B8

AIRPORT AND SURROUNDS

TERRESTRIAL FAUNA

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B8 AIRPORT AND SURROUNDS TERRESTRIAL FAUNA

8.1 INTRODUCTION

This chapter outlines existing terrestrial fauna values within and around the Sunshine Coast Airport (SCA). Specifically, it considers fauna habitats and communities, threatened terrestrial fauna species, and migratory species potentially affected by activities associated with the SCA Expansion Project (the Project). Flora, aquatic and marine (including migratory marine birds and turtles) values are considered in Chapters B7 Terrestrial Flora, B9 Aquatic Ecology and B10 Marine Ecology respectively.

This chapter has been developed specifically to address the following relevant sections of the Terms of Reference (TOR) for the Environmental Impact Statement (EIS):

- Section 5.2 Nature Conservation
  - Section 5.2.1 Sensitive Environmental Areas (Description of Environmental Values and Potential Impacts and Mitigation Measures)
  - Section 5.2.2 Terrestrial Flora (Description of Environmental Values and Potential Impacts and Mitigation Measures) (where these relate to faunal values of the study area)
  - Section 5.2.3 Terrestrial Fauna (Description of Environmental Values and Potential Impacts and Mitigation Measures).
- Section 11 Matters of National Environmental Significance
  - Section 11.2 Impact on Listed Threatened Species and Ecological Communities and Listed Migratory Species.

8.2 NOMENCLATURE AND TERMINOLOGY

Specification of the study area in this chapter took a conservative approach and considered the potential geographic extent of both direct and indirect impacts. The 'study area' thereby refers to land within 5 km of the existing SCA (**Figure 8.2a**), which has been modified from Chapter A4, Project Description to reflect the reduced nature of impacts associated with fauna ecology.

Significant landmarks and important habitat areas are referred to throughout this report and are detailed in **Table 8.2a** and illustrated in **Figure 8.2a**.

8.3 METHODOLOGY AND ASSUMPTIONS

8.3.1 Desktop assessment and background sources

Prior to undertaking field investigations, a desktop review of ecological records, databases and literature relating to terrestrial vertebrate species occurring within a 25-50 km radius of the SCA (hitherto referred to as the Desktop Assessment study area) was undertaken in order to:

- Compile a local-area species list (i.e. a list for all terrestrial vertebrate species known from the Desktop Assessment study area), with particular focus on Endangered, Vulnerable or Near Threatened (EVNT) species which may be later targeted during field investigations
- Identify specific locations (i.e. geographical coordinates) for EVNT records (where possible)
- Provide a regional perspective on fauna values identified during field investigations.

South East Queensland (SEQ) is well surveyed, and database searches yielded 91,705 point-specific locations within the Desktop Assessment study area. Enlarging the search area (beyond a 50 km radius) would lead to the inclusion of many irrelevant records (e.g. records of species for which there is no suitable habitat within or adjacent the study area) and adds little to our understanding of faunal values of the study area.

Each of the inspected databases (**Table 8.3a**) has inherent limitations that must be considered when interpreting the results of database searches.

In addition to providing a list of known EVNT species, database records may be used to assess the likelihood of EVNT species occurring (see **Section 8.3.3.3**) within the study area, based on record frequency (i.e. the number of records of an EVNT species over a specified time frame). While useful, record frequency must be used cautiously as database records are biased towards conspicuous fauna such as birds. The likelihood of EVNT fauna occurring within the study area (particularly cryptic fauna such as herpetofauna and bat species) must therefore be assessed against other criteria as well (including the results of targeted field surveys).

It is also important to note that a species' presence in a database does not mean that the species is regularly observed in the study area. Single, unusual records may represent transient or vagrant animals. Such records need to be carefully evaluated against the species' current known distribution and habitat requirements.

Existing literature (including published and unpublished books, papers and reports) was reviewed to provide additional information and relevant EVNT species. Reports of particular relevance to this work included:

- White, D., White, D. and Power, N. (2005). Targeted species surveys of the Sunshine Coast Airport, Marcoola, Maroochy Shire, Queensland. Report prepared for OTEK Australia Pty Ltd
- EcoSmart Ecology and 3D Ecological Consulting. (2010). Sunshine Coast Airport Master Plan Implementation Project. Preliminary Review of Significant Environmental Factors
- BMT WBM. (2010). Sunshine Coast Airport Preliminary Ecological Report (Final Report). Report prepared for ARUP Pty Ltd.

Table 8.2a: Relevant terminology and geographic references used throughout this chapter

Feature	Location/Description
Study area	The area within a 5 km radius of the SCA including the mouth of the Maroochy River.
Area of focus	The area of direct impact (i.e. clearing zones) plus the immediately adjacent Wallum Heath Management Area
WHMA	Wallum Heath Management Area
Finland Road	Crosses the Eastern SCA drain and heads north through disused cane fields
Finland Road East	Heads east of Finland Road toward the Mt Coolum National Park
Helicopter training area	A regularly slashed area to the west of the WHMA
Eastern SCA drain	A large artificial drain running east-west along the southern boundary of the existing SCA and extending under Finland Road to the Maroochy River
Northern SCA drain	The existing artificial drain running north-south along the eastern boundary of the existing SCA; distinct from the 'northern perimeter drain' which will be created as part of the proposed runway development.
SCA	The existing SCA precinct including the WHMA and helicopter training area
Development area	The proposed SCA development area
Marcoola drain	A large artificial drain running from the Mt Coolum Golf Course east to the Maroochy River
Eastern NP Drain	The east-west artificial drain located to the north of the existing SCA within the Mt. Coolum National Park
Northern NP Drain	The north-south artificial drain near the western boundary of the Mt. Coolum National Park
Finland Road Swamp/ Wetland	A wetland located off Finland Road, south of the study area (-26.6134, 153. 0679)
Finland Creek	A small natural creekline crossing Finland Road
Mt Coolum National Park	Refers to the aggregate of National Park estate both north (northern section) and south (southern section) of the SCA. Officially this is Noosa National Park, Mt Coolum section
'do minimum' scenario	The 'do minimum' scenario assumes the existing runways and operating procedures, and a forecast of future aircraft movements at the airport
Preliminary Design	The proposed construction and operation of Runway 13/31 with standard mitigation measures

- Meyer, E. (2010). Results of frog surveys undertaken in costal reserves managed by the Sunshine Coast Regional Council: February – March 2010. Draft report prepared for Sunshine Coast Regional Council by Ed Meyer.
- Ingram, G. and Agnew, L. (2010). Wallum Sedgefrog *Litoria olongburensis* Surveys and Habitat Assessments for the Proposed Sunshine Motorway Duplication (Kawana Way to Mooloolah River Interchange) and Multi-modal Transport Corridor (Main Drive to Maroochy Boulevard). Prepared January 2010 for the Queensland Department of Transport and Main Roads
- GHD. (2011). Significant Impact Assessment Report, Sippy Downs Trunk Sewer Project. Prepared for Unitywater, June 2011.

These, and other sources, were extensively used to provide project background, develop EVNT species profiles and understand potential impacts. Any specific location details for EVNT species was added to the database containing records from sources identified (see **Table 8.3a**).

Once compiled, EVNT records from the desktop assessment were plotted using ArcGIS in order to spatially represent known occurrences of EVNT species within the study area and broader Desktop Assessment study area.

Figure 8.2a: Landmarks within the study area

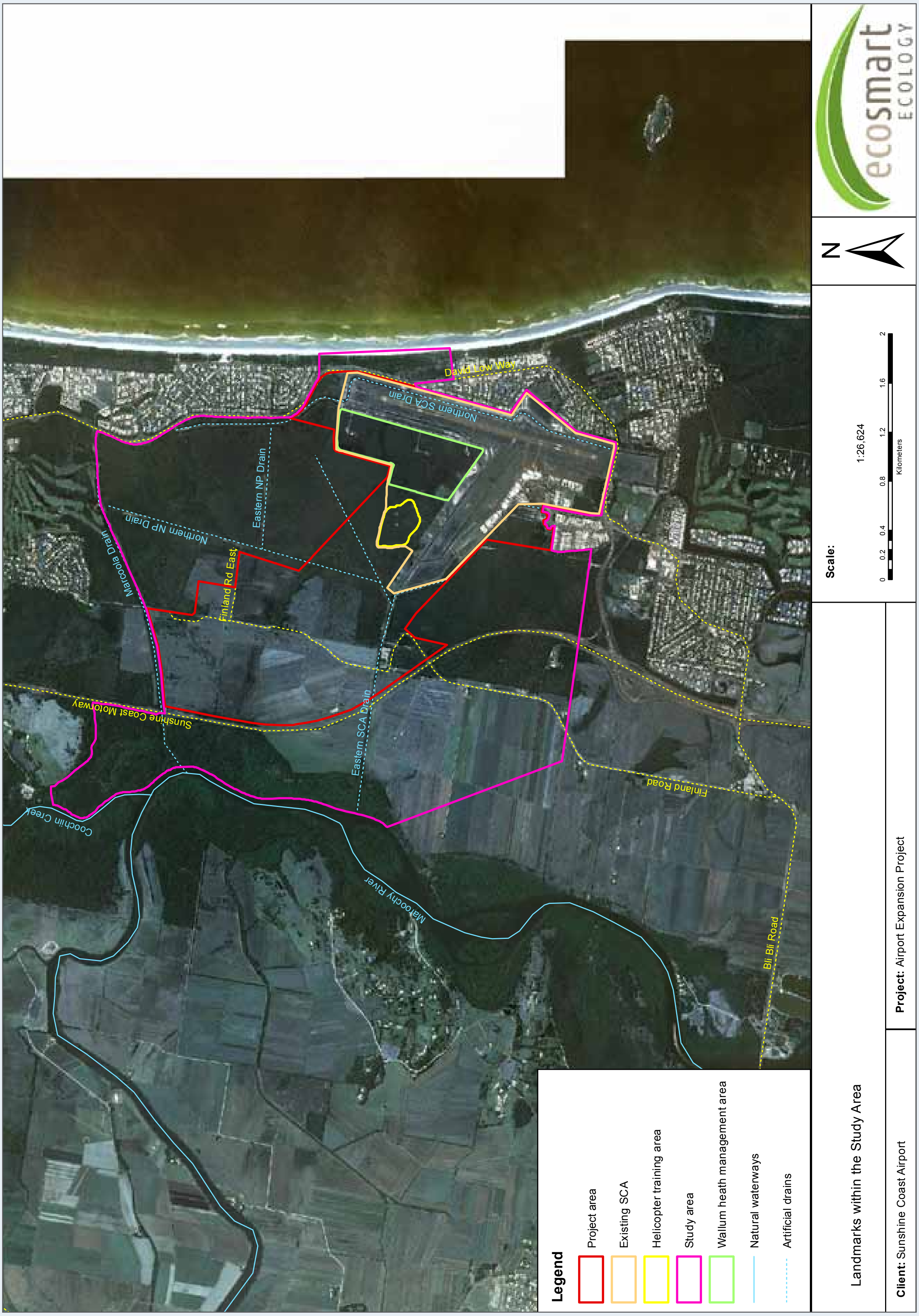


Table 8.3a: Databases sources

Source	Notes	Abbreviation	Survey Buffer
Queensland Museum collections database	Specimen-backed, so highly reliable. Geographic co-ordinates available.	QM	25 km
Birds Australia Atlas	Typically reliable with database entries vetted for obvious errors. Geographic co-ordinates available. Only data collected from 1980 onwards was used.	BA	25 km
DERM WildNet	Moderately reliable observations. No geographic co-ordinates available.	WN	50 km
EPBC Protected Matters search tool	Predictive only. Of limited use for vertebrates. Reflects the location of the search area in respect to the species known distribution rather than actual observations.	EPBC Online	25 km
Atlas of Living Australia	Based largely on museum collections and therefore reliable. However can include records without dates (which are often very old records).	ALA	50 km
EcoSmart Ecology database	Observations only. Geographic co-ordinates available. Dataset compiled from EcoSmart Ecology field surveys and personnel observations.	ESE	50 km

Aerial photography and spatial data available from the Queensland Department of Environment and Heritage Protection (DEHP), including Essential Habitat maps, Biodiversity Planning Assessment (SEQ v3.5) and the Back on Track Framework were also used to inform the current assessment of faunal values.

8.3.2 Field survey overview

A number of field surveys were used to gather data on terrestrial fauna values within the study area from October 2010 through to September 2012. Surveys undertaken during this period included baseline (general fauna) surveys as well as targeted surveys for Ground Parrot, acid frog species (including Wallum Froglet, Wallum Rocketfrog and Wallum Sedgefrog) and Water Mouse. Timing and duration of these surveys are summarised in **Table 8.3b**. Details of each survey component are provided in the sections below.

8.3.3 Baseline terrestrial vertebrate survey

General fauna surveys documenting the diversity of terrestrial vertebrate species within the study area were undertaken from 26/09/2012-30/09/2012, inclusive. Surveys were undertaken under QPWS licence WISP06137309 and Animal Ethics Licence CA 2012/07/624. Field survey methods are consistent with relevant guidelines for baseline and species-specific assessment of faunal values (e.g. Eyre *et al.*, 2012; DEWHA 2011). All ecologists participating in surveys of the SCA have the skills, qualifications and experience in fauna surveying to successfully undertake surveys.

8.3.3.1 Sites selection (stratification)

Extensive traverses were undertaken through the study area and adjoining Mt Coolum National Park to properly assess the range and extent of habitat types present. During these investigations, five Broad Vegetation Groups (BVGs) were identified: forest woodland, heath, disturbed habitats (agricultural and developed land), foredunes and intertidal habitats (see **Section 8.5**). Fauna survey techniques were undertaken within each of these BVGs to ensure representative sampling from the range of habitat types present within and adjacent the study area.

Table 8.3b: Fauna survey timing and duration

Survey Component	Date(s)	Season	Duration (days)
Baseline	26 – 30 Sept 12	Spring	5
Acid Frogs	12 – 15 Oct 10	Spring	3
	17 – 19 Jan 12	Summer	3
	01 – 02 Mar 12	Summer	2
Ground Parrot	15 – 17 Sept 10	Spring	2
	12 – 15 Oct 10	Spring	2
	01 – 2 Nov 10	Spring	2
	10 – 11 Dec 11	Summer	2
	18 – 20 Jan 12	Summer	2
	14 – 16 Feb 12	Summer	2
	20 – 22 Mar 12	Autumn	2
	26 – 28 Apr 12	Autumn	2
	22 – 24 May 12	Autumn	2
	20 – 22 Jun 12	Winter	2
	19 – 21 Jul 12	Winter	2
	08 – 10 Aug 12	Winter	2
	12 – 14 Sept 12	Spring	2
Water Mouse	29 Nov 12	Spring	1

Sites were not randomly located within each BVG but chosen in order to:

- Maximise the number of detected fauna species
- Maximise the likelihood of detecting priority (e.g. Biodiversity Assessment and Mapping Methodology (BAMM) or Back on Track (BOT taxa)) or EVNT species.

Survey sites were therefore generally placed in areas of higher quality habitat (e.g. areas of undisturbed or less disturbed habitat).

Although regularly visited and subjected to bird surveys, active searching and habitat assessment, no trapping was undertaken in disturbed habitat or coastal dunes. Active survey methods (e.g. active searching, spotlighting) were considered adequate to document faunal values of these BVGs. Intertidal habitats, which included areas of Coastal She-oak and mangrove vegetation, are largely outside the direct impact zone for this Project. Significant impacts on fauna in such habitats are therefore considered unlikely. Thus, while targeted searches for specific EVNT species were undertaken (e.g. Water Mouse), no trapping was undertaken in such habitats.

The location of trapping sites with respect to BVGs is provided in **Figure 8.3a**.

8.3.3.2 Sampling methods

Vertebrate communities were sampled using a variety of standard survey techniques including trapping (Elliot, pitfall, harp and funnel), direct observation (spotlighting, bird survey, and incidental observations), remote sensing (Anabat ultrasonic bat detection, bio-acoustic recording, camera trapping), and active search methods (rolling logs, rocks and other debris).

Trapping methods

A total of five trapping sites were established during the survey, with each site operational for four consecutive nights. Trapping sites were typically configured in a 100 x 100m plot, consistent with Eyre *et al.*, (2012). Five pitfall buckets along a single drift fence with two funnel traps at each end were established within the centre of the plot. Around this, 20 Elliot traps are positioned in nearby vegetation, each separated by approximately five to ten metres. All sites were visited twice daily, once in the morning and once in the late evening.

Microchiropteran bat species were captured using two dual bank harp traps. Harp traps were positioned in locations where bat activity is typically high, such as along tracks and roads, or over narrow watercourses. Harp trapping was undertaken over three nights during the baseline survey.

Observation methods

Bird surveys

A total of 20 bird surveys were undertaken throughout the study area encompassing all major habitats. Surveys were undertaken during autumn, spring and summer to account for seasonal variation in bird diversity and migratory patterns (Eyre *et al.*, 2012). Surveys took place during the morning (e.g. typically before 9 am) when avian activity peaks, although additional surveys were also undertaken periodically throughout the day to increase the diversity of species detected. Survey length varied from 20-30 minutes depending on habitat complexity and bird activity.

During bird surveys, data was collected by sampling birds by sight and sound along either a 50 m transect (seven locations), while centred around a discrete point. Bird survey transects were surveyed at least twice (rarely three) to increase the likelihood of detecting species missed during previous surveys.

Incidental observations of birds seen within and adjacent the study area during surveys were also recorded throughout the study period. These predominantly occurred as ‘fly-over’ records, or observations while undertaking other activities.

Spotlighting surveys

Nocturnal surveys were undertaken by two observers walking through habitats searching for arboreal mammals, small and medium sized terrestrial mammals, frogs, geckoes, nocturnal snakes and birds. Animals were detected by eye shine, call or direct observation. Spotlighting surveys were undertaken at each trap site, as well as a number of other locations, and typically lasted a minimum of 30 minutes. Spotlighting surveys undertaken as part of the baseline assessment equated to approximately 14 person hours.

Playback was used to increase the likelihood of detecting nocturnal birds (owls/nightjars) and arboreal mammals (possums/gliders/koalas).

Opportunistic spotlighting throughout the study area was used regularly and across many seasons while undertaking targeted survey works.

Opportunistic observations

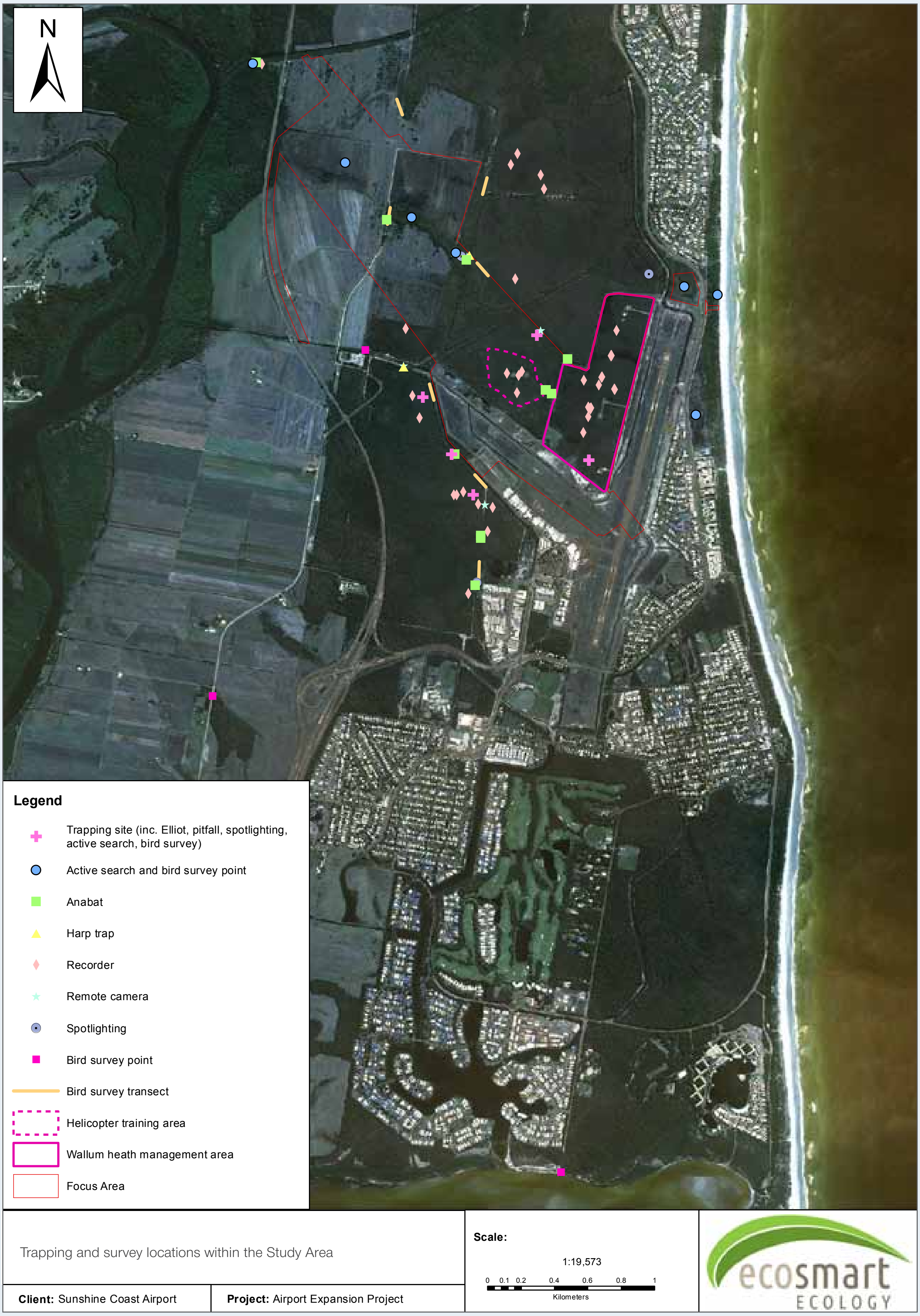
Opportunistic observations of new or unusual fauna were recorded throughout the baseline assessment as well as during targeted surveys. Records included species heard and/or seen during surveys as well as species detected by other means (e.g. scats, tracks, scratch mark, nests, feeding signs, and remains).Opportunistic observations of taxa in proximity to the study area (e.g. Finland Road Swamp) were also recorded.

Remote sensors and cameras

Ultrasonic bat call detection

Ultrasonic call detection and recording of microchiropteran bats was carried out using an Anabat device located in remnant and non-remnant vegetation around the SCA. The device was set to record from dusk until dawn and located in areas most likely to have high bat activity (e.g. tracks, roads, waterways). Whilst most habitat types were surveyed, bat detection focused on areas most likely to have high bat activity (e.g. woodlands with hollows or adjacent waterways). Anabat recording was undertaken on two or more nights in every month between June and September 2012 (inclusive) for a total of eight Anabat survey nights.

Figure 8.3a: Trapping and survey locations within study area



Bio-acoustic recorders

Bio-acoustic recorders (SongMeter, SM2, Wildlife Acoustics Inc.) were used to target Ground Parrots within the study area and adjacent to the airport within Mt Coolum National Park. These recorders allow multiple audio-recordings to occur concurrently, detecting not only Ground Parrots but other vocal vertebrates including amphibians and birds. The automated bio-acoustic recording, which occurred monthly between February and September 2012, was set up so as to record calls one hour either side of sunset. This period coincides with high bird and amphibian calling activity including the period of maximum calling activity for Ground Parrots.

Remote sensor cameras

Remote Sensor Cameras (Reconyx HC600) were used to survey for medium-sized and larger terrestrial vertebrates. Remote Sensor Cameras were used in preference to hair or cage trapping as this non-invasive method allows for greater capture rates over extended periods whilst reducing stress on animals (de Bondi *et al.*, 2010; Claridge *et al.*, 2010; Paull *et al.*, 2012). Further, camera traps allow detection of a species that are difficult to detect using either cage or hair traps (Vine *et al.*, 2009; Robley *et al.*, 2010). Two camera traps were deployed for two days and nights between four locations during the September baseline survey.

Habitat searches and habitat assessment

Habitat searches

Active searching was undertaken at trapping sites and supplementary survey sites within each habitat type (see **Figure 8.3a**). Habitat searches involved two observers spending 30-60 minutes rolling rocks and logs, searching debris, inspecting trees for scratches and searching for scats/feeding remains.

Koalas and Glossy Black-Cockatoos were a particular focus during habitat searches as these EVNT species are known to occur within the local area and some marginal habitat is present within the study area. *Eroticoscincus graciloides* was searched for at one site where habitat appeared suitable (i.e. a small area of tall eucalypt forest adjacent Finland Road). Feed tree species for Koala's (e.g. *Eucalyptus tereticornis* and *E. robusta*) were inspected for scratches and scats, while ort (i.e. feeding remains) searches were undertaken under favoured Glossy Black-Cockatoo feed tree species (e.g. *Casuarina* and *Allocasuarina spp.*). Generally, food trees for both these species were localised to scarce.

Habitat assessment

Habitat assessment primarily focused on determining the suitability of habitat for EVNT species known to occur within the local area. Suitability was determined by comparing ecological requirements of individual EVNT species (e.g. the presence of known feed trees, prey availability, tree hollows, ground cover, habitat complexity, retreat sites, water availability etc.) to observed habitat characteristics.

8.3.3.3 Evaluation of likelihood

All species listed under the NC Act or EPBC Act that have been recorded within 25-50km were assessed for their likelihood of occurring within the study area or immediate surrounds. Each species was assessed based on criteria listed in **Table 8.3c**.

Table 8.3c: Likelihood of species occurrence

Likelihood of Occurrence	Criteria
Known	Recorded within and/or immediately adjacent study area AND Suitable habitat still present within and/or adjacent study area
Likely	Not recorded within and/or immediately adjacent study area; though suitable habitat within or adjacent study area AND Numerous recent records (< 20 years old)<10 km from study area from desktop assessment
Possible	Not recorded within and/or immediately adjacent study area AND Suitable habitat within or adjacent study area and numerous records from Desktop Assessment study area, but records > 10 km away or > 20 years old OR Marginal habitat within or adjacent study area with few records, but recently (1990+) recorded within 10 km of study area
Unlikely	No suitable habitat within or immediately adjacent study area; AND/OR Few records from desktop assessment and records > 10 km from study area only
Transient	Habitat within/adjacent study area considered marginal for species and with few records from Desktop Assessment study area AND Species highly mobile and known to occasionally appear in areas away from known population centres (usually birds). Species unlikely to permanently establish.

8.3.4 Acid frog surveys

Acid frog surveys were undertaken along 50 m transects within areas of suitable habitat (i.e. areas of remnant and regrowth wet heath, sedgeland and Melaleuca woodland supporting surface water). A total of 27 transects were surveyed for frogs across the study area during the survey period. The location of transects is shown in **Figure 8.3b**. Federal survey guidelines (DEWHA 2010) indicate that surveys for acid frogs (and particularly the EPBC Act –listed Wallum Sedgefrog) should include both call detection and visual searches. Accordingly, at each transect the following methods were employed.

Call detection

On arrival at the transect starting point (0 m), a five minute census of calling frogs within five metres was undertaken. This method was repeated at the completion of the 50 m transect. Additional call detection at defined points, not associated with transects, was also used on an opportunistic basis.

Transect searches

A visual encounter survey one metre either side of the 50 m long transect was undertaken by observers walking along the transect line, each using a head torch to scan vegetation. In order to detect as many frogs as possible, dense vegetation was parted or moved after an initial scan. The maximum survey effort equalled or exceed one person hour per transect, depending on the vegetation density and frog activity.

Opportunistic records and searches

Opportunistic acid frog observations were recorded whilst undertaking other activities (e.g. Ground Parrot surveys, general traverses) within the survey area.

On wet nights with heightened calling activity, surveys were also undertaken along various drains within the SCA. Observers traversed the length of these drains from vehicle listening for frog calls, and stopping approximately every 50 m. Wet heath areas within the adjacent Mt Coolum National Park, including areas mapped as RE 12.2.7 (sedge dominated wetlands), were visually assessed during the day for habitat suitability and revisited at night if found suitable.

Calling Wallum Sedgefrogs were also noted on bio-acoustic recorders established for the purpose of Ground Parrot sampling.

Assessment and mapping of acid frog breeding habitat

In conjunction with aerial imagery of the study area, information from field studies was used to map areas of known and likely Wallum Sedgefrog breeding habitat within the area of focus. Water quality sampling (i.e. pH) and vegetation data (see methods outlined in Ground Parrot methodology, **Section 8.3.5**) assisted in habitat mapping. Criteria for assessing the value of breeding habitat for Wallum Sedgefrogs are outlined in **Table 8.3d**.

Aerial imagery of the Study Site and information from field studies (including data on water quality, surface water hydroperiod, vegetation cover and frog presence/abundance) was also used to delineate areas of likely Wallum Rocketfrog breeding habitat within the area of focus. Criteria used in the assessment of Wallum Rocketfrog breeding habitat are provided in **Table 8.3e**. Similarly detailed mapping of breeding habitat for Wallum Froglets was not possible due to difficulties delineating areas of likely breeding habitat. Mapping of Wallum Froglet habitat is therefore likely to overestimate the extent of breeding habitat for this species.

Table 8.3d: Criteria for assessing the value of breeding habitat for Wallum Sedgefrogs

Value as breeding habitat	Criteria
Known	Known to support successful recruitment (based on the presence of juvenile animals [SVL<20 mm] during surveys)
Likely	Records of adult Wallum Sedgefrogs only AND Surface water common after rain, but typically ephemeral (persisting for 4 or more weeks during the wet season) AND Surface water acidic (pH<5.0) and clearly tannin-stained. Upright sedges and/or Bungwall Fern also common and trees scarce or absent.
Unlikely	No Wallum Sedgefrog records OR Very few Wallum Sedgefrog records during surveys (and no records of juvenile animals); AND Surface water scarce, generally persisting for less than 2 weeks after rain; Tree cover dense; Upright sedges and Bungwall Fern scarce; and/or Where water present for extended periods, water pH>5.0 with little tannin-staining and *Litoria fallax* (a potential competitor) common

Figure 8.3b: Acid frog sampling locations

Acid frog sampling locations

Client: Sunshine Coast Airport

Project: Airport Expansion Project

Scale: 1:4,012

0 0.0225 0.045 0.09 0.135 0.18 0.225 Kilometers

ecosmart ECOLOGY

Table 8.3e: Criteria for assessing the value of breeding habitat for Wallum Rocketfrog

Value as breeding habitat	Criteria
Known	Known to support successful recruitment (based on the presence of juvenile animals [SVL<20 mm] during surveys)
Likely	Nearby records of calling animals (within 20 m) AND Surface water common after rain, but typically ephemeral (persisting for 4 or more weeks during the wet season) AND Vegetation in areas of surface water sufficiently sparse to sparse or, at most, mid-dense AND Surface water acidic (pH<5.0) and clearly tannin-stained
Unlikely	No nearby records of calling animals AND Surface water scarce, generally persisting for less than 2-3 weeks after rain; AND/OR Vegetation in areas of shallow surface water very dense AND/OR Where water present for longer periods, water pH>5.0 with little tannin-staining and *Litoria nasuta* (a potential competitor) common

8.3.5 Ground Parrot surveys

Ground Parrot surveys were undertaken monthly from September to November 2010, and monthly from December 2011 to September 2012.

8.3.5.1 Field data collection

Ground Parrot data was gathered using one of four methods: call triangulation, flush transects, call counts and bio-acoustic recording. Call triangulation and flush transects were used on all surveys, while call counts and bio-acoustic recording were added in the months following and including February 2012. The inclusion of these methods allowed:

- The remote recording of surrounding habitats (i.e. within the nearby Mt Coolum National Park, or helicopter training area) for Ground Parrot presence/absence, thereby freeing observers to concentrate on areas of highest Ground Parrot activity (i.e. the WHMA)
- Population estimates based on flush and triangulation to be compared to estimates based on call frequency (as per Spearritt and Krieger (2007)
- The validation of remote recorders as a cost-effective method for population monitoring.

Both call triangulation and flush transect methods collect data along permanent transects running the length of the WHMA (**Figure 8.3c**). These methods estimate the position of birds and therefore provide insights into areas of regular use.

The presence and abundance of Ground Parrots outside the area of focus was evaluated via aural census and automated call-recorders Details of all Ground Parrot survey methodologies are described below.

Call triangulation

Call triangulation uses a central transect running the length of the WHMA, clearly marked with flagging tape and star pickets. Along this transect, listening points were established at 50m intervals. During dusk calling bouts, which typically lasted between 15 and 25 minutes, two observers worked their way from opposite ends along the transect, stopping for approximately one to two minutes at each point to note call trajectory (i.e. the direction from which calls originate). Directional data (lines of direction) from each listening point are plotted on a large aerial map, with intersecting lines indicating the position of calling birds. Only those points with three or more intersecting lines are recorded, unless the observers can clearly delineate the location from nearby calling individuals. Once established, the coordinate position may be calculated and uploaded into GIS software.

On several occasions a third observer assisted with triangulation from specific locations along the eastern roadway that runs parallel to the WHMA. Call trajectories were recorded from these locations using the same method as observers on the central transect. This data was used to augment data collected from the central transect.

The methodology described above is consistent with that used in other published Ground Parrot studies (Meredith *et al.*, 1984; McFarland 1991b).

Flush transects

During daylight hours, two observers walk parallel to the central transect and three additional transects (**Figure 8.3c**). The distance between observers was ~ 30-40 m (i.e. 15-20 m either side of the transect), roughly twice the bird-to-observer flush distance (~20m; McFarland 1991a). To increase flush probability, each observer swung a bell,

Figure 8.3c: Ground Parrot triangulation points and flush transects

Ground Parrot triangulation points and flush transects	Scale: 1:4,355 (0 0.0225 0.045 0.09 0.135 0.18 0.225 Kilometers)	ecosmart ECOLOGY
Client: Sunshine Coast Airport / **Project:** Airport Expansion Project		

fixed to the end of a two metre rope and two metre pole, backwards and forwards as they progressed through the vegetation.

Using this method, a strip of linear habitat approximately 80 m wide is sampled. Each time a bird is flushed, its flush location was recorded using GPS for later inclusion in GIS software. Flushed birds are tracked visually to ensure they are not counted twice during the exercise.

During March, April, July and, August 2012, observers surveyed the helicopter training area using similar flush techniques, although the area was sufficiently small to allow the observers to sample the bulk of the area in one circular sweep.

Opportunistic flush transects were walked through potentially suitable habitat outside of the SCA within Mt Coolum National Park on a regular basis. These opportunistic transects were walked by either one or two observers using a similar methods to those used within the WHMA. The location of opportunistic flush transects is shown in **Figure 8.3c**.

The location of Ground Parrots flushed whilst undertaking other activities (e.g. habitat assessment) within the survey area were also recorded. Such opportunistic records were common during surveys and included valuable records of birds flushed outside of the flush transect survey area.

Call counts

Call counts record the frequency of Ground Parrot calls heard during calling bouts. The methodology used to estimate the number of calling birds heard during each bout is described in Spearritt and Krieger (2007). With this method, observers stand at defined locations and record the number of calls made by Ground Parrots and call bout duration (i.e. time of first call and last call). Only complete calls, consisting of multiple notes in sequence are counted. Calls are counted irrespective of loudness or direction. Using call frequency (i.e. total calls/call duration [minutes] x 10), Ground Parrot abundance can be estimated using the index provided in **Table 8.3f**.

Sound recorders

To increase survey effort outside of the WHMA, bio-acoustic recorders (SongMeter, SM2, Wildlife Acoustics Inc.) were deployed within the helicopter training area and nearby Mt Coolum National Park.

Table 8.3f: Ground Parrot call index

Call Frequency	Abundance Range
0-0	0-0
>0-10	1-3
>10-20	2-6
>20-55	4-10
>55-100	8-13
>100	>12

Bio-acoustic recorders were also used within the WHMA to test their efficiency by comparing the number of recorded calls to the number of calls recorded by an observer positioned within 1-2 m of recorders.

Bird call frequency from bio-acoustic recorders was strongly correlated with observer call frequency (R = 0.84) indicating data from call recorders and point call counts are similarly reliable. Based on these, results, call recorders of similar make and model may be used in future population monitoring of Ground Parrots within and adjacent the study area.

Ground Parrot point call count and sound recorder locations are indicated in **Figure 8.3d**.

Vegetation surveys

To better understand habitat usage within the study area, information on vegetation was collected throughout the WHMA and helicopter training area. Vegetation was assessed by recording the following variables within a 1x1 m quadrat: species composition and abundance (measured as percentage ground cover); percentage bare substrate/water/leaf litter; height and species of the tallest vegetation; and the number of woody stems > 1 m in height. For each flora species within a quadrat the abundance of flowering and seeding was scored on a scale of 0 (no flowering/seeding) to 4 (profuse flowering/seeding). In addition, water depth and the vertical vegetation density (measured at 20 cm intervals) was recorded at the centre of each quarter of the quadrat. For the purposes of analysis, measurements from each quarter were averaged for each 1x1 m quadrat.

Quadrats were set at specific locations from which birds were flushed (75 quadrats), or from random locations throughout the entire area (152 quadrats). Data was gathered on a monthly basis, and the location of vegetation quadrats was recorded using a GPS for later spatial analysis of habitat usage using GIS software.

8.3.5.2 Statistical analysis and mapping

Data analysis and mapping was used to examine two key questions in regards to Ground Parrot values. Firstly, where do Ground Parrots primarily occur? And secondly, do Ground Parrots preferentially select some habitats over others?

Do Ground Parrots preferentially select habitats?

Habitat within the WHMA and helicopter training area was mapped using field observations and satellite imagery of the study area. With the exception of weed and 'sedge-dominated areas', habitats were separated according to structural differences rather than compositional differences (**Table 8.3g**). Habitat differences were later validated using principal component analysis on vegetation data collected during field investigations.

The extent of each habitat type was calculated, and the expected number of bird records compared to actual records using a goodness of fit test (Chi-square). Due to the limited extent of sedgeland, fewer than five bird records were predicted in this habitat type, and it was therefore pooled with the habitat most structurally similar – heath.

Figure 8.3d: Ground Parrot point call count and sound recorder locations

Table 8.3g: Differentiation of habitat types within the Wallum Heath Management Area

Habitat	Key Descriptive Features
Open dry heath	• Never included water within a 1x1 m plot • Projective foliage cover was <100% • Vertical density usually <50% above 40cm • Never with emergent stems extending more than 1 m above other vegetation.
Open wet heath	• Almost always with at least some water within a 1x1 m plot • Projective foliage cover was <100% • Vertical density usually <50% above 40cm (not including water depth) • Never with emergent stems extending more than 1 m above other vegetation.
Heath	• Almost always with at least some water within a 1x1 m plot • Projective foliage cover always 100% • Vertical density >50% at heights above 40 cm, • Regularly with tall (>1m above other vegetation) emergent stems.
Sedgeland	• Almost always with at least some water within a 1x1 m plot • Projective foliage cover ~100% • Vertical density variable • Upright sedge species (*Baloskion pallens, Juncus sp., Baumea teretifolia*) contribute to >80% of cover within a 1x1 m plot
Slashed Vegetation	• Never included water within a 1x1 m plot • Vertical density <50% above 20 cm • Projective foliage cover <50% • Vegetation height never extending above ~30 cm.
Weeds	• Thick mats of *Pennisetum purpureum* and *Sorghum halepense* • Projective foliage cover always 100% • Vertical density >50% to at least 60 cm

Where do Ground Parrots occur?

Fixed kernel density using least-squares cross validation for 50, 75 and 95 per cent confidence intervals was used to map the extent of Ground Parrot records. The resulting map illustrates the extent of habitat occupied by Ground Parrot and shows areas of highest record density (based on 2011/12 sampling). To ensure sample bias was not a contributing factor, fixed kernal density was calculated and mapped individually for flush and triangulation records. These were then compared with each other, as well as against the kernel density for all records (i.e. pooled flush and triangulation). No significant difference between record type in extent (95 per cent CI) or record density (50 per cent CI) was noted.

Unfortunately the number of Ground Parrots located during each season was insufficient for meaningful statistical analysis of seasonal habitat use, although inferences have been drawn by comparing kernel density across seasons.

8.3.6 Water Mouse surveys

Aerial photography and existing RE mapping was used to determine possible habitat for Water Mouse along the Maroochy River and Marcoola drain (refer **Figure 8.3e**). Areas of potential habitat (including areas of marine couch, *Casuarina glauca* woodland and mangrove vegetation at the mouth of the Marcoola drain) were subsequently searched for signs of Water Mouse including prey middens, nest mounds, mud plastering/plugging and slurry trails associated with nests in hollow trees and burrows in supralittoral banks.

Water Mouse searches were conducted on the 29/11/2012 by two ecologists experienced with the species and their habits. Searches were conducted to the north and south of the Marcoola drain along the banks of the Maroochy River. Searches undertaken south of the drain extended to the northern limit of QPWS surveys (Les Donald, *pers. comm.*).

8.3.7 Survey conditions, assumptions and limitations

8.3.7.1 Survey conditions

Rainfall from October 2011 through to March 2012 exceeded the summer average by as much as 60 per cent (1,579 mm in 2011/12 vs. an average of 987 mm). Above average summer rainfall was also experienced in 2010/11 when the SCA received 2119 mm (214 per cent of average summer rainfall). Consequently, rainfall over the 2010/11 and 2011/12 represent the two wettest years in the last decade. Above average summer rainfall has been the predominant pattern since the summer of 2008/09 (**Figure 8.3f**).

Figure 8.3e: Water Mouse search traverses within potential habitat

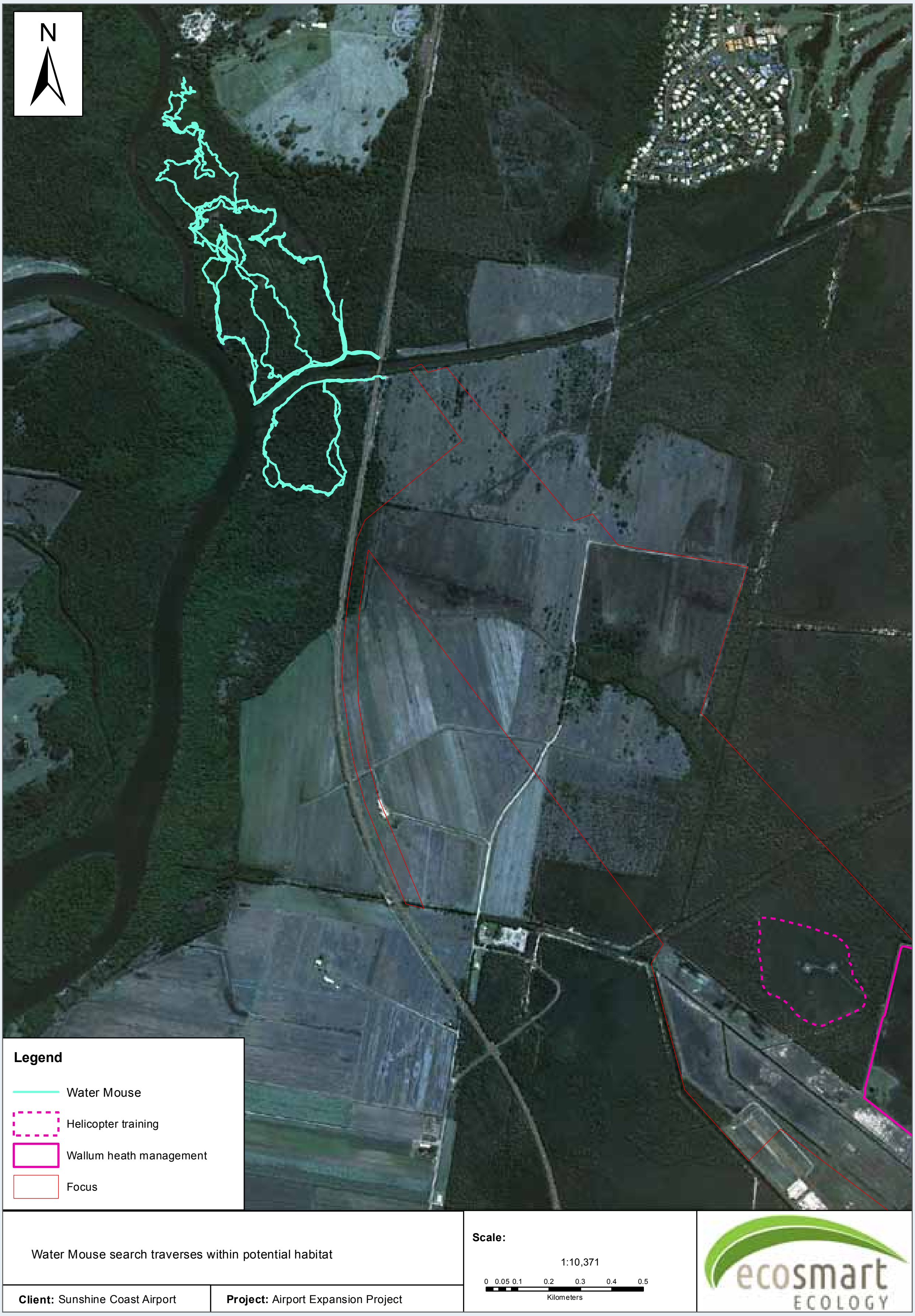
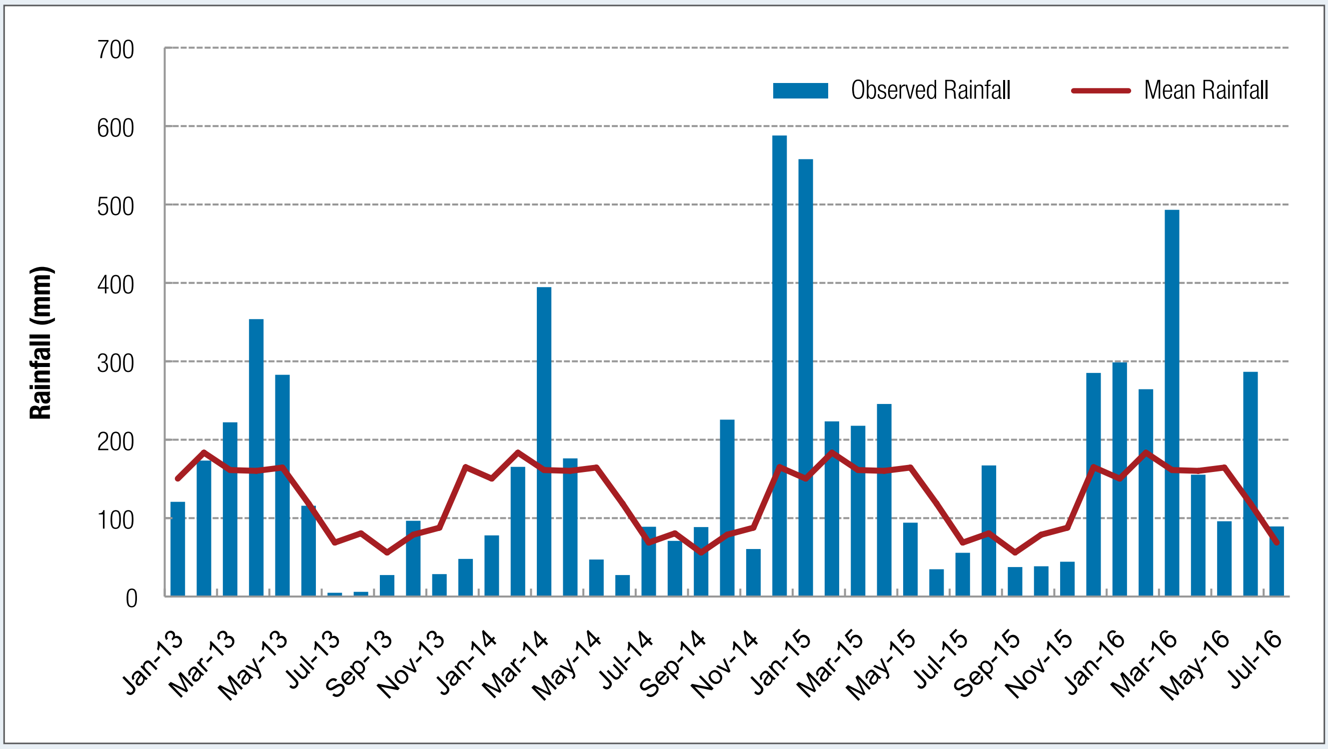


Figure 8.3f: Monthly rainfall totals from January 2009 to July 2012



Surveys in May 2012 coincided with prolific flowering of *Melaleuca quinquenervia*. General bird surveys and spotlighting was undertaken in flowering *Melaleuca* habitats to search for taxa foraging for abundant nectar and pollen sources.

Baseline survey

The baseline survey was undertaken between the 26/9/12 – 30/9/12 (inclusive). Conditions during the surveying were suitable for detection of most resident fauna with calm, warm sunny days and balmy nights. Though there was no rain during surveys, light rainfall (five millimetres) was recorded just prior to surveys commencing on the 25/9/12. Temperatures ranged between 13.9°C and 29°C, providing suitable conditions for reptile and small mammal activity. Calm conditions provided excellent conditions for bird activity during each morning's survey.

Ground Parrots

Monthly Ground Parrot surveys were undertaken from September through to November 2010 and from December 2011 to September 2012, with each survey lasting two-and-a-half days. For the most part, surveys were carried out under highly suitable conditions for detection of Ground Parrots. Strong winds and severe storms in December 2011 did, however, prevent triangulation surveys, and unexpected light rain may have reduced Ground Parrot flushes in February 2012. Strong winds in September 2010 are also likely have reduced the detectability of calling birds.

Acid Frogs

Three separate surveys targeting acid frog species (each of two days duration) were undertaken following heavy rainfall in October 2010, January 2012 and March 2012. Conditions during surveys were warm, humid and overcast. With heavy rain preceding surveys and abundant surface water, conditions were close to ideal for detection of acid frog species.

Acid frog surveys were conducted following rainfall and under conditions consistent with federal survey guidelines.

Water Mouse surveys

Field surveys targeting Water Mouse were undertaken at low tide on the 29/11/12 under very warm and humid conditions.

8.3.7.2 Limitations and assumptions

While unlikely to account for all vertebrate species occurring within the study area, repeat surveys undertaken for this assessment will have captured much of the faunal diversity. Surveys are most likely to have underestimated the diversity/ abundance of dasyurid mammals (due to the absence of trapping during winter months) and invertebrate taxa (which were not targeted during surveys and only recorded on an opportunistic basis). Notwithstanding these limitations, results of field and desktop studies allow for a robust and detailed assessment of existing values for terrestrial vertebrate fauna, in particular conservation significant species (i.e. EVNT species, Migratory species listed under the EPBC Act and other regionally/ locally significant fauna).

Notably, surveys included extensive targeted works for those EVNT taxa which might experience adverse impacts from the airport expansion. Ground Parrot surveys, for example, have included sampling during every month of the year (although not consecutively), while survey work targeting acid frog species included repeat surveys under optimal conditions. With regards to EVNT species, survey work undertaken for this assessment significantly exceeded recommended state and federal survey guidelines. Notwithstanding this, the following limitations are recognised with regards to EVNT species:

- During Ground Parrot triangulation surveys, point call surveys and sound recordings, detectability was affected by helicopter and/or plane noise. During these periods birds continue to call but are not always detectable to the surveyor and it is probable that this interference has resulted in calling activity being underestimated
- While Ground Parrot works have been conducted over every month of the year, these have not occurred consecutively, but rather as two survey periods (Sept - Nov 2010 and Dec - Sep 2012). Temporal variation (i.e. between years) may therefore mask seasonal variation in habitat use
- Calculations of current Ground Parrot habitat use (i.e. kernal density) are based on works undertaken over a relatively short ecological timescale (13 surveys spanning a total of 25 months), and as such, other areas of habitat within the WHMA may be utilised under different management regimes or different climatic conditions
- Slashing of vegetation within the helicopter training area occurred during early August 2012, coinciding with the onset of Ground Parrot breeding. This area was not sampled in 2010 and therefore its importance as breeding habitat for Ground Parrots cannot be properly evaluated
- The western side of the Maroochy River has not been surveyed for Water Mouse, however based on vegetation (RE) mapping this area appears suitable for this species.

The assessment of impacts provided in this report is based, in part, on modelling of Project impacts in Chapters B3 Geology, Soils and Groundwater and B15 Noise and Vibration. The current assessment is therefore subject to the limitations/deficiencies inherent in these studies. As such, impacts on faunal values may deviate from those predicted (if, for example, key assumptions underlying models prove incorrect).

8.4 POLICY CONTEXT AND LEGISLATIVE FRAMEWORK

Legislation of relevance to the current assessment includes the commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the state *Nature Conservation Act 1992* (NC Act). The state-administered *Vegetation Management Act 1999* (VM Act), *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act) and *Nature Conservation (Koala) Conservation Plan 2006* also have some relevance to fauna protection in relation to specific taxa or ecological values.

8.4.1 *Environment Protection and Biodiversity Conservation Act 1999*

The EPBC Act provides for:

- Identification and listing of species and ecological communities as threatened
- Development of conservation advice and recovery plans for listed species and ecological communities
- Development of a register of critical habitat
- Recognition of key threatening processes.

The EPBC Act is administered by the federal Department of Environment (DoE). The legislation provides a legal framework for the protection and management of nationally and internationally important flora, fauna, ecological communities, and heritage places. These important values are considered Matters of National Environmental Significance (MNES) under the Act. MNES include species listed as 'Vulnerable', 'Endangered' or 'Critically Endangered' under the EPBC Act as well as migratory species listed under international treaties/agreements such as Japan-Australia Migratory Birds Agreement (JAMBA) and China-Australia Migratory Birds Agreement (CAMBA). Actions which will, or are likely, to have a 'significant impact' on MNES will require approval from the federal environmental minister.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will (EPBC Act Policy Statement 1.1):

- Lead to a long-term decrease in the size of an important population of a species
- Reduce the area of occupancy of an important population
- Fragment an existing important population into two or more populations
- Adversely affect habitat critical to the survival of a species
- Disrupt the breeding cycle of an important population
- Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
- Introduce disease that may cause the species to decline
- Interfere substantially with the recovery of the species.

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or are:

- Key source populations either for breeding or dispersal
- Populations that are necessary for maintaining genetic diversity
- Populations that are near the limit of the species range.

A number of policy documents and plans relevant to listed species have been published in support of the Act.

Those relevant to listed species considered in this report include:

- A draft Wallum Sedgefrog referral guideline released in September 2011 (SEWPaC 2011). The guideline provides acceptable mitigation measures for a variety of potential impacts
- Recommended survey guidelines for Wallum Sedgefrogs (DEWHA 2010)
- A National Recovery Plan for the Wallum Sedgefrog (Meyer *et al.*, 2006)
- National recovery plan for the Water Mouse (false water rat) *Xeromys myoides* (DERM 2010)
- Draft National Recovery Plan for the Grey-headed Flying-fox *Pteropus poliocephalus* (DECCW 2009).

8.4.2 *Nature Conservation Act (Qld) 1992*

The NC Act provides for the identification, protection and management of Queensland's threatened flora and fauna, as well as regulating the use and disturbance of all wildlife. The management and regulations within the NC Act are administered by the Department of Environment and Heritage Protection (DEHP).

Actions relevant to the description of ecological values under the *Nature Conservation Act 1992* include the provision for eleven classes of protected areas ranging from:

- National Parks (scientific)
- World heritage management and international agreement areas
- National Parks (Aboriginal land)
- Nature Refuges
- Coordinated conservation areas involving private property
- Five classes of native wildlife are defined by the *Nature Conservation (Wildlife) Regulation* 2006 (NCR):
  - Extinct in the Wild
  - Endangered
  - Vulnerable
  - Near Threatened
  - Least Concern.

These classes collectively relate to native species and protected wildlife. International and prohibited wildlife classes relate to non-native species. Approval is required under the NC Act to take (which includes to injure or harm) a protected animal. The NC Act defined 'protected animal' as an animal that is prescribed under the NC Act as threatened, near threatened or least concern wildlife.

8.4.3 *Land Protection (Pest and Stock Route Management) Act (Qld) 2002*

The LP Act provides a framework and powers for improved management of weeds, pest animals and the stock route network. The act provides for designation of threat classes to exotic species which:

- Degrade natural resources
- Threaten conservation of biodiversity
- Threaten remnant vegetation
- Reduce rural production
- Interfere with human health and recreational activities.

Exotic species that pose threat under the listed categories are declared under one of the following three categories detailed below.

- **Class 1 Pest**: fauna or flora species that has potential to become a very serious pest in Queensland in the future.
- **Class 2 Pest**: fauna or flora species has already spread over substantial areas of Queensland, but its impact is considered sufficiently serious to warrant control.
- **Class 3 Pest**: fauna or flora species that is commonly established in parts of Queensland but its control by landholders is not warranted unless the plant is impacting, or has potential to impact on a nearby ESA.

8.4.4 *Environmental Offsets Act 2014*

The *Environmental Offsets Act* 2014 (Offsets Act) was passed with amendments on 22 May 2014 and proclaimed on 1 July 2014. It is supported by the Environmental Offsets Regulation 2014, the Queensland Environmental Offsets Policy and the Financial Settlement Offset Calculation Methodology.

