



DESIGN JOINT VENTURE

# Mooloolah River Interchange (Stage 1) – Preliminary and Detailed Design

## Baseline Water Mouse Monitoring Report

Department of Transport and Main Roads


10 October 2024



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# 1. Introduction

## 1.1 Overview

The Mooloolah River Interchange (MRI) Project (Stage 1) holds an approval under the Commonwealth *Environment, Protection and Biodiversity Act 1999* (EPBC Act) (EPBC 2008/4361). The Department of Transport and Main Roads (TMR) previously proposed the upgrade, extension, construction and operation of a section of the Sunshine Motorway between Caloundra and Maroochydore, as part of the Multi-Modal Transport Corridor (MMTC) Project in 2008. A separate Project to duplicate the Sunshine Motorway, from the Kawana Way exit to the Mountain Creek exit onto Prelude Drive, was also proposed in 2011. The Sunshine Motorway Duplication and components of the MMTC Project have been amalgamated, to enable a single Project to be progressed and delivered, thus forming the current MRI Project.

The proposed MMTC action was approved subject to conditions on the 1 September 2010. In 2015, an amendment was issued to the Department of Climate Change, Energy, the Environment and Water (DCCEEW), (the former Department of Agriculture, Water and the Environment and Department of the Environment and Energy) to include additional areas outside the original MMTC Project area with combined conditions issued on 28 August 2015. The MRI Project area is presented in Figure 1.1. The full set of amalgamated conditions are attached as Appendix A.

Condition 4A (b) of EPBC 2008/4361 required a baseline data collection program to be established to determine:

- i. The area of occupancy of the Water Mouse population within the Project area
- ii. The water quality and salinity levels at high and low tide levels
- iii. The condition and extent of water mouse habitat to be retained/avoided by the action, for comparison against appropriate control sites.

The *Baseline Water Mouse Data Collection Program (dated 09 November 2022)* was approved by DCCEEW on 24 November 2022.

## 1.2 Purpose of this report

This Baseline Water Mouse Monitoring Report has been prepared to present the findings of the Baseline Water Mouse Data Collection Program as per Condition 4A (b) of EPBC 2008/4361.

## 1.3 Scope and limitations

This report has been prepared by the GHD|SMEC Design Joint Venture for the State of Queensland acting through the Department of Transport and Main Roads (“TMR”) and may only be used and relied on by TMR for the purpose agreed between GHD|SMEC Design Joint Venture and TMR.

This report was prepared pursuant to the terms of CN-17731 Provision for Preliminary and Detailed Design Services for Sunshine Motorway –Mooloolah River Interchange Upgrade Project (Stage 1), including C7545 – General Conditions of Contract, Consultants for Engineering Projects dated August 2021 (Contract).

GHD|SMEC Design Joint Venture otherwise disclaims responsibility to any person other than TMR arising in connection with this report. GHD|SMEC Design Joint Venture also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD|SMEC Design Joint Venture in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD|SMEC Design Joint Venture has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD|SMEC Design Joint Venture, acting reasonably and subject to the terms of the Contract, as described in this report. If any of the assumptions are found to differ from reality, this may impact on the report.

GHD|SMEC Design Joint Venture has prepared this report on the basis of information provided by TMR and others who provided information to GHD|SMEC Design Joint Venture (including Government authorities), which GHD|SMEC Design Joint Venture has not independently verified or checked beyond the agreed scope of work. GHD|SMEC Design Joint Venture does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

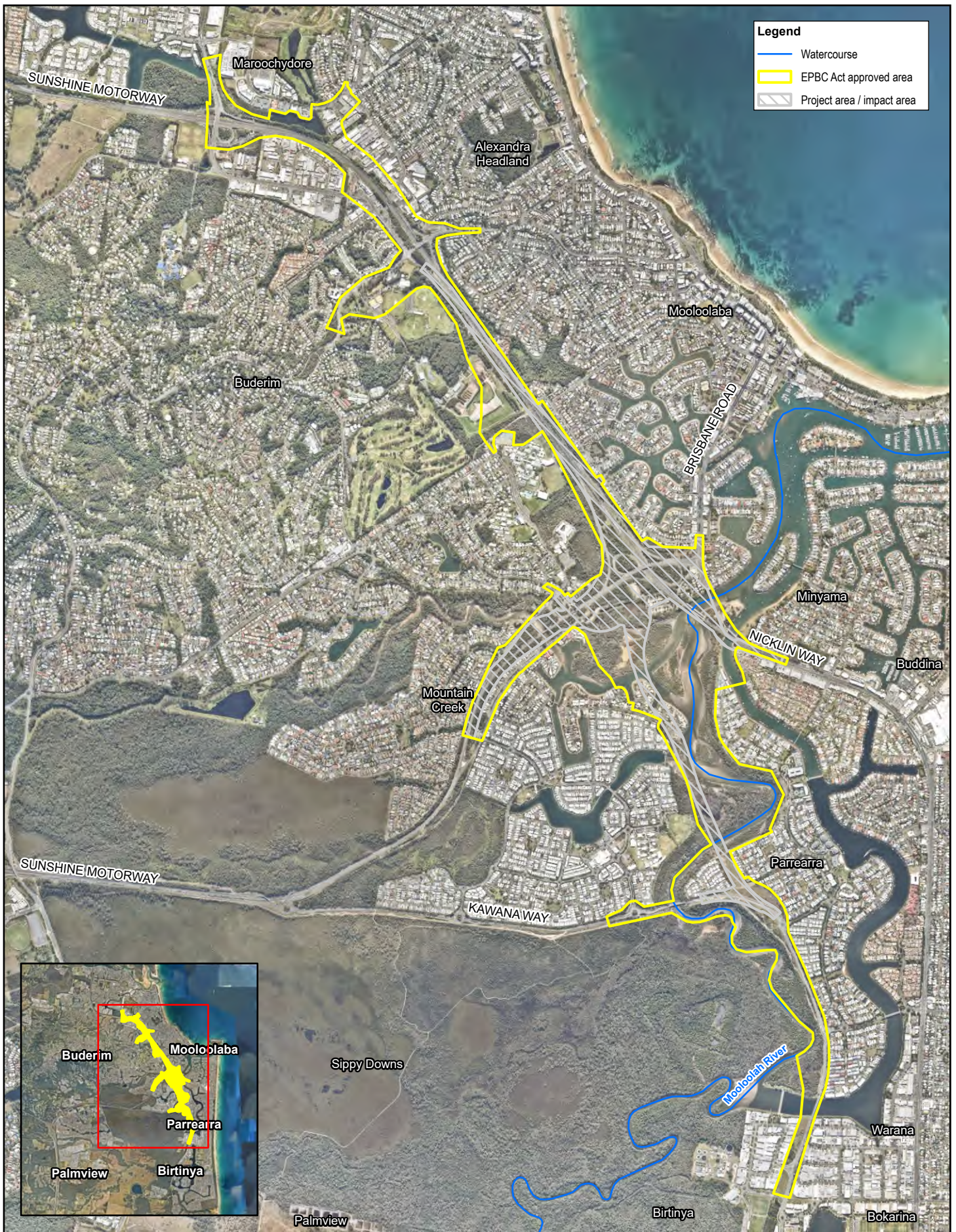
## 1.1 Definitions

The terminology presented in Table 1.1 is used throughout this report and presented on Figure 1.1.

