
- surveys would only function to confirm the presence of lizards (copper skinks), but not provide useful quantitative information on their numbers.

[7] When long-tail bats capture flying insects they increase the frequency of their echolocation ‘clicks’ as they home in on prey. This unique type of echolocation call can be identified on the spectrograms and the relative frequency of feeding buzzes provides an indication of foraging habitat.

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Instead, an assessment of the habitat availability was undertaken, with the assumption that copper skinks were likely to be present where there was suitable habitat.

5.5 Avifauna

The primary source of avifauna data was gathered via casual visual and call observations when onsite. These were taken in conjunction with the 5 & 6 October 2017 site walk-over, 20 November 2017 ABM set-out, 5 December 2017 ABM collection, 20 December 2017 ABM collection, 23 March 2018 ABM set out, and 7 March 2018 ABM collection.

In addition to the casual surveys, birds were surveyed using five-minute bird counts following Department of Conservation best practice (Hartley & Greene, 2012) which largely follows Dawson & Bull's (1975) methodology. The counts occurred over two days (5 & 6 October) during the morning or early afternoon (Appendix 5). The survey at this site was unbounded (no cut off distance) and included birds seen flying overhead. Five counts were carried out across the site and these were located on the farm edge of the riparian vegetation to maximise the range of habitat types surveyed and potential species detected (count locations provided in Appendix 6). In combination with the large amount of time spent onsite making casual observation we consider this to be sufficient to provide an understanding of the utilisation of habitats by birds within this pasture dominated site.

5.6 Assessment of ecological significance

The ecological significance of the site was assessed against the WRC's RPS criteria (Section 11A – Table 11-1) for assessing sites of significant indigenous biodiversity (Waikato Regional Council, 2016). This table is provided below as Table 2.

Table 2: Reproduced from the Waikato Regional Council Policy Statement (2016): Table 11-1: Criteria for determining significance of indigenous biodiversity.

Previously assessed site	
1.	It is indigenous vegetation or habitat for indigenous fauna that is currently, or is recommended to be, set aside by statute or covenant or by the Nature Heritage Fund, or Ngā Whenua Rāhui committees, or the Queen Elizabeth the Second National Trust Board of Directors, specifically for the protection of biodiversity, and meets at least one of criteria 3-11.
Ecological values	
2	In the Coastal Marine Area, it is indigenous vegetation or habitat for indigenous fauna that has reduced in extent or degraded due to historic or present anthropogenic activity to a level where the ecological sustainability of the ecosystem is threatened.
3.	It is vegetation or habitat that is currently habitat for indigenous species or associations of indigenous species that are: classed as threatened or at risk, or endemic to the Waikato region, or at the limit of their natural range.

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4.	It is indigenous vegetation, habitat or ecosystem type that is under-represented (20% or less of its known or likely original extent remaining) in an Ecological District, or Ecological Region, or nationally.
5.	It is indigenous vegetation or habitat that is, and prior to human settlement was, nationally uncommon such as geothermal, chenier plain, or karst ecosystems, hydrothermal vents or cold seeps.
6.	It is wetland habitat for indigenous plant communities and/or indigenous fauna communities (excluding exotic rush/pasture communities) that has not been created and subsequently maintained for or in connection with: waste treatment; wastewater renovation; hydroelectric power lakes (excluding Lake Taupō); water storage for irrigation; or water supply storage; unless in those instances they meet the criteria in Whaley et al. (1995).
7.	It is an area of indigenous vegetation or naturally occurring habitat that is large relative to other examples in the Waikato region of similar habitat types, and which contains all or almost all indigenous species typical of that habitat type. Note this criterion is not intended to select the largest example only in the Waikato region of any habitat type.
8.	It is aquatic habitat (excluding artificial water bodies, except for those created for the maintenance and enhancement of biodiversity or as mitigation as part of a consented activity) that is within a stream, River, lake, groundwater system, wetland, intertidal mudflat or estuary, or any other part of the coastal marine area and their margins, that is critical to the self-sustainability of an indigenous species within a catchment of the Waikato region, or within the coastal marine area. In this context “critical” means essential for a specific component of the life cycle and includes breeding and spawning grounds, juvenile nursery areas, important feeding areas and migratory and dispersal pathways of an indigenous species. This includes areas that maintain connectivity between habitats.
9.	It is an area of indigenous vegetation or habitat that is a healthy and representative example of its type because: its structure, composition, and ecological processes are largely intact; and if protected from the adverse effects of plant and animal pests and of adjacent land and water use (e.g. stock, discharges, erosion, sediment disturbance), can maintain its ecological sustainability over time.
10.	It is an area of indigenous vegetation or habitat that forms part of an ecological sequence, that is either not common in the Waikato region or an ecological district, or is an exceptional, representative example of its type.

Role in protecting ecologically significant area	
11.	It is an area of indigenous vegetation or habitat for indigenous species (which habitat is either naturally occurring or has been established as a mitigation measure) that forms, either on its own or in combination with other similar areas, an ecological buffer, linkage or corridor and which is necessary to protect any site identified as significant under criteria 1-10 from external adverse effects.

5.7 Evaluation of the level of ecological effects

The methodology for assessing the significance of the ecological effects associated with the proposal was based on the Environment Institute of Australia and New Zealand's (EIANZ) Draft Ecological Impact Assessment Guidelines (EIANZ, 2015).

In summary, this method required an assessment of:

- Ecosystem/habitat and species values as described in Table 3 and Table 4, Section 5.7.1;
- The magnitude of effect using the criteria listed in Table 5, Section 5.7.2; and
- The level of ecological effect using the decision matrix presented in Table 6, Section 5.7.3, which determines the level of effect based on the ecological value of the ecosystems or species assessed and the magnitude of effect.

5.7.1 Assigning ecological value to vegetation, habitats and species

For vegetation and habitats, we have assigned ecological value based on the matters to be considered when assigning ecological value outlined in Table 3 (from EIANZ 2015).

Table 3: Matters to be considered when assigning ecological value to vegetation and habitats

Matter	Assessment considerations
Representativeness	Extent to which area is typical or characteristic Size
Rarity/distinctiveness	Amount of habitat or vegetation remaining Supporting nationally or locally threatened, at risk or uncommon species Regional or national distribution limits Endemism Distinctive ecological features Natural rarity
Diversity and pattern	Level of natural diversity Biodiversity reflecting underlying diversity
Ecological context	Contribution to network, buffer, linkage, pathways Role in ecosystem functioning Important fauna habitat Contribution to ecosystem services

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For individual plant and animal species, the national threat status was used for scoring of ecological value (Table 4).

Table 4: Assigning value to species for assessment purposes (from EIANZ 2015).

Threat category (from Townsend et al. (2008))	**Assigned Value**
Threatened – Nationally Critical, Endangered or Vulnerable	Very High
Nationally At Risk – Declining	High
Nationally At Risk – Recovering, Relict or Naturally Uncommon	Moderate - High
Not Threatened, locally uncommon/rare	Moderate
Not Threatened, common locally	Low

5.7.2 Assessing magnitude of effect

Once ecological value had been determined, the magnitude of the effect on ecological values was assessed. The magnitude of the effect was a measure of the extent, or scale, of the effect, its duration, and the degree of change that it will cause. A typical scale of magnitude ranged from very high to negligible, as shown in Table 5.

Table 5: Criteria for describing magnitude of effect (from EIANZ 2015)

Magnitude	**Description**
Very High	Total loss of, or very major alteration to, key elements/features/ of the existing baseline conditions, such that the post-development character, composition and/or attributes will be fundamentally changed and may be lost from the site altogether; AND/OR Loss of a very high proportion of the known population or range of the element/feature
High	Major loss or major alteration to key elements/features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed; AND/OR Loss of a high proportion of the known population or range of the element/feature
Moderate	Loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed; AND/OR Loss of a moderate proportion of the known population or range of the element/feature
Low	Minor shift away from existing baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances or patterns; AND/OR Having a minor effect on the known population or range of the element/feature
Negligible	Very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation; AND/OR Having negligible effect on the known population or range of the element/feature

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5.7.3 Assessing level of ecological effect

The overall level of the effect was determined by applying the following matrix (Table 6), which combined the ecological value of the site or species (Table 3 and Table 4) and the magnitude of effect (Table 5).

Table 6: Criteria for describing level of effect (From EIANZ 2015)

		ECOLOGICAL VALUE			
		Very High	High	Moderate	Low
MAGNITUDE	Very High	Very High	Very High	High	Moderate
	High	Very High	Very High	Moderate	Low
	Moderate	Very High	High	Low	Very Low
	Low	Moderate	Low	Low	Very Low
	Negligible	Low	Very Low	Very Low	Very Low

The EIANZ (2015) guidelines note that the level of effect can be used as a guide to the extent and nature of ecological response (e.g., mitigation) required.

For example:

- 'Very high' and 'High' represent a high level of effect on ecological or conservation values and warrant avoidance and / or extremely high intensity mitigation and remediation actions. Biodiversity offsetting should be considered where these adverse effects cannot be avoided.
- 'Moderate' represents a level of effect that requires careful assessment and analysis of the individual case. Such an effect could be mitigated through avoidance, design, or extensive appropriate mitigation actions.
- 'Low' and 'Very low' should not normally be of concern, although normal design, construction and operational care should be exercised to minimise adverse effects. If effects are assessed taking mitigation into consideration, then it is essential that prescribed mitigation is carried out to ensure Low or Very low level effects.
- 'Very low' level effects can generally be considered to be classed as 'not more than minor' effects.

6.0 Vegetation ecological values

The site is dominated by exotic pasture grassland with the majority of the non-pasture vegetation features occurring along the Waikato River banks and gully escarpments. A vegetation map is provided in Appendix 1 which should be referred to for the locations of specific vegetation types. A list of the plant species recorded at the site, which includes scientific names, is provided in Appendix 2.

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The vegetation on the site has been classified into several types (Table 7) which are further described in the following sections. In addition to these mapped and described areas, there are several non-native trees scattered amongst the farmland in the north of the site. These were not considered to be of ecological value and were not assessed or described further.

Table 7: Breakdown of vegetation types in the Amberfield site.

Area	Vegetation type	Mapped area (ha)
Waikato River riparian vegetation	Chinese privet – rank grass – gorse	0.2591
	Kānuka – privet – mahoe	3.3689
	Privet - alder	4.0941
	Planted native – kānuka	1.8851
	Mahoe – privet – alder	0.9643
Gully scarps	Chinese privet weed field – mamaku – willow	0.7038
	Chinese privet – hawthorn – holly	0.2011
	Willow – pine/macrocarpa shelterbelt	0.4507
	Macrocarpa – poplar – cabbage tree	0.5327
	Chinese privet – willow – black berry	0.5001
Other vegetation	Planted native areas	0.6400
	Shelterbelts	0.5546
	Ornamental gardens	2.7779
	Barberry hedgerow (assumed an average of 1m wide along length)	0.2713
	Kahikatea patch	0.0290
	Ephemeral streamside vegetation	0.2648

The national vegetation survey database was accessed for four species lists located in the southern half of Hamilton and nearby to the site. These plant lists were for Mangaone & Mangaonua Stream, Graham Island, Hamilton, Southwell Bush, and Claudlands Bush with record dates ranging from 1955 to 1973[8]. Across all plant list data for the nearby sites the only at risk plant listed was poroporo (*Solanum aviculare* var. *aviculare*) which is At Risk – Declining (de Lange et al., 2013). No threatened plants were listed at any site nearby. Poroporo was not found on the site during site surveys.

6.1.1 Waikato River riparian vegetation

The Waikato River riparian area on the site is vegetated for its entire length and consists of several different vegetation types with the dominant canopy trees changing between kānuka, mahoe, and pest plants such as Chinese privet, and tree privet along the river. The majority of the vegetation types are dominated by pest plant species, contain little sub-canopy vegetation and support few or no native plants to provide succession to established native canopy trees such as kānuka. The riparian vegetation was classified into the following types described below.

[8] National vegetation survey database identifiers for the four sites: MNGA, GRAH, Q559, and CLAU respectively.

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6.1.1.1 Chinese privet - rank grass – gorse

One area in the north of the site is relatively open compared to the rest of the riparian margin and pest plant dominated. Here Chinese privet is dominant (canopy of Chinese privet <2m high) with rank grass and gorse in more open areas (Figure 4). Grey willow is present on the river edge with a few emergent alder and occasional blackberry and Japanese honeysuckle throughout (Figure 5).

Figure 4: Chinese privet with gorse and exotic rank grass on Waikato River bank. Amberfield site.

Figure 5: Chinese privet (foreground), Japanese honeysuckle climbing alder tree (background). Obscured is a small willow on rivers edge. Waikato Riverbank Amberfield site.

6.1.1.2 Kānuka – privet – mahoe

Kānuka is present as the dominant canopy vegetation along large stretches of the Waikato River at the site. Where it occurs, it is most often growing over an understory dominated by the pest plant Chinese privet with mahoe scattered throughout. In the wetter areas along the river edge in these areas grey willow is common. As with most of the site, alders are commonly emergent in these areas (Figure 6).

In the south of the site the kānuka – privet assemblage is also associated with holly on the vegetation edge with Chinese privet only occurring in the shaded interior of the vegetation. Native shrubs and ferns such as red matipo, karamu, maidenhair fern and lance fern, are scattered in these areas. Only under kānuka in the northern half of the site is the understory free enough of exotic pest plants for these natives to be dominant (Figure 7 & Figure 8). No regeneration of kānuka seedlings was observed onsite during the survey. Pest plants such as *Tradescantia*, Jerusalem cherry, hawthorn, and African club moss were also common groundcover and sub-canopy species.

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Figure 6: Kānuka canopy with Chinese privet dominant underneath. Emergent alder shown in background. Waikato Riverbank Amberfield site.

Figure 7: Kānuka with relatively pest plant free understory in northern half of Amberfield site on Waikato Riverbank

Figure 8: Understory under kānuka canopy where natives dominate in northern end of Amberfield site on Waikato Riverbank.

6.1.1.3 Privet – alder

Several riparian areas (Privet - alder 1 & 3) along the Waikato River contain no or only occasional native species in the canopy. These areas are characterised by Chinese privet and emergent alders as the dominant canopy vegetation with grey willow common along the lower slope of the river bank (Figure 9). Within this vegetation type in the north and south of the site the diversity of the understory is low with only occasional native ferns, shrubs, and climbers such as lance fern, karamu, red matipo, and pohuehue. More common than these occasional native species are a range of pest plant species such as holly, English ivy, blackberry, and Jerusalem cherry. In many areas the majority of the understory is privet seedlings (Figure 11).

In one smaller area on a short steep bank (Privet – alder 2) tree privet becomes the dominant vegetation with a relatively bare, but native dominated, understory assemblage consisting of silver fern, shining and sickle spleenwort, and other ground ferns (Figure 10).

Figure 9: Typical example of Chinese privet and emergent alder vegetation type. Waikato Riverbank Amberfield site.

Figure 10: Sparse understory under tree privet with silver fern in foreground. Waikato Riverbank Amberfield site.

Figure 11: Examples of the understorey of the Chinese privet vegetation with abundant Chinese privet seedlings. Amberfield site.

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6.1.1.4 Planted native – kānuka

Around the confluence of the Waikato River and the small stream associated with the minor gully in the south of the site there is an area of planted native species and naturally occurring kānuka and silver fern vegetation.

The planted area consists of varied plantings of rimu, kohuhu, broadleaf, karamu, kowhai, *Hebe sp.* (planted cultivar), tanekaha, corokia, broadleaf, *Psuedopanex* hybrids, cabbage tree, ngaio, kauri, wineberry, karaka, miro, mahoe, totara, flax, rewarewa, kahikatea, lemonwood, and red matipo (Figure 12). Naturally occurring kānuka is dominant on the river bank south of the stream/River confluence (Figure 13). Near the Waikato River at the tip of a cliff occurs the only white rata (*Metrosideros perforata*) found onsite.

The ground cover in the stream confluence area is dominated by *Tradescantia* but is open with frequent spleenworts and other ground ferns high up the slope (Figure 14).

Above the stream confluence area on the northern bank a wet seep has induced a small area of plants tolerant of wet conditions, such as cutty grass, *Isolepis reticularis*, wiwi, and a single kahikatea tree (Figure 15).

Figure 12: Planted native area at confluence of stream and Waikato River. Amberfield Site.

Figure 13: Naturally occurring kānuka on southern side of confluence of small stream and Waikato River. Amberfield site.

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Figure 14: Ground ferns; leatherleaf fern, hounds tongue, and sickle spleenwort on upper scarp of minor gully. Amberfield site.

Figure 15: Small seep supporting plant species tolerant of wet conditions, with a single kahikatea in background. Amberfield site.

6.1.1.5 Mahoe – privet - alder

At the southern end of the site along the Waikato River (Area 13) the privet canopy is replaced with mahoe. Chinese privet forms the majority of the sub-canopy. Alders are frequently emergent in this area. Near the middle of this area exists a small native dominated patch of vegetation which contains the site's only large, older native trees (primarily consisting of mahoe and a single tawa (Figure 16)). The southern portion of this area contains a large macrocarpa (Figure 16) and becomes dominated by pest plants. Chinese privet and Japanese honeysuckle are the dominant vegetation cover throughout most of the southern end of this area.

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Figure 16: Native dominated vegetation patch with large macrocarpa in background on Waikato Riverbank, Amberfield site.

Figure 17: Large tawa tree located at southern end of Amberfield site on the Waikato Riverbank.

6.1.2 Gully scarps

The minor gully which runs through southern third of the site is relatively sparsely vegetated compared to the banks of the Waikato River. It contains a plant species assemblage dominated by non-natives, with only occasional, scattered patches of natives.

6.1.2.1 Chinese privet weed field – mamaku – willow vegetation

South of the minor gully stream confluence with the Waikato River is a steep area of cut-over exotic pines (the pines were felled in the summer of 2012/2013) which has now been replaced with a predominately low stature pest plant assemblage comprised of Chinese privet, blackberry, barberry, and regenerating pine. Some large mamaku ferns and native *Carex* sedges remain in the wetter areas near the gully bottom (Figure 18). At the southern end of this area willows become common in the gully bottom and a single large oak tree is present.

6.1.2.2 Chinese privet – hawthorn – holly

Near the area described above, in another area of cut-over pines (felled at the same time as above area), is a small area of pest plants consisting mostly of Chinese privet, hawthorn, and holly (Figure 19).

6.1.2.3 Willow – pine/macrocarpa shelterbelt

South of the two areas described above is an area of willows in the gully bottom with an adjacent pine/macrocarpa shelterbelt (Figure 20). A small patch of planted kowhai is also present at the end of the western arm of the area.

6.1.2.4 Macrocarpa – poplar - cabbage tree

Near the midpoint of the minor gully within an area of macrocarpa trees a small wet area contains grey willow with areas of native cutty grass, cabbage trees, and mamaku fern (Figure 21). There is also a single totara at the southern end of this area.

6.1.2.5 Chinese privet – willow – blackberry

The southern-most area of vegetation on the eastern scarp of the minor gully supports vegetation similar to that described in sections 6.1.2.1 and 6.1.2.2. It is dominated by pest plant

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assemblages growing through exotic plantation slash (Figure 21). The species assemblage consists of Chinese privet, barberry, blackberry, grey willow and woolly nightshade with a few native mamaku and kiokio in shaded areas. Across the gully on the western side, a small area of vegetation contains a similar species assemblage (but has not been planted in exotic plantation species).

Figure 18: Steep area of cut-over pines with a low-stature pest plant assemblage. Mamaku in the foreground and Carex species grow in the gully bottom. Amberfield site.

Figure 19: Pest plant patch high on minor gully scarp at Amberfield site.

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Figure 20: Willow dominated gully bottom with shelterbelt in background within minor gully of Amberfield site.

Figure 21: Wet area amongst macrocarpa trees with cabbage trees and other native vegetation on minor gully bank at Amberfield site.

Figure 22: Vegetation assemblage dominated by pest plants on minor gully scarp in Amberfield site.

6.1.3 Other vegetation

Outside of the Waikato Riverbank and the minor gully there are several other shelterbelts, hedgerows, planted areas, and ornamental gardens within the site. There are also isolated trees, especially in the northern half of the site, which are a mixture of alder, oak, kānuka, and poplar.

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6.1.3.1 Planted native areas

In the southern end of the site there are two areas of planted native species (Figure 23 and Figure 24). As with much of the site, pest plants species have invaded and are abundant. The north-eastern patch (Planted native area 1) is dominated by pest plants. The native species assemblage in these areas is relatively diverse compared to the natural vegetation in the area and includes: totara, karaka, mamaku, wheki, mahoe, kiokio, kahikatea, rimu, flax, cabbage tree, tanekaha, kowhai, *Olearia albida*, broadleaf, red matipo, kānuka, and kohuhu.

Pest plants include Chinese privet, grey willow, barberry, blackberry, and Chinese fan palm.

6.1.3.2 Shelterbelts

Two shelterbelts occur in the northern half of the site. The southern-most shelterbelt (Shelterbelt 2) is poplar which transitions to swamp oak in the western half of the shelterbelt. There are dense pest plants such as Chinese privet, Jerusalem cherry, and woolly nightshade along much of its length. The northern shelterbelt consists of poplar which transitions to mostly native tree species (lacebark, broadleaf, karamu, kohuhu, and titoki) in the northern half of its length. It contains a similar pest plant assemblage as the previous shelterbelt with the addition of large tree privet, English ivy, smilax, pampas, and onion weed.

6.1.3.3 Ornamental gardens

In the north of the site there is an area where two dwellings have extensive ornamental gardens which have large non-native trees and a range of non-native (and rarely native) ornamental garden species. These areas were not surveyed in detail because, in terms of their vegetation, they are of limited ecological value.

6.1.3.4 Barberry hedgerows

There are barberry hedgerows throughout the site (Figure 25). These hedgerows were mostly monocultures of barberry but occasionally other pest plants such as Chinese privet were present.

6.1.3.5 Kahikatea patch

There is one small stand of planted kahikatea on the site (Figure 26). This small stand has native shrubs such as mahoe, red matipo, and karamu present in its understorey, however, English ivy forms a dense groundcover under the kahikatea trees.

6.1.3.6 Ephemeral streamside vegetation

Alongside an ephemeral stream in the northern end of the site is a fenced off area of mostly long rank grass, tree privet, and willows. It does support sparse native cutty grass, but is otherwise dominated by exotic plants and pasture.

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Figure 23: North-eastern area of planted native vegetation showing the dominance of pest plants such as willow in the southern end of the Amberfield site.

Figure 24: South-western planted native patch showing the dominance of native species in the southern end of the Amberfield site

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Figure 25: Example of barberry hedgerow on Amberfield site.

Figure 26: Small kahikatea stand in Amberfield site

7.0 Fauna ecological values

7.1 Bats

7.1.1 Literature review

Previous bat monitoring undertaken across Hamilton City clearly demonstrates that the rural-urban fringe to the south of city, within which the project site is located, is core habitat for the Hamilton long-tailed bat population (Kessels & Associates Ltd, 2017; Le Roux & Le Roux, 2012; Opus International Consultants Ltd, 2016). All of the studies reviewed produced similar results, confirming that the large vegetated gullies containing tributaries of the Waikato River are key landscape features providing connectivity for bats to move through a comparatively modified landscape. However, the results of these studies often demonstrated high relative variability in activity between ABMs placed within the same gully habitat, indicating that microhabitat characteristics influence bat activity. This is likely in relation to the presence of roosts in the landscape.