The Offsets Act introduces a new framework for environmental offsets in Queensland. Under the framework provided by the Offsets Act, the existing five issue-specific offset policies are replaced by a single State policy governing the assessment of environmental offsets.

The Offsets Act will bind all persons including the State, but is expressed not to affect or limit the functions and powers of the Coordinator-General under the *State Development and Public Works Organisation Act 1971* (SDPWO Act).

8.5 EXISTING CONDITIONS AND VALUES

Existing terrestrial vertebrate values within and surrounding the proposed activities are described in this section. While all faunal values within 5 km of the SCA are considered (i.e., the study area), values most likely to be affected (i.e. within the area of focus, defined as the direct impact zone plus the immediately adjacent WHMA; see **Figure 8.2a**) have prominence.

8.5.1 Desktop review

Literature and database searches yielded a total of 91,705 vertebrate records within 50 km of the SCA including. This total includes records of 40 frog, 90 reptile, 401 bird and 78 mammal species. General fauna values, including fauna habitats, fauna communities and pest species are discussed in **Section 8.5.2**. Relevant species of local significance, including those at the limit of their range or priority species under planning tools (e.g. Biodiversity Planning Assessment for SEQ, Back on Track [BOT] species), are also mentioned where relevant within **Section 8.5.2**.

The desktop review has recognised a large number of EVNT species (49), as occurring within 50 km of the study area. Most of these species are considered unlikely to occur at the SCA due largely to a lack of suitable habitat or highly mobile/ transient species seldom occurring on site **(Appendix B8:A**). Impacts on these species will be negligible or non-detectable and, as such, they are no longer considered in this report. Endangered, Vulnerable or Near Threatened species considered further in this report are indicated in **Table 8.5a**.

In addition to EVNT species, Migratory species protected under the EPBC Act are also known to occur within the local area. Migratory bird values are considered in **Section 8.13**.

8.5.2 Terrestrial fauna habitats and communities

8.5.2.1 Habitats and fauna diversity

A total of 157 terrestrial vertebrate species were recorded from the study area during surveys, including 11 amphibian, 107 bird, 21 mammal and 19 reptile species (see **Appendix B8:B** for full list).

Vegetation and Regional Ecosystems within the area of focus have been stratified into five broad fauna habitats (as per Eyre *et al.*, 2012): remnant forest/woodland (i.e. *Melaleuca* woodland and eucalypt forest); heath; disturbed habitat (agricultural and developed land); coastal foredune; and

Table 8.5a: Relevant EVNT species considered in this study

Scientific Name / Common Name	Status# NCA	Status# EPBC	Likelihood of Occurring	Relevant Section
Crinia tinnula / Wallum Froglet	V		Known	**Section 8.8**
Litoria freycineti / Wallum Rocketfrog	V		Known	**Section 8.8**
Litoria olongburensis / Wallum Sedgefrog	V	V	Known	**Section 8.7**
Ephippiorhynchus asiaticus / Black-necked Stork	NT		Known	**Section 8.12.1**
Accipiter novaehollandiae / Grey Goshawk	NT		Known	**Section 8.12.2**
Lewinia pectoralis / Lewin's Rail	NT		Known	**Section 8.12.3**
Numenius madagascariensis / Eastern Curlew	NT	M	Known (downstream)	**Section 8.12.4**
Pezoporus wallicus / Ground Parrot	V		Known	**Section 8.9**
Phascolarctos cinereus / Koala	V	V	Possible	**Section 8.12.5**
Pteropus poliocephalus / Grey-headed Flying-fox	LC	V	Known	**Section 8.10**
Xeromys myoides / Water Mouse	V	V	Known (downstream)	**Section 8.11**

 # LC = Least Concern, NT = Near Threatened, V = Vulnerable, E = Endangered; M = Migratory.

Figure 8.5a: Distribution of broad vegetation groups (fauna habitats) within and surrounding the area of focus

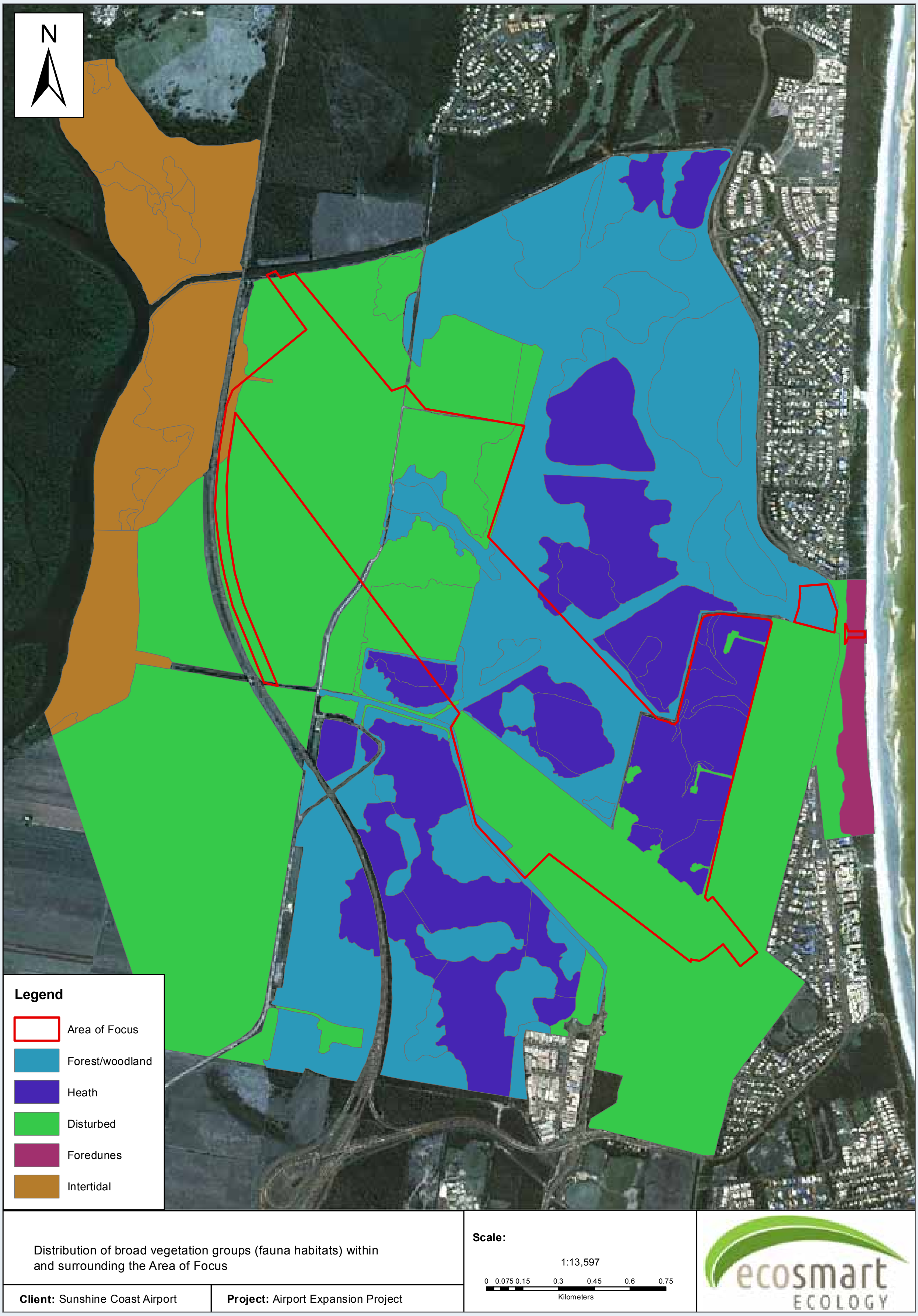
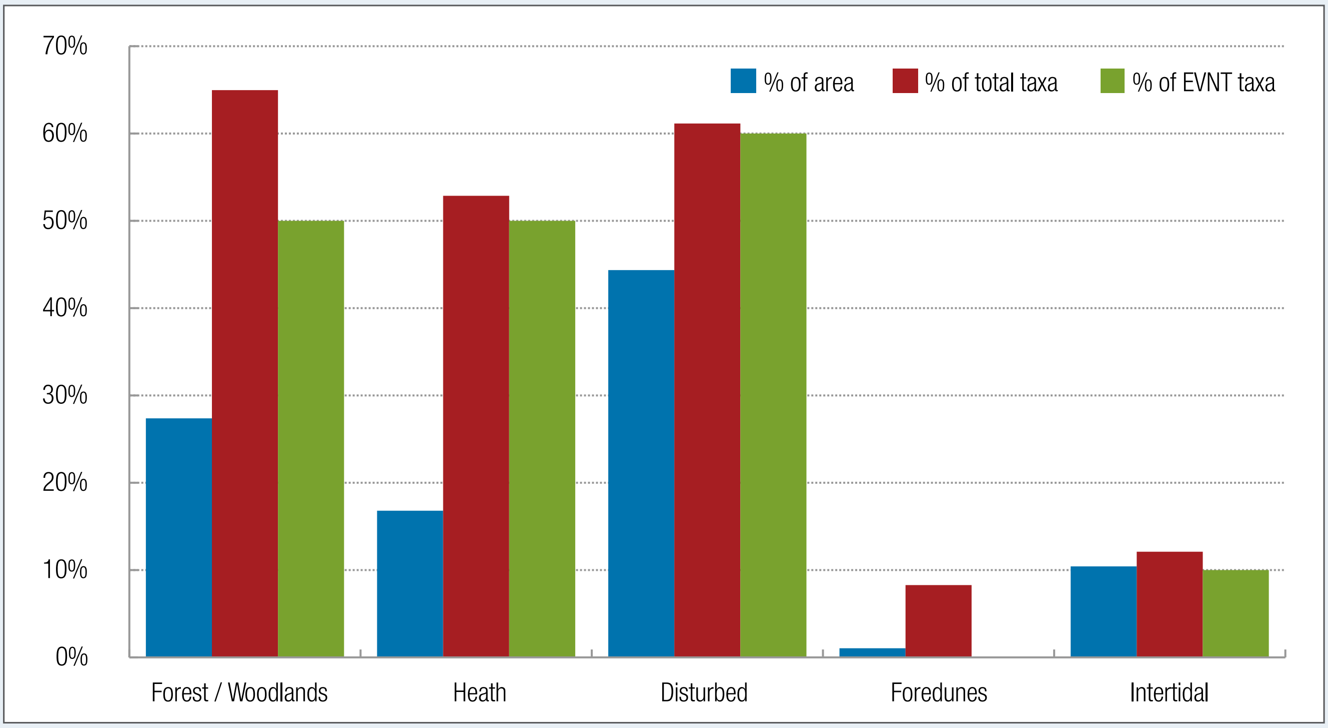


Figure 8.5b: Extent and contribution of broad vegetation groups (fauna habitats) to vertebrate diversity



intertidal/supralittoral areas supporting mangroves and *Casuarina glauca* woodland. The distribution of these habitats within the area of focus is illustrated in **Figure 8.5a**.

Disturbed habitats constitute almost half of the Focus Area, while forest and heath cover 27 per cent and 17 per cent of this area respectively. Though limited in extent, both forest and heath habitats contribute significantly to overall vertebrate diversity, heath, in particular, supports a high number of EVNT taxa relative to its extent (**Figure 8.5b**).

While typically supporting low vertebrate diversity, disturbed areas within the SCA provide habitat for a significant number of vertebrate species including several EVNT species. As discussed below, the greater-than-expected diversity within these disturbed habitats may be attributed to the presence of vegetated drains containing surface water. Transient EVNT taxa such as Black-necked Storks have rarely been recorded in artificial drains, and the water within is also likely to attracted dispersing acid frogs. These records however, do not represent permanent populations.

Vegetated drains within disturbed habitats may contributed to high EVNT diversity, although the scattered observations are likely to represent dispersing or transient individuals rather than permanent populations (see discussion in text).

The Maroochy River provides habitat for species such as Brahminy Kite, White-bellied Sea-eagle and Whistling Kite. These species fly over the SCA sporadically.

Forest/Woodland

Forest/woodland (broadly analogous with RE 12.2.7) is the most widespread remnant vegetation within the area of focus, forming broad ecotonal areas with adjoining heath.

The majority of forest habitats in this area are dominated by *Melaleuca quinquenervia*, which favours very moist or water-logged soil and forms a dense overlapping canopy usually around 15 m in height. In slightly drier soils (including mounded spoil along artificial drains), *Eucalyptus tereticornis* and *E. robusta* may emerge above the *Melaleuca* canopy (**Figure 8.5c**).

Forest habitat provides abundant pollen and nectar sources, subject to the flowering of *M. quinquenervia*, *E. tereticornis* and *E. robusta*. Flowering is most common between March and September (see **Table 8.10b**) attracting numerous nectarivores including White-cheeked, White-throated, Scarlet and Brown Honeyeaters, Little Wattlebird, Little and Noisy Friarbird, Scaly-breasted and Rainbow Lorikeet and several Flying-fox species (including the EPBC Act-listed Grey-headed Flying-fox).

Below the canopy, a dense layer of shrubs is present, the composition of which varies depending on soil moisture. In wet areas, sedges and ferns (in particular *Blechnum indicum* and *Balloskion tetraphyllum*) dominate; while dryer soils associated with eucalypts support a greater diversity of species including *Hakea*, *Pteridium*, and *Lomandra* species. Although present throughout forest/woodland habitats, local abundance of fauna may increase in areas where *Eucalypts* are more common. Vertebrate species commonly recorded in this habitat during surveys included White-crowned Snake (*Cacophis harriettae*), Eastern Yellow Robin, Little and Grey Shrike-thrush, Eastern Whipbird, Red-browed Finch, and Golden Whistler, White-throated Gerygone, Brown Thornbill, Fan-tailed Cuckoo and White-throated Treecreeper.

Common frog species encountered in forests/woodland habitat include Striped Marshfrog (*Limnodynastes peronii*),

Figure 8.5c: Melaleuca woodlands with dense understory

Common Sedgefrog (*Litoria fallax*), Graceful Treefrog (*L. gracilenta*), Striped Rocketfrog (*L. nasuta*) and Ruddy Treefrog (*L. rubella*). While these species could be found in many habitat types, they were generally more abundant in areas without acidic tannin stained water such as in forest habitats associated with Finland Creek where it crosses Finland Road.

A number of EVNT species may inhabit or take advantage of forest habitats. Areas with a slightly taller canopy and abundant perches (e.g. areas with taller eucalypt trees) suit the foraging habits of Grey Goshawk, while *Eucalyptus tereticornis* and *E. robusta*, are favoured feed trees of Koala. Flowering *E. tereticornis* and *M. quinquenervia*) also attract large numbers of flying-fox including the Grey-headed Flying-fox. However with the exception of Grey-headed Flying fox, no EVNT taxa are expected to regularly frequent forest/woodland habitat in the area of focus.

Other taxa of special interest (i.e. those listed in the SEQ Biodiversity Planning Assessment [BPA]) likely to occur in abundance within forest habitats included Little Wattlebird, Copper-backed Broodfrog (*Pseudophryne Raveni*), Little-red Flying-fox, *Scotorepens sp. (parnaby)* and *Calyptotis scutirostrum*. Known food plants (i.e. *Gahnia* spp) for two priority butterfly taxa (*Hesperilla donnysa* and *Tisiphone abeona*) occur in this habitat, however neither species is known to occur within the study area. The Delicate Mouse (*Pseudomys delicatulus*), which reaches its eastern limit on the Sunshine Coast, has been recorded within the local area (within nearby Maroochy River Conservation Park) and though not recorded during these could possibly occur on site.

Migratory species such as Rufous Fantail and Black-faced Monarch are more likely to occur in forest/woodland than any other habitat within the SCA.

<u>Heath</u>

The structural and floristic composition of heath within the area of focus (including remnant and regrowth derived heath aithin the WHMA) varies significantly with soil moisture. In areas of dry soil, the heath can be dense and comparatively tall (up to ~ 2m in height), with a compact shrub layer of Hakea actites and *Leptospermum sp.* Where soils are subject to periodic inundation/water logging), species such as *Blechnum indicum, Empodisma minus* and *Baloskion tetraphyllum* can form a thick dense layer to ~1 m. Where surface water remains present for several weeks during the wet season, erect sedges including *Baumea* spp and *Balloskion pallens* dominate. Within the context of the Focus Area, areas dominated by sedge (fitting the description of RE 12.2.15) are rare and generally restricted to lower-lying parts of the WHMA. Common to all heath within the study is the lack of taller emergent canopy species.

Vegetation within the WHMA is subject to slashing which would likely inhibit the growth of taller woody vegetation (including taller shrubs and *Melaleuca quinquenervia*). At the time of surveys, this area supported a mixture of sedgeland and low heath (see **Figure 8.5d** – **Figure 8.5f**).

Heath within the area of focus provides dense cover and foraging habitat for small passerines such as Red-backed Fairy-wren and Tawny Grassbirds, although these species can also be found in more open vegetation. *Banksia robur* and *Xanthorea fulva* are common in heath within the area of focus and, when flowering, attract large numbers of nectarivores including honeyeaters, lorikeets and flying foxes. Small insectivorous birds such as White-browed Scrubwren, Rainbow Bee-eater, and Grass Skinks (*Lampropholis delicata*), are also common in heath vegetation.

Figure 8.5d: Dense heath dominated by Hakea actites to the immediate west of the existing SCA

Figure 8.5e: Dense wet heath dominated by Blechnum indicum from within the Wallum Heath Management Area

Heath, and areas of mixed heath-sedgeland, provide habitat for several EVNT species including Wallum Froglet, Wallum Rocketfrog, Wallum Sedgefrog, Lewin's Rail and Ground Parrot. Little Wattlebird and *Pseudophryne raveni*, both non-EVNT priority taxa (under the BPA), were also regularly recorded from heath habitats. Heath may also provide habitat for Scute-snouted Calyptotis (*Calyptotis scutirostrum*) and Coastal Petaltail Dragonfly (*Petalura litorea*), although these species were not recorded during our surveys. Known food plants (i.e. *Gahnia* spp) for two priority butterfly taxa (Varied Sedge Skipper [*Hesperilla donnysa*] and Swordgrass Brown [*Tisiphone abeona*]) occur in areas of heath, however neither species have been observed on site.

The Grass Skink (*Lampropholis guichenoti*) has previously been recorded from within the study area (two records in 1995), and was captured on five occasions during our surveys. The species is at its northern extent within the Noosa-Maroochy Wallum Area and is of taxonomic interest being isolated from southern populations and, unlike their southern counterparts, preferring heath habitat (SEWPaC 2012a).

Figure 8.5f: Locations where water persists for several weeks are dominated by erect sedge species including Baumea sp and Balloskion pallens

Figure 8.5g: Disturbed habitats adjacent Finland Road

Disturbed (agricultural and developed land)

Disturbed habitats within the area of focus include large areas of abandoned cane farm either side of Finland Road (refer **Figure 8.5g**, as well as managed areas around the existing SCA operations. These areas have little native vegetation, restricted to isolated Acacia or areas of sparse *M. quinquenervia* regrowth with grasses such as *Imperata cylindrica* and *Andropogon virginicus* common. These disturbed habitats lack the structural complexity inherent in native vegetation.

Vertebrates which inhabit these areas are adapted to open habitats or grasslands and are typically very abundant. Commonly recorded species include Australian Magpie, Torresian Crow, Pied Butcherbird, Black-shouldered Kite, Pheasant Coucal, Golden-headed Cisticola, Red-backed Fairy-wren, Brown Quail, Magpie-lark, Nankeen Kestrel, Welcome Swallow, Crested Pigeon, Chestnut-breasted Mannikin and Willie Wagtail. In areas regularly mown around the existing runway operations, Masked Lapwings and Australasian Pipit are abundant.

Some species may venture into disturbed habitat from adjacent remnant vegetation to forage either in thick grass (e.g. Lewin's Rail, Buff-banded Rail, Eastern Grey Kangaroo) or areas of short grass/bare ground (e.g. Peaceful Dove and Bar-shouldered Dove).

Pest species, particularly Feral Dog, Feral Cat, European Fox, Cane Toad, and Common Myna, are more common in disturbed habitats.

Few EVNT species are likely to regularly occur within disturbed habitats, although transient species may occur sporadically (e.g. Black-necked Stork) while others may occasionally 'spill' into disturbed habitats from adjacent populations (e.g. Wallum Sedgefrog). These exceptional occurrences have led to an elevated number of EVNT records from disturbed areas (see **Figure 8.5a**). Notable exceptions include Lewin's Rail, which can be found in exotic flooded grasslands particularly in areas close to existing vegetation, and the Wallum Froglet. The latter is commonly recorded in disturbed habitat on the Sunshine Coast including areas formerly under pine (EcoSmart Ecology, 2012; Meyer, 2010). Other EVNT species have been recorded sporadically in disturbed areas within the study area (e.g. Black-necked Stork and Wallum Sedgefrog).

Cattle Egrets, a common Migratory species, take advantage of open habitats, particularly in areas of high soil moisture and are likely to utilise open paddocks alongside Finland Road for foraging.

No natural waterway with open water occurs within the area of focus. However larger artificial drains, which run along the eastern boundary and southern boundary of the existing airport, have permanent, open water mixed with sections of sedge and dense grass (**Figure 8.5h**).

Fish, aquatic invertebrates and aquatic plants attract a variety of bird species including Pacific Black Duck, Pied Cormorant, Plumed Whistling-duck, Dusky Moorhen and White-faced Heron. Areas of open water with dense sedge grass cover within the area of focus are also known to provide habitat Latham's Snipe, a Migratory species listed under the EPBC Act.

Black-necked Stork has been sporadically recorded in the region, and historically observed on the larger drains within the existing SCA (Avisure data 2010). Records of this species are likely to represent transient individuals, however, and the species is unlikely to occur on site with any frequency.

Coastal foredunes

Coastal dune habitat within the area of focus is minor in extent, and restricted to a narrow linear strip east of David Low Way (refer **Figure 8.5i**). This habitat is separated from other areas of native vegetation by urban development and the aforementioned roadway. Vegetation within this area comprises low closed forest dominated by *Casuarina equisetifolia, Banksia integrifolia, Macaranga tanarius, Pandanus tectorius, Acacia leiocalyx, Alphitonia excelsa, Alectryon coriaceus* and *Melaleuca quinquenervia*. Ground cover in this area varies with tree/shrub canopy cover. Where there is a well-developed canopy of trees and shrubs, ground cover is sparse. Elsewhere the ground layer is dense and includes *Passiflora sp., Imperata cylindrica, Bidens pilosa, Spinifex sericeus* and several common exotic pasture grasses. Invasive weeds which smother native vegetation (including Asparagus Fern [*Asparagus aethiopicus*]), are common in this area. The presence of weeds is likely to reduce the value of dune vegetation for ground dwelling vertebrates.

Figure 8.5h: Habitats along artificial drains provide habitat for waterfowl tolerant of disturbance

Figure 8.5i: Coastal dune habitat between Sunshine Coast Airport and Marcoola Beach

Figure 8.5j: Mangrove Habitats to the north-west of the Sunshine Coast Airport

Given the narrow extent and limited connectivity of dune vegetation within the Focus Area, dune habitat is of limited value to most fauna. In particular, the diversity and abundance of ground-dwelling fauna within dune habitat is likely to be low, and larger mammals (e.g. wallabies and kangaroos) are unlikely to occur here. The Eastern Striped skink (Ctenotus robustus) and other common small lizards such as *Lampropholis delicata* are likely to dominate the ground-dwelling vertebrate community.

Birds and bats, being more mobile, are more able to take advantage of seasonal or temporal resources in isolated patches of foredune vegetation. In particular, flowering *Banksia integrifolia* along coastal dunes may attract nectivorous birds and bats including Grey-headed Flying-fox. Ubiquitous bird species dominated the avian community in this area including Torresian Crow, Brown Honeyeater, Eastern Yellow Robin, White-cheeked Honeyeater, Rainbow Lorikeet, Silvereye, Welcome Swallow and Brahminy Kite. Notable species recorded during our surveys from coastal dune habitat included Rainbow Bee-eater, and Rufous Fantail, both of which are listed as Migratory under the EPBC Act.

Areas of coastal dune vegetation, particularly those with dry vine thicket species (e.g. *Alphitonia excelsa* and *A. coriaceus*) can have diverse butterfly communities. Systematic survey for butterflies has not been undertaken, however at least seven species were noted including Orchid Swallowtail (*Papilio aegeus*), Blue Tiger (*Tirumala hamata*), Glasswing (*Acraea andromacha*), Large Grass Yellow (*Eurema hecabe*), Hairy Line-blue (*Erysichton lineata*), Small Dusky Blue (*Candalides erinus*) and Small Green-banded Blue (*Psychonotis caelius*).

Intertidal

Intertidal habitats within the study area (i.e. Coastal She-oak and Mangrove woodland/forest) are minor in extent, and largely restricted to the fringes of the Mt Coolum drain and Maroochy River (refer **Figure 8.5j**). Though not recorded during surveys, mangroves within this area are likely to regularly attract mangrove specialist species such as Mangrove Gerygone, Mangrove Honeyeater and Striated Heron. Other vertebrates utilising this habitat (e.g. Brown Honeyeater) are likely to have broad habitat requirements and also occur in adjacent vegetation.

Water Mouse, which inhabits mangrove and estuarine habitats, are well known along the Maroochy River adjacent to the area of focus.

8.5.3 Exotic pest species

A total of eight feral terrestrial vertebrate species have been recorded from the study area. These include three listed as Class 2 declared animals under the LPA. Class two declared animals, are feral species established in Queensland that have, or may have, a substantial negative economic, environmental or social impact. **Table 8.5b** lists all known feral terrestrial vertebrate species from the study area. Four pest species are known to pose significant risks to biodiversity: the Feral Dog/Dingo, Fox, Cat and Cane Toad.

8.6 CORRIDOR VALUES

Background

Natural landscapes which have little human disturbance have high levels of connectivity allowing recolonisation of vacated habitat as well as movement of animals to and from occupied habitat.

With little or no immigration, loss of genetic diversity, demographic stochasticity, inbreeding, homozygosity and founder effects, may pose a significant threat to the survival of isolated populations (Franklin 1980; Traill *et al.*, 2007). Thus, without strong connectivity, small isolated populations are at greater risk of extinction (Lindenmeyer and Burgman 2005; Lindenmeyer and Fischer 2006). Detailed discussion of these issues is outside the scope of this study (see Russell 1996), however it is worth noting that these impacts are not immediately obvious and can take generations to manifest.

Deleterious genetic drift in small populations can reduce fitness and lead to local extinctions years, decades and even centuries after the isolating event. Retention of vegetated wildlife corridors facilitating movement of fauna between otherwise isolated habitat patches is therefore of crucial importance in ensuring the long term viability of animal populations in fragmented landscapes.

Where fully functional, wildlife corridors will perform a number of important roles (Lindenmeyer and Burgman 2005; Lindenmayer and Fischer 2006) including:

- Facilitate the movement of animals through suboptimal habitat
- Provide habitat for resident populations
- Enhance dispersal success by reducing mortality during dispersal
- Prevent and reverse local extinctions by allowing empty patches to be recolonised
- Promote the exchange of genes between subpopulations, thereby reducing genetic drift and inbreeding depression
- Maintain species richness at the patch and landscape scale.

The functionality of wildlife corridors for different fauna (i.e. the degree to which a corridor fulfils the abovementioned roles) will depend on a range of factors including dispersal behaviour, mode of movement (e.g. flying, crawling, hopping, etc.), predation risk, and how these interact with landscape attributes (e.g. topography, vegetation cover and density) (Recher *et al.*, 1987). In most cases this will differ between species, so that not all corridors will function equally well for all species. Inter-specific interactions, such as competition and/or predation, can also affect corridor function differently in different species (Catteral *et al.*, 1991).

It is also recognised that attributes of the corridor itself influence movement and therefore must be considered. Influencing factors include:

- Corridor width and length (Andreassen *et al.*, 1996) and the potential for edge effects (Bennett 1992)
- Landscape position (Claridge and Lindenmayer 1994; Lindenmayer 2002)
- Surrounding habitats
- The size and value of habitat/populations which is connected by the corridor

Inter-corridor habitat suitability (quality) and the surrounding habitat matrix (Lindenmayer *et al.*, 1994; Lindenmayer 2002; Merrit and Wallis 2004; see **Figure 8.6a**).

Table 8.5b: Pest vertebrate species recorded from the study area

Scientific Name Common Name	LPA classification	Abundance	Potential Biological Impacts
Rhinella marina Cane Toad	Not Declared	Abundant	Highly toxic, and may fatally poison anything that tries to prey upon it. Preys upon a wide variety of small native animals. May compete for resources with native animals “The biological effects, including lethal toxic ingestion, caused by Cane Toads (Rhinella marina)” is a key threatening process listed under the EPBC Act. Abundant widespread occurrences are currently mapped in the study area by Biosecurity Queensland (2008b).
Canis lupus Feral Dog/ Dingo	Class 2	Undefined	Can carry diseases, such as distemper and parvovirus. Competes with native fauna for resources and preys upon a wide variety of native animals. Common widespread occurrences are currently mapped in the study area by Biosecurity Queensland (2008b).
Vulpes vulpes European Fox	Class 2	Uncommon	Preys upon a wide variety of native fauna, particularly small mammals and has been implicated in the extinction of a number of native species. “Predation by European Red Fox” is a key threatening process under the EPBC Act. Common widespread occurrences are currently mapped in the study area by Biosecurity Queensland (2008b).
Felis catus Feral Cat	Class 2	Uncommon	Preys upon a wide variety of native animals and has been implicated in the extinction of a number of native species (Burbidge and Manley 2002). Competes for resources with native species. “Predation by Feral Cat” is a key threatening process under the EPBC Act. Common widespread occurrences are currently mapped in the study area by Biosecurity Queensland (2008b).
Passer domesticus House Sparrow	Not Declared	Uncommon	Associated with human habitation, competes with native species within townships and development.
Spilopelia chinensis Spotted Turtle Dove	Not Declared	Uncommon	Associated with human habitation, competes with native species within townships and development.
Sturnus tristis Common Myna	Not Declared	Uncommon	Associated with human habitation, competes with native species within townships and development. Common widespread occurrences are currently mapped in the study area by Biosecurity Queensland (2008b).
Sturnus vulgaris Common Starling	Not Declared	Common	Associated with human habitation, competes with native species within townships and development.

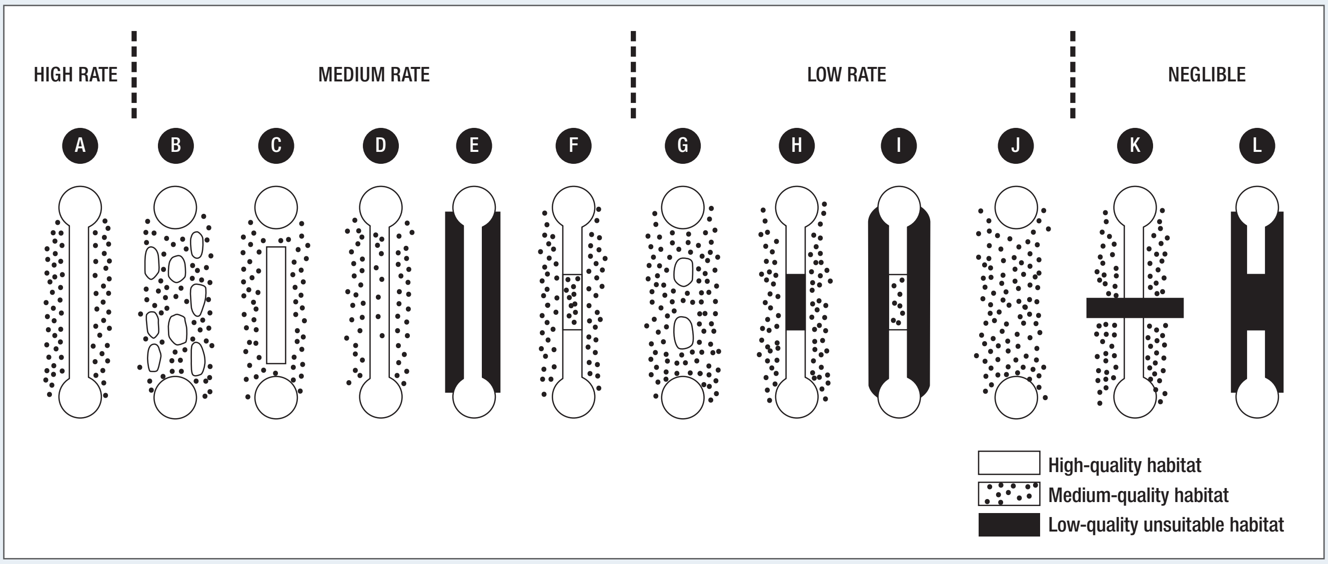
Key: Class 2 declared animal; Non-declared: Non-declared animal; LPA: Land Protection (Pest and Stock Route Management) Act 2002

Major (state and regional) wildlife corridors

Biodiversity Planning Assessment mapping (DERM 2007) shows remnant vegetation within the study area forming part of a state wildlife corridor extending from Eudlo Creek Conservation Park south of the Maroochy River, north to the Cooloola Region and west to Tewantin Sate Forest (See **Figure 8.6b**). While well-connected with remnant vegetation to the north and east, connectivity between the study area and remnant vegetation to the south is poor, due to development south of the southern section of Mt Coolum NP. Movement of ground-dwelling fauna south through the study area to the Maroochy River is therefore likely to be limited.

An alternative, albeit narrow, route to the Maroochy River is available through coastal foredune vegetation. This passage crosses David Low Way, follows vegetation approximately 80 m wide (30 m wide at its narrowest near Mudjimba Park) for 2.9 km, to cross Ocean Drive near the northern corner of the Maroochy River Conservation Park. Dune vegetation along this route is windswept and weed-infested and competition and/or predation from exotic species is likely to be high. The opportunity for movement of ground-dwelling fauna along this coastal route is, therefore, likely to be limited. Similarly, movement of ground-dwelling fauna south across the Maroochy River to Eudlo Creek Conservation Park appears unlikely.

Figure 8.6a: The effect of habitat quality within and surrounding a corridor on corridor function (i.e. the frequency or rate of movement along a corridor)



Source: Queensland Department of Main Roads (2000)

For highly mobile fauna, such as birds, bats and winged invertebrates, development south of the SCA and the Maroochy River are unlikely to pose a significant barrier to dispersal. Such mobile fauna may therefore continue moving south/south west via a regional corridor extending south through to Mooloolah River National Park and south-west to Eudlo (See **Figure 8.5b**). Thus, for highly mobile fauna, habitat within the study area may facilitate movement across the broader landscape.

For mobile fauna dependent on heath (e.g. Ground Parrot), habitat within the SCA and adjoining lands may be particularly important, providing a stepping stone for animals moving south to Mooloolah River National Park (the nearest sizeable area of heath south of the Maroochy River). Without this important stepping stone, fauna dependent on heath would be forced to travel even further between areas of remnant habitat north and south of the Maroochy River.

Local corridors

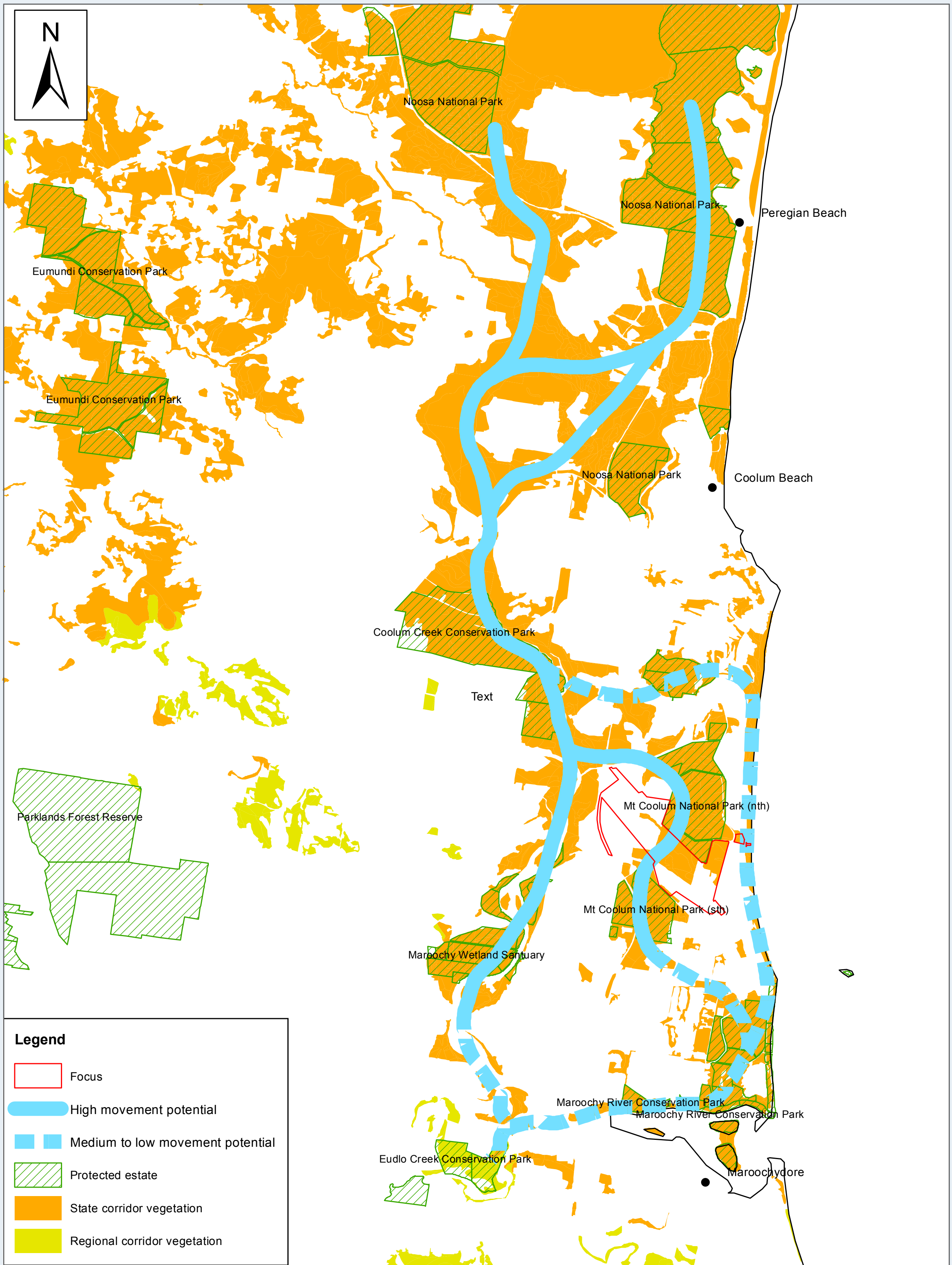
Remnant vegetation within immediate proximity to the SCA is well-connected. Vegetation in the northern section of Mt Coolum NP is connected to vegetation within the southern section of Mt Coolum NP by an area of remnant habitat approximately 430 wide (situated at the end of the existing 12/30 runway). Movement may only be hindered by a number of artificial drains, the largest (~4 m wide) passing along the southern boundary of the SCA (i.e. Eastern SCA Drain). While these drains are unlikely to affect frogs or flying animals (birds, bats, and butterflies), smaller ground-dwelling mammals and reptiles may be hesitant to cross. Movement of small ground-dwelling animals over drains may be limited to areas of shallower water, dense matted vegetation and/or fallen trees/shrubs, though on balance it is likely that most fauna will move over these drains readily.

Large patches of habitat to the south of the SCA are restricted to areas associated with the Maroochy River Conservation Park. This vegetation abuts the Maroochy River in the south which, as discussed above, is likely to act as a barrier to movement of ground-dwelling fauna. Movement of fauna between the Maroochy River Conservation Park and the southern section of Mt Coolum NP will be affected by intervening development including David Low Way, the North Shore Sporting Complex and housing on Menzies Drive. Movement of ground-dwelling fauna to and from the Maroochy River Conservation Park is therefore likely to be limited.

Summary

Mt Coolum National Park, which surrounds the existing SCA, forms part of an extensive wildlife corridor facilitating movement of fauna north-south from Lake Weyba to the Maroochy River. Although bisected by a number of roads, connectivity through this corridor south to the northern section of Mt Coolum NP remains high. Movement of ground-dwelling fauna from the southern section of Mt Coolum NP, south to the Maroochy River and Maroochy River Conservation Park is likely to be limited as a result of clearing and development to the north and south of David Low Way. Movement of ground-dwelling fauna further south is also limited with the Maroochy River acting as a barrier to dispersal for most, if not all, ground-dwelling fauna. For more mobile species such as birds, bats and butterflies, movement south of the SCA is more likely.

Figure 8.6b: Corridor vegetation (SEQ BPA) and potential fauna movement routes within the study area



Corridor vegetation (south-east Queensland BPA) and potential fauna movement routes within the Study Area

Scale: 1:67,502

0 0.375 0.75 1.5 2.25 3 3.75 Kilometers

Client: Sunshine Coast Airport

Project: Airport Expansion Project

ecosmart ECOLOGY

8.7 WALLUM SEDGEFROG

8.7.1 Existing species knowledge

Status

EPBC – Vulnerable; NCA – Vulnerable; IUCN – Vulnerable; BOT: Medium

Distribution and habitats

The Wallum Sedgefrog occurs in 'wallum' habitat (i.e. coastal sand plains and dunes as well as sand islands off the Queensland coast) from Lake Woongeel, Fraser Island south to Woolgoolga, northern New South Wales (Hines *et al.*, 1999; Hines and Meyer 2011). Due to sea level rises during the Pleistocene and, more recently, anthropogenic habitat loss and disturbance, the distribution of the Wallum Sedgefrog is highly fragmented (James 1996; Hines *et al.*, 1999; Meyer *et al.*, 2006).

Within wallum habitat, Wallum Sedgefrogs are most commonly associated with ephemeral (seasonally inundated) perched swamps with emergent sedges (Liem and Ingram 1977; Meyer *et al.*, 2006; Hines and Meyer, 2011; Shuker and Hero 2012). While more commonly associated with remnant wallum habitat, the Wallum Sedgefrog is known to inhabit areas of disturbed wallum habitat, including former pine plantation (E. Meyer and M. Sanders *unpub. obs.*)

Ecology

In areas of suitable habitat, individuals can be found clinging to sedges and, less commonly, other emergent vegetation (including grasses and small shrubs) near water (Shuker and Hero, 2012; E. Meyer and M. Sanders *pers. obs.*). In the presence of surface water, Wallum Sedgefrogs may be located almost any time of year; however, calling frogs are heard mostly from September-May after rain (Meyer *et al.*, 2006; E. Meyer and M. Sanders *unpub. obs.*). Calling occurs mainly after dark but may occur during the day if conditions are suitable (e.g. under overcast conditions with light rain) (E. Meyer *unpub. obs.*).

Breeding occurs during the warmer months (spring, summer, and early autumn) in oligotrophic water after heavy rain (Ehmann 1997). Eggs are laid in still water at the base of reed stems in tannin-stained acidic waters ranging in pH from 3.5 - 5.0 (Meyer 2004; Hines and Meyer 2011; Anstis 2002). Dilute, tannin-stained and acidic waters typical of wallum are known to inhibit recruitment in less acid-tolerant amphibian species including the Common Sedgefrog (*Litoria fallax*), an ecologically-similar congener less tolerant of acidic waters than the Wallum Sedgefrog (Freda 1986; Meyer 2004). Water chemistry may therefore play an important role in limiting competition with such competitor species (Ingram and Corben 1975; Meyer *et al.*, 2006).

Larvae (tadpoles) of the Wallum Sedgefrog feed on biofilm (algae, bacteria and other micro-organisms) enveloping submerged sedges (Anstis 2002; Meyer *et al.*, 2006).

Depending on the time of year, sedgefrog tadpoles may take from 6-8 weeks to complete development (E. Meyer *unpub. obs.*).

The movement patterns of Wallum Sedgefrogs are not well known. While residing in wetland habitats year round, Wallum Sedgefrogs may disperse into nearby heath and woodland during very wet periods (Hines and Meyer 2011; E. Meyer *unpub. obs.*). Recolonisation of habitat destroyed by fire (see Lewis and Goldingay, 2005) suggests the species may disperse over large distances (up to 500 m and possibly more) provided suitable movement corridors are available (James 1996; Lewis and Goldingay 2005; Meyer *et al.*, 2006).

Documented threats

A number of threats have been identified as potentially impacting the Wallum Sedgefrog including:

- Habitat removal, fragmentation and degradation of suitable habitat for agriculture, pine plantations, housing and infrastructure such as canal development, drainage projects and transport corridors (Ingram and McDonald 1993; Hines *et al.*, 1999)
- Changes in hydrological regimes, increased nutrients or sediments, altered water quality (salinity, acidity, nutrient levels and toxicity, dissolved oxygen, temperature and turbidity) due to landscape modification. This could include urban run-off from fertilisers, detergents, oils, etc. (Meyer *et al.*, 2006)
- Use of biocides for weed and mosquito control programs (Meyer *et al.*, 2006)
- Construction of physical barriers which limit movement between water bodies
- Mortality on roads adjacent to populations (Goldingay and Taylor 2006)
- Predation from introduced fish (i.e. Gambusia holbrooki) (Hines *et al.*, 1999)
- Weed spread (Meyer *et al.*, 2006)
- Feral pigs, *Sus scrofa* (Meyer *et al.*, 2006)
- Introduced pathogens (i.e. *Batrachochytrium dendrobatidis*) (Meyer *et al.*, 2006)
- Competition from other frog species such as *L. fallax*, following habitat disturbance (Meyer *et al.*, 2006)
- Inappropriate fire management (Meyer *et al.*, 2006).

8.7.2 Extent of occurrence

8.7.2.1 Regional and local context

In Queensland, the Wallum Sedgefrog occurs on offshore dune islands and adjacent coastal dunes and sand plains from Fraser Island south to the Queensland – New South Wales border. On the Queensland coast, this species is largely confined to the Cooloola region (north of the Noosa River) and Sunshine Coast (from the Noosa River, south to Beerwah).

The only other mainland records of Wallum Sedgefrog south of the Sunshine Coast are from Ningi, to the south-west of Bribie Island (J. Richards, *pers. comm.*), Tallebudgera/ Tugun on the Gold Coast and Woolgoolga, northern New South Wales (Hines *et al.*, 1999). Thus, on the Queensland mainland, Wallum Sedgefrogs are largely restricted to a narrow coastal strip of approximately 150 km extending from Beerwah north to Cooloola. Within this region, the majority of known Wallum Sedgefrog habitat (60-70 per cent) occurs within protected estate.

Two large tidal river systems (the Noosa and Maroochy River) extend inland from the coast forming a significant barrier to the dispersal of Wallum Sedgefrogs. Populations separated by these rivers are likely to have been isolated from one another for some time (i.e. many thousands of years) and may have diverged genetically from one another. While the level or significance of genetic divergence/ structuring across the Maroochy and Noosa Rivers is unknown, populations separated by these rivers are, for conservation management purposes, treated as distinct Management Units (MUs) (*sensu* Moritz 1994) – (given likely divergence in allele frequencies across the Maroochy and Noosa Rivers). Hence, in Queensland, the mainland distribution of the Wallum Sedgefrog (north of the Caboolture River) comprises three putative MUs: Cooloola, Peregian and Caloundra (Sanders *et al.*, 2012).

The Cooloola MU lies north of the Noosa River and includes large populations of the Wallum Sedgefrog associated with wet heath and sedgeland, east of the Como Scarp, mostly within National Park.

The Peregian unit, which extends south from the Noosa River to the Maroochy River, includes populations near Lake Weyba and Peregian, north of Yandina Coolum Road (M. Sanders and E. Meyer *pers. obs.*) as well as the SCA. Clearing and urban development within this unit has probably fragmented the Peregian unit into two sub-units, one extending almost uninterrupted from Noosa to the Yandina-Coolum Road (~15 km), and the second (including the SCA) from Mt Coolum south to the Maroochy River.

The Caloundra unit extends south from the Maroochy River to Ningi and includes the Beerwah Scientific Reserve. Wetland habitat within this unit has been extensively modified resulting in significant loss and fragmentation of Wallum Sedgefrog habitat.

8.7.2.2 Mapped essential habitat

Essential Habitat for the Wallum Sedgefrog within the study area includes remnant vegetation mapped as REs 12.2.7, 12.2.12 and 12.2.15. The extent of Essential Habitat for this species is summarised in **Table 8.7a**.

8.7.2.3 Occurrence within the study area

During surveys in 2010/2011, Wallum Sedgefrogs were recorded from within SCA land at the helicopter training area and WHMA (see **Figure 8.7a**). Individual frogs were also recorded along a drainage channel to the near south of the WHMA. Outside of the SCA, Wallum Sedgefrogs were only recorded within the northern section of Mt Coolum NP (i.e. to the near east of Finland Road East). Numbers of Wallum Sedgefrog and the extent of suitable sedgefrog breeding habitat at this location were extremely limited.

Records of the Wallum Sedgefrog within the SCA are mostly from mapped remnant wet heath/ sedgeland and regrowth wet heath within the WHMA and helicopter training area (see **Figure 8.7a**). Within the WHMA and helicopter training area, Wallum Sedgefrogs were recorded mostly from areas of deeper water (≥10 cm) with upright sedges (e.g. *Baumea* spp., *Baloskion pallens*) and Bungwall Fern (*Blechnum indicum*) (**Figure 8.7b**). This includes areas of sedgeland adjacent raised access tracks (e.g. the perimeter fence track; see **Figure 8.7c**). Within the helicopter training area Wallum Sedgefrogs were found only in areas of deeper water (≥ 10 cm), immediately adjacent to helicopter landing pads (See **Figure 8.7a**). These areas appear to have been created by the excavation of soil used to create landing pads. Surface waters in areas of occupied habitat were low in pH (range: 4-4.6; N=6), and heavily tannin-stained (range: 26.9-45.7 mg/L tannic acid; N=5).

Within the northern section of Mt Coolum NP, small numbers of Wallum Sedgefrog were recorded from an area of wet heath north of the SCA (to the near east of Finland Road East) with mostly sparse sedge cover and relatively little surface water. In this area, Wallum Sedgefrog habitat appears to be limited to small areas with deeper surface water (> 10 cm) and upright sedges. The extent of this habitat within the area surveyed appears limited (i.e. < 10 m x 5 m). Wallum Sedgefrogs were not recorded in the southern section of Mt Coolum National Park where preferred habitat (i.e. seasonally inundated areas dominated by upright sedges and/or Bungwall Fern [*Blechnum indicum*]) is scarce and surface water too ephemeral to support recruitment. As such, habitat within this area is unlikely to support a significant breeding population. At wet times, wet heath in this area may provide habitat for small numbers of dispersing animals.

Table 8.7a: Mapped essential habitat for the Wallum Sedgefrog within the study area

RE	Brief description	Extent in study area
12.2.7	Remnant *Melaleuca quinquenervia* open-forest to woodland	179.77 ha
12.2.12	Remnant closed/wet heath	215.40 ha
12.2.15	Swamps with *Baumea* spp., *Juncus* spp. And *Lepironia articulate*	35.80 ha

Figure 8.7a: Wallum Sedgefrog records (this study) compared to Regional Ecosystem mapping

Figure 8.7b: Blechnum and sedge habitats suitable for Wallum Sedgefrog

Figure 8.7c: Sedge dominated Wallum Sedgefrog habitat adjacent the SCA perimeter fence track

Despite the presence of deeper water and upright sedges (*Baumea* spp. and *Lepironia articulata*), Wallum Sedgefrogs were largely absent from drainage channels constructed adjacent the WHMA and north-south runway (RWY 18/31). This may be due in part to the presence of large numbers of Common Sedgefrog (*Litoria fallax*) – a potential competitor associated with disturbed wallum environs - and the presence of predatory fish (in particular *Gambusia holbrooki*). Water within these drainage channels is far less acidic (up to pH 6.5), less heavily tannin-stained (< 8.4 mg/L tannic acid) and, therefore, highly suitable for Common Sedgefrogs which commonly co-exist with Mosquitofish (E. Meyer, *pers. obs.*). Drainage channels to the north and west of the existing airport also appear largely unsuitable for Wallum Sedgefrog, but may at times provide habitat for dispersing animals.

Cleared land subject to cultivation to the north-west of the SCA does not appear to provide suitable habitat for the Wallum Sedgefrog. Drainage channels dissecting land in this area also appear unsuitable for the Wallum Sedgefrog. Swamp habitats directly adjacent (north) of the SCA does not provide suitable habitat for Wallum Sedgefrogs. This small area retains non acidic, clear water, for extensive periods. No Wallum Sedgefrogs have been recorded in this area despite searches.

8.7.3 Breeding (recruitment 2011/12)

During surveys in 2011/2012, recently-metamorphosed and sub-adult Wallum Sedgefrogs (SVL< 20 mm) were recorded at a number of locations within the WHMA indicating successful breeding/recruitment. Most breeding records from this area are from areas of deeper water (> 10 cm) dominated by sedges (e.g. *Baumea* spp. and *Balloskion pallens*) (**Figure 8.7d**). Despite the presence of apparently suitable breeding habitat, no juvenile frogs were recorded from the helicopter training area during surveys.

Outside of the WHMA and helicopter training area, there appears to be little, if any, suitable breeding habitat for Wallum Sedgefrogs (i.e. areas of deeper water (>10 cm) supporting upright sedges). Areas of apparently suitable habitat along drainage lines within the SCA and broader study area are unlikely to support breeding by the Wallum Sedgefrog due to high densities of the Common Sedgefrog and/or predatory fish (in particular *Gambusia holbrooki*).

8.7.4 Relative abundance

The relative abundance of Wallum Sedgefrogs at survey sites during Summer 2011/2012 is shown in **Figure 8.7e**. Numbers of Wallum Sedgefrog recorded on transects varied widely, with a maximum of 91 individuals recorded from sedge-land in the north-west of the WHMA (see **Figure 8.7e**). Counts of between 31-40 individuals were recorded at a number of other sites with deeper water (> 10 cm deep) and a cover of upright sedges. Most counts, however, were of less than 20 animals. Lower counts (< 10) were mostly associated with areas of wet heath with shallow surface water (< 5cm deep) and fewer sedges. Numbers around the helicopter training area were also low, despite the presence of sedges and water to around 15 cm depth. Counts of 30 individuals and higher are not unexpected and compare favourably with transect-based counts elsewhere on the Sunshine Coast, (E. Meyer, K. Lowe and M. Sanders, *unpub. obs.*), as well as Bribie Island and northern New South Wales (Lewis and Goldingay, 2005; Hines and Meyer, 2011).

Count data suggests the WHMA supports a sizeable population of Wallum Sedgefrogs, numbering several hundred animals. Though sizeable for such a small area, larger populations are likely to occur at Mooloolah River National Park and Beerwah Scientific Area, where Wallum Sedgefrogs occur at similar densities (K. Lowe, *unpub. data*) but the extent of suitable habitat is far greater. While count data is lacking, the extent of suitable habitat within Noosa National Park (i.e. north of the Yandina-Coolum Road) suggests numbers of Wallum Sedgefrog may be similarly high elsewhere within the Peregian MU. This, however, requires confirmation.

8.7.5 Potential movement/dispersal

Occupied habitat within the SCA is located 900 m from the nearest area of known (occupied) habitat within the northern section of Mt Coolum NP. Intervening habitat (wet heath and Melaleuca woodland) may support occasional movement/dispersal of animals between these areas, particularly during wet periods. Opportunities for dispersal to areas of suitable habitat elsewhere appear limited due to:

- A paucity of suitable habitat in proximity to areas of known habitat, other than that north of the SCA
- The absence of suitable ground cover (i.e. near contiguous taller sedge, grass or shrub cover) for animals dispersing south and, to a lesser extent, east and west of occupied habitat
- The presence of housing and roads (including busy David Low Way) to the south and east of the SCA.

8.7.6 Importance of SCA Wallum Sedgefrog population

The SCA Wallum Sedgefrog population is one of several populations within the Peregian MU (one of three discrete MUs on the Sunshine Coast [see Section 8.7.2.1]). Comparative data on Wallum Sedgefrog abundance from other occupied sites within the Peregian MU, however, are limited and, given the extent of suitable occupied habitat within Noosa and Tewantin National Parks (where the species is locally abundant [E. Meyer, *unpub. obs.*]), larger viable populations may occur elsewhere within the Peregian MU. Without data to confirm this, a precautionary approach has been adopted when assessing the importance of the SCA population.

Figure 8.7d: Wallum Sedgefrog breeding records and Wallum Sedgefrog habitat

Figure 8.7e: Relative abundance of Wallum Sedgefrogs within the SCA

As a sizeable source population, the SCA Wallum Sedgefrog population may contribute significantly to the long-term viability of the Peregian MU and, ergo, maintenance of genetic diversity within the species as a whole. As such, the SCA population may be considered an important population as defined in the Significant Impact Guidelines for Matters of National Environmental Significance (DEH, 2006).