*Table 1.1 Definitions used in this report*

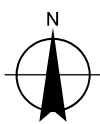
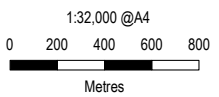
<b>Term</b>	<b>Definition</b>
Project footprint	The Project footprint represents the areas subject to direct development impact and proposed land clearing for MRI Project, as displayed in Figure 1.1.
Project area	The Project area is the likely impact area associated with the construction of the MRI Project and the habitats immediately adjacent (Figure 1.1).
EPBC Act Approved Action Area	The proposed MMTC action was approved subject to conditions on the 1 September 2010. In 2015, an amendment was issued to DCCEEW (the former Department of Agriculture, Water and the Environment and Department of the Environment and Energy) to include additional areas outside the original MMTC Project area with combined conditions issued on 28 August 2015.





**Legend**

- Watercourse
- EPBC Act approved area
- Project area / impact area



Map Projection: Transverse Mercator  
 Horizontal Datum: GDA2020  
 Grid: GDA2020 MGA Zone 56



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Member of the Surbana Jurong Group

Department of Transport and Main Roads  
 Mooloolah River Interchange  
 Water Mouse Monitoring Report

Project No. 12553095  
 Revision No. A  
 Date 09/10/2023

**Project area**

**FIGURE 1-1**



## 2. Methodology

### 2.1 Literature review

A comprehensive literature review was undertaken during the preparation of the *Baseline Water Mouse Data Collection Program (dated 09 November 2022)* to detail the current knowledge on the water mouse and the recommended survey guidelines and methodologies. This included a review of Government and public reports, conservation plans, listing documents, independent published articles and peer-reviewed papers. Key resources utilised are presented in Table 2.1.

Table 2.1 Literature reviewed as part of the desktop assessment

Author	Year	Document title
<b>Commonwealth resources</b>		
DAWE	2021	Conservation Advice for <i>Xeromys myoides</i> (Water Mouse).
DAWE	2021	National Recovery Plan for the water mouse ' <i>Xeromys myoides</i> '.
Department of Sustainability, Environment, Water, Population and Communities (DEWHA)	2009	Significant impact guidelines for the vulnerable water mouse ( <i>Xeromys myoides</i> ).
DEWHA	2009	Background paper to EPBC Act policy statement 3.20 - Significant impact guidelines for the vulnerable water mouse ( <i>Xeromys myoides</i> ).
DEWHA	2011	The Survey Guidelines for Australia's Threatened Mammals
<b>State resources</b>		
Eyre <i>et al.</i> – Department of Environment and Science (DES)	2018	Terrestrial Vertebrate Fauna Survey Assessment Guidelines for Queensland.
<b>Public resources</b>		
Van Dyck, S.	1997	<i>Xeromys myoides</i> in mangrove communities of North Stradbroke Island, southeast Queensland
Ball, D.	2004	Distribution and habitat of the false water rat, <i>Xeromys myoides</i> in intertidal areas of central eastern Queensland.
Kaluza et al.	2016	The distribution and density of water mice ( <i>Xeromys myoides</i> ) in the Maroochy River of southeast Queensland, Australia.
Kaluza, J.	2018	The ecology and conservation of the water mouse ( <i>Xeromys myoides</i> ) along the Maroochy River Catchment in southeast Queensland.

### 2.2 Field survey methodologies

The baseline monitoring program was undertaken in accordance with the *Baseline Water Mouse Data Collection Program (dated 09 November 2022)* and used an integrated approach of habitat assessments, daytime active searches and night-time Elliott trapping in accordance with the *Background paper to EPBC Act policy statement 3.20 - Significant impact guidelines for the vulnerable water mouse (Xeromys myoides)* (DEWHA, 2009b).

A description of the field survey methods utilised during the baseline monitoring program are presented in Table 2.2.



Table 2.2 Field survey methods

Survey method	Description
Habitat assessments	<p>Targeted habitat assessments were undertaken for all fauna species with the aim of recording all notable habitat features in the Project area including vegetation types and species, presence of prey species and prey middens, hollow-bearing trees etc. Habitat assessments were undertaken in conjunction with daytime searching and included photos and GPS references.</p> <p>The assessments considered the follow habitat characteristics specific to water mouse:</p> <ul style="list-style-type: none"> <li>– The connectivity of habitats between low and high tide.</li> <li>– The structural complexity and type of estuarine vegetation.</li> <li>– Presence of foraging resources (i.e small crabs) and habitat features (i.e hollow mangroves).</li> <li>– The level of disturbance and potential threats to the species.</li> </ul>
<b>Survey effort summary</b>	<b>67 habitat assessments</b>
Daytime active searches	<p>Daytime active searches for nesting structures were conducted in a transect style and spaced at 50-100 m intervals. Active searches were conducted in every hectare of intertidal an/or supralittoral water mouse habitat within the Project area. Special attention was afforded to supralittoral banks and habitat features listed in the DEWHA (2009b).</p> <p>Potential nesting structures were identified based on presence of the following features:</p> <ul style="list-style-type: none"> <li>– Mounds usually 20–60 cm in height with a basal circumference of 1.6–4.8 m, with one to three entrance holes, although other entrances may be hidden. Burrow entrances can be at the top, sides or bottom, or in adjoining banks or fallen timber.</li> <li>– Fresh mud plastering on the top may indicate that a mound has been built up to maintain its height above high tide level. Mud pathways also may be present on the side of mounds where the water mouse has excavated mud from a tunnel and spread it along a track. Mud plastering’s may include bits of vegetation, dried leaves, sedges and crab shells.</li> <li>– A distinctive musty odour indicating animals are present in the mound.</li> <li>– Mounds overgrown with sedges or incorporated into the roots or trunk of emergent trees such as casuarinas may be active.</li> <li>– Mound nests in good indication that other, cryptic nests may also be present in mangrove trees and supralittoral banks. Water mouse nests have also been recorded in sites adapted from spoil heaps, such as excavated or bulldozed sand, rocks and earth, and tree-stump waste.</li> </ul>
<b>Survey effort summary</b>	<b>All areas of suitable habitat – 6.69 ha</b>
Elliott trapping	<p>Elliott trapping is the only reliable method for estimating water mouse population density (DEWHA, 2009b). Elliott trapping was undertaken over two events, in summer 2022 and winter 2023. Each survey, nocturnal Elliot trapping was conducted over 4-5 consecutive nights in areas of water mouse habitat located within the Project area. Elliott traps were deployed in a zigzag or sinusoidal curve along 8 x 200 m transects through the intertidal zone to the low-water edge of the mangroves, with 25 Elliott traps in each transect. Four transects were used for every 5 ha of suitable habitat, in accordance with DEWHA, 2009b). Each Elliott trap was deployed at least 5 m apart and positioned as far as considered practical while being able to check for trapped animals before inundation by the high tide. Traps were baited with pilchards cut in half. The final configuration of trapping transects was informed by information gathered from daytime searches for nesting structures and daily tidal ranges. The arrangement of traps is presented in Figure 2.1.</p> <p>The trapping program is discussed further in Section 2.2.1. A summary of the trapping effort is present in Table 2.3.</p>
<b>Survey effort summary</b>	<b>1620 trap nights across to trapping events (720 traps in summer, 900 traps in winter)</b>
BioCondition assessments	<p>BioCondition assessments were conducted to assess the quality of suitable water mouse habitat identified during the initial 2022 fauna field surveys. Assessments were conducted in accordance with the methodology outlined in <i>BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland Version 2.2</i> (Eyre, et al., 2015). Five survey sites and one reference site were assessed within the MMTc Corridor. Field data was compared against benchmark data for each surveyed RE to quantify the value and condition of vegetation and water mouse habitat.</p>
<b>Survey effort summary</b>	<b>Six survey sites and one reference site.</b>