Of the bat monitoring that has been undertaken in close proximity to the project site, bat activity in Hammonds Bush, located directly across the Waikato River from the project site, appears to be key roosting habitat for the Hamilton population (Kessels & Associates Ltd, 2017; Le Roux & Le Roux, 2012; Opus International Consultants Ltd, 2016). Surveys undertaken in the Mangaonua and Mangakotukutuku gullies, located to the east and west of the site respectively, also recorded regular bat activity but generally at lower levels compared to Hammonds Bush.

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Recent radio tracking surveys have also demonstrated that long-tailed bats are not limited to the gully network in Hamilton South, but are also commuting overland in areas where anthropogenic disturbance is limited (AECOM, pers. comm. March 2018).

7.1.2 Acoustic activity surveys

The results of the acoustic surveys have been broken down into three sub-sections: relative long-tailed bat activity, sunset and sunrise activity, and foraging activity. These are briefly described below:

i. The relative activity levels provide a general description of the number of bat passes recorded at different locations across the site, providing insight to hotspots and key habitats such as commuting corridors.

ii. As long-tailed bats are nocturnal and generally emerge from their roosts near dusk and re-enter them before sunrise, bat activity close to sunset and sunrise can be indicative of bats roosting close by. Consequently, analysis of this activity can assist in drawing conclusions on the likelihood of roosts occurring onsite.

iii. Finally, long-tailed bats emit a different echolocation call when they are homing in on prey, this call is referred to as a feeding buzz. Analysing the occurrence of feedings buzzes on the acoustic recorders provides information on the importance of the site as a foraging ground as opposed to bats just commuting through the site to more productive habitats.

7.1.2.1 Relative activity levels

7.1.2.1.1 Summer survey period

Automatic bat monitors were deployed on 20 November 2017 for 15 nights (example of deployment shown in Figure 27). During this period the minimum overnight temperature was 9.8°C and it rained[9] on two nights. Consequently, 13 nights of data were analysed for the majority of ABMs. However, four ABMs recorded no data due to equipment malfunctions. A further four did not record for the full duration of the survey as excessive interference[10] caused the SD cards to fill up. A summary of the results for each ABM deployed is provided in Table 8, and the mean number of bat passes recorded each night per detector is provided in Appendix 3.

Bats were recorded at 23 of the 26 functioning ABMs and with two exceptions, the highest levels of bat activity recorded along the transects extending into the site from the Waikato River (see Section 5.3.2.2) were recorded on the river margin. The two exceptions to this pattern were transects A and D, both of which followed shelterbelts of tall stature exotic trees.

The highest level of bat activity occurred at B1 (Appendix 3 - bat results map) which was located on the margin of the Waikato River directly opposite Hammonds Bush. Activity levels at B1 averaged 19.6 ± 2.8 passes per night. The activity recorded at B1 was twice that of the next highest sampling location, D3 (9.5 ± 1.3 passes per night) which was deployed along the large shelterbelt traversing the site south of Hammonds Bush (Figure 28). Of the four ABMs that recorded moderate levels of bat activity (averaging between 5.01 – 10 passes per night), three were located along the aforementioned shelterbelt. This is interesting because it suggests that the level activity along this shelterbelt was comparable to the activity along the river margin.

[9] ≥ 5 mm cumulative throughout the night.

[10] The interference appeared to be internal electrical interference causing the units to self-trigger and resulting in approximately 14,000 files per unit over the survey period.

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The shelterbelt in question extents westward beyond the site towards the Mangakotukutuku Gully and three ABMs were also deployed along this section of the shelterbelt. Of these three units, one malfunctioned but the other two both recorded bats. One of these units recorded bats on 92% of nights. The levels of activity recorded along this shelterbelt, both within and outside of the site, relative to other locations on site indicate that this feature provides connectivity across the project site from the Waikato River west towards the Mangakotukutuku Gully.

The remainder of the ABMs recorded either low or very low levels of activity (averaging between 1.01 – 5 or 0.1 – 1 passes per night respectively), while three ABMs located in the southern extent of the site did not record any bat activity.

7.1.2.1.1 Autumn survey period

Automatic bat monitors were deployed again on 7 March 2018 for 16 nights. During this period the minimum overnight temperature was 8.5°C and it rained[11] on one night. Consequently, 15 nights of data were analysed for each ABM. However, a single ABM, B1, recorded no data due to an SD card malfunction.

Bats were recorded on all 18 functioning ABMs, ranging from a total of 9 to 403 bat passes over 15 nights. The general trend across all transects was an increase in bat activity in the autumn period compared to the summer survey with the most considerable increases seen along transects C and D. Acoustic recorder D3, located along the main shelterbelt near the middle of the site showed a particularly notable increase from an average of 9.5 to 27 bat passes per night.

Overall the pattern of relative activity levels has stayed the same across the site with the river-edge ABMs recording the most activity except for transects A and D which both occurred along shelterbelts.

7.1.2.2 Sunset/sunrise activity

7.1.2.2.1 Summer survey period

Of the 26 functioning ABMs, activity within an hour of sunset was recorded on 10 units. The average number of passes within an hour of sunset across the survey period for these 10 units was 2.4 passes. The maximum number of sunset passes was 6 of a total of 255 passes at location B1, across the river from Hammond park. Unit C1, also located along the river margin recorded the earliest pass, 28 minutes after sunset.

Activity within an hour of sunrise was recorded at four of the 26 functioning ABMs. However, it should be noted that three ABMs were set-up incorrectly and did not record for a full hour after sunrise (units stopped recording at 04:55, sunrise was at 04:47). The average number of passes within an hour of sunrise across the survey period for these four units was 0.75 passes, the maximum recorded at any unit was two passes across the survey period. Again, Unit C1 recorded the latest activity however in this instance it was still close to an hour (53 minutes) before sunrise.

There were three locations that recorded activity within an hour of both sunset and sunrise but sunset recordings never followed sunrise activity the preceding morning as would be expected for bats entering a roost then exiting the following evening.

7.1.2.2.2 Autumn survey period

Activity levels within an hour of sunset were comparable between survey periods 14 of the 18 functioning units recording sunset activity. The average number of passes within an hour of

[11] ≥ 5 mm cumulative throughout the night.

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sunset across the survey period for these 14 units was 2.6 passes. The maximum number of sunset passes was 7 at unit F3 (the most inland unit along transect F) which only recorded 10 passes across the survey period. Six of these seven recordings were recorded between 8 pm and 8:30 pm on March 17.

Transect F as a whole showed and interesting pattern of sunset/sunrise activity. Although there was comparatively low activity at the two inland ABMs along this transect[12], both ABMs recorded several (between 2 and 6) bat passes close to sunset[13] over the evenings of 17 and 18 March. This activity could indicate that there was a roost, likely solitary given the low activity and the time of year, being used in the area over that time.

Sunrise activity increased notably during the Autumn survey period with 13 of 18 ABMs recording bat activity within an hour of sunrise. The average number of sunrise passes at also increased from 0.75 to 7.5 across the survey period. Of the 13 ABMs that recorded sunrise activity, four of these recorded corresponding activity close to sunset the following night, potentially indicating roost entry and emergence. Of these four ABMs, three were located along the river margin. The fourth was unit E2 located next to the riparian margin by the gully, this unit recorded a bat pass 58 minutes before sunrise on the March 21 (survey night March 20) followed by another pass 45 minutes after sunset that evening.

Figure 27: ABM (top right of photo) in situ near the Waikato River on the Amberfield site.

[12] ABMs F2 and F3 averaged 1.5 and 0.7 passes per night respectively.

[13] Within 30 mins to an hour after sunset.

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Figure 28: Area of comparatively high bat activity on the Amberfield site; poplar shelter belt (note trees shown without leaves as this photo taken during vegetation survey not during ABM placement).

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Table 8: Summary information and results of the summer acoustic bat survey undertaken for the assessment of ecological effects of Amberfield project, Hamilton (ND indicates no data).

ABM ID	Date Set	Recorder Type	Nights Deployed	Nights Analysed	Total No. of Passes	Mean No. of Passes per Night	% of Nights with Passes	Total No. of Feeding Buzzes	% of Passes that were Feeding Buzzes
Bat 01	20-Nov-17	Bat Recorder Ver B4							**ND**
Bat 02	20-Nov-17	Bat Recorder Ver A1.3	6	6	31	5.2	100%	2	6%
Bat 03	20-Nov-17	Bat Recorder Ver B4	15	13	9	0.69	46%	1	11%
Bat 04	20-Nov-17	Bat Recorder Ver B4							**ND**
Bat 05	20-Nov-17	Bat Recorder Ver B4	15	13	3	0.23	15%	0	0%
Bat 06	20-Nov-17	Bat Recorder Ver B4	15	13	2	0.15	8%	0	0%
Bat 07	20-Nov-17	Bat Recorder Ver F.3	15	13	5	0.38	8%	0	0%
Bat 08	20-Nov-17	Bat Recorder Ver B4	15	13	74	5.69	92%	4	5%
Bat 09	20-Nov-17	Bat Recorder Ver B4							**ND**
Bat 10	20-Nov-17	Bat Recorder Ver B4	15	13	2	0.15	15%	0	0%
Bat 11	20-Nov-17	Bat Recorder Ver B4							**ND**
Bat 12	20-Nov-17	Bat Recorder Ver B4	15	13	0	0	0%	0	0%
Bat A1	20-Nov-17	Bat Recorder Ver A1.3	15	13	31	2.38	69%	1	3%
Bat A2	20-Nov-17	Bat Recorder Ver A1.3	15	13	47	3.62	92%	2	4%
Bat A3	20-Nov-17	Bat Recorder Ver A1.3	8	8	23	2.88	88%	0	0%
Bat B1	20-Nov-17	Acoustic Rec ARM v1.2	15	13	255	19.62	100%	4	2%
Bat B2	20-Nov-17	Acoustic Rec ARM v1.2	15	13	21	1.62	69%	0	0%
Bat B3	20-Nov-17	Acoustic Rec ARM v1.2	15	13	15	1.15	46%	0	0%
Bat C1	20-Nov-17	Acoustic Rec ARM v1.2	15	13	49	3.77	100%	0	0%
Bat C2	20-Nov-17	Bat Recorder Ver A1.3	13	11	4	0.36	27%	1	25%
Bat C3	20-Nov-17	Bat Recorder Ver A1.3	10	9	1	0.11	11%	0	0%
Bat D1	20-Nov-17	Bat Recorder Ver A1.3	15	13	9	0.69	46%	1	11%
Bat D2	20-Nov-17	Bat Recorder Ver A1.3	15	13	57	4.38	92%	3	5%
Bat D3	20-Nov-17	Acoustic Rec ARM v1.2	15	13	124	9.54	100%	11	9%
Bat E1	20-Nov-17	Acoustic Rec ARM v1.2	15	13	111	8.54	100%	0	0%
Bat E2	20-Nov-17	Acoustic Rec ARM v1.2	15	13	11	0.85	77%	0	0%
Bat E3	20-Nov-17	Acoustic Rec ARM v1.2	15	13	58	4.46	62%	5	9%
Bat F1	20-Nov-17	Bat Recorder Ver B4	15	13	5	0.38	38%	0	0%
Bat F2	20-Nov-17	Bat Recorder Ver B4	15	13	0	0	0%	0	0%
Bat F3	20-Nov-17	Bat Recorder Ver B4	15	13	0	0	0%	0	0%

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Table 9: Summary information and results of the autumn acoustic bat survey undertaken for the assessment of ecological effects of Amberfield project, Hamilton (ND indicates no data).

ABM ID	Date Set	Recorder Type	Nights Deployed	Nights Analysed	Total No. of Passes	Mean No. of Passes per Night	% of Nights with Passes	Total No. of Feeding Buzzes	% of Passes that were Feeding Buzzes
Bat 04	07-Mar-18	Acoustic Rec ARM v1.2	16	15	11	0.7	47%	0	0%
Bat A1	07-Mar-18	Acoustic Rec ARM v1.2	16	15	25	1.7	73%	0	0%
Bat A2	07-Mar-18	Acoustic Rec ARM v1.2	16	15	89	5.9	93%	1	1%
Bat A3	07-Mar-18	Acoustic Rec ARM v1.2	16	15	127	8.5	93%	5	4%
Bat B1	07-Mar-18	Acoustic Rec ARM v1.2							**ND**
Bat B2	07-Mar-18	Acoustic Rec ARM v1.2	16	15	27	1.8	73%	1	4%
Bat B3	07-Mar-18	Acoustic Rec ARM v1.2	16	15	9	0.6	40%	0	0%
Bat C1	07-Mar-18	Acoustic Rec ARM v1.2	16	15	123	8.2	100%	0	0%
Bat C2	07-Mar-18	Acoustic Rec ARM v1.2	16	15	30	2.0	73%	1	3%
Bat C3	07-Mar-18	Acoustic Rec ARM v1.2	16	15	12	0.8	67%	0	0%
Bat D1	07-Mar-18	Acoustic Rec ARM v1.2	16	15	69	4.6	100%	0	0%
Bat D2	07-Mar-18	Acoustic Rec ARM v1.2	16	15	173	11.5	100%	9	5%
Bat D3	07-Mar-18	Acoustic Rec ARM v1.2	16	15	403	26.9	100%	13	3%
Bat E1	07-Mar-18	Acoustic Rec ARM v1.2	16	15	114	7.6	100%	0	0%
Bat E2	07-Mar-18	Acoustic Rec ARM v1.2	16	15	30	2.0	67%	1	3%
Bat E3	07-Mar-18	Acoustic Rec ARM v1.2	16	15	59	3.9	87%	2	13%
Bat F1	07-Mar-18	Acoustic Rec ARM v1.2	16	15	155	10.3	93%	2	13%
Bat F2	07-Mar-18	Acoustic Rec ARM v1.2	16	15	22	1.5	80%	0	0%
Bat F3	07-Mar-18	Acoustic Rec ARM v1.2	16	15	10	0.7	27%	0	0%

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7.1.2.3 Foraging habitat

During the summer survey, feeding buzzes were recorded at 11 sampling locations and the results indicate that foraging activity is generally focussed in the northern extent of the site where the shelterbelts and other stands of large trees are located (Appendix 3 - Bat results map). Only one of the five ABMs located in the gully in the southern area of the site recorded any feeding buzzes. The highest level of feeding activity was recorded at D3 along the main shelterbelt, 11 feeding buzzes (9% of total passes) were recorded here during the survey.

Similar results were found during the autumn survey, feeding buzzes were recorded at nine of the 18 functioning ABMs. These ABMs were located both north and south across the site but again high levels were recorded along the main shelterbelt.

The total number of feeding buzzes recorded and percentage of all bat passes which contained feeding buzzes is summarised for each ABM in Table 8 and Table 9.

7.1.2.4 Acoustic activity summary

Based on the activity results reported above, the site as a whole, and the northern extent of the site in particular, is used by long-tailed bats for commuting, periodic foraging and potentially opportunistic roosting.

The temporal variation in activity throughout the night for each ABM over both survey periods is graphed in Appendix 4. Some sampling locations showed bimodal peaks, which is not unusual for insectivorous bats as this generally correlates with increased insect activity. Low levels of bat activity were recorded within an hour of sunset and/or sunrise at various locations across the site during both monitoring periods. Given the remote sensing limitations of acoustic recorders, we conclude whether long-tailed bats are roosting on, or near, the site. However, the low activity levels indicate that if there are roosts, they are likely solitary.

Section 5.3.3 provides a description of the potential long-tailed bat roost habitat on site.

7.1.3 Roost habitat assessment

Multiple potential roost trees were identified within the site, these included mature exotic trees namely willow, pine, oak, alder and poplar trees either with cavities and/or loose bark. Also present are mature kānuka trees with loose bark (examples shown in: Figure 30, Figure 31, Figure 32, and Figure 33). Most of the potential roost trees are located within the riparian vegetation that will be maintained and buffered as part of the proposed development design.

The main shelter belt is comprised of poplar and she-oak ranging between 30 cm to 70 cm in DBH and is interspersed with tree privet. Although bat activity along the shelterbelt is comparatively high, no suitable roosting habitat was identified during ground-based surveys. Furthermore, little activity was recorded at any of the shelterbelt ABMs within the first hour after sunset[14] (Appendix 4). During the summer survey a single pass was recorded within an hour of sunset on unit D3 over the 13 nights analysed. During Autumn, a further single pass was recorded within an hour of sunset at recorders D1 and D3 over the 15 nights analysed. It should be noted however that there was a fair amount of activity with an hour of sunrise along the shelterbelt during the autumn surveys, this ranged between 3 and 17% of all passes recorded on the ABMs along the shelterbelt. Activity close to sunrise was regularly recorded at multiple locations across the site during the autumn surveys (see Section 7.1.2.2).

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[14] Sunset time 19:31 as at March 18 2018 in Tauranga (the closest available location on the LINZ Sunrise/Sunset tables, see https://www.linz.govt.nz/sea/nautical-information/astronomical-information)

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Several semi-mature oaks approximately 40 cm to 50 cm in DBH, some of which contain small cavities, occur along the races in the northern extent of the site. It is likely that most of these will be removed during the development. These trees have limited connectivity to the main vegetated areas of the site but still have a low potential to be occupied as solitary roosts.

An interesting pattern was also noted along transect F, although based on the activity results reported above, the site as a whole, and the northern extent of the site in particular is used by long-tailed bats for commuting, periodic foraging and potentially opportunistic roosting. The temporal variation in activity throughout the night for each ABM over both survey periods is graphed in Appendix 4. Some sampling locations showed bimodal peaks, which is not unusual for insectivorous bats as this generally correlates with increased insect activity.

Figure 29: Example of potential bat roosting habitat present on the Amberfield site; alder trees and kānuka along western edge of riparian margin.

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Figure 30: Example of potential bat roosting habitat present on the Amberfield site; Old pine tree on riparian margin.

Figure 31: Example of potential bat roosting habitat present on the Amberfield site; kānuka along the riparian margin with loose bark.

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Figure 32: Example of potential bat roosting habitat present on the Amberfield site; crack willow with clear cavity (left trunk) along gully in southern area of the site.

Figure 33: Example of potential bat roosting habitat present on the Amberfield site; oak tree located along a farm race with a potentially hollow knot hole on trunk.

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7.2 Herpetofauna

A review of the New Zealand Herpetofauna Bioweb database reveals only copper skink records and non-native frog species in the nearby area (5 km radius) to the Amberfield site. Based on our observations, and the land use history of the site, it is likely that native copper skinks are present (and are a protected species) but it is unlikely that any native gecko or any threatened or at risk herpetofauna species are present.

Potential habitat for copper skink is found throughout the site. With the amount of micro-habit features preferred by copper skink including leaf litter, natural and artificial debris, areas of long grass, and areas of dense vegetation is variable across the site. Much of the undergrowth within vegetated areas contains only sparse vegetation but may still provide habitat values for copper skink. Examples of the micro-habitats available onsite are shown in Figure 34, and a breakdown of the habitats available, their area, and their potential value as copper skink habitat are provided in Table 10.

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Figure 34: Examples of micro-habitats suitable for copper skink in the Amberfield site. Descriptions starting from left. Top row: Woody debris and long grass in shelterbelt, rotten wood log in privet-alder vegetation, long grass on pasture side of riparian vegetation. Bottom row: dense Tradescantia found in several areas onsite (area pictured located in planted native – kānuka vegetation), dense vegetation and woody debris (obscured by vegetation) in Chinese privet – mamaku – willow vegetation, and debris build-up under barberry hedgerow.

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Table 10: Break down of suitable copper skink micro-habitats available within each area and their value as habitat for copper skink in the Amberfield site.

Vegetation type	Mapped area (ha)	Habitat description	Habitat value of habitat type for copper skink.[15]
Chinese privet – rank grass - gorse	0.2591	Dense rank grass. Minimal natural debris.	Medium
Kānuka – privet – mahoe	3.3689	Minimal natural debris – mostly sparse ground cover in this vegetation type with few areas of long grass and only very shallow debris build up. Rank grass common on fence line.	Medium
Privet - alder	4.0941	Minimal natural debris – mostly bare ground with privet seedlings present. Some areas of shady rank grass where canopy opens. Rank grass common on fence line.	Medium
Planted native – kānuka	1.8851	Dense ground cover (*Tradescantia*) and build-up of natural debris common.	High
Mahoe – privet - alder	0.9643	Shallow build-up of leafy debris and fern fronds under canopy common. Rank grass common on fence line.	Medium
Chinese privet weed field – mamaku – willow	0.7038	Large areas of long rank grass and woody debris left from felling of pines.	High
Chinese privet – hawthorn – holly	0.2011	Rank grass and dense vegetation cover entire area.	High
Willow - pine/macrocarpa shelterbelt	0.4507	Very little cover with most areas grazed. Small area of woody debris at the end of south-western arm of mapped extent.	Low
Macrocarpa – poplar - cabbage tree	0.5327	Rank grass, dense *Carex*, and build-up of leaf matter and woody debris under macrocarpa.	High
Chinese privet – willow – blackberry	0.5001	Area has relatively sparse shrubby vegetation but is well vegetated in long grass. Woody debris remain from felled exotic woodlot.	Medium
Planted native areas	0.6400	Long rank grass, dense vegetation and natural debris build-up.	High

[15] Note "Habitat value of habitat type for copper skink" is not equivalent to "ecological value" used in the assessment of ecological value further in this report. This value refers only to the value of the area with regards to its suitability for copper skink.

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Vegetation type	Mapped area (ha)	Habitat description	Habitat value of habitat type for copper skink.[15]
Shelterbelts	0.5546	Long grass and build-up of woody debris common.	High
Ornamental gardens	2.7779	Dense vegetation and natural and artificial debris.	Medium
Barberry hedgerow (assumed an average of 1m wide along length)	0.2713	Build-up of woody debris within hedgerow footprint common but very narrow habitat located in unsuitable grazed pasture matrix.	Low
Kahikatea patch	0.0290	English ivy under kahikatea.	Medium
Ephemeral streamside vegetation	0.2648	Large area of rank grass – little other habitat features.	Medium
Debris and rank grass around farm buildings etc.	1.1497[16]	Areas around most buildings clear of debris but longer grass common. All areas isolated from other habitats by grazed pasture and have been highly disturbed by farming activities.	Low
Grazed pasture	Balance of remaining survey area (approximately 102.9 ha)	Unsuitable grazed pasture.	Negligible

7.3 Avifauna

A list of avifauna species recorded during the various site visits and five-minute bird counts is provided in Appendix 5 and Table 11 respectively.

Table 11: Avifauna species list and conservation status - all observations for Amberfield site.

Species		Conservation Status - Robertson et al. (2013)	Notes
Common name	**Scientific name**		
California quail	*Callipepla californica*	Introduced and naturalised	
Common myna	*Acridotheres tristis*	Introduced and naturalised	
Common pheasant	*Phasianus colchicus*	Introduced and naturalised	
Common starling	*Sturnus vulgaris*	Introduced and naturalised	
Eastern rosella	*Platycercus eximius*	Introduced and naturalised	
Eurasian blackbird	*Turdus merula*	Introduced and naturalised	

[16] Area includes large areas of unsuitable habitat such as building footprints, mown grass, paved area, etc. area measurement should be used only as an indication of extent. Area calculation does not include milking shed in the south of the property as this contained little to no suitable micro-habitats.