8.8 WALLUM ROCKETFROG (*LITORIA FREYCINETI*) AND WALLUM FROGLET (*CRINIA TINNULA*)

8.8.1 Existing species knowledge

Status

Wallum Rocketfrog (*Litoria freycineti*): NCA – Vulnerable; IUCN – Vulnerable

Wallum Froglet (*Crinia tinnula*): NCA – Vulnerable; IUCN – Vulnerable; BOT – High

Distribution and habitat

The Wallum Rocketfrog and Wallum Froglet are terrestrial species that occupy sandy soils and sandstone along the Queensland and New South Wales coast (including sand islands off the Queensland coast), from about Fraser Island, south to Kurnell (Wallum Froglet) and, in the case of the Wallum Rocketfrog, south as far as Jervis Bay (Meyer *et al.*, 2006; Hines *et al.*, 1999). Due to sea level rises during the Pleistocene and, more recently anthropogenic habitat loss and disturbance, the distribution of these frog species is now highly fragmented (Hines *et al.*, 1999; Meyer *et al.*, 2006).

Ecology

The Wallum Rocketfrog and Wallum Froglet are commonly found in areas of wet heath subject to periodic inundation. In addition to wet heath, the Wallum Froglet inhabits acidic paperbark (*Melaleuca*) swamps and sedgeland. In disturbed wallum habitat, the Wallum Rocketfrog and Froglet may also be found in low-lying areas with only sparse grass and sedge cover (Meyer *et al.*, 1999; E. Meyer and M. Sanders *unpub. obs.*). This includes fire breaks and access tracks through wallum heath and areas formerly under Slash Pine (*Pinus eliotti*), where shallow surface waters are utilised for breeding (Meyer 2010; Hines and Meyer 2011; Sanders *et al.*, 2012). The Wallum Froglet may also breed in shallow surface water along cleared tracks as well as borrow pits and drainage ditches (Meyer 2010; Hines and Meyer, 2011).

The Wallum Rocketfrog breeds in spring and summer following rain. Eggs are laid in shallow water in areas with sparse ground cover. Larvae (tadpoles) of the Wallum Rocketfrog are benthonic, feeding mainly on detritus and sediment at the bottom of ponds (Anstis 2002; Meyer *et al.*, 2006). Depending on conditions, tadpoles complete their development within 5-8 weeks (Anstis 2002; E. Meyer *unpub. obs.*)

The Wallum Froglet may breed any time of year, depending on rainfall (Meyer *et al.*, 2006). Eggs are laid singly or in small clumps and attached to grass stems, sedges, twigs and branches in mostly shallow water. Wallum Froglet tadpoles are benthonic feeding on detritus and bottom sediments (Anstis 2002; Meyer *et al.*, 2006). Depending on the time of year, tadpoles of the Wallum Froglet may complete their development from eight weeks to six months (Anstis 2002; E. Meyer *unpub. data*). Like the Wallum Sedgefrog, the Wallum Rocketfrog and Wallum Froglet are acid tolerant, breeding in tannin-stained waters with a pH as low as pH 3.5 and less (Hines and Meyer 2011). Dilute, tannin-stained and acidic waters typical of the wallum are known to inhibit recruitment in less acid-tolerant amphibian species including the Striped Rocketfrog (*Litoria nasuta*), an ecologically-similar congener (Straughan 1966; Freda 1986). Water chemistry may therefore play an important role in limiting competition with related species (Ingram and Corben 1975; Meyer *et al.*, 2006). Faced with strong competition from ecologically-similar 'sibling' species, 'acid' frog species like the Wallum Rocketfrog and Wallum Froglet may be displaced from areas of disturbed wallum habitat (Ingram and Corben 1975). Actions which increase the potential for competition with sibling species are therefore considered a threat to acid frog species (Meyer *et al.*, 2006).

Non-breeding habitat usage in both the Wallum Rocketfrog and Wallum Froglet remains poorly documented, however both species have been recorded some distance (many tens of metres) from breeding habitat in nearby Banksia woodland and/or open eucalypt forest (Meyer *et al.*, 2006). Movement of Wallum Rocketfrogs into habitat surrounding breeding areas appears common, with adult animals regularly encountered in nearby heath (E. Meyer and M. Sanders, *unpub. obs.*; see also **Figure 8.8b**).

Documented threats

A number of threats have been identified as potentially impacting the Wallum Rocketfrog and Wallum Froglet including:

- Habitat removal, fragmentation and degradation of suitable habitat for agriculture, pine plantations, housing and infrastructure such as canal development, drainage projects and transport corridors (Ingram and McDonald 1993; Hines *et al.*, 1999)
- Changes in hydrological regimes, increased nutrients or sediments, water quality (salinity, acidity, nutrient levels and toxicity, dissolved oxygen, temperature and turbidity) due to landscape modification. This could include urban run-off from fertilisers, detergents, oils, etc. (Meyer *et al.*, 2006)
- Use of biocides for weed and mosquito control programs (Meyer *et al.*, 2006)
- Construction of physical barriers which limit movement between water bodies
- Mortality on roads adjacent to populations (Goldingay and Taylor 2006)

- Predation from introduced fish (i.e. *Gambusia holbrooki*) (Hines *et al.*, 1999)
- Weed spread (Meyer *et al.*, 2006)
- Feral pigs, Sus scrofa (Meyer *et al.*, 2006)
- Introduced pathogens (i.e. *Batrachochytrium dendrobatidis*) (Meyer *et al.*, 2006)
- Competition from ecologically-similar frog species such as the Common Rocketfrog (*Litoria nasuta*) and Beeping Froglet (*Crinia parinsignifera*) following disturbance (Meyer *et al.*, 2006)
- Inappropriate fire management (Meyer *et al.*, 2006).

8.8.2 Extent of occurrence

8.8.2.1 Regional and local context

In Queensland, the Wallum Froglet occurs on offshore dune islands and adjacent coastal dunes and sand plains from Litabella National Park (north of Bundaberg) south to the New South Wales border. Here, Wallum Froglets are found across most of the Cooloola Region and Sunshine Coast, south as far as Caboolture. South of Caboolture, it occurs more patchily within the Greater Brisbane Area and Gold Coast (Meyer *et al.*, 2006).

In Queensland, the Wallum Rocketfrog is patchily distributed from Fraser Island south to the New South Wales border with scattered records from the Cooloola region and Sunshine Coast south as far as Beerwah State Forest (Meyer *et al.*, 2006; Meyer 2010; E. Meyer and M. Sanders *unpub. data*).

The Wallum Froglet appears to be widespread and locally abundant in wallum habitat on the Sunshine Coast (Meyer 2010; E. Meyer and M. Sanders *unpub. data*).

Densities of the Wallum Rocketfrog on the Sunshine Coast are generally low, with calling aggregations seldom numbering more than 20 animals (Meyer 2010; E. Meyer *unpub. data*). Densities of calling animals are generally highest in low open (often disturbed) wallum vegetation with shallow surface water (Hines and Meyer 2011; Meyer *unpub. data*). Areas supporting significant numbers of the Wallum Froglet and Wallum Rocketfrog on the Sunshine Coast include:

- Beerwah Scientific Reserve in Beerwah State Forest, south of the Mooloolah River
- Mooloolah River National Park and Palm View Conservation Park, south of the Mooloolah River
- Mt. Coolum National Park and adjacent SCA
- Mt Emu and associated coastal swamps to the north of the study site, north of the study area
- Habitats behind Peregian Springs (Noosa National Park) which extend north to around Lake Weyba and are probably connected to Mt Emu populations
- Areas formerly under pine plantation within the Bell's Creek catchment, north of Bell's Creek Road (EcoSmart Ecology. 2012).

On the Sunshine Coast, two large tidal river systems (the Noosa and Maroochy Rivers) extend well inland forming significant barriers to dispersal of Wallum Froglet and Wallum Rocketfrog. Populations separated by these rivers are likely to have been isolated from one another for some time (i.e. tens of thousands of years or more) and may have diverged genetically from one another. Genetic studies of the Wallum Froglet support this view, with significant sequence divergence (above 3.5 per cent) between populations north and south of the Noosa River (Renwick 2006). Thus, for the purposes of conserving genetic diversity, populations separated by these rivers should be treated as distinct MUs (*sensu* Moritz 1994) or, in the case of Wallum Froglet populations north and south of the Noosa River, Evolutionary Significant Units (*sensu* Moritz, 1994). Hence, in Queensland, the mainland distribution of the Wallum Froglet and Rocketfrog (north of the Caboolture River) comprises at least three MUs: Cooloola, Peregian and Caloundra (Sanders *et al.*2012).

The Cooloola MU lies north of the Noosa River and includes large populations of the Wallum Froglet and Wallum Rocketfrog associated with wet heath and sedgeland, east of the Como Scarp, mostly within National Park (e.g. Great Sandy National Park). Connectivity amongst area of habitat within this unit is high.

The Peregian unit, which extends south from the Noosa River to the Maroochy River, includes populations near Lake Weyba and Peregian, north of Yandina Coolum Road (M. Sanders and E. Meyer *unpub. data*) as well as the SCA. Clearing and urban development south of Coolum Beach, has resulted in fragmentation of habitat, reducing connectivity between areas of occupied habitat north south of Mt Coolum and the Marcoola area. North of Coolum Beach, connectivity amongst habitat areas remains high.

The Caloundra unit extends south from the Maroochy River to Ningi and includes the Beerwah Scientific Reserve. Wetland habitat within this unit has been extensively modified resulting in significant loss and fragmentation of Wallum Froglet and Wallum Rocketfrog habitat. Despite this, the Caloundra MU supports significant numbers of both species within Mooloolah River National Park, Beerwah State Forest and land formerly under pine plantation within the Bell's Creek catchment.

8.8.2.2 Mapped essential habitat

Essential Habitat for the Wallum Froglet and Wallum Rocketfrog within the study area includes remnant vegetation mapped as REs 12.2.7, 12.2.9, 12.2.12, 12.2.15 and 12.3.5a. The extent of Essential Habitat for this species is summarised in **Table 8.8a**.

8.8.2.3 Occurrence within and adjacent the SCA

Within the SCA, large numbers of calling Wallum Froglet were recorded from wet heath within the WHMA and helicopter training area (see **Figure 8.8a**). Calling animals were also recorded from cleared land alongside runway 12/30, with a sizeable chorus of frogs recorded near the

Table 8.8a: Mapped essential habitat for the Wallum Froglet and Wallum Rocketfrog within 5 km from the SCA

		Extent in study area (ha)	
RE	**Brief description**	**Wallum Froglet**	**Wallum Rocketfrog**
12.2.7	Remnant Melaleuca quinquenervia open-forest to woodland	179.77 ha	179.77 ha
12.2.9	Banksia aemula woodland on dunes and sand plains. Usually deeply leached soils	16.64 ha	0 ha
12.2.12	Remnant closed/wet heath	215.40 ha	215.40 ha
12.2.15	Swamps with Baumea spp., Juncus spp. and Lepironia articulata	35.80 ha	35.80 ha
12.3.5a	Melaleuca quinquenervia open forest on coastal alluvium	0.30 ha	0.30 ha

northern end of the runway. Elsewhere numbers of calling animals were low. Outside the SCA, Wallum Froglets were recorded within Mount Coolum National Park (i.e. to the north and west of the SCA). Though reasonably widespread, Wallum Froglets were not as abundant within Mt Coolum National Park as in the WHMA and helicopter training area. However, given the spread of records and extent of suitable habitat, both northern and southern sections of Mt Coolum National Park appear to support significant numbers of Wallum Froglet.

Aside from the SCA and Mount Coolum National Park, calling Wallum Froglets were also recorded from sites in cleared land to the east of Finland Road and east of David Low Way (**Figure 8.8a**). Wallum Froglet habitat east of Finland Road has been extensively modified due to cane farming and appears limited in extent. Areas of shallow, acidic tannin-stained water suitable for breeding are, for the most part, associated with 4WD/bike tracks.

Wallum Rocketfrogs were primarily recorded from wet heath in the centre and north of the WHMA (See **Figure 8.8a**). Smaller numbers were also recorded from wet heath vegetation in the far south of the WHMA, and nearby helicopter training area, (see **Figure 8.8a**). While significant numbers of animals were recorded from dry heath near the centre of the WHMA, numbers of Wallum Rocketfrog in dry heath were generally much lower compared with numbers in wet heath. Mapping of Wallum Rocketfrog habitat (which include areas of dry heath adjoining likely breeding habitat) may therefore overestimate the extent of occupied habitat for this species within the SCA. Elsewhere within the SCA, the Wallum Rocketfrog was also recorded from slashed grassland/sedgeland to the near east of the WHMA (i.e. adjacent RWY 18/36, **Figure 8.8c**). Numbers in this area, however, were extremely low (with only one or two individuals recorded during Ground Parrot Surveys).

Unlike the Wallum Froglet, the Wallum Rocketfrog was recorded outside of the SCA only once during surveys: in dense wet heath within the southern section of Mt Coolum National Park. The extreme scarcity of Wallum Rocketfrog records outside of the SCA may be attributed to a lack of suitable breeding habitat (i.e. areas of low open heath and/or sedgeland with shallow acidic surface water and low densities of the Common Rocketfrog ,where surface waters persisting for five to six weeks over summer).

8.8.3 Breeding (summer of 2011/12)

Incidental observations of tadpoles and juvenile frogs during surveys indicate breeding and, in the case of the Wallum Rocketfrog, successful recruitment within the SCA. While no juvenile Wallum Froglets were recorded during surveys, successful recruitment within the SCA under very wet conditions (like those experienced during surveys) is highly likely. Whether the Wallum Rocketfrog and Wallum Froglet would be as successful in recruiting under drier conditions is unknown.

Within the SCA, Wallum Froglets may breed successfully in areas of wet heath and cleared grass/sedgeland on sandy and peaty soil, where water persists for six to eight weeks over summer and eight or more weeks during winter. This includes low-lying areas within and adjacent the WHMA and helicopter training area, as well as areas of inundated slashed grass/sedgeland to the immediate south of the northern section of Mt Coolum NP (i.e. adjacent RWY 12/30.

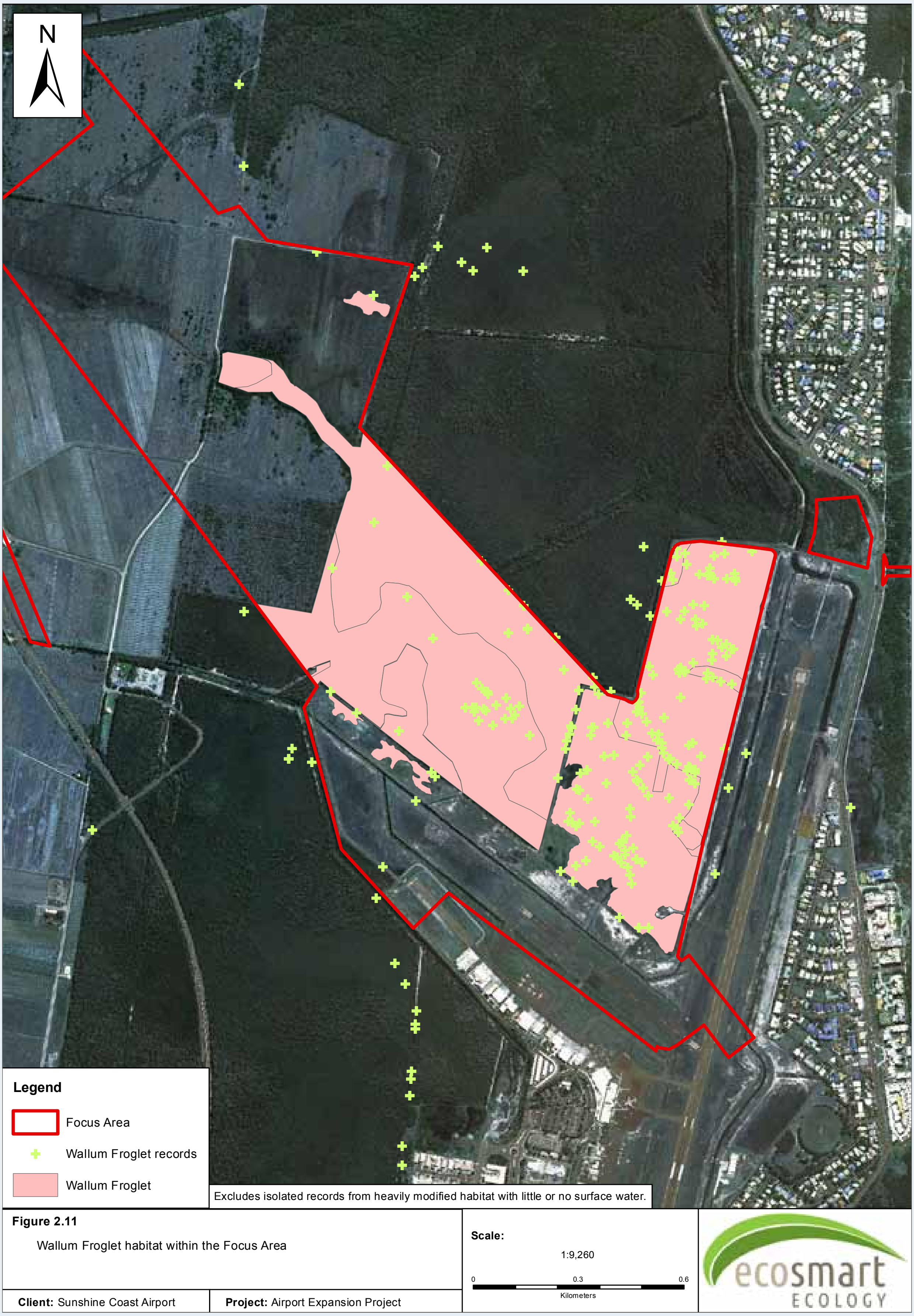
Breeding habitat suitable for the Wallum Rocketfrog includes areas of shallow water with sparse cover within the WHMA and helicopter training area. Wetter areas of slashed grassland/sedgeland fringing these areas could also be utilised for breeding, but only where surface water is present for long enough to allow tadpoles to complete development (i.e. six to eight weeks). Usage of more heavily disturbed areas within the SCA (i.e. slashed grass/sedgeland in proximity to runways) appears limited with few Wallum Rocketfrog records, but numerous records of the Common Rocketfrog, a likely competitor. Areas of likely Wallum Rocketfrog breeding habitat within the SCA are shown in **Figure 8.8b**.

Likely breeding habitat for the Wallum Froglet could not be mapped precisely due to difficulties delineating breeding habitat for these species. All areas of remnant and regrowth melaleuca woodland and wet heath containing records of the Wallum Froglet are therefore considered breeding habitat for these species (see **Figure 8.8b** and **Figure 8.8c**). This precautionary approach is, however, likely to overestimate the actual extent of breeding habitat for this species.

Figure 8.8a: Wallum Rocketfrog and Wallum Froglet records within and surrounding the SCA

Figure 8.8b: Wallum Rocketfrog habitat

Figure 8.8c: Wallum Froglet habitat within the focus area



8.8.4 Relative abundance

During surveys, Wallum Froglets were recorded at high densities (up to 30 per transect) within both the WHMA and the helicopter training area. Given the abundance of Wallum Froglet records and large number of frogs heard calling during surveys, habitat within and adjacent these areas is likely to support a sizeable population of Wallum Froglets, numbering in the thousands. Numbers of Wallum Froglet were also high in low-lying areas of slashed grass/sedgeland along the existing RWY 12/30. Elsewhere, numbers of Wallum Froglet appear to be significantly lower with likely breeding habitat more limited in extent. While quantitative data on the abundance of Wallum Froglets are scarce, anecdotally at least, numbers of this species within the SCA appear similar to those recorded elsewhere on the Sunshine Coast (E. Meyer and M. Sanders *unpub. data*).

Densities of Wallum Rocketfrog were generally low, with 1-5 frogs heard calling along most transects surveyed during summer 2011/2012. Higher densities of Wallum Rocketfrog (up to 30 frogs heard/transect) were recorded at a small number of sites with more open cover within the WHMA (**Figure 8.8d**). Given the number of animals seen and heard during surveys and the extent of potentially suitable breeding habitat, the population of Wallum Rocketfrogs within the existing SCA is likely to number in the low hundreds. As such, the population of Wallum Rocketfrogs on site compares favourably with other areas of known occupied habitat on the Sunshine Coast. With only a single animal recorded during surveys, numbers of Wallum Rocketfrog within southern Mt Coolum National Park appear to be very low, due most likely to a paucity of suitable breeding habitat (see above). The complete absence of records from northern Mt Coolum National Park, suggests numbers of this species are also very low north of the SCA (again, most likely due to a paucity of suitable habitat).

8.8.5 Potential movement/dispersal

The distribution of Wallum Froglet records within the SCA and broader study area (**Figure 8.8a**) suggests significant potential for dispersal through remnant wet heath and Melaleuca woodland. Isolated records from cleared land to the north-west of the study area suggest Wallum Froglets may also disperse through low-lying areas with little native vegetation cover.

As such, movement/dispersal of Wallum Froglets to/from areas of suitable habitat north and south of the area of focus is highly likely. Movement of Wallum Froglets to occupied habitat east of the SCA (across David Low Way) is also possible, though mortality of frogs crossing David Low Way could be significant. Opportunities for movement/dispersal into areas of suitable habitat elsewhere appear limited due to loss and modification of habitat around Mt Coolum and south of the SCA (due to urban and resort development).

Figure 8.8d: Slashed habitats to the near east of the Wallum Heath Management Area

Opportunities for dispersal/movement of Wallum Rocketfrogs to areas of suitable habitat outside of the SCA (but still within the study area) are somewhat more limited due to a paucity of suitable breeding habitat elsewhere. Breeding habitat within Mt Coolum National Park (west and north of the SCA) appears limited in extent, as evidenced by the paucity of Wallum Rocketfrog records during field surveys (see above). Notwithstanding this, animals would be able to move to/from northern Mt Coolum National Park, with relative ease due to the presence of suitable cover (i.e. low, mid-dense or dense cover of sedges, ferns and/or heath). Movement of animals west to southern Mt Coolum National Park is also possible, though less likely under dry conditions due to a paucity of ground cover. Movement of Wallum Rocketfrogs east-west across existing runway 12/30 is therefore likely to occur less frequently. Movement of Wallum Rocketfrogs to an area of potential habitat east of the SCA (i.e. mown grass and sedgeland on the far side of David Low Way) is also possible. As with the Wallum Froglet, opportunities for movement/dispersal into areas of suitable habitat elsewhere (i.e. further north and further south) appear limited due to loss and modification of habitat around Mt Coolum and south of the SCA (due to urban and resort development in these areas).

8.9 GROUND PARROT

8.9.1 Existing species knowledge

Status:

NCA – Vulnerable; BOT–High

Distribution and habitat

Ground Parrots occur in scattered, disjunct locations within 25 km of the coast from the Cooloola/Fraser Island region south to Tasmania. There is also an isolated genetically-distinct population in Western Australia which has recently been recognised as a distinct species (Joseph *et al.*, 2011; Murphy *et al.*, 2011). Within Queensland, Ground Parrots occur south from Maryborough to the Sunshine Coast, including Fraser Island. Historically, Ground Parrots were known as far south as the northern suburbs of Brisbane (Chisholm 1924; McFarland 1991c), however the species' range has contracted north and, in Queensland, Ground Parrots are now only known to occur as far south as the southern section of Mt. Coolum National Park, just north of David Low Way.

Ground Parrots occur in low-closed heathland, sedgeland and button grass communities, but on mainland Australia favour graminoid heaths (Meredith *et al.*, 1984; McFarland 1988; McFarland 1989; Bryant 1994). In Queensland, birds seem to prefer drier areas of graminoid heathlands but may also occur in wet heathlands, particularly in summer (McFarland 1988; 1991a). They usually avoid extremely wet or flooded areas, or heathlands with a shrub or tree canopy (McFarland 1991a). Records of individuals from pastures, grasslands and estuarine flats (McFarland 1989; Forshaw 2002) probably represent dispersing juvenile birds, or birds dislodged by fire or flood.

Ecology

Ground Parrots are highly cryptic in nature and difficult to observe. While they remain active during the day, most are detected when calling at dusk and dawn (McFarland 1991a). Radio-tracking studies in Cooloola National Park have found that adult birds have an average home range of 9.2 ha (McFarland 1991a). Males have smaller home ranges than females and despite having overlapping ranges birds tend to be solitary (McFarland 1991b). Within their territories, birds forage for seeds, herbaceous plants and small fruits (Barker and Vestjens 1980). It is thought that diet selection is based on the seasonal availability, accessibility and size of seeds and fruit (McFarland 1991a).

Ground Parrots breed between August and December, although data suggests they may breed earlier in Queensland, particularly August and September (McFarland 1989). Nests are positioned on dry ground within heath that has not been burnt for at least 3-4 years (McFarland 1991b). Clutch size ranges from three to four eggs. Two months after fledging young birds begin to disperse (Meredith *et al.*, 1984).

Numerous studies throughout Australia have found that habitat suitability, and therefore Ground Parrot density, is influenced by fire. However studies have found conflicting results (Baker and Whelan 1994), suggesting the response of Ground Parrots to fire may follow one of two possible scenarios. The first is that long-unburnt heath will become unsuitable and Ground Parrot numbers will gradually decline to zero (Meredith *et al.*, 1984; McFarland 1989; references in Baker and Whelan 1994). The second suggests birds will remain in heath left unburnt (Baker and Whelan 1994 and references therein, Spearritt and Krieger 2007; Baker *et al.*, 2010). These conflicting results may suggest that vegetation characteristics, rather than age since fire, may be important in determining Ground Parrot density (Meredith *et al.*, 1984; McFarland 1991b, Baker and Whelan 1994) and therefore appropriate management must be population or location specific. All areas of habitat become unsuitable immediately following fire (McFarland 1991a, Meredith *et al.*, 1984), and may remain so for up to four years after fire (Baker and Whelan 1994; Garnett *et al.*, 2010).

Adult birds are considered to be sedentary, although juvenile dispersal is readily assumed in literature (e.g. McFarland 1991a, Higgins 1999). The presence of vagrant birds as much as 200 km from the nearest known population suggests that long-distance movements might be possible (Meredith *et al.*, 1984; Garnett *et al.*, 2010). However the frequency of movements over 100 km is unknown and dispersal of juveniles up to 80 km are considered more probable (Joseph *et al.*, 2011).

Because of their cryptic nature, Ground Parrots are more often heard than seen. Unlike most bird species, Ground Parrots have clearly defined call bouts that are almost solely confined to low-light conditions around dusk and dawn (refer **Table 8.9a**). Call bouts appear to be regulated by ambient light levels, and as such may be influenced by full moon conditions (McFarland 1991b). Dawn call bouts appear to last longer than dusk bouts, though call frequency is higher around dusk.

Table 8.9a: Dusk and dawn call bout characteristics

Time of Day	Start light intensity (lux)	End light intensity (lux)	Duration of call bout (min)	Calls per bird
Dawn	? (<0.5)	4.3 ± 0.3	25.4 ± 0.8	0.37 ± 0.01
Dusk	13.8 ± 0.6	? (<0.5)	18.7 ± 0.4	0.42 ± 0.02

Source: McFarland 1991b. Means ± standard errors provided; light intensities at the start of dawn calling and end of dusk calling were below the lightmeter's capacity (<0.5 lux).

Documented threats

The distribution of Ground Parrots has contracted significantly since European settlement, and it is now extinct in South Australia (Higgins 1999). Historic declines are probably linked to habitat clearance and destruction, particularly for urban development. Ongoing habitat loss is less severe, as most remaining populations now reside within protected estate (Garnett *et al.*, 2010). However, within protected areas, habitat degradation from factors such as altered water hydrology and inappropriate fire regimes may affect habitat characteristics and preclude Ground Parrots (Meredith *et al.*, 1984; McFarland 1989; McFarland 1991c, Forshaw 2002). Historical aerial photography of the Marcoola region, for example, shows extensive thickening of heath and the incremental spread of tall canopy (probably Melaleuca) vegetation.

Birds may also be killed by foxes and cats, and on rare occasions fly into wire fences, windows or motor vehicles (Higgins 1999 and references therein).

High rates of hatching failure have been recorded in SEQ (McFarland 1991b) and this may prevent population recovery. Genetic diversity within, and between Queensland subpopulations are low, suggesting increased susceptibility to inbreeding depression and further loss of genetic diversity (Chan *et al.*, 2008).

8.9.2 Ground Parrots within the SCA

In the Marcoola area, Ground Parrots occur within the SCA and adjacent Mt. Coolum National Park. Ground Parrot values within the SCA are discussed in detail below. The occurrence of Ground Parrots in the surrounding area is discussed in Section 8.9.3.

8.9.2.1 Abundance

It is thought that the WHMA within the SCA contains a population of between 13 and 16 Ground Parrots. An additional two to three birds may frequent the helicopter training area, although there is insufficient data to determine if this area is permanently inhabited.

During the study, flush counts within the WHMA averaged 5.16 birds (standard deviation = 2.4; max = 9; n = 12), which is less than estimates based on triangulation (average= 10.8; standards deviation = 2.5; max = 14; n = 10). Counts based solely on flush data are likely to significantly underestimate population abundance due to the following methodological limitations:

- The area surveyed using flush transects amounts to 63 per cent of the total WHMA (based on a 24 m flush distance; see McFarland 1991c) which is considerably less than that surveyed using triangulation
- Birds do not always flush when disturbed (McFarland 1991c), and as such the number of birds detected by flushing may under-represent abundance along transects.

Estimates based on triangulation are also likely to be slightly inaccurate due to the following:

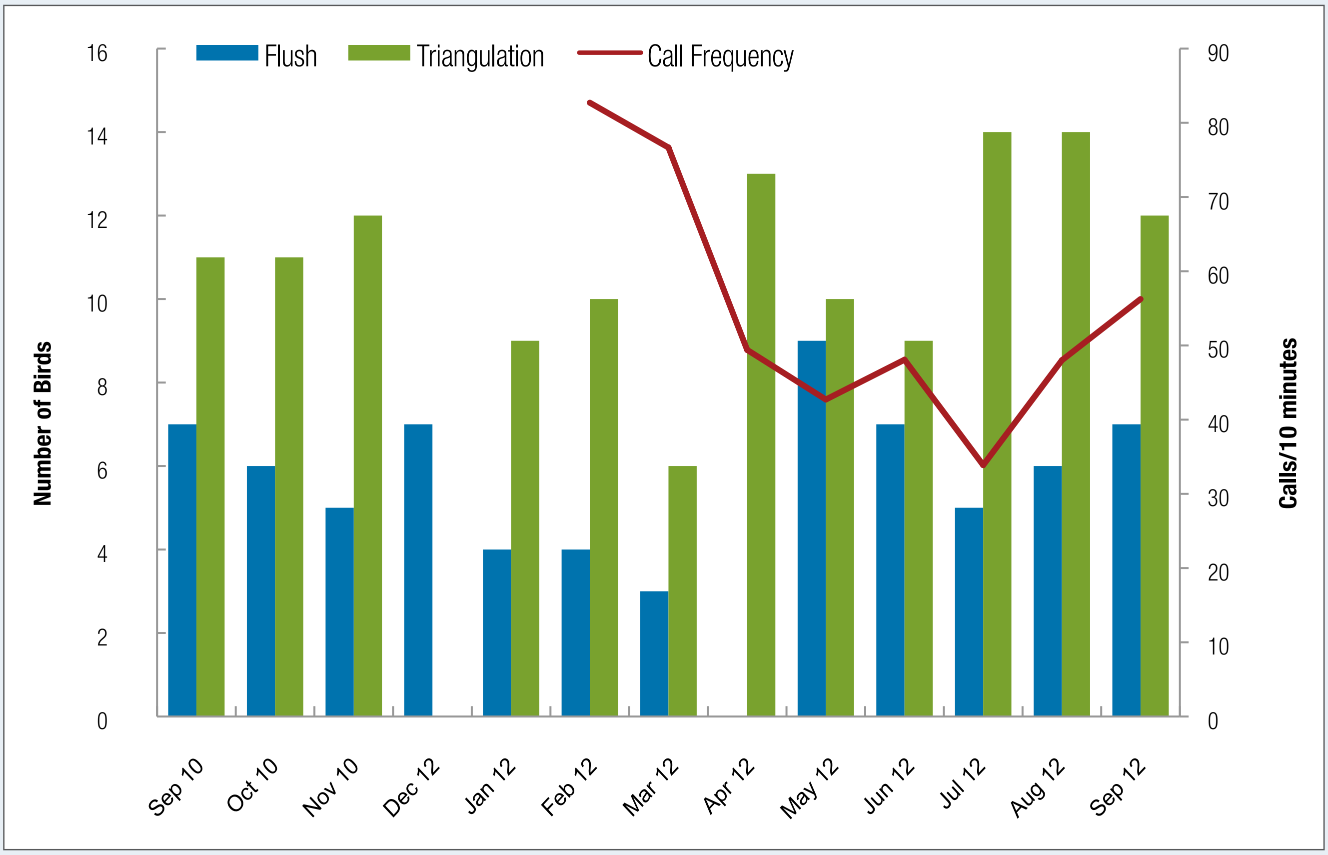
- Birds can move during call bouts, thereby potentially increasing the number of triangulations (our observations however, suggest that movements during call bouts at the SCA was not common and as such, movement of calling birds is unlikely to have significantly influenced counts based on triangulation of calling individuals.)
- Triangulation counts are based solely on accurate fixes (i.e. where three or more lines of direction intersect), such that some calling birds are excluded from counts
- Triangulation counts may underestimate the number of birds calling where a cluster of birds, or moving birds, confused trajectory overlap.

The highest number of triangulation fixes during any single survey was 14 in the months of July and August. Evidence suggested that at least another 2 birds were heard calling during August surveys. Considering this data and the above sampling limitations, the number of Ground Parrots likely to occur within the SCA is estimated at 13-16 birds.

Estimates of population size detected by triangulation and flushing were lower in late summer and early autumn (i.e. January through to March; see **Figure 8.9a**. However, during our sampling period the number of Ground Parrot appears to have rebounded during the following moths (i.e. from April through to May). Call rate declined dramatically between February (~82 calls/10 min) and July (~33/10 min; see **Figure 8.9a**), despite no obvious reduction in call bout duration (average = 15.26 mins, standards deviation = 2.4). While call frequency declined precipitously during this period, the number of flushed birds and triangulation fixes over the same period did not, implying that the birds may have been calling less rather than declining in number.

This result casts doubts over the accuracy of population estimates based on call rate (McFarland 1991c, Spearritt and Krieger 2007), and further work is required to test the validity of call frequency as a method for monitoring population abundance.

Figure 8.9a: Flush and triangulation estimates compared to call rate (calls per 10 minutes) within the WHMA



Outside of the WHMA, small numbers of Ground Parrots (i.e. two or three birds) were also recorded within the helicopter training area. Within this area, birds were recorded during November, March, April and July, suggesting semi-regular usage of habitat. Bird numbers within the helicopter training area ranged from one to three individuals.

8.9.2.2 Area of occupancy

During monthly surveys, 247 Ground Parrot records were collected within the SCA using flush and call triangulation methods (**Figure 8.9b**). The vast majority of records (212 or ~86 per cent) are from within the WHMA, although a surprising number of records were located from the immediately adjacent mown vegetation to the east (26 or ~11 per cent). These areas are within the SCA airside precinct, and surrounded by a high chain-wire fence. Nine records (~3 per cent of records on SCA land) were from the helicopter training area, which is unfenced.

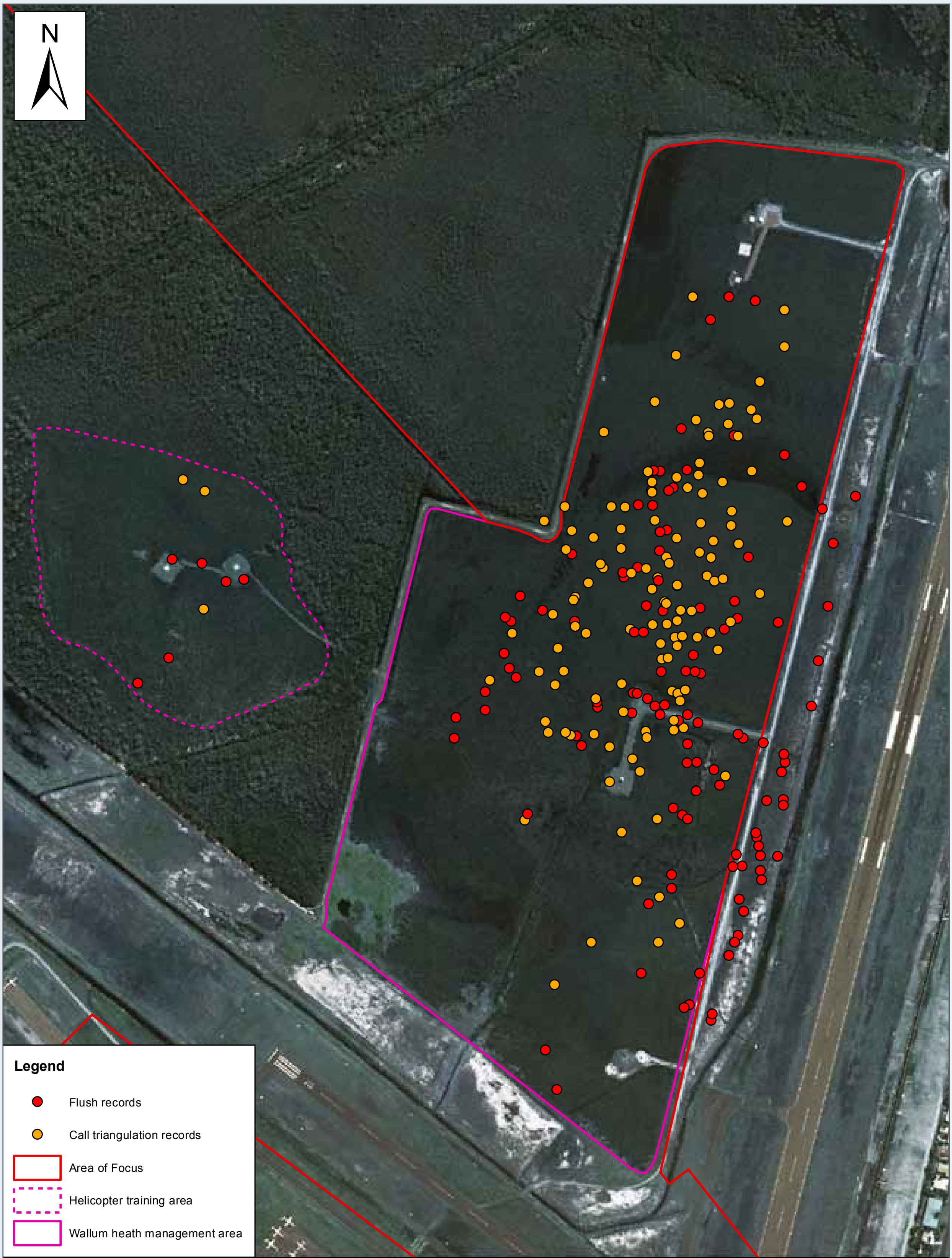
While birds were often recorded within regularly slashed heath-grassland to the immediate east of the WHMA, they were rarely recorded from this area on or after dusk. On the one occasion Ground Parrots were heard calling from this area on dusk, birds called only briefly. Birds heard calling at this time, could not be located during searches of this area after dark, suggesting birds had moved elsewhere after calling.

Without exception, all birds flushed during the day from within the slashed area quickly retreated to nearby denser habitat. McFarland (1991a) also found birds more likely to land in thicker vegetation once flushed. It is therefore believed that birds use the slashed area east of the WHMA for foraging, and retreated to nearby dense habitats for cover/shelter and overnight roosting. Due to the wariness and cryptic behaviour of Ground Parrots, birds were usually only seen after flushing from dense cover. On one occasion, however, an individual was observed feeding on *Cynodon dactylon*, an exotic grass common along access tracks (**Figure 8.9c**). As reported by McFarland (1991a) only the beak was used to handle food, although the feet were used to move stems to within reach.

Major areas of Ground Parrot use (based on fixed kernel density confidence intervals of 50, 75 and 95 per cent) are shown in **Figure 8.9d**. Highest densities are located in the centre of the WHMA, where low open heath is the dominant vegetation type. However, other areas of low open heath in the north and south are not has well occupied. It remains unclear why these areas are less utilised.

During autumn, winter and spring there appears to be little seasonal variation in the areas that Ground Parrots use, with approximately 75 per cent overlap between seasons (**Table 8.9b**). During summer, however, the spread of records contracted significantly (**Figure 8.9e**), with birds concentrated in the central region of the WHMA. Having occurred outside of the breeding season (i.e. August-September) this shift cannot be attributed to nest site fidelity. The summer months of 2011/12 were however extremely wet, with cumulative falls exceeding 170 per cent of average summer rainfall resulting

Figure 8.9b: Flush and call triangulation records of Ground Parrots within the SCA



Flush and call triangulation records of Ground Parrots within the SCA		Scale: 1:3,890 (0, 0.02, 0.04, 0.08, 0.12, 0.16, 0.2 Kilometers)
Client: Sunshine Coast Airport	**Project:** Airport Expansion Project	

Figure 8.9c: Regularly mown grassy roadsides with abundant Cynodon dactylon

in widespread flooding and inundation of low lying areas (including portions of the WHMA). The contraction in area of occupancy may therefore be related, in part at least, to inundation of the WHMA. This, however, ignores the fact that autumn rainfall data was similar to that over Summer 2011/2012 (167 per cent of average autumn rainfall) and as such the area of occupancy would need to be rough similarly for autumn months. The exact reason(s) for the observed contraction in area of use therefore remains unclear.

8.9.2.3 Habitat selection

Different habitat types within the SCA are not used equally by Ground Parrots, with some habitats occupied more frequently than others (Chi Square << 0.005, n = 208). **Figure 8.9f** shows observed and expected Ground Parrot numbers within each habitat type. It is obvious from this figure that during 2011/12 Ground Parrots favoured open drier heath and slashed vegetation adjacent roads, over wetter and/or denser heath and sedgeland and disturbed areas dominated by weeds. Difference between expected and observed use of slashed habitats is likely to be greater than shown, as mapping of slashed habitats (and therefore expected number of birds) includes vehicle tracks with a hard stony surface of little value to Ground Parrots.

In a previous study at Cooloola, McFarland (1989) found Ground Parrots used wet and dry heath seasonally, being more prevalent in wet areas during summer and dry areas during winter. During this study, the Cooloola area experienced above average winter rainfall and below average summer rainfall. As a result, wet areas were dry during summer and dry areas had standing water (2-4 cm) for much of autumn and winter. By contrast our study was undertaken during a period of above average summer and autumn rainfall (see **Figure 8.3f**), and as such, surface water was extremely abundant even in areas which might normally have been dry. Under these conditions Ground Parrots favoured drier heath near the centre of the WHMA.

Table 8.9b: Seasonal overlap in habitat use and total area of 95 per cent CI from kernel density estimation. Total number of seasonal records is also indicated

	Summer	Autumn	Winter	Area (ha)	No. Records
Spring	50.3%	74.7%	75.3%	54.3915	70
Summer	X	57.3%	56.7%	18.9563	50
Autumn	X	X	78.9%	33.1805	60
Winter	X	X	X	39.4835	53

Figure 8.9d: Kernel density estimation showing areas of Ground Parrot activity

Kernel density estimation showing areas of Ground Parrot activity

Client: Sunshine Coast Airport

Project: Airport Expansion Project

Scale:

1:3,890

0 0.02 0.04 0.08 0.12 0.16 0.2

Kilometers

ecosmart ECOLOGY

Figure 8.9e: Seasonal density of Ground Parrot records. Birds appear to use similar areas over consecutive seasons, except summer when records contracted

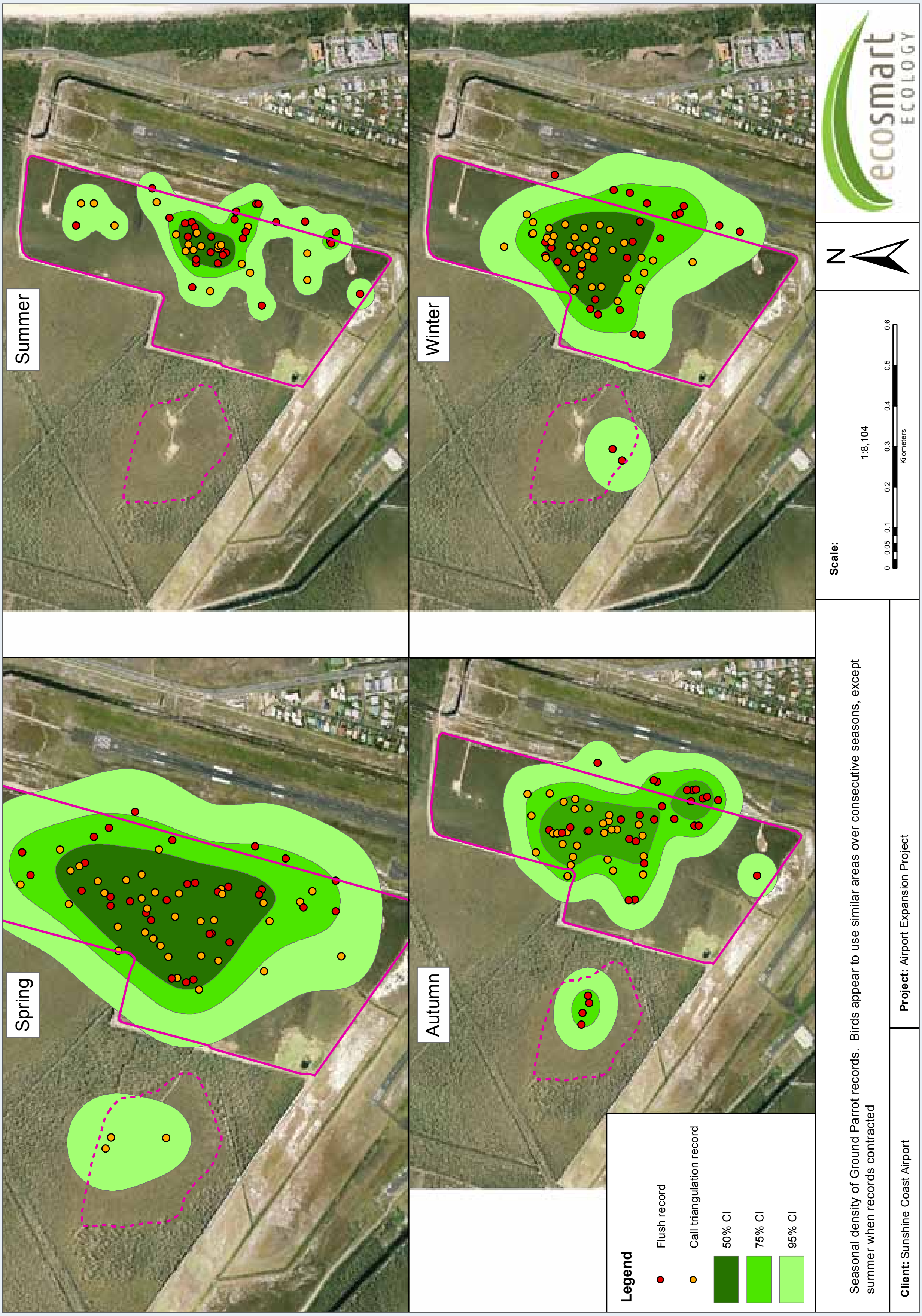


Figure 8.9f: The observed and expected number of Ground Parrot records in different habitats at the SCA. Birds were more common than expected in open dry heath and road/slash habitats, but less common in open wet heath, heath/sedge or disturbance areas dominated by weeds.

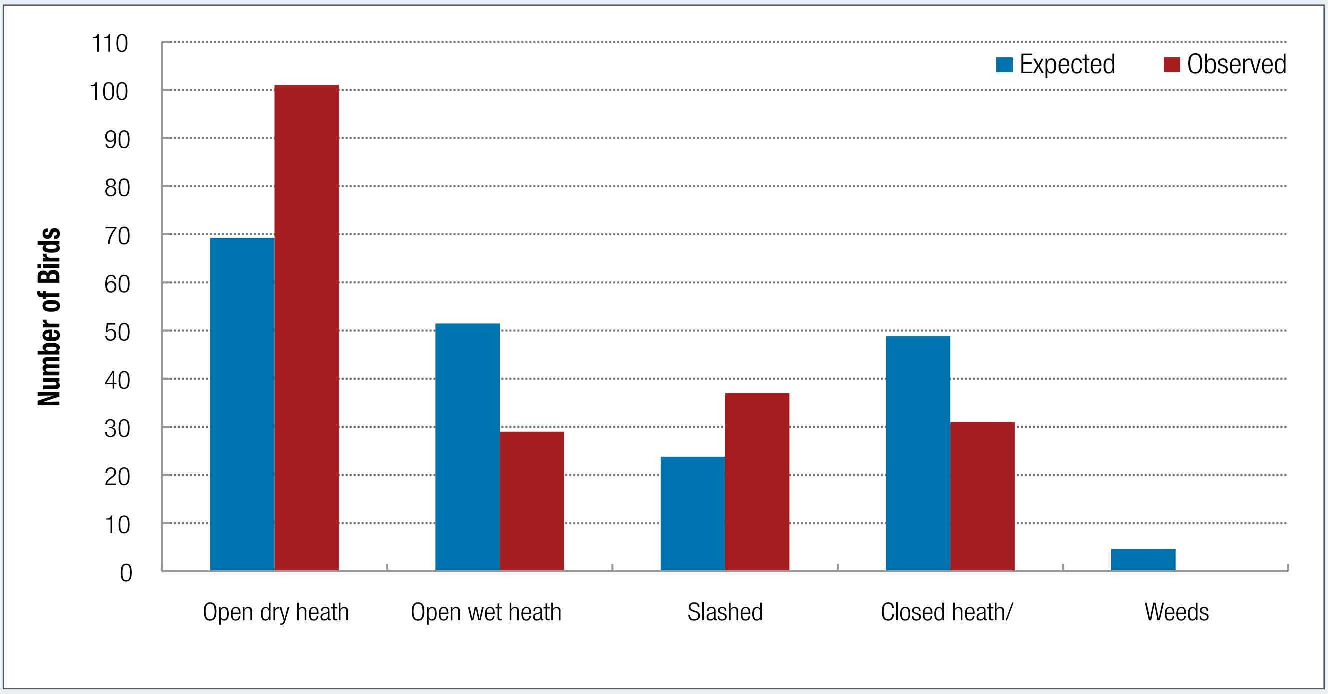


Figure 8.9g: Habitat utilised by Ground Parrots at the SCA: open drier heath (top left) slashed vegetation (top right); and open wet heath (bottom left), heath with Melaleuca regrowth (bottom right). Most records of Ground Parrot were from open dry heath and slashed vegetation.

Under normal conditions (i.e. with average/ normal seasonal totals), Ground Parrots might be expected to favour drier heath in the summer (when rainfall is high) and areas of wetter heath during autumn and winter (when rainfall is lower).

8.9.2.4 Mapped essential habitat

Essential Habitat for Ground Parrot within the study area includes remnant vegetation mapped as REs 12.2.12 and 12.2.15. The extent of Essential Habitat for this species within 5 km of, and including, the SCA is summarised in **Table 8.9c**. Current Essential Habitat mapping for this species includes vegetation presently inhabited by Ground Parrot as well as and areas not currently inhabited by this species. Ground Parrots have also been regularly recorded in areas not included within current Essential Habitat mapping, predominantly areas considered to be non-remnant in the southern portion of the WHMA and along the eastern WHMA perimeter road (refer **Figure 8.9g**).

8.9.3 Regional and local context

8.9.3.1 Extent of occurrence within the Sunshine Coast region

Within the Sunshine Coast region (i.e. Caloundra north to Noosa), Ground Parrots have been recorded south as far as Caloundra, although there are no records of this species south of Mooloolah River National Park from after 1975. For the most part, remaining areas of occupied habitat (and known subpopulations) are separated by short distances, usually less than one kilometre. In some cases, however, areas of occupied habitat may be separated by much greater distances. For example, habitat north of Yandina-Coolum Road and habitat south of Mt Coolum are separated by more than 6 km, while habitat adjacent the SCA is separated from Mooloolah River National Park by 11 km or more. For the purposes of conservation, the Sunshine Coast Ground Parrot population may be divided up into three distinct MU (**Figure 8.9h**):

- **Peregian:** extending approximately 14 km from the Yandina-Coolum Road north to David Low Way (Noosa). This area includes the bulk of Ground Parrot habitat within the Sunshine Coast. Areas of habitats are, for the most part, separated only by native vegetation and narrow roads (Havana Road East, Emu Mountain Road, Eenie Creek Road, and numerous National Park management trails), which are unlikely to hinder movement in any measureable fashion.
- **Marcoola:** between Sunshine Coast Drive and David Low way, including Mount Coolum National Park (north and south) as well as the SCA. Habitats are connected by remnant vegetation, although only a narrow portion of remnant vegetation remains to the west of the SCA.
- **Mooloolah:** habitat within Mooloolah River National Park.

Within Mooloolah River National Park birds were recorded until circa 1980, after which a series of fires is thought to have caused the localised extinction of Ground Parrots (McFarland 1991c). While there are occasional unconfirmed records, no birds have been recorded in Mooloolah River National Park despite repeated surveys. It remains unclear why Ground Parrots have not repopulated Mooloolah National Park, despite apparent recovery of vegetation.

The Queensland range of the species has therefore contracted, and it is now only regularly recorded south to Mt Coolum National Park between the SCA and David Low Way (i.e. form habitat supporting the Marcoola population centre).

The Marcoola population

Ground Parrots have been recorded from most areas of suitable habitat surrounding the SCA. Monitoring by Queensland Parks and Wildlife Service regularly recorded between 1 and 3 birds (maximum count ~8 in 2004) calling from within the National Park near the Finland Road overpass of the Sunshine Coast Motorway (i.e. the southern section of Mt Coolum NP). Remote bio-acoustic recording from within the same habitat (but approximately 800 m south-east) during this study detected a single Ground Parrot, though most recordings failed to locate any birds.

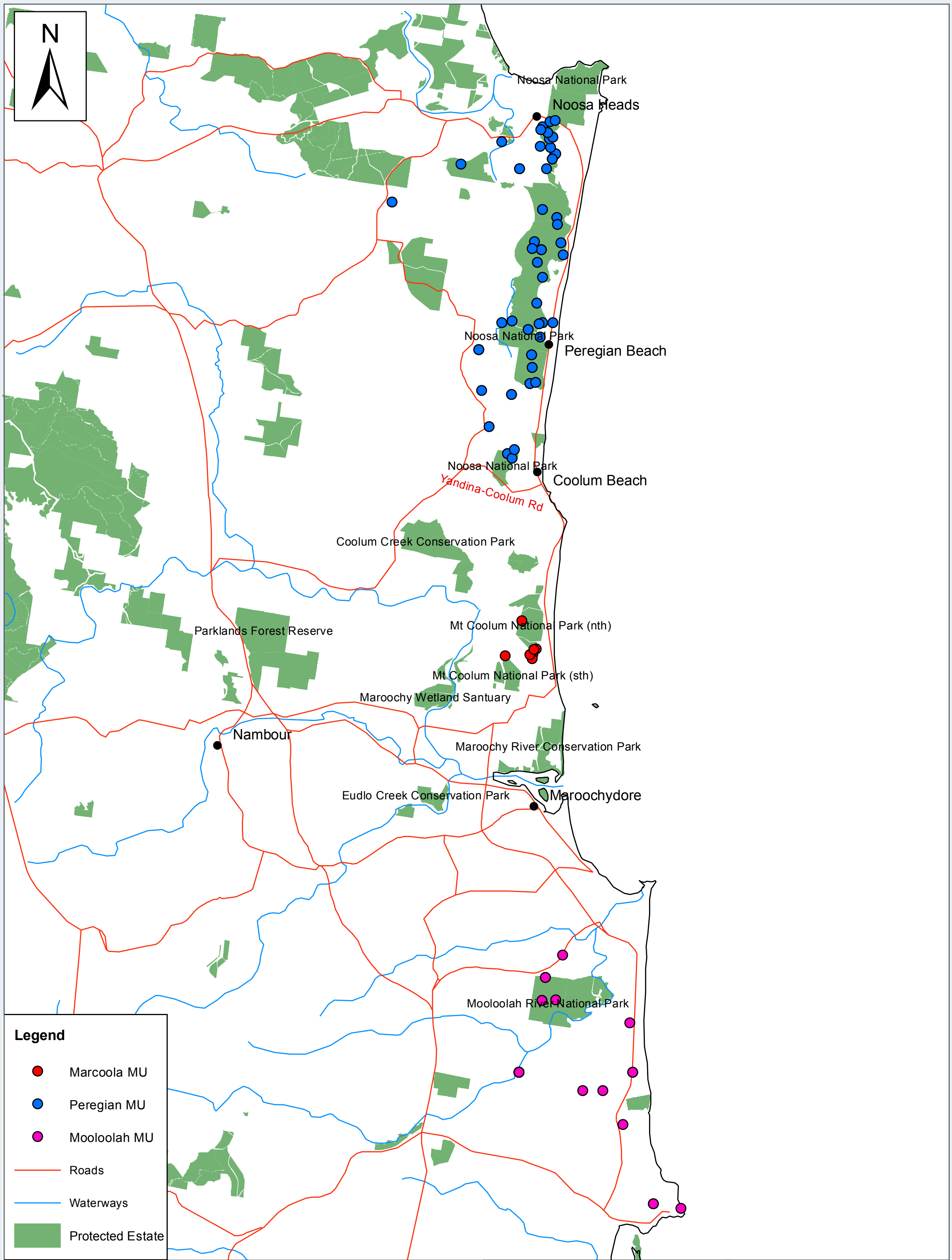
While vegetation to the immediate north of the main SCA airport drain (i.e. west of the runway) is mapped as Essential Habitat for Ground Parrots (see **Figure 8.9i**), surveys suggest the area is currently unsuitable and not inhabited by this species. The vegetation in this area is extremely dense and dominated by tall (> 2 m) woody species (e.g. *Hakea actites* and *Allocasuarina* sp.), quite unlike habitats favoured by Ground Parrots. Bio-acoustic sampling and walk transects through the area have failed to locate any Ground Parrots. However, it is recognised that this area may become suitable following re-instigation of an appropriate fire regime and subsequent reduction in woody vegetation. The area therefore should not be discounted as potential future Ground Parrot habitat.