## 2.2.1 Trapping program

Two trapping surveys have been conducted to establish baseline data on the water mouse population within the MRI Project area. The baseline trapping program incorporated a summer and a winter trapping event:

- Summer trapping – 5 nights from 5- 10<sup>th</sup> December 2022
- Winter trapping – 5 nights from 13 – 18<sup>th</sup> July 2023

Trapping transects were located in optimal water mouse habitat, that were identified through detailed desktop and field surveys of water mouse habitat value, completed for the Project in March/April 2022 (DJV, 2022a). The number of transects was determined in accordance with the Commonwealth survey guidelines in DEWHA (2009b) which state that a minimum recommended trap effort is 320 trap nights per 5 ha of potential water mouse habitat. In total, 8 trapping transects were conducted during each survey event, 2 within the Seriata Way Environmental Reserve, 4 within Brightwater (eastern) Environmental Reserve and 2 east of Brightwater Estate (Figure 2.1). Traps were deployed in a zigzag or sinusoidal curve along 200 m transects orientated perpendicular to the tide, as recommended by DEWHA (2009b). The location of Elliott traps deployed during the trapping program is presented in Figure 2.1. A summary of the survey effort during the trapping program is presented in Table 2.3.

*Table 2.3 Summary of trapping effort at the completion of the trapping program*

Survey area	Size (ha)	Required trap nights	Transects x traps		Total traps per night		Total trap nights
			Summer	Winter	Summer	Winter	
Seriata Way	3.4 ha	217	2 x 20	2 x 25	40 for 4 nights	50 for 4 nights	360
Brightwater (eastern)	6.5	416	4 x 20	4 x 25	80 for 5 nights	100 for 5 nights	900
East of Brightwater Estate	3.1	198	2 x 20	2 x 25	40 for 4 nights	50 for 4 nights	360
<b>Total</b>		<b>831</b>	<b>8 x 20</b>	<b>8 x 25</b>	<b>720</b>	<b>900</b>	<b>1620</b>



*Plate 2.1 Representative photographs of Elliott traps deployed at low tide along a mangrove forest and mudflat ecotone*

## 2.3 Water quality monitoring

Condition 4A (b)(ii) requires that prior to commencing the action a baseline data collection program is established to determine the water quality and salinity levels at high and low tide within the water mouse (*Xeromys myoides*) habitat to be impacted by the Project. A Baseline Surface Water Quality Monitoring Program has been developed for the Project which includes two monitoring locations within water mouse habitats immediately adjacent to the Project area. Monitoring sites were selected to enable consistency through all stages of the Project, including baseline assessment, pre-construction, construction and post-construction, and were located either upstream or downstream of the Project area.

Baseline monitoring provides an indication of water quality conditions in the vicinity of the Project area without any potential influence from the Project. During construction and operation, sites located upstream of the Project area will be used to provide an indication of water quality without any potential influence from the Project, while sites located downstream of the Project area will allow for the comparison assessment of potential impacts associated with construction or operation of the Project.

At each monitoring site, monthly water quality sampling was undertaken for a period of a maximum of 12 months commencing in August 2022 and completed in August 2023. Monitoring for water quality and salinity levels included the following variables:

- Visual observations of the presence of potential pollutants and contaminants (e.g. rubbish or other gross pollutants, hydrocarbons (i.e. shine, film or slick to the water surface), tannins and/or paint)
- *In situ* measurements of:
  - Water temperature (°C)
  - Electrical conductivity (µS/cm)
  - pH
  - Dissolved oxygen (percent saturation and mg/L)
  - Turbidity (NTU)

All water quality monitoring was undertaken by a qualified environmental scientist with appropriate training and experience. The location of water quality monitoring locations is presented in Figure 2.1 and described in Table 2.4.

Table 2.4 Description of water quality monitoring sites

Site	Location	Site Description	Catchment	Location	Access	Lot Plan
WM01	North	Mooloolah River, northern bank	Mooloolah	-26.69650, 153.11384	Via footpath at the end of Mara Court	Unallocated State Land
WM02	South	Mooloolah River, southern bank	Mooloolah	-26.71012, 153.11656	Via the footpath along the high bank of the Mooloolah River	Unallocated State Land

## 2.4 Quality of habitat

Condition 4A (b)(iii) requires that the condition and extent of water mouse habitat to be retained/avoided by the action, be evaluated for comparison against appropriate control sites. Habitat quality was assessed using the framework outlined in the *Guide to determining terrestrial habitat quality Version 1.3* (DES, 2020). Site-based attributes were assessed in accordance with the Queensland Herbarium's BioCondition method and indicate the general vegetation condition in the matter area compared to a reference site (a BioCondition benchmark).

Six BioCondition Sites (BC1, BC2, BC3, BC4, BC5, BC10) were established, one within each individual REs and a Reference Site adjacent to the Project area (REF-BC-2). As per the approved Baseline Water Mouse Data Collection Program, BC1, BC3 and BC4 are located within areas to be retained/avoided by the Project and will be compared against results from the Reference Site (REF-BC-2). BC10 was previously referred to within the Baseline Water

Mouse Data Collection Program as BC11. While BC 13 has been removed from ongoing habitat quality assessment for the water mouse due to lack of habitat features for the species.

BCs have been selected to provide representative sites of the surrounding Project area and in areas of habitat where the water mouse has been previously recorded. The location of the survey sites presented in Figure 2.1, with the majority of the proposed sites located within the Brightwater Eastern Environmental Reserve and the Serjata Way Environmental Reserve.

GPS locations of BioCondition plots is provided in Table 2.5. A full methodology for assessing quality of habitat / BioCondition scoring to allow to repeatability is provided in Appendix B. Representative photos each of BioCondition plot at baseline level are provided in Appendix C.