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Species		Conservation Status - Robertson et al. (2013)	Notes
Common name	**Scientific name**		
Eurasian skylark	*Alauda arvensis*	Introduced and naturalised	
European goldfinch	*Carduelis carduelis*	Introduced and naturalised	
Grey warbler	*Gerygone igata*	Not Threatened	Heard only outside of 5MBC survey periods
Greylag goose	*Anser anser*	Introduced and naturalised	
House sparrow	*Passer domesticus*	Introduced and naturalised	
Little shag	*Phalacrocorax melanoleucos brevirostris*	Not Threatened	
Malay spotted dove	*Streptopelia chinensis tigrina*	Introduced and naturalised	
North Island fantail	*Rhipidura fuliginosa placabilis*	Not Threatened	
Paradise shelduck	*Tadorna variegata*	Not Threatened	
Pukeko	*Porphyrio melanotus*	Not Threatened	
Sacred kingfisher	*Todiramphus sanctus vagans*	Not Threatened	
Shining cuckoo	*Chrysococcyx lucidus*	Not Threatened	
Silvereye	*Zosterops lateralis*	Not Threatened	
Song thrush	*Turdus philomelos*	Introduced and naturalised	
Spur-winged plover	*Vanellus miles novaehollandiae*	Not Threatened	
Swamp harrier	*Circus approximans*	Not Threatened	
Tui	*Prosthemadera novaeseelandiae*	Not Threatened	
Welcome swallow	*Hirundo neoxena*	Not Threatened	
White-faced heron	*Egretta novaehollandiae*	Not Threatened	

The Amberfield site has a diverse avifauna (25 species) comprised of 13 native species and 12 exotic species which includes both terrestrial species, and species associated with wetland/water habitats. This reflects its location directly adjacent to the Waikato River. In terms of abundance, the avifauna assemblage is dominated by naturalised introduced species which are common in the agricultural landscape surrounding Hamilton such as common starling, house sparrow, and European goldfinch. The native species present are all widespread and common species such as silvereye and pukeko. No threatened or at risk species were detected in any surveys or observations.

The species observed were consistent with previous surveys in, and around, Hamilton City (Cornes et al., 2012a; Fitzgerald & Innes, 2013). Species that have been detected in the wider Hamilton City area that were not detected onsite includes three species classified as “At Risk –

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Recovering"; North Island kākā, pied shag, and New Zealand dabchick and two species classified as "At Risk – Naturally Uncommon"; little black shag and black shag (At Risk – Naturally Uncommon). The riparian vegetation along the river may be utilised by the At Risk shag species for roosting and/or nesting, but there is no suitable habitat for New Zealand dabchick onsite. Like other rural and urban parts of the Hamilton area, kākā may visit the site when dispersing during winter, or as a short visit, but are unlikely to inhabit the area for long periods (Fitzgerald & Innes, 2013).

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8.0 Summary of ecological values

8.1 Vegetation

Vegetation other than exotic pasture grasses on this site is primarily located along the Waikato River and in the minor gully to the south of the site. Overall, the vegetation assemblage onsite is variable along the Waikato River with a mixture of native and non-native dominated areas. Vegetation within the minor gully to the south is dominated by non-native species.

The vegetation across the site is either shade-tolerant pest plant species such as Chinese and tree privet as a dominant canopy, or it contains a significant amount of pest plant seedlings in the understory. Chinese privet and tree privet are particularly aggressive invaders and are, as observed on this site, able to dominate the recruitment cohort and ultimately may be able to prevent native species regeneration and possibly replace native species assemblages (Wotton & McAlpine, 2013). While not associated with any impacts of development at the site, and/or the wider Peacocke Plan Change Area, without management, pest plants are likely to be an ongoing threat to the ecological values present onsite and should be considered in this areas ecological context.

As described in the initial assessments for the SNAs present onsite (Cornes et al., 2012b), kānuka forest is under-represented in the Hamilton City area. We have assessed the kānuka dominated vegetation (3.37ha), the Mahoe dominated vegetation (0.94ha), and the area of planted native vegetation and kānuka (1.89ha) along the Waikato River as having **High** ecological value with regard to vegetation. These high value areas total 6.2ha and represent approximately 5.12% of total surveyed area and 35.54% of the survey area that is not grazed or under buildings and associated infrastructure. All other areas, which include small areas of planted native trees (including the small kahikatea patch) and areas of predominately non-native vegetation, are of **Low** ecological value with regard to vegetation These low value areas total 11.28ha and represent approximately 9.28% of total surveyed area and 64.46% of the survey area that is not grazed or under buildings and associated infrastructure.

8.2 Fauna

8.2.1 Bats

Previous city-wide long-tailed bat surveys have demonstrated that the Hamilton City long-tailed bat population is now restricted to the southern rural-urban fringe of the city due to anthropogenic disturbance (Le Roux & Le Roux, 2012). The project site is located in this last remaining habitat for long-tailed bats in Hamilton City. Although the levels of bat activity recorded in this study were not as high as some habitats in the Hamilton south area, the acoustic surveys confirmed that long-tailed bats are regularly commuting through the site and occasionally foraging around habitat features such as the shelterbelts. The patterns of activity indicate that the site provides habitat connectivity between the Hammonds Bush - Mangaonua gully area and the Mangakotukutuku gully, all of which are key remaining landscape features for long-tailed bats.

The site also contains potential roost habitat that could be used opportunistically by solitary bats. During the summer survey, a single ABM recorded significantly more bat activity than the other 25 successfully deployed ABMs. This ABM was located on the margin of the Waikato

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River directly opposite known long-tailed bat roosting habitat in Hammonds Bush. Unfortunately, this ABM malfunctioned during the second survey period and no data was collected from that location.

The results from both survey periods demonstrate that the shelterbelts running east-west and north-south across the site are important habitat features with similar, or more, activity being recorded at these locations compared to the ABMs located on the margin of the Waikato River. These results indicate that the shelterbelts provide habitat connectivity across the site for bats commuting between Hammonds Bush and Mangaonua Gully, to the Mangakotukutuku Gully to the west.

The gully in the southern area of the site also recorded moderate to low levels of bat activity, most of which was focussed in the lower reaches close the Waikato River. This gully is comparatively large, incised and vegetated with tall stature trees, all features generally considered preferred habitat for long-tailed bats in the Hamilton context. However, unlike the shelterbelts, the gully does not provide continuous vegetated connectivity across the pastoral landscape to the Mangakotukutuku Gully. This lack of connectivity may explain the lower levels of bat activity around this landscape feature in comparison to the shelterbelts.

Given the Threatened – Nationally Critical threat status of long-tailed bats, and the above findings on their use of the habitats available onsite, the ecological value of the site for long-tailed bats has been assessed as **Very High** following the EIANZ guidance criteria outlined in Table 4 (Section 5.7.1).

8.2.2 Herpetofauna

Overall the site contains 1.87ha of low quality (1.54% of total surveyed area/ 10.04% of non-grazed area), 12.26ha of medium quality (10.09% of total surveyed area/ 65.74% of non-grazed area), and 4.52ha of high quality (3.72% of total surveyed area/ 24.23% of non-grazed area) habitat for copper skink. These habitats include dense undergrowth vegetation, natural and artificial debris, and long rank grass which are primarily located within the vegetation along the Waikato River and in the minor gully in the southern end of the site.

Copper skinks are not threatened are widespread (Peace, 2004) and in previous experience we have found them to be relatively widespread in low numbers throughout the wider Hamilton area. For these reasons, we have assessed the sites ecological value for herpetofauna as **Low** following the EIANZ guidance criteria outlined in Table 4 (Section 5.7.2).

8.2.3 Avifauna

Avifauna within this site is typical of the wider Hamilton area and the species assemblage found is consistent with previous surveys (Cornes et al., 2012a; Fitzgerald & Innes, 2013). The species assemblage consists of common native and non-native species. No threatened or at risk species were detected at any time during the site investigations.

At risk species that were not detected in the surveys at this site, but have been found in previous Hamilton surveys, could utilise the site, but are likely to be relatively rare visitors and are primarily associated with the Waikato River. As such, the riparian vegetation in this area is considered to be of higher ecological value than the remainder of the site.

Recognising the above, we have assessed the riparian habitats (10.57ha) along the Waikato River within the site as having **Medium-High** ecological value for avifauna due to the potential presence of At Risk – Naturally Uncommon species a, with the reminder of the surveyed area

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(110.93ha) having **Low** ecological value for avifauna following the EIANZ guidance criteria outlined in Table 4 (Section 5.7.2).

8.3 Ecological significance

As almost all areas surveyed within the Amberfield site detected long-tailed bats, a threatened species, all areas of the site that could be considered habitat for this species meet criteria 3 of the WRC RPS criteria for a significant natural area. We have provided an assessment against the WRC RPS criteria in Table 11 to show which other areas meet the significant natural area threshold.

For the purpose of this assessment of ecological significance; we have separated the site into the following areas (refer to Figure 1 and Table 2 for area locations):

- the two existing SNA areas,
- the Waikato River riparian vegetation previously not identified to be significant (assessed as an aggregate),
- the minor gully vegetation, and
- the remainder of the site (including shelterbelts).

It is worth noting that Cornes et al (2012b) identified SNA 48 as meeting criterion 4 due to the under-representation of kānuka in the Hamilton area, but did not identify SNA 54 as meeting the criteria. Within this assessment we consider SNA 54 to meet this criterion for the same reason as SNA 48.

It is also our opinion that the entire Waikato River's riparian vegetation meets criterion 11 of the WRC RPS criteria as this area protects and buffers the Waikato River which is an important bat commuting corridor and provides connectivity between important habitats for long-tailed bats. This includes the identified SNAs and high value bat habitats (such as the Hammond Park area) opposite the river from the Amberfield site. The buffering role these areas have will become even more important as the development of the Peacocke Structure Plan Area progresses.

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Table 12: Amberfield areas assessed against WRC RPS ecological significance criteria. Waikato River riparian vegetation indicates those areas not already identified as SNA 54 or 48.

		SNA 54	SNA 48	Waikato River riparian vegetation	Minor gully vegetation	Remainder of the site
	Previously assessed site					
1.	It is indigenous vegetation or habitat for indigenous fauna that is currently, or is recommended to be, set aside by statute or covenant or by the Nature Heritage Fund, or Ngā Whenua Rāhui committees, or the Queen Elizabeth the Second National Trust Board of Directors, specifically for the protection of biodiversity, and meets at least one of criteria 3-11.	x	x	x	x	x
	Ecological values					
2	In the Coastal Marine Area, it is indigenous vegetation or habitat for indigenous fauna that has reduced in extent or degraded due to historic or present anthropogenic activity to a level where the ecological sustainability of the ecosystem is threatened.	x	x	x	x	x
3.	It is vegetation or habitat that is currently habitat for indigenous species or associations of indigenous species that are: • classed as threatened or at risk, or • endemic to the Waikato region, or • at the limit of their natural range.	✓	✓	✓	✓	✓
4.	It is indigenous vegetation, habitat or ecosystem type that is under-represented (20% or less of its known or likely original extent remaining) in an Ecological District, or Ecological Region, or nationally.	✓	✓	x	x	x
5.	It is indigenous vegetation or habitat that is, and prior to human settlement was, nationally uncommon such as geothermal, chenier plain, or karst ecosystems, hydrothermal vents or cold seeps.	x	x	x	x	x
6.	It is wetland habitat for indigenous plant communities and/or indigenous fauna communities (excluding exotic rush/pasture communities) that has not been created and subsequently maintained for or in connection with: • waste treatment; • wastewater renovation; • hydro electric power lakes (excluding Lake Taupō); • water storage for irrigation; or • water supply storage; unless in those instances they meet the criteria in Whaley et al. (1995).	x	x	x	x	x
7.	It is an area of indigenous vegetation or naturally occurring habitat that is large relative to other examples in the Waikato region of similar habitat types, and which contains all or almost all indigenous species typical of that habitat type. Note this criterion is not intended to select the largest example only in the Waikato region of any habitat type.	✓	✓	x	x	x

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		SNA 54	SNA 48	Waikato River riparian vegetation	Minor gully vegetation	Remainder of the site
8.	It is aquatic habitat (excluding artificial water bodies, except for those created for the maintenance and enhancement of biodiversity or as mitigation as part of a consented activity) that is within a stream, River, lake, groundwater system, wetland, intertidal mudflat or estuary, or any other part of the coastal marine area and their margins, that is critical to the self sustainability of an indigenous species within a catchment of the Waikato region, or within the coastal marine area. In this context "critical" means essential for a specific component of the life cycle and includes breeding and spawning grounds, juvenile nursery areas, important feeding areas and migratory and dispersal pathways of an indigenous species. This includes areas that maintain connectivity between habitats.	x	x	x	x	x
9.	It is an area of indigenous vegetation or habitat that is a healthy and representative example of its type because: • its structure, composition, and ecological processes are largely intact; and • if protected from the adverse effects of plant and animal pests and of adjacent land and water use (e.g. stock, discharges, erosion, sediment disturbance), can maintain its ecological sustainability over time.	x	x	x	x	x
10.	It is an area of indigenous vegetation or habitat that forms part of an ecological sequence, that is either not common in the Waikato region or an ecological district, or is an exceptional, representative example of its type.	x	x	x	x	x
Role in protecting ecologically significant area						
11.	It is an area of indigenous vegetation or habitat for indigenous species (which habitat is either naturally occurring or has been established as a mitigation measure) that forms, either on its own or in combination with other similar areas, an ecological buffer, linkage or corridor and which is necessary to protect any site identified as significant under criteria 1-10 from external adverse effects.	✓	✓	✓	✓	x

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9.0 Assessment of effects on ecological values

9.1 Vegetation

The proposed development avoids all but two very small isolated areas of the vegetation of high ecological value and maintains a set-back from the both the Waikato River riparian strip and the minor gully to the south to preserve the native vegetation currently onsite as shown in the concept plan (Figure 35). Impacts on the low ecological value vegetation will predominately be restricted to the loss of non-native vegetation such as barberry hedges and isolated trees within the farmland and small areas of native plantings (planted native area 1 and a small patch of kahikatea, refer to the vegetation map in Appendix 1). With two small isolated areas of impacts on identified higher value vegetation.

We have assessed this loss of 5.30ha out of 11.28ha (47.0%) **Low** value vegetation as having a **Moderate** magnitude of effect. This represents a **Very Low** level of effect. With the loss of 0.019ha out of 6.2ha (0.31%) of **High** value vegetation as having a **Negligible** magnitude of effect. This represents a **Very low** level of effect. This assessment reflects only the ecological values of the vegetation itself. However, its wider value as habitat for fauna is also considered in the following sections. A low or very low level of effect would not normally be of concern as described in Section 5.7.3.

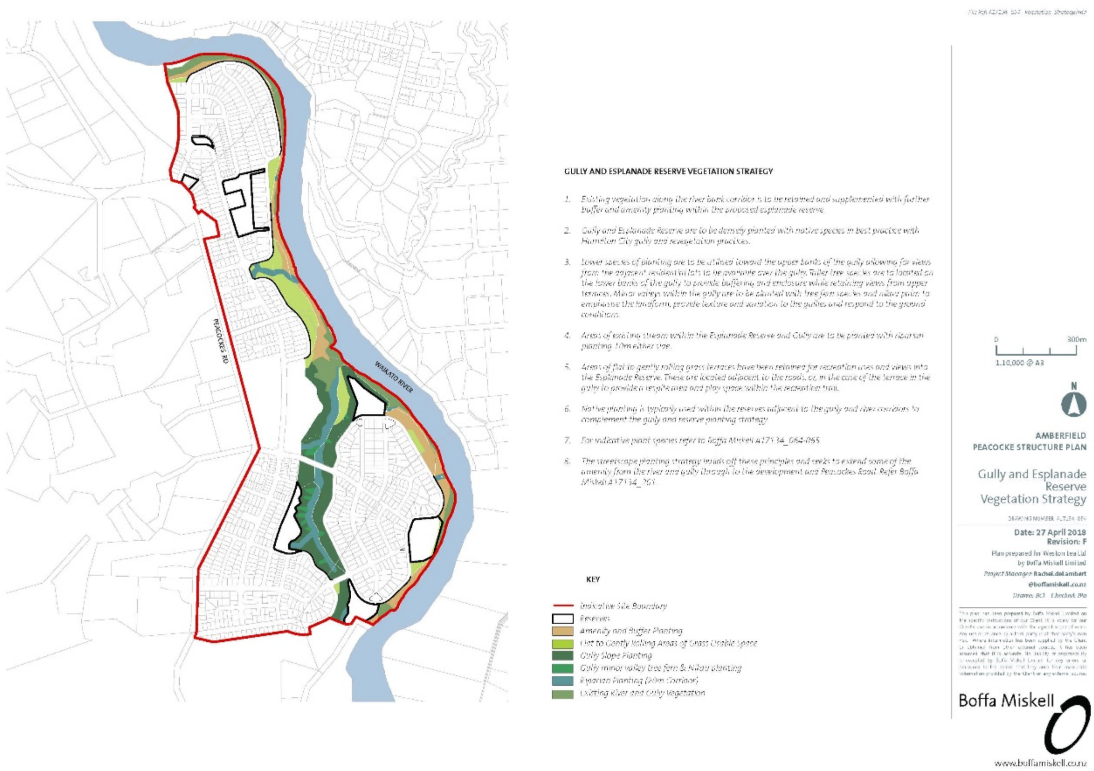

Figure 35: Vegetation strategy plan for the Amberfield development showing areas of vegetation to remain and proposed planting and greenspace (Refer to Amberfield Gully and Esplanade Reserve Vegetation Strategy in the Open Space Strategy and Concepts document for detail).

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9.2 Fauna

9.2.1 Bats

The concept plan for the development of the Amberfield site has sought to avoid, as much as practicable, direct habitat impacts on long-tailed bats within the site's footprint. This includes vegetation removal, and encroachment on the Waikato River and minor gully corridors. The timing of the bat activity recorded does not indicate that bats are likely to be regularly roosting within the development footprint; rather, they are commuting and foraging within it.

However, development will permanently increase anthropogenic disturbance in the form of increases in lighting, roading, noise, and housing densities. This is a potentially significant impact; as suitable long-tailed bat habitat is now highly restricted in Hamilton City. Furthermore, as long-tailed bats are known to be sensitive to anthropogenic disturbance such as lighting and noise (Le Roux & Le Roux, 2012), a residential development of the density proposed is likely to make the site effectively permanently impermeable to bats meaning they will no longer be able to continue to forage or disperse across or within the site at all. These disturbance effects have the potential to also significantly impact and change the characteristics of the dispersal corridors and high value habitats close to the development site.

For example, previous research on the Hamilton population has shown that a shift from rural roads (generally unlit) to residential roads of a similar density can reduce bat activity by 86% while an increase in housing density from less than one house per hectare to less than five corresponds with a 40% decrease in bat activity (Le Roux & Le Roux, 2012).

In addition to the habitat loss and indirect effects described above the removal of vegetation where it cannot be avoided and the disturbance including noise, vibration, and lighting associated with construction works has the potential to directly impact on long-tailed bats present in the area. This could lead to direct effects on long-tailed bats such as mortality, injury, abandonment of roosts, and/or total avoidance of areas.

Based on Table 5 in Section 5.7.2 the magnitude of effects of the development will be **Very High** as this represents a very major alteration to the baseline condition of the area. Furthermore, long-term effects mean that the attributes of the site which contribute to its use by long-tailed bats would be lost from the site altogether.

This magnitude of effect, combined with an ecological value of **Very High** means that without mitigation, the overall level of the ecological effect of the project on long-tailed bats is **Very High**. This represents a high level of effect on ecological or conservation values and warrants avoidance and/or extremely high intensity mitigation and remediation actions. Offsite mitigation and/or biodiversity offsetting should be considered where these adverse effects cannot be avoided as described in Section 5.7.3.

9.2.2 Herpetofauna

The Amberfield development concept plan (Figure 35) has been developed to avoid as much direct impact on copper skink habit that is practicable. The development will still have potential impacts on copper skinks which could include direct injury, mortality, due to land clearance, earth works, construction activities, and the associated noise and disturbance as well as the permanent loss of habitat occurring though the conversion of farmland to an urban environment. Expected loss of habitat based on development footprint has been measured to be: 1.44ha out

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of 1.87ha (76.7%) of low quality, 3.11ha out of 12.26ha (25.4%) of medium quality, and 0.77ha out of 4.52ha (17.1%) high quality habitats[17].

We have assessed the permanent loss of habitat and associated temporary construction disturbance effects on native herpetofauna as having a **Moderate** magnitude of effect as it represents a moderate proportion of the current habitat available that will be impacted.

This magnitude of effect combined with an ecological value of **Low** means the overall level of the ecological effect of the project on herpetofauna is **Very Low**. A low significance of effect would not normally be of concern and would not require mitigation as described in Section 5.7.3.

9.2.3 Avifauna

The proposed development is likely to cause only a minor disturbance to the bird species present within the site. With the majority of effect occurring from the change of habitat from pasture dominated farmland to an urban landscape.

The majority of the habitat loss impacts areas classified as providing **Low** value habitat for avifauna this includes the grazed pasture and other low value vegetation outside of the riparian corridor. With a small amount (0.019ha or 0.18%) of Waikato River riparian vegetation potentially impacted that has been assessed as being of **Moderate-High** ecological value for avifauna.

The potential loss of a small area of riparian vegetation on the Waikato River has been assessed as having a **Negligible** magnitude of effect and the removal of much of the **Low** value habitat as having a **High** magnitude of effect on avifauna ecological values.

A **High** magnitude of effect combined with a **Low** ecological value (grazed area and low value vegetation removed) and a **Negligible** level of effect combined with a **Moderate-High** ecological value (riparian vegetation) result in a **Low** and **Very Low** level of ecological effect respectively. A low or very low level of effect would not normally be of concern (EIANZ, 2015).

Additional to the loss/change of habitat type there will be temporary direct and indirect effects on avifauna on site related to the noise and increased activity associated with construction works onsite has the potential to cause disturbance to birds in the vicinity of the works. Given the large amount of riparian vegetation being retained onsite that is suitable as refugia and foraging and the majority of the area of works is currently dominated pasture habitat disturbance impacts are likely to be **Low**.

There exists a potential for an increased magnitude of effect where construction works occur close to the Waikato River corridor while birds are nesting (particularly if the nesting birds are one of the At Risk shag species potentially present in the area). This can have adverse effects such as increasing stress levels, incubating or brooding birds leaving the nest more frequently and for longer periods, nest desertion and failure. In this circumstance the number of nesting birds likely to be affected is small and the magnitude of the effect would be **Low**. A permanent increase in noise, activity, and disturbance will result from the urbanisation of the area may have an effect on avifauna at this site. However, the species present frequently occur within the urban and greenspace environment through Hamilton City (Fitzgerald & Innes, 2013) and we have assessed that the overall magnitude of effect would be **Low** based on Table 5 (Section

[17] Quality of habitat for copper skink should not be confused with ecological value. This presents only the habitat value to copper skinks a non-threatened native species.

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5.7.2) as while there would be a discernible alteration from baseline composition and attributes of the avifauna assemblage this would be minor.

For all of the above disturbance effects a **Low** magnitude of effect combined with **Moderate-High** ecological value (highest habitat value onsite for avifauna) results in a **Low** level of ecological effect. A low level of effect would not normally be of concern as described in Section 5.7.3.

Overall, including temporary and permanent effects we consider the potential effect on avifauna to be **Low** this being the highest level of potential effect assessed above.