Ground Parrots have been historically recorded in vegetation to the immediate north-west of the WHMA (i.e. within the northern section of Mt Coolum NP). Several birds, for example, were observed flying from the SCA into the National Park in 2004. However, no birds have been located in this area since 2008 (Douglas 2012), and no birds have been located in the current surveys.

Table 8.9c: Mapped essential habitat for Ground Parrots within the study area

RE	Brief description	Extent in study area
12.2.12	Remnant closed/wet heath	209.68 ha
12.2.15	Swamps with *Baumea* spp., *Juncus* spp. and *Lepironia articulate*	31.08 ha

Figure 8.9h: Ground Parrot Management Units (MU) within the Sunshine Coast region



Ground Parrot Management Units (MU) within the Sunshine Coast region

Scale: 1:138,562

0 0.5 1 2 3 4 5 6 Kilometers

Client: Sunshine Coast Airport

Project: Airport Expansion Project

Figure 8.9i: Mapped essential habitat for the Ground Parrot within and surrounding the area of focus

Last burned in 1994, the heath at this location has thickened (~100 per cent Projected Foliage Cover) and no longer resembles more open heath vegetation preferred by Ground Parrots within the SCA.

Suitable Ground Parrot habitat is also present to the near north of the SCA, just east of Finland Road East. Structurally, vegetation in this area is remarkably similar to the low open heath where bird abundance is high within the SCA. However, despite considerable survey effort, including both opportunistic flush transects and bio-acoustic recording, no parrots have been located in this area. In 2002, QPWS monitoring recorded three birds in this area, but yearly census since this time has located birds on only one occasion since(with two birds recorded in 2007). Superficial inspection suggests graminoids may be less abundant here than in areas where Ground Parrots are abundant (i.e. the WHMA), though this requires quantitative examination.

A small area of low heath with potential value to Ground Parrots is located to the immediate south of the Mt Coolum Golf Course (~1.8 km north of the WHMA). Similar to vegetation to the immediate west of the WHMA, heath in this location is dense and contains emergent woody vegetation. In its current state, habitat at this location is unlikely to be utilised by Ground Parrots. Habitat in this area may, however, be rendered suitable with removal of woody vegetation following fire.

8.9.3.2 Population size and trends

While there is no recent documented population estimates for Ground Parrots on the Sunshine Coast, an estimate is provided by McFarland (1991c) based on surveys and habitat extent in the late 1980's. His estimates were between 100-300 birds, with 300 being an optimistic estimate based on habitat availability (i.ee not actual records). Existing Sunshine Coast Ground Parrot estimates therefore represent a minimum 3.4 per cent, or maximum 10.3 per cent, of Queensland's population (based on McFarland's minimum population estimate of 2,900 birds in Queensland).

A more up-to-date estimate of the Sunshine Coast population may be gained by examining Ground Parrot data collected during annual QPWS monitoring which encompasses most, but not all, areas of potential habitat. During 2012, Ground Parrots were detected at fourteen survey sites within seven discrete habitat patches (including near Finland Road and the existing airport) (QPWS data). Based on maximum count estimates, (**Table 8.9d**) the total number of Ground Parrots detected during 2012 is estimated at 53 birds, which includes 14 from the SCA location (site M3). Due to methodological limitations, this number is most likely to underestimate the numbers present within surveyed habitat. Moreover, since not all areas of suitable habitat on the Sunshine Coast were surveyed, the number of Ground Parrots occurring in this area may be higher. Even so, it is unlikely that the total population of birds on the Sunshine Coast exceeds 100.

As shown in **Table 8.9d**, numbers of Ground Parrot recorded by QPWS on the Sunshine Coast vary widely between and within sites. With the exception of C3 C5 and M3, all areas regularly monitored by QPWS (i.e. with five or more years data) have had no calling Ground Parrots on at least one occasion, and often more. By comparison, estimates of Ground Parrots within the SCA (M3) are consistently high and more stable than other sites (see **Table 8.9d**). Furthermore, the data shows that the relative contribution of the SCA to the regional Ground Parrot population is substantial.

Since 2004, there has been a notable decline in the average number of Ground Parrots recorded at QPWS survey locations across the Sunshine Coast (**Figure 8.9j**). However, pre-2001 estimates are generally consistent with estimates since 2007. The decline may therefore, reflect natural variation within the population and whether Ground Parrot numbers will recover to 2004 levels is presently unclear.

In Section 8.9.2.1, it was discussed that there is between 13 and 16 birds within the WHMA of the SCA. It is possible that another 2-3 birds could occur within both the helicopter training area and nearby National Park, though data suggests that birds are sporadic in areas outside the SCA. The Marcoola subpopulation is therefore conservatively estimated to be between 14 and 18 individuals, with a considerable portion confined to the SCA. Under current conditions, birds within the SCA are critical to the long-term survival of the Marcoola subpopulation.

With between 15 and 19 resident birds, the Marcoola subpopulation is the largest and most stable of all Sunshine Coast subpopulations, conservatively representing >20 per cent of birds within the region. Within the Sunshine Coast, remaining Ground Parrot populations are sufficiently small to be at risk from extinction by stochastic events e.g. fire). The overall survival of the species within the region is therefore likely to be maintained by recolonisation (following extinction) from nearby subpopulations. Larger populations are of great importance as they have the greatest potential for growth (i.e. breeding and dispersal), highest genetic diversity and are most resilience to extinction. With this ecological backdrop, it is understandable why all remaining Sunshine Coast Ground Parrot subpopulations are considered to be important (D. McFarland *pers. comm*) and why, in particular, the Marcoola subpopulation is important to the overall persistence of the species on the Sunshine Coast (assuming mixing with populations to the north of Mt Coolum).

8.9.4 Potential movement/dispersal

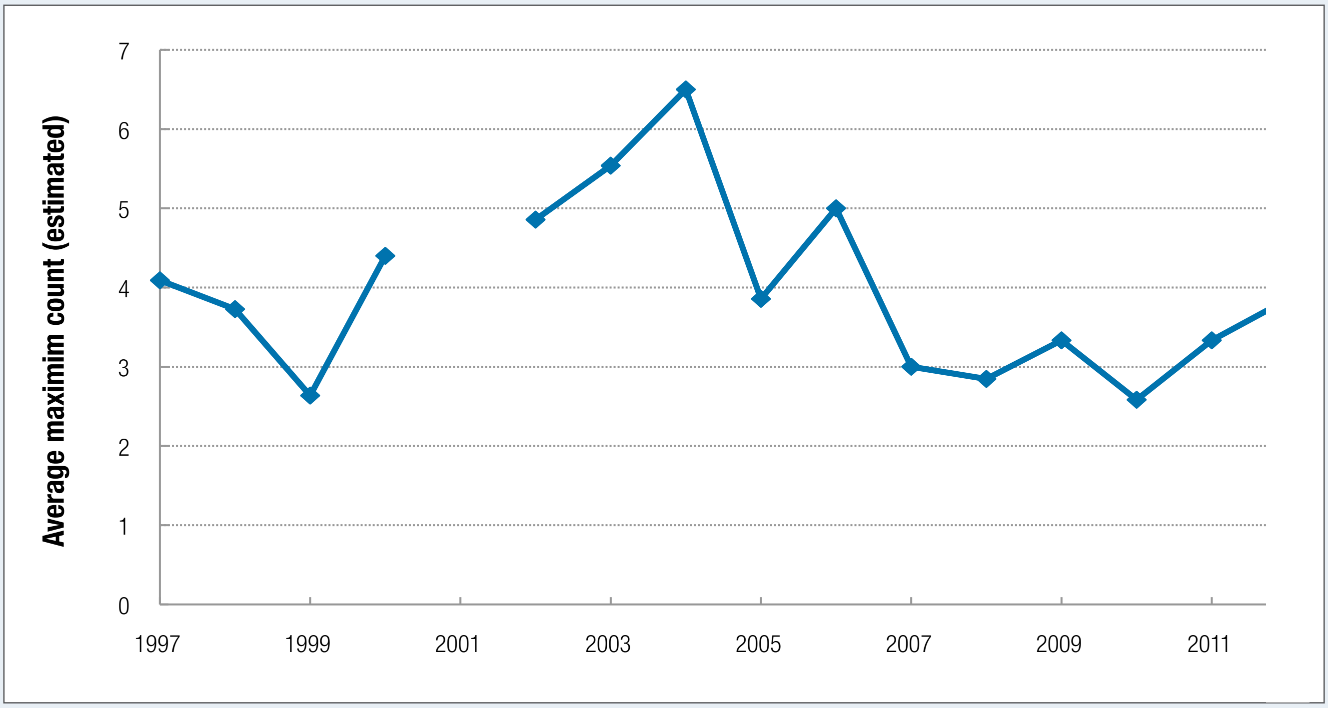
<u>Movements south from the SCA</u>

The nearest area of suitable Ground Parrot habitat south of the SCA lies to the immediate south-west of the existing RWY 12/30, within Mt Coolum NP (southern section). To access this area, birds could move through intact vegetation around the western end of the runway, or fly directly over the runway itself. Most airport activity along this runway is restricted to daylight hours, and light spill in this area is minimal. As such, Ground Parrot movements at dusk, dawn and overnight are unlikely to be affected by existing airport lighting.

Table 8.9d: Ground Parrot estimates for QPWS monitoring sites since 1997 (QPWS data). QPWS data for the SCA (M3) is highlighted in blue

Monitoring site ID	Number of monitoring events	Number of years with monitoring data	Average maximum number (estimated)	Std dev	Highest maximum count	Lowest maximum count	Maximum count estimate for 2012
A1	21	13	3.62	3.31	12	0	1
A2	9	6	2.67	2.16	6	0	-
B1	21	14	1.5	1.51	4	0	3
B2	1	1	6		6	6	-
C1	22	12	4.58	3.06	9	0	2
C2E	29	16	5.5	3.27	11	1	4
C2NW	1	1	3		3	3	3
C2W	15	10	4.2	1.93	7	2	7
C3	24	14	6.07	2.37	11	3	4
C4	18	12	2.08	1.78	5	0	4
C5	19	13	4.08	1.32	6	2	3
C6	21	14	3.9	3.58	10	0	3
D1	15	11	3.18	2.64	10	0	1
E1	6	2	0	0	0	0	-
M2	15	9	2.67	2.29	8	0	4
M3	**13**	**8**	**11**	**2.07**	**14**	**7**	**14**
M4	12	8	0.63	1.19	3	0	0
M5	2	1	2		2	2	-
MR1	5	3	0	0	0	0	-
MR2	5	3	0	0	0	0	-
MR3	1	1	0		0	0	-
PB1999	1	1	6		6	6	-

Figure 8.9j: Standardised QPWS Ground Parrot counts since 1997(estimated number of birds/number of sampling locations). Years with <5 samples excluded (2001)



Further south, habitats within Mooloolah River National Park are separated by over 10 km of urban development, and there is no direct path for Ground Parrot movement using vegetation or even open paddocks. Ground Parrots have been recorded considerable distance (~200 km) from suitable habitat Garnett *et al.*, 2010) and are thought to disperse distances of up to 80 km (Meredith *et al.*, 1984; Joseph *et al.*, 2011). The Mooloolah River National Park should, therefore, be well within the reach of Marcoola birds. Reasons for the ongoing absence of Ground Parrots from this area is unclear, but could possibly relate to factors such as habitat suitability or an unknown barrier to dispersal (e.g. light pollution?). Regardless, if this area was to be recolonised, it is most probable that the source population would be Marcoola.

<u>Movements north from the SCA</u>

The Marcoola subpopulation of Ground Parrots is separated by a distance of approximately 6 km from subpopulations north of the Yandina-Coolum Road. Historical aerial imagery shows habitat was once present along the coast, connecting these subpopulations. This habitat has been lost, and movement between these subpopulations will have been affected. Under current conditions, Ground Parrot movement north from Marcoola would have to negotiate the following:

- Areas of urban development east of South Coolum Road where the impact of artificial lighting on movement is unknown, and as such, birds are more likely to use one of the two alternative routes below
- Open paddocks and disused cane farms bordering the Sunshine Coast Motorway
- Remnant native vegetation north along Coolum Creek to the Yandina-Coolum Road before swinging east to follow remnant vegetation bordering this road.

Immigration rates of Ground Parrots to and from the Marcoola subpopulation to the north remains unclear. However, based on likely movement capability, it is probable that movement/dispersal (particularly by juveniles) would be sufficient to maintain adequate genetic flow, counter demographic instability, and also allow recolonisation following localised extinction.

8.9.5 Existing threats to the SCA population

To restrict animal access to runways, the SCA is surrounded by a 2 m high chain-wire fence, which is regularly maintained. Culling of large animals (including larger birds, kangaroos, and introduced predators) is also undertaken as required. This active management, which is designed to ensure aircraft safety, undoubtedly benefits Ground Parrots by reducing feral predator abundance. The SCA population is probably the only Australian population of Ground Parrots that is not subject to exotic predator threats.

Presently, the WHMA is actively managed to reduce canopy growth so as to maintain aircraft vision. Vegetation control occurs in three separate areas, each with slightly different management regimes. Available information on the three management regimes is described below.

The WHMA: This area was slashed in 2008 leaving most of the vegetation at a height of approximately 500 mm (Douglas 2012). Subsequent control of woody species (predominantly *M. quinquenervia* regrowth) was undertaken in 2013 and included cut-and-stump poisoning. Other than the removal of larger woody elements, this recent activity did not significantly affect vegetation structure.

A narrow strip to the immediate east of the WHMA: This area is slashed frequently, usually six times a year to a height of no lower than 150mm, and

The helicopter training area: This area is slashed to a height of 150mm, at 6-12 month intervals however the past two years have seen the helicopter area go without slashing up until August 2012.

Under appropriate management conditions, slashing is likely to simulate the effect of fire in curtailing shrub/tree growth, to the benefit of Ground Parrots. Without slashing, canopy elements (e.g. *M. quinquenervia*) would proliferate rendering large areas unsuitable in the long-term. Slashing and active management of the WHMA, including a road surrounding the area, also reduces the risk of unplanned fire within the WHMA. Slashing can therefore be highly beneficial for Ground Parrots, and may even be required to maintain current population abundance.

While appropriate slashing has significant long-term benefits, it does present some inherent short-term risks. Slashing during breeding season may reduce recruitment by destroying nests and/or reducing opportunities for nesting (due to a lack of suitable ground cover). Over-frequent slashing, or slashing at an inappropriate height (e.g. too low), may also affect vegetation density, reducing the value of areas as refugia.

8.10 GREY-HEADED FLYING-FOX

8.10.1 Existing species knowledge

<u>Status</u>

NCA– Least Concern; EPBC– Vulnerable; BOT– Critical

<u>Distribution and habitat</u>

Though once abundant between Rockhampton Queensland and Mallacoota Victoria, the range of Grey-headed Flying-foxes has contracted considerably (Tidemann 1998). They are no longer present in the Rockhampton and Hervey Bay areas and have declined in numbers around Brisbane (Duncan *et al.*, 1999).

As with other flying-fox species, the occurrence of Grey-headed Flying-foxes is heavily dependent on the availability of foraging resources and roost sites. As canopy-feeding frugivores and nectarivores, Grey-headed Flying-foxes frequent fruiting and flowering trees in rainforests, open eucalypt forests, woodlands, *Melaleuca* swamps and Banksia woodlands (Eby 1998; Duncan *et al.*, 1999). Individuals will also readily forage in fruit crops and introduced tree species within urban environments.

Roosts are commonly within dense vegetation close to water: primarily rainforest patches, stands of Melaleuca, mangroves or riparian vegetation (Nelson 1965). Colonies frequently roost in native vegetation, but may also use exotic vegetation in urban areas as well (Birt *et al.*, 1998).

Ecology

The ecology of Grey-headed Flying-foxes is heavily influenced by spatio-temporal changes in the abundance of foraging resources. Individuals may move large distances (up to 40 km) during a night in search of food (Nelson 1965; Spencer *et al.*, 1991; Parsons *et al.*, 2006). Colonies of grey-headed Flying-fox may move greater distances (e.g. >1,000 km) in order to exploit seasonally-abundant abundant food sources (Eby 1991; Churchill 1998; Tidemann and Nelson 2004; Roberts *et al.*, 2012). Rivers, roads and other notable landmarks are thought to be used as navigation aids. When not breeding, Grey-headed Flying-foxes may move frequently between camps and, during periods of localised flowering, temporary camps may appear. Breeding animals, however, usually show some fidelity to maternity roosts (Eby 1998; Duncan *et al.*, 1999). Breeding usually occurs at three years of age during spring when food resources are most plentiful (Martin 2000).

Documented threats

Grey-headed flying-foxes are subject to several threatening processes, the most significant being loss and fragmentation of habitat. Habitat loss and fragmentation in the 1800s and early 1900s is believed to have resulted in a 50 per cent decline in the national population by the 1930s (Duncan *et al.*, 1999). The loss of habitat in coastal areas (particularly areas of winter foraging habitat) remains a serious threat to the species. Conflict with commercial fruit growers, for whom flying-foxes represent a pest, has resulted in direct culling of animals and disturbance of nearby camp/roost sites. Other threatening processes include: accumulation of lethal levels of lead in urban areas (Hariono *et al.*, 1993); electrocution on overhead powerlines (which kills disproportionately high numbers of lactating females) (Duncan *et al.*, 1999); and conversion of old-growth forests and woodlands to young, even-aged stands due to too-frequent burning (NPWS 2002). Competition with the ecologically similar Black Flying-fox (Pteropus alecto) may also be affecting populations (Department of Environment [DE] 2013a).

Table 8.10a: Numbers of Grey-headed Flying-fox at roost sites within 50 km of the SCA

Name	Type	Distance to SCA	2003-2011 Estimates			2012 Estimates		
			Min	Max	N	Min	Max	N
Eudlo Creek CP	Abandoned	6.3 km	0	300	19	0	0	1
Kandanga	Permanent	44.3 km	0	148,252	48	1,049	148,252	10
Landsborough	Seasonal	24.6 km	0	8,500	17	0	1,800	3
Mooloolaba	Seasonal	8.7 km	0	250	21	0	4	3
Goat Island CP	Seasonal	23.6 km	0	100,00	14			0
Nambour Bypass	Seasonal	11.4 km	0	22,500	15	0	0	1
Peachester	Seasonal	39.2 km	0	14,400	15			0
Ringtail Creek	Seasonal	32.6 km	0	9,000	15	0	9,000	4
Woodford	Seasonal	49.3 km	0	26,125	26	0	3,000	2
Cassia	Temp – occupied	8.0 km	0	200	2	0	0	1
Coolum	Temp – Occupied	6.2 km	0	1,000	9			0
Kinmond Creek	Temp – Occupied	38.5 km	0	11,880	14	0	500	2
Maroochydore	Temp – Occupied	5.2 km	800	10,200	13	1,400	6,000	4
Palmwoods	Temp – Occupied	16.4 km	50	50	1	50	50	1
Tooway Creek	Temp – Occupied	20.7 km	0	6,104	24	0	75	3
Weyba Creek	Temp – Occupied	21.9 km	0	0	21	0	0	2
Conondale	Temp – unoccupied	39.2 km	0	1,800	4	0	1,800	2
Cooran	Temp – unoccupied	39.7 km	0	15,000	4	0	0	1
Eerwah Vale	Temp – unoccupied	22.6 km	0	1,700	16			0
Nambour	Temp – unoccupied	11.4 km	0	2,880	7	0	0	2
Parklands	Temp – unoccupied	11.2 km	0	13,000	13			0

Source: EHP unpublished data. N = number of counts/estimates

8.10.2 Extent of occurrence and regional context

Field investigations confirmed the presence of Grey-headed Flying-foxes foraging within remnant vegetation adjacent the existing airport. Most individuals seen were foraging with Black Flying-foxes in flowering Melaleuca quinquenervia during a peak in flowering in May 2010. Based on field observations it was estimated that the ratio of Grey-headed Flying-foxes to Black Flying-foxes is approximately 3:1. Approximately 20-30 Grey-headed Flying-foxes were observed along a 1 km linear track bordering the northern portion of the study area.

Flying-foxes form mixed camps, usually in vegetation which provides shade and are in proximity to water (Nelson 1965). Camps may be permanent, seasonal or temporary. Data provided from QPWS shows 21 flying-fox camps within 50 km of the SCA (**Figure 8.10a**). Only one of these camps (Kandanga, approximately 44 km to the north-west of the SCA) is considered permanent. Seven camps are seasonal camps, thirteen appear to be temporary camps of which seven are currently occupied, and one camp appears to have been abandoned (**Table 8.10a**).

The abundance of Grey-headed Flying-foxes within these camps varies. Based on QPWS counts in 2012, Kandanga remains the largest camp, with numbers at this camp swelling to over 148,000 in February 2012. Other significant counts in 2012 included Ringtail Creek (9,000 in March), Woodford (3,000 in January), Maroochydore (6,000 in July), Landsborough (1,800 in January/July) and Conondale (1,800 in January). Numbers at other camps which contained significant numbers in previous years have not been well documented (e.g. Goat Island). While the maximum estimated nightly foraging distance of Grey-headed Flying-foxes is estimated at 50 km, most animals forage within a 15 km radius of daytime roost sites (Eby, 1991; Tidemann, 1998). Animals foraging within the SCA are therefore most likely to originate from one or more of the 8 camps located within a 15 km radius of the SCA. Anecdotal evidence from airport staff suggest that most Flying-foxes traverse in a north-south direction, suggesting that the Maroochydore camp could be the primary source of foraging Grey-headed Flying-foxes.

While suitable roost vegetation is present within the study area (e.g. in tall eucalypts and melaleucas along the creek crossing Finland Road); no flying-fox camps have been located within this area despite regular visits since 2010. Thus, presently Grey-headed Flying-foxes use vegetation within the SCA only for foraging.

Foraging resources around the airport include remnant vegetation dominated by *Eucalyptus tereticornis, E. robusta and M. quinquenervia* (RE's 12.2.7 and 12.3.5). These species may flower prolifically from January to September, with peak flowering in autumn and winter (**Table 8.10b**). Other foraging resources, which may be used sporadically, include large flowering *Banksia integrifolia* and *B. aemula* (RE's 12.2.9 and 12.2.14). Vegetation communities dominated by these flowering species are indicated in **Figure 8.10b**. Other potential food sources such as fruit trees are rare and restricted to five or six large mango trees adjacent Finland Road.

8.10.3 Potential movement

The Grey-headed Flying-fox is a highly mobile species and often observed flying over densely populated urban areas. As such, it is unlikely that the species will use clearly defined movement routes, but rather radiate out from camp locations. This notwithstanding, flying-foxes navigate by sight and probably use major landmarks such as rivers and roads as navigation aids (Roberts *et al.*, 2006).

With numerous camps nearby (20 within 50 km and 36 within 70 km) significant numbers of Grey-headed Flying-foxes are likely to pass over the SCA over the course of a year. Numbers of animals passing over the SCA would be expected to peak when dominant canopy species (i.e. *Melaleuca* and *Eucalyptus* species) within and/or adjacent the SCA are in flower.

Table 8.10b: Flowering phenology of canopy trees from the SCA which attract Grey-headed Flying-fox

Species / Common Name	Summer			Autumn			Winter			Spring		
	D	J	F	M	A	M	J	J	A	S	O	N
Melaleuca quinquenervia Broad-leaved Paperbark		mid-blue	mid-blue	dark-blue	dark-blue							
Eucalyptus robusta Swamp Mahogany				mid-blue		dark-blue	dark-blue	dark-blue		mid-blue		
Eucalyptus tereticornis Forest Red Gum						mid-blue	dark-blue	dark-blue	dark-blue	dark-blue		
Banksia integrifolia Coastal Banksia			mid-blue	dark-blue	dark-blue	dark-blue	dark-blue	dark-blue	mid-blue	mid-blue		
Banksia aemula Wallum Banksia						dark-blue	dark-blue					

Dark-blue = frequent flowering (> 50%); mid-blue = regular flowering (25-49%); light-blue = occasional flowering (5-24%). Sources: Law et al., (2000), McFarland (1985) and Dalgleish (1999) based on flowering phenology at mid-north coast of NSW.

Figure 8.10a: Known flying-fox camps within 50 km of the SCA

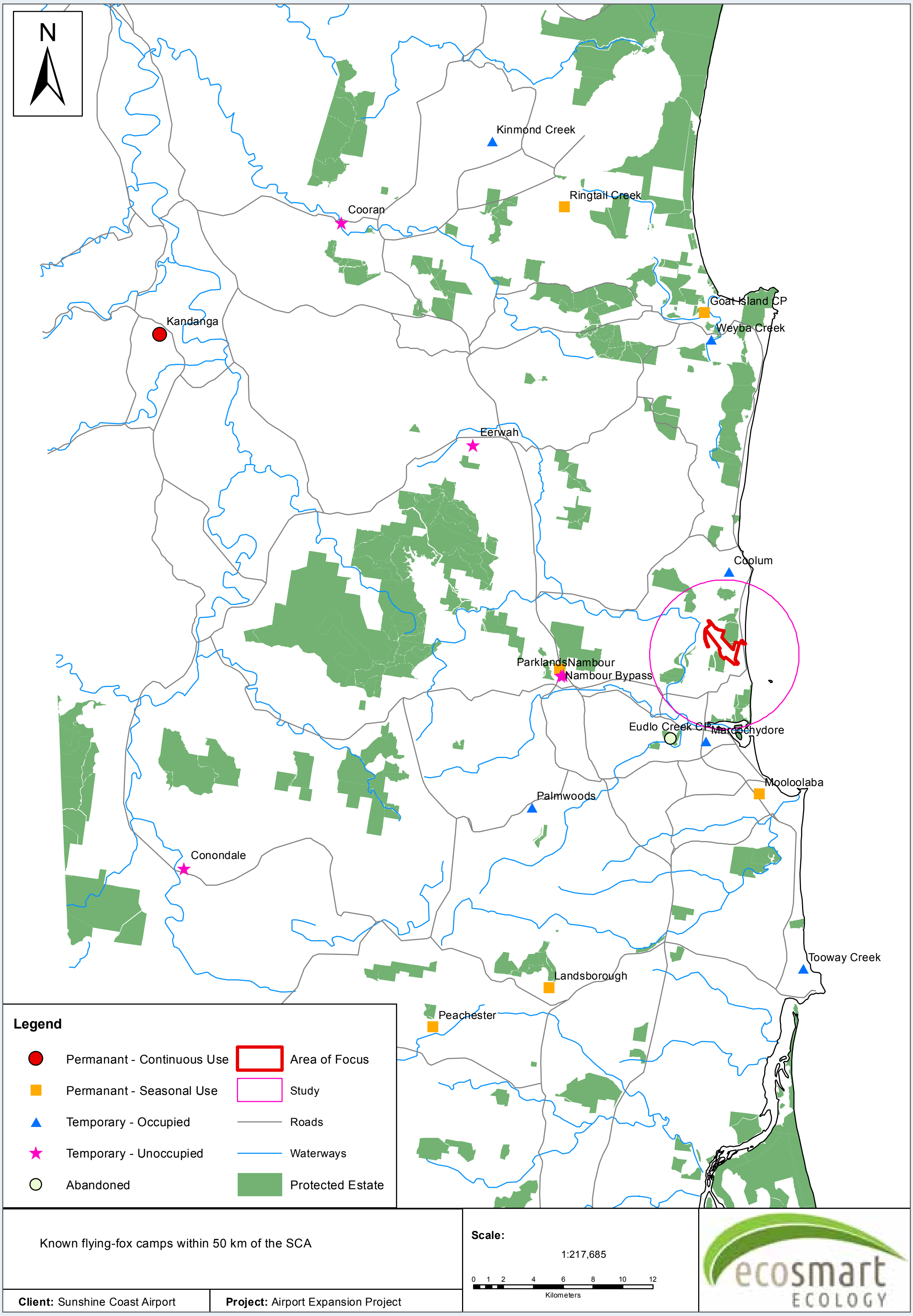
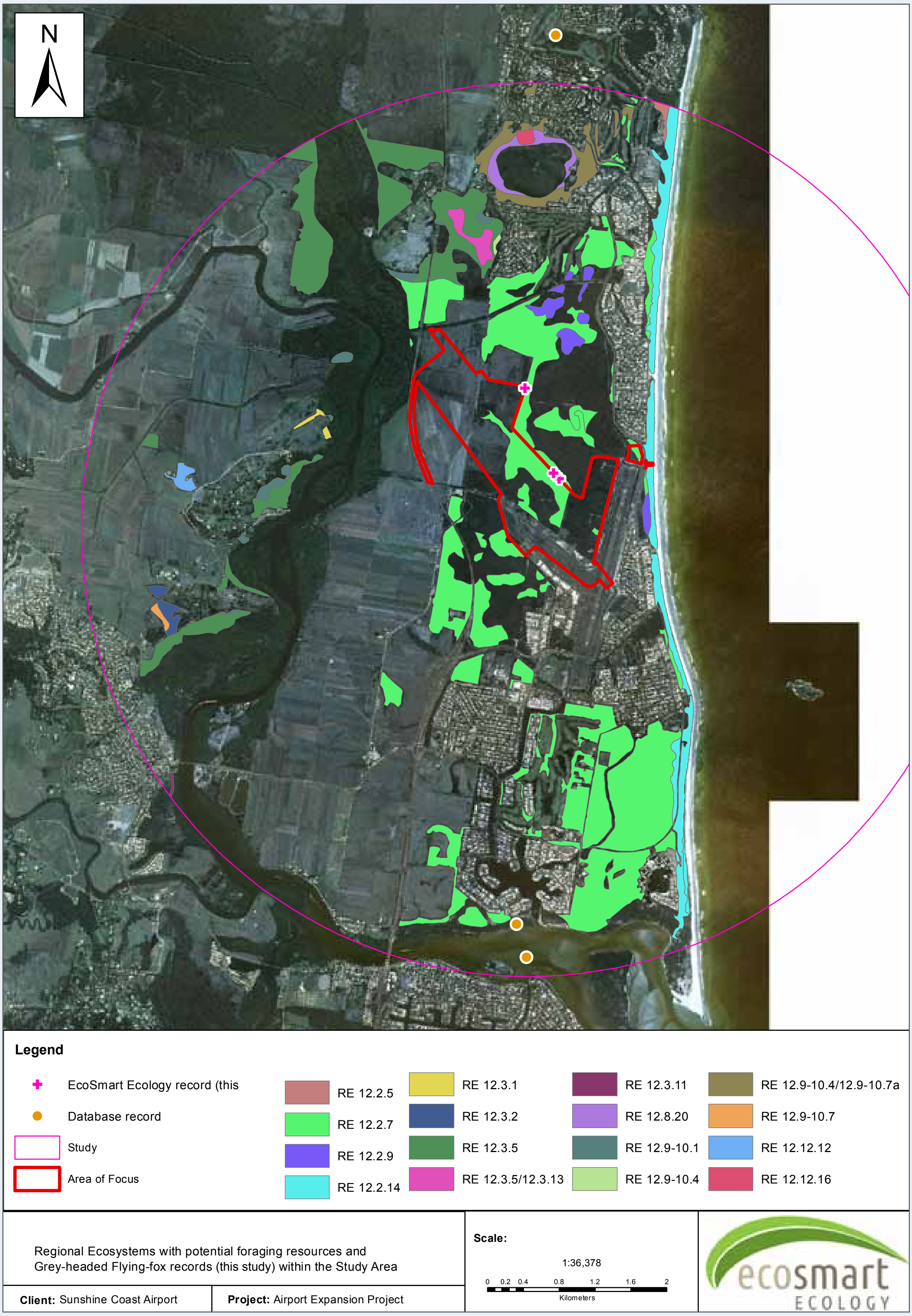


Figure 8.10b: Regional Ecosystems with potential foraging resources and Grey-headed Flying-fox records (this study) within the study area



8.11 WATER MOUSE

8.11.1 Existing species knowledge

Status

NCA–Vulnerable; EPBC– Vulnerable; BOT – High

Distribution and habitat

The Water Mouse occurs along the eastern and northern Australian coastline, including coastal parts of central and southern Queensland. In southern Queensland, it occurs at scattered localities from the Coomera River (50 km south-east of Brisbane) north to Hervey Bay, including the islands of Morton Bay (DE 2013). In SEQ, the Water Mouse inhabits mangroves, saline grassland and sedgeland within or adjacent the intertidal zone. Dominant canopy species in these habitats include Grey Mangrove (*Avicenna marina*), Red Mangrove (*Rhizophora stylosa*), Orange Mangrove (*Bruguiera gymnorhiza*), River Mangrove (*Aegiceras corniculatum*), Yellow Mangrove (*Ceriops tagal*), and Coastal She-oak (*Casuarina glauca*). Common understory species within Water Mouse habitat include sedges (*Juncus kraussii, Baumea juncea, B. rubiginosa, Fimbristylis ferruginea*) and Saltwater Couch Grass (*Sporobolus virginicus*)(Van Dyck and Burbidge 1992, Van Dyck 1996; Van Dyck and Gynther 2003; Russell and Hale 2009).

Ecology

The Water Mouse is a nocturnal/crepuscular, semi-aquatic species that feeds predominantly on marine invertebrates, particularly small crabs (Menkhorst and Knight 2001). Known to move up to 2.9 km per night (Van Dyck and Strahan 2008), animals spend most of their time foraging between the nest and first 100 m of mangroves (Van Dyck 1996). Within this region, between the supralittoral bank and the mangroves, Water Mouse utilise a diversity of microhabitats including tidal pools, channels, crab holes, crevices and tree hollows in standing and fallen timber, leaves and driftwood(Van Dyck 1996). Although a capable swimmer, individuals prefer to use known pathways over exposed mud/sand and avoid swimming.

The Water Mouse nests in the supralittoral or littoral zone, amidst sedges, saltmarsh/marine couch grass, or mangroves (Van Dyck and Durbidge 1992; Van Dyck 1996; Van Dyck and Gynther 2003). Depending on the location, animals may construct free-standing mounds, or build nests in mud-lined tree hollows. Nests may also be excavated in embankments, piles of spoil and soil surrounding the root mass of fallen trees (Van Dyck and Gynther 2003; Van Dyck *et al.*, 2003).

Breeding is thought to occur year round, with gravid females, lactating females and/or juveniles having been found in most months. Clutches of at least four are born within nests and may be moved between different sections of the nest. Multiple individuals may live within each nest, indicating multiple females may give birth within a single nest (Van Dyck and Strahan 2008).

Documented threats

The Water Mouse faces a diverse range of threats. Ongoing residential development, resort and marina development, sand mining and other infrastructure projects threaten existing habitats and are likely to increase fragmentation/isolation of remaining areas of occupied habitat. Developments in proximity to occupied habitat can also affect hydrology and water quality reducing prey abundance (Zimmerman *et al.*, 2000; Ball *et al.*, 2004).

Introduced predators (including feral and domestic dogs, foxes and feral and domestic cats) may also pose a threat to Water Mice, while recreational activities in proximity to Water Mouse habitat (such as four-wheel driving, use of boats, jet skis, and camp fires) may have localised impacts on habitat quality (DERM 2010). Rising sea-levels may also affect supralittoral vegetation and swamp existing nest locations (Department of Environment 2013b).

8.11.2 Extent of occurrence and regional context

The Water Mouse is well known from mangrove and supralittoral communities along the Maroochy River. Surveys by QPWS have, to date, identified 62 nest locations between the Bli Bli Bridge and the drainage line 200 m south of the Mt Coolum drain (**Figure 8.11a**). With the exception of a short (1.2 km) stretch of the river opposite the Maroochy Wetland Sanctuary, nests are located regularly along the eastern river bank, with the closest approximately 1.3 km south of the Marcoola drain.

Recent surveys conducted for the EIS to the immediate north of the area surveyed by QPWS work failed to locate nesting sites. However, a probable feeding midden (**Figure 8.11b**) was located within a large area of Saltwater Couch and Coastal She-oak (see **Figure 8.11a**) to the south of the Marcoola drain. This midden was located in close proximity to areas of mangroves with abundant Water Mouse prey (small crabs). Though areas north of the Marcoola drain have been less intensively surveyed, all current records are restricted to habitats south of the Marcoola drain.

Habitat around the mouth of the Marcoola drain includes tall dense swaths of Mangrove Fern (*Acrostichum speciosum*), and extensive areas of *Casuarina glauca/Melaleuca* open forest. These habitats where either too dry or not suitable for abundant prey. While a narrow fringe of mangrove is present along the drain, the drain is generally steeply incised with little low tide forage habitat.

Habitat to the near north of the Marcoola drain (i.e. between the drain and the confluence of Coolum Creek) appears suitable with extensive mosaic areas of mangrove, mudflat and Saltwater Couch (*Sporobolus virginicus*).

The population is considered important under the EPBC Act (DEWHA 2009a) as it:

- Shows evidence of recent activity
- Occurs in habitat critical to the survival of the species
- Occurs in a protected area

Figure 8.11a: Water Mouse records along the Maroochy River

Figure 8.11b: Water Mouse prey midden within Casuarina glauca woodland near the mouth of the Marcoola drain

- Occurs at or near the limits of the range of one of the regional populations
- Preserves high genetic diversity for the species.

Mangrove habitat is also located along the lower stretches of the Maroochy River south of the Bli Bli Bridge to near Oyster Bank Road, a distance of approximately 1.2 km (**Figure 8.11a**). It is unclear if Water Mouse inhabits this area. Clearing associated with Oyster Bank Road has removed mangrove habitats to within approximately 500m of the Sunshine Coast Motorway Bridge. Mangroves and supralittoral vegetation stretches along the northern bank from the Motorway to near the Maroochy River mouth including the Maroochy River Conservation Park. The Water Mouse is known to inhabit mangroves within the Maroochy River Conservation Park.

In the broader region, the nearest known Water Mouse records occur approximately 18 km south-east of the Maroochy River at Eudlo Creek National Park and 28 km south along Bells Creek. These three populations (Maroochy River, Eudlo Creek and Bells Creek) are separated by long stretches of unsuitable habitat that will pose a significant movement barrier for Water Mice. As such gene flow between these populations appears unlikely.

8.11.3 Potential movement and dispersal along the Maroochy River

Suitable Water Mouse habitat stretches along the northern/eastern bank of the Maroochy River from the Bli Bli Bridge to Coolum Creek (north of Marcoola drain). The suitability of habitat further north along Coolum Creek is unclear.

A number of small artificial drainage lines, and some residential housing (off Cook Road) occur along the east bank of the Maroochy River north of the Bli Bli Bridge. However, it is unlikely that these will pose a barrier for movement and, as such, movement/dispersal along the east bank is likely to be uninterrupted. Little suitable habitat occurs along the Maroochy River west of the Coolum Creek junction.

The potential for movement of Water Mice to the south, over David Low Way and Muller Park, is less clear. In this area, mangrove vegetation is replaced by rock-walled banks, open manicured lawns and walking paths which provide little opportunity for shelter/retreat. While this artificial habitat is limited in extent (stretching approximately 200m south of the Bli Bli Bridge), it could pose a significant barrier to Water Mice.

Similarly, the river bank has been modified further south, along Oysterbay Road. While scattered mangroves and *Casuarina glauca* are present, most vegetation has been replaced by rock-wall, manicured lawns and a dual lane bitumen road. Areas of habitat more natural habitat suitable for movement of Water Mouse are separated by a distance of over 700 m. Movement of Water Mice through this area therefore seems unlikely.

Given the long-stretches of open surf beach to the north and south of the Maroochy River mouth, and the lack of coastal swamp behind the dunes in either direction, the Maroochy River population is likely to be isolated.

8.12 OTHER POSSIBLE SIGNIFICANT VERTEBRATE SPECIES

Five additional EVNT species have been recorded within the study area; Back-necked Stork, Grey Goshawk, Lewis Rail, Eastern Curlew and Koala. Recorded locations are indicated in **Figure 8.12a**. Koala records are not included in **Figure 8.12a**, but are illustrated later in Section 8.12.5.

8.12.1 Black-necked Stork

Status

NCA – Near Threatened; BOT: Low

Distribution, habitat and biology

Though partially nomadic, Black-necked Storks may remain in an area for many years (Marchant and Higgins 1990). Though they occur predominantly in palustrine wetlands, Black-necked Storks are also known frequent estuaries, littoral habitats and flooded grasslands. They occur in both fresh and saline wetlands but prefer open fresh waters such as shallow swamps, billabongs and pools on floodplains (Marchant and Higgins 1990; Johnstone and Storr 1998). Black-necked Storks can often be observed around the edges of artificial waterbodies, including smaller farm dams. Shallow water (i.e. < 500mm) favoured by foraging Black-necked Storks (Dorfman *et al.*, 2001), is uncommon at deep, large artificial waterbodies used for water storage (e.g. Ewan Maddock Dam). As such, the Black-necked stork is more commonly recorded in shallower, ephemeral wetlands.

Foraging activity is mostly restricted to shallow waters less than 0.5 m in depth. Recent studies have suggested that not all wetlands within an individual's home range are of equal value, with drying wetlands supporting higher densities of prey (i.e. amphibians, fish and aquatic arthropods) of higher value to Black-necked Storks (Dorfman *et al.*, 2001). The loss of ephemeral wetlands with high densities of prey may therefore disproportionately impact resident populations (Dorfman *et al.*, 2001).

Thirteen Black-necked Stork records have been identified from existing data sources, the majority predating 1995. However since 2002, Black-necked Storks have been recorded on at least five occasions within close proximity (< 5 km) of the SCA. Three of these records are located within the study area: one near Finland Road (2004) and the others inside the SCA fenceline (April 2009 and February 2010). While these records confirm the presence of Black-necked Stork within the study area, suitable habitat within proximity to the SCA is limited to:

- A small wetland located near Finland Road, south of the Sunshine Coast Motorway overpass
- Larger drains within the area, including the drain south of the Mt Coolum Golf Course, drains within the Mt. Coolum National Park, the drain along the southern boundary of the current airport and drains within the SCA fenced area
- The Maroochy River, its tributaries and associated wetlands (e.g. Maroochy Wetland Sanctuary)
- The Mooloolah River
- Seasonally inundated grassland in fields to the west of Finland Road and west of the Sunshine Coast Motorway.

Black-necked Stork territories in northern NSW with resident breeding pairs typically include extensive wetlands, and birds rarely travel more than 10 km from their nest (Clancy and Andren 2010). Within and adjacent the study area, urbanisation and human disturbance is considerable, and remaining foraging habitat is fragmented, scarce and never far from infrastructure. Although some foraging opportunities are retained along the Maroochy and Mooloolah River, development now flanks much of the lower Mooloolah River catchment and the Mooloolah River is likely to be regularly traversed by boats. Black-necked Storks are shy and quick to take flight, and as such, foraging within the Maroochy River may be regularly disrupted. Furthermore, no birds were recorded in, or adjacent to, the SCA during these studies. These factors suggest that suitable conditions for permanent occupation within the local area are unlikely, and recent records probably represent transient individuals.

8.12.2 Grey Goshawk

Status

NCA – Near Threatened; BOT: Low

Distribution, habitat and biology

The Grey Goshawk is regularly recorded within the region with ~230 records within 50 km of the SCA. Thirteen records, mostly between 1998 and 2005, are from within five kilometres of the airport and Grey Goshawks were recorded on five occasions during current surveys from within, or in close proximity to, the development area. On one occasion, a pair of birds was observed perched together near Finland Road. The accumulation of these records and the observation of two birds together, suggest that the SCA is within the home range of a resident pair of Grey Goshawks.

Grey Goshawks are largely resident (Olsen 1995). Within resource rich habitats home range size varies between sexes, with females using larger territories (587 ha) than males (105 ha). The home range of male and female Grey Goshawks contracts considerably during breeding season (11 ha and 80 ha respectively) (Burton and Olsen 2000). No studies have been conducted on Grey Goshawks in areas with fewer resources, but typically raptor home range expands with lower prey density (Olsen 1995). The home range extent of the resident pair within the local area is unknown.

Grey Goshawks breed during different months, depending on their latitudinal location. In north Queensland, breeding may commence as early as August, while further south (e.g. Victoria) pairs typically do not start breeding until September (Marchant and Higgins 1993; Debus 1998). All observations during the current surveys occurred in the cooler months of the year, during which time Grey Goshawks have an expanded home range (Burton and Olsen 2000). The lack of (recent) spring records near the SCA may suggest that the area does not form part of a breeding territory.

Figure 8.12a: Black-necked Stork, Grey Goshawk, Lewin's Rail and Eastern Curlew records within the study area. EcoSmart Ecology records (this study) and other database records shown separately.

Grey Goshawks are most common in tall forested habitat which provides a dense shaded canopy and abundant perches from which to launch foraging attacks. Open habitats are much less heavily frequented, especially during the breeding season (Burton and Olsen 2000). Generally, habitats within the study area are open, with large areas either modified for cropping or remnant vegetation of low dense heath. Forested areas of high value for Grey Goshawk is restricted to patches of Swamp Mahogany (*Eucalyptus robusta*) and/or Forest Blue Gum (*E. tereticornis*). Melaleuca forest may also have some value for the species, but with fewer perching opportunities is probably less favourable.

8.12.3 Lewin's Rail

Status

NCA – Near Threatened; BOT: Low

Distribution, habitat and biology

Lewin's Rails are extremely shy and cryptic, making them very difficult to detect and therefore a species that is rarely recorded. There are only three recent records of Lewin's Rail within 10 km of the SCA: one in the Maroochy Wetland Sanctuary; one in Arcoona Conservation Reserve; and a third from modified grasslands within the area of focus near Finland Road.

Lewin's Rail is known to inhabit permanent fresh, brackish or saline swamps, wetlands, wet heath, coastal lagoons and paddocks, although ephemeral waterbodies may also be frequented (Pizzey and Knight 2007; Marchant and Higgins 1993). The Lewin's Rail recorded in 2010 was heard from an area of wet exotic grassland adjacent thick riparian vegetation. This type of habitat is not unusual for the species (Leicester 1960; M. Sanders *pers obs*). As such, habitat for the species within the study area is quite extensive, with thick wet grasslands common between Finland Road and the Sunshine Coast Motorway. Areas of wet heath and *Melaleuca* woodland within the SCA may also provide habitat for this species.

Alternative habitats are also common outside the study area and include extensive flooded paddocks north off Coolum Creek and at the corner of Ernest Road and Finland Road. Remnant swampland (e.g. REs12.3.5 and 12.3.8) adjacent to Coolum Creek and within the Mt. Coolum National Park may also provide habitat for this species. Similarly suitable habitat is likely to be abundant within the broader region as well.

Little is known of this species' movements, although in favourable habitats birds seem to be resident and can breed in high densities (e.g. four-five nests in four acres; Leicester 1960). There is also evidence to suggest that the species may be seasonal or nomadic in some areas, moving into areas when conditions are favourable (Marchant and Higgins 1993). It is not known if the bird recorded in 2010 is resident locally, or a transient individual. However it is worth noting that no evidence of the species has been recorded since this initial record, despite repeated visitation of the original location and similar habitats nearby.

8.12.4 Eastern Curlew

Status

NCA - Near Threatened; EPBC – Migratory; BOT – Low

Distribution, habitat and biology

The Eastern Curlew is a large migratory wader which inhabits intertidal mudflats, particularly those with exposed seagrass, where it forages for marine invertebrates, particularly crabs and small molluscs (Higgins and Davies 1996). Breeding does not occur in Australia; rather birds make an annual migration north to marshes and damp bogs in eastern and far south-eastern Siberia, northern Mongolia and northern Manchuria (Geering *et al.*, 2007). Birds return from their breeding grounds in mid-September before spreading south along Australia's coastline (Minton *et al.*, 2011). While strictly coastal, the Eastern Curlew may venture some distance upstream along tidal creeks and rivers habitats (M. Sanders *pers. obs*).

While there is suitable habitat for this species in the far north-west of the study area, the extent of habitat in this area is limited and therefore unlikely to support large numbers of birds. More extensive areas of suitable habitat (mudflat and mangroves) are located along the Maroochy River and Eastern Curlews have been recorded as far upstream as Stoney Wharf Road. Two birds have been previously recorded at this location, one in 1993 and one in 2003, although it is probable that Eastern Curlews regularly move up the river to areas of suitable habitat within the Maroochy Wetland Reserve.

During high-tide, when foraging areas are inundated by water, Eastern Curlews gather with other migratory waders at specific high-tide roosts. No high-tide roosts are located immediately adjacent the study area, with the nearest located ~8.5 km downstream of Stoney Wharf Road on the western side of Goat Island.

8.12.5 Koala

Status

EPBC – Vulnerable; NCA –Least Concern; BOT: Low

Distribution, habitat and biology

Endemic to eastern Australia, the Koala is a solitary species that is widespread across low altitude, coastal and inland areas from Cooktown, Queensland to the Mt. Lofty Ranges, South Australia (Munks *et al.*, 1996; Menkhorst and Knight 2001). Koalas occur in eucalypt woodland and *sclerophyll* forests, on foothills, plains and in coastal areas (Martin and Handasyde 1999; Menkhorst and Knight 2001; Dyck and Stratham 2008).

Koala records in proximity to the SCA are sparse; only eight records occur within 5 km of the study area, all of which predate 2004. The two closest records, from 2003 and 1995 respectively, are less than 1 km from the SCA (see **Figure 8.12b**).

Figure 8.12b: Koala records in the study area, and vegetation communities dominated by feed trees (Eucalyptus regrowth) in the area of focus. Scattered E. robusta can be found throughout the area of focus, but never in high densities.

Koala records in the Study Area, and vegetation communities dominated by feed trees (Eucalyptus regrowth) in the Area of Focus. Scattered E. robusta can be found throughout the Area of Focus, but never in high densities.

Scale: 1:32,435

0 0.2 0.4 0.8 1.2 1.6 2 Kilometers

Client: Sunshine Coast Airport

Project: Airport Expansion Project

ecosmart ECOLOGY

It is well known that Koalas feed on eucalypts, however not all eucalypts are of equal value as fodder. Rather, Koalas inhabit forests with a high proportion of preferred tree species (Phillips *et al.*, 2000; Rhodes *et al.*, 2005; Matthews *et al.*, 2007), often on fertile soils. In coastal southern Queensland preferred *Eucalyptus* species include *Eucalyptus camaldulensis, Eucalyptus propinqua, Eucalyptus tereticornis* and *E. robusta* (McAlpine *et al.*, 2008). While two preferred tree species (*Eucalyptus tereticornis* and *E. robusta*) occur within the study area, neither of these is abundant. The highest density of preferred Koala trees occurs in a small area located on the creek near Finland Road (**Figure 8.12b**), however scattered *E. robusta* are located adjacent artificial drains crossing the northern section of Mt Coolum NP. The paucity of these trees, and irregularity of Koala observations, suggest that the area is unlikely to support a resident Koala population. Rather, observations are likely to reflect dispersing or roaming individuals. Despite searches, no Koala evidence (scratches or scats) was located during our surveys within the study area.

Koala records are common 10-15 km west of the study area in Parklands Forest Reserve, Ferntree National Park and Panorama Drive Koala Park. Records in Bli Bli support the premise that Koala are probably able to move from these areas east toward the Maroochy River corridor. However, Koala movement over the River seems unlikely. Higher value habitats are located to the north near Mt Coolum (mapped as 'low value bushland' habitat under the *South East Queensland Koala State Planning Regulatory Provisions 2010* [SPRP 2010]), and as such, these areas are likely to be the source of Koala records near the SCA.

No vegetation within, or immediately adjacent, the area of focus is mapped as 'Koala habitat' or as 'assessable Koala development area' under the SPRP 2010, and no koalas have been seen during this or previous surveys. The closest area of mapped Koala value is located to the north in association with vegetation around the Coolum Golf Course.

8.13 MIGRATORY SPECIES

A total of 46 migratory bird species, as listed under the EPBC Act, have been recorded from the study area and local surrounds. These birds can be broadly categorised as follows:

- Marine birds, which includes species that 'spend the majority of their life at sea' and includes albatross, petrels and shearwaters (not addressed here, see Chapter B10 Marine Ecology)
- Shorebirds (including waders), associated with tidal estuarine and mangrove environments (**Section 8.13.1**)
- Terrestrial species which are usually associated with heavily vegetated areas (**Section 8.13.2**)
- Non-tidal wetland migratory species (**Section 8.13.3**)
- Other migratory species (**Section 8.13.4**).

8.13.1 Migratory shorebirds

Migratory shorebirds or waders comprise of the suborder Charadriiform, which feed in shallow water along the edges of lakes, rivers and the ocean. Migratory species within this suborder include common coastal waders such as sandpipers, godwits, plovers and stilts (amongst others). Most migratory waders visiting Australia (including various sandpipers, godwit, and plover species) breed in the Northern Hemisphere (e.g. Siberia, China, Alaska) and migrate across the globe through the East Asia-Australian Flyway to spend spring and summer feeding in Australia and New Zealand (Asia-Pacific Migratory Wader Conservation Committee 2001; Geering *et al.*, 2007; Bamford *et al.*, 2008).

In Australia, significant habitats for waders include expanses of wet, open mud- and sand-flats, which may or may not include aquatic vegetation such as sea-grass. While these habitats are most commonly found along the Australian coastline in association with estuaries, they can also occur on inland lakes and rivers as well as artificial habitats such as sewage ponds.

Within these habitats, migratory waders feed on benthic invertebrates alongside or within shallow water. A wader's daily routine is driven by the tide, with birds moving from to feeding grounds at low tide to aggregate as mixed flocks at high-tide roosts (Geering *et al.*, 2007). Wader density on intertidal flats are shaped by a number of factors including prey density, competition/density of other wader species, disturbance, prevailing climatic conditions and proximity to high-tide roosts (Geering *et al.*, 2007).

Within the study area potential foraging habitats of mud- or sand-flat are largely limited to within ~2.5 km of the Maroochy River mouth. While boating and human activity within the river is high, the location is a well-known and a popular wader watching location. Four high tide roosts occur within the river mouth and regularly observed wader species include Bar-tailed Godwit, Whimbrel, Eastern Curlew, Double-banded Plover, and Red-necked Stint. Less common species include Terek Sandpiper, Grey-tailed Tattler, Curlew Sandpiper, Great Knot, Lesser Sand Plover, and Greater Sand Plover (QWSG 2010).

Migratory waders known from within 50 km of the study area are documented in **Table 8.13a**; those known to occur along the Maroochy River are identified separately in this table.

8.13.2 Terrestrial migratory birds

Two species of migratory bird associated with terrestrial habitats, Rufous Fantail and Rainbow Bee-eater, were recorded during EcoSmart Ecology surveys of the SCA. Rainbow Bee-eaters were common and regularly recorded throughout all areas of the Study Site. The Rufous Fantail was noted on five occasions, and almost always in association with thick mesic habitats (particularly forest dominated by eucalypts). Refer **Table 8.13b**.

Mesic forest habitats may also have some value as foraging and/or breeding habitat for Black-faced Monarch, which has been recorded nearby in the Maroochy Wetland Sanctuary.