Table 2.5 GPS location of BioCondition plots (GDA2020 zone 56)

BioCondition plot	Start		End	
	Easting	Northing	Easting	Northing
BC01	511140.5701	7046861.82	511161.5141	7046909.794
BC02	510917.9487	7046829.064	510936.5905	7046870.825
BC03	511637.5739	7045664.572	511688.7732	7045690.559
BC04	511429.2516	7046091.642	511512.5802	7046029.534
BC05	511533.7204	7045919.978	511465.2045	7045969.813
BC10	511396.745	7045961.095	511430.4226	7045861.676
REF02	511821.6824	7045760.848	511732.3994	7045714.665

## 2.5 Compliance with guidelines

The monitoring program implemented and associated fieldwork presented in this Report have been prepared in accordance with the following documentation and guidelines:

- Baseline Water Mouse Data Collection Program (dated 09 November 2022).
- Conservation Advice for *Xeromys myoides* (Water Mouse) (DAWE, 2021a).
- Survey guidelines for Australia's threatened mammals. EPBC Act survey guidelines 6.5 (DSEWPaC, 2011).
- National Recovery plan for the water mouse (false water rat) *Xeromys myoides* (DAWE, 2021b).
- Draft Significant impact guidelines for the vulnerable water mouse *Xeromys myoides*. Draft EPBC Act policy statement. (DEWHA, 2009a).
- Background paper to EPBC Act policy statement 3.20 - Significant impact guidelines for the vulnerable water mouse (*Xeromys myoides*) (DEWHA, 2009b).

## 2.6 Ethics statement

Field surveys were conducted in accordance with the following permits and approvals:

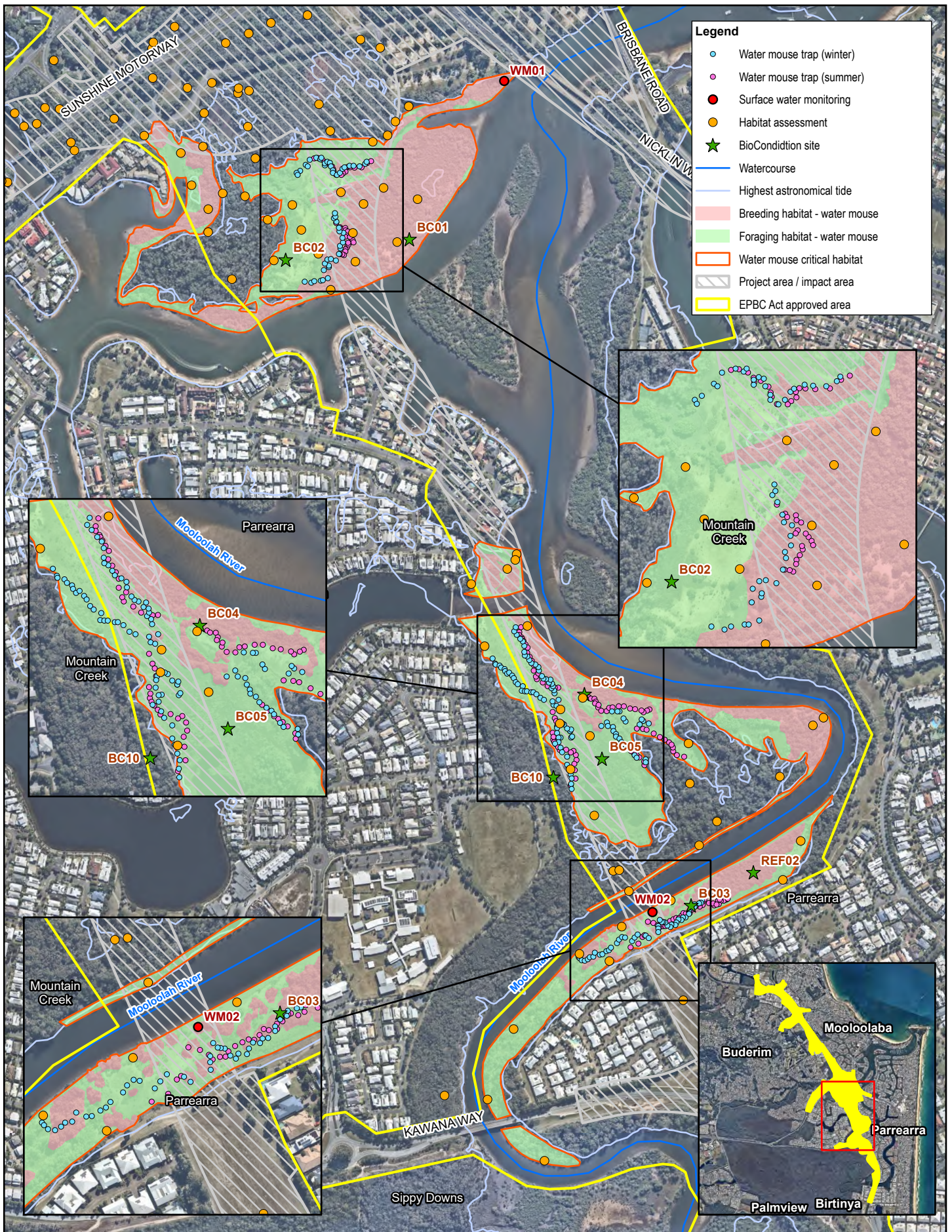
- Department of Employment, Economic Development and Innovation Scientific Users Registration Certificate (Registration Number 132)
- DES Scientific Purposes Permit (permit number WISP15723315)
- DES Rehabilitation Permit (permit number WA0042164)
- Animal Researcher Authority issued by the accredited GHD Animal Ethics Committee
- Queensland Code of Practise – Care of Sick, Injured or Orphaned Protected Animals in Queensland
- Australian Code of Practice for the Care and Use of Animals for Scientific Purposes.



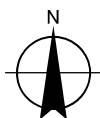
In accordance with Part 13 of the EPBC Act, no killing, injuring, taking, trading, keeping or moving of a member of the following occurred as a part of the survey efforts:

- Listed threatened species or ecological community (refer to Sections 196 and 196A-196E of the EPBC Act).
- Listed migratory species (Sections 211, 211A-211E).





1:9,000 @A4  
 0 50 100 150 200  
 Metres



Map Projection: Transverse Mercator  
 Horizontal Datum: GDA2020  
 Grid: GDA2020 MGA Zone 56



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Department of Transport and Main Roads  
 Mooloolah River Interchange  
 Water Mouse Monitoring Report

Project No. 12553095  
 Revision No. 0  
 Date 1/10/2024

Distribution of survey effort  
 within the project area

FIGURE 2-1



### 3. Species information

#### 3.1 Species ecology

The water mouse is a small, nocturnal rodent with a maximum head and body length of 126 mm and maximum weight of 64 g. It has short, very dense and silky fur that is dark slate-grey above and pure white below. In Queensland, adults are usually white-spotted dorsally. The ears are rounded and short and the eyes are very small. The hindfeet are not webbed. The tail is slender, thinly haired and very finely ringed (smooth). The water mouse has only two molars in each of the upper and lower rows (Gynther and Janetzki, 2008).

#### 3.2 Distribution

The water mouse occurs in coastal and estuarine regions of Queensland, the Northern Territory and Papua New Guinea (DCCEEW, 2023). The species' Australian distribution extends from the Gold Coast in south-east Queensland to Arnhem Land in the Northern Territory (DCCEEW, 2023), however the species once occurred in northern New South Wales (Van Dyck and Gynther, 2006). In south-east Queensland, the water mouse is distributed from the Gold Coast and Moreton Bay area to the Great Sandy Strait, and as far inland to the Beerwah State Forest (Ball, 2004; DAWE, 2021a; Kaluza et al., 2016).