9.3 Ecological effects summary

The utilisation of this area by the Threatened – Nationally Critical long-tailed bat is the primary ecological constraint in this area and because of the threat status of this species and extensive modification of a part of its habitat the overall potential ecological effect is **Very High**.

10.0 Mitigation

10.1 Vegetation mitigation

Potential effects on vegetation at this site are very low as where practicable areas of high ecological value for vegetation are avoided, but there is a significant opportunity to enhance the ecological value of the area. The proposed vegetation strategy (Figure 35) for the area shows a large (4.75ha) area of proposed buffer and amenity planting along the river bank to supplement the existing riparian vegetation by provide additional planting. A further large (6.00ha of gully bank plantings and 0.44ha of gully tree ferns and nikau plantings) area of plantings within the minor gully to the south of the site is also proposed. Additionally, within the minor gully and along other small waterways a riparian strip (10m either side) is proposed to be established with a total area across the site of 2.6ha. These areas of proposed planting total 13.79ha.

These areas will be planted for the purpose of enhancing the ecological value of the area, and will be of predominately native plantings, with some non-native species that provide amenity values and habitat values for native fauna.

As much of the area indicated to be planted is currently pasture grassland, or low stature pest plant shrubs, or areas of previously identified low value vegetation we recommend planting early successional species (see below) as they grow well in the open and grow rapidly allowing them to suppress pest plant growth. The maintenance of plantings and control of pest plants in this area will be essential to ensure successful establishment of native vegetation.

Recommended species for plantings on well drained soils (the majority of the site including all but the low riparian areas) are; kānuka, lacebark, totara, matai, wineberry, lancewood, and kowhai. In wet soils recommended early succession species are; karamu, manuka, swamp sedge, wheki, and ribbonwood.

Once established, these early successional species can then be under-planted with a range of middle and late stage successional species. A detailed gully restoration guide (Gully restoration guide - A guide to assist in the ecological restoration of Hamilton's gully systems" prepared for

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Hamilton City Council by Wall & Clarkson (2006)) is available that is suitable for this site. It includes a full list of species that are appropriate to plant in this area, detailed locations, and when to plant different species.

We recommend a full and detailed planting plan is prepared for the site that outlines; species, plant size, plant spacing, and weed management which will be consistent with the above recommendations and guidelines. This plan should also identify elements of existing vegetation where it occurs in the proposed planting areas that should be retained (such as tall stature exotic trees which may have value for native fauna) or enhanced to prevent unintended negative effects of potentially present native fauna.

With the additional riparian and gully plantings that are proposed within the site, the development is likely to provide a **net benefit** in terms of the vegetation values onsite.

Above and beyond the recommended mitigation described above there are additional opportunities for ecological enhancement by restoring the existing Waikato River riparian vegetation back to native dominated riparian vegetation. This would require a significant long-term pest plant control effort and restoration planting and should only be done under a long-term restoration plan that takes into account the long-term land ownership status of the greenspace areas. A short-term effort without long-term management is likely to revert back to pest plant dominated vegetation. Any potential restoration or modification of the remaining riparian or gully vegetation should be done with thought to the value of this vegetation as habitat for native-fauna. For example, large scale removal or destructive control methods may be inappropriate in this area. A considered and staged approach would be required to manage these complexities.

10.2 Bat mitigation

The Amberfield development is located in a wider area that will undergo significant changes in land use - from lifestyle blocks and agriculture to an urban residential area which will include considerable transport corridors. We have treated this wider area change as one of the most important considerations in developing a strategy that will provide meaningful long-term mitigation for long-tailed bat.

10.2.1 Onsite mitigation recommendations

To avoid indirect and direct effects on bats, bat sensitive design should be used across the site. Such implementation strategies should include:

- A vegetated setback from key bat habitat features on site as shown in Figure 35 including:
  - the margin of the Waikato River;
  - if practicable within the “Knoll park” a portion of the shelterbelt discussed above and shown in the bat monitoring map in Appendix 3 (along transect D, and Bat 02) and;
  - the minor gully in the southern area of the site also shown in the bat results map (located along transect E, Bat 05, and Bat 06).
- The vegetation used in the above setbacks should be selected and planted to maximise screening of the above features from anthropogenic disturbance (Figure 35).

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- Street, building and sports field lighting should be avoided wherever possible. If unable to avoid, lighting design should follow guidelines for bat sensitive lighting (e.g. Stone (2013)).
- Further to the above, street lighting should be avoided along the two road crossings that bisect the minor gully if practicable.
- The upper reaches of the minor gully should be revegetated with species that include tall stature trees and this vegetated corridor should be extended beyond the gully and the project site to provide a second continuous vegetated corridor from the Waikato River across the structure plan area to the Mangakotukutuku gully as shown in the Peacock Structure Plan as 'future reserve' (Figure 2).
- Where suitable, plantings should include tall stature native and exotic trees known to be used by long-tailed bats as roosts. Such species could include native podocarps, Eucalyptus species, oak, poplars and willows. It should be noted however, that these trees will be unlikely to provide roost cavities for a minimum of 50 years and therefore cannot be considered mitigation in the short-term.
- Where earthworks will not later encroach on these areas, buffer plantings should be established as early as is practicable.
- Develop a bat management plan that addresses the potential effects on bats related to the felling of potential roost trees, where this cannot be avoided, and temporary construction disturbance effects on bats.
  - The long-tailed bat is 'absolutely protected' under the Wildlife Act (1953, s63 (1)(c)) Department of Conservation (DOC). A Wildlife Act Authority to potentially disturb long-tailed bats as part of construction works is required for this project due to their presence. Wildlife act authority permits can take a significant amount of time to process and should be applied for at the earliest opportunity to prevent delays.

The response to these measures with regards to habitat retention and planting is shown in the Amberfield Gully and Esplanade Reserve Vegetation Strategy (Figure 35).

10.2.1.1 Key bat habitats onsite

The results of the acoustic bat surveys have demonstrated long-tailed bat activity onsite was focussed around the shelterbelts, and to a lesser extent, the minor gully and inland margin of the Waikato River vegetation corridor.

East-west shelterbelt

The main shelterbelt traversing the site east to west appears to provide connectivity for bats from the Waikato River to the Mangakotukutuku Gully. This shelterbelt will not be retained as part of the development. The reasoning behind this is that:

- The shelterbelt is impacted by two residential road crossings and the major Peacockes Road upgrade. This cannot be avoided as the shelterbelt traverses the full width of site from east to west.
- As the shelterbelt is not in a gully, it will not be bridged and the amount of earthworks required to build the roads will result in the removal of a large proportion of the shelterbelt.

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- The shelterbelt does not have natural buffering from anthropogenic disturbance provided by the topography of the gullies. Consequently, retaining this feature, even with vegetative buffering, may not necessarily mean that bats will continue to use it.
- It is likely that this shelterbelt is an important feature because it has almost complete vegetative connectivity further west beyond the site boundary to the Mangakotukutuku Gully. This western area beyond the site boundary is also part of the wider Peacocke Structure Plan and is scheduled for future development. Consequently, if the shelterbelt was retained on the project site, future development may result in the western extent of corridor being severed later.

Minor gully

Results from acoustic bat recorders deployed along the minor gully to the south of the site showed less bat activity relative to the shelterbelt discussed above. The gully is incised and vegetated with tall stature trees, features generally considered preferred habitat for long-tailed bats in the Hamilton context. However, unlike the shelterbelt, the gully does not currently provide continuous vegetated connectivity across the pastoral landscape to the Mangakotukutuku Gully. This lack of connectivity may explain the lower levels of bat activity around this feature in comparison to the shelterbelt.

However, given the incised nature of the gully it is likely that this feature will become more important to long-tailed bats as they respond to the anthropogenic development in the surrounding landscape. Consequently, we propose retaining, enhancing, and extending the vegetative connectivity of this gully to provide an alternative commuting corridor for bats through the post-development landscape. This gully forms part of a ‘Future Reserve’ network scheduled in the Peacocke Structure Plan (Figure 2) which will ensure connectivity is maintained to the Mangakotukutuku Gully through future stages of development.

Existing riparian vegetation along the margin of the Waikato River

Acoustic recorders generally picked up less activity along the inland riparian vegetation margin compared to the shelterbelts. Again, this is likely due to a lack of east – west connectivity. Given these results, the primary importance of this riparian vegetation strip is to buffer the Waikato River and other key offsite bat habitats from the impacts of the development. In response to this, all of this vegetation will be maintained and buffered with dense, multi-levelled plantings, aimed at avoiding light from the development spilling east into the river corridor.

This buffer planting to the existing riparian vegetation varies in width from a minimum of 1 m in the parts of northern extent of site, to approximately 50 m elsewhere (see Figure 35).

The limited width of the buffer planting in the northern extent is a response to engineering limitations of the riverside road. This area is across the river from Hammond Park and the entrance to the Mangaonua Gully, both key habitats for the bat population. To compensate for the limited width of buffer planting in this area and ensure light spill into these key habitats is avoided, the below mitigation will be implemented:

- 2.5 m of tall-stature buffer vegetation including under-planting to block gaps will be planted on the western margin of the road to block light from the residential lots immediately to the west;
- Low stature (up to 2 m shrubs) will be planted along the 4 m of 1:1 batter slope on the eastern margin of the road to block the light from car headlights;
- A minimum of 1 m at the toe of the batter slope to plant a dense row(s) of tall, fast growing shelterbelt trees to further block light.

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- Streetlights along the eastern road will designed to minimise light spill including being low to the ground and highly directional (details are subject to lighting specialist report).
- To further buffer light from the inland lots, the residential roads further inland will be planted with evergreen street trees; and
- All buffer vegetation in this northern area, and the tall stature shelterbelt trees in particular, will be planted as soon as it practicable.

Further to the above we recommend:

- In the detailed design phase, working towards lowering the road to maximise the area of natural batter (as opposed to reinforced earth wall) that can be planted with tall stature tree species. This will allow for plantings that are closer to the road reserve and therefore elevated which will provide more immediate light buffering as opposed to growing from the base of the batter slope below the road;
- Inter-planting the existing riparian vegetation (largely comprised of Chinese privet) with tall stature native trees to infill light gaps; and
- Utilising the batter slope between lots for buffer planting which will provide more light buffering from the terraced residential lots further west.

10.2.2 Offsite Mitigation Recommendations

In the wider Peacocke Structure Plan and surrounds we have recognised that strategies can be implemented that will limit the development's impacts and prevent as far as practicable offsite impacts as described above. However, the future context of the site means options are not available to meaningfully and fully mitigate for the overall habitat and flight corridor losses to long-tailed bats onsite. Although the proposed mitigation measures above should prevent wider and more severe effects from development we've assessed the residual potential magnitude of effect to be **High.**

The proposed mitigation should minimise, as much as practicable, offsite impacts as well as retain most key habitat features. However, the potential post-mitigation impacts would still represent a major alteration to key elements/features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed as described within Table 5 (Section 5.7.2).

This magnitude of effect, combined with an ecological value of **Very High** means the overall level of the ecological effect of the project on long-tailed bats is **Very High**. This represents a high level of effect on ecological or conservation values and warrants avoidance and/or extremely high intensity mitigation and remediation actions.

To manage this residual effect an offsite mitigation plan will need to be developed which will mitigate the potential impacts on the affected long-tailed bat population by focussing on gaining a better understanding of their ecology in the peri-urban environment and using this knowledge to protect, enhance and create habitat offsite.

Some preliminary work has been done on an approach to address the development of this plan:

> The Amberfield project team have met with the Department of Conversation (DOC) to explore these residual effect issues. The idea of establishing a long-tailed bat focused trust for the wider Peacocke Structure Plan area that financial contributions can be made to, and that will go towards funding activities that have direct and measurable conservation outcomes for long-tailed bats. The purpose of this fund would be to

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mitigate for those effects which cannot be managed within the development context in the Peacocke Structure Plan area.

The trust's funding parameters have yet to be finalised but examples of potential funding directions would likely include a mixture of: further radio tracking to identify and subsequently protect roost trees; habitat enhancement, protection and creation; pest control, and monitoring. A draft set of parameters and discussion on them can be found in Appendix 7. We consider that if multiple developments and projects in the area can contribute to this mitigation over the long-term, that the outcome of this would be of greater benefit than disparate and project-specific responses to mitigation could achieve. DOC representatives were supportive of this approach and will be part of the further development of this plan.

10.2.3 Bat mitigation concluding remarks

Given the sensitivity of long-tailed bats to anthropogenic disturbance, we have assessed that the onsite mitigation package described above will decrease the magnitude of effect from **Very High** to **High.** Consequently, our ecological assessment has concluded that the development will result in a **Very High** level of effect (refer to Section 5.7) that cannot be avoided, or adequately mitigated, using onsite mitigation techniques.

However, it is important to view this assessment within the context of the wider Peacocke Structure Plan that comprises mixed density residential housing and associated infrastructure corridors across 720 ha of key habitat for the Hamilton south long-tailed bat population. The Amberfield development comprises only a small proportion of the area approved for large-scale development. Consequently, onsite mitigation for bats, for example maintaining shelterbelts as flight corridors, will likely be nullified by the proposed upgrade of Peacockes Road and future development on neighbouring properties. Hence it is our opinion that the proposed onsite mitigation, i.e. bat sensitive design to minimise anthropogenic disturbance on the Waikato River and the small gully within site, is the best practicable onsite mitigation option because its success is not dependent on other developers within the wider Peacocke Structure Plan area to continue said mitigation further west.

Our proposal to mitigate residual effects on the Hamilton-South long-tailed bat population by way of a trust, as recommended in the above section, will ensure a cohesive, long-term approach to long-tailed bat conservation that will have a greater benefit than disparate and project-specific responses across the Peacocke Structure Plan area.

In conclusion, given the permitted baseline of the Structure Plan, we believe that if the long-tailed bat focused trust (refer to Appendix 7 – Draft Bat mitigation trust parameters) can be set-up in a timely manner and run effectively, this in combination project-specific bat sensitive design which avoids offsite impacts (as outlined in Section 10.2.1) would be an appropriate mitigation strategy as well as the best outcome for long-tailed bats in response to the implementation of the Peacocke Structure Plan.

10.3 Herpetofauna mitigation

While the very low level of ecological effect on herpetofauna values would not normally require mitigation, all native lizard species are 'absolutely protected' under the Wildlife Act (1953, s63 (1) (c)) Department of Conservation (DOC). A Wildlife Act Authority to capture, handle, transfer lizards, and incidentally kill protected wildlife (even non-threatened species) as part of

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construction works is required for this project due to the presence of lizard habitats and the potential for absolutely protected wildlife to be present.

A Lizard Management Plan will be required to support a Wildlife Act Authority application and should include the proposed methodology to manage impacts on native lizards. Wildlife act authority permits can take a significant amount of time to process and should be applied for at the earliest opportunity to prevent delays.

With regards to lizard management, it should be noted that lizard survey methods currently available have poor detection rates as a consequence of typically low population densities, species cryptic colouration, difficulty in surveying preferred habitats and behaviour/activity patterns (Anderson et al., 2012). As such, even an intensive lizard survey will not detect all individuals in the population or, possibly all species present. Experience with previous lizard salvage efforts in the wider Hamilton area has consistently resulted in few individuals; even with significant effort and resource inputs in attempts to salvage them from impacted habitats. As such we do not recommend active salvage is undertaken in this area to mitigate for construction and disturbance impacts. Instead lizard management should focus on incidental capture protocol and, although not required to mitigate effects, the creation of high value lizard habitats as this will likely have a greater net benefit for copper skink populations in the area.

The proposed vegetation strategy (Figure 35) includes many areas such as the gully and riparian strips that could be specifically planted and enhanced for the creation of habitats suitable for copper skink. These areas should include plantings and habitat elements which maximise the copper skink's preferred habitat attributes such as: dense vegetation, rotting logs, leaf litter, and any other natural cover that may provide refugia (Peace, 2004). The intention of this is to provide high quality habitat for copper skinks within a short amount of time. Additionally, the large amounts of additional riparian and gully plantings proposed will provide suitable copper skink habitat in the medium to long-term as natural debris and vegetation cover builds.

With the proposed additional riparian and gully plantings within the area the development will have a **net benefit** for copper skinks within the site.

10.4 Avifauna mitigation

Habitat loss effects on avifauna ecological values at this site are low. The additional planting proposed in the concept plan (Figure 35) and detailed within the above sections on vegetation and herpetofauna would increase the available bird habitat onsite and further protect the Waikato River and its associated avifauna. Streetscapes, greenspaces, and amenity areas should include trees that attract native species such as kowhai that will also improve the permeability to the urban environment to native bird species.

To manage construction impacts no mitigation is likely to be required, but we recommend pre-construction surveys on the farm side of the Waikato River riparian vegetation to determine whether any shag species are nesting onsite at the time. It is most likely they would nest on the riverside willow and be buffered from effects. However, if at risk shag species are found to be nesting in close proximity to the construction footprint, before works commence, then the area should be avoided until nesting is complete. The shag species potentially present have egg laying time ranges that overlap to the extent where nesting birds can be present any time of year. The approach of pre-construction surveys demonstrates a precautionary approach to this potential impact on avifauna.

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The increase in available habitat from new plantings, in combination with the additional buffering of the existing habitat and the incorporation of trees with food value to the urban environment, would mitigate for some of the effects of the habitat loss/change onsite associated with urbanisation. The approach of pre-construction nesting bird surveys to ensure no nesting At-Risk bird species are impacted by construction activities combined with the large areas of planting onsite would likely result in a **neutral or slightly beneficial** impact on avifauna at this site.

11.0 Conclusions and Recommendations

This assessment has determined that the Amberfield site contains ecologically significant habitat for the Threatened – Nationally Critical long-tailed bat. The ecological impact of the proposed urbanisation of the area is on this bat species and has been assessed as having a potential for very high ecological effect. To mitigate for this impact on long-tailed bats several actions have been recommended:

- Retention of the riparian vegetation along the Waikato River and minor gully corridor to provide continued habitat and commuting corridors for long-tailed bats and buffer adjacent bat habitats.
- Retention of tall stature trees and shelterbelts where practicable to attempt to maintain bat flight corridors and potential roost sites.
- Provide additional buffer planting to the Waikato River corridor.
- Re-vegetate the minor gully in the south with tall stature vegetation to create additional flight corridors within the site.
- Develop a lighting design strategy for street, greenspace, and housing that is adjacent to the Waikato River corridor and minor gully in the south that demonstrates an approach which will result in the prevention of light flooding into these areas or adjacent habitat.
- Develop a bat management plan that addresses the felling of potential roost trees and temporary construction disturbance effects on bats.
- Incorporate tall stature trees in planting plans that will have roost site value for bats in the future.

This mitigation strategy has focused on reducing the offsite impacts on important adjacent habitats and flight corridors while retaining as much habitat onsite as possible. However, urbanisation at this site and development proposals in the wider area poses significant constraint on the ability to mitigate for the permanent reduction in bat habitat availability onsite which leaves a Very High level of residual ecological effect. To mitigate this residual impact; we have recommended the establishment of a long-tailed bat focused trust for the wider Peacocke Structure Plan area that financial contributions can be made to (by multiple developers), and that will go towards funding activities that have direct and measurable conservation outcomes for long-tailed bats.

Other than the impacts on long-tailed bats, the habitats and vegetation that are directly impacted by the proposed development and urbanisation are generally of low ecological value

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with regards to vegetation, herpetofauna, and avifauna. All high value vegetation or moderate-high habitat for avifauna to be retained and unmodified except for a small area (0.019ha) of riparian vegetation in the south of the site.

We have recommended as part of mitigating the temporary construction impacts on avifauna that a nesting bird survey (with focus on At-Risk shag species) be under taken along the Waikato River riparian vegetation prior to construction to inform on whether areas need to be avoided or specific mitigation should be considered. Construction impacts on herpetofauna involve an incidental capture protocol but not dedicated salvage as this has not proven to be an efficient way to mitigate for construction impacts due to low capture rates despite high survey efforts in the Hamilton area.

The proposed additional riparian/buffer planting on the Waikato River corridor and the revegetation of the minor gully would likely improve ecological values for vegetation and herpetofauna. The impacts on avifauna after the proposed mitigation are likely to be neutral or slightly beneficial.

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13.0 Appendices

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Appendix 1 – Amberfield Vegetation Map

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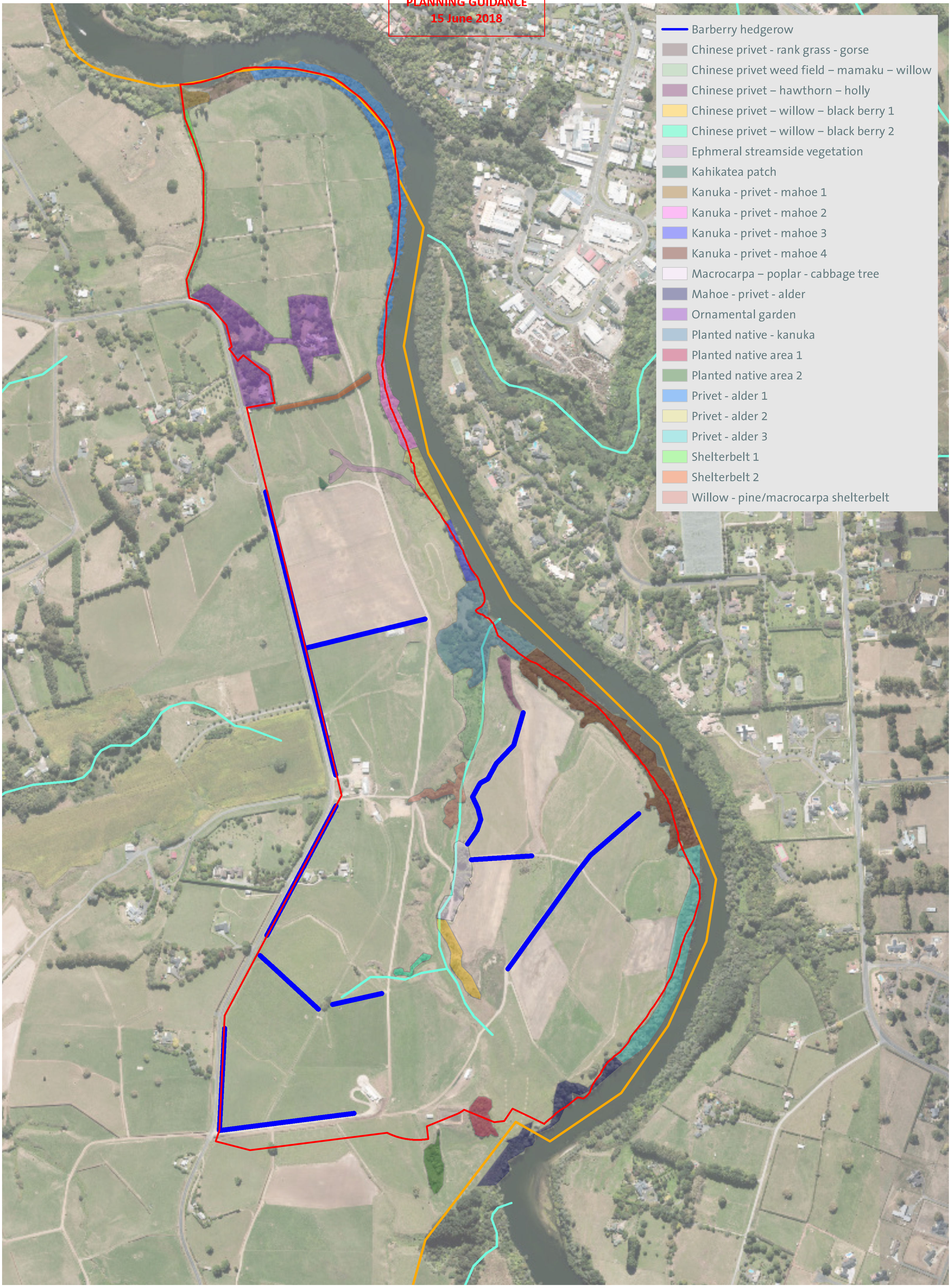
File Ref: A17134_13_Vegetation_Map.mxd



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Data Sources: LINZ Aerials, Hamilton City Council, Waikato Regional Council, Boffa Miskell.