Table 8.13a: Migratory wader species identified in databases within 50 km of the study area

Scientific Name	Common Name	Probable Occurrence in the SCA
Actitis hypoleucos	Common Sandpiper	Unlikely, no records from the Maroochy River
Arenaria interpres	Ruddy Turnstone	Known to occur but unlikely upstream of Motorway
Calidris acuminata	Sharp-tailed Sandpiper	Known to occur but unlikely upstream of Motorway. Reported in Avisure monthly bird strike reports, but it is unclear from these reports if birds are predicted or observed.
Calidris alba	Sanderling	Known to occur but unlikely upstream of Motorway
Calidris canutus	Red Knot	Unlikely, no records within the Maroochy River
Calidris ferruginea	Curlew Sandpiper	Known to occur but unlikely upstream of Motorway
Calidris melanotos	Pectoral Sandpiper	Unlikely, no records within the Maroochy River
Calidris ruficollis	Red-necked Stint	Known to occur but unlikely upstream of Motorway
Calidris tenuirostris	Great Knot	Known to occur but unlikely upstream of Motorway
Charadrius bicinctus	Double-banded Plover	Known to occur but unlikely upstream of Motorway
Charadrius leschenaultii	Greater Sand Plover	Known to occur but unlikely upstream of Motorway
Charadrius mongolus	Lesser Sand Plover	Known to occur but unlikely upstream of Motorway
Charadrius veredus	Oriental Plover	Unlikely, no records within the Maroochy River
Gallinago hardwickii	Latham's Snipe	Does not inhabit tidal estuarine wetlands. Considered in Section 2.10.3.
Limicola falcinellus	Broad-billed Sandpiper	Unlikely, no records within the Maroochy River
Limosa lapponica	Bar-tailed Godwit	Known to occur but unlikely upstream of Motorway
Limosa limosa	Black-tailed Godwit	Known to occur but unlikely upstream of Motorway
Numenius madagascariensis	Eastern Curlew	Known to occur but unlikely upstream of Motorway
Numenius minutus	Little Curlew	Unlikely, no records within the Maroochy River
Numenius phaeopus	Whimbrel	Known to occur but unlikely upstream of Motorway
Pluvialis fulva	Pacific Golden Plover	Known to occur but unlikely upstream of Motorway
Pluvialis squatarola	Grey Plover	Unlikely, no records within the Maroochy River
Rostratula australis	Australian Painted Snipe	Does not inhabit tidal estuarine wetlands. Considered in Section 2.10.3.
Tringa brevipes	Grey-tailed Tattler	Known to occur but unlikely upstream of Motorway
Tringa incana	Wandering Tattler	Known to occur but unlikely upstream of Motorway
Tringa nebularia	Common Greenshank	Known to occur but unlikely upstream of Motorway
Tringa stagnatilis	Marsh Sandpiper	Unlikely, no records within the Maroochy River
Xenus cinereus	Terek Sandpiper	Known to occur but unlikely upstream of Motorway

However, this species is uncommon in the local area (with only one record within 10 km) and the extent of suitable habitat within the SCA area is limited.

While both White-throated Needletail and Fork-tailed Swift have been recorded within the local area, both species are aerial foragers and do not rely on any particular habitat type. These species will readily move quickly through the area and are transient in behaviour.

8.13.3 Non-tidal wetland migratory birds

Six migratory birds associated with non-tidal wetlands have been identified within 50 km of the study area (**Table 8.13c**). Cattle Egrets and Eastern Great Egrets are regularly observed within the study area, while White-bellied Sea-eagles are often observed along the Maroochy River with the odd animal occasionally seen flying over the SCA.

While Latham's Snipe has been only sporadically recorded in the local area (one historic record from 1995), 20 individuals were observed in the south-east corner of the SCA during surveys. Sixteen of these birds were flushed from a relatively small area of modified heath to the east of the existing RWY 12/30 (i.e. to the immediate west of Keith Royal Park). An additional two individuals were also observed in the central section of the WHMA, whilst two individuals were seen within Lot 101 adjacent to David Low Way (i.e. outside the SCA to the immediate north of RWY 18/36). To qualify as 'important habitat' under EPBC assessment guidelines, an area must be able to support at least eighteen individuals. Based on habitat extent and quality, it is probable that the high abundance of Latham's Snipe is atypical within the SCA and not reflective of normal abundance.

Table 8.13b: Terrestrial migratory birds occurring within 50 km of the study area

Scientific Name	Common Name	Probable Occurrence in the SCA
Anthochaera phrygia	Regent Honeyeater	Unlikely
Apus pacificus	Fork-tailed Swift	Known/transient
Cyclopsitta diophthalma coxeni	Coxen's Fig-Parrot	Unlikely, locally extinct
Hirundapus caudacutus	White-throated Needletail	Known/transient
Merops ornatus	Rainbow Bee-eater	Known, recorded within study area
Monarcha melanopsis	Black-faced Monarch	Possible
Myiagra cyanoleuca	Satin Flycatcher	Unlikely
Rhipidura rufifrons	Rufous Fantail	Known, recorded within the study area

Table 8.13c: Non-tidal wetland Migratory birds known from within 50 km of the study area (excluding this study)

Scientific Name	Common Name	Probable Occurrence in the SCA
Ardea ibis	Cattle Egret	Known. Often recorded in open paddocks and grasslands.
Ardea modesta	Eastern Great Egret	Known. Observed on Finland Road swamp and often recorded along the Maroochy River
Plegadis falcinellus	Glossy Ibis	Not recorded and considered unlikely within the SCA. Noted nearby at Finland Road swamp.
Gallinago hardwickii	Latham's Snipe	Known/transient. At least one historic record and one recent observation within the study area. Discussed in Avisure monthly bird strike reports, but it is unclear in these documents if records represent observed birds or possible strike risk predictions.
Rostratula australis	Australian Painted Snipe	Unlikely/transient. Suitable habitat is limited and the two records within 10 km are likely to reflect transient individuals.
Haliaeetus leucogaster	White-bellied Sea-eagle	Known. Often observed flying along the Maroochy River.
Nettapus coromandelianus	Cotton Pygmy-Goose	Unlikely, as no suitable habitat within study area

8.13.4 Other migratory birds

With the exception of Little Tern, the remaining migratory birds identified in background searches are marine/pelagic species. Marine species, which are birds that spend the majority of the life at sea (e.g. albatross, shearwaters and petrels) are considered in Chapter B10 Marine Ecology. The Little Tern is known from only the mouth of the Maroochy River and has not been recorded west of Goat Island.

8.14 APPROACH TO IMPACT ASSESSMENT

Recognised impact assessment methodology establishes the context in which impacts will occur (Existing Values; see **Sections 8.5** to **8.13** of this report), identifies potential impact pathways, and then evaluates the possible consequence of these pathways. A variety of impact pathways can affect vertebrate values in relation to the proposed activities including (but not limited to):

- Direct loss of habitat possibly leading to reduced extent of occurrence or isolation of habitats/populations
- Changes to groundwater conditions, including modification of groundwater level, groundwater fluctuation or groundwater quality
- Increased light
- Increased noise
- Changes to vegetation structure or composition (e.g. weed infestation).

The effect of these impact pathways, and any other relevant pathways (e.g. plane strike for flying vertebrates), will be evaluated by considering:

- Impact Likelihood: the probability of an interaction between a potential threat and the sensitive receptor
- Impact Magnitude: the consequence or severity of an impact.

Assessment of the likelihood and magnitude of impacts is then used to assess the significance of impacts (see Section 8.14.3) with and without mitigation (residual impacts). Criteria for assessing the likelihood and magnitude of impacts are defined in Sections 8.14.1 and 8.14.2.

Plane activity is expected to increase at the SCA irrespective of the current proposed development, and impacts will therefore deviate from current conditions (e.g. increased noise). To clarify the impact of this development on faunal values, two scenarios are considered (where relevant):

1. The 'do minimum' scenario, which retains the current airport configuration but allows for predicted future flight frequency
2. The 'new runway' scenario, which is the subject of this study.

Finally, while the potential impacts can be broken down into individual pathways, these pathways rarely act in isolation, and as such, an overall impact assessment based on the accumulation of impact pathways will be assessed where relevant.

8.14.1 Impact likelihood

The impact likelihood evaluates the probability of an interaction between a potential threat and the sensitive receptor. Criteria for assessing the likelihood of an impact on faunal values are outlined in **Table 8.14a**.

Table 8.14a: Definition of preliminary impact likelihood criteria

Impact Likelihood	
Highly Unlikely	Highly unlikely to occur but theoretically possible
Unlikely	May occur during construction/life of the project but probability well below 50 per cent; unlikely but not highly unlikely
Possible	As likely to occur as not to occur (i.e. probability of impact about 50%)
Likely	Likely to occur; probability greater than 50 per cent
Highly Likely/Almost Certain	Very likely to occur as a result of the proposed project construction and/or operations; could occur multiple times during relevant impacting period

8.14.2 Impact magnitude

Impact magnitude reflects the consequences or severity of an impact taking into account:

- The geographical extent of an impact (with particular reference to the relative importance of habitat for the survival of listed species at the local, bioregional, state or national level)
- The duration of an impact (**Table 8.14b**)
- The degree of change from previous/existing conditions and the 'do minimum' scenario, and implications thereof for the survival/persistence of existing values
- Matters of National Environmental Significance significant impact criteria for relevant taxa.

Criteria for assessing the magnitude of an impact are provided in **Table 8.14c**.

Table 8.14b: Definition of impact duration

Relative Duration of Environmental Effects	
Temporary	Days to Months
Short Term	Up to 1 Year
Medium Term	From 1 to 5 Years
Long Term	From 5 to 50 Years
Permanent / Irreversible	In excess of 50 Years

Table 8.14c: Criteria for assessing the magnitude of impacts

Significance/ Consequence	Description of significance
Very High	*Impacts(s) considered critical to the decision-making process.* Impact(s) recognisable/detectable and highly significant at a national or international level. i.e., impacts with the potential to adversely affect the status of species under the EPBC Act and 'significant' impacts on EPBC Act-listed 'migratory' species listed under CAMBA, JAMBA, ROKAMBA and the Bonn Convention. This includes: • impacts resulting in a population decline and/or reduction in range or area of occupancy affecting a species' status under the EPBC Act; and/or • impacts on EPBC Act-listed 'migratory' species assessed as 'significant' under current EPBC Act policy guidelines.
High	*Impact(s) important to the decision making process* Impacts are recognisable/detectable and highly significant at a state level (i.e. having the potential to adversely affect listing under the NC Act [based on current guidelines for listing]); and/or • Impacts significant at a national level (i.e. 'significant' under the EPBC Act), but unlikely to adversely affect the status of species under the EPBC Act. This includes impacts resulting in: • a population decline and/or reduction in range or area of occupancy within Queensland, with the potential to adversely affect a species status under the NC Act; and/or • fragmentation or partial loss of populations resulting in reduction in extent of occurrence and/or area of occupancy without significantly affecting a species' status under the EPBC Act.
Moderate	*Impact(s) recognisable/detectable and relevant to decision-making (including the development of environmental mitigation measures)* Impact(s) only significant at a state, bioregional and/or local level and unlikely to adversely affect status under the NC or EPBC Act. This includes impacts resulting in: • the loss/disturbance of habitat for NC Act-listed threatened species; and/or • loss/disturbance of areas of 'high ecological significance' and wildlife corridors identified in the SEQ BPA and State Planning Policy 3/11: Coastal Protection

Significance/ Consequence	Description of significance
Minor	*Impact(s) unlikely to be of importance in the decision making process, but relevant in the consideration of mitigation measures* Impact(s) recognisable/detectable but not significant at a local, federal, state or bioregional level. E.g. minor loss/disturbance of habitat for non-threatened fauna resulting from the limited clearing of non-remnant vegetation or clearing in heavily disturbed areas.
Negligible	*Impact(s) within the normal bounds of variation and not significant at a local, federal, state or bioregional level* This includes impacts which are beneath levels of detection and, impacts that are within the normal bounds of variation (including the 'do minimum' scenario)

8.14.3 Impact significance

The significance of development-related threats on identified vertebrate values will be derived from the risk matrix provided in **Table 8.14d**.

8.14.4 Residual risk

Measures to mitigate impacts are to prevent, reduce and, where possible, offset the risk of impacts. Mitigation measures can include avoiding or minimise impacts as part of the design layout, sensitive construction methods or otherwise through the application of best practice environmental management measures as part of Environmental Management Framework (and EMP). As many impacts may reinforce or accumulate, a variety of impact mitigation measures may be necessary.

Using the risk matrix in **Table 8.14d**, the impact significance rating may be adjusted downward following the application of mitigation measures to produce a residual risk rating. However, it must be recognised that some mitigation measures may be based on inadequate knowledge, unproven strategies, or methods that have varying historic success. It may therefore be necessary to re-adjust the residual risk (both impact likelihood and magnitude) based on the probability of successful mitigation (i.e. mitigation confidence). The residual risks presented at the end of the assessment takes into consideration the probability of mitigation success.

Table 8.14d: Impact risk matrix for assessment of significance

		Negligible	Minor	Moderate	High	Very High
Likelihood	Highly unlikely	Low	Low	Low	Medium	Medium
	Unlikely	Low	Low	Medium	Medium	High
	Possible	Low	Medium	Medium	High	High
	Likely	Medium	Medium	High	High	Very High
	Almost certain	Medium	High	High	Very High	Extreme

8.15 IMPACT ASSESSMENT, MITIGATION AND RESIDUAL RISKS

8.15.1 Inherent Mitigation

During the preparation of this EIS, a number of measures were included within the design to reduce or eliminate potential environmental impacts. Justification for, and details of, these design measures are outlined below and Chapter A4 – Project Description and A5 – Project Construction. Based on this design, impacts have been assessed and further mitigation measures recommended where necessary.

8.15.2 Infrastructure Modifications

The project footprint has been modified to include only the new runway area, with the future new terminal precinct excluded from the Project. The ends of the runway also shifted south-east along the same alignment by 310 m. These design amendments minimised the amount of clearing south of the runway, including an area of remnant vegetation north of the southern section of Mt Coolum National Park.

8.15.3 Groundwater Controls

Detailed discussion of existing groundwater conditions, model assumptions, potential impacts and mitigation is provided in Chapter B3 – Geology, Soils and Groundwater. A brief review is provided here for context.

Baseline Conditions

Indurated sand ('coffee rock') is typically present at depths between approximately 0.5 m to 5 m BGL across the Project area. It is anticipated to be of relatively low permeability compared with the overlying and underlying alluvial sands. The indurated sand varies in depth, thickness and degree of cementation across the site. It is likely that the indurated sand contains voids and weaknesses across relatively small distances.

Because coffee rock has relatively low permeability, it plays an important role in the existing hydrogeological processes, which, within coastal plain aquifers, can be a significant factor in the relationship between fresh and saline groundwater. Investigations at the site identified a shallow 'perched' watertable above the coffee rock in three boreholes installed between the runway and northern section of Mt Coolum National Park. The underlying regional groundwater was identified below the coffee rock layer.

The relatively low permeability of the indurated sand layer suggests it could act as a barrier to groundwater flow. However, it is likely that the regional aquifer would be hydraulically connected at the catchment scale to the shallow aquifer, and the coffee rock would act as a semi-confining layer.

Groundwater above the coffee rock is likely to be semi-perched. Groundwater may flow from the shallow perched watertable down through the coffee rock to the aquifer below. This flow is expected to occur preferentially through weaknesses and voids in the coffee rock. Annual net recharge into the regional aquifer makes up a small percentage (1-5%) of precipitation infiltrating the subsurface (gross recharge). During dry weather groundwater may move upwards through the coffee rock via capillary action and plant uptake resulting in evaporation and evapotranspiration.

Monitoring (see Chapter B3 – Geology, Soils and Groundwater) indicates that groundwater has relatively low salinity in the regional aquifer , salinity levels were measured at approximately 210–310 mg/L in the WHMA and approximately 470–540 mg/L in the lower 'floodplain' part of the site. Surface water salinity levels were very low, being measures at between 70 and 90 mg/L near the National Park boundary. Monitoring of the perched aquifer indicates that water levels are strongly influenced by rainfall; a similar trend was not identified in the regional aquifer. These results suggest that water quality in the perched aquifer is most strongly influenced by surface water quality, although the regional aquifer may influence the perched aquifer in some places where discontinuities lead to interchange between the two aquifers.

Groundwater quality in the sub-surface aquifer is moderately acidic with measured pH ranging from 4.2 to 5.0 north of the northern perimeter drain. Surface water in existing drains is slightly more acidic (pH 3.7 to 4.1), which is probably due to the influence of acidic soils.

Surface water drains within and surrounding the SCA generally follow the flat topography with extremely low gradients of <0.1 per cent, resulting in relatively stagnant channel flows and therefore insignificant discharge rates of groundwater.

A groundwater model was prepared to assess and quantify potential impacts associated with the construction of the new runway. The model was used to predict groundwater levels and salinity concentrations before, during and after delivery of sand. As the site is characterised by relatively flat topography and groundwater gradients, a three-dimensional flow model with depth-averaged material parameters was adopted to represent groundwater flow conditions at the scale of the regional aquifer. Assumptions used in the modelling are described in Chapter B3 – Geology, Soils and Groundwater. Importantly, the model includes the installation of a high-quality liner to reduce infiltration of seawater from the hydraulic sand delivery into the underlying aquifer (described in more detail below).

Assumptions adopted in the modelling include:

- The reclamation will be undertaken as described in the construction methodology in Chapter A5.
- The perimeter bund will be approx. 1 m to 2.5 m above surface level and the polishing pond embankment will be approx. 3.75 m AHD
- The maximum filling level was assumed at 3.3 m AHD
- The polishing pond will be unlined, as it is underlain by a thick layer of naturally occurring clay material, which acts as a barrier to tailwater infiltration

- The bunds and fill area are lined by a very high quality high-density polyethylene (HDPE) liner with an assumed £ 3 punctures/ha
- Although the underlying soils across the site are stratified, most notably by a low permeability coffee rock layer, site investigations indicate the movement of groundwater across these strata and therefore weighted horizontal and vertical hydraulic conductivities were adopted for the coffee rock layer
- Weighted vertical and horizontal hydraulic conductivities were assigned to area with soft clay, similar to that for the coffee rock (so low permeability), and
- A base layer of sand extending to 15 m AHD was assumed beneath the coffee rock layer.
- A value of 1% has been adopted for net recharge. Subsequent field investigations have indicated that net recharge could be closer to 5%. Model results for salinity impacts may therefore be considered conservative.

The results of the modelling are considered to be a conservative reflection of the salinity concentrations in the regional aquifer (beneath the coffee rock).

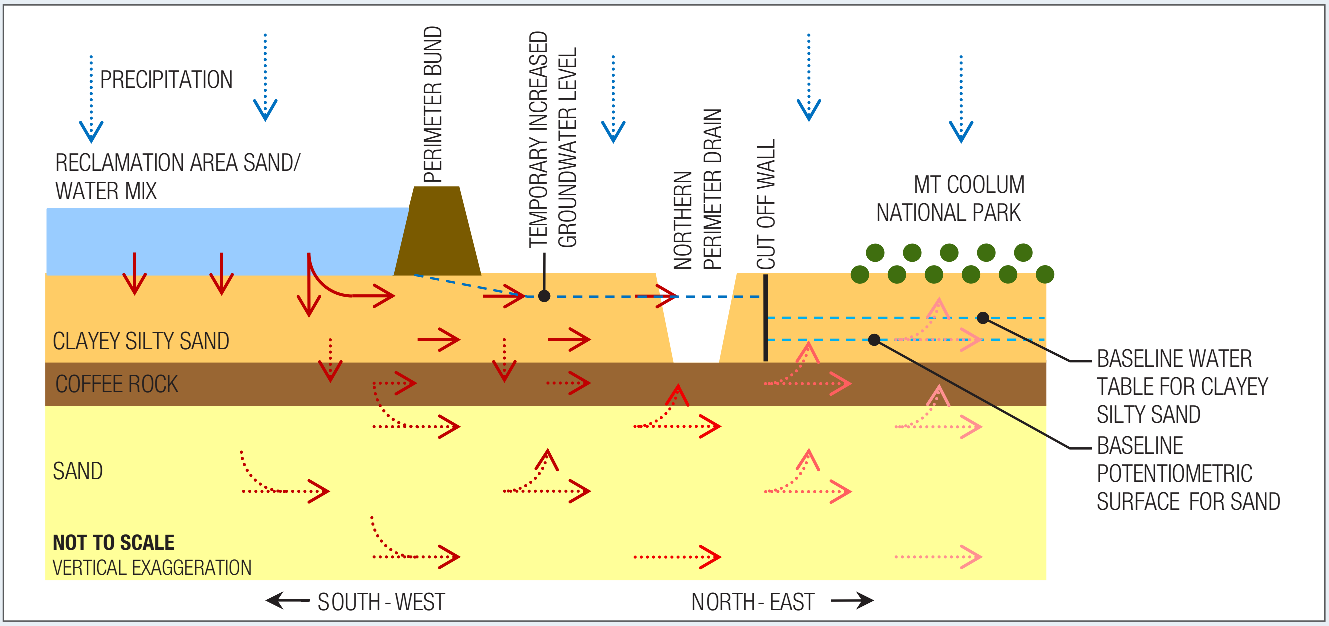
The regional aquifer generally flows laterally across through the sands beneath the coffee rock, although it could potentially flow up through the coffee rock where there are discontinuities or the coffee rock sits below the level of the regional watertable. In areas where the coffee rock is relatively shallow, the potential for water from the regional aquifer to occur above the coffee rock is considerably reduced. Boreholes drilled for groundwater assessment indicate a perched aquifer above coffee rock that ranges between 1.5 m and 0.4 m below ground level; however, the extent of discontinuities is not known. Based on the results of the field investigations, it is expected that any flow of higher salinity water from the regional aquifer into the perched aquifer would be localised to areas where the coffee rock is deeper or discontinuous.

The conceptual hydrogeological model of tailwater infiltration from hydraulically delivered sand is shown in **Figure 8.15a**. The solid red arrows indicate tailwater movement, and the dashed arrows indicate potential pathways into the surrounding environment, the faded arrows indicate less tailwater infiltration further from the reclamation area. Although not shown in **Figure 8.15a**, the potentiometric surface (which is an imaginary surface that defines the level to which water in a confined aquifer would rise were it completely pierced with wells) for the hydraulic head in the semi-confined unit is below the perched watertable level in the uppermost stratigraphic unit.

The proposed northern perimeter drain would intercept and drain away saline tailwater from the upper layers of the aquifer between the reclamation area and the drain. However, some tailwater is also expected migrate through the coffee rock layer into the lower regional aquifer. While the coffee rock layer is likely to act as a partial barrier to tailwater infiltration into the regional aquifer, investigations indicate that the coffee rock is discontinuous, allowing some interaction between the perched and regional aquifers. Consequently, the lower permeability layer of coffee rock cannot be relied upon to contain tailwater infiltration in the upper layers of the aquifer where it would be intercepted by the northern perimeter drain.

Given the sensitivity of the neighbouring National Park and WHMA to potential groundwater impacts, mitigation of groundwater level and salinity impacts was considered necessary for the project. Consequently, the design was modified to include a high quality liner within the base of the reclamation area to minimise infiltration of seawater into the underlying groundwater. **Figure 8.15b** shows the conceptual

Figure 8.15a: Hydrogeological conceptualisation of tailwater infiltration with no mitigation



hydrogeological model of tailwater infiltration with a liner, indicating an expected reduced infiltration rate and therefore lower salinity concentration in groundwater.

The predicted seepage was used to predict the potential groundwater elevation and salinity impacts from the reclamation activities. The model results are illustrated in **Figure 8.15c** and **Figure 8.15d**. **Figure 8.15c** shows the contours of the predicted 0.1 m increase in groundwater head at the end of filling and 1 year after filling is complete. A head increase of 0.1 m was selected as the impact indicator, as changes less than 0.1 m would be indiscernible from natural variation.

The modelling indicates that the 0.1 m increase in groundwater head is not expected to extend beyond approx. 250 m from the reclamation area, or approx. 80 m into the northern section of the national park.

Figure 8.15d shows the contours of 1,000 mg/L salinity concentration in the regional aquifer. The modelling indicates the 1,000 mg/L contour is unlikely to cross the SCA property boundary within 100 years from the completion of filling. Modelling over a 300-year period indicates the following:

- Salinity concentrations 50 m from the northern perimeter drain (approximately the national park boundary) are predicted to peak at 1,000 mg/L approximately 200 years after filling is complete; and
- Salinity concentrations 150 m from the northern perimeter drain are not predicted to exceed 500 mg/L over 300 years.

Although the extent of discontinuities in the confining coffee rock layer is unknown, should expression of deeper groundwater occur near the surface saline influence is likely to be localised in extent, and owing to diffusion would be considerably less than the concentration in the regional aquifer.

The south western side of the site is predicted to have groundwater impacts of negligible significance due to the sub-regional groundwater flow from the fill area to the east and north-east towards the coast.

Design Modification – Perimeter Drain

The potential drawdown effect from the northern perimeter drain was modelled to assess variation in water levels in the adjacent groundwater systems. The northern perimeter drain extends from the new runway's junction with RWY 18/36 to Marcoola Drain, near the Sunshine Motorway. The drain will have a base width of 10 m and be approximately 1.5 m deep. Initial modelling indicated that the northern perimeter drain could cause unacceptable drawdown in neighbouring environments; consequently, a cut-off wall is proposed to be installed on the northern side of the perimeter drain to prevent the flow of groundwater from the perched aquifer into the drain. **Figure 8.15e** diagrammatically shows the effect of the cut-off wall in preventing drawdown of the adjacent groundwater table.

As indicated in **Figure 8.15e**, drawdown of the watertable is expected to occur only between the drain and cut-off wall; this distance will be minimised, taking into account the stability of the drain. It is proposed to install a plastic (HDPE) sheet pile wall, which will significantly reduce the potential for flow into the northern perimeter drain and address potential drawdown impacts in the national park.

Figure 8.15b: Hydrogeological conceptualisation of tailwater infiltration with a high quality liner indicating reduced infiltration

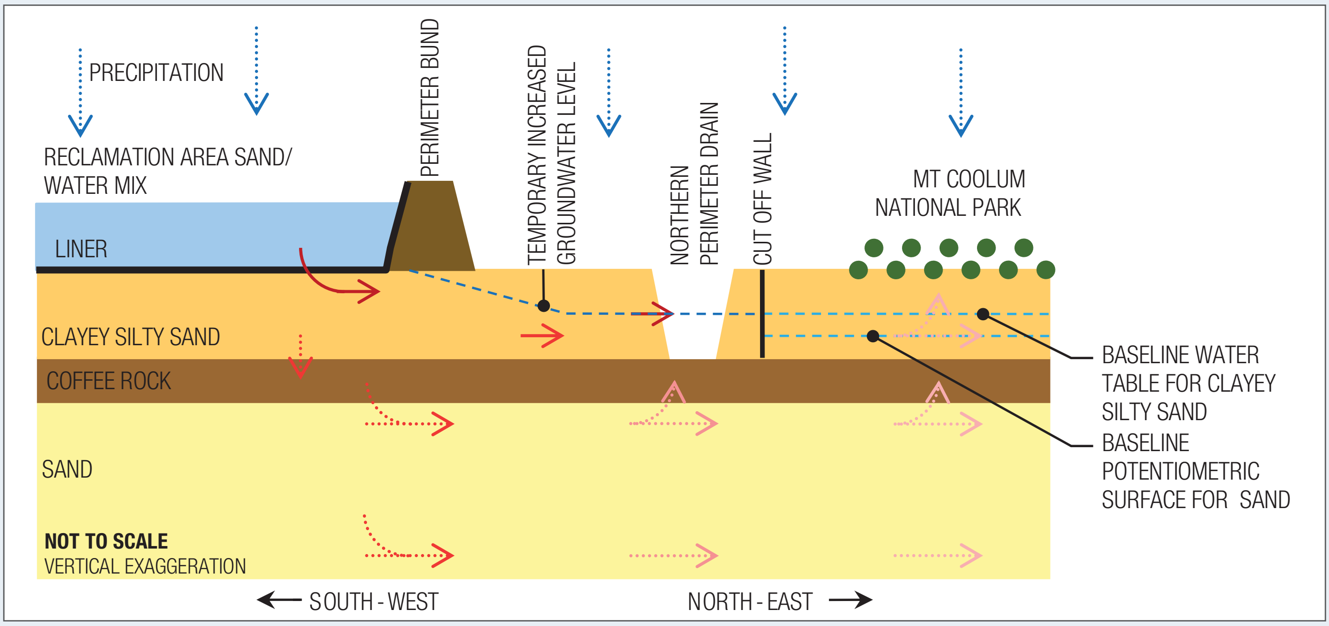


Figure 8.15c: Contours for predicted 0.1 m increase in groundwater head during and after reclamation

Contours for predicted 0.1 m increase in groundwater head during and after reclamation

Scale: 1:10,773

0 0.1 0.2 0.4 0.6 Kilometers

Client: Sunshine Coast Airport

Project: Airport Expansion Project

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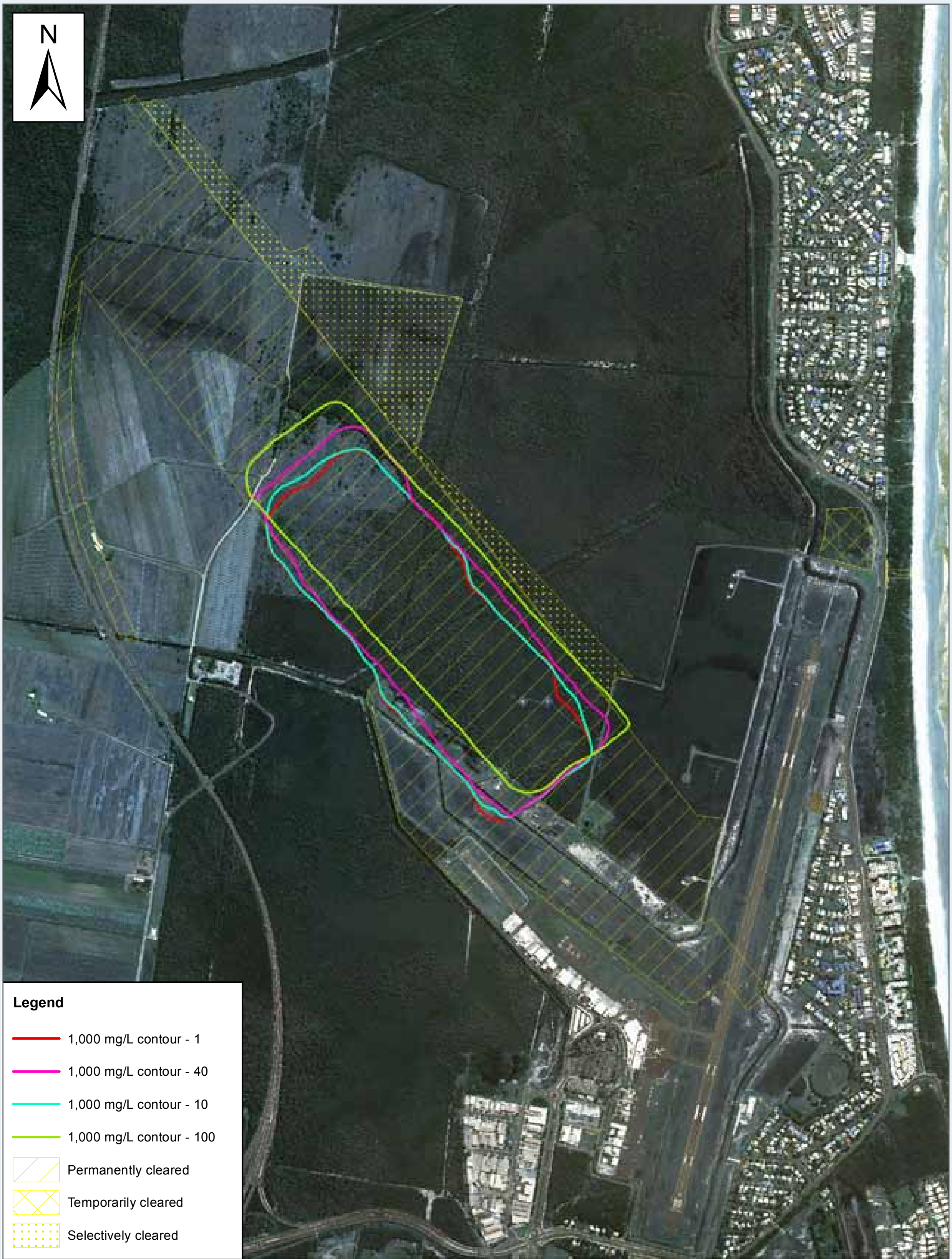
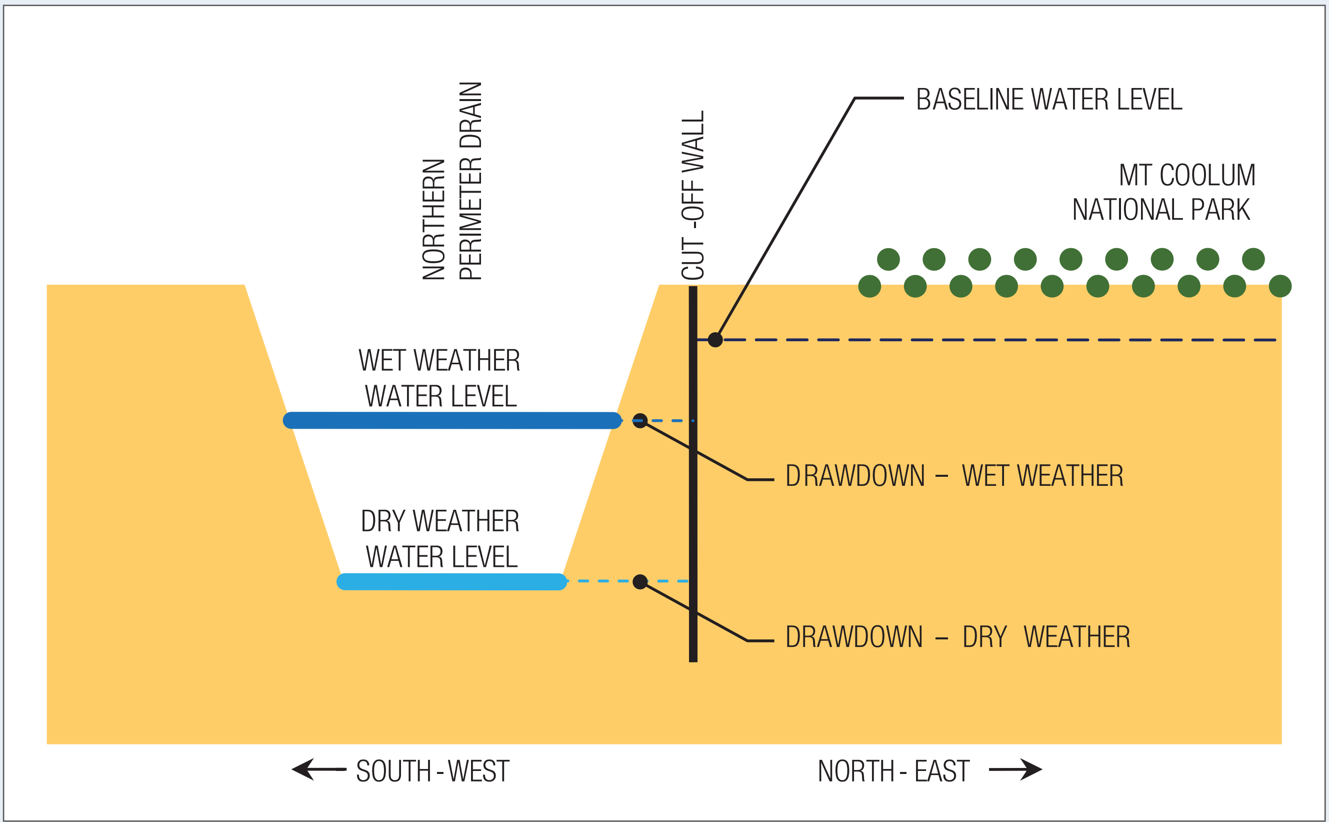
Figure 8.15d: Contours for predicted 1,000 mg/L salinity concentration in groundwater during and after reclamation



Contours for predicted 1000 mg/L salinity concentration in groundwater during and after reclamation	**Scale:** 1:10,773 (0 0.1 0.2 0.4 0.6 Kilometers)	ecosmart ECOLOGY
Client: Sunshine Coast Airport	**Project:** Airport Expansion Project	

Figure 8.15e: Hydrogeological conceptualisation of northern perimeter drain and cut-off wall



It is expected that such a sheet pile barrier is likely to reduce drawdown to an extent that is well below natural random or climatic driven fluctuations of the current watertable. The overall effective permeability of the sheet pile barrier would be well below the permeability of the sand and the sheet piles would be founded into coffee rock or installed at greater depth if coffee rock is absent.

Both the installation of the northern perimeter drain and the cut-off wall will also assist in reducing lateral movement of salt through groundwater above the coffee rock layer. Saline influence on adjacent environmental values (i.e. Mt Coolum National Park and WHMA) is likely to be restricted to upward migration from water below the coffee rock.

8.15.4 Construction Noise Control

Baseline Conditions

The existing noise environment to the immediate north of the northern perimeter drain (i.e. Mt Coolum National Park and WHMA) was quantified through attended and unattended noise monitoring (see Chapter B15 – Noise and Vibration).

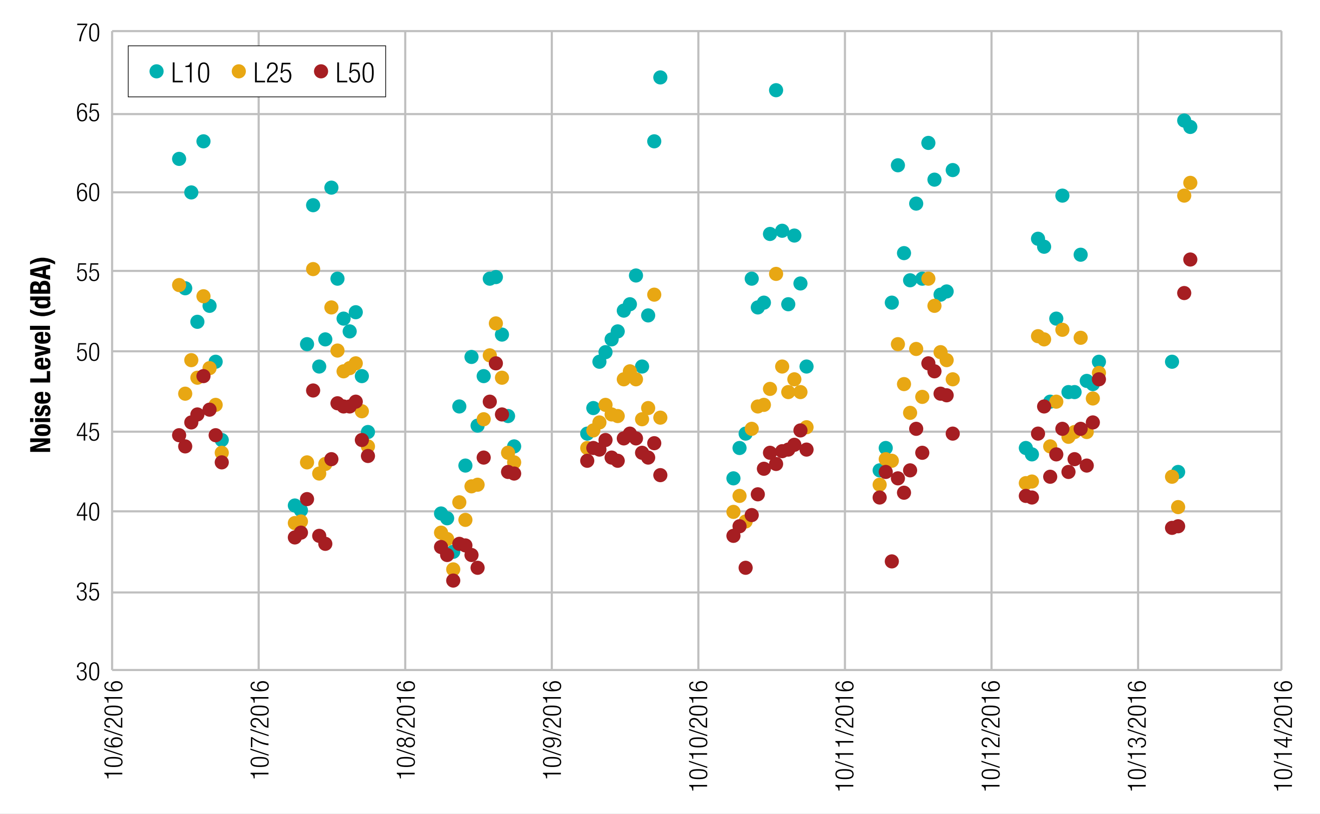
Ambient noise levels are dominated by aircraft and airport operations, with some road traffic and natural noise sources (e.g. wind in trees, surf noise) audible during periods of inactivity at the airport. The greatest maximum noise levels result from narrow-body jets (B737 and A320), though these noise events last only seconds. Persistent noise sources include light aircraft and helicopter operations, with multiple helicopters often operating concurrently.

With regard to the assessment of construction noise, the most appropriate descriptors of the ambient noise environment are statistical parameters L10, L25 and L50, representing the noise level exceeded for 10 per cent, 25 per cent and 50 per cent of the monitoring period. The results for these descriptors are shown graphically in **Figure 8.15f** for 60 minute intervals between 6.00am and 7.00pm (covering standard construction hours) over a two week monitoring period at a location on the boundary of Mt Coolum National Park and the WHMA (monitoring location L in Chapter B15 – Noise and Vibration). Therefore the L10, L25 and L50 represent the noise levels exceeded for 6, 15 and 30 minutes respectively. These descriptors represent the typical range of ambient noise in the absence of short duration, high noise level aircraft noise events.

Based on the figure above, the ambient noise environment during the day, in the absence of high noise level aircraft noise events, could be described as typically ranging between 35-65 dBA. A reasonable approximation of the energy average noise level (L_{Aeq}) in this noise environment, calculated using these descriptors (thus excluding loud aircraft noise events), is 48 dBA. The measured L_{Aeq} from all noise, including loud aircraft events, was 58 dBA. While noise levels were slightly lower during the night, ambient noise conditions were comparable as shown in **Figure 8.15g**.

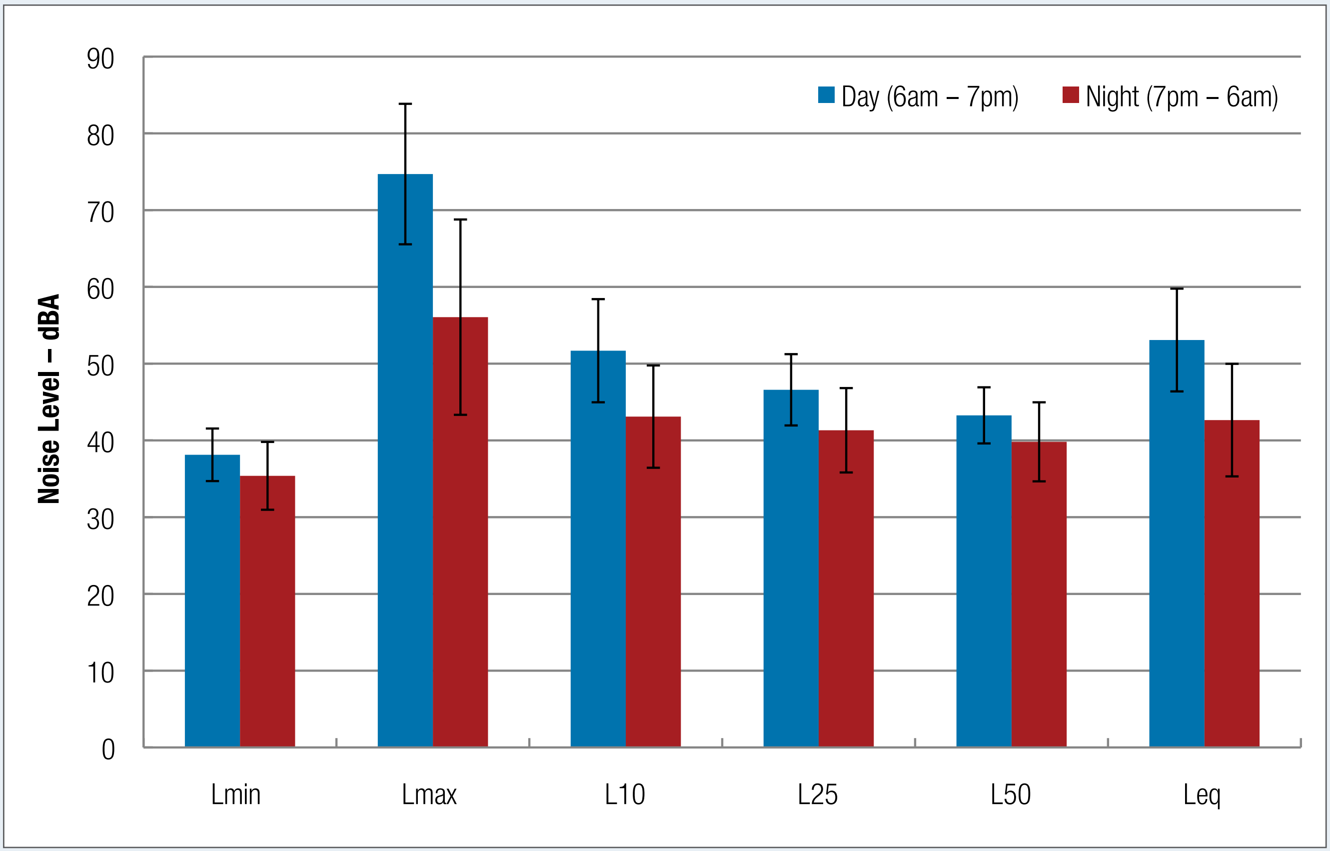
Given the sources of noise affecting the ambient noise environment described above, it is reasonable to conclude that the ambient noise levels measured would be representative of ambient noise levels throughout the

Figure 8.15f: A two-week snapshot of typical noise levels (between 6am to 7pm) to the north of the northern perimeter drain



(data based on location L in Chapter B15: approximately 150 m north of the proposed drain on the boundary between Mt Coolum National Park and WHMA)

Figure 8.15g: While consistently lower, ambient noise at night is comparable to day time noise.



National Park and WHMA.

Construction Noise Assessment

Preliminary investigations revealed the need for mitigation to reduce unwanted high noise in nearby sensitive environmental areas (i.e. Mt Coolum National Park and the WHMA). The construction methodology includes acoustic bunding (earth mound) between noise sources and sensitive environmental receivers as a nominal noise attenuation measure; it will be necessary for the construction contractor to demonstrate that the noise goals can be achieved before construction commences. Modelled noise levels with this measure for Package 1, Package 2 south-east (day) and Package 2 central (day) are shown in **Figure 8.15h** to **Figure 8.15j** respectively. Modelling results for other stages, which have lower noise levels, are available in Chapter B15 – Noise and Vibration.

With mitigation, the scenario having the loudest sustained noise levels is expected to be the reclamation works during initial (southeast) and middle (central) phases of Package 2. Noise sources during this and other phases of construction are predicted to be dominated by mobile plant. The predicted L_{Aeq} noise level is modelled conservatively and assumes that most plant would operate simultaneously. In this regard the modelled scenario could be considered to represent the upper range of predicted noise levels.

Based on these scenarios, the construction noise level (L_{Aeq}) is predicted to range between 50 dBA at the southern end of the WHMA and 40 dBA at the northern end. These noise levels are largely consistent with the ambient noise environment, approximately 48 dBA L_{Aeq} during standard construction hours.

8.16 POTENTIAL IMPACTS

8.16.1 General Faunal Values

The Project could affect faunal values of the Study Area through a variety of impact pathways. The Sections below provide an overview of impacts that might occur, and types of fauna that might be affected. More detailed discussion of impacts on EVNT species is provided in Section 8.16.7, while migratory species are considered in Section 8.16.8.

8.16.1.2 Habitat Loss, Mortality and Displacement

In total, 202.31 ha of land will be cleared or modified for development (**Figure 8.16a**), most of which is agricultural or developed land (126.65 ha, 62.6%; **Table 8.16a**). These disturbed areas hold little value for vertebrate species, and taxa inhabiting these areas are common and widespread.

The remaining area (75.66 ha. 37.4%) consists of native or advanced regrowth habitat, the bulk of which will be permanently (66.81 ha, 33.0%) lost. Clearing or modification of existing vegetation (particularly closed heath and forest/woodland) will result in habitat loss (reduced area of occupancy), displacement, and, mortality of native fauna. Those individuals displaced by clearing are competitively disadvantaged and usually perish rather than establish new territories, and as such, capture and translocation prior to or during disturbance may be of little benefit.

Impacts from temporarily cleared, or selectively cleared, habitats will be less acute. Temporarily cleared vegetation will be rehabilitated following completion of work, and provided adequate monitoring and control of weeds is undertaken in these areas, vegetation and habitats should, in the long-term, simulate those initially lost. Impacts in selectively cleared areas, which will be slashed during operation to ensure vegetation does not exceed 1.5 m in height, will affect fauna disproportionately. Species which rely on horizontal vegetation complexity (ie, low shrubs and ground-covering vegetation) such as small mammals, reptiles and some frogs, are likely to continue inhabiting these areas.

Table 8.16a: Extent of clearing associated with the proposed activities.

Habitat Type	Vertebrate Habitats Modified or Lost (ha)			
	Permanent	Temporary	Selective	Total Extent Modified
Forest/woodland	37.93	2.63	5.74	46.30
Heath	27.51	0.00	0.29	27.80
Disturbed	105.34	0.09	21.21	126.65
Foredunes	0.00	0.19	0.00	0.19
Intertidal	1.37	0.00	0.00	1.37
TOTAL	172.15	2.91	27.24	202.31

Figure 8.15h: Predicted noise (L10) during package 1 works

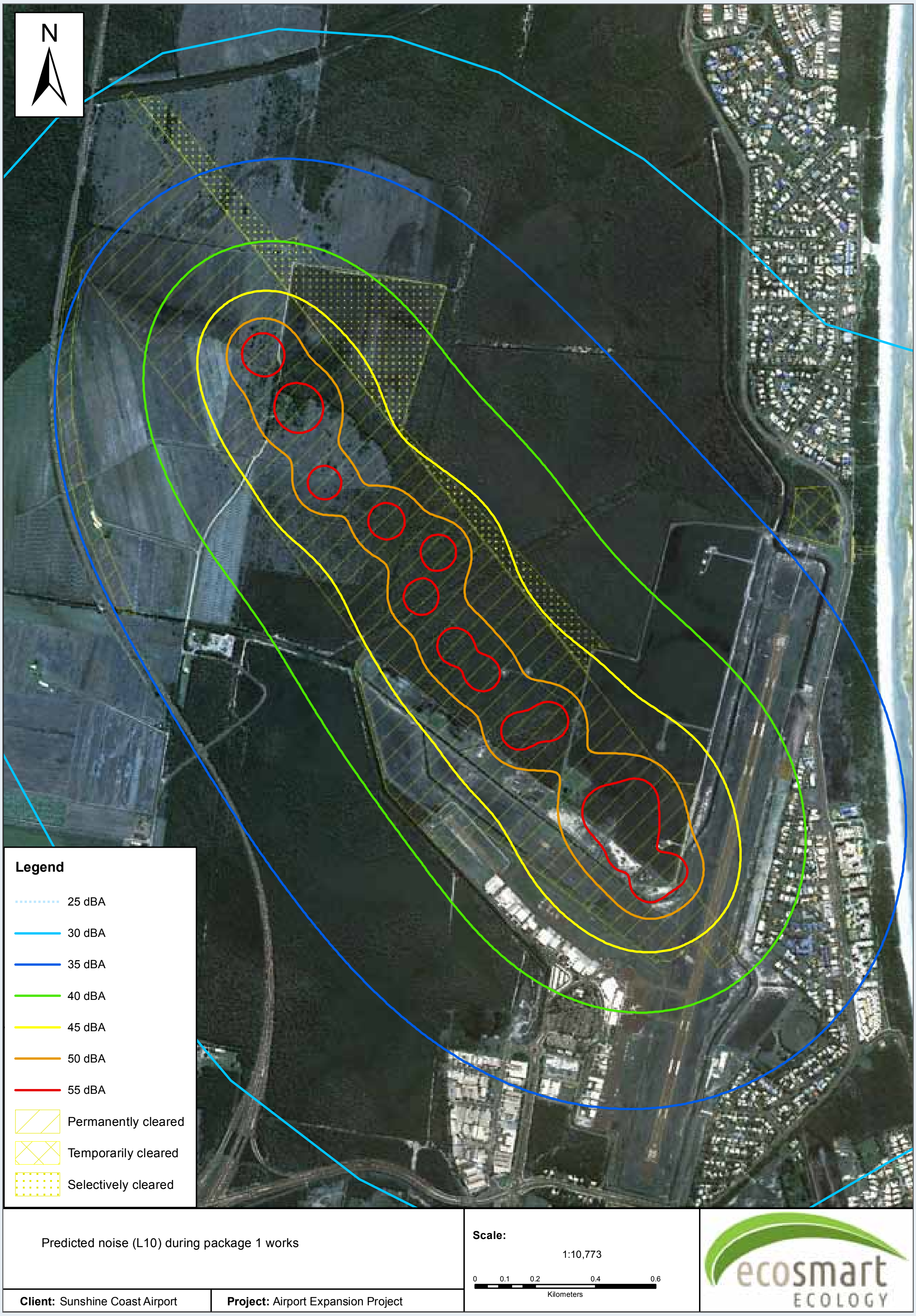
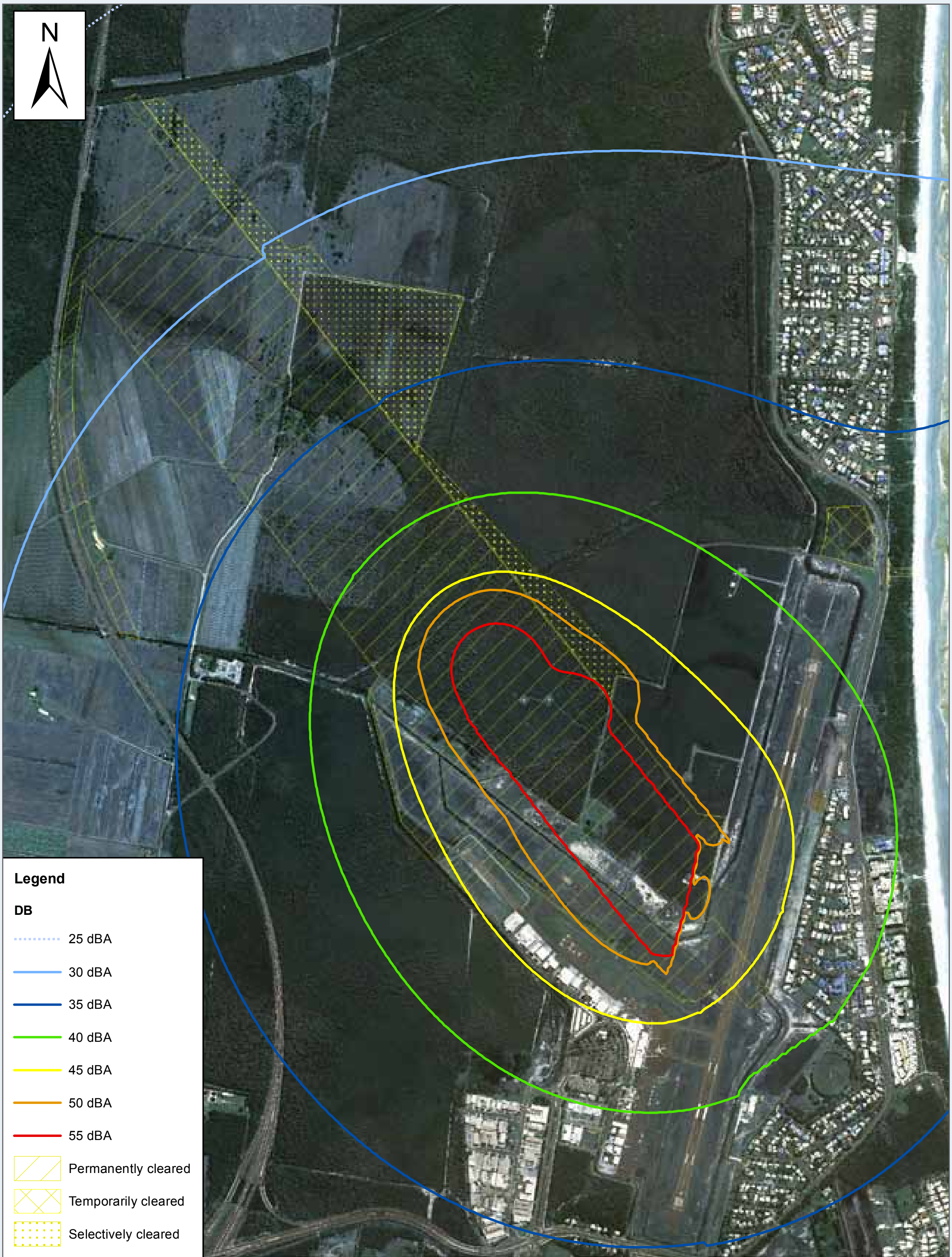


Figure 8.15i: Predicted noise (L10) during initial package 2 (southeast day) works



Predicted noise (L10) during initial package 2 (southeast day) works		Scale: 1:10,773 (0, 0.1, 0.2, 0.4, 0.6 Kilometers)
Client: Sunshine Coast Airport	**Project:** Airport Expansion Project	

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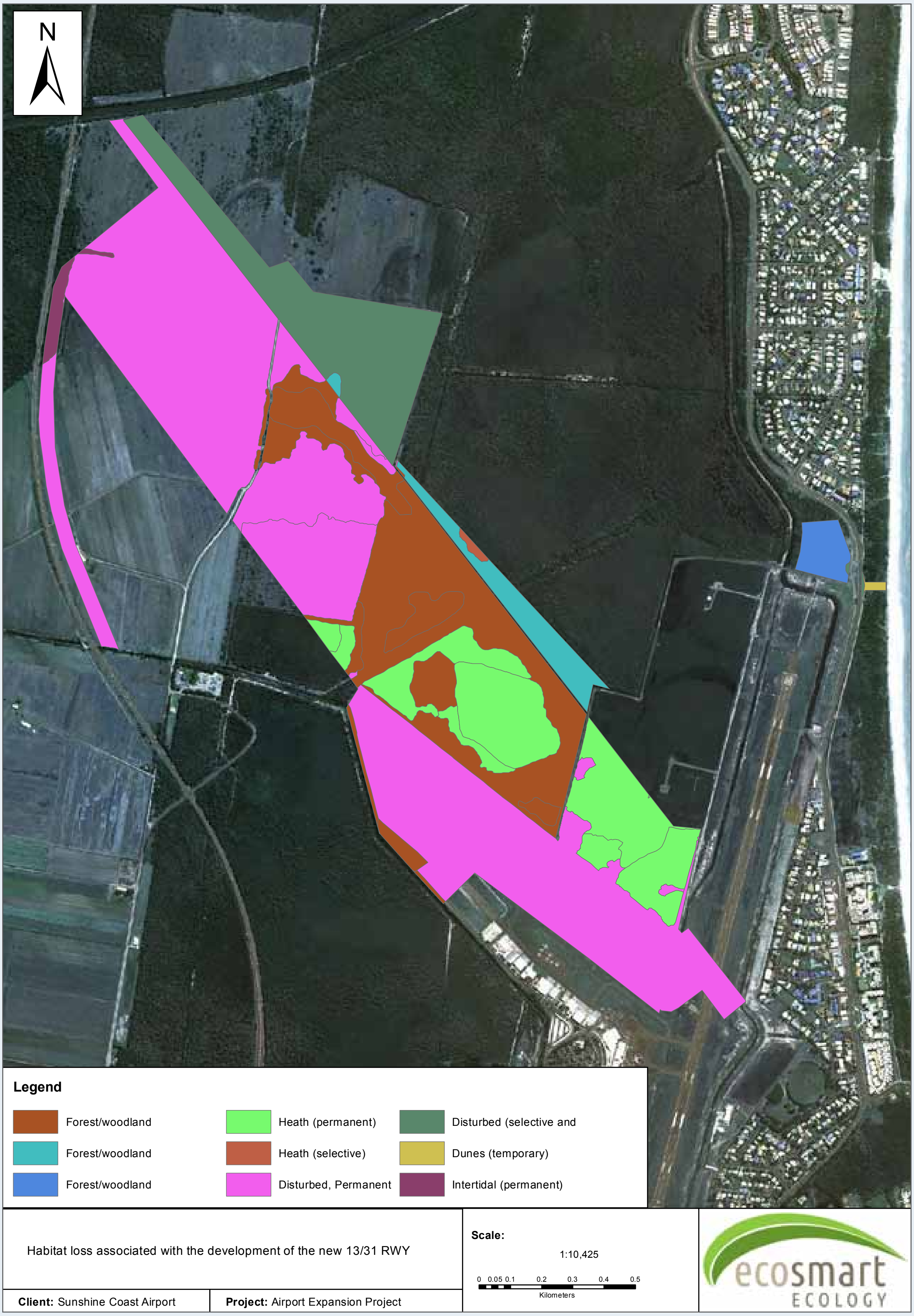
Figure 8.15j: Predicted noise (L10) during middle package 2 (central day) works

Predicted noise (L10) during middle package 2 (central day) works		Scale: 1:10,773	ecosmart ECOLOGY
Client: Sunshine Coast Airport	**Project:** Airport Expansion Project		

Figure 8.16a: Habitat loss associated with the development of the new 13/31 RWY



The loss of tall woody elements from selectively cleared areas can benefit some species (see discussion in Sections 8.5.2.1 and 8.5.3.1 as examples). By contrast, species which rely on vertical habitat complexity (ie, trees, taller shubs, hollows etc) such as birds, arboreal mammals and bats will find selectively cleared areas unsuitable.