The modelled distribution of the water mouse within Australia and southeast Queensland is presented in Plate 3.1 and Plate 3.2, respectively.

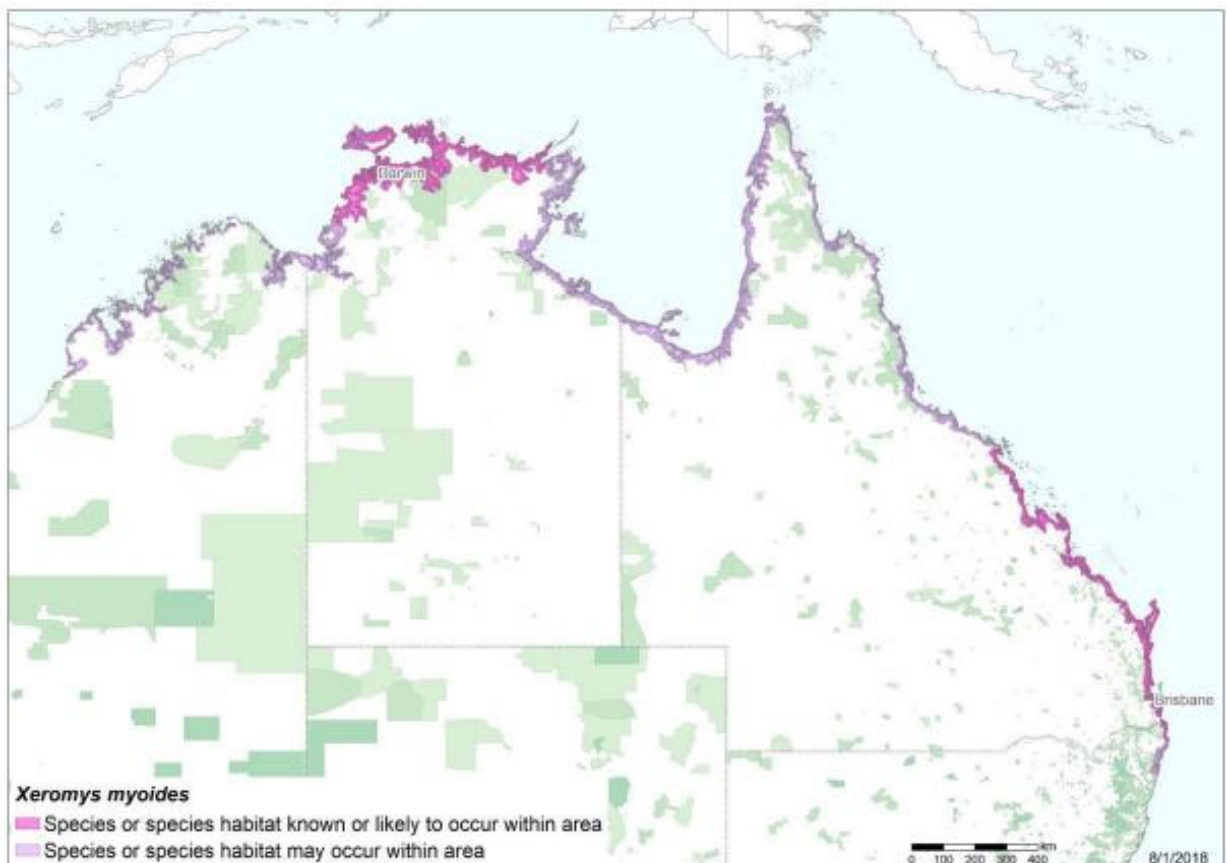


Plate 3.1 Modelled distribution of the water mouse within Australia (DAWE, 2021)

Indicative distribution of Water Mouse (*Xeromys myoides*) - Southeast Queensland

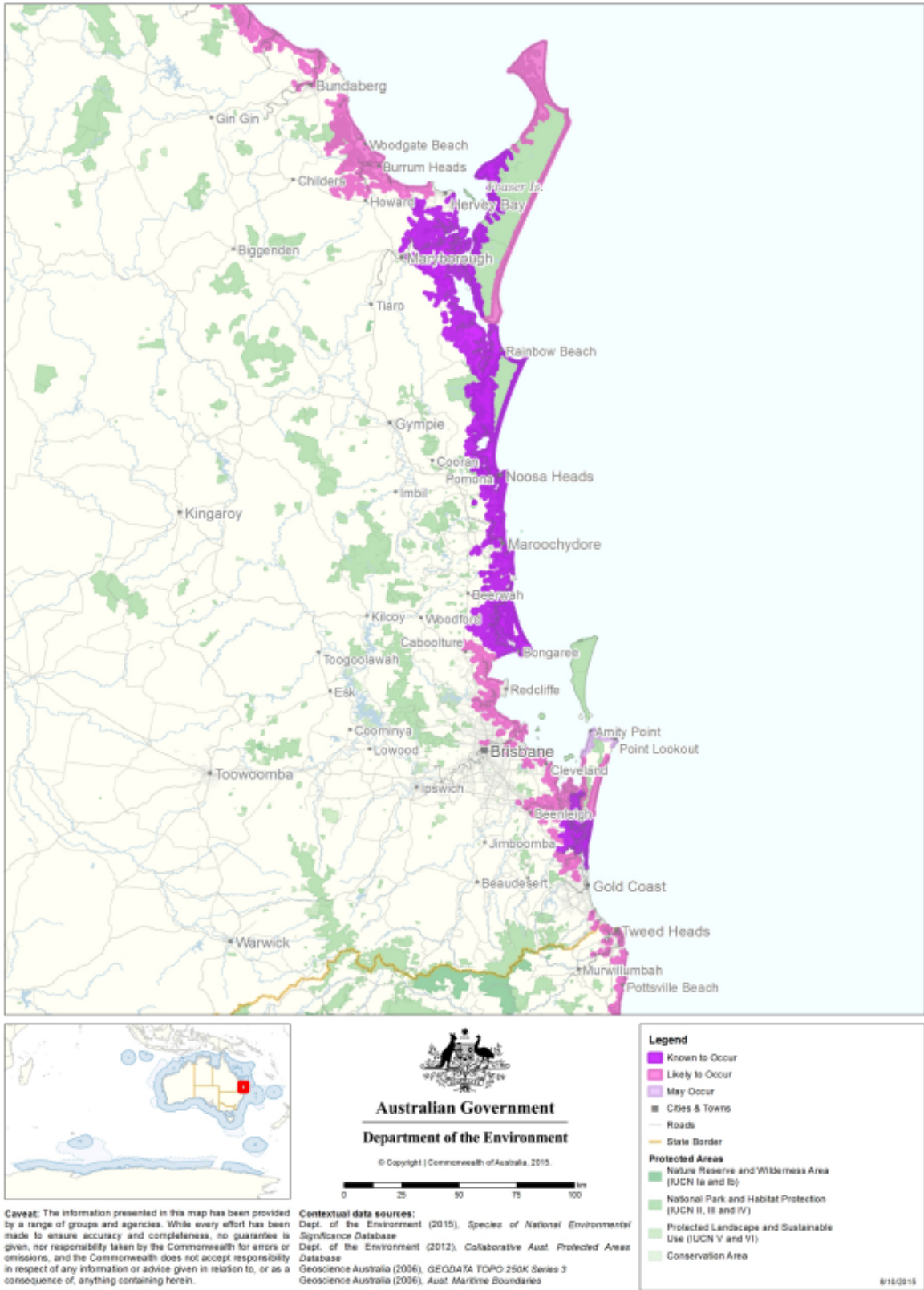


Plate 3.2 Modelled distribution of water mouse habitat within southeast Queensland (DAWE, 2021)