Projection: NZGD 2000 New Zealand Transverse Mercator

Legend
Site Boundary
Peacocke Structure Plan
Streams

A17134 HAMILTON SOUTH DEVELOPMENT

Amberfield - Vegetation Map

Date: 11 May 2018 | Revision: 2

Plan Prepared by Boffa Miskell Limited

Project Manager: Rachel.deLambert@boffamiskell.co.nz | *Drawn:* MDu | *Checked:* ABl

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Appendix 2 – Plant Species List

Common Name	Scientific Name	Category/threat status	Notes
Maidenhair fern	*Adiantum cunninghamii*	Native - Not threatened	
Kauri	*Agathis australis*	Native - Not threatened	
Wineberry	*Aristotelia serrata*	Native - Not threatened	
Shining spleenwort	*Asplenium oblongifolium*	Native - Not threatened	
Sickle spleenwort	*Asplenium polyodon*	Native - Not threatened	
Lance fern	*Austroblechnum lanceolatum*	Native - Not threatened	
Tawa	*Beilschmiedia tawa*	Native - Not threatened	
Cutty grass	*Carex geminata*	Native - Not threatened	
Mingimingi	*Coprosma propinqua* var. *propinqua*	Native - Not threatened	
Karamu	*Coprosma robusta*	Native - Not threatened	
Cabbage tree	*Cordyline australis*	Native - Not threatened	
Corokia	*Corokia cotoneaster*	Native - Not threatened	
Karaka	*Corynocarpus laevigatus*	Native - Not threatened	
Silver fern	*Cyathea dealbata*	Native - Not threatened	
Mamaku	*Cyathea medullaris*	Native - Not threatened	
Giant umbrella sedge	*Cyperus ustulatus*	Native - Not threatened	
Kahikatea	*Dacrycarpus dacrydioides*	Native - Not threatened	
Rimu	*Dacrydium cupressinum*	Native - Not threatened	
Wheki	*Dicksonia squarrosa*	Native - Not threatened	
N/A	*Diplazium australe*	Native - Not threatened	
Rasp fern	*Doodia australis*	Native - Not threatened	
Mapere	*Gahnia xanthocarpa*	Native - Not threatened	
Broadleaf	*Griselinia littoralis*	Native - Not threatened	
Lacebark	*Hoheria sexstylosa*	Native - Not threatened	
Thread fern	*Icarus filiformis*	Native - Not threatened	
N/A	*Isolepis reticularis*	Native - Not threatened	
Wiwi	*Juncus australis*	Native - Not threatened	
Rewarewa	*Knightia excelsa*	Native - Not threatened	
Kānuka	*Kunzea robusta*	Native - Not threatened	
Pukatea	*Laurelia novae-zelandiae*	Native - Not threatened	
Machaerina	*Machaerina sinclairii*	Native - Not threatened	

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Common Name	Scientific Name	Category/threat status	Notes
Mahoe	*Melicytus ramiflorus*	Native - Not threatened	
Pohutukawa	*Metrosideros excelsa*	Native - Not threatened	
White rata	*Metrosideros perforata*	Native - Not threatened	
Hounds tongue fern	*Microsorum pustulatum* subsp. *pustulatum*	Native - Not threatened	
Pohuehue	*Muehlenbeckia australis*	Native - Not threatened	
Ngaio	*Myoporum laetum*	Native - Not threatened	
Red matipo	*Myrsine australis*	Native - Not threatened	
N/A	*Olearia albida*	Native - Not threatened	
Lace fern	*Paesia scaberula*	Native - Not threatened	
Swamp kiokio	*Parablechnum minus*	Native - Not threatened	
Kiokio	*Parablechnum novae-zelandiae*	Native - Not threatened	
Flax	*Phormium tenax*	Native - Not threatened	
Tanekaha	*Phyllocladus trichomanoides*	Native - Not threatened	
Lemonwood	*Pittosporum eugenioides*	Native - Not threatened	
Kohuhu	*Pittosporum tenuifolium*	Native - Not threatened	
Totara	*Podocarpus totara* var. *totara*	Native - Not threatened	
Miro	*Prumnopitys ferruginea*	Native - Not threatened	
Bracken	*Pteridium esculentum*	Native - Not threatened	
Leather-leaf fern	*Pyrrosia elaeagnifolia*	Native - Not threatened	
Kowhai	*Sophora tetraptera*	Native - Not threatened	
Psuedopanex hybrid/cultivar	*Psuedopanex* sp.	Native - Cultivar	
Hebe	*Veronica* sp.	Native - Cultivar	Most likely one of the many cultivar/hybrid variants advertised as "*Hebe speciosa*".
Onion weed	*Allium triquetrum*	Exotic	
Alders	*Alnus glutinosa*	Exotic	
Smilax	*Asparagus asparagoides*	Exotic	
Barberry	*Berberis glaucocarpa*	Exotic	
Bindweed	*Calystegia* sp.	Exotic	Likely a hybrid of non-native and native species.
She-oak / swamp oak	*Casuarina glauca*	Exotic	
Pampas	*Cortaderia selloana*	Exotic	

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15 June 2018

Common Name	Scientific Name	Category/threat status	Notes
Hawthorn	*Crataegus monogyna*	Exotic	
Macrocarpa	*Cupressus macrocarpa*	Exotic	
English ivy	*Hedera helix*	Exotic	
Holly	*Ilex aquifolium*	Exotic	
Tree Privet	*Ligustrum lucidum*	Exotic	
Chinese privet	*Ligustrum sinense*	Exotic	
Japanese honeysuckle	*Lonicera japonica*	Exotic	
Willow weed	*Persicaria maculosa*	Exotic	
Inkweed	*Phytolacca octandra*	Exotic	
Pine	*Pinus* sp.	Exotic	
Oak	*Quercus robur*	Exotic	
Blackberry	*Rubus fruticosus* agg.	Exotic	
Grey willow	*Salix cinerea*	Exotic	
Crack willow	*Salix xfragilis*	Exotic	
African club moss	*Selaginella kraussiana*	Exotic	
Woolly nightshade	*Solanum mauritianum*	Exotic	
Jerusalem cherry	*Solanum pseudocapsicum*	Exotic	
Chinese fan palm	*Trachycarpus fortunei*	Exotic	
Tradescantia	*Tradescantia fluminensis*	Exotic	
Gorse	*Ulex europaeus*	Exotic	

Appendix 3 – Bat Monitoring Results Maps

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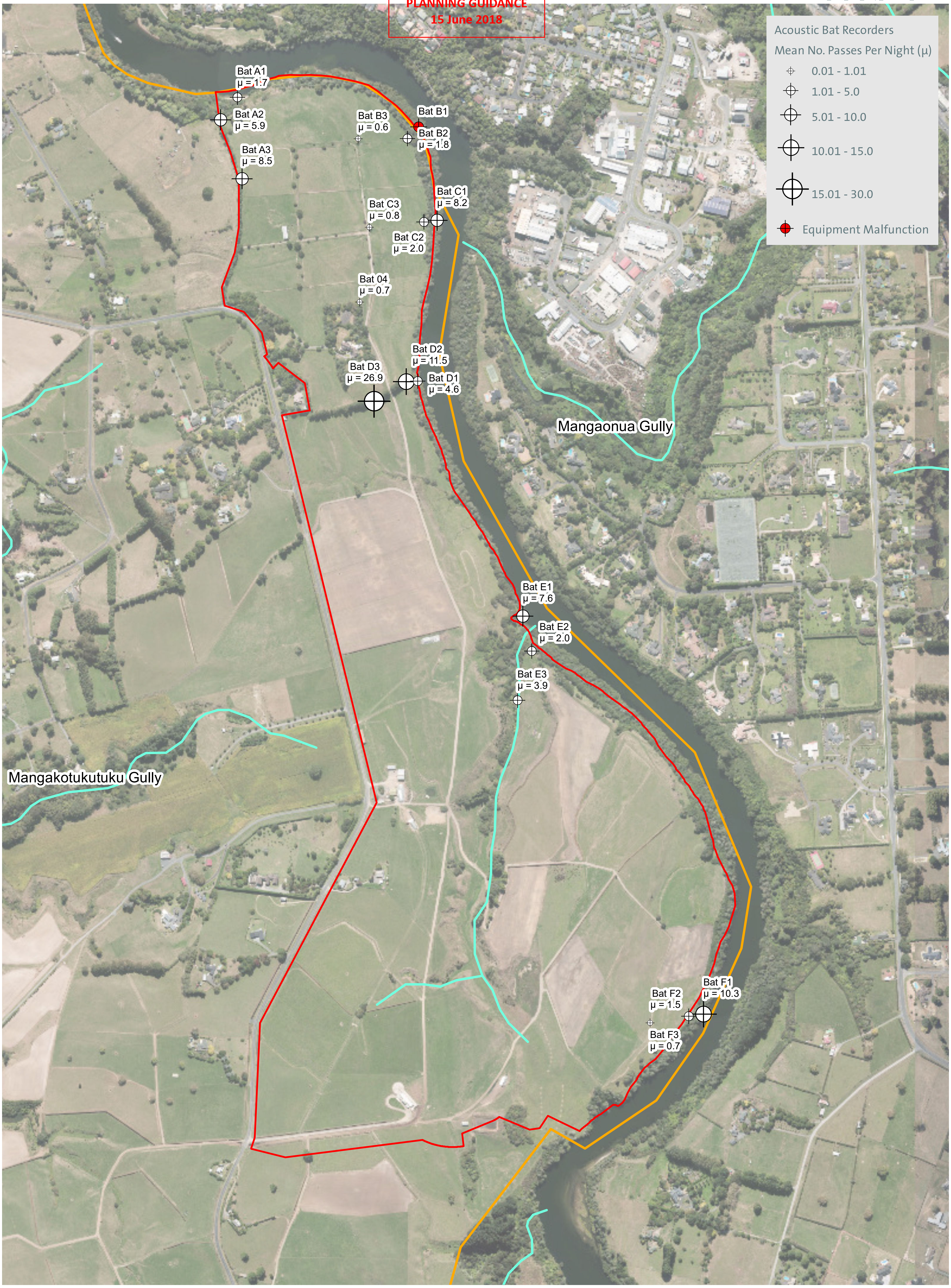
File Ref: A17134_12a_Bat_Map_Autumn_Rev1.mxd



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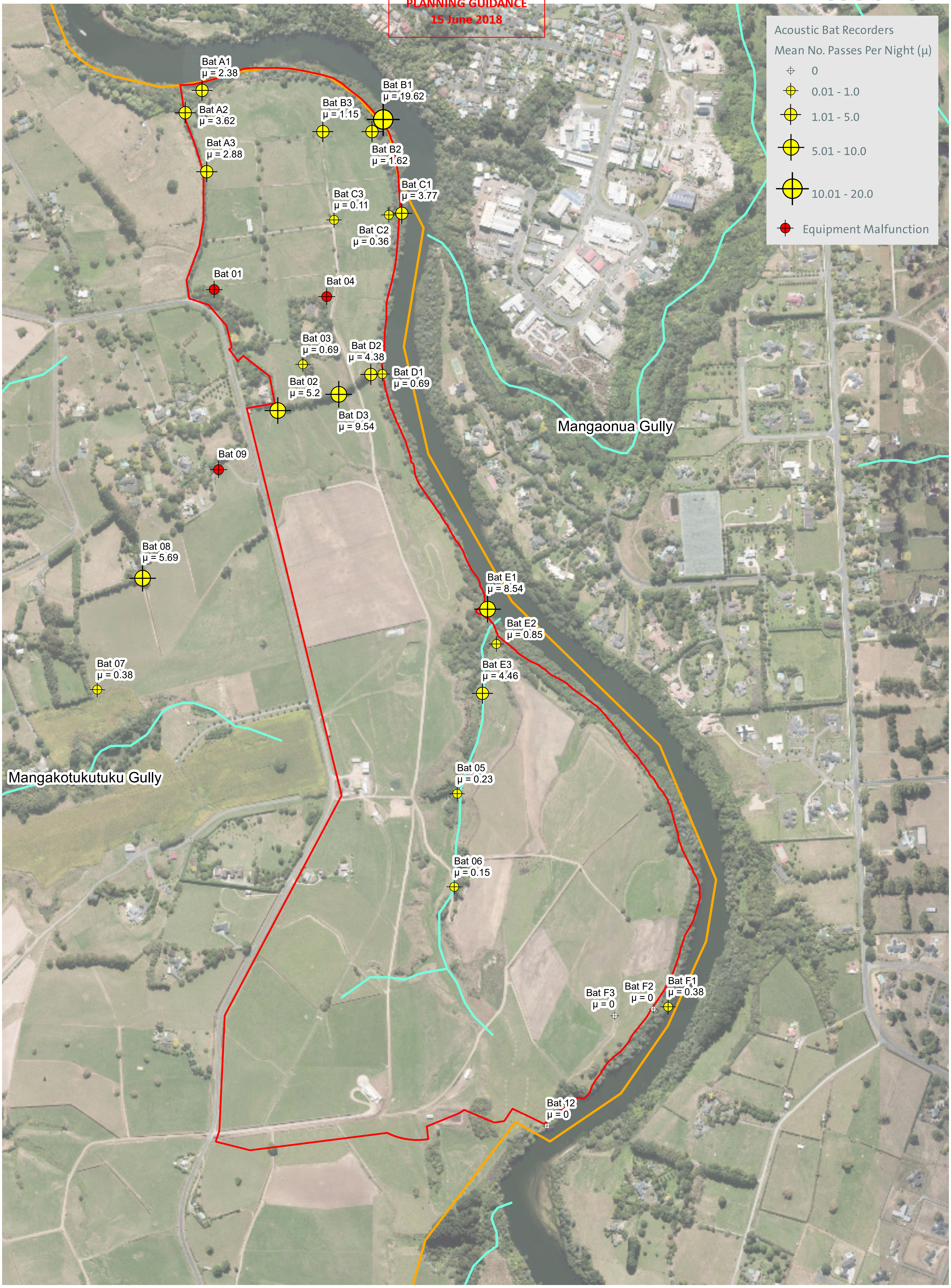
Data Sources: LINZ Aerials, Hamilton City Council, Waikato Regional Council, Boffa Miskell.
Projection: NZGD 2000 New Zealand Transverse

Legend
- Site Boundary
- Peacocke Structure Plan
- Streams

A17134 HAMILTON SOUTH DEVELOPMENT
Amberfield
Bat Monitoring Results - Autumn

Date: 11 May 2018 | Revision: 1
Plan Prepared by Boffa Miskell Limited
Project Manager: Rachel.deLambert@boffamiskell.co.nz | *Drawn:* GCu | *Checked:* ABl

File Ref: A17134_12_Bat_Map_Summer_Rev3.mxd



Boffa Miskell
www.boffamiskell.co.nz

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Data Sources: LINZ Aerials, Hamilton City Council, Waikato Regional Council, Boffa Miskell.

Projection: NZGD 2000 New Zealand Transverse

Legend
Site Boundary
Peacocke Structure Plan
Streams

A17134 HAMILTON SOUTH DEVELOPMENT

Amberfield
Bat Monitoring Results - Summer

Date: 11 May 2018 | Revision: 3

Plan Prepared by Boffa Miskell Limited

Project Manager: Rachel.deLambert@boffamiskell.co.nz | *Drawn:* GCu | *Checked:* ABl

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Appendix 4 – Temporal Distribution of Bat Activity Across the Night

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Temporal distribution of bat activity over the night at each site successfully surveyed during the summer bat survey period, 20 November to 4 December 2017.

Approximate time of sunset and sunrise was 8:27 pm and 5:47 am respectively on 8 December in Tauranga – the closest location provided in the LINZ Sunrise and Sunset tables. See https://www.linz.govt.nz/sea/nautical-information/astronomical-information

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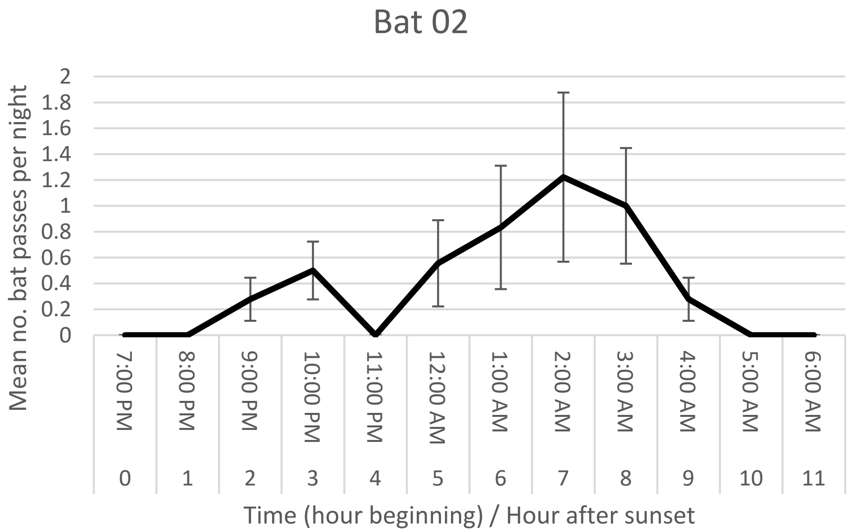

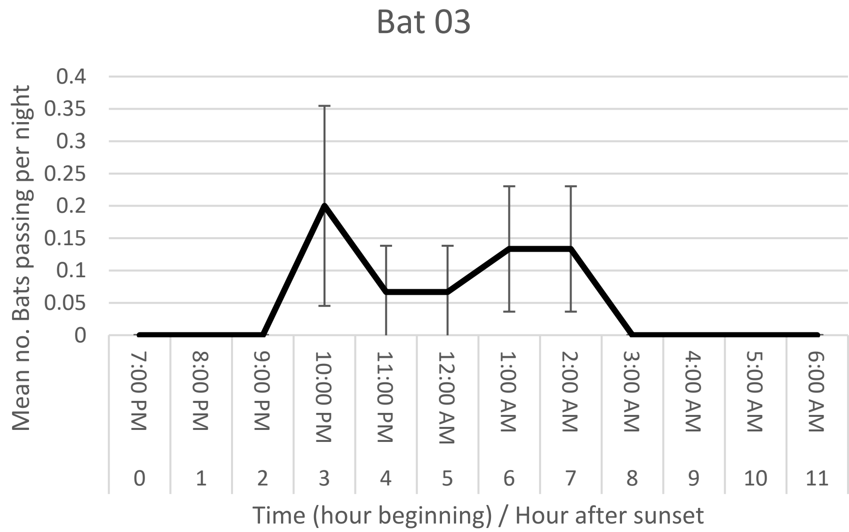

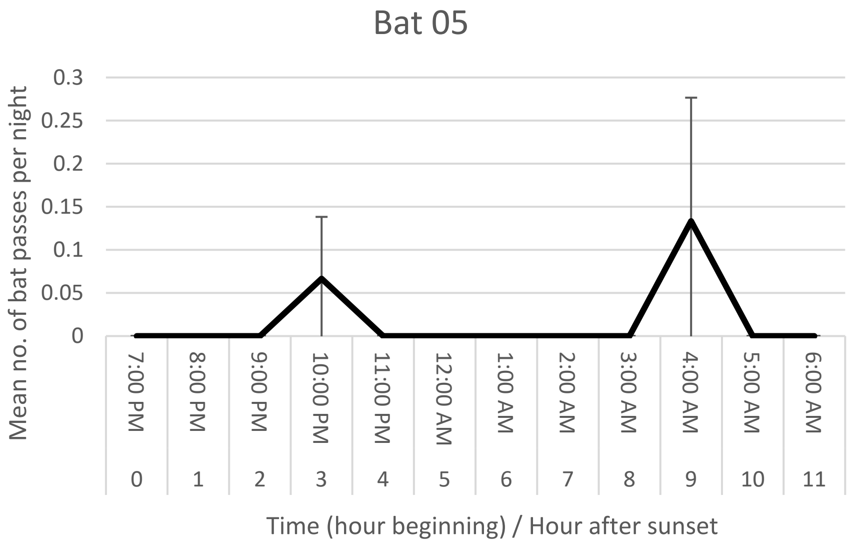

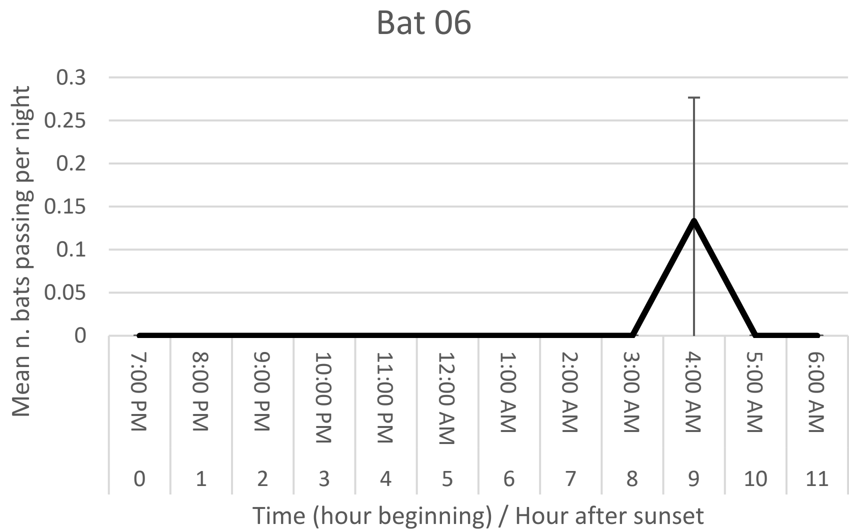

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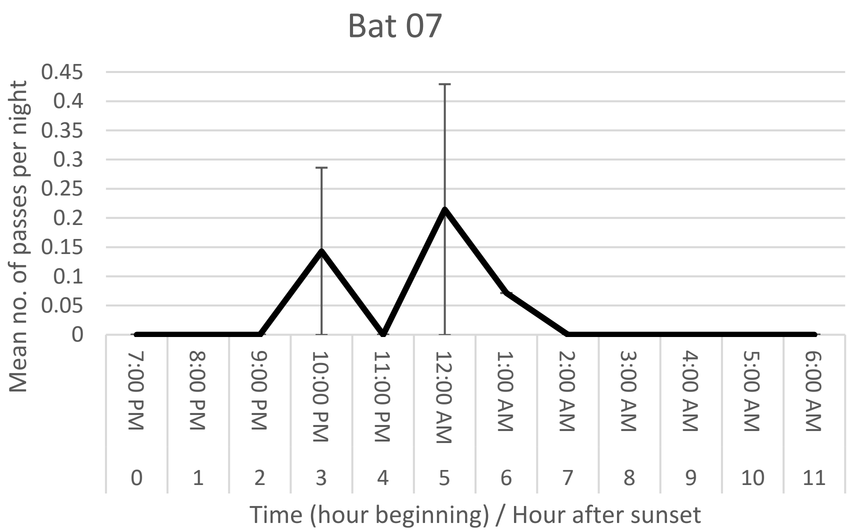