With the exception of species treated in the below Sections, affected species are common and widespread within Queensland and the region. It is therefore unlikely that any of these common species will be placed at a greater risk of local extinction.

The impact of habitat loss (ie, reduced area of occupancy) on fauna as a result of the proposed activities will be reduced by the provision of habitat offsets (see discussion on acid frog and Ground Parrot mitigation, Section 8.17). In consideration of these offsets, the impacts of habitat loss on fauna is expected to be negligible.

8.16.1.2 Habitat degradation

In addition to direct habitat loss through clearing, habitat degradation can render previously suitable habitats unsuitable, or less suitable (Hobbs 2001). Sources of habitat degradation associated with the current project include:

- Edge effects resulting from clearing and/or modification of vegetation.
- Reduced water quality (particularly increased salinity).
- Modification to hydrologic regimes.
- Changes to vegetation.
- Invasive species (including competitors, predators or weeds).
- Light pollution.
- Increased noise.

Each of these sources of habitat degradation is considered in more detail below.

<u>Edge Effects</u>

The removal and modification of vegetation can affect faunal values within adjoining habitat directly (via changes in ambient light, temperature and humidity) and indirectly (via changes in the structure and/or floristic composition of vegetation as well as increased predation by, and/or competition with, species associated with more open/disturbed habitat). The extent and severity of these 'edge effects' is largely dependent on the contrast between modified and retained/remnant habitats, with edge effects more pronounced where there is a marked contrast between the modified and retained habitat.

Existing edges surrounding the SCA are complex; some areas have high contrast (where adjoining habitats differ markedly in structure (eg, around RWY 12/30), while other areas have less contrast (eg, around the helicopter training area). However, even in areas with high contrast, visible evidence of deleterious edge effects (ie, degradation of vegetation adjoining areas of cleared/modified habitat) are difficult to detect. Deleterious impacts on terrestrial vertebrate fauna are also difficult to discern with the diversity and abundance of native fauna along disturbance edges similar to that further back away from edges. Edge effects associated with clearing/modification of vegetation during construction of the new runway are therefore unlikely to result in significant degradation of retained habitat, provided no new exotic species are introduced and abiotic factors (eg hydrologic conditions) are not affected.

<u>Water quality impacts</u>

Saline discharge into groundwater

Increased salinity is known to affect vegetation composition, which in turn would affect fauna community composition. Salinity can also affect amphibians, with embryos and larvae unlikely to tolerate salinities greater than one to five per cent sea water (350 mg/L to 1,750 mg/L) (Shoemaker 1992; Gomez-Mestre *et al*., 2003; Chinathamby *et al*., 2006; Sanzo *et al*., 2006).

Recognising this risk, the Project has included a number of inherent design measures to limit saline discharge (see Section 8.15.3). Modelling the success of these design measures on saline influence has indicated that salinity concentrations in the regional aquifer 50 m from the northern perimeter drain are likely exceed 1,000 mg/L 200 years after filling is complete, while concentrations 150 m from the northern perimeter drain are not expected to exceed 500 mg/L some 300 years after filling is complete.

While these concentrations are higher than existing surface water (which is typically <100 mg/L), mixing of the regional and perched aquifers will be limited by a layer of coffee rock (see Section 8.15.3 for details). Based on the assessment provided in Chapter B3 – Geology, Soils and Groundwater, upward mixing of groundwater across the coffee rock layer is unlikely, and should it occur, saline impacts would be localised.

Uncontrolled discharge from pipeline

Uncontrolled discharge of salt water from the sand delivery pipeline could also result in localised impacts on surface and groundwater quality (i.e. increased salinity). Should unexpected discharge occur, the placement of the pipeline to the east of an existing access road (along the eastern boundary of the WHMA) and south of the north perimeter drain is likely to limit impacts within the WHMA. Leakage from pipes could, however, impact upon areas of Ground Parrot foraging habitat to the east of the WHMA (see below for discussion). To help mitigate this risk, the sand delivery pipeline along the eastern WHMA boundary will be checked regularly for leaks or signs of fatigue/damage.

Controlled discharge from the northern perimeter drain

The planned discharge of tailwater from the fill platform via the northern perimeter drain during construction could affect water quality (i.e. salinity and turbidity levels) along the lower (tidal) reaches of the Marcoola drain. The resulting impacts on water quality, however, are expected to be minor with median salinity levels increasing only slightly (by up to 26 ppt). Turbidity and TSS levels within the Marcoola drain are also likely to increase by 25 to 38 per cent during the construction period. Impacts on water quality further downstream along the Maroochy River are even less detectable and within the bounds of natural variation due to rapid mixing of discharge with tidal waters at the Marcoola drain entrance (see Chapter B6 – Surface Water and Hydrology). Any possible impacts on fauna (such as a reduction in the availability of benthic invertebrate prey due to reduced water quality) is expected to be largely negligible.

Altered hydrologic conditions

Groundwater studies have recognised that a layer of indurated sand ('coffee rock') plays an important role in impeding vertical water flow (see Chapter B3 – Geology, Soils and Groundwater), and therefore contributes to sub-surface and surface water ponding. The construction of the northern perimeter drain, which in places would approach coffee rock depth, could cause localised drawdown affecting surface water ponding (extent and duration) within the adjacent Mt Coolum National Park and WHMA. If allowed, changes to water hydrology could result in modification to habitats, affecting fauna composition as well as reducing breeding opportunities for amphibian species.

Recognising this risk, the project has been modified to include a cut-off wall (see Section 8.15.3). By preventing lateral water movement, the cut-off wall will prevent water drawdown within adjacent sensitive values. Based on the assessment provided in Chapter B3 – Geology, Soils and Groundwater, no changes to existing sub-surface or surface water hydrology within the adjacent Mt Coolum National Park or WHMA is expected.

Weed Invasion

Weeds can significantly alter the structure and floristic composition of native vegetation both directly (by displacing/outcompeting native plant species) and indirectly (by modifying ambient conditions and the frequency and intensity of fire). While potentially benefitting some species, resulting changes in vegetation cover are more likely to impact negatively on resident fauna. Some weed species may also cause mortality of native fauna directly by trapping and/or poisoning native animals (eg, Silver-leaved Desmodium, *Desmodium uncinatum*)

While standard weed control measures are inherent in the project design (including the removal of a large area of exotic grass currently threatening acid frog and Ground Parrot habitat in the south-western corner of the WHMA), additional measures will assist in reducing the risk of weed impacts (see Section 8.6.6).

Invasive fauna species (including feral predators)

Clearing of native vegetation may provide invasive animals with improved access to foraging resources within areas of remaining habitat to the detriment of native taxa. Of particular concern in this regard are exotic mammalian predators such feral cats, dogs, foxes and pigs which can have a considerable impact on native fauna in areas of remnant habitat (Dickman 1996b; Bradshaw *et al*., 2007).

The SCA is located in an area subject to historical clearing and fragmentation of native vegetation, and as such, exotic species are already present within lands surrounding the SCA. Furthermore, the proposed actions are unlikely to increase food resources for predatory taxa (ie, cat, fox, dog and pig) and it is therefore unlikely that the proposed actions will lead to the introduction of new invasive fauna, or lead to a significant increase in the abundance of invasive species in surrounding native habitats.

Under existing conditions, predators are excluded from sensitive fauna habitats within the SCA by the perimeter security fence. Construction of RWY 13/31 will require a new perimeter fence, following the decommissioning of the existing perimeter fence. Maintaining a continuous uninterrupted perimeter fence is a key security requirement, and as such, existing predator exclusion conditions will be maintained.

Light Pollution

Changes in ambient light are known to affect the physiology and behaviour of fauna with important consequences for foraging success, reproduction, predator avoidance, changes to circadian rhythms, and navigation (Salmon 2003; Longcore and Rich 2004; Rich and Longcore 2006; Navara and Nelson 2007; Perry *et al*., 2008). Light from anthropogenic sources (eg, street lighting) can therefore affect the distribution and abundance of fauna (Perry *et al*., 2008). Though there are few studies on the impacts of artificial lighting on Australian fauna, research has shown behavioural changes in most faunal groups, for example sugar gliders, amphibians, sea turtles, and birds (Ogden 1996; Longcore and Rich 2004).

Artificial lighting used during construction and operation of the new runway is likely to affect night light levels within habitat adjacent the development area. Sources of artificial light associated with the new runway include:

- Temporary lighting used during construction.
- Approach lighting on the new RWY 13/31 including Simple Approach Lighting System (SALS), High Intensity Runway Lights (HIRL) and Precision Approach Path Indicator (PAPI).
- Operational and security lighting associated with airport buildings and hangars.

The nature of these light sources, their impact on ambient light levels within the Study Area, and resulting impact on fauna are discussed in detail below.

Construction lighting

Twenty-four hour construction lighting would be required during dredging and reclamation works, over a three to six month period. Construction lighting associated with these activities is likely to include mobile light towers, typically consisting of two to four 1,000 w lights on 6 to 9 m extendable poles. While these lights are directional, limiting the extent of light spill to a confined area, some minor localised light spill is likely.

During construction, nocturnal lighting would only be required at the fill face during sand delivery, which would move north-west across the fill platform in a systematic manner. As such, areas of adjoining habitat would not be subject to light exposure for the entire reclamation period. Therefore, any light exposure is anticipated to be relatively short in duration.

Light penetration during sand placement would be influenced by vegetation characteristics: areas of dense vegetation (e.g. *Melaleuca* forest) would be least affected, while light spill in very open habitats (e.g. modified grasslands) would be more extensive. Most vertebrate species inhabiting these communities are widespread and abundant within the local region, and as such, impacts during construction on the broader vertebrate community are likely to be minor. Impacts of lighting on threatened fauna species are considered individually elsewhere in this report.

Light spill during other stages of development is not expected to significantly exceed existing conditions.

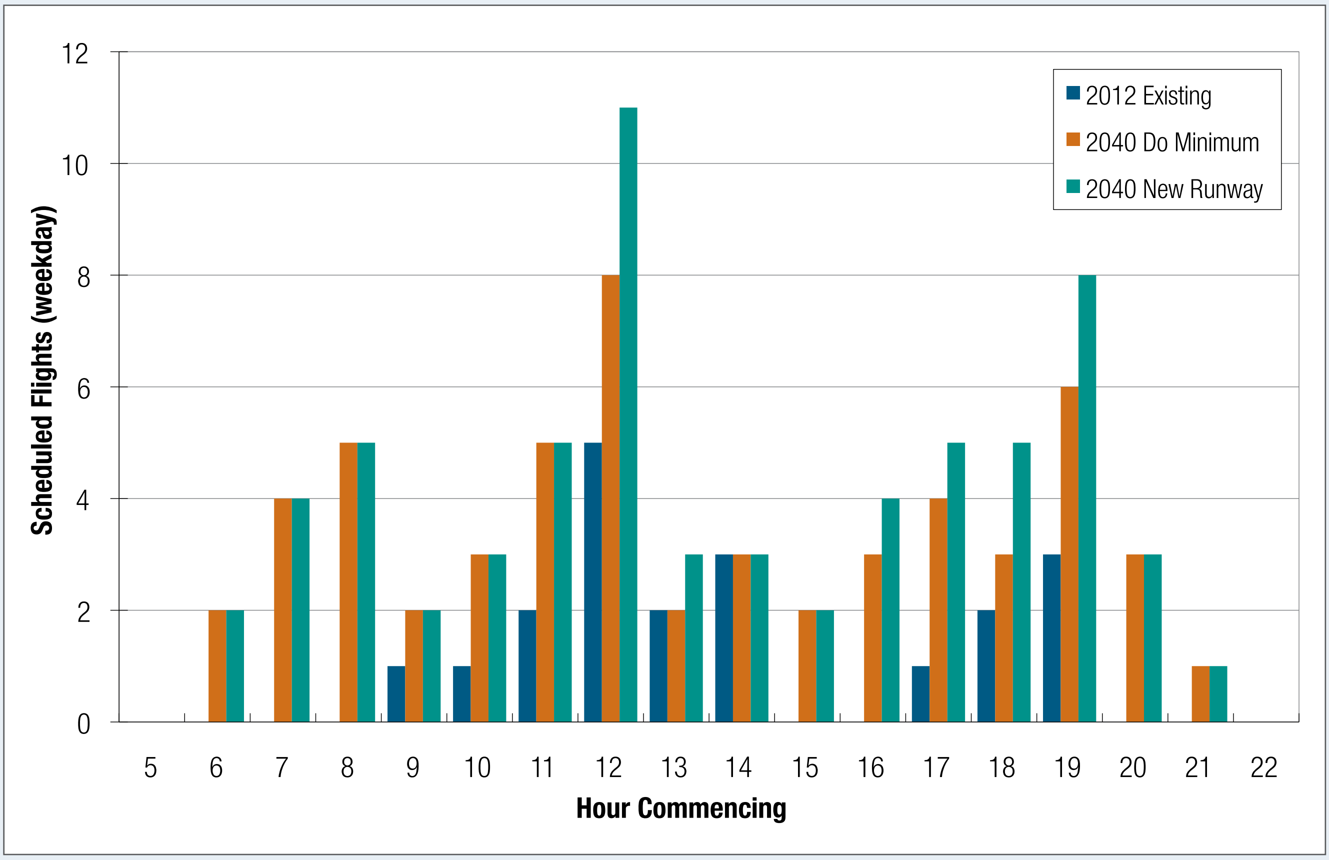
Approach lighting

Approach lighting is used under poor light (i.e. at dusk and dawn, at night and with inclement weather) on plane approach and departure (HIRL only) and would be operational for a duration of approximately five minutes/flight. Regular Passenger Transport (RPT) flights are only expected between the hours of 6.00am and 9.30pm, and therefore possible impacts from approach lighting would be restricted to a few hours following dusk (with less potential for impact during the longer summer days).

Currently four RPT flights land at the SCA after 5.00pm (when lighting is poor), with the last flight scheduled at 9.30pm. Based on predicted schedules, flight frequency would increase in both the 'do minimum scenario' (i.e. minimal development, the existing runway retained) as well as the 'new runway' scenario (**Figure 8.16b**). By 2040, RPT flights are expected to increase to 14 flights after 5.00pm in the 'do minimum' scenario, while 18 flights are expected under the 'new runway' scenario. No RPT flights under either scenario are expected after 10.00pm. The new runway would therefore result in only a small increase in predicted flight frequency.

General Aviation (GA) flights, which include private aircraft and freight, occur sporadically at the current airport. Future GA flightpaths under the new runway scenario cannot be accurately predicted. However it is expected that GA movements would increase irrespective of the proposed RWY 13/31 development (see Chapter D3 – Aircraft Noise).

Figure 8.16b: Current and predicted RPT flight frequency



Weekend flight schedule with slightly fewer flights, particularly early (6-7am) and later (9pm) in the day.

Calculations based on omnidirectional lighting suggest that at a distance of 130 m from SALS and HIRL, light intensity would approximate 1.2 and 0.6 lux respectively. Considering highly directional lighting would be used, and retained habitats (i.e. Mt Coolum National Park and the WHMA) are at least 150 m from these light sources, intense light spill is unlikely.

Precision Approach Path Indicator lighting would be much closer, approximately 95 m from remnant vegetation. Omnidirectional PAPI lights would produce approximately 2.67 lux at a distance of 75 m. However, as with other approach light sources, these lights would be highly directional, significantly reducing light spill into surrounding native vegetation.

Considering the operational time would be restricted to periods before 10.00pm, and low level of light spill into retained habitats, no approach light impacts on native fauna communities are expected.

Operational lighting

Operational lighting that has the greatest potential to affect fauna would be permanent lights, such as street and building lights. However several factors suggest these lights would not significantly affect surrounding fauna values:

- Existing safety lighting is already in operation at the SCA.
- The proposed construction of high-mast, high-intensity metal halide floodlights (MOS 139 compliant) on aprons will be minimal (i.e. one new light; eight existing) and located within an existing developed area.
- While illuminated throughout the night, apron flood lights (MOS 139 compliant) would be at full intensity only until shortly after last flight, following which they are dimmed by approximately 50%.
- Other intense light sources such as operational areas adjacent hangars etc, would be directed toward the new 13/31 runway away from existing habitats and shielded by buildings.

The proposed 13/31 runway would separate all northern habitats from operational nights.

Light impacts to bat communities

Bats are solely nocturnal, highly mobile (i.e. more likely to come into contact with artificial lights) and forage at a height where light spill is most likely. As such, this group of mammals may be disproportionately affected by artificial lighting.

Current research suggests that bat response to light is species-specific (eg Jung and Kalko 2010). Some species, which are not light adverse, would benefit from lighting due to an associated increase in insect abundance. Other species are light adverse, and in some cases even small amounts of light may impinge on activity (Patriarca and Debernardi 2010).

In one of the few Australian studies investigating the response of microbats to artificial lighting, Scanlon and Petit (2008) found that within an urban matrix highest bat foraging activity was correlated with dark parks rather than artificially lit parklands. Well lit parklands advantaged some species, such as *Chalinolobus gouldii* and *Mormopterus* species. In contrast, Adams *et al*., (2005) found that more bat species were detected in lit areas and the number of foraging passes increased; although several species were identified less often in lit areas (eg *Nyctophilus* spp., *Chalinolobus morio*). The difference in these studies probably underlines the species-specific response of bat species to lighting and the potential loss of light-sensitive bat species in urban areas.

While some species identified at the airport are likely to be light adverse, light spill is expected to be limited in extent and duration (as discussed above). As such, light impacts on bat communities or species would be low, possible undetectable.

Larger Flying-foxes are often observed moving over well-lit urban areas with significant light pollution. Light impacts from the proposed activities are therefore not expected to affect this group of mammals.

Increased Noise

While sudden loud noise can initiate an immediate flight response in most wildlife, noise is most likely to affect fauna which communicate through sound. Fauna (in particular amphibian and bird species) may use sound to (1) attract and bond with mates, (2) defend territories, (3) maintain contact with social groups, (4) beg for food (birds), and/or (5) warn of approaching danger (Parris and Schneider 2008). Increased ambient noise from anthropogenic sources can reduce the distance over which acoustic signals can be detected, by interfering or masking call detection/efficacy. This can result in a variety of impacts on individual species or affect vertebrate community composition/structure (Reijnen and Foppen 1994; Reijnen *et al*., 1995; 1996; Forman *et al*., 2002; Parris and Schneider 2008; Katti and Warren 2004; Sun and Narrins, 2005; Bee and Swanson, 2007; Hoskin and Goosem, 2010; Eigenbrod *et al*., 2009).

Construction Noise

Construction noise associated with the proposed activities is most likely to simulate the low-frequency constant noise associated with roadways, and as such, has the potential to affect bird communities. Amphibian communities are less likely to be affected, with construction works to be restricted to between 6.30am and 6.30pm in all phases except Package 2, dredging and reclamation (see Chapter B15 – Noise and Vibration for more details).

Initial modelling of construction noise suggested noise levels within adjacent sensitive environmental areas (i.e. Mt Coolum National Park and the WHMA) might be higher than desired. Mitigation measures were included within the Project design, and subsequent modelling shows that noise levels are not expected to increase above existing background noise levels, except in very close proximity to construction. These impacts are relatively minor, localised, and temporary. While construction noise may disadvantage a small number of individuals close to the development for short periods, it is not expected to lead to long-term changes in vertebrate communities.

Aircraft/helicopter Noise

The main source of existing aircraft noise, RWY 18/36, is approximately 100 m from sensitive habitats (ie, the WHMA), while the new RWY 13/31 centreline is approximately 400 m from retained habitats. Noise modelling predicts that the increased distance, and advances in new aircraft design, will ensure that noise amplitude under the new runway conditions will not exceed existing levels.

While noise amplitude should not increase, flight activity on the new runway may increase the frequency of peak noise periods. Predicted 2040 RPT flight schedules suggest flight frequency will increase, although flight frequency is expected to be similar under both ‘do minimum’ and ‘new runway’ scenarios (see **Figure 8.16b**). Average flights during daylight hours (6 am to 5 pm), when birds are active and calling, will increase from 1.3 movements per hour to 3.5 movements per hour under the ‘do minimum’ scenario and 4 movements under the ‘new runway’ scenario. Peak flight frequency will coincide with the hour commencing at midday, with 8 predicted flights under the ‘do minimum’ scenario and 11 under the ‘new runway’ scenario. Far fewer flights (no more than 5 per hour) are expected under either scenario in the hours prior to 11am.

Assuming each flight produces elevated noise levels sufficient to mask bird calls for a duration of 2.5 minutes, large periods of the day will remain unaffected. This may cause minor temporal changes in calling behaviour (ie, individuals may cease calling during elevated noise), but on balance is not expected to affect vertebrate communities.

Predicted increases in runway usage during the evening are also similar under both future scenarios. The last RPT flight is anticipated at 9.30 pm, leaving extended periods during the night for nocturnal fauna to avoid the effects of noise.

The proposed RWY 13/31 is not expected to increase the frequency of helicopter flights (Chapter D5 – Aircraft Noise). Over time it is anticipated that circuit training of all types would gradually decrease as demand for RWY 13/31 usage by arriving and departing aircraft increases.

While unlikely to significantly affect the amount of aircraft noise any more than the ‘do minimum’ scenario, operation of the new runway will shift the geographical location of noise sources, and therefore exposed new areas to aircraft noise while relieving others.

8.16.1.2 Loss of Movement/Dispersal Corridors

Clearing and development activities will affect two potential movement corridors, the BPA-mapped state significant corridor located to the immediate west of the existing airport, and the narrow foredune corridor east of the SCA. The BPA mapped state significant corridor along the Maroochy River will remain largely unaffected and is not considered further.

Western (state significant) Corridor Impacts

Development of the new runway (13/31) will intersect the western state-significant corridor, separating vegetation in the north and southern sections of Mt Coolum National Park by a distance of approximately 550 m. For the most part, cleared land along this runway is unlikely to support any vegetation other than mown grass/sedges. The new runway will also be surrounded by a 2 m high chain-wire fence (necessary for airport security and also benefits protection of ground parrot), and as such movement of ground-dwelling fauna along the western corridor is likely to be reduced. In some cases (eg, large native animals and cover-dependent species with low mobility) movement north-south across the runway may no longer be possible, leaving animals in the southern section of Mt Coolum National Park isolated from habitat in the northern section of Mt Coolum National Park.

Movement of other ground-dwelling fauna (eg, small mammals, reptiles) across the new runway may also be constrained by surface water along the northern perimeter drain.

Saline water will discharge into the northern perimeter drain for some time during and after hydraulic delivery of sand. The presence of saline surface water may limit the movement of terrestrial fauna sensitive to elevated salinity such as frogs. Given that the hydraulic conductivity within the upper perched aquifer of the runway is higher than that below (i.e., the regional aquifer), it is unlikely that saline discharge will persist within the northern perimeter drain for more than 5 years. As such, saline water is unlikely to affect movement of frog species across the new runway in the long term.

As discussed, there is limited potential for southern movement (connecting to the Maroochy River Conservation Reserve) and, based on current designs, the most likely scenario is the isolation of these ground-dwelling species in the southern section of Mt Coolum National Park. Recognising this potential impact, mitigation measures have been developed in Section 8.17.6.

Bird species, being more mobile, have greater potential to move across areas of cleared land. However, while some bird species move readily through treeless areas (eg, honeyeaters); others are reluctant to move far from vegetation (eg, fairy-wrens, scrubwrens etc). Movement of these species to and from the southern section of Mt Coolum NP may therefore be reduced.

Similarly, some insectivorous bat species (microchiropterans) will readily move across open land, or through areas with artificial lighting, while others are more reluctant to do so. While it is known that bat response to lighting and open environments is species-specific, data available on the particular bat species which occur at the SCA is scant. At least one species (*Nyctophilus bicolor*) is light averse and a ‘clutter’ species and, similar to *N. gouldi* (Threlfall *et al*., 2013), will be reluctant to cross open areas with artificial lighting. The impact on the movement of other insectivorous bats remains unknown.

Large flying-fox bats (megachiropterans) readily move across urban areas with existing light pollution and open, modified landscapes. The proposed development is therefore unlikely to affect the movement of this group of nocturnal mammals.

Foredune Corridor Impacts

To facilitate development, a small section of foredune vegetation (approximately 20 m wide) will be cleared for installation of a temporary pipeline for sand-fill operations. There operations are expected to be completed within three to six months and revegetation works will follow, and as such, impacts will be temporary. Most fauna species moving to/from SCA along this corridor will have already crossed David Low Way, and therefore show a high level of mobility. Localised clearing of dunal vegetation is unlikely to constrain movement of these animal species. Movement of less mobile fauna north-south along this corridor could, however, be interrupted during sand-fill operations.

8.16.2 Wallum Sedgefrog

8.16.2.1 Habitat loss (reduced area of occupancy) and Associated Mortality

Habitat Loss

Construction of the new runway would necessitate the clearing and filling of known (occupied) Wallum Sedgefrog habitat within the SCA. This includes 1.67 ha of wet heath and sedgeland mapped as known or likely Wallum Sedgefrog breeding habitat within the WHMA and adjoining helicopter training area (23.4% of total habitat; **Figure 8.16c**). Intervening areas of remnant and non-remnant regrowth heath or *Melaleuca* forest, used infrequently by dispersing animals, will also be lost, though this is unlikely to affect movement between areas of retained habitat within and adjacent the SCA.

The loss of habitat surrounding breeding areas is also unlikely to limit foraging/shelter opportunities, for non-breeding animals as these needs are likely to be met within breeding habitat (as evidenced by the continued presence of Wallum Sedgefrogs in breeding areas during dry and wet periods [Lowe and Hero 2013; E. Meyer unpub. obs.]).

Clearing and development of wet heath and melaleuca woodland/forest would result in the permanent loss of 47.07 ha of Essential Habitat (see **Figure 8.16d**), though only a small proportion (<4%, mostly representing areas within the helicopter training area) of this is likely to support breeding by the Wallum Sedgefrog and/or provide foraging/shelter opportunities for non-breeding animals (other than animals dispersing between existing breeding areas). An additional 2.52 ha at the northern tip of the existing 18/36 runway will be temporarily cleared for pipe laydown during construction. Once construction is completed, this area will be rehabilitated. Selective clearing north of the northern perimeter drain (ie, removal of tall woody vegetation through slashing to ensure vegetation does not exceed 1.5 m) is unlikely to render habitats unsuitable for the Wallum Sedgefrog.

The loss of Wallum Sedgefrog habitat will be mitigated through the establishment of compensatory habitat within the SCA (see Section 8.6.1), and provided these measures are successful, no net-loss of habitat is anticipated.

Mortality

In addition to habitat loss, clearing and filling within the SCA is likely to result in mortality of Wallum Sedgefrogs. Abundance data from transects within the clearing zone suggest affected frogs are unlikely to exceed one or two hundred. This is a relatively small number compared with the total estimated population within the SCA (as inferred from count data elsewhere within the WHMA).

8.16.2.2 Fragmentation

In the case of the Wallum Sedgefrog, loss of non-breeding habitat is not expected to have any significant impacts on connectivity between areas of retained habitat as these are located north (and not south) of the proposed runway.

8.16.2.3 Slashing

In order to maintain runway visibility, vegetation to the immediate north of the northern perimeter drain and within the WHMA would need to be slashed repeatedly so that tree/shrub cover remains below 1.5 m (the maximum height allowable immediately adjacent the proposed runway). Slashing would occur within the existing WHMA (an area subject to historic slashing regimes) and extend into areas of remnant vegetation to the immediate north of the northern perimeter drain. Slashing would affect 5.84 ha of remnant vegetation mapped as Essential Habitat, as well as known habitat (not mapped as Essential Habitat) within the retained portion of the WHMA (see **Figure 8.16d**).

Frequent, low slashing has the potential to remove both woody growth (ie, tree/shrub cover) as well as sedge cover resulting in fewer opportunities for foraging and shelter and, potentially, breeding as well. While the loss/reduction in sedge cover is likely to be short-lived (with sedges regrowing rapidly under wet conditions), slashing will result in a permanent reduction in tree/shrub cover. This reduction in tree/shrub cover is unlikely to impact negatively on the Wallum Sedgefrog which isn't reliant on trees or shrub cover for survival. With an appropriate slashing regime, reduced sedge cover is also unlikely to have a significant long-term impact on Wallum Sedgefrog numbers, as evidenced by successful recruitment of Wallum Sedgefrogs in the slashed wet heath/sedgeland of the WHMA and chopper-rolled heath/sedgeland at Caloundra South (PER, 2012).

As well as the aforementioned impacts on habitat, slashing could result in direct mortality of Wallum Sedgefrogs. Though the number of frogs killed and/or injured as a result of slashing is difficult to estimate, habitats within the WHMA support significant numbers of Wallum Sedgefrog (possibly several hundred). The actual number likely to be killed or injured by slashing will most likely depend on when slashing occurs (ie, the timing and frequency of slashing) and the height at which vegetation is slashed. Slashing during wet periods, when frogs are generally more active above ground

Figure 8.16c: Areas of Wallum Sedgefrog breeding habitat within the area of direct disturbance.

Areas of Wallum Sedgefrog breeding habitat within the area of direct disturbance. Assessment of areas mapped as known or likely breeding habitat is based on criteria outlined in Section 1.3.4.

Client: Sunshine Coast Airport | **Project:** Airport Expansion Project

Figure 8.16d: Lost and modified acid frog Essential Habitat (including Essential Habitat for the Wallum Sedgefrog).

Lost and modified acid frog Essential Habitat (including Essential Habitat for the Wallum Sedgefrog).	Scale: 1:7,277 (0, 0.1, 0.2, 0.4 Kilometers)	ecosmart ECOLOGY
Client: Sunshine Coast Airport / **Project:** Airport Expansion Project		

would appear to pose a greater threat than slashing in the 'dry', when Wallum Sedgefrogs may be sheltering at the base of grass/sedge clumps and tussocks. Similarly, slashing of vegetation at or very near ground level is more likely to result in mortality of animals than slashing at heights of >0.5 m. Mortality from slashing, can therefore be managed so as to avoid significant mortality of Wallum Sedgefrog.

Given the above, slashing of vegetation is unlikely to have an enduring impact on the Wallum Sedgefrog provided vegetation isn't slashed too low and/or sufficient time is allowed for sedge cover and numbers of acid frog species to recover.

8.16.2.4 Noise

Construction Noise

While the sensitivity of Wallum Sedgefrogs to noise pollution is unknown, studies on other frog species show high levels of background noise (eg, airplane flyby and traffic noise emanating from busy roads) can interfere with male calling behaviour and female detection of male calls (Sun and Narrins, 2005; Bee and Swanson 2007). Excessive noise during the breeding season could therefore affect reproductive success, although negative noise impacts at other times, (ie, during periods of low rainfall such as winter and spring) is unlikely.

Given the above, noise associated with package 1 and package 3 of construction is unlikely to significantly affect calling/breeding by the Wallum Sedgefrogs since:

- Construction activities during these phases are not expected to continue beyond 6:30pm (Table 8.5b), and
- Active earth-moving machinery is unlikely during, or immediately following, heavy rainfall due to constraints on the movement of machinery over sodden ground.

Unlike package 1 and 3, noise associated with dredge and fill operations (ie, package 2) will occur for start periods during the day and night and, as such, has a greater potential to impact on calling behaviour. Noise during this phase will primarily emanate from the dredge booster pump and associated mobile plant equipment (two dozers in the day and one at night, see Chapter B15 – Noise and Vibration). However, as discussed in Section 8.15.4, mitigation measures are now inherent in the project design and will significantly reduce noise levels in adjacent wallum habitats. Only a small portion of the WHMA will experience construction noise exceeding existing ambient noise levels (ie, LAeq >42 dBA; see), and then only for a relatively short duration (approximately 4 weeks depending on the area). These impacts are unlikely to affect retained Wallum Sedgefrog populations.

Operational Noise

Operation of the new runway would not see any significant increase in air traffic at night to/from the SCA beyond that expected under the 'do minimum' scenario (with aircraft continuing to land on the existing 18/36 runway). Nor would noise produced by aircraft using the new runway exceed existing noise levels within the SCA (see Chapter D5 – Aircraft Noise). As such, RWY 13/31 is unlikely to result in any increase in aircraft noise levels than would occur with ongoing use of the existing 18/36 RWY. The expected increase in aircraft noise, moreover, is unlikely to affect Wallum Sedgefrog calling/breeding behaviour to any great extent given few aircraft movements are expected after 10 pm (except in exceptional circumstances).

While unlikely to increase noise levels within the SCA, resulting changes in aircraft flight paths will, see an increase in engine noise in known habitat to the immediate north (ie, within the northern section of Mt Coolum NP), as well as at mapped Essential Habitat (ie, remnant melaleuca wetland mapped as RE 12.2.7) within Maroochy River Conservation Park, south-east of the SCA. While this increase is noted, it is not expected to affect Wallum Sedgefrog for the reasons outlined above, and also the fact that noise levels of overflying aircraft will be lower than levels within the SCA itself.

8.16.2.5 Lighting

While the response of Wallum Sedgefrogs to increased night light is poorly understood, studies of other species show calling may be inhibited by high levels of ambient light (including moonlight) (Granda *et al*., 2009; Buchanan, 1993; Baker and Richardson 2006). Whether acid frogs are affected by artificial light spill in other ways is unknown. However, available evidence suggests increases in night light are unlikely to impact significantly on the Wallum Sedgefrog, which is known to call strongly on wet overcast days and also moon-lit nights (E. Meyer, pers. obs.; M. Sanders, pers. obs.).

Table 8.16b: Proposed construction works

Package	Works	Proposed Hours	Commencement	Completion
1	Civil	6 days per week, 6.30am-6.30pm	1st Quarter 2016	1st Quarter 2017
2	Dredging	6 days per week, 6.30am-6.30pm with dredging and placement occurring 7 days, 24 hours per day	3rd Quarter 2017	1st Quarter 2018
3	Pavements	6 days per week, 6.30am-6.30pm	1st Quarter 2018	3rd Quarter 2019
4	Terminal upgrades	6 days per week, 6.30am-6.30pm	3rd Quarter 2017	3rd Quarter 2019

Source: Chapter B15 – Terrestrial Noise

Figure 8.16e: Minor short-term (<4 weeks) noise impacts will affect a small area of retained Wallum Sedgefrog habitat during early night works of package 2

Minor short-term (<4 weeks) noise impacts will affect a small area of retained Wallum Sedgefrog habitat during early night works of package 2

Scale: 1:4,745

0 0.1 0.2 Kilometers

ecosmart ECOLOGY

Client: Sunshine Coast Airport **Project:** Airport Expansion Project

The persistence of a healthy breeding population of Wallum Sedgefrogs in similar proximity to existing runway lighting within the WHMA would also argue against a significant impact on this species.

8.16.2.6 Weed invasion

Native undisturbed wet heath and melaleuca habitats around the SCA are relatively resilient to weed infestation, and typically weeds only become dominant following disturbance. Soil disturbance and increased light penetration adjacent to retained native vegetation is inevitable, and as such, the establishment of weeds is likely. However due to the resilience of these habitats, widespread infestation is probably unlikely provided other factors such as nutrients are not adversely affected.

A particularly concerning weed infestation is located in the south-western corner of the WHMA where historic land-use has increased soil nutrients. This area is now dominated by a near monoculture of thick *Megathyrsus maximus var maximus, Melinis repens* and *Sorghum halepense*. Historic air photos suggest that this infestation is gradually spreading, albeit slowly, into adjacent wet heath habitats (ie, the WHMA). This area of weed infestation is within the development footprint and will be removed. Recommendations to ensure its spread have been included within the EMP (see Chapter E3).

Standard and appropriate weed management procedures (see Chapter B7 – Terrestrial Flora) should be sufficient to reduce the risk of weed introduction or spread. However in consideration of the sensitive fauna habitats, particularly within wallum heath habitats (including the WHMA), additional weed monitoring will be undertaken.

8.16.2.7 Altered Water Hydrology and Quality

<u>Increased Salinity</u>

Systematic sampling of existing salinity concentrations in surface waters was not undertaken, however available evidence suggests that salinity is relatively low. Sampling of two drains within the adjacent Mt Coolum National Park found salinity levels in surface water of 70 and 90 mg/L.

The tolerance of Wallum Sedgefrogs to elevated salinity is unknown, although water salinity in wallum habitats which they occupy are typically < 100 mg/L (**Table 8.16c**).

Modelling inherent design features of RWY 13/31 indicates that groundwater salinity concentrations 50 m north of the northern perimeter drain will peak at 1,000mg/L (approximately 200 years after filling is complete) and will not exceed 500 mg/L 150 m from the northern perimeter drain (see Section 8.4.3) (approximately 300 years after filling is complete). While these concentrations exceed the known salinity range of Wallum Sedgefrog habitats, groundwater salinity would be contained by a layer of coffee rock. Based on the information provided in Chapter B3, upward migration of saline groundwater from below the coffee rock is unlikely. Further, should upward salinity migration occur, impacts are anticipated to be localised and minor.

<u>Alteration to Groundwater Hydrology</u>

Surface water within the Mt Coolum National Park and WHMA are seasonal, flooding during the wet season and drying during periods of low rainfall. These habitats, which prevent the establishment of exotic fish, are favoured by Wallum Sedgefrogs and changes to existing conditions may impact habitat suitability/breeding success.

As detailed in Section 8.15.3, the project now includes the installation of a cut-off wall to the immediate north of the northern perimeter drain. This inherent design feature will prevent lateral sub-surface water flow. No drawdown is expected from the proposed northern perimeter drain. Project related changes to existing hydrological conditions in the adjacent Mt Coolum National Park and WHMA are therefore not expected.

8.16.3 Wallum Rocketfrog and Wallum Froglet

8.16.3.1 Habitat Loss (reduced area of occupancy), and Associated Mortality

<u>Habitat Loss</u>

Construction of the new runway will necessitate clearing and filling of Wallum Froglet and Wallum Rocketfrog habitat within the SCA. Estimated loss of breeding and non-breeding habitat for these two species (as a result of resulting clearing and filling) is provided in **Table 8.16d**.

Clearing and filling will result in the loss of known and/or likely Wallum Froglet habitat in the south of the WHMA as well as wet heath/melaleuca woodland to the immediate north-west (ie, immediately adjacent the WHMA and existing cross runway 12/30) (see **Figure 8.16f**). Likely breeding habitat along the existing cross-runway 12/30 will also be lost as a result of clearing and filling (see **Figure 8.16f**). Despite this loss, remaining habitat within the SCA is likely to support a sizeable breeding population numbering in the hundreds.

In the case of the Wallum Rocketfrog, clearing and filling will result in the loss of habitat within the southern WHMA and nearby helicopter training area (see **Table 8.16d** and **Figure 8.16g**). Despite this loss, the vast majority of known

Table 8.16c: Salinity levels in surface water at known acid frog breeding sites outside of the Study Area.*

Species	Salinity range (mg/L)	Information source
Wallum Sedgefrog	7.5-93.75	Simpkins *et al.*, 2013; EcoSmart Ecology, unpub. data
Wallum Froglet	7.5-99.1	Simpkins *et al.*, 2013; EcoSmart Ecology, unpub. data
Wallum Rocketfrog	7.5-37.5	EcoSmart Ecology, unpub. data

Table 8.16d: Estimated loss (ha) of Wallum Froglet and Wallum Rocketfrog habitat

	Estimated Loss of Habitat*	
Species	**Breeding**	**Non-breeding**
Wallum Froglet (*Crinia tinnula*)	60.63 ha	N/A
Wallum Rocketfrog (*Litoria freycineti*)	1.67 ha	20.18 ha

** Excludes areas of known habitat in which vegetation will be slashed but not cleared, as areas of slashed vegetation provide suitable habitat for acid frog species.*

Wallum Rocketfrog habitat (including likely breeding habitat in the centre and north of the WHMA) will be retained. As such, clearing/filling of habitat during construction of the new runway is unlikely to have a marked impact on juvenile recruitment. Areas of retained habitat within the SCA also support much higher densities of Wallum Rocketfrog than habitat within the clearing area, with the vast majority of records within the central and northern parts of the WHMA. As such, retained habitat within the SCA is likely to support a sizeable population of Wallum Rocketfrogs. Clearing is therefore unlikely to affect the long-term persistence of the SCA Wallum Rocketfrog population.

Clearing and filling of wet heath and melaleuca woodland/forest during construction will result in the loss of 47.07 ha of mapped Essential Habitat for both the Wallum Rocketfrog and Wallum Froglet. However, based on field surveys, less than half of this is known or likely to be utilised by the Wallum Rocketfrog. An additional 2.52 ha at the northern tip of the existing 18/36 runway will be temporarily cleared for pipe laydown during construction. Once construction is completed, this area will be rehabilitated. Selective clearing north of the northern perimeter drain (ie, removal of tall woody vegetation through slashing to ensure vegetation does not exceed 1.5 m) is unlikely to render habitats unsuitable for the Wallum Rocketfrog or Wallum Froglet.

Impacts of habitat loss on the Wallum Rocketfrog and Wallum Froglet will be mitigated through the establishment of compensatory breeding habitat within the SCA and broader Sunshine Coast region (see Section 8.6.1). Provided re-establishment of these habitats is successful, no net-loss of habitat is anticipated.

Mortality

In addition to habitat loss, clearing and filling of existing habitat would result in mortality of frogs. Given the abundance of Wallum Froglets within and adjacent the SCA, the number killed during clearing and filling is unlikely to threaten the viability of the local Wallum Froglet population. Wallum Rocketfrogs, by contrast, appear to have a more restricted distribution with most records from the WHMA and helicopter training area. While a significant portion of these two areas will be lost, dense Wallum Rocketfrog records occur in the central and northern areas of the WHMA and therefore the loss of individuals is likely to be disproportionately less.

8.16.3.2 Fragmentation

Clearing of remnant and regrowth vegetation north and east of runway 12/30 may limit opportunities for movement of animals to and from southern Mt Coolum National Park. Movement of the Wallum Froglet and Wallum Rocketfrog across the new runway may also be constrained by saline discharge within the northern perimeter during and after hydraulic delivery of sand. With a significant reduction in saline discharge after 5 years, any resulting impacts on the movement of these species is likely to be short-lived and, as such, saline surface water is unlikely to constrain the movement of Wallum Froglets and Wallum Rocketfrogs in the long term.

With significant numbers of Wallum Froglet either side of the runway, this reduction in movement/dispersal is unlikely to pose a significant threat to the survival/persistence of populations within and adjacent the SCA. With the Wallum Rocketfrog all but absent from southern Mt Coolum National Park and little or no suitable breeding habitat other than that within the SCA, reduced movement/dispersal across the new runway is also unlikely to affect the survival/persistence of Wallum Rocketfrog populations within or adjacent the SCA.

8.16.3.3 Slashing

In order to maintain sight lines along the new runway, vegetation to the north of the northern perimeter drain will need to be slashed repeatedly so that tree/shrub cover remains below 1.5 m.

Slashing in this area will affect Wallum Froglet and Wallum Rocketfrog habitat reducing tree and shrub cover and, depending on the height at which vegetation is slashed, sedge cover as well. While the loss/reduction in sedge cover is likely to be short-lived (with sedges regrowing rapidly under wet conditions), slashing will result in a permanent reduction in tree/shrub cover.

Resulting changes in vegetation cover are unlikely to impact negatively on the Wallum Froglet which is largely terrestrial and is commonly encountered in slashed heath/sedgeland (see EcoSmart 2012; Meyer 2010; Meyer and Hines 2011). In the case of the Wallum Rocketfrog, a reduction in sedge cover could prove beneficial, creating additional areas of breeding habitat for this species (ie, areas of shallow water with sparse sedge cover) (see eg, Meyer, 2010; Hines and Meyer, 2011).

As well as the aforementioned changes in vegetation cover, slashing within occupied habitat could result in mortality of both Wallum Froglet and Wallum Rocketfrog. Mortality levels of these ground-dwelling species is likely to be low, however, provided slashing does not occur below 0.4-0.5 m, as both species are predominantly ground-dwelling.

Figure 8.16f: Wallum Froglet habitat loss and modification

Wallum Froglet habitat loss		Scale: 1:7,277 (0, 0.1, 0.2, 0.4 Kilometers)	ecosmart ECOLOGY
Client: Sunshine Coast Airport	**Project:** Airport Expansion Project		

Figure 8.16g: Wallum Rocketfrog habitat loss

Wallum Rocketfrog habitat loss. Breeding habitats will be offset at 1:1, while the less valueable non-breeding habitats at 4:1 (ie, 25% of lost non-breeding habitat offset).

Scale:

1:7,500

0 0.1 0.2 0.4
Kilometers

Client: Sunshine Coast Airport

Project: Airport Expansion Project

ecosmart ECOLOGY

8.16.3.4 Noise pollution

Construction Noise

Similar to the Wallum Sedgefrog, the specific response of Wallum Froglets and Wallum Rocketfrogs to noise is unknown, although studies of other frog species suggests noise could affect breeding behaviour (Sun and Narrins 2005; Bee and Swanson 2007). However for reasons outlined in Section 8.15.4, construction noise is not anticipated to affect these species during construction of package 1 and 3. Only minor, localised and short-term (approximately 4 weeks in any one area) impacts are expected during the early stages of package 2. These impacts are not expected to affect retained Wallum Rocketfrog or Wallum Froglet populations.

Operation

While the new runway may alter the geographical location of noise, for reasons outlined in Section 8.5.2.4, no significant increase in noise impacts are expected during operation on retained populations of Wallum Rocketfrog or Wallum Froglet.

8.16.3.5 Lighting

Available evidence suggests increased lighting will have little impact on the Wallum Froglet, which calls and breeds readily by day as well as on moon-lit nights (E. Meyer, pers. obs.).

While less well understood, light impacts on the Wallum Rocketfrog could be similar to those documented in other frog species, such as affecting call frequency, mate selection, and therefore breeding success (Granda *et al*., 2009; Buchanan, 1993; Baker and Richardson 2006). However, it is not expected that light will affect this species, either during construction or operation, as:

- Construction lighting adjacent breeding habitat (ie, the retained WHMA) will be restricted to reclamation activities (ie, early and mid stages of package 2). Package 2 construction activities will be restricted to a period of approximately three to six months, and as such, light spill will be short-term.
- Lighting associated with reclamation activities will be directional, and light spill is not expected to be significant.
- Apron lighting associated with terminal structures are not expected to significantly increase in intensity or duration. Four existing apron lights currently project toward the WHMA; one additional apron light projecting toward the WHMA will be constructed. Further, the construction of runway 13/31 would require vegetation removal from the southern WHMA, extending the distance between apron light sources and acid frog habitats from approximately 370 m to 680.
- Runway lighting would be operational for only a small portion of the night shortly following dusk (no lighting anticipated after 22.00) and is not expected to significantly increase light spill to nearby acid frog habitats (see Section 8.5.4.3) for discussion on light intensity from runway lighting).

8.16.3.6 Weed invasion

The movement of vehicles, machinery and personnel during construction of the new runway could facilitate the introduction and spread of invasive weed species into acid frog habitat within the SCA. While the risk during operation is greatly reduced, activities such as slashing (particularly in areas of heathland) may also spread existing weeds or result in the establishment of new weeds.

Existing remnant vegetation and advanced heath regrowth appears relatively resilient to weed infestation, and as such, widespread weed infestation is unlikely. Standard and appropriate weed management procedures (see Chapter B7 – Terrestrial Flora) should be sufficient to reduce the risk of weed introduction or spread. However in consideration of the sensitive fauna habitats, particularly within wallum heath habitats (including the WHMA), additional weed monitoring will be undertaken.

8.16.3.7 Altered Water Hydrology and Quality

Increased groundwater salinity

While the specific tolerance of Wallum Froglets and Wallum Rocketfrogs to salinity is not known, habitats in which these species are known to occur are typified by concentrations less than 100 mg/L. A number of measures have been included within the design of RWY 13/31 to reduce the effects of saline waters on adjacent values. Modelling post-development salinity suggests that groundwater salinity will increase in proximity to the development. However based on the assessment provided in Chapter B3, the likelihood of upward migration of groundwater below the coffee rock layer into shallow sub-surface and surface waters is unlikely. If upward migration was to occur, impacts are likely to be localised and minor.

Altered Groundwater Hydrology

The project design includes a cut-off wall to the immediate north of the northern perimeter drain. This measure has been included to ensure there is no drawdown of sub-surface groundwater from the proposed development in the adjacent Mt Coolum National Park or WHMA. As such, existing hydrological regimes within retained Wallum Rocketfrog and Wallum Froglet habitats will be preserved.

8.16.4 Ground Parrot

8.16.4.1 Direct Habitat Loss (reduced area of occupancy)

Loss of Habitat within the SCA Precinct

Ground Parrot habitat within the SCA precinct (including the helicopter training area) includes a subset of, and extends beyond, areas of mapped Essential Habitat for this species. Ground Parrot abundance and activity within the WHMA and helicopter training area is consistently higher and more stable than surrounding areas of Essential Habitat. Therefore, under current management practices in nearby National Park estate, habitats within the SCA appear key to the long-term persistence of the species in the Marcoola region.

Construction and operation of the new 13/31 runway would result in the permanent loss of 15.06 ha (37.5%) of vegetation within the WHMA. Approximately 7.88 ha of this area is currently used by Ground Parrots (based on 95% CI mapping of study records). The majority of active Ground Parrot habitat in the WHMA and helicopter training area is located north of proposed clearing. Importantly, areas of highest activity (representing 50% CI) will not be affected, while only 0.11 ha of habitat supporting moderate activity (75% CI) would be permanently affected (**Table 8.16e**).

A narrow strip of open modified land to the immediate south-east of the retained WHMA will remain post-construction. Ground Parrots are reluctant to venture far from dense vegetation (never seen more than 50m from cover during Ground Parrot surveys), and while currently used for foraging, the long-term value of this southern strip may be reduced due to increased distance from cover.

In addition to the aforementioned losses, some temporary habitat loss will occur with the construction and operation of the sand delivery pipeline (a period of 6-9 months). Based on a corridor width of 15 m, this would affect approximately 0.81 ha of Ground Parrot foraging habitat (including 0.51 ha of 75% CI and 0.31 ha of 95% CI). The proposed pipeline runs east of, and immediately adjacent to, the eastern WHMA perimeter road. On completion, this pipeline will separate the WHMA, located to the immediate west of the pipeline, from the retained narrow strip of mown forage habitat to the immediate east of the pipeline. While the pipeline will be raised on mounds, the value of this area may be slightly less favourable to Ground Parrots as: (1) the 1m diameter pipe will place a physical barrier between foraging birds and refugia, requiring animals to break from traditional short-distant movement behaviour (ie, flight just above, or movement along, the ground), and (2) a visual barrier will be placed between foraging birds and refugia.

Loss of Essential Habitat

Records from this work suggests that under current conditions mapped Essential Habitat adjacent and surrounding the SCA, is unlikely to be used by Ground Parrot (eg, immediately to the west of the WHMA) or, at best, inhabited by low numbers of Ground Parrots. Nevertheless, these mapped habitats are generally consistent with prescribed essential habitat factors, and recolonisation is possible under different environmental conditions (ie, with more frequent fire). The potential loss of essential habitat (22.84 ha) due to the proposed development accounts for approximately 15.2% of essential habitat available to Ground Parrots in the Marcoola area (ie, essential habitat north of David Low Way and south of Suncoast Beach Drive), although it is recognised that under current conditions a portion of mapped essential habitat is likely to be uninhabited.

A range of mitigation measures have been suggested to alleviate the impact of habitat loss on this species, including augmentation/improvement of existing habitats, creation of new habitats, and management of regional habitats to better improve Ground Parrot population viability on the Sunshine Coast.

Increased Mortality (during clearing)

Adult Ground Parrots are mobile and likely to avoid direct mortality during vegetation clearing. Nestlings and fledglings however, cannot quickly relocate, and as such, mortality could occur if clearing coincided with breeding (ie, August and September).

Displaced birds, which could number be between 1 and 3 individuals, are unlikely to relocate to nearby habitat (which appears unsuitable under current conditions). Nor are displaced individuals likely to relocate into adjacent occupied habitat due to increased competition, and possible aggression from, established birds. Rather, without mitigation displaced individuals are likely to be permanently lost from the population, representing a reduction of the local Marcoola population by approximately 10%.

8.16.4.2 Fragmentation (leading to isolation)

Juvenile Ground Parrots have been recorded considerable distance from areas of known habitat, suggesting long-distance movement is possible. However there appears to be no direct evidence of flight behaviour that could be attributed to long-distant Ground Parrot movement (ie, flights high above the vegetation for long-distances, or a series of short-flights in a specific direction). Rather, birds fly short distances just above the vegetation before dropping into cover (McFarland 1989). Long-distant movement by other reclusive bird species occur under the cover of darkness, and we therefore suggest that long-distance Ground Parrot flight occurs at night, or perhaps during low-light hours (when birds can be observed flying during call bouts). Under such conditions birds could move over open habitats (including cleared landscapes), a possibility which is supported by the

Table 8.16e: Total existing, and anticipated loss, of Ground Parrot habitat based on 2011/12 activity

Habitat	Total extent of habitat (ha)	Extent lost (ha)				
		50% CI	75% CI	95% CI	Total	% of total habitat
Permanent habitat loss#	30.01	0	0.11	7.77	7.88	26.2%
Temporary habitat loss		0	0.31	0.51	0.81	2.70%

*# Based on active areas assessed using kernel density analysis in this study; see **Figure 8.9b**.*

Figure 8.16h: Extent of Ground Parrot habitat loss at SCA (based on 2011/12 activity)

Extent of Ground Parrot habitat loss at SCA (based on 2011/12 activity)		Scale: 1:4,231
Client: Sunshine Coast Airport	**Project:** Airport Expansion Project	

probability that documented long-range movements are likely to have included open areas.