### 3.3 Habitat preference

The water mouse inhabits intertidal saltmarsh, mangroves and adjacent freshwater wetland habitats, favouring habitat with connectivity throughout the supralittoral zone (DAWE, 2021a; Kaluza, 2018). Low-tide saltmarsh communities are often utilized for foraging, particular areas supporting salt couch (*Sporobolus virginicus*) and samphire (*Sarcocornia quinqueflora*), and an abundance of prey species (i.e. crabs, molluscs and flatworms). Nesting habitat occurs below the high-tide mark and amongst dense saltmarsh and mangrove vegetation (Kaluza et al., 2016). Nest structures are primarily as a freestanding, termite-style mound (Van Dyck and Gynther, 2003); however several nest variations are known, including within hollow trunks of mature mangroves, internal use of tidal banks of swamp oak (*Casuarina glauca*), or man-made or soil heap structures, typically located on the terrestrial fringe (DCCEEW, 2022).

### 3.4 Home range and movement

The home range and foraging movements of the water mouse are not well studied; however both are thought to vary between localities and resource availability (DCCEEW, 2023). The water mouse has been observed to travel up to 3 km a night, while criss-crossing home ranges averaged 0.7 ha (Gynther and Janetzki, 2008). This is similar to estimates by Van Dyck (1997) at Rainbow Channel on North Stradbroke Island, who calculated an average home range of 0.64 ha. Males were also reported to have a larger home range than females (male average 0.77 ha; female 0.53 ha). Home range estimates differed greatly between sites with animals radio tracked further south at Canalpin Creek, Queensland, had a much larger home range estimate of 3.42 ha. The species is highly territorial and larger home ranges are the result of multiple factors, including microhabitat complexity, the width of the mangrove zone, vegetation type, landscape topography and recent weather (Van Dyck, 1997).

### 3.5 Historical records

No historical records occur within the Project area of the wider Mooloolah River catchment. Known populations of the water mouse occur within the Sunshine Coast region and the species has also been recorded within the Beerwah State Forest (Thomas, 1889), Coochin Creek (ALA, 2023), Pumicestone Passage (Kaluza, 2018) and the Maroochy River (Kaluza et al., 2016), with local density estimates ranging from 0.44 – 0.66 individuals per hectare of suitable habitat (Kaluza et al., 2016). Historical records of the water mouse are presented in Plate 3.3.

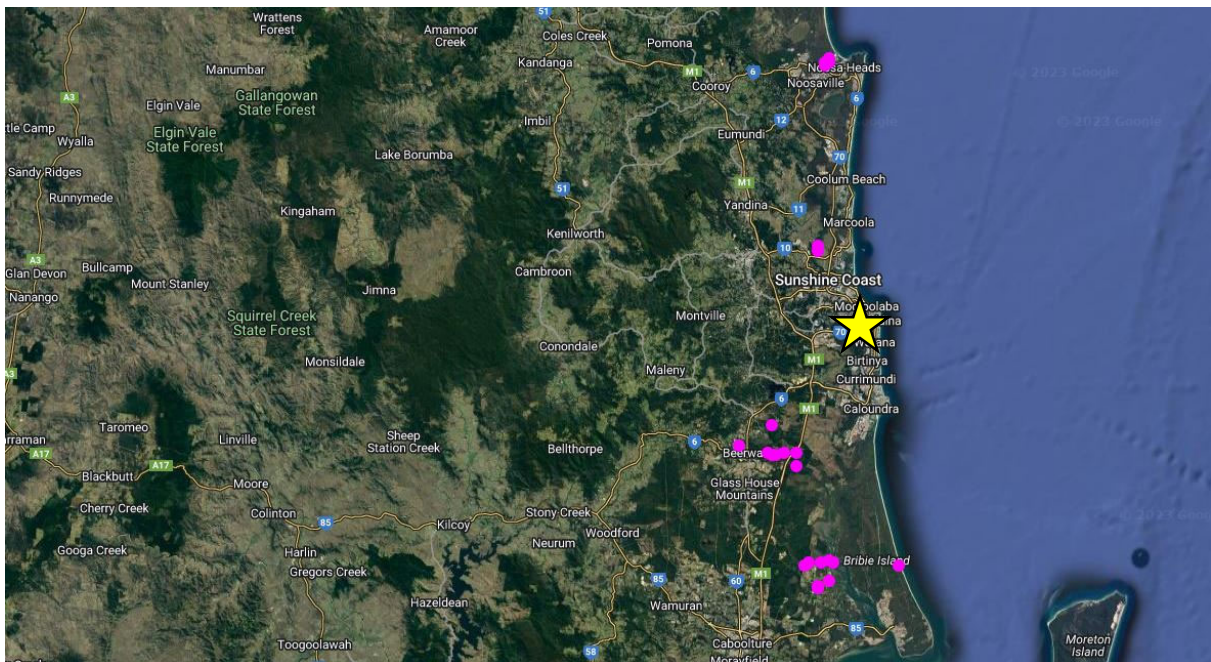


Plate 3.3 Historical records of the water mouse within the Sunshine Coast region (ALA, 2023). Project indicated by yellow star.

## 4. Field results

### 4.1 Species presence

The water mouse was confirmed present from 10 locations within the Project area during the 2023 winter survey event (Plate 4.1 and Figure 4.1). The species was confirmed present from the Brightwater (eastern) Environmental Reserve, with no individuals recorded within Seriated Way or from areas east of Brightwater Estate. Trapped individuals represented a mix of both male and female (4 male, 3 female, 3 unidentified), implying the population is relatively stable and self-sustaining. All records were restricted to mangrove communities; however the species is likely to utilise fringing saltmarsh and *Casuarina glauca* communities for foraging and dispersal. All recorded individuals were trapped below the highest astronomical tide. These findings represent the first records of the species within the Mooloolah River catchment (DES, 2023; ALA, 2023). The species was not confirmed present during the 2022 summer trapping event.

Despite no mud nests being observed during the field surveys, 36 suitable nesting locations, largely representing mature mangrove hollows or supralittoral mounds, were confirmed present.

Representative photographs of water mice captured during the 2023 winter trapping event are provided in Plate 4.1.