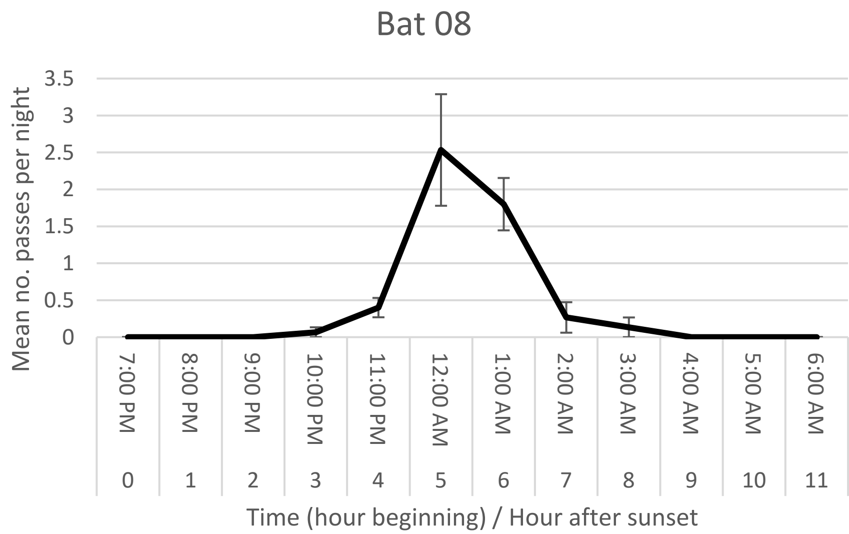

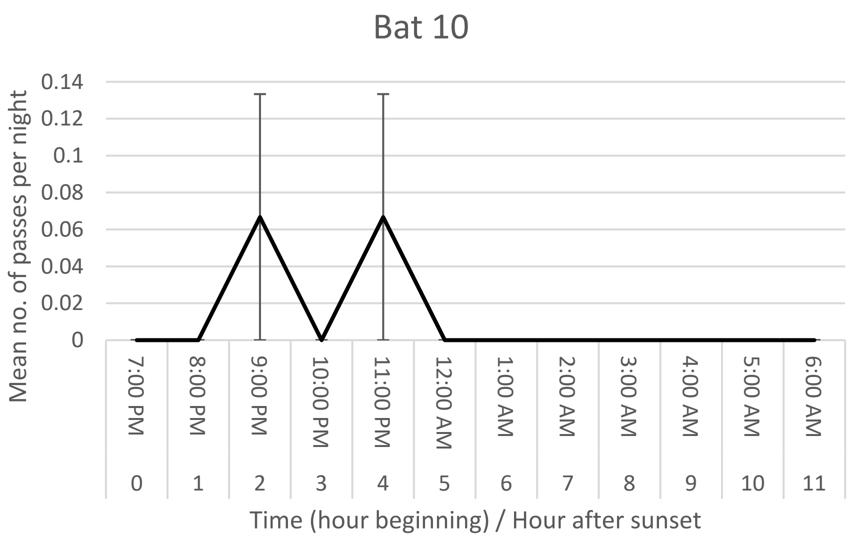

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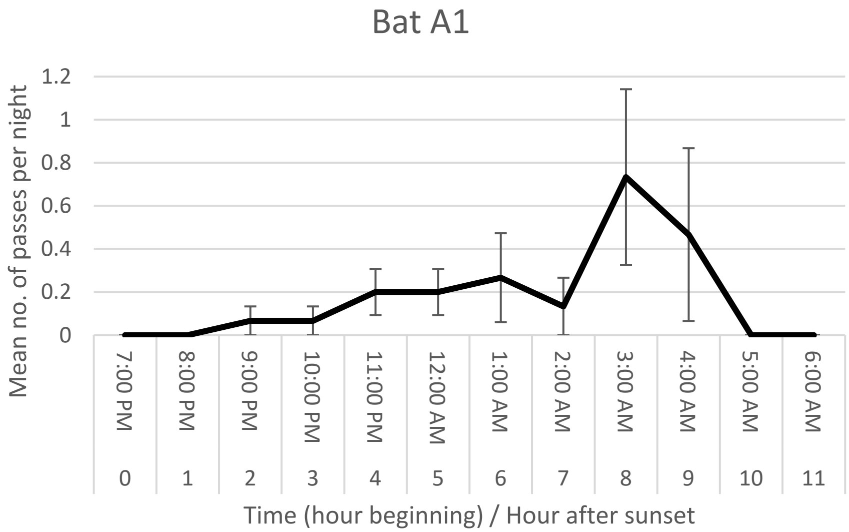

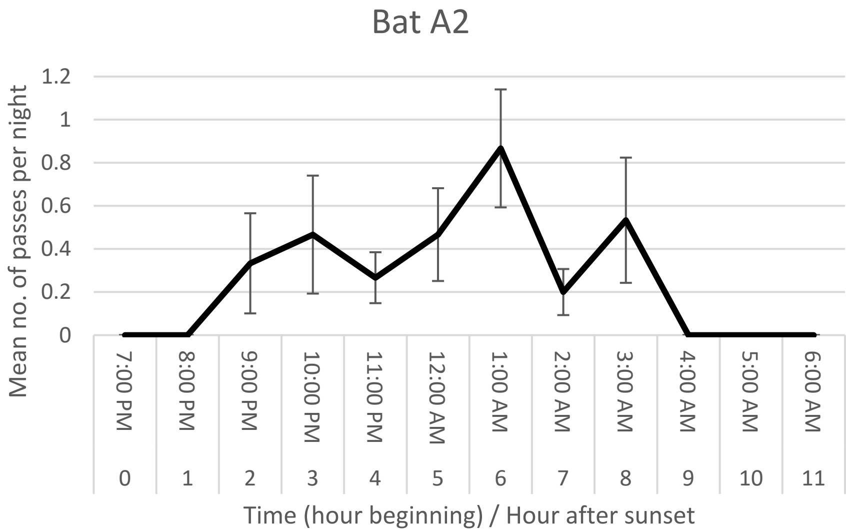

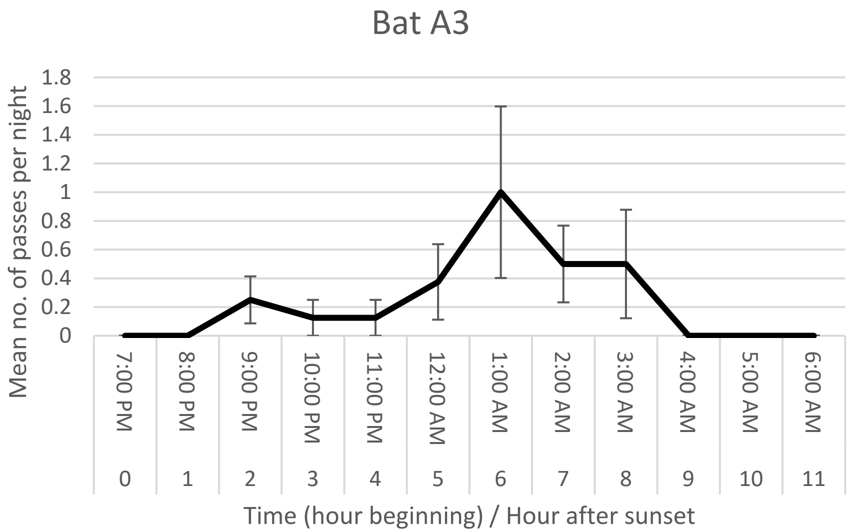

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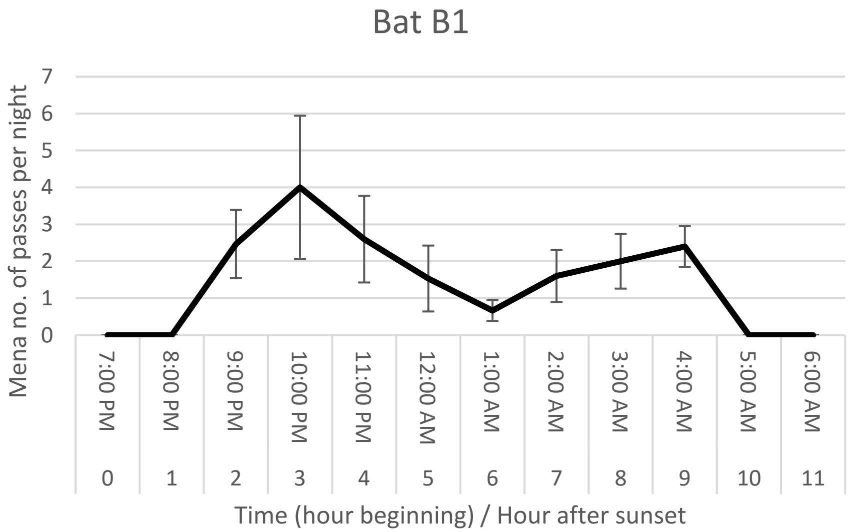

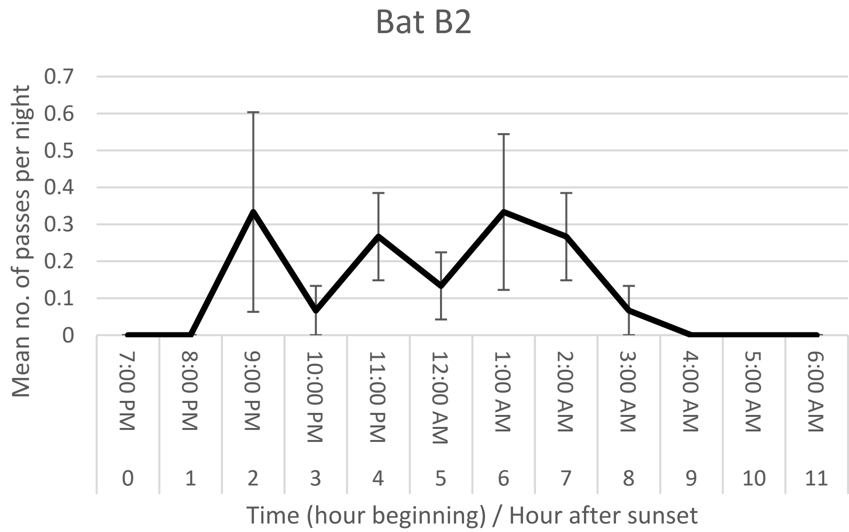

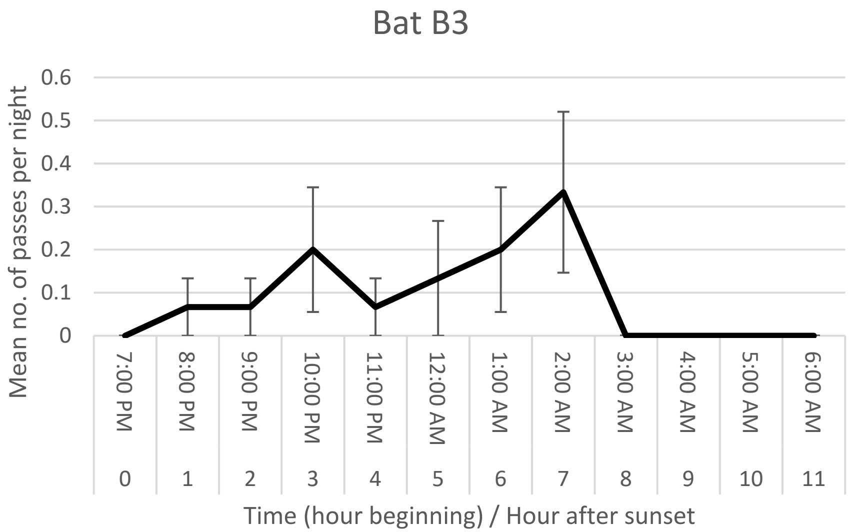

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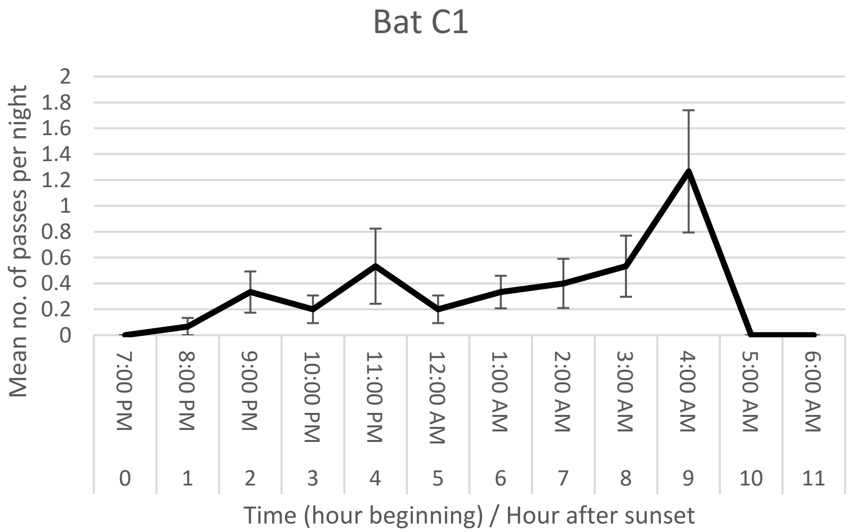

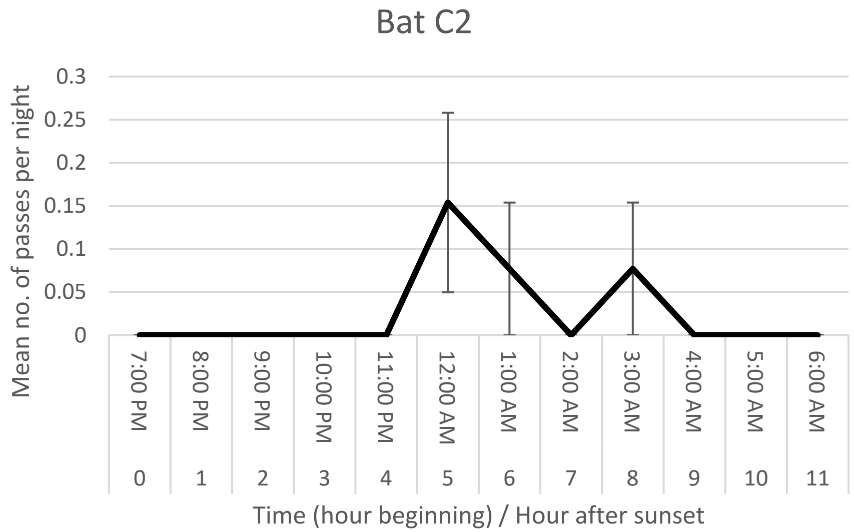

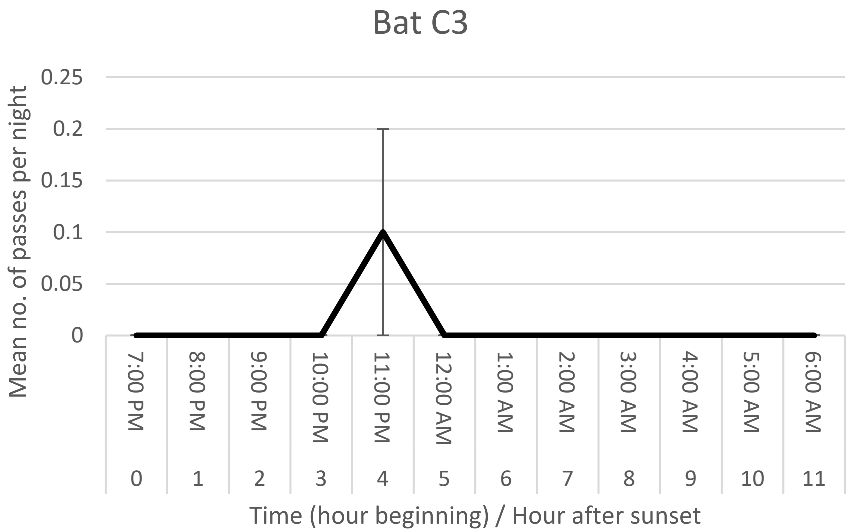

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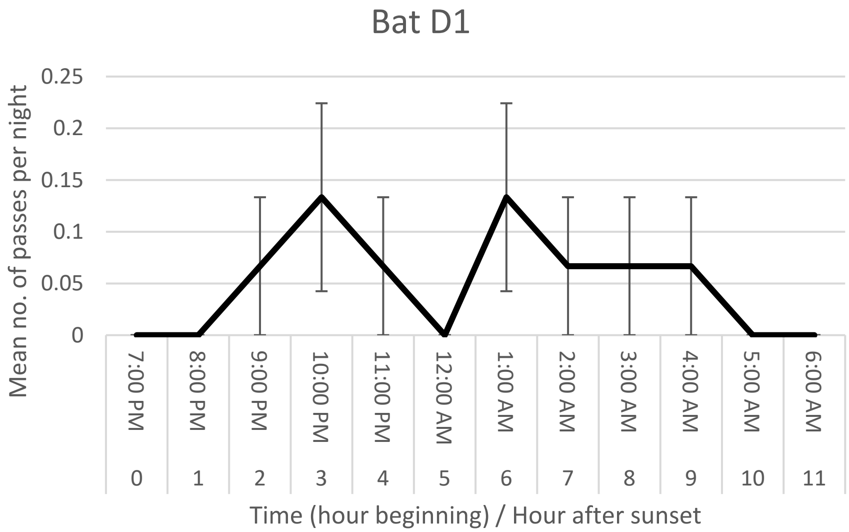

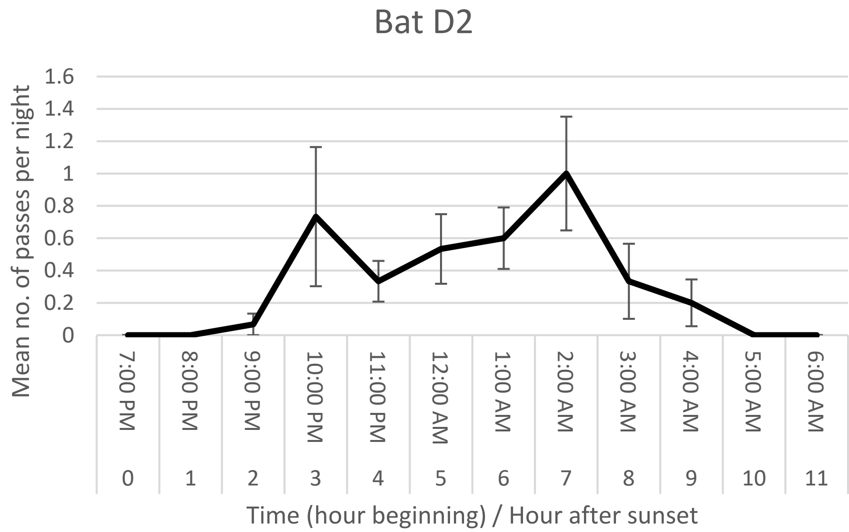

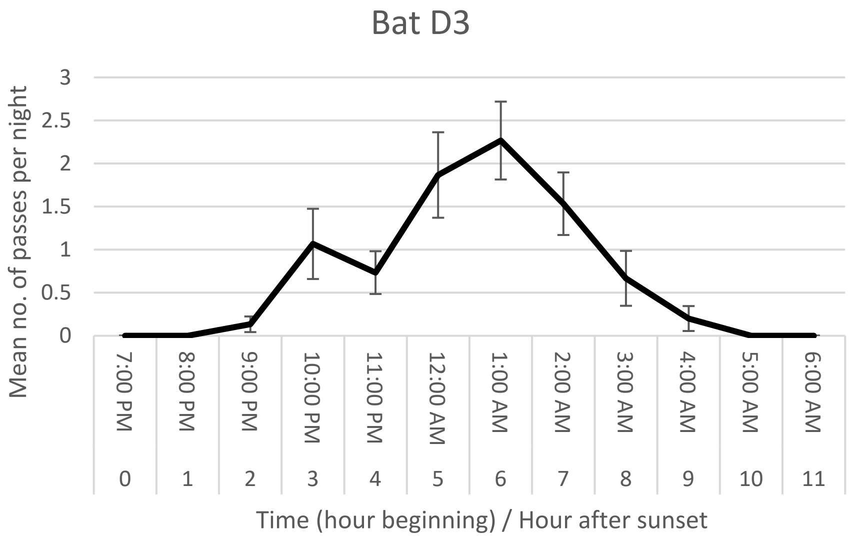

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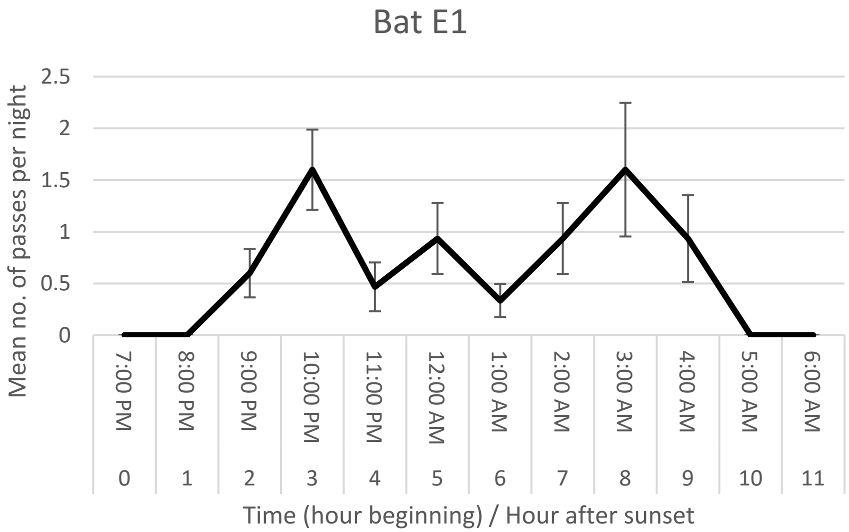

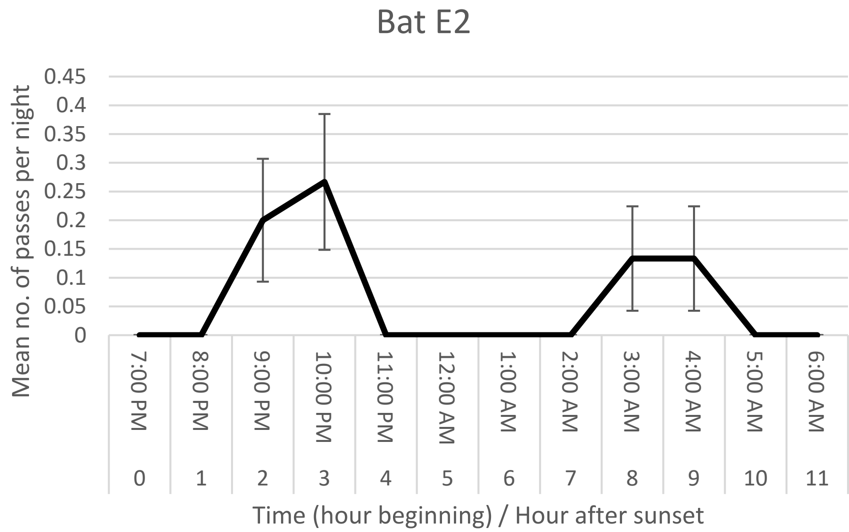

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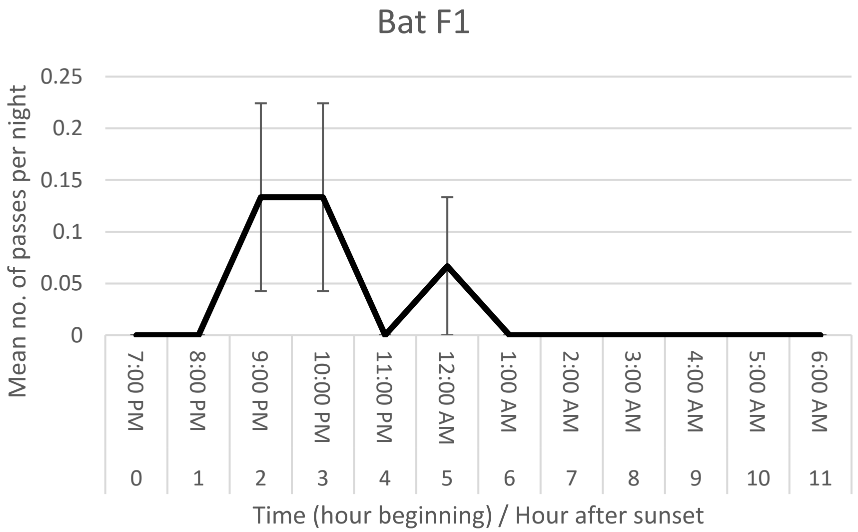

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Temporal distribution of bat activity over the night at each site successfully surveyed during the autumn bat survey period, 7 to 22 March 2018.