However movement and passage may be significantly affected by landform features, and in particular, movement and artificial lighting associated with urbanisation may be avoided. This may, for example, explain why Ground Parrots have not recolonised the Mooloolah River National Park (which is separated from known populations by expansive areas of urban development) since local extinction in the 1980's, despite the apparent presence of suitable habitat.

Data suggests that Ground Parrots, under current conditions, are able to move south into the southern section of Mt Coolum NP (ie, as evident by the appearance of birds at monitoring locations after periods of apparent absence). Based on the above, it seems possible that birds would avoid 24hr light, noise and movement associated with the existing airport infrastructure, and as such, the most likely passage is to the west of existing hangers. Whether remnant vegetation is used in preference to a more direct flight over an un-illuminated runway (ie, existing runway 12/30), is unknown.

Construction of the new 13/31 runway would result in the loss of remnant vegetation to the immediate north-west of the existing 12/30 runway. Ground Parrot habitats in the northern (ie, the WHMA and northern section of Mt Coolum NP) would be separated by approximately 550m of open artificial habitats from Ground Parrot habitat in the south (ie, the southern section of Mt Coolum NP). Due to lighting, noise and movement, bird passage over the new runway during operational hours seems highly unlikely, and as such, the opportunity for Ground Parrot movement will be slightly more restricted, confined to periods after approximately 9:30pm (ie, last scheduled RPT flight). However, while there may be some slight reduction in movement frequency, some north/south movement over runway 13/31 is more likely than not.

Increased light, noise and movement during construction may also hinder Ground Parrot movement where it coincides with periods of low ambient light (ie, dusk/dawn/night). Night works are not scheduled for packages 1 and 3 (works to occur between 6.30am and 6.30pm), though activities may continue beyond dusk during the months of March (part) to October (ie, during periods of short day length).

Package 2 dredging works will include 24 hour operation, (with sand discharge occurring 2 -3 times for up to 2.5 hours in any 24 hour period) but is expected to be completed in 14-33 weeks, with works more likely to be completed early in this period than later. Overnight artificial lighting and work during this package of works will be restricted to the fill face. Lighting and work associated with the fill face is likely to be restricted to a length of runway rarely exceeding more than 200 m. Furthermore, fill activities will progress gradually from the south-east to the north-west of runway 13/31, and as such, nocturnal light sources located between Ground Parrot habitats during construction will be temporary.

As part of package 3 works, a batch processing plant (which will require 24hr security lighting) would be required near the new 13/31 runway. While light spill from this source is likely to be limited, particularly if directional lighting and spill guards are installed, its location reduces the area through which Ground Parrots may move under the cover of darkness. As an additional mitigation measure, this light source would be located to avoid possible Ground Parrot movement passage ie, at the northern or southern end of the runway.

8.16.4.3 Lighting

Light from artificial light sources can significantly affect the behaviour and physiology of animals and therefore the presence and abundance of fauna in areas affected by light pollution. In the case of the Ground Parrot, increased night light levels within the SCA could increase the risk of predation by foxes and cats (see eg, Daly *et al*., 1992; Mouget and Bretagnolle 2000). The likelihood of increased predation, however, is considered low, due to the 2.4 m high chain-wire predator-proof fence which surrounds the airport. Adverse impacts on foraging behaviour are also unlikely as Ground Parrots forage during the day.

Unlike many bird species, Ground Parrots have discrete calling periods which are influenced by ambient light (ie, calling occurs at low-light conditions around dusk and dawn). Increased ambient light levels within the SCA could therefore lead to changes in Ground Parrot calling behaviour. The disruption of these calling 'bouts' has the potential to affect mate selection and territory establishment leading to reduced breeding success.

Potential lighting sources at the SCA which could interrupt or modify Ground Parrot calling would include runway lighting, operational lighting, and construction lighting.

Runway lighting

Approach lighting would include a Simple Approach Lighting System (SALS), and High Intensity Runway Lights (HIRL). The SALS lighting is positioned at either end of the runway strip, well away from Ground Parrot habitats, and both lighting systems are directional, pointing parallel to the runway. The HIRL is positioned at ground level and of variable intensity, with the highest intensity used only in very poor visibility conditions (ie, during heavy fog or rain). Approach lighting is only operational during low-light, and is not illuminated when the runway is not in use. It is expected that runway lighting would be operational for approximately five minutes during arrival and departure.

Omni-directional SALS and HIRL calculations suggest that, at a distance of 130 m, light levels will be no more than ~1.2 and ~0.6 lux respectively. Ground Parrot habitat (within the WHMA) is at least minimum distance of 150 m from these light sources, and in contrast to omni-directional calculations, the SALS and HIRL lighting will be highly directional and light spill is likely to be low or negligible.

Precision Approach Path Indicator (PAPI) lighting will be considerably closer to Ground Parrot habitats. At a distance of 75 metres, omni-direction calculations suggest light spill from this source would be no more than ~2.7 lux. However, similar to SALS and HIRL, PAPI lighting will be highly direction and located at least 95 m from Ground Parrot habitats. Light spill from this source is likely to be low or negligible.

In consideration of the above, all forms of approach lighting (SALS, HIRL and PAPI) are unlikely to result in a significant deviation from existing light conditions in Ground Parrot habitats. Furthermore, light spill is likely to be well below intensities which start or end dusk and dawn calling bouts.

Operational lighting

Operational lighting may be derived from two primary sources: apron flood lighting and infrastructure lighting (ie, safety and security lighting around car-parks and hangers etc).

Apron flood lighting uses high-powered metal halide floodlights on high-masts. These lights are currently positioned on, and around, the existing terminal and are in use for extended periods while planes are departing/boarding. It is likely that apron lights will be operational throughout the dusk calling period in both 'do minimum' and 'new runway' scenarios. While these lights would project toward the WHMA, impacts from apron lighting will be minimal since:

- Four existing apron lights currently project toward the WHMA, and are in operation during dusk call bouts without any notable impact on bird call frequency or duration (M. Sanders and A. McNab pers obs).
- Future development associated with runway 13/31 would result in the addition of only one new apron light projecting toward the WHMA. This additional light would be located in close proximity to existing apron lights.
- The construction of runway 13/31 would require vegetation removal within the WHMA, extending the distance between Ground Parrot habitat and apron lighting from approximately 370m to 680m.

The new 13/31 runway would separate habitat with highest Ground Parrot density (ie, the WHMA) from other operational light sources, and tall canopy vegetation separates the southern section of Mt Coolum NP. This tall vegetation, which in most areas is >3 m wide, and often >15m wide, would screen most light spill. The influence of lighting on Ground Parrot habitats from other infrastructure sources is expected to be minimal.

Operational lighting, which will be effectual 24hrs (excluding apron lighting, which will be used only until the last flight), could contribute to reduced movement of Ground Parrots into southern habitats. The possible implications of this are considered in Section 8.5.4.2.

Construction lighting

Twenty-four hour construction lighting would be used during dredging and reclamation for a duration lasting no longer than six months. Construction lighting used at the fill face is likely to be provided by mobile light towers, typically consisting of 2-4 1000w lights on 6-9 m extendable poles. While these lights are directional and will be pointed away from native vegetation, some light spill into Ground Parrot habitat (within the WHMA) is likely. Light impacts on Ground Parrot are considered minor; however, as lighting associated with reclamation would only use only at the fill face and move north-west over the fill platform in a systematic manner. As such construction lighting will remain close to Ground Parrot habitat for only a short time (ie, weeks rather than months).

8.16.4.4 Noise

There is no published data available on the sensitivity of Ground Parrots to noise, or what impacts noise might have on resident birds. Studies of other bird species suggest background noise can mask predator arrival and associated alarm calls, as well as interfering with acoustic signals used in territory defence and courtship/breeding (Forman and Alexander 1998; Andrews *et al*., 2006; Slabbekoorn and Ripmeester 2008).

In the specific context of the SCA it is suggested that increased noise on Ground Parrot predator avoidance behaviour is unlikely to due to the following considerations:

- Flushed birds do not emit alarm calls, and birds have not been observed reacting to the alarm calls of other bird species. As such masking of alarm calls is unlikely to lead to increased predation.
- Most large predators (except some raptors) are excluded from the SCA by the perimeter fence and ongoing animal control. Thus, even though birds may not hear approaching predators, the risk of predation remains low.

Possible masking of signals from artificial noise therefore, would be restricted to periods when birds actively call, a period of approximately 25 minutes at dusk and dawn. Potential noise sources during these periods include airplane activity, and construction noise. Operational noise associated with day-to-day running of the airport (ie, associated with infrastructure or vehicle movement) are not expected to increase above existing levels and will be buffered by the new 13/31 runway.

Aircraft Noise

Though the ability of Ground Parrots to detect conspecific calls above background noise is unknown, in-field observation suggests aircraft noise is likely to render Ground Parrot calls inaudible. Despite call masking, brief periods of aircraft noise did not appear to significantly impinge on Ground Parrot activity. However, an increase in the frequency of elevated noise (ie, increased aircraft movement) could render calls ineffective for a greater portion of their call bout.

On the Sunshine Coast sunrise occurs between approximately 4.45 am and 6.30 am. Based on information provided in Chapter D3, only two RPT flights would occur in the later portion of this period (scheduled for 6,20 and 630 am) under future flight scenarios (ie, both 'do minimum' and 'new runway' scenarios). Importantly, these flights will occur after sunrise during the breeding season. Noise from aircraft movements is not expected to significantly affect dawn call bouts.

Sunset on the Sunshine Coast occurs between approximately 5.00 pm and 6.45 pm. Currently three RPT flights are scheduled during this period, but are expected to increase to seven under the 'do minimum' scenario and ten under the 'new runway' scenario. Based on remote recorders deployed at the SCA, Ground Parrot calls are masked for approximately 2.5 minutes during plane activity, depending on plane size. Thus, approximately 83% of the time in which Ground Parrots could call remains unaffected in the 'do minimum' scenario, or 76% in the 'new runway scenario'.

Highest aircraft frequency during dusk hours would occur after 5.10pm (both 'do minimum' and 'new runway' scenarios), when four RPT flight movements occur in 15 minutes (ie, one flight every 5 minutes). In this worst-case scenario, 50% of the call bout could be unaffected.

It is not known if each call period (ie, morning vs. evening) has equal value, though it is known that call rates are typically higher during dusk calling (eg, 0.42 calls/bird/min vs. 0.37; McFarland 1991b). The noise tolerance threshold of Ground Parrots is also unknown, though it is worth noting that future aircraft activity within the SCA (and hence aircraft noise levels within existing habitat) will be similar without the construction of the new 13/31 runway. As such, construction of the new runway will have no more impact on noise levels within occupied Ground Parrot habitat than noise levels associated with the existing main runway would.

Construction of RWY 13/31 would not increase the frequency or duration of helicopter training flights over the WHMA, Over time the new runway would reduce the circuit training over this area.

Construction Noise

Construction activities will occur in four packages, as outlined in Table 5.1a (see Chapter A5). With the exception of dredging (package 2), and construction noise will be largely restricted to daylight hours (ie, between 6.30am and 6.30pm), six days a week. For most of the year, these periods will not affect Ground Parrot calling, but could overlap during months with short day length (approximately April and September inclusive). Potential construction noise during call periods may overlap with the breeding season, when call behaviour may be more important.

Mitigation measures included within the design will significantly reduce noise in adjacent Ground Parrot habitats. However, as shown in **Figure 8.16i**, there remains some potential for minor noise elevation during package 1. Mitigation measures will be used to further reduce potential noise during construction of package 1 and 3. No elevated noise is expected during package 4.

Package 2 construction activities including the operation of a dredge booster pump are estimated to occur approximately 2.5-3 times in a 24 hour period with dispersal by one (night) or two (day) dozers. Unlikely package 1 and 3 activities, package 2 construction works would occur 24hrs a day. Modelling predicted noise show that construction noise will be at its worst during night works early in package 2 (southeast works). During this period, which is likely to last weeks rather than months, a portion of the WHMA will experience slightly elevated noise levels (see **Figure 8.16j**). This minor elevation, which will be short in duration, is not expected to have significant impacts on Ground Parrots.

8.16.4.5 Plane and Vehicle Strike

Plane Strike

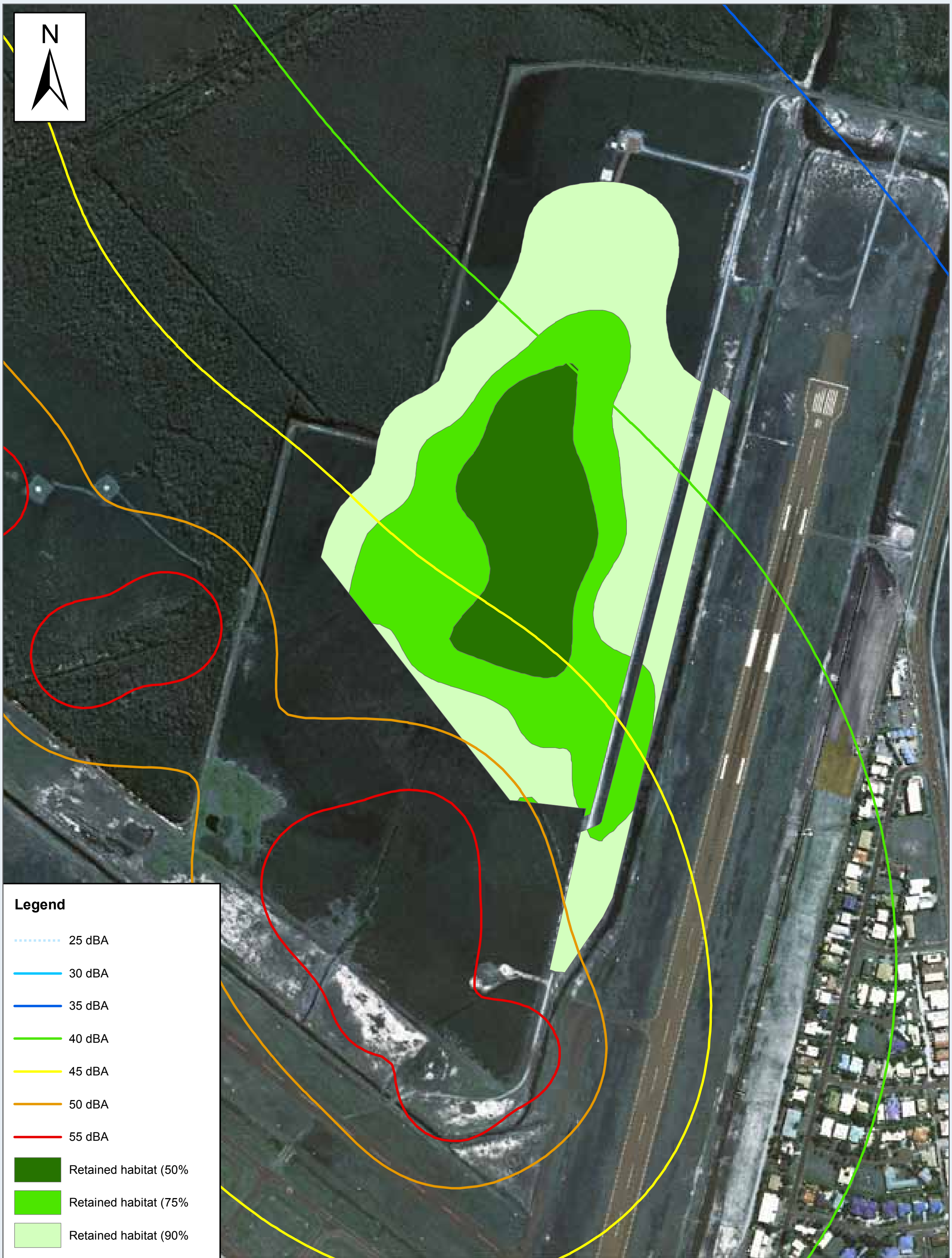
The close proximity of existing habitats to the proposed runway suggests plane strike could pose a threat to Ground Parrots. Observations of Ground Parrots at the SCA, however, suggest otherwise, with birds only seen flying low and swiftly over dense ground cover (eg, heath). In addition, birds disturbed in mown vegetation to the west of the active runway (18/36) were only observed flying to the WHMA and never toward the runway. Ground Parrots have never been recorded as a plane strike incident at the SCA. As such, mortality from plane strike does not appear to pose a significant threat to Ground Parrots, at least not under current conditions.

Plane activity is expected to increase under both the 'do minimum' scenario and the 'new runway' scenario (see Section 8.5.1.2 and 8.5.4.4 for details). Construction of the new runway is therefore unlikely to increase the risk of bird strike any more than the 'do minimum' scenario would. With new runway situated over 200m from Ground Parrot habitat, (as opposed to just 150 m), construction of the new runway could even reduce the risk of plane strike relative to the 'do minimum' scenario.

Vehicle Strike

Vehicle movement in proximity to Ground Parrot habitat could result in mortality of Ground Parrots flushed from vehicle tracks or nearby vegetation. Though potentially occurring during construction and operation of the new runway, the likelihood of Ground Parrots being struck and killed by vehicular traffic is extremely low because: (1) despite regular movement of vehicles around the existing WHMA, few if any Ground Parrots have been killed or injured as a result of a vehicle strike; (2) vehicular traffic around Ground Parrot habitat is generally slow-moving (less than 40 km); and (3) levels of vehicular traffic near Ground Parrot habitat during operation of the new runway are likely to remain below.

Figure 8.16i: Modelled noise conditions (L10) on retained Ground Parrot habitats during package 1 construction activities



Modelled noise conditions (L10) on retained Ground Parrot habitats during package 1 construction activities

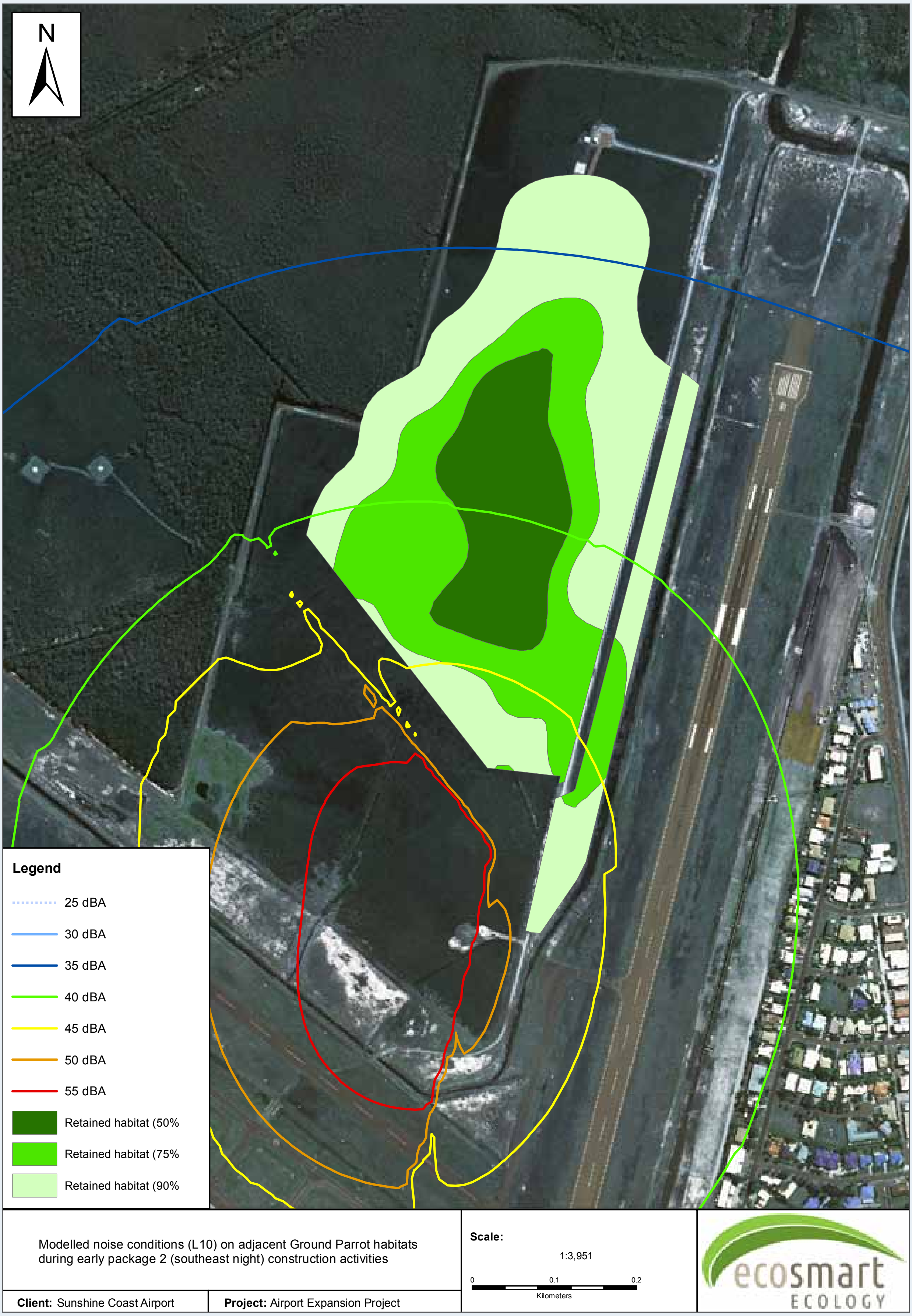
Scale: 1:3,951

0 0.1 0.2 Kilometers

Client: Sunshine Coast Airport **Project:** Airport Expansion Project

ecosmart ECOLOGY

Figure 8.16j: Modelled noise conditions (L10) on adjacent Ground Parrot habitats during early package 2 (southeast night) construction activities



8.16.4.6 *Altered Water Hydology and Quality*

While Ground Parrots are less reliant on surface water than some vertebrates (eg, amphibians), their habitats are shaped by hydrological regimes, and as such, changes to water ponding (extent or duration) and quality (eg, salinity) could affect habitat value.

Modification of the proposed northern perimeter drain, and inclusion of the cut-off wall and reclamation liner, will significantly reduce the likely impacts to sub-surface groundwater hydrology or quality. Based on the assessment provided in Chapter B3 – Geology, Soils and Groundwater, modification to existing hydrological regimes within the adjacent WHMA is not predicted.

Sedges are a critical component of suitable Ground Parrot Habitat. While the specific tolerance of sedge species within the WHMA to salinity is not known, salt influence from the proposed activities in sub-surface groundwater (above the coffee rock) is unlikely. In the unlikely event that some saline influence does occur, impacts will be localised and minor.

8.16.4.7 *Introduced Predators*

The bulk of the Marcoola population, resides within the airport precinct. This area is surrounded by a 2.4 m high chain-wire fence which is buried into the ground and regularly serviced. As such larger mammalian predators such as cats, foxes and dogs are largely excluded from core Ground Parrot habitat within the SCA. Furthermore, large animals which do manage to enter the SCA precinct are actively culled to reduce the risk of plane strike. As such, the SCA is free of all large mammalian predators, including cats and foxes, which could pose a serious threat to Ground Parrots. The exclusion of larger animals form the SCA may therefore contribute significantly to the well-being of Ground Parrots within the WHMA.

Shortly following vegetation clearing, a similar 2.4 m high chain-wire fence will be constructed around the development area, encompassing the existing airport, WHMA, and any new areas of compensatory habitat. For security, new fencing will be established prior to the removal of existing fencing, and as such, introduced predators will not gain access to sensitive areas within the airport.

Ensuring the new fence is completed before removing the old fence will mitigate the risk of predator access.

Once fencing has been completed, access for machinery and trucks will be required throughout construction (to last approximately 34 months). While relatively unlikely, predators may gain access during this period either through open gates (ie, when machinery is entering) or beneath poorly designed gates. Gates have therefore been redesigned to ensure space beneath is insufficient to allow predator access (ie, ~5cm). Gate operation will also be policed to ensure animals are not allowed to enter with construction vehicles.

Upon runway completion, continued maintenance and ongoing animal control is likely to ensure long-term predator impacts will not increase.

8.16.4.8 *Slashing*

Slashing of the WHMA and other areas of low heath will be required to ensure canopy species are not allowed to proliferate, encouraging birds or bats into the potential flight path. Slashing, which is currently undertaken within the WHMA and helicopter training area by SCA, has some inherent short-term risks for Ground Parrots. Slashing could deleteriously affect Ground Parrots by:

- Excessively reducing vegetation cover resulting in the loss of shelter and causing temporary abandonment of the area by a large number of individuals.
- Reducing recruitment due to the loss of suitable nesting habitat shortly before and/or during the breeding season.
- Increasing adult mortality through during the slashing process (although Ground Parrots quickly flush ahead of slow-moving objects and are likely to avoid machinery).
- Increasing mortality of eggs and nestling birds, should slashing occur during the breeding season.

Were slashing to occur too infrequently, ensuing changes in the structure and floristic composition of wet heath within the WHMA (including increased abundance of woody vegetation and reduced abundance of graminoids) could also have a deleterious effect on Ground Parrot habitat. Thus, in the longer term, slashing may significantly benefit Ground Parrots by preventing thickening of tall woody vegetation such as *Melaleuca* and *Hakea*, and promoting the growth of seed-bearing graminoids (ie, sedges and grasses). In this way, an appropriate slashing regime would significantly benefit Ground Parrots.

Given the above, maintenance of the current slashing regime is important to the long-term survival of the species in the WHMA. It is not anticipated that the proposed activities would significantly alter existing slashing regimes, and therefore significant impacts from slashing are not expected. However, it will be necessary to document an appropriate slashing regime to ensure the area is managed for the long-term survival of the species.

8.16.4.9 *Weed Infestation*

Native undisturbed wet heath and melaleuca habitats around the SCA are relatively resilient to weed infestation, and typically weeds only become dominant following disturbance. Soil disturbance and increased light penetration adjacent to retained native vegetation is inevitable during construction, and as such, the establishment of weeds within these areas is likely. Widespread infestation within undisturbed areas is unlikely provided other factors such as soil hydrology and chemistry (eg, soil nutrient, solute and pH status) are not adversely affected.

Standard and appropriate weed management procedures (see Chapter E3 – EMP) should be sufficient to reduce the risk of weed introduction or spread. However, given the proximity of core Ground Parrot habitat to disturbance areas, weed monitoring and control will be extended to include non-listed environmental weeds (eg, exotic grasses etc.

With successful implementation of these measures, construction of the new runway is unlikely to result in the establishment and/or spread of weeds into areas of Ground Parrot habitat within or adjacent the SCA. Clearing during construction of the new runway could, furthermore, curtail the spread of weeds from an existing infestation which threatens Ground Parrot habitat in the far south-west of the WHMA.

8.16.5 Grey-headed Flying-fox

8.16.5.1 Direct Loss of Foraging Habitat

No historic or active Flying-fox camps occur within the SCA, and as such, disturbance to known roosts is not expected as a result of the Project. However vegetation loss will reduce available foraging resources within the local area. The main resource for flying-foxes within the SCA is flowering *Eucalypts* and *Melaleucas* (RE's 12.2.7 and 12.3.5). During peak flowering periods, vegetation dominated by these species can attract large numbers of Grey-headed Flying-fox, which, based on flight direction, are likely to originate from the Maroochydore camp. Other minor resources include tall dense stands of *Banksia integrifolia* (within RE 12.2.14) and *B. aemula* (RE 12.2.9), as well as a small number of planted Mango trees.

The proposed airport expansion will result in the loss of 41.8 ha of Grey-headed Flying-fox foraging habitat (**Table 8.16f**), or approximately 3.94% of similar habitats within 15km of the Maroochydore camp. Flowering and fruiting resources will occur in a variety of other Regional Ecosystems throughout the area, as well as in non-remnant areas associated with parks and gardens (eg, cultivated mango trees, *Callistemon* spp etc). In the broader context (ie, within 15 km of the Maroochydore camp), clearing associated with the airport will result in only a minor loss of remnant foraging habitat (0.65%).

The provision of additional mitigation measures (habitat offsets) will reduce the long-term loss of foraging habitat for this species, and as such, impacts are not expected to be significant.

8.16.5.2 Altered Water Hydrology and Quality

The Grey-headed Flying-fox cannot be directly affected by altered water hydrology or quality. However the species would be adversely affected should changes to water conditions influence vegetation composition, leading to a loss of foraging resources.

Inherent Project design measures have been included to restrict potential impacts to groundwater. No adverse impacts on vegetation are expected (see Chapter B7), and therefore no adverse impacts are expected on Grey-headed Flying-fox resources.

8.16.5.3 Plane strike

Flying-foxes are known to pose a threat to aeroplanes, causing significant damage on impact (Hall and Richards 2000). Data from flying-fox strikes within Australia show that most incidents occur below 300 m (96% of strike records), with almost 76% occurring at 150 m. For reasons unknown, more strikes occur on departure (74% of strikes) than landing (24.8% of strikes; Parsons *et al*., 2009). As flying-foxes typically leave their day roosts to fly to foraging sites within 30 minutes of sunset (Parry-Jones and Augee 1992; Welbergen 2006), strikes are most common between 1700 and 2000 hrs.

Current data for the SCA shows that only one flying-fox strike has been recorded, which on average equates to 0.023 strikes per 10,000 aircraft movements. Several factors suggest that the risk of flying-fox strike may increase under the Project:

- Observations of flying-fox movement around the SCA indicate that the bulk of individuals move in a north-south direction, parallel to existing plane take-offs and landings. The new runway, with its more east-west alignment, will take aircraft across this favoured flying-fox flight path.
- The new alignment would cross the Sunshine Coast motorway and the Maroochydore River/Coolum Creek, two significant linear topographical features within the local area. Flying-foxes are known to use linear topographical features as navigational aids, and therefore disproportionate numbers of individuals may stream over these areas.
- Finally, the approach height of aircraft is well below 150 m when crossing these linear landmarks, a height at which most flying-fox strikes occur.

Under the proposed development, planes will land on a 3 degree flight path, taking them to below the 300 m flight-strike risk threshold at approximately 5,325m from the runway threshold. Based on this information, the risk of flying-fox strike will be greatest between the Coolum Waste Landfill on Yandina-Coolum Road and the new runway.

The risk of flying-fox strike will vary according to local abundance and predominant flying-fox flight path direction. Both abundance and flight direction will be influenced by local flowering events, and as such, the risk of strike would be more likely to occur between the hours of 1700 and 2000 during the months of February/March and August/September.

8.16.6 Water Mouse

The proposed activities will not result in the direct loss of mangrove/intertidal habitat, or create barriers to Water Mouse movement/dispersal. Possible impacts are therefore restricted to altered prey (small crab and molluscs) abundance resulting from loss of water quality within downstream mangrove habitats.

Marine ecology studies (Chapter C4) suggest that impacts within the Marcoola drain could include increased turbidity (predicted to increase by 25%) and increased salinity (from 3.5ppt to 25 ppt). However these impacts will be spatially restricted to the lower reaches of the Marcoola drain (ie, below point of discharge), and temporally constrained to the phase 2 construction period (approximately 3-6 months for

Table 8.16f: Estimated extent of potential foraging habitat (remnant vegetation only) within 15 km of the Maroochydore camp and comparative loss associated with proposed activities

Regional Ecosystem	Loss (ha)	Extent within 15km (ha)	% of local resources*
12.2.5. Corymbia spp., Banksia integrifolia, Callitris columellaris, Acacia spp. open forest to low closed forest on beach ridges usually in southern half of bioregion	0	25.78	0
12.2.7. Melaleuca quinquenervia open forest to woodland on sand plains	41.62	830.97	5.01
12.2.9. Banksia aemula woodland on dunes and sand plains. Usually deeply leached soils	0	41.86	0
12.2.14. Foredune complex	0.18	185.45	0.09
12.3.1. Gallery rainforest (notophyll vine forest) on alluvial plains	0	410.49	0
12.3.4. Melaleuca quinquenervia, Eucalyptus robusta open forest on or near coastal alluvial plains	0	28.17	0
12.3.5. Melaleuca quinquenervia open forest on coastal alluvium	0	1700.25	0
12.3.6. Melaleuca quinquenervia, Eucalyptus tereticornis, Lophostemon suaveolens woodland on coastal alluvial plains	0	45.34	0
12.3.11. Eucalyptus siderophloia, E. tereticornis, Corymbia intermedia open forest on alluvial plains usually near coast	0	83.82	0
12.3.14. Banksia aemula woodland on alluvial plains usually near coast	0	117.97	0
12.5.2. Eucalyptus tereticornis, Corymbia intermedia on remnant Tertiary surfaces, usually near coast. Usually deep red soils	0	18.62	0
12.8.14. Eucalyptus eugenioides, E. biturbinata, E. melliodora open forest on Cainozoic igneous rocks	0	52.32	0
12.8.3. Complex notophyll vine forest on Cainozoic igneous rocks. Altitude <600m	0	15.30	0
12.9-10.16. Araucarian microphyll to notophyll vine forest on sedimentary rocks	0	443.35	0
12.9-10.17. Open forest complex often with Eucalyptus acmenoides, E. major, E. siderophloia +/- Corymbia citriodora on sedimentary rocks	0	495.56	0
12.12.1. Simple notophyll vine forest usually with abundant Archontophoenix cunninghamiana (gully vine forest) on Mesozoic to Proterozoic igneous rocks	0	144.29	0
12.12.12. Eucalyptus tereticornis, E. crebra or E. siderophloia, Lophostemon suaveolens open forest on granite	0	283.32	0
12.12.15. Eucalyptus siderophloia, E. propinqua, E. acmenoides open forest on near coastal hills on Mesozoic to Proterozoic igneous rocks	0	1082.66	0
12.12.16. Notophyll vine forest on Mesozoic to Proterozoic igneous rocks	0	136.81	0
12.12.23. Eucalyptus tereticornis +/- E. eugenioides woodland on crests, upper slopes and elevated valleys on Mesozoic to Proterozoic igneous rocks	0	6.27	0
TOTAL	41.80	6,149.00	0.68%

**Calculations based on remnant RE's (v8) within 15km of the Maroochydore camp* dredging). Long-term impacts are not expected and changes at the mouth of the drain (ie, confluence of the Maroochy River) will be within natural variation.

The Marcoola drain is fringed by a narrow strip of mangroves which will provide extremely limited foraging habitat. While temporary changes to crab and mollusc communities may occur along the drain during construction, much larger areas of habitat along the Maroochy River will be unaffected. Importantly, downstream habitats with high Water Mouse densities will not be impacted.

No impacts are therefore expected from the proposed runway development, and no special mitigation measures are necessary.

8.16.7 Other EVNT Species

Populations of EVNT species known to occur or regularly frequent the SCA area, and as such, are at the greatest risk of development impact. Five other species have not been recorded but may occur, have been historically recorded (Koala), or may occur sporadically (Black-necked Stork, Grey Goshawk, Lewin's Rail). Due to the lack of high quality habitat and/or the transient nature of these six species, the risk of adverse impact on these species is greatly reduced. Potential impacts specific to the six species are briefly discussed below.

<u>Black-necked Stork</u>

The Black-necked Stork has been recorded on at least one occasion along artificial drains within the SCA, but is a rare sporadic visitor to the SCA. No resident pairs are known from the region, and therefore the loss of habitats is unlikely to affect the species in the broader area.

No impacts on water quality within the Maroochy River, and therefore no reduction in potential prey, is expected as a result of the proposed activities (see Chapter C4 – Marine Ecology).

The risk of plain strike may increase slightly due to the realignment of aircraft approach/departure over the Maroochy River and Column Creek. However, the probability of plain strike remains very low.

No special mitigation measures are considered necessary for this species.

<u>Grey Goshawk</u>

Grey Goshawks have been irregularly recorded in the local area, including several records within, or in proximity to, the Study Area. Despite broadly traversing the SCA during regular visits, no evidence of nesting has been noted.

The loss of woodland and heathland communities will result in a minor reduction in foraging habitat, although this loss is small (<1%) in the context of similar habitats available in the local area (see for example **Table 8.5f**; calculations based on habitats within 15 km of the SCA). Ongoing incremental loss of habitat and its potential impact on Grey Goshawk in this area is unknown.

Being highly mobile, the proposed actions will not affect the dispersal or movements of Grey Goshawks.

<u>Lewin's Rail</u>

Lewin's Rail was recorded once from waterlogged exotic grassland adjacent remnant habitats on Finland Road, but could potentially occur in similar grasslands or in waterlogged heathlands. The species can be difficult to detect, but given the lack of records despite regular visits, it is probable that birds are sporadic or infrequent.

Known habitat will be lost to facilitate the development, though the exact quantity is difficult to calculate due to difficulty in mapping waterlogged exotic grassland. Nevertheless, similar exotic grasslands are likely to be widely distributed in the local area, and the loss of these habitats for the SCA expansion is expected to represent a minor fraction of available habitat.

Lewin's Rails are highly mobile and the proposed actions are unlikely to create barriers to movement or dispersal.

No special mitigation measures are considered necessary for this species.

<u>Eastern Curlew</u>

The proposed activities will not result in the direct loss of mangrove, mudflat or sandbank habitat for the Eastern Curlew. Birds are not expected to frequent Marcoola beachfront, or the Marcoola drain. Further, these birds are highly mobile and the creation of barriers that might affect movement will not occur.

No impacts on water quality within the Maroochy River are anticipated, and in particular, important sandflat and mudflat habitats at the mouth of the Maroochy River will not be affected (see Chapter C4).

Approach and departure flight paths under the new runway scenario is likely to reduce in-flight aircraft noise over foraging habitat at the mouth of the Maroochy River (see Chapter D3 – Aircraft Noise)

No special mitigation measures are considered necessary for this species.

<u>Koala</u>

Koalas have been recorded eight times within 5 km of the Study Area, with all observations predating 2004. Despite targeted surveys for Koala, the species was not detected within or adjacent the SCA. Habitat surrounding the SCA is marginal, and generally restricted to narrow or small timbered areas with tall *Eucalyptus tereticornis*, and *E. robusta.* The largest area with moderately dense cover of preferred feed trees is located along Finland Road and is a mere 3.13 ha in extent. This area would be lost as a result of the proposed actions.

Due to infrequent use of the SCA and surrounds, the loss of these habitats is not expected to affect the species.

18.16.8 EPBC Act Migratory Species

Migratory Shorebirds and Little Tern

Impacts to shorebird habitats that require assessment include:

- The minor loss of habitat for the construction and operation of the sand delivery pipeline at Marcoola Beach.
- The minor loss of habitat (<10 m^2) for the construction of the northern perimeter drain on the southern bank of the Marcoola drain.
- Increased human activity inhibiting foraging along Marcoola Beach during sand delivery pipeline assembly and decommissioning.
- Deterioration of water quality within the Marcoola drain and Maroochy River from sedimentation and increased salinity/acidity leading to the loss of downstream foraging habitats.
- Noise associated with departing and arriving flights on habitats at the mouth of the Maroochy River.

Shorebirds are typically scarce along busy beachfronts, and are far more common along estuaries or on sandflats and mudflats. Since regular human activity along beaches such as Marcoola interrupts shorebird foraging, impacts from minor loss of habitat and increased human activity on beaches are therefore likely to have negligible impacts on local shorebird populations.

Little Terns forage over open water adjacent to the beach and are usually not usually influenced by beach front activities. The pump-out location is situated in deep water, approximately 600 to 1,000 m offshore from Marcoola Beach (see Chapter C2 – Dredging and Reclamation), and as such, unlikely to affect Little Tern foraging patterns.

Shorebird foraging habitat along the Marcoola drain is limited in extent and unlikely to support large numbers of waders. No waders have been recorded at this location.

While suspended solids and salinity levels within the Marcoola drain are expected to increase, particularly during construction, these impacts are expected to be highly localised and temporary (see Chapter C4). Impacts to water quality within the Maroochy River are expected to remain within the bounds of normal variation and large areas of Migratory Shorebird habitat at the mouth of the river will be unaffected.

Habitats of high value for migratory shorebirds (ie, at the mouth of the Maroochy River) are approximately 2 km from the direct flight path under the new runway scenario. Noise from approaching or departing planes using the new runway is not expected to increase above background noise levels. This is an improvement from existing conditions, which required planes to bank and turn above the mouth of the Maroochy River when using the existing 18/36 north-south runway.

Terrestrial Migratory Birds

A small number of terrestrial birds (eg, Rufous Fantail and Rainbow Bee-eater), listed as migratory species are known to occur in low densities within and around the SCA. These species are widespread and common within the region. The loss of terrestrial habitats will not affect local or regional populations of these species, and furthermore, mitigation measures for habitat offsets will benefit both the Rufous Fantail and particularly the Rainbow Bee-eater.

Non-tidal Wetland Migratory Birds

Cattle Egrets are common within the local area and region, frequently highly disturbed agriculture and grazing land. The species has been gradually expanding its range across northern and eastern Australia (McKilligan 2005). The loss of cleared habitats where this species has been observed will not affect local populations.

While the Eastern Great Egret may sporadically occur along artificial drains within the SCA, areas of suitable habitat are largely restricted to the Maroochy River. No impacts to this system are expected (see discussion above under Migratory Shorebirds).

A significant number of Latham's Snipe have been recorded from within the SCA, predominantly restricted to a small area of vegetation to the east of the existing 18/36 RWY. While this area will not be directly affected by the proposed activities, it is within the flight path for the new runway, and as such, will be subjected to significant noise and movement. On balance, it seems unlikely that this area will maintain its existing value for Latham's Snipe.

Other potential migratory bird species occur either too infrequently, or outside of any detectable disturbance, to be affected.

8.17 ADDITIONAL MITIGATION MEASURES AND RESIDUAL IMPACTS

8.17.1 Acid Frog Impact Mitigation

A number of the impacts on acid frog species (including habitat loss due to clearing and filling, slashing of vegetation, altered groundwater hydrology, reduced water quality, and weed invasion) require additional mitigation. Mitigation specific to acid frog species (ie, offsetting the loss of acid frog habitat) is discussed in detail below.

The proposed development will result in the loss of both breeding and non-breeding habitat for acid frog species. To address this issue, offsets for acid frog habitat loss will be provided within suitable areas within the SCA and elsewhere on the northern Sunshine Coast. The estimated area of habitat loss requiring offsetting is provided separately for each species in **Table 8.17a**.

*Table 8.17a: Estimated loss of acid frog habitat requiring offsetting**

Species	Estimated Loss of Occupied Habitat*
Wallum Froglet (*Crinia tinnula*)	60.63 ha[1]
Wallum Rocketfrog (*Litoria freycineti*)	21.85 ha[2]
Wallum Sedgefrog (*Litoria olongburensis*)	1.67 ha[3]

* Excludes areas of known habitat in which vegetation will be slashed but not cleared, as areas of slashed vegetation provide suitable habitat for acid frog species.

1 Based on mapping in **Figure 8.16f**. Includes areas of likely breeding habitat and adjoining habitat used by non-breeding animals for foraging, shelter and/or dispersal between areas of breeding habitat within the SCA.

2 Based on mapping in **Figure 8.16g**. Includes areas of likely breeding habitat and adjoining habitat used by non-breeding animals for foraging, shelter and/or dispersal between areas of breeding habitat within the SCA.

3 Based on mapping in **Figure 8.16d**. Includes areas of habitat used regularly by breeding and non-breeding animals. Excludes vegetation used infrequently by animals moving between areas of known habitat.

Offsets within the SCA

Within the SCA, potential for the creation of acid frog breeding habitat occurs within selected areas of the retained WHMA. However to minimise any adverse impacts on Ground Parrot habitat, compensatory frog breeding habitat will need to be restricted to the far north where current Ground Parrot activity is low or absent (**Figure 8.17a**).

Under existing conditions, land in the north of the WHMA appears highly suitable for the creation of acid frog breeding habitat (as evidenced by successful recruitment of Wallum Sedgefrogs in areas of artificially-created habitat adjacent vehicular access tracks in this area), though soil removal will be required to create low-lying areas with ponding water. Ground water monitoring to determine fluctuations in ground water levels (and to inform pond depth) will be required prior to soil disturbance. Stringent weed control must be applied during pond construction to avoid introducing weeds into sensitive surrounding habitats (ie, retained acid frog habitat and Ground Parrot habitat within the WHMA). Monitoring of frog numbers and recruitment success will also be required to ensure successful recreation of acid frog habitat in this area.

Compensatory habitat offsetting the loss of existing acid frog habitat will also be created in the wedge shaped area of SCA land to the near north of the northern perimeter drain (an area of dense wet heath with emergent *Melaleuca* measuring 5.84 ha) (**Figure 8.17a**). In this area, operational constraints will require the removal of tall woody species (ie, *Melaleuca* trees, which, at current densities, might render habitat unsuitable for acid frog breeding), though vegetation below 1.5m in height may be retained. Upon canopy removal, a mosaic of seasonal ponded water, wet heath, and dry heath will be created. As in the WHMA, construction of compensatory breeding habitat will be informed by studies investigating groundwater hydrology.

Assuming successful creation of breeding habitat, the mosaic of wet and drier habitats in this area will provide breeding and non-breeding habitat for acid frog species (and Ground Parrot as well, provided ongoing maintenance regimes (ie, slashing) are suitable). As with habitat recreation in the WHMA, monitoring of frog numbers and recruitment success will be required to assess the efficacy of compensatory habitat.

Creation and monitoring of compensatory habitat will be guided by a formal management plan detailing construction methods, criteria for evaluating the success of compensatory habitat and guidelines for monitoring frog numbers and recruitment success.

Assuming the successful recreation of breeding habitat, most if not all Wallum Sedgefrog habitat lost to development (other than that used infrequently by dispersing animals) could be replaced through the construction of breeding ponds. Successful creation of breeding ponds for the Wallum Sedgefrog will also help offset the loss of Wallum Froglet and Wallum Rocketfrog habitat, though based on estimated losses, additional habitat would need to be created to fully offset habitat loss affecting these species. With limited opportunity for habitat creation elsewhere within the SCA, additional offset area will also need to be found outside the SCA (see below).

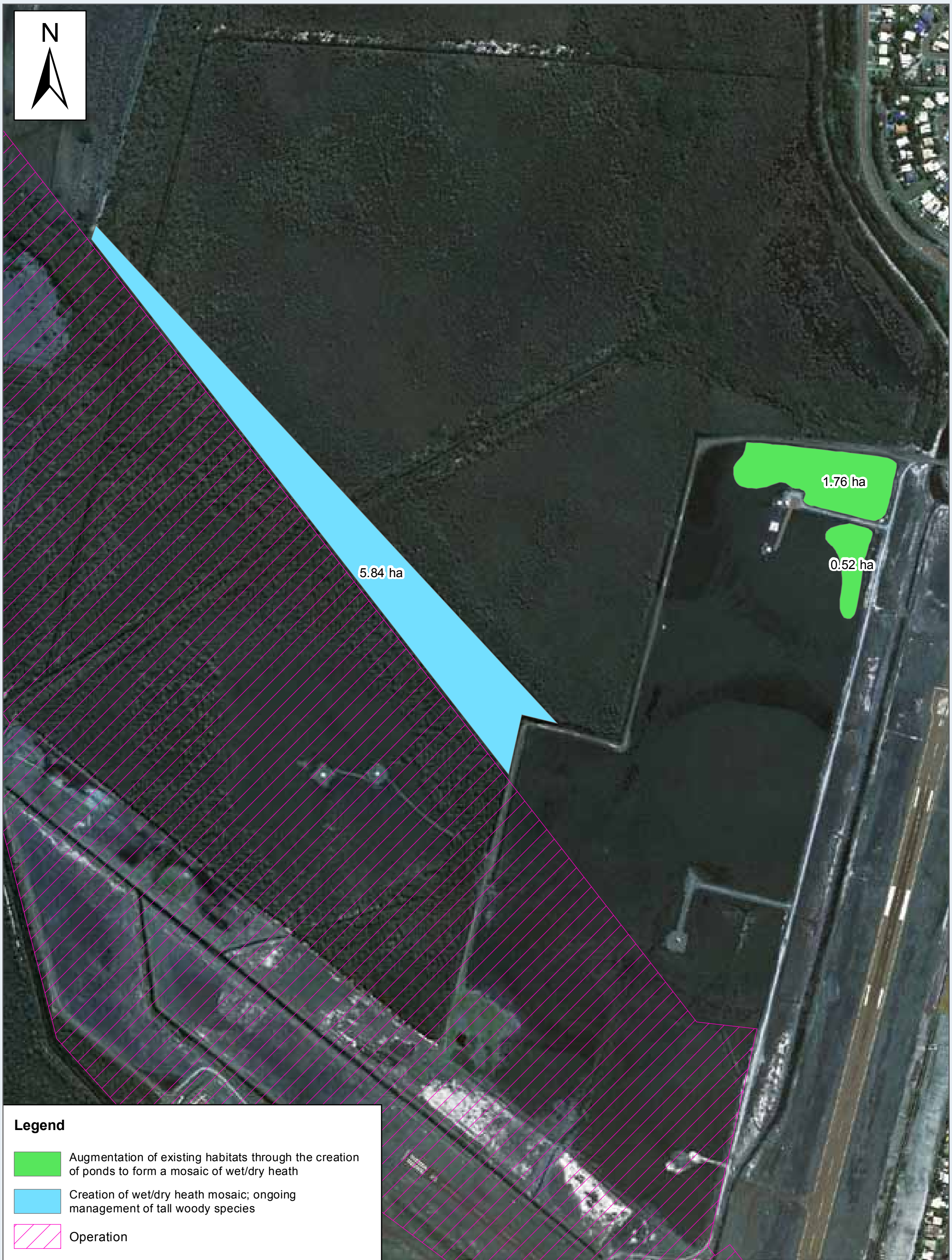
Offsets outside the SCA

Additional offsetting of Wallum Froglet and Wallum Rocketfrog habitat loss needs to occur outside of the SCA, preferably within the Peregian MU (ie, north of the Mooloolah River and south of the Noosa River). The SCA and Sunshine Coast Council have identified Palmview (also known as Lower Mooloolah River Environmental Reserve) as the preferred offset, a property located to the east of Claymore Road, Palmview (Lots 37C3147, 1RP27759 and 2RP27760; see Chapter B7 for further details).

Preliminary investigations of this property have identified 8.09 ha of regrowth sedgeland which appears highly suitable for wallum frog species. While detailed investigations on water quality, hydrology and other relevant factors have not been undertaken, previous works have identified all three Wallum frog species as present (Stringybark Consulting 2012).

An additional 114.24 hectares of the reserve is suitable for *Melaleuca* forest, and depending on localised hydrology, may provide additional habitat for Wallum Rocketfrog and Wallum Froglet. With ongoing management, some areas could also be revegetated to wet heath (see Chapter B7 for further details).

Figure 8.17a: Identified acid frog habitat offset areas within the SCA totalling 8.12 ha



Identified acid frog habitat offset areas within the SCA totalling 8.12 ha

Scale: 1:5,000

0 0.03 0.06 0.12 0.18 0.24 0.3 Kilometers

Client: Sunshine Coast Airport

Project: Airport Expansion Project

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Wallum Frog Management Actions

Upon approval of the SCA expansion, onsite and offsite wallum frog management actions will documented within the wallum heath management plan and offset (Palmview) management plan. Relevant wallum frog actions within these plans would include:

- Performance criteria, responsibilities and timeframes.
- Monitoring of retained populations (abundance) within the SCA during construction to evaluate population trends. Monitoring should include at least two surveys each year following rainfall during summer months. Monitoring should include collection of relevant water quality parameters to ensure construction does not indirectly affect habitats.
- Evaluation of existing wallum frog values at the proposed Palmview offset site. This work should include at least two surveys during or shortly following summer rainfall to determine both abundance and reproductive success (i.e., the presence of advanced tadpoles/metamorphs).
- Vegetation/habitat criteria for rehabilitation/habitat restoration at Palmview and the northern precinct of the WHMA.
- The creation of a ‘test' pond in the northern precinct of the WHMA, to demonstrate success of the habitat creation concept.
- Annual monitoring of wallum frog values (abundance and breeding success) and habitat criteria for a period of at least 5 years post remedial at both Palmview and northern precincts of the WHMA.
- Yearly reporting of monitoring results.

Residual Impacts

With the successful creation of compensatory habitat on-site and off-site (and also the implementation of mitigation measures addressing altered groundwater hydrology, reduced water quality, slashing and weed invasion (as outlined in Sections 8.6.4 and 8.6.6), construction of the new runway is unlikely to affect the long-term viability of acid frog populations within or adjoining the SCA. With no significant adverse impact on local or regional populations the overall significance of development related threats on acid frog species is considered low.

8.17.2 Ground Parrot Impact Mitigation

The mitigation measures documented below apply specifically to the Ground Parrot. Mitigation measures addressing impacts of broader relevance, ie, impacts of importance not only to the Ground Parrot but other fauna as well (eg, groundwater drawdown, salinisation, light and noise pollution, weed invasion and increased risk of predation), are discussed in later sections.

8.17.2.1 Habitat Loss

The proposed actions will lead to the loss of 7.79 ha of habitat currently used by Ground Parrots (based on 2011/12 study results). To minimise the impact of habitat loss, two strategies will be employed:

- Extend the extent of, and continue to manage appropriately, the existing WHMA.
- Ensuring a co-ordinated approach to conservation and management of Ground Parrot populations on the Sunshine Coast by the establishment of a Recovery Team overseeing the creation and implementation of a Ground Parrot Recovery Plan. The overall aim of this plan will be to identify and implement actions to ensure the long-term persistence of Ground Parrot within retained habitats throughout the Sunshine Coast region.

Offsets within the SCA

Based on current activity patterns, Ground Parrots appear largely absent from the very northern portion of the WHMA. Reasons for the lack of Ground Parrot activity in this area remain unclear, though it appears that suitable seed producing plants, in particular sedges, may be less common in this area than other parts of the WHMA supporting larger numbers of Ground Parrot. The creation of acid frog breeding ponds in this area is likely to encourage sedge growth, leading to an increase in Ground Parrot foraging resources. Seeding of this area with favoured food plants following pond creation (including Caustis recurvata, Pseudanthus orientalis and Sprengelia sprengelioides may further increase the attractiveness of habitat in this area for Ground Parrots. This augmented area, consisting of approximately 2.28 ha, will not affect existing Ground Parrot habitat (see Figure 8.17b).

In addition to the above augmentation, the retained WHMA will be extended to include a 5.84 ha linear stretch of habitat alongside of the northern perimeter drain (see Figure 8.17b). While vegetation within this area is currently dominated by Melaleuca forest, control of woody species will be required for airport visibility and safety. Vegetation in this area cannot exceed 1.5 m in height, and will therefore require slashing on a semi-regular basis. These activities would promote seed-producing monocots, and simulate current management activities within the helicopter training area and WHMA. As such, management of this area could create an area structurally and floristically consistent with inhabited Ground Parrot habitats.

The wedge-shaped area of offset habitat discussed above will be different in shape (long and narrow) to the area lost. Linear stretches of habitat force inhabitants to move large distances in search of food, as well as often having less resources per capita, than similar sized consolidated fragments (Recher et al., 1987; Zanette et al., 2000; Lindenmayer and Fischer 2006).

It should be noted that the value of the offset would be increased if adjacent land management practices (ie, within Mt Coolum NP) are improved to encourage the return of Ground Parrots to the adjoining National Park.

Figure 8.17b: Ground Parrot habitat creation and augmentation.

Ground Parrot habitat creation and augmentation

Scale: 1:5,000

0 0.03 0.06 0.12 0.18 0.24 0.3
Kilometers

ecosmart ECOLOGY

Client: Sunshine Coast Airport

Project: Airport Expansion Project

To be successful, the slashing program within the SCA will need to be guided by ongoing monitoring of habitat values and, as such, a carefully-considered adaptive management plan for the Ground Parrot, both for the SCA and broader Sunshine Coast population, will be prepared (included as part of the Ground Parrot Recovery Plan; see below). This plan should include triggers for woody vegetation control.

To be successful, any fire or slashing management of woody regrowth will be required into perpetuity. If successful, habitat offset and augmentation will result in a 4.1% increase (7.19 ha lost; 8.12 ha gained) in available Ground Parrot habitat. However, as these measures are largely untested, additional indirect mitigation measures have been recommended to improve management of the species throughout the Sunshine Coast region.

Ground Parrot Recovery Team

A recovery team will be established to guide, prioritise and oversee Ground Parrot recovery actions both within the SCA and across the broader Sunshine Coast region. This team should include, as a minimum, a SCA representative, a university researcher, A QPWS representative and an experienced fire ecologist. Where possible, previous experience and understanding of Ground Parrot ecology is preferable.

The recovery team will prepare a recovery plan which should be outcome-oriented, practical, easily understood and contain actions that are achievable and cost effective.