Plate 4.1 Water mice trapped within the Project area during the winter survey event



## 4.1.1 Difference between the summer and winter trapping events

Water mouse activity has been known to vary in response to meteorological conditions and in response to past and future environmental events (Kaluza et al., 2016). Whilst previous studies have documented higher water mouse activity during summer (Kaluza et al., 2016), the results of the baseline water mouse monitoring program reported higher water mouse activity and presence during the cooler winter months. The contrasting results of the summer and winter trapping event can be partially explained by variations in the lunar cycle and tidal system (Kaluza et al., 2016). These variables are discussed below. Whilst solar radiation, local rainfall and temperature are also reported to influence water mouse activity (Kaluza et al., 2016), these variables were not recorded during the field survey.

### 4.1.1.1 Tidal range

Tidal variation is a likely factor influencing the contrasting results of the summer and winter trapping events. Local tidal cycles impose frequent, natural changes in conditions within intertidal habitats (e.g. the availability of foraging habitat and resources) and are highly influential in determining water mouse behaviours (Cabrita et al., 1998; Kaluza et al., 2016).

The baseline water mouse trapping program was conducted over two contrasting tidal cycles. While both tidal cycles had overnight lows, maximising nocturnal foraging time, the summer trapping event experienced a low, evening high tide and a larger morning high tide (Plate 4.2). In contrast, the winter event experienced a larger evening high tide and a lower morning high tide (Plate 4.3). Evening high tides ranged from 1.16 m – 1.33 m during the summer event with greater evening tide recorded during winter (ranging 1.63 m – 1.78 m). The higher evening tide could potentially explain the species' increased foraging activity (resulting in increased trap success) experienced during the winter survey. Previous surveys have reported water mouse activity to peak 2 hours after sunset, with most activity occurring within 4 hours of sunset (Kaluza et al., 2016). Therefore, high evening tides are likely to be more beneficial for water mouse foraging due to an increase in the area subject to tidal inundation, with an associated increase in deposition of prey / fresh sediment and prey activity resulting from the higher evening tide.