Approximate time of sunset and sunrise was 7:31 pm and 7:16 am respectively on 18 March in Tauranga – the closest location provided in the LINZ Sunrise and Sunset tables. See https://www.linz.govt.nz/sea/nautical-information/astronomical-information

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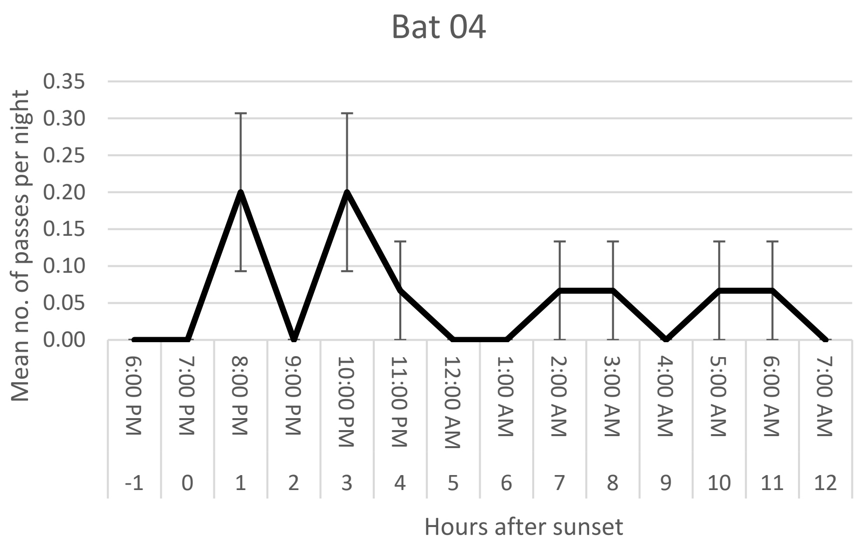

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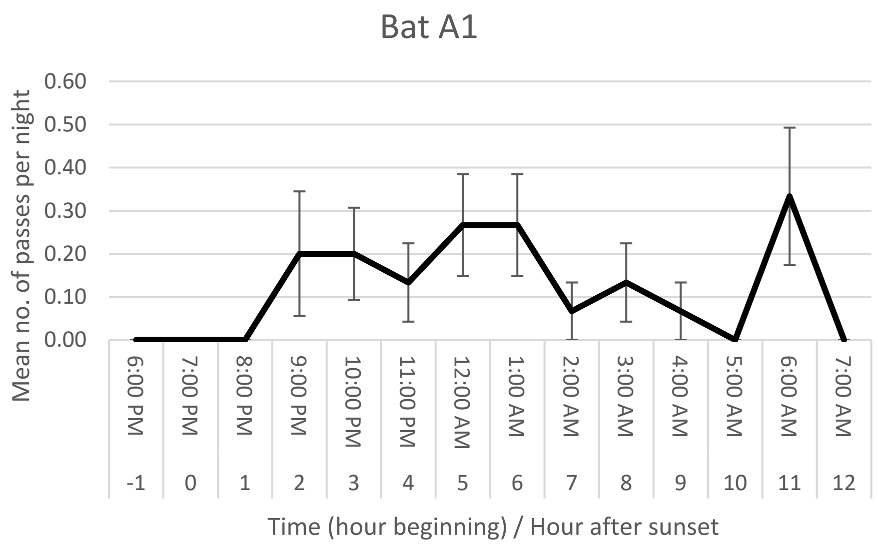

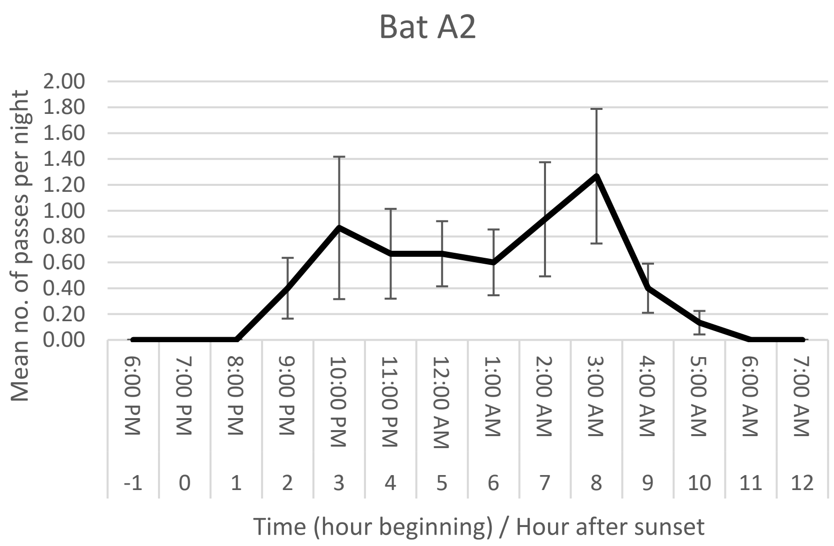

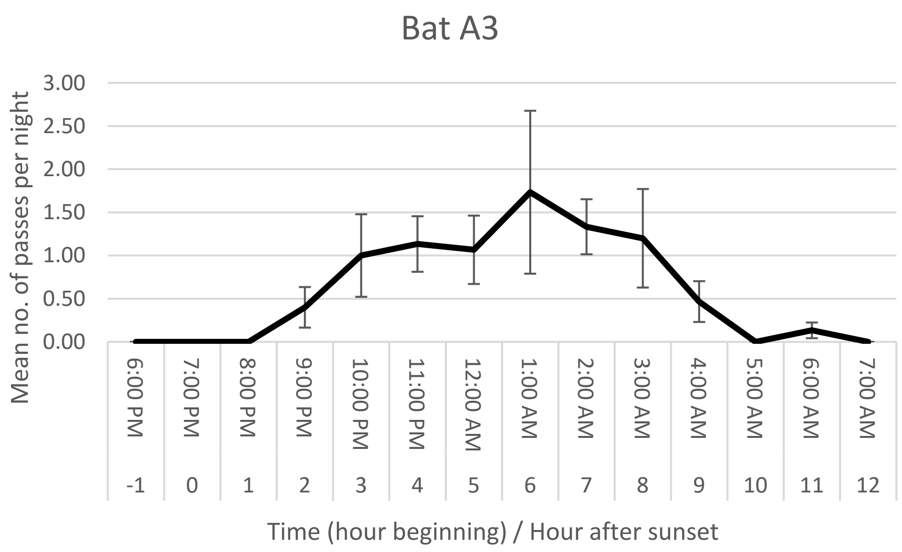

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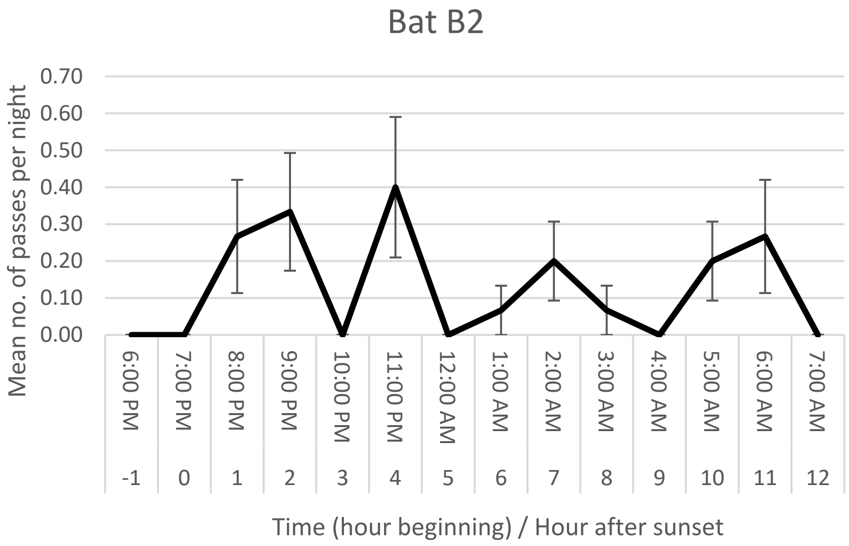

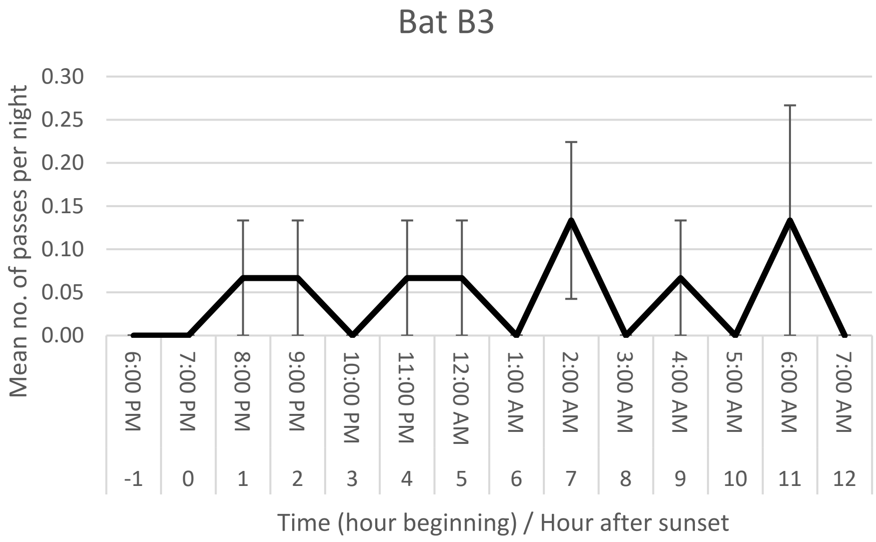

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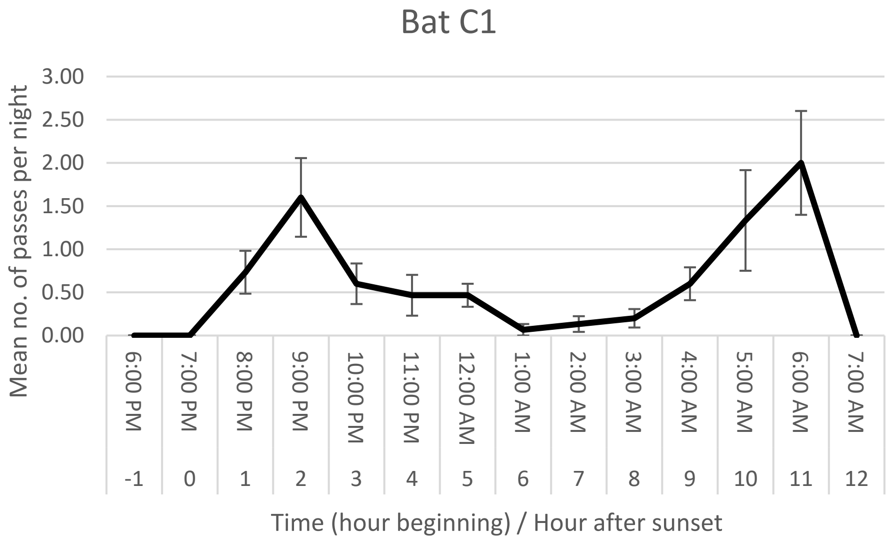

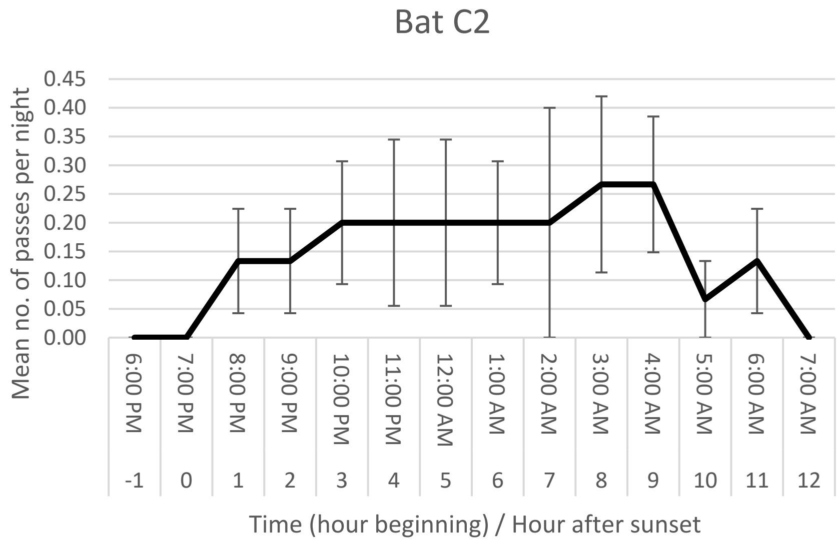

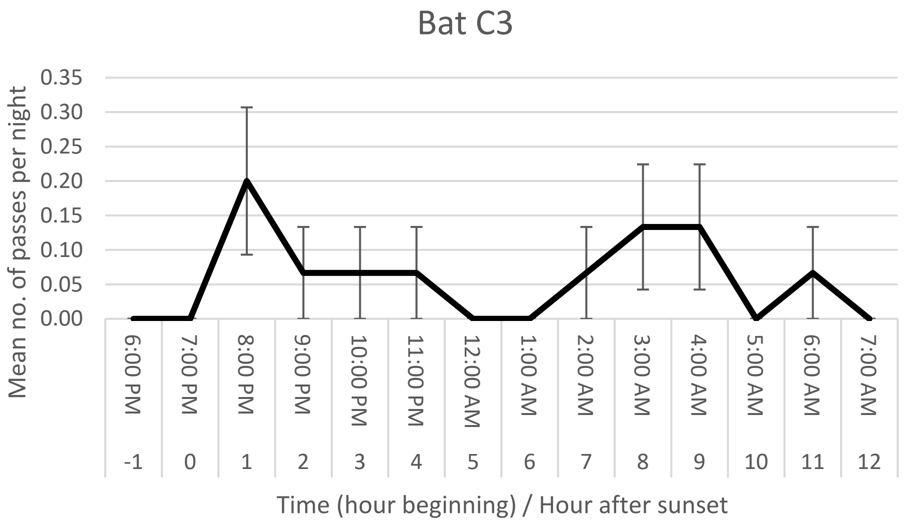

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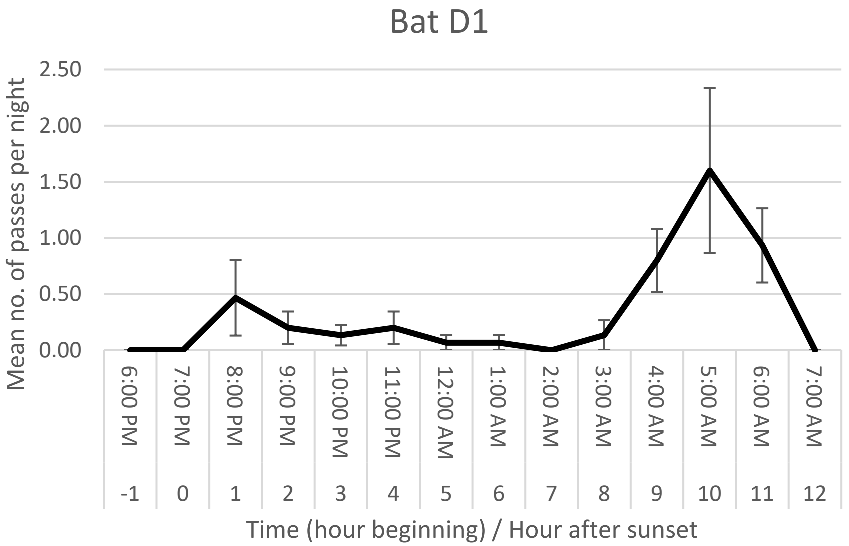

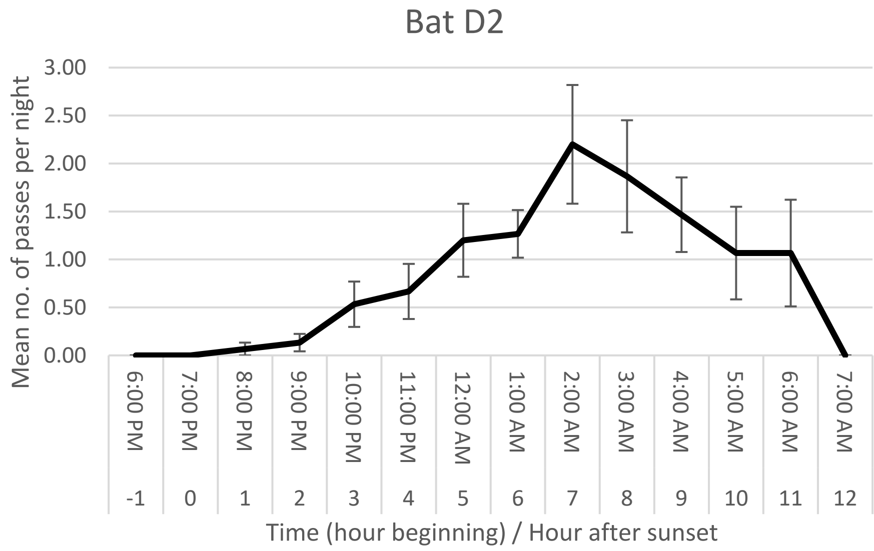

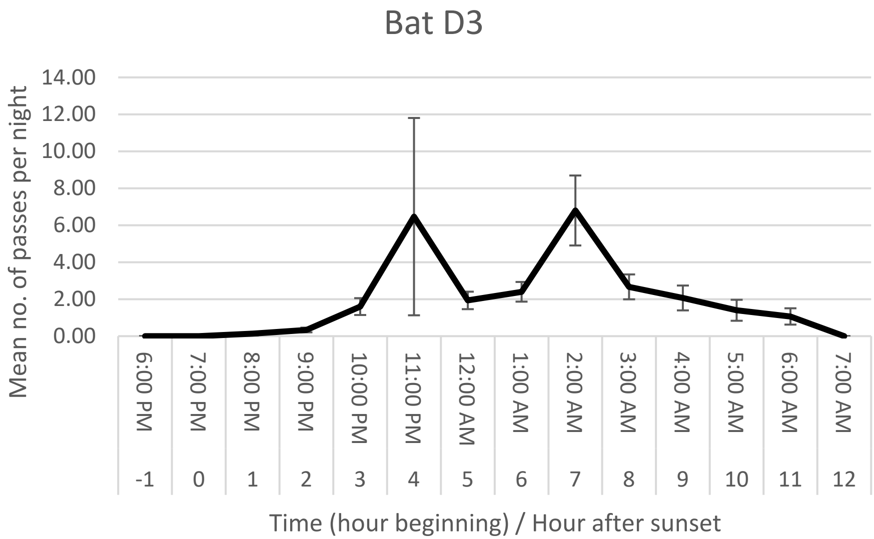

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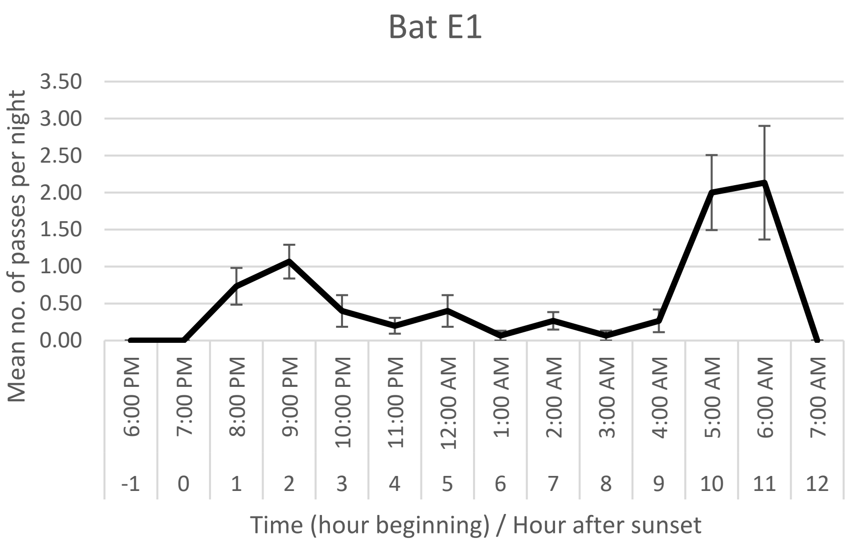