Importantly, the plan should be completed within 6 to 12 months of the team being established and, thereafter updated in accordance with new knowledge or changed conditions. In addition to guiding recovery actions (including fire management and feral predator control), the team should formulate research priorities, both for the SCA (ie, identification of habitat features which predict Ground Parrot abundance and can therefore be used as rehabilitation criteria) and the broader Sunshine Coast region (eg, population estimates, current movement and gene flow between subpopulations, and response of Ground Parrots to fire).

Any successful recovery plan should be based on strong scientific understanding (Burbidge 1996; Dickman 1996a). The SCA Master Plan Project will fund Ground Parrot research through development and initial implementation of the Recovery Plan process over a period of 5 years. In addition to identifying, and therefore contributing to the mitigation of, regional threats, Ground Parrot research will inform management of existing and offset habitat within the SCA.

At this stage, whilst not wanting to pre-empt the direction of the Recovery Plan, some considerations might include:

- Acknowledging that whilst some monitoring of Ground Parrot populations is undertaken by the QPWS, systematic monitoring and regional proactive management of the species is largely under-resourced and lacking. The development of the Project (including implementation of mitigation measures outlined in this report) provides the opportunity to improve Ground Parrot management on the Sunshine Coast by:
  - Facilitating (ie, funding) the establishment of a Ground Parrot recovery team to oversee, co-ordinate and priorities Ground Parrot management and research on the Sunshine Coast.
  - Increasing funding and resources for Ground Parrot research informing on management of existing habitats, and possibly funding to support the re-introduction of the species into historic habitat within Mooloolah National Park.
  - Increasing resources for appropriate fire management of existing Ground Parrot habitat within the Mt Coolum NP.
  - Exploring the feasibility of placing, and maintaining, a predator proof fence around the northern section of Mt Coolum NP (ie, areas north of the SCA and south of Mt Coolum Golf Course).
- Fire plays an important role in maintaining the structure and floristic composition of heath vegetation (Watson 2001) and, as such, is important in the management and maintenance of Ground Parrot habitat. The Project will improve fire management in Ground Parrot habitats on the airport site.
- Given that considerable thickening of heath has occurred within National Park adjacent the SCA, as is clearly evident by examination of historical aerial photography (c.a. 1958-2008) and on-ground observations. It is likely that these habitats, over time, have become less favourable for Ground Parrots, and this work has shown that these areas are now rarely frequented. Returning or introducing an appropriate fire regime may therefore increase the value of habitat within Mt Coolum National Park for Ground Parrots and expanding the overall area of suitable habitat for the Marcoola subpopulation.

Feral Animal Fencing

The existing perimeter fence around the SCA has, by and large, excluded predators such as cats, foxes and dogs significantly reducing predation pressure on Ground Parrots within the SCA. However, large areas of nearby Ground Parrot habitat remain accessible to local predators. While successful predator control through baiting is unlikely, predators may be excluded from adjacent habitats if the existing SCA perimeter fence, or a new similar fence, is placed around the northern section of Mt Coolum National Park (ie, the area north of the SCA and south of the Marcoola drain).

Reducing Mortality Risks (during vegetation clearance)

To avoid potential impacts to nests and fledglings, vegetation clearing within the WHMA will not occur during the months of July to September (inclusive).

8.17.2.2 Fragmentation/isolation

Assessment of the Preliminary Design has identified that light during phase 2 of construction has some, albeit low, potential to affect Ground Parrot movement to and from the southern section of Mt Coolum NP. To help reduce adverse impact on Ground Parrot movement, the Batch Processing Plant, which was located within the line-of-site between the WHMA and southern section of Mt Coolum MP, will be relocated to either the southern or northern end of runway 13/31. The final location of the Batch Processing plant will be determined prior to construction and documented in the Environmental Management Plan. Relocation of the Batch Plant will ensure that lighting from this source cannot affect Ground Parrot movement.

Other measures to reduce general light impacts will also assist in alleviating minor light impacts on Ground Parrot habitats.

8.17.2.3 Noise

Construction

Acute noise impacts on Ground Parrots is not anticipated given inherent mitigation in the noisiest periods of construction (i.e. dredging in Package 2), although minor short-term impacts could occur during construction of package 1 and early (southeast) stages of package 2 at night, but only when these periods overlap with Ground Parrot calling bouts.

To ensure there is no risk of noise impacts on Ground Parrots, the following measures will be undertaken:

- Calling cues for Ground Parrot bouts (ie, light levels – lux) will be monitored for a period of at least six months prior to construction in order to clearly define call conditions;
- Noise levels during call bouts within 50m of development will be monitored regularly throughout construction.
- Contractors during Package 2 in particular will be encouraged to avoid the sensitive dawn and dusk calling periods (of 30 minute durations) for noisy operations.
- Develop and adaptive management approach to noise such that construction activities would be modified to reduce noise levels in the WHMA.

Other proposed noise mitigation measures, are detailed in Chapter B15 – Terrestrial Noise and Vibration.

Residual Impacts

If successful, habitat offsets and augmentation for Ground Parrot will result in a slight increase (4.1%) in available Ground Parrot habitat. Existing habitats suitable for Ground Parrots have been created by accident (eg, the helicopter landing area), and therefore it seems feasible that targeted offset creation could be successful. Whether suitable habitat can be successfully created within identified offset areas (in particular the wedge-shaped area immediately adjacent the northern perimeter drain) is, however, uncertain.

Currently, Ground Parrots do not seem inhibited by sharply contrasting edges between dense cover and open modified habitat, regularly moving between the two for foraging. Core habitats (ie, areas of 50% and 75% CI) are, on balance, away from sharply contrasted edges toward the centre of dense heath vegetation. Studies have shown that, in some bird species, nest predation can increase along contrasting edges (Wilcove 1985; Andren and Angelstam 1988; Lahti 2001; Vetter *et al*., 2013). Whether this, and other subtler edge effects, will decrease the value of existing habitats in proximity to clearing is unclear.

In light of the above uncertainties, and considering impacts rarely work in isolation but rather accumulate, the residual impact level on Ground Parrots is high.

The current Marcoola population is estimated to be approximately between 14 and 18 birds, with the majority (13-16 birds or over 70% of the estimated population) occurring within the SCA. A population of this size may be highly susceptible to deleterious stochastic, genetic and demographic processes affecting the long-term viability of populations. Impacts affecting population size and/or immigration of Ground Parrots from the north (ie, actions not relating or associated with the SCA) are of considerable concern. The persistence of the Marcoola subpopulation, therefore hinges on the successful implementation of mitigation measures identified above.

Finally, it is noted that immigration from northern Ground Parrot populations (ie, from the Peregian MU) may significantly influence the long-term survival of the Marcoola subpopulation. We have argued that northern movements are still likely, and as such, long-term survival may be heavily influenced by future intervening activities. Informed management of the species along the Sunshine Coast, based on scientific evidence and understanding, is a priority.

8.17.3 Grey-headed Flying-fox Impact Mitigation

The proposed actions will result in the loss of 41.8 ha of Grey-headed Flying-fox foraging habitat. The loss of foraging vegetation is minor in the context of regional values, though incremental impacts are noted. Habitat loss will be compensated, at least in part, by the provision of off-site acid frog habitats where those offsets are dominated by large stands of *Melaleuca*. Low-lying wet heath, which should be the focus of off-site offsets, would have less value for Grey-headed Flying-fox.

Residual Impacts

With extensive areas of suitable foraging habitat remaining, the loss of 0.65% of available foraging habitat is unlikely impact significantly on numbers of Grey-headed Flying-foxes within the Maroochy area. The value of habitat offsets for Grey-headed Flying-fox will be influenced not only be the extent of *Melaleuca* habitat created, but also the location of off-site *habitats*. While Flying-foxes may travel longer distances, foraging efficiency will be reduced for distances further than 15 km from the Maroochy roost due to increased traverse costs.

Bat strike is an ever present risk associated with airports located in proximity to flying-fox camps. Although the Sunshine Coast Airport currently has a very low bat strike rate, the proposed increased in air traffic and extended airport operation hours will allow planes to arrive and depart over an extended period compared with current flight times, as such an increase in strike rate may occur. Ultimately strike rate will be influenced by the number of Flying-foxs within the local area. At the time of writing this assessment the nearest roost (Tepequar Drive), from which most animals crossing the proposed alignment originate, was vacant.

On balance, these residual impacts are not expected to significantly impact the local population.

8.17.4 Reducing Hydrologic Impacts

Inherent mitigation measures have been included within the project design to minimise impacts to groundwater. Successful implementation of these measures is expected to alleviate potential impacts on sensitive environmental values. No additional measures are required.

Uncontrolled Tailwater Discharge

Although identified as a low-risk, uncontrolled discharge associated with delivery of sand along the pipeline to the fill platform has the potential to impact wet heath areas, and particularly Ground Parrot/acid frog habitats within the WHMA. The final alignment, which follows the existing airport runway perimeter road along the western boundary of the WHMA, has been selected to avoid significant impacts to this area (see Chapter A5 Project Construction). Minor spills or leaks along this alignment are expected to have only localised impacts, the bulk of spill water will run east into the existing perimeter drain, away from sensitive habitats. Other features of the project that have been included to reduce the risk of uncontrolled discharge include:

- Daily checking of the pipeline for any signs of water leak or stress. Repair and maintenance will occur immediately.
- Regular turning of the pipeline to avoid wall thinning.
- Immediate stope of pump operation in the event of major pipe failure.
- Development of a response plan in the event of major leakage/failure.

Residual Impacts

Design measures have reduced the likely lateral movement of sub-surface groundwater (ie above coffee rock) between the development and adjacent environmental values (ie, Mt Coolum National Park and the WHMA). Increased drawdown affecting surface water ponding (extent and duration) is not expected. The potential for saline impacts will be influenced by upward migration through discontinuities in the coffee rock, the extent of which is not known. Based on the assessment provided in Chapter B3, salinity influence on adjacent environmental values is unlikely; should some upward migration of salts occur impacts are likely to be limited in extent and minor. Salinity will not affect existing values where concentrations do not exceed < 100 mg/L.

8.17.5 Maintaining Connectivity

8.17.5.1 Foredune Connectivity

A 20m wide strip of foredune vegetation would be temporarily disturbed with assemblyand laying of the pipeline. This area will be rehabilitated once works are completed. Dredging and sand delivery is anticipated to be completed in approximately 3-6 months, and as such, impacts are expected only in the short term. Following fill completion, the dunes would be returned to their original form and the area planted/seeded with indigenous native species. Existing weed infestations within sand-dune habitats suggest this vegetation is susceptible to weed incursion. Weed management and control is covered in B7 – Terrestrial Flora.

8.17.5.2 Maintaining connectivity to the southern section of Mt Coolum National Park

Development of RWY 13/31 will result in the complete loss of remnant vegetation connecting northern and southern sections of Mt Coolum National Park. To compensate and ensure the southern section of Mt Coolum National Park is not completely isolated, a new corridor will be established around the western extent of the development (see **Figure 18.7c**). The corridor will be approximately 100 m wide along most of its length, except for a small constriction near the corner of the RWY 13/31. Features and actions required to establish this corridor include:

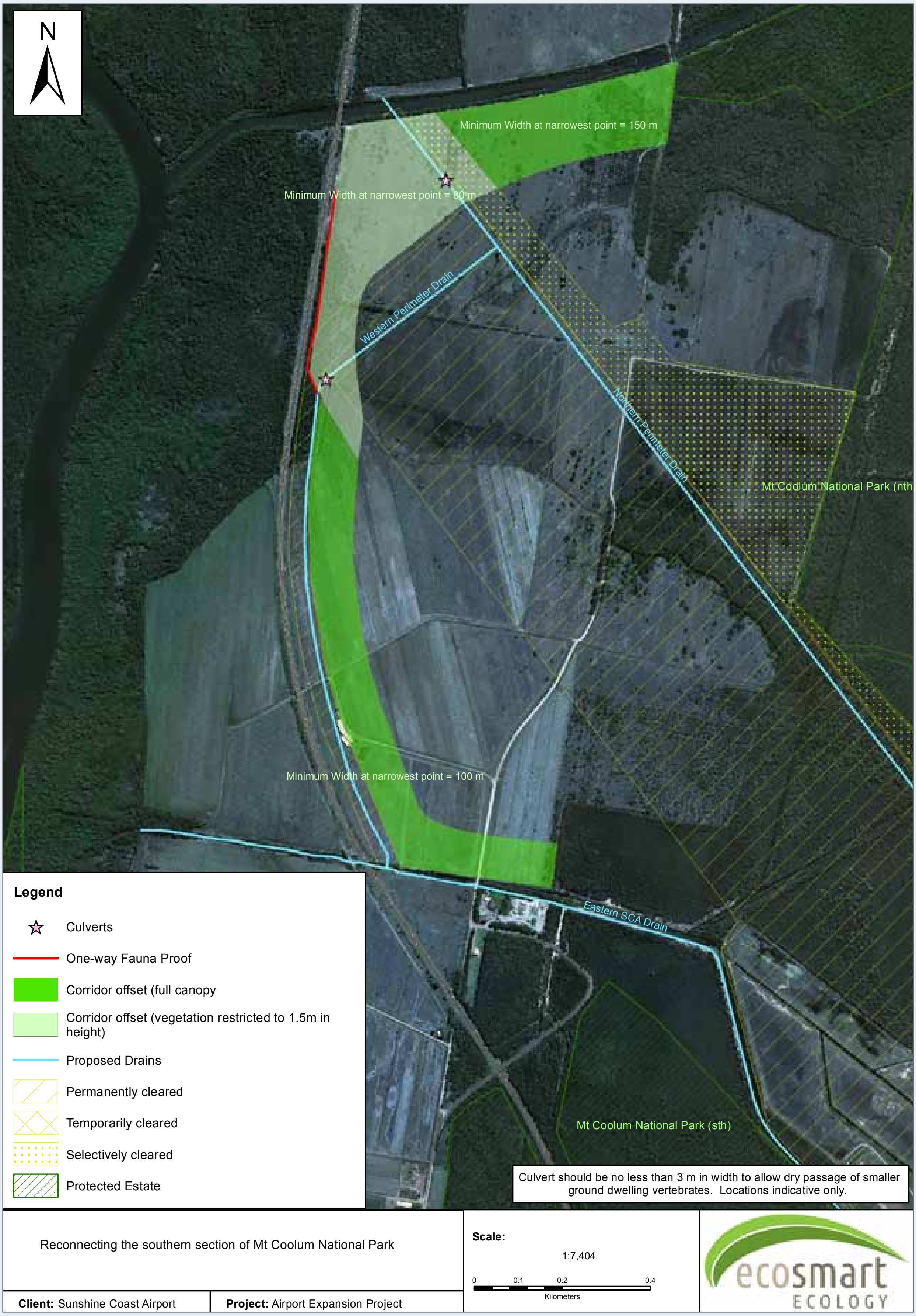
- Revegetation works to establish endemic vegetation of sufficient density to allow passage by cover-dependant species. Along most of the corridor this vegetation will include canopy tree species, except at the northern end of RWY 13/31 where vegetation cannot exceed 1.5 m in height for safety and aircraft vision.
- Culverts over major drains, including the northern perimeter drain, the new western drain, and Eastern SCA drain, to promote dry passage (particularly for small terrestrial vertebrates),
- The use of the proposed western drain, which runs south from the northern end of RWY 13/51, as a deterrent to reduce animal access onto the Sunshine Coast Motorway, and
- A 200 m long fauna-proof chain wire fence running north along the Sunshine Coast Motorway to prevent animal access.

These features are illustrated in **Figure 8.17c**.

To guide the creation of this corridor, rehabilitation and management actions will be included within the wallum heath management plan (see Section 8.6.6). These should include:

- Performance criteria, responsibility and timelines.
- Planting zones, considering airport operational constraints (eg, areas of low heath for aircraft approach/visibility, bird/bat attractants and risk of plane strike).
- Rehabilitation species (endemic to local area), planting densities and planting methods.

Figure 8.17c: A new wildlife corridor to reconnect the southern section of Mt Coolum National Park



- Location, specifications, and construction protocols for fauna crossings over the three drains.
- Location and specification for fauna-proof fencing along the Sunshine Coast motorway.
- Monitoring success (including provision for replacing lost individuals) and weed control. Monitoring during establishment should be frequent, but may be reduced with age. Monitoring should proceed until performance criteria have been met.

The wallum heath management plan will be developed upon approval of the EIS, and revegetation works will commence shortly thereafter (i.e., prior to commencement of construction). This will maximise vegetation growth prior to the loss of the existing corridor connection for the construction of the new runway. It is envisaged that reasonable cover could be established within 5 years, allowing movement of many small to medium-sized vertebrates.

8.17.5.3 Residual Impacts

Provided long-term weed control and management of revegetation is undertaken within disturbed areas of foredune, long-term impacts to north-south fauna movement in this area is unlikely.

Provision of the new corridor would, on balance, reduce the impact of fragmentation on southern portions of the Mt Coolum National Park. Its use will be species-specific, with those animals able to find sufficient resources within the corridor to establish territories more likely to maintain flow than those requiring larger habitats. Its success will also be influenced by rehabilitation efforts.

8.17.6 Management of Heathland Habitats (including the WHMA)

This study has highlighted the importance of the WHMA for a number of taxa including three acid frogs (Wallum Froglet, Wallum Rocketfrog and Wallum Sedgefrog) and Ground Parrot. Historic management of the WHMA has been guided by operational constraints resulting in relatively infrequent/irregular slashing. Under this regime the WHMA has continued to support viable breeding populations of the aforementioned fauna and, as discussed below, may even have benefitted these species in the long run. Nevertheless, management of this area could be further improved if also guided by ecological considerations.

Without slashing, large areas of the WHMA will return to *Melaleuca* dominated forest, to the detriment of Ground Parrots and acid frogs. Thickening of *Melaleuca* is already obvious in the south-west portion of the WHMA, and few Ground Parrots were found inhabiting this zone. Appropriate slashing, is therefore, the most ecologically important management tool for the WHMA.

An appropriate slashing regime would ensure:

- General vegetation height does not exceeding 1.5 m.
- Emergent (ie, > 1.2 m) Melaleuca regrowth should not reach densities greater than one per 25 m^2.
- Slashing does not interfere significantly with breeding of EVNT fauna, and as such, should only occur during the months of December, May, June or July.
- Vegetation isn't slashed any lower than 0.5 m.
- The entire WHMA is not slashed at once (with slashing staged over seasons/years to ensure inhabitants can move to retained refugia).
- Slashing is restricted to areas within the WHMA that exceed maximum height, and as such, an inspection to delineate the active slash area from excluded vegetation may be required by a qualified ecologist prior to slashing.

Active short-term management (ie, cut and stump poison) may also be required to control *Melaleuca* regrowth, particularly in the south-west portion of the existing WHMA and the new WHMA extension. Once *melaleuca* abundance has been reduced, slashing should maintain low *Melaleuca* abundance with minimal additional effort.

A number of exotic weed species are currently present within the southern portion of the WHMA. While the majority of infestations will be removed to facilitate the construction of the new runway, outbreaks of these, and any other potential weed species should be monitored and controlled. Weed control strategies that should be implemented within the management of the WHMA include:

- Stringent sanitation and inspection of all slashing equipment to prevent the introduction of new weed species.
- Mapping existing weed infestations with the intent to either document their eradication, or to ensure the infestation does not spread. This should include the control and mapping of non-declared exotic weeds such as grasses.
- Any weed control strategies should consider sensitive values within the WHMA (eg, acid frogs, Ground Parrots), and as such, may need input from a qualified ecologist.

These management strategies should be coupled with ongoing fauna monitoring (particularly Ground Parrot abundance) to ensure management strategies are improved or adapted as necessary. Management and monitoring of the area should be documented in a detailed wallum heath management plan, which will replace the existing plan (ie Hammermeister *et al*., no date). The scope of this plan will also need to be broadened to include areas of compensatory habitat adjacent the northern perimeter drain and creation of wet heath in the northern precinct of the WHMA.

<u>Residual Impacts</u>

Management of heath habitats within the SCA, guided by scientific research, should improve the value of these areas in the long-term for a wide variety of species, but particularly the Ground Parrot.

8.17.7 Reducing Light Spill

The proposed SALS associated with the new runway would be used only during aircraft approach/departure. Predicted flight schedules suggest that plane activity would be restricted to several hours shortly following dusk, leaving ambient light levels unaffected for the remaining night. In addition, the inclusion of highly direction runway approach lighting is an inherent control measure in the proposed airport design, and as such, predicted light spill to nearby fauna sensitive areas are not expected to be significant. Additional management of runway light sources is therefore unnecessary.

Similarly, impacts from artificial lighting during construction on sensitive faunal values would be short-term and minor. While these impacts are likely to be minor, some cost-effective measures could further reduce impacts. For example, lights which emit long wavelengths (orange-yellow lights) are less likely to attract invertebrates and therefore insectivorous birds and bats, as well as being less likely to deter light sensitive vertebrates (van Tets *et al*., 1969). Long wavelength, or low intensity lights, could therefore be considered for locations where their use will not affect work productivity or safety. Other recognised light mitigation measures which will be used in appropriate locations are detailed in **Table 8.16b**. Project specific and fauna-sensitive light solutions and specifications will be detailed in the Environmental Management Plan (see Chapter E3 – Environmental Management Plan).

<u>Residual Impacts</u>

While there may be some short to medium-term lighting impacts associated with development, these impacts are not expected to be significant. Little or no long-term impacts from light spill is anticipated, with the exception of its possible contribution to reduced Ground Parrot dispersal/movement to the south.

8.17.8 Reducing Noise

8.17.8.1 Construction Noise

Inherent design measures have reduced the potential for noise impacts during construction, and as such only minor impacts are expected. These are unlikely to affect most vertebrates. To ensure any possible risk to Ground Parrots have been mitigated, a number of management measures have been outlined in Section 8.15.4. These will also benefit other fauna species.

8.17.8.2 Aircraft Noise

Noise impacts from aircraft operation associated with the new RWY 13/31 (ie, 'new runway' scenario) are not expected to exceed the 'do minimum' scenario (ie, predicted future increase in operation on RWY 12/30), though there will be an increase in aircraft noise under both scenarios from existing conditions. Additional measures which will effectively mitigate aircraft noise is unlikely.

Table 8.17b Recognised measures to reduce the impact of artificial light spill

Action	Mitigation Measure	Description
Minimise	Minimise the number of lights	Use only required lighting, and wherever possible use non-permanent lights (eg, personal torches, vehicle lights)
	Turn off unnecessary lighting	Ensure lights are not used when not required for work productivity or safety.
	Flashing lights	Use, where possible, flashing lights in preference to permanent light sources.
Confine	Shielding and lowering light fixtures	Reduce the height at which light fittings are positioned and use light shielding to confine the spread of light.
	Use directional lighting	Ensure lighting is aimed away from native vegetation wherever possible.
Substitute	Lower intensity bulbs	Replace high-intensity bulbs with lower intensity bulbs.
	Low-pressure sodium bulbs	Use low-pressure sodium (LPS) lights as a first-choice light source to produce longer wavelengths.
	Replace unsuitable light types	Avoid using halogen, metal halide or fluorescent lights (white lights) where possible, and only use white lights in contained areas where colour rendition is required.
	Light filters	Exclude short-wavelength light with the use of filters, attaching filters to light sources to increase light wavelengths (yellow-orange)

8.17.8.3 Residual Impacts

Mitigation measures, as detailed in Section 8.15.4, will effectively manage noise and no residual noise risks are anticipated during construction.

A similar increased aircraft activity is expected under both the 'do minimum' and 'new runway' scenarios and, as such, no increase in noise impacts can be attributed to the operation of the new runway. However both scenarios vary from existing conditions and could therefore affect existing fauna values.

8.17.9 Exotic Predator Control

Similar measures for control of fauna within the SCA (including fencing and culling of pest animals will be required for all future airport activity, and as such, development of the new runway is not expected to affect predator abundance within the SCA during operational phases. While there is limited risk that exotic predators may gain access during construction, the risk can be largely negated by:

- The closure of gates at night when predatory movement peaks.
- Opening gates during the day only when vehicle access is required; with gates remaining closed at all other times.
- Engineering gates to ensure predators cannot gain access when gates are closed (ie, reducing ground clearance to ~ 5 cm).

Temporary fencing is not preferred, but where necessary could be used for durations not exceeding 1-2 weeks, and must comply with the above design criteria. Should any overnight breaks in the permitter fencing occur during construction, predator monitoring or control (specifically targeting feral cats) should be initiated under the supervision/design of a qualified ecologist.

Residual Impacts

While there is a very slight increase in the possibility of a predator to access significant values within the SCA during construction, this risk will be largely managed through implementation of the above strategies. No long-term increase in predator impacts are expected on fauna values.

8.17.10 Environmental Management Plan

Considerations specific to fauna management during construction and operation are provided in Chapter E3 – Environmental Management Plan.

8.18 SIGNIFICANCE ASSESSMENT

8.18.1 Assessment Against Federal Impact Guidelines

The significance of impacts of the proposed development on Matters of National Environmental Significance, as defined under the EPBC Act, is considered below.

Table 8.18a: Wallum Sedgefrog

Significance Criteria:	Assessment
Would the impacts identified and assessed:	
Lead to a long-term decrease in the size of an important population of a species?	Known and likely breeding habitat within the SCA will be affected by vegetation clearing. Assuming the successful recreation of breeding habitat (ie, construction of breeding ponds with suitable groundwater hydrology within the SCA) a significant long-term reduction in population size is unlikely. The project may also increase abundance in other populations through the success creation of artificial habitats in off-site locations.
Reduce the area of occupancy of an important population?	Known and likely breeding habitat within the SCA will be affected by vegetation clearing. Assuming the successful recreation of breeding habitat (ie, construction of breeding ponds in areas with suitable groundwater hydrology within the SCA) the area of habitat occupied by the SCA population will likely match current area of occupancy. The project may also increase area occupancy of other populations within the region through the success creation of artificial habitats in off-site locations.
Fragment an existing important population into two or more populations?	Since the SCA population occurs north of proposed RWY 13/31 (and not south or west of it) construction of the runway would not fragment this population into two or more populations.
Adversely affect habitat critical to the survival of a species?	Although some areas of breeding habitat would be lost to development, these areas would be re-created (see above). With appropriate mitigation (including the instillation of high quality liner under fill and lining the northern perimeter drain to minimise impacts on groundwater hydrology and salinity) construction of the proposed runway is not considered to have significant adverse impact on remaining areas of breeding habitat.
Disrupt the breeding cycle of an important population?	The project is not expected to disrupt the breeding cycle of the population, although some breeding habitat would be affected by the proposed development.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	With appropriate and effective mitigation (including successful recreation of breeding habitat, installation of the reclamation liner under saline fill, and the cut-off wall to minimise impacts on hydrology and water quality), construction of the new runway is unlikely to cause a significant decline in the Wallum Sedgefrog population.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	With the development and implementation of an effective weed management plan, weed species are unlikely to pose a significant threat to Wallum Sedgefrog habitat within or immediately adjacent the SCA. Construction of the new runway is also unlikely to increase the risk of competitor or predatory species (such as the Common Sedgefrog and Mosquitofish) becoming established within Wallum Sedgefrog habitat.
Introduce disease that may cause the species to decline?	The Project is not expected to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species?	With successful implementation of mitigation measures outlined in this assessment, the proposed development is unlikely to interfere substantially with the recovery of the Wallum Sedgefrog.

Table 8.18b: Grey-headed Flying-fox

Significance Criteria:	Assessment
Would the impacts identified and assessed:	
Lead to a long-term decrease in the size of an important population of a species?	Approximately 0.65% of regional foraging resources (ie, within 15km of the Maroochy Camp) would be affected by the proposed development of RWY 13/31. This is not anticipated to significantly reduce the size of the local population, the abundance of which fluctuates seasonally and temporally. Some loss of foraging habitat will be mitigated by creation of artificial acid frog habitats off-site, where these offsets are dominated by ***Melaleuca***. The new 13/31 runway may increase the risk of plane/flying-fox interaction. While the risk of mortality from plane strike cannot be accurately assessed, on balance, increased mortality is not expected to be significant.
Reduce the area of occupancy of an important population?	While some foraging habitat will be lost, this will not reduce Grey-headed Flying-fox area of occupancy.
Fragment an existing important population into two or more populations?	Grey-headed Flying-foxes are highly mobile and the proposed activities will not fragment the existing population.
Adversely affect habitat critical to the survival of a species?	Though some foraging habitat will be lost, vegetation used by roosting animals will not be affected. The loss of foraging habitat is minor (0.65 % of regional resources), and will in part be offset through the creation of offsite habitats (where those habitats include tall ***Melaleuca*** vegetation).
Disrupt the breeding cycle of an important population?	The project is not expected to disrupt the breeding cycle of the population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	While the project will reduce foraging habitat, lost habitat is minor in the context of regional habitat availability (~0.65 %, based on 15km from the Maroochy Roost). This minor loss of habitat is not likely to cause a significant decline of the species. Further, loss of foraging habitat may be mitigated through offsite offsets where that habitat includes stands of ***Melaleuca*** vegetation.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	The proposed activities will not result in the establishment of a harmful invasive species
Introduce disease that may cause the species to decline?	The Project is not expected to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species?	The proposed development is unlikely to interfere substantially with the recovery of the Grey-headed Flying-fox

Table 8.18c: Water Mouse

Significance Criteria:	Assessment
Would the impacts identified and assessed:	
Lead to a long-term decrease in the size of an important population of a species?	While the proposed actions will remove a very minor area of mangrove habitat along the Marcoola drain, this area is unlikely to be used by Water Mouse. Downstream habitats, which support known populations of Water Mouse will not be directly or indirectly impacted.
Reduce the area of occupancy of an important population?	The proposed actions will not reduce Water Mouse area of occupancy.
Fragment an existing important population into two or more populations?	The proposed activity will not fragment an existing population of Water Mouse.
Adversely affect habitat critical to the survival of a species?	Downstream habitats known to be inhabited by Water Mouse will not be adversely affected by the proposed activities.
Disrupt the breeding cycle of an important population?	The project is not expected to disrupt the breeding cycle of the population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No areas of known, or likely, Water Mouse habitat will be directly or indirectly impacted.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	The proposed activities will not result in the establishment of a harmful invasive species
Introduce disease that may cause the species to decline?	The Project is not expected to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species?	The proposed development is unlikely to interfere substantially with the recovery of the Water Mouse.

8.18.2 Migratory Bird Populations

Important habitat, as defined in DEWHA (2009b), does not occur within the area of development influence with the exception of downstream habitats at the mouth of the Maroochy River where at least 17 migratory shorebirds are known to occur, several in densities which might approach 0.1% of their East Asian-Australasian flyway population. Impacts on this area and its species are considered in **Table 8.18d** below.

While it remains likely that the observed abundance of Latham's Snipe within the SCA is a one-off event, impacts to this species have also been assessed against EPBC guidelines (see **Table 8.18e**).

Table 8.18d: EPBC Impact assessment of Migratory Shorebirds at the mouth of the Maroochy River

Element Affected	Impact Criteria	Comment
Important Habitat	Loss of important habitat	No loss of habitat will occur at the mouth of the Maroochy River
	Degradation of important habitat leading to a substantial reduction in migratory shorebirds using the site	No impact on water quality, and therefore habitat quality, is expected along the Maroochy River
	Increased disturbance leading to a substantial reduction in migratory shorebirds using important habitat	Flight path modelling suggests the frequency of planes flying over the mouth of the Maroochy River is likely to be reduced. No other disturbance factor will be introduced as a result of the development.
	Direct mortality of birds leading to a substantial reduction in migratory shorebirds using important habitat.	Plane flight path under the new runway will largely avoid areas of high Migratory bird abundance (ie, at the mouth of the Maroochy River), and as such, an increase in direct mortality is not expected.

Table 8.18e: EPBC Impact assessment of Latham's Snipe

Element Affected	Impact Criteria	Comment
Important Habitat	Loss of important habitat	Large areas of possible Latham's Snipe habitat will be retained within the SCA, including locations with high (one-off?) abundance (ie, to the immediate west of Keith Royal Park. Some minor loss of habitat from the WHMA will occur, though this will be offset through the creation of artificial habitats to the north of the northern perimeter drain.
	Degradation of important habitat leading to a substantial reduction in migratory shorebirds using the site	Provided that (1) weed management strategies are followed throughout construction and operation, and (2) impacts to groundwater are successfully mitigated, no degradation of habitats are expected.
	Increased disturbance leading to a substantial reduction in migratory shorebirds using important habitat	Flight paths under the new 13/31 RWY will increase noise and movement directly over habitats where numbers of Latham's Snipe have been recorded (ie, the area to the immediate west of Keith Royal Park). It remains unclear if Latham's Snipe will continue to frequent this area due to the increased disturbance. However, this area is relatively small and it remains highly unlikely to support 18 or more birds on a regular basis. Other areas of much larger habitat, particularly within the WHMA, will not be affected.
	Direct mortality of birds leading to a substantial reduction in migratory shorebirds using important habitat.	While their remains a small increased risk of flight strike, Latham's Snipe typically fly within 1-2 metres above vegetation when flushed. This is below expected flight heights. No substantial increase in Latham's Snipe mortality is expected.

8.18.3 Assessment against recovery plans

The significance of impacts of the proposed development against relevant recovery plans for the Wallum Sedgefrog and Water Mouse is considered below.

Table 8.18f: Assessment against Wallum Sedgefrog and Water Mouse recovery plan objectives

Recovery Plan	Objective	Action/response
Wallum Frogs, Meyer et al 2006	To identify areas of habitat critical to the survival of wallum frog species more accurately.	It is not within the scope of the EIS to identify critical areas throughout wallum frog distributions. The population within the SCA has been assessed against the 'important population' criteria provided within EPBC Act Significant Impact Guideline documents and populations within the SCA will be protected to ensure no long-term decline.
	To protect habitat critical to wallum frog survival and important wallum frog populations from threatening processes.	Mitigation measures and management of existing populations have been developed as part of the Project to ensure long-term survival of populations at the SCA. Wallum sedgefrog located in the WHMA will be protected in perpetuity through a conservation tenure as will acid frog habitat rehabilitated at Palmview will also have a conservation tenure applied.
	To rehabilitate degraded wallum frog habitat.	The SCA actions include evaluation, rehabilitation and monitoring of degraded wallum frog habitat at Palmview. This will provide an offset for the loss of habitat within the SCA and will be protected in perpetuity.
	To determine population trends in areas of disturbed undisturbed and rehabilitated habitat	Following approval, the SCA will prepare a management plan for the WHMA and Palmview offset areas. These plans will include monitoring of retained populations at the SCA during construction, as well as populations in artificially created wet heath (WHMA) or rehabilitated degraded habitats (Palmview).
Water Mouse Breittfuss et al 2010	Identify habitats supporting populations of the water mouse and map the current distribution	This objective is outside of the scope of this EIS to map distribution throughout this species range. This EIS has contributed to the known distribution of the species through site survey for the Project which has located water mouse slightly north of existing records along the Maroochy River.
	Describe key biological and ecological features of the water mouse and its habitat.	This objective is not within the scope of this EIS. This work has however contributed to Water Mouse habitat through the description of existing values where Water Mouse were located.
	Monitor population trends and identify and manage threats to species' survival.	It is not within the scope of this EIS to monitor population trends more broadly.
	Rehabilitate habitat to expand extant populations	As a result of the Project no Water Mouse habitat will be disturbed.
	Increase public awareness of, and involvement in water mouse conservation.	This objective is not applicable and outside the scope of this EIS. However, the EIS may act to make the community aware of the local population.

8.18.4 Impact Assessment Summary

The Project will result in a variety of direct and indirect impacting processes, which have the potential to affect fauna values. Those of concern which have been subject to additional mitigation measures include:

- The loss of 60.63 ha of acid frog (Wallum Sedgefrog, Wallum Rocketfrog and Wallum Froglet) habitat. The provision of offset habitats, if successful, within the SCA and off-site will largely compensate for the loss of these habitats.
- The loss of 7.78 ha of active Ground Parrot habitat (based on 2011/12 studies). Offset habitats will be created within the SCA, and considerable resources will be allocated to the management of the species across the region. Increased management will aim to reduce existing threats, improve habitat value, and therefore increase Ground Parrot abundance throughout the region, thereby reducing reliance on one-or-two source populations. Assuming offset habitats are successful, the project will result in a 4.1% increase (7.19 ha lost; 8.12 ha gained) in available Ground Parrot habitat. However, habitat recreation for Ground Parrots is largely untested and relies on a linear stretch of land which may not hold as much value as consolidated areas.
- Reduced connectivity between northern and southern sections of Mt Coolum NP. Creation of a new corridor around the western extent of the new runway, will assist in reducing habitat and population isolation. The value of this corridor will be influenced by species specific traits and rehabilitation success. Movement of Ground Parrots into habitats within the southern section of Mt Coolum National Park is uncertain, though on balance remains possible.
- Increased saline infiltration into the groundwater table from the fill platform would be reduced by the instillation of high-quality liner. The lateral movement of saline tailwater not captured by the liner through sub-surface water (ie, above coffee rock) would be intercepted by a cut-off wall to the immediate north of the northern perimeter drain. These measures would restrict saline influence to upward migration of salts through the coffee rock from the regional aquifer. While extent of discontinuities in the coffee rock is not known, based on the assessment provided in Chapter B3, significant impacts on sub-surface and surface waters are not expected.
- Perched aquifer drawdown is not expected due to the installation of a cut-off wall to the immediate north of the northern perimeter drain. Existing hydrology, including surface water ponding (extent and duration), in adjacent habitats should therefore remain unaffected.
- Minor potential increase in the risk of Grey-headed Flying-fox plane strike.
- Minor increases in construction noise are not anticipated to significantly affect any individual fauna species or affect fauna communities, provided inherent mitigation measures are successful. To ensure there is no risk of noise to Ground Parrots, construction noise will be monitored during call bouts and noise controls introduced as required.
- Aircraft noise will increase, though not significantly more than would occur without the construction of RWY 13/31. Increased aircraft movements, with or without the development of RWY 13/31, will reduce periods of unaffected Ground Parrot calling, though on balance this is not believe to pose a significant threat. While aircraft noise may affect the behaviour of some species (ie, reduce calling during flight movements), it is not expected to affect the broader vertebrate community.

A summary of all perceived impacts, their mitigation, and associated residual risks are summarised in **Table 8.18g**. Impact pathways during construction and operational phases have been combined where possible, and only those impacts pathways relevant to each value have been address (ie, proposed actions will not directly impact migratory shorebird habitats and is therefore not considered).

Table 8.18g: Impact Assessment Summary Table

Impacted Value	Impacting Process	Inherent Mitigation	Impact Assessment			Additional Mitigation	Residual Risk
			Likelihood	Magnitude	Risk		
Fauna habitats/ common fauna species (ie, non-listed taxa)	Direct loss of habitat (reduced area of occupancy)	Clearing restricted to development limits and clearly demarcated	Almost certain	Minor	Medium	Sand fill delivery pipes located to minimise habitat disturbance Offsite habitat compensation	Medium
	Increased mortality during construction	Veterinarian or qualified euthanasia officer for treating injured and stranded wildlife.	Almost certain	Minor	Medium	None	Medium
	Fragmentation	None	Almost certain	Moderate	High	Re-connection through provision of a 100m wide corridor running around the western extent of RWY 13/31	Medium
	Habitat degradation (inc. noise, lighting, weed invasion, salinity, hydrology, predation)	Construction noise (except phase 2) restricted to between 6.30am and 6.30pm) Standard weed control Design to include reclamation liner, northern perimeter drain and cut-off wall to retain existing hydrology and restrict saline movement Sand fill delivery pipes regularly checked and rotated Directional lighting used during construction and operation Runway lighting (SALS) used only during flight take-off/landing Construction vehicles maintained and muffled and noise controls (including noise barrier) included in project design	Almost certain	Moderate	High	Dredge Management Plan to address pipe failure response Use of glare guards with construction lighting to reduce light spill Use of low wattage bulbs and lights emitting long-wavelengths (orange-yellow) light in preference to bright white light Management of perimeter fence design and construction Construction access gates engineered to reduce predator access Development and implementation of weed monitoring and management strategies (as detailed in the wallum heath management plan) which should include: • Stringent sanitation and inspection of all slashing equipment to prevent the introduction of new weed species to wallum heath areas, • Mapping existing weed infestations with the intent to either document their eradication, or to ensure the infestation does not spread. This should include the control and mapping of non-declared exotic weeds such as grasses • Any weed control strategies should consider sensitive values within the WHMA (eg, acid frogs, Ground Parrots), and as such, may need input from a qualified ecologist.	Medium
Wallum Sedgefrog	Direct habitat loss (reduced area of occupancy)	Clearing restricted to development limits and clearly demarcated	Almost certain	Moderate	High	Creation of compensatory breeding habitat (ie, artificial breeding ponds) within the SCA Provision of off-site offset	Medium

Impacted Value	Impacting Process	Inherent Mitigation	Impact Assessment			Additional Mitigation	Residual Risk
			Likelihood	Magnitude	Risk		
	Mortality (during construction)	None	Likely	Minor	Medium	None	Medium
	Fragmentation/ Isolation	None	Unlikely	Minor	Low	None	Low
	Noise (construction and operation)	Construction vehicles maintained and muffled Construction noise (except package 2) restricted to between 6.30am and 6.30pm) Noise suppression of booster pump including noise bund	Possible	Minor	Low	None	Low
	Lighting (operation)	Intermittent usage of directional (vs. omnidirectional) runway lighting Reduced runway lighting outside hours of operation	Possible	Negligible	Negligible	None	Negligible
	Lighting (construction)	Use of directional construction lighting	Possible	Minor	Low	Use of glare guards with construction lighting to reduce light spill Use of low wattage bulbs and lights emitting long-wavelengths (orange-yellow) light in preference to bright white light	Low
	Slashing of native vegetation	Slashing for the removal of tall shrubs and trees (ie, where slashing necessary to maintain sight lines)	Almost Certain	Moderate	High	Development and implementation of wallum heath management plan ensuring slashing occurs infrequently, at a height of 0.5 m or higher, and only during the dry season	Low
	Weed invasion/ spread	Standard weed control measures	Likely	Moderate	Medium	Development and implementation of weed monitoring and management strategies which should include: • Stringent sanitation and inspection of all slashing equipment to prevent the introduction of new weed species to wallum heath areas, • Mapping existing weed infestations with the intent to either document their eradication, or to ensure the infestation does not spread. This should include the control and mapping of non-declared exotic weeds such as grasses • Any weed control strategies should consider sensitive values within the WHMA (eg, acid frogs, Ground Parrots), and as such, may need input from a qualified ecologist. • Removal of existing weed infestations in the very south-west corner of the WHMA	Low

Impacted Value	Impacting Process	Inherent Mitigation	Impact Assessment			Additional Mitigation	Residual Risk
			Likelihood	Magnitude	Risk		
	Reduced water quality (ie, increased salinity of ground and surface waters)	Installation of high quality reclamation liner Construction of northern perimeter drain to intercept runoff from saline fill Cut-off wall to reduce later flow of salts through water perched above coffee rock	Unlikely	High	Medium	None	Medium
	Altered groundwater hydrology	Cut-off wall to the immediate north of the northern perimeter drain	Unlikely	High	Medium	None	Medium
	Predation	New perimeter fencing constructed prior to removal of existing fencing; no gaps between new and old fences	Unlikely	Negligible	Negligible	Construction access gates engineered to minimise predator entry (ie, gap to ground no more than ~5 cm) Gates open to traffic; closed when not in use and at night.	Negligible
	Cumulative impacts (of the above pathways)	See above	Almost Certain	High	Extreme	See above	Medium
Wallum Rocketfrog and Wallum Froglet	Direct habitat loss (reduced area of occupancy)	Clearing restricted to development limits and clearly demarcated	Almost Certain	Moderate	High	Creation of compensatory breeding habitat (ie, artificial breeding ponds) within the SCA Provision of off-site offset	Medium
	Fragmentation/ Isolation (Wallum Rocketfrog)	None	Unlikely	Minor	Low	None	Low
	Mortality (during construction)	None	Almost Certain	Minor	Medium	None	Medium
	Noise (construction and operation)	Construction noise (except package 2) restricted to between 6.30am and 6.30pm) Noise suppression of booster pump, including noise bund	Possible	Minor	Low	Increased sound suppression of booster pump station	Low
	Lighting (operation)	Intermittent usage of directional (vs. omnidirectional) runway lighting Reduced runway lighting outside hours of operation	Possible	Negligible	Negligible	None	Negligible
	Lighting (construction)	Use of directional construction lighting	Possible	Minor	Low	Use of glare guards with construction lighting to reduce light spill Use of low wattage bulbs and lights emitting long-wavelengths (orange-yellow) light in preference to bright white light	Low

Impacted Value	Impacting Process	Inherent Mitigation	Impact Assessment			Additional Mitigation	Residual Risk
			Likelihood	Magnitude	Risk		
	Slashing of native vegetation	Slashing for the removal of tall shrubs and trees (ie, where slashing necessary to maintain sight lines)	Likely	Minor	Medium	Development and implementation of wallum heath management plan ensuring slashing occurs infrequently, at a height of 0.5 m or higher, and only during the dry season	Low
	Weed invasion/ spread	Standard weed control measures	Likely	Moderate	Medium	Development and implementation of weed monitoring and management strategies which should include: • Stringent sanitation and inspection of all slashing equipment to prevent the introduction of new weed species to wallum heath areas, • Mapping existing weed infestations with the intent to either document their eradication, or to ensure the infestation does not spread. This should include the control and mapping of non-declared exotic weeds such as grasses • Any weed control strategies should consider sensitive values within the WHMA (eg, acid frogs, Ground Parrots), and as such, may need input from a qualified ecologist. • Removal of existing weed infestations in the very south-west corner of the WHMA	Low
	Reduced water quality (ie, increased salinity of ground and surface waters)	Installation of high quality reclamation liner Construction of northern perimeter drain to intercept runoff from saline fill Cut-off wall to reduce later flow of salts through water perched above coffee rock	Unlikely	High	Medium	None	Medium
	Altered groundwater hydrology	Cut-off wall to the immediate north of the northern perimeter drain	Unlikely	High	Medium	None	Medium
	Predation	New perimeter fencing constructed prior to removal of existing fencing; no gaps between new and old fences	Unlikely	Negligible	Negligible	Construction access gates engineered to minimise predator entry (ie, gap to ground no more than ~5 cm) Gates open to traffic; closed when not in use and at night.	Negligible
	Cumulative impacts (of the above pathways)	See above	Almost Certain	High	Extreme	See above	Medium

Impacted Value	Impacting Process	Inherent Mitigation	Impact Assessment			Additional Mitigation	Residual Risk
			Likelihood	Magnitude	Risk		
Ground Parrot	Direct habitat loss (reduced area of occupancy)	Clearing restricted to development limits and clearly demarcated	Likely	High	High	Sand fill delivery pipes located to minimise Ground Parrot habitat disturbance Recreation of wet/dry heathland in partially cleared areas, and improvement of habitat in retained areas. Improved management of regional habitats to improve meta-population stability through: The formulation of a Ground Parrot recovery team and Recovery plan, Increased research on Ground Parrot habitat use, threats, and population demographics. Increased resources for heathland fire management Investigate feasibility of, and contribute funds to, the re-establishment of a Ground Parrot population within Mooloolah River National Park.	High
	Mortality (during construction)	None	Possible	Minor	Low	Vegetation clearing will not occur during the months of July to September (inclusive)	Low
	Fragmentation/ isolation	None	Possible	High	Medium	None	Medium
	Operational Noise (compared to 'do minimum scenario')	None	Unlikely	Minor	Low		Low[1]
	Construction Noise	Construction noise (except package 2) restricted to between 6.30am and 6.30pm) Machinery maintained and muffled Suppression of booster pump noise, including noise bund	Possible	Moderate	Medium	Further research to define call bout parameters (ie, light level). Monitoring of construction noise in Ground Parrot habitats during call bouts Modification of construction methods/ equipment/noise suppression if construction noise exceeds 5% ambient noise.	Low
	Lighting (operation)	Intermittent usage of directional (vs. omnidirectional) runway lighting No runway lighting outside hours of operation (ie, after last scheduled flight)	Possible	Negligible	Negligible	None	Negligible

Impacted Value	Impacting Process	Inherent Mitigation	Impact Assessment			Additional Mitigation	Residual Risk
			Likelihood	Magnitude	Risk		
	Lighting (construction)	Use of directional construction lighting	Possible	Minor	Low	Use of glare guards with construction lighting to reduce light spill Use of low wattage bulbs and lights emitting long-wavelengths (orange-yellow) light in preference to bright white light	Low
	Slashing	None	Likely	Moderate	Medium	Appropriate slashing regime documented within the wallum heath management plan Regime (including slash height) regularly reviewed and improved through research into appropriate vegetation parameters (which should exceed operational safety limits) Slashing to retain areas of refugia (mosaic slashing) Slashing not to occur during breeding (July to September inclusive)	Medium
	Weed invasion/ spread	Standard weed control measures	Possible	Minor	Low	Development and implementation of weed monitoring and management strategies which should include: • Stringent sanitation and inspection of all slashing equipment to prevent the introduction of new weed species to wallum heath areas, • Mapping existing weed infestations with the intent to either document their eradication, or to ensure the infestation does not spread. This should include the control and mapping of non-declared exotic weeds such as grasses • Any weed control strategies should consider sensitive values within the WHMA (eg, acid frogs, Ground Parrots), and as such, may need input from a qualified ecologist. • Removal of existing weed infestations in the very south-west corner of the WHMA	Low
	Reduced water quality (ie, increased salinity of ground and surface waters)	Installation of high quality reclamation liner Construction of northern perimeter drain to intercept runoff from saline fill Cut-off wall to reduce later flow of salts through water perched above coffee rock	Unlikely	Moderate	Low	None	Low

Impacted Value	Impacting Process	Inherent Mitigation	Impact Assessment			Additional Mitigation	Residual Risk
			Likelihood	Magnitude	Risk		
	Altered groundwater hydrology	Cut-off wall to the immediate north of the northern perimeter drain	Unlikely	Moderate	Low	None	Low
	Predation	New perimeter fencing constructed prior to removal of existing fencing; no gaps between new and old fences	Unlikely	High	Medium	Construction access gates engineered to minimise predator entry (ie, gap to ground no more than ~5 cm) Gates open to traffic; closed when not in use and at night.	Low
	Cumulative impacts (of the above pathways)	See above	Almost certain	High	Extreme	See above	High
Grey-headed Flying-fox	Direct habitat loss (reduced area of occupancy)	Clearing restricted to development limits and clearly demarcated	Highly unlikely	Minor	Negligible	Off-site compensatory habitat (for acid frogs) will benefit this species in areas dominated by Melaleuca	Negligible
	Reduced water quality (ie, increased salinity of ground and surface waters leading to changed vegetation composition)	Installation of high quality reclamation liner Construction of northern perimeter drain to intercept runoff from saline fill Cut-off wall to reduce later flow of salts through water perched above coffee rock	Unlikely	Moderate	Low	None	Low
	Increased mortality (plane strike)	None	Likely	Minor	Medium	None	Medium
	Cumulative impacts (of the above pathways)	As above	Likely	Minor	Medium	As above	Medium
Water Mouse	Direct habitat loss (reduced area of occupancy)	None	Unlikely	Minor	Low	None	Low
	Increased mortality (during construction)	None	Highly unlikely	Negligible	Negligible	None	Negligible
	Reduced water quality	None	Unlikely	Minor	Low	None	Low
	Cumulative impacts (of the above pathways)	As above	Unlikely	Minor	Low	As above	Low

Impacted Value	Impacting Process	Inherent Mitigation	Impact Assessment			Additional Mitigation	Residual Risk
			Likelihood	Magnitude	Risk		
Other EVNT taxa	Direct habitat loss (reduced area of occupancy)	Clearing restricted to development limits and clearly demarcated	Possible	Minor	Low	Off-site compensatory habitat (for acid frogs) may also provided compensatory habitat for Grey Goshawk and Lewin's Rail	Low
	Increased mortality (during construction)	Veterinarian or qualified euthanasia officer for treating injured and stranded wildlife.	Unlikely	Minor	Low	None	Low
	Noise (operation and construction)	Construction noise (except phase 2) restricted to between 6.30am and 6.30pm) Machinery maintained and muffled Suppression of booster pump noise including noise bund	Unlikely	Minor	Low	None	Low
	Lighting (operation and construction)	Intermittent usage of directional (vs. omnidirectional) runway lighting No runway lighting outside hours of operation	Unlikely	Minor	Low	Use of glare guards with construction lighting to reduce light spill Use of low wattage bulbs and lights emitting long-wavelengths (orange-yellow) light in preference to bright white light	Low
	Weed invasion	Standard weed control strategies	Possible	Minor	Low	Development and implementation of weed monitoring and management strategies which should include: • Stringent sanitation and inspection of all slashing equipment to prevent the introduction of new weed species to wallum heath areas, • Mapping existing weed infestations with the intent to either document their eradication, or to ensure the infestation does not spread. This should include the control and mapping of non-declared exotic weeds such as grasses • Any weed control strategies should consider sensitive values within the WHMA (eg, acid frogs, Ground Parrots), and as such, may need input from a qualified ecologist. • Removal of existing weed infestations in the very south-west corner of the WHMA	Low
	Reduced water quality (ie, increased salinity of ground and surface waters)	Installation of high quality reclamation liner Construction of northern perimeter drain to intercept runoff from saline fill Cut-off wall to reduce later flow of salts through water perched above coffee rock	Unlikely	Moderate	Low	None	Low

Impacted Value	Impacting Process	Inherent Mitigation	Impact Assessment			Additional Mitigation	Residual Risk
			Likelihood	Magnitude	Risk		
	Altered groundwater hydrology	Cut-off wall to the immediate north of the northern perimeter drain	Unlikely	Moderate	Low	None	Low
	Predation	New perimeter fencing constructed prior to removal of existing fencing; no gaps between new and old fences	Unlikely	High	Medium	Construction access gates engineered to minimise predator entry (ie, gap to ground no more than ~5 cm) Gates open to traffic; closed when not in use and at night.	Medium
	Cumulative impacts (of the above pathways)	See above	Possible	Minor	Low	See above	Low
EPBC Migratory Species (terrestrial migrants inc Latham's Snipe)	Direct habitat loss (reduced area of occupancy)	Clearing restricted to development limits and clearly demarcated	Almost certain	Minor	Medium	Off-site compensatory habitat (for acid frogs) will benefit this species in areas dominated by Melaleuca	Low
	Mortality (during construction)	Veterinarian or qualified euthanasia officer for treating injured and stranded wildlife.	Unlikely	Minor	Low	None	Low
	Fragmentation	None	Unlikely	Minor	Low	None	Low
	Noise (operation and construction)	Construction noise (except phase 2) restricted to between 6.30am and 6.30pm) Machinery maintained and muffled Suppression of booster pump noise including noise bund	Unlikely	Minor	Low	Increased noise suppression of booster pump station Construction activities (including operation of booster pump) excluded for a period of 25 before onset and 25 minutes after morning and evening call bouts Further research to define call bout parameters (ie, light level).	Low
	Lighting (operation and construction)	Intermittent usage of directional (vs. omnidirectional) runway lighting No runway lighting outside hours of operation	Unlikely	Minor	Low	Use of glare guards with construction lighting to reduce light spill Use of low wattage bulbs and lights emitting long-wavelengths (orange-yellow) light in preference to bright white light	Low

Impacted Value	Impacting Process	Inherent Mitigation	Impact Assessment			Additional Mitigation	Residual Risk
			Likelihood	Magnitude	Risk		
	Weed invasion	Standard weed control strategies	Possible	Minor	Low	Development and implementation of weed monitoring and management strategies which should include: Stringent sanitation and inspection of all slashing equipment to prevent the introduction of new weed species to wallum heath areas, Mapping existing weed infestations with the intent to either document their eradication, or to ensure the infestation does not spread. This should include the control and mapping of non-declared exotic weeds such as grasses Any weed control strategies should consider sensitive values within the WHMA (eg, acid frogs, Ground Parrots), and as such, may need input from a qualified ecologist. Removal of existing weed infestations in the very south-west corner of the WHMA	Low
	Reduced water quality (ie, increased salinity of ground and surface waters)	Installation of high quality reclamation liner Construction of northern perimeter drain to intercept runoff from saline fill Cut-off wall to reduce later flow of salts through water perched above coffee rock	Unlikely	Moderate	Low	None	Low
	Altered groundwater hydrology	Cut-off wall to the immediate north of the northern perimeter drain	Unlikely	Moderate	Low	None	Low
	Predation	New perimeter fencing constructed prior to removal of existing fencing; no gaps between new and old fences	Unlikely	High	Medium	Construction access gates engineered to minimise predator entry (ie, gap to ground no more than ~5 cm) Gates open to traffic; closed when not in use and at night.	Low
	Cumulative impacts (of the above pathways)	See above	Possible	Minor	Low	See above	Low
EPBC Migratory species (Shorebirds)	Noise (operation)	None	Unlikely	Negligible	Negligible	None	Negligible
	Reduced water quality	none	Unlikely	Negligible	Neligible	None	Negligible
	Cumulative impacts (of the above pathways)	See above	Unlikely	Negligible	Negligible	See above	Negligible

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(Footnotes)

1 Based on increased impacts above the predicted 'do minimum' scenario, not existing condition

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