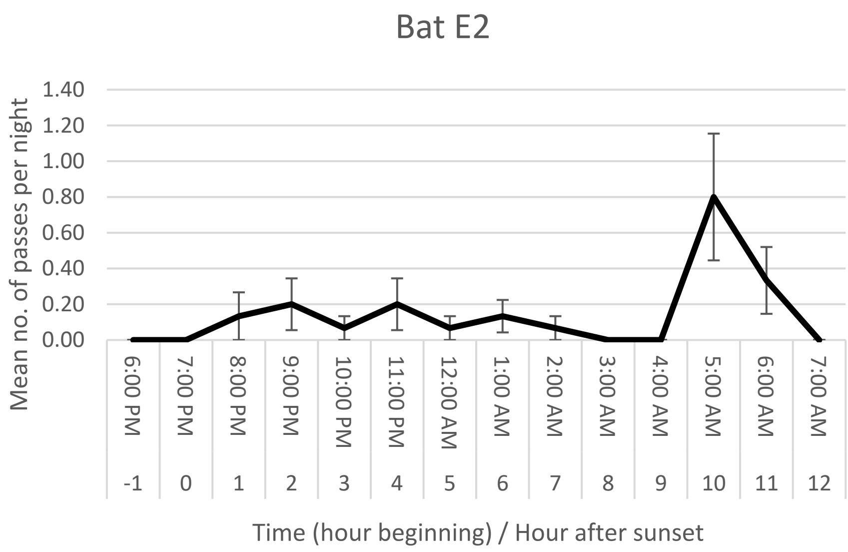

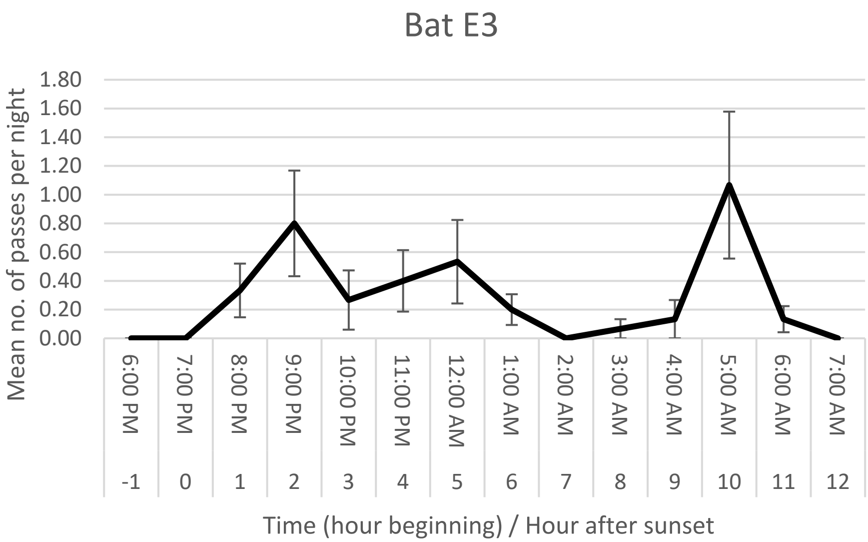

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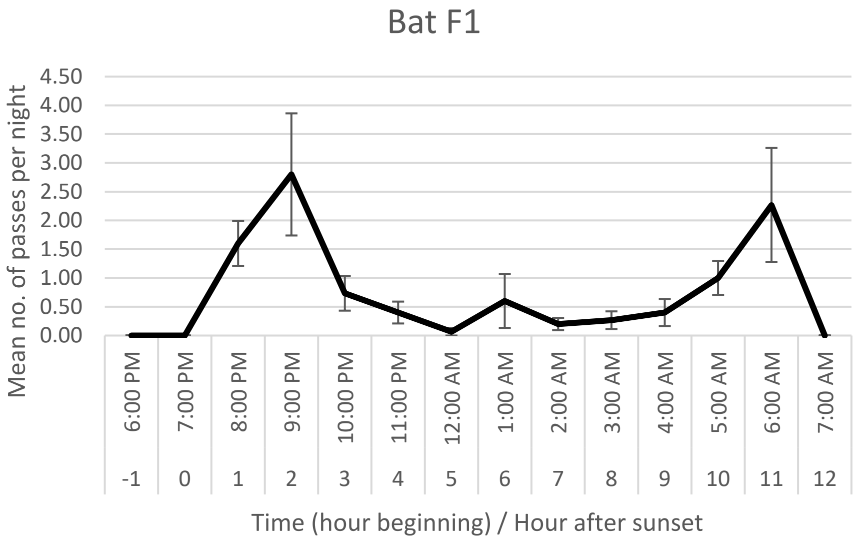

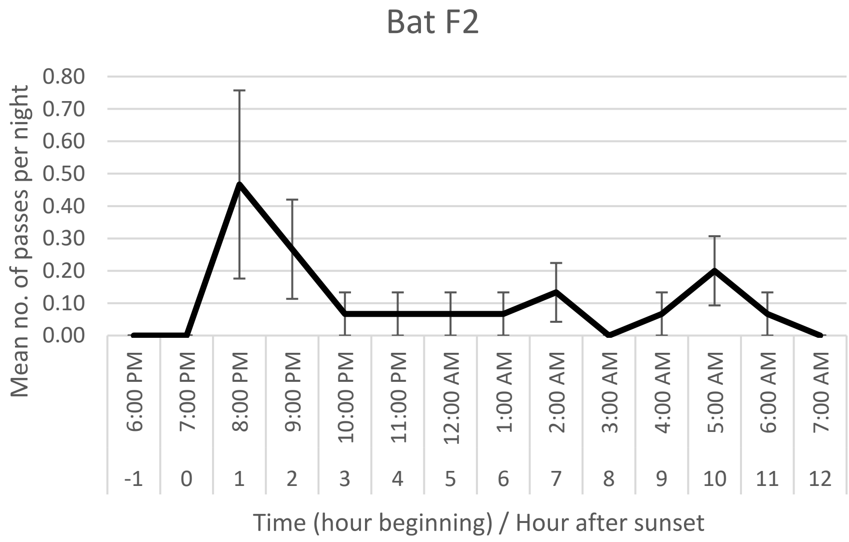

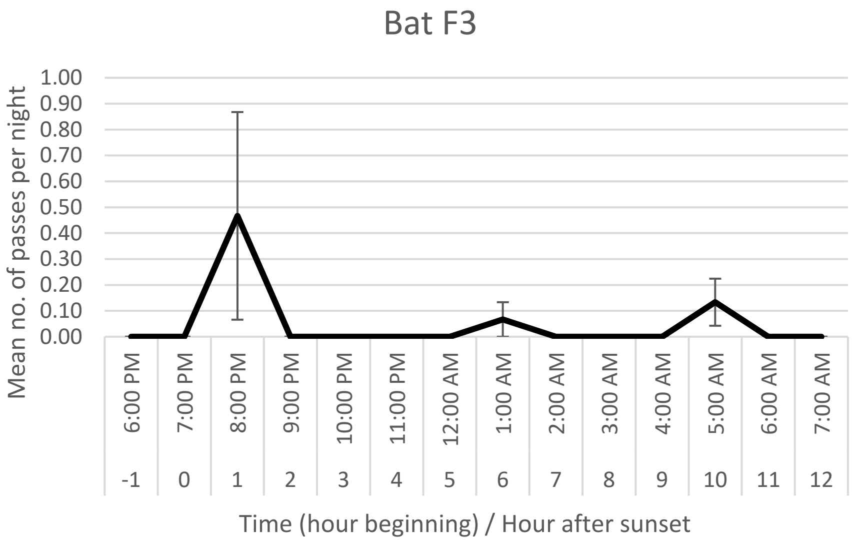

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Appendix 5 – Five-minute Bird Count Data

Table 13: Five-minute bird count data for Amberfield site.

Observer	**Andrew Blayney**	**Date**	**5&6/10/2017**	**General location**	**Hamilton South**		**Specific location**		**Amberfield**	
Line number	Amberfield		Amberfield		Amberfield		Amberfield		Amberfield	
Station number	1		2		3		4		5	
Grid ref (Easting, 7 digits)	1804055		1804462		1804504		1804563		1805030	
Grid ref (Northing, 7 digits)	5812868		5812536		5812093		5811823		5811191	
Start time (24 hour)	11:21		13:42		09:02		09:36		10:51	
Temperature (1-6)	5		5		4		4		4	
Wind (0-3)	0		1		0		0		0	
Other noise (0-2)	1		1		1		0		0	
Sun (minutes)	2		5		0		0		0	
Precipitation type (N,M,R,H,S)	N		N		N		N		N	
Precipitation value (0-5)	0		0		0		0		0	
Species	**Seen**	**Heard**	**Seen**	**Heard**	**Seen**	**Heard**	**Seen**	**Heard**	**Seen**	**Heard**
European goldfinch	5	2								
Tui		1		1		2		4		1
Pukeko	2		3	2	3			1		1
Sacred kingfisher	1			3	1	2	2			2
Shining cuckoo		1								
Welcome swallow	1						3			
Common pheasant	1							1		
Silvereye	6	2	1		6			1		
Malay spotted dove	1		2							
Eurasian blackbird				2	1				3	
Common starling					4		22	1		
Spur-winged plover				2						
North Island Fantail				1			1	1	2	1
European goldfinch					7	3			2	2
House sparrow					1					
Swamp harrier					1					
Song thrush							1			
Paradise shelduck							4			
White-face heron							2			
Eurasian skylark							4	1		
Unidentified (seen briefly from a distance)									1	

Sun (0-5) Record approximate duration, in minutes, of bright sun on the canopy immediately overhead

Seen and Heard
Birds that are first heard should be entered under **H** (even if they are later seen), birds that are first seen should be entered under **S**. Adding H and S should give the total number of birds observed

Time 24 hour clock, at the beginning of each count

Unbounded Counts are unbounded

Temperature
1 freezing < 0°C
2 cold 0-5 °C
3 cool 6-10 °C
4 mild 11-15 °C
5 warm 16-22 °C
6 hot > 22 °C

Wind The average for each five-minute count on a modified Beaufort scale:
0 Leaves still or move without noise (Beaufort 0 and 1)
1 Leaves rustle (Beaufort 2)
2 Leaves and branches in constant motion (Beaufort 3 and 4)
3 Branches or trees sway (Beaufort 5, 6 and 7)

Other Noise i.e. Other than wind the average for the five minutes
0 not important
1 moderate
2 loud

Precipitation type
Average for each count
N None
M Mist
R Rain
H Hail
S Snow

Precipitation value
0 None
1 Dripping foliage
2 Drizzle
3 Light
4 Moderate
5 Heavy

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Appendix 6 – Five-minute Bird Count locations

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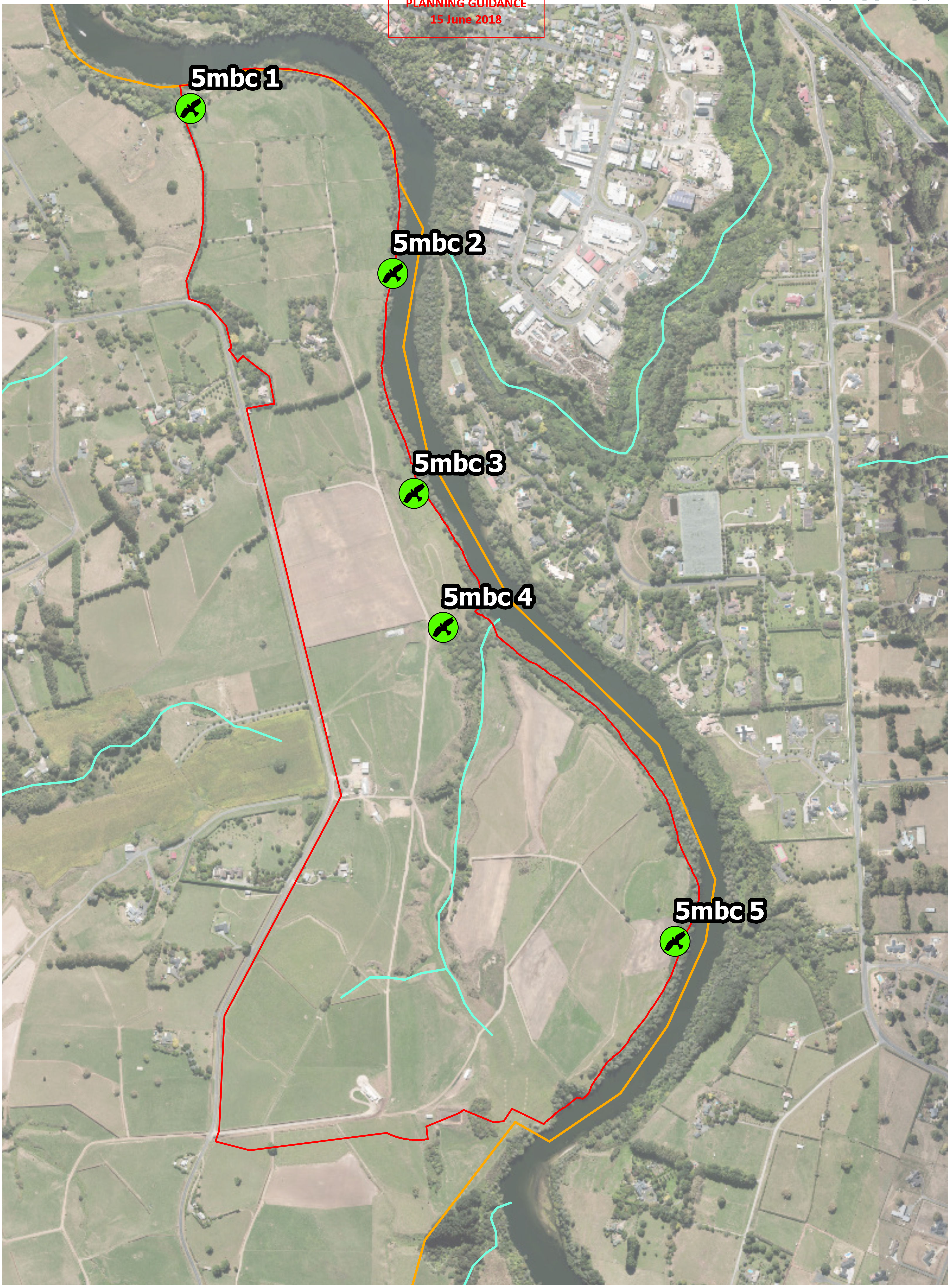
File Ref: A17134_14_BirdCount_Map.mxd



Boffa Miskell
www.boffamiskell.co.nz

0 150 300 m
1:7,000 @ A3

Data Sources: LINZ Aerials, Hamilton City Council, Waikato Regional Council, Boffa Miskell.

Projection: NZGD 2000 New Zealand Transverse Mercator

Legend
- Bird Count Locations
- Site Boundary
- Peacocke Structure Plan
- Streams

A17134 HAMILTON SOUTH DEVELOPMENT

Amberfield - Bird Count Locations

Date: 11 May 2018 | Revision: 0

Plan Prepared by Boffa Miskell Limited

Project Manager: Rachel.deLambert@boffamiskell.co.nz | *Drawn:* HHu | *Checked:* ABl

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Appendix 7 – Draft Bat mitigation trust parameters

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Boffa Miskell

Memorandum

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+64 3 901 0004

Attention:	Amberfield project team
Company:	Weston Lea Ltd
Date:	23/04/2018
From:	Andrew Blayney (Ecologist) and Georgia Cummings (Ecologist – bat specialist)
Project No:	A17134

Amberfield – Ecological parameters for bat mitigation trust

Potential funding directions

Activity group	Activity detail	Guidance, explanation, and expected measures of success.
Pest animal control	Undertake mammalian predator control in established long-tailed bat habitats.	Predator control could include either trapping or poison baiting. For predator control to be effective, generally, it should occur over a large area and protect a core area from predator re-invasion. However, the Hamilton south bat population occurs in a matrix of land use types and typically use long, narrow vegetated corridors; a difficult type of habitat to effect predator control over. As such predator control if not able to be effected at a landscape level would be best utilised to focus on discrete intensive pest control to protect roosting habitats. Success would be expected to result in increased utilisation of protected roosts, greater survival of roosting bats, and in the circumstance of maternal roosts an increase of fecundity and survival of juveniles to adulthood. In lieu of detailed population monitoring this may be detected by roost counts and a trend of increased (or at least not declining) bat activity over time at predator controlled sites.

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	Establish devices to exclude mammalian predators from known and potential roost sites.	Exclusion devices could include metal bands or other devices below and above known roost cavities to exclude mammalian predators or larger scale excluder fencing around bat roosting sites. This treatment could also be applied to potential roost cavities (but not confirmed to be utilised) in habitats connected to known bat habitats as predator pressure may influence roost site selection and utilisation. Success would mirror that described above for mammalian predator control.
	Undertake invasive wasp control in established long-tailed bat habitats.	Baiting for wasp control could be implemented in known bat habitats. Wasps can significantly decrease invertebrate abundance and may decrease available food items for bats. Wasp can reach high densities where there is a source of honeydew and with the giant willow aphid now common in the Waikato, wasp numbers could increase in willow habitats and therefore potential bat habitat areas. Potential direct impacts on adult or juvenile bats are not known but wasp predation on juvenile birds has been observed in New Zealand. Success would be expected to result in increased foraging efficiency resulting in improved body condition and higher reproductive success. This success would be difficult to detect but would contribute to overall population fecundity and survival.
Habitat protection	Legal protection of long-tailed bat habitats.	This could be enacted through the acquiring of land containing confirmed or potential (assuming the area has connectivity to known bat habitats) bat habitats and/or green corridors connecting these habitats and establishing long-term legal protection on these areas. Or alternatively endowing/vesting to local government or the Department of Conservation to be established as a park/reserve for the purposes of bat conservation. Alternative mechanisms could include the financial incentivising of legal protection of bat habitats on private land. The protected land would require long-term management. Success would mean the continued protection of important bat habitat and commuting corridors which would help to maintain the long-term viability of the Hamilton south bat population. This activity alone would not immediately enhance the bat population but instead aims to halt future impacts on bat habitat.
	Protection of long-tailed bat roost trees.	The loss of large trees that are suitable for bat roosting is likely to be a current and future driver of population decline for the Hamilton south bat population. These trees can be both native and non-native species and are generally old and not readily able to be replaced. Identifying bat roosting trees particularly communal roosting trees and thereafter proactively protecting them through a legal mechanism.

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		Success would be expected to increase the number of identified roost trees and limit impacts on these trees. As with legal protection of habitats this activity alone would not immediately enhance the bat population but instead aims to halt future impacts on the bat population.
Habitat creation and/or improvement	Creation of bat habitat	Creating bat habitat that has connectivity to existing bat habitats could increase the available foraging, commuting, and, in the long-term, roosting habitats available to the Hamilton south bat population. This could include planting of farmland land with insect attracting native plant species and the establishment of vertically varied vegetation communities to create flyways to provide increased foraging and commuting opportunities. Areas that would provide best benefit for planting would be those that have natural edges such as ponds, wetlands, gullies, and riparian areas. A component of the plantings should include native and/or non-native tree species that are known to provide roosting features such as cavities when older (and preferably known to provide these features at a relatively young age). Success for these areas of created habitat would be that bats either start using these new areas for commuting and/or foraging or (if already using the area) increase their usage of these areas overtime.
	Improvement of bat habitat	Existing habitat could be enhanced by increasing the density and diversity of invertebrate attracting native species and filling in gaps in the vegetation (taking care not to plant out flyways and established vegetation edges – consider using a mixture of low stature and tall stature plants to maintain or create vertical variation). Buffer planting added between potential sources of disturbance (lighting, noise, and roading) and existing habitat to reduce existing disturbance impacts on known habitats. Modification and/or updating existing lighting structures with bat friendly lighting in known bat habitats to reduce existing lighting impacts on bat populations. Success of bat habitat improvement should result in an increase of bat activity in the area including the increase in bat foraging behaviours and greater roost occupancy/utilisation.
	Creation or improvement of commuting corridors	Where two or more known bat habitats are close to one another with no direct (or relatively direct) connection between them[1], a planted corridor could be established to aid in commuting and dispersal of the bats. Additionally, currently used corridors that

[1] they may be connected by a lengthy and non-direct potential corridor.

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		have potential barriers such as roads, lighting, and lack of vegetation could be improved in similar ways. The improvement or creation of corridors may include addition of vegetation to the corridor and establishment of a dark corridor for commuting. As bats will fly over open ground and utilise artificial structures this could be as simple as establishing dark areas for crossing roads or modifying public space lighting nearby to prevent flooding of light into potential commuting paths. This should result in bats either beginning to use the created, or improved potential commuting corridors, or increase their use of them. Ultimately the effect should be bats expending less energy commuting or dispersing between habitat patches when compared to previously used, less direct, commuting corridors and increasing overall population survival and fecundity.
	Artificial roost boxes	The addition of artificial bat roosts in known bat habitat areas could be used to supplement available roost trees. Recent detected use of artificial bat roosts in the area mean this approach deserves some additional effort. The bat roosts currently utilised are those which have banding above and below which exclude mammalian predators. The current artificial bat roost models used in Hamilton are based on overseas roosts that are used by more opportunistic bats that regularly roost in artificial structures such as dwellings and bridges. Consequently, the addition of roost boxes that better emulate tree cavities could be explored. Success would be bat utilising these artificial roosts which will ultimately increase the number of roosting sites available to the population. Communal roosts have specific thermal requirements and are considered a limiting resource for long-tailed bat populations. Consequently, increased roost availability will have population level effects, but these will be hard to detect as there may be a significant lag time between roost establishment and bats using them.
Research	Research into the ecology of the Hamilton long-tailed bat population(s)	As discussed above, roosting habitat is a limiting resource for long-tailed bats. Consequently, identifying and protecting existing bat roosts is key to the continued survival of the Hamilton bat population particularly considering the proposed development across large areas of southern Hamilton. The most effective technique of identifying long-tailed bat roosts is radio telemetry studies. Radio telemetry studies are currently being undertaken in Hamilton. Collaborating and extending these studies would be highly beneficial particularly if identified roosting areas can be enhanced and protected from future development. This activity alone would not immediately enhance the bat population but instead aims to halt future impacts on bat habitat.

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		Long term population studies (mark recapture) is the most recognised method of measuring population increase or decrease overtime. It is hypothesised that the long-tailed bats in Hamilton are part of a single population and therefore undertaking a long term mark recapture study to detect trends in the population would provide information on the general efficacy of all of the management options discussed above.
	Research to assess the efficacy of management techniques.	Undertake research on Hamilton bat population that with knowledge gained will improve the ability to conserve the population. Many of the activities above contain many unknowns on their efficacy and how best to go about implementing them. Aside from the mark-recapture research discussed above, more focussed research could be undertaken to measure the response of the Hamilton bat population to various management techniques. This will allow for an accurate assessment of their relative efficacy and enable adaptation to techniques overtime to better the outcome for the bats. Some examples of research topics based on above activities: • Will bats use and forage in newly created habitats and how long between planting and bats starting to use the area? • Will bats use newly established vegetated corridors between current habitats? • What effect does reducing lighting and noise effects on an existing roost site have? • Will bats utilising commuting corridors more if they are improved through lighting modification and/or plantings? • What environmental or roost design factors can explain the utilisation of artificial bat roosts in Hamilton South? • What effect does wasp control have on bat populations? Success of these activities would lead to new information that could lead to better conservation measures to ensure the long-term viability of the Hamilton south Bat population.

Location of activities

These activities should be focused within the area of the Hamilton South bat population. This population is not likely a discrete population with clear boundaries and likely has linkages to wider Waikato south bat populations. The anticipated area where the potential activities described above could be carried out is in or near the Waikato River and tributary gullies between Hamilton City (Cobham Drive/ SH1 bridge) and Cambridge (Victoria Street bridge). This includes the Mangakotukutuku, Mangaonua, Mangaharakeke, Mangaone, Nukuhau, Mystery Creek, and Mangawhero gullies along with any other connected smaller gully or stream features. Residential, lifestyle, and agricultural land would also be included in this area within a band along the Waikato River extending approximately 5km beyond the extent

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of the gullies and Waikato River. An indicative map of this area is shown below in Figure 1. It is possible as more is learnt about the Hamilton South bat population and its linkages to other areas that projects outside of this mapped area that could demonstrate potential conservation benefit for the Hamilton south population could be considered. Additionally, while emphasis should be on the Hamilton South area this approach should be adaptive to actual and potential development in this area and consequently going further afield and protecting another, already legally protected (i.e. DOC land) population shouldn't be ruled out if logistics, land availability, and/or long-term security of bat habitats pose a significant barrier to the ability to effect meaningful and effective conservation of the long-tailed bat population in this area.

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Figure 1: Indicative area of Bat mitigation activities