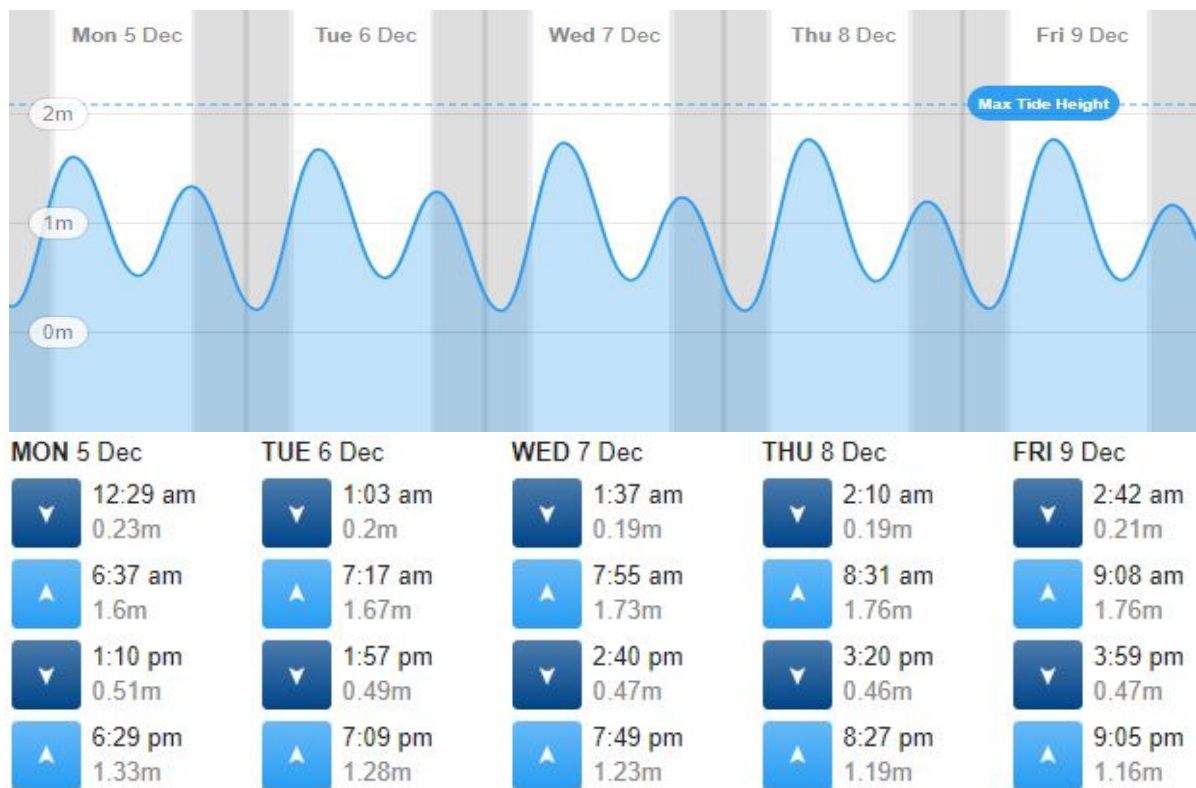


Plate 4.2 Tidal variation during the summer trapping event

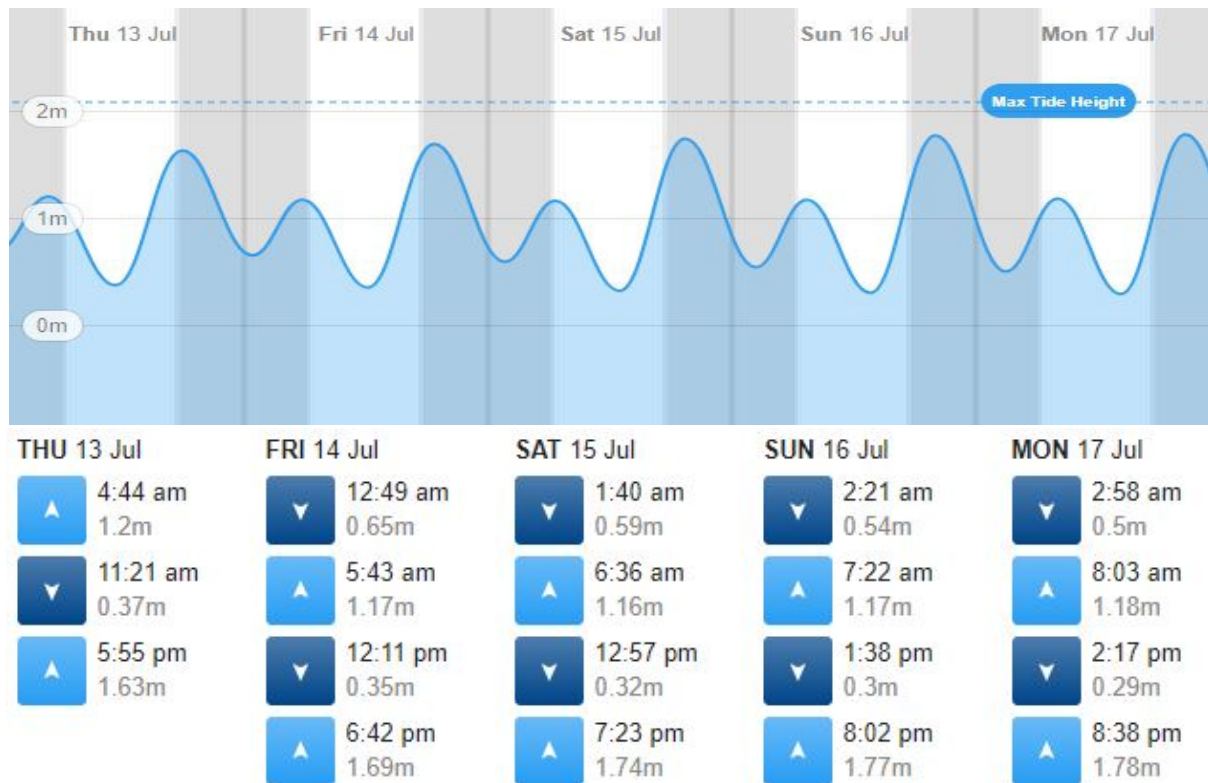


Plate 4.3 Tidal variation during the winter trapping event

#### 4.1.1.2 Lunar cycle and lunar illumination

Variations in moonlight between the two trapping events also has the potential to partially explain the contrasting results of the summer and winter trapping events. Species interactions within intertidal habitats are often guided by light availability, which can determine the timing and success of predatory activity and the ability of prey to avoid predation (Garrett et al., 2019). Natural light has the potential to alter the dynamics of predator-prey interactions, and high moonlight can influence foraging activity if the perceived predation pressure is high (Kaluza et al., 2016). The unsuccessful summer survey was conducted under a full moon, with lunar illumination ranging from 93% - 100% (Plate 4.4). These conditions represent the highest natural light conditions, and thus, likely represents the highest perceived predation pressure for prey species like the water mouse. This reflects the findings of the survey, with no water mice trapped under the full moon and high illumination (summer event). In contrast, the successful winter survey event was conducted at the end of the lunar cycle, with new moon on the final night of the survey event (Plate 4.5). Lunar illumination ranges from 5% - 0, representing the lowest stage of illumination during a lunar cycle. The influence of natural and artificial light on species interactions and foraging behaviours has been well documented in terrestrial and intertidal ecosystem, with decreased foraging activity often correlated with increased light (Nunez et al., 2021; Garrett et al., 2019). This relationship was likely influential during the baseline trapping program.





Plate 4.4 Moon cycle during the summer trapping event



Plate 4.5 Moon cycle during the winter trapping event

## 4.2 Suitable habitat within the Project area

Suitable habitat for the water mouse within the Project area was field verified during targeted fauna surveys in April / May 2022 (GHD, 2022). Suitable habitat was confirmed present at three locations: Seriata Way Environmental Reserve, Brightwater (eastern) Environmental Reserve and east of Brightwater Estate (Figure 4.1). Field surveys have confirmed the presence of three suitable REs (RE 12.1.1, 12.1.2 and 12.1.3) which supported essential habitat factors for the water mouse.

RE 12.1.3 was found to be dominated by mangrove species on regularly inundated quaternary estuarine tidal deposits (Plate 4.6). This unit is dominated by *Avicennia marina* subsp. *australasica* (grey mangrove) with *Bruguiera gymnorhiza* (orange mangrove) sometime co-dominant or sub-dominant in the canopy with *Rhizophora stylosa* (red mangrove) a scattered subcanopy tree and *Aegiceras corniculatum* (river mangrove) a scattered shrub. *Ceriops australis* (yellow mangrove) forms small patches of shrubs on slightly higher areas less frequently inundated or for shorter periods of time. *Excoecaria agallocha* (milky mangrove) was common in the ecotone between mangroves and saltmarsh/saltpan.

RE 12.1.2 was found to vary between the following two vegetation descriptions, as shown in (Plate 4.7):

- Saltpan with small patches of *Sporobolus virginicus* and *Juncus kraussii* with isolated chenopods such as *Suaeda australis*, *S. arbusculoides* and *Salicornia quinqueflora* subsp. *quinqueflora* with occasional low shrub *Avicennia marina* and *Excoecaria dallachyana* (Plate 4.7).
- Grassland of *Sporobolus virginicus* and *Juncus kraussii* with *Suaeda australis*. *Ruppia maritima* is present where standing water is present, with *Triglochin striata* present on the margins of pools.

RE 12.1.1 consists of habitat dominated by *Casuarina glauca* in the intertidal zone, which is occasionally inundated, supporting marginal woodland on the edge of the RE 12.1.2 salt pans / grassland and provides foraging resources for the water mouse (Plate 4.8). The vegetation associated with the grasslands and salt pans of RE 12.1.2 extend into the ground layer of the *Casuarina glauca* woodland, extending the suitable foraging habitat.



Plate 4.6 Examples of RE 12.1.3 - mangrove shrubland to low closed forest on marine clay plains and estuaries





**Plate 4.7**      *Examples of RE 12.1.2 - Saltpan vegetation on marine clay plains*



**Plate 4.8**      *Examples of RE 12.1.1 - Casuarina glauca woodland on margins of marine clay plains*



## 4.2.1 Area of occupancy

A species' area of occupancy is defined as the area within its 'extent of occurrence' which is occupied by a species, excluding cases of vagrancy (IUCN, 2012). At a species' level, the area of occupancy for the water mouse extends from southeast Queensland to western Northern Territory. However, in spite of its large extent of occurrence, the species' area of occupancy has been estimated as less than 2000 km<sup>2</sup> due to fragmentation and habitat loss (Dickman et al. 2000).

The area of occupancy of the water mouse at a local scale was calculated following the baseline field surveys. The area of occupancy was verified using confirmed records from the trapping surveys and areas of habitat assessed as representing habitat critical to the survival of the species (Section 4.2.2). Using these criteria, the area of occupancy represents 6.69 ha of habitat within Seriated Way, Brightwater (eastern) and areas east of Brightwater Estate. It should be noted that at this stage in the monitoring, water mouse has only been confirmed present from within Brightwater (eastern), however due to the presence of suitable habitat and potential habitat connectivity to other areas, all suitable habitat within the Project area is considered to be occupied. Therefore, all habitat critical to the survival of the species within the Project area (6.69 ha) is considered occupied unless future trapping efforts undertaken as part of this program can confirm the habitat is unoccupied.

## 4.2.2 Habitat critical to the survival of the species

Using the referral guidelines, habitat critical to the survival of the water mouse includes all mangrove communities, intertidal communities, and coastal freshwater wetlands with one or more of the following four features:

- Intact hydrology
- Prey resources (Crustaceans, marine polyclads and marine pulmonates and bivalves)
- Active water mouse nest structures
- A defined supralittoral bank that could enable the construction of nests.

Using these criteria, field surveys confirmed the presence of 6.69 ha of habitat critical to the survival of the water mouse within the Project area (Figure 4.1). Habitat critical to the survival of the species represented three REs - RE 12.1.1, 12.1.2 and 12.1.3. All three areas of water mouse habitat met the criteria of 'critical habitat' owing to the presence of prey resources, supralittoral banks and the intact hydrology of the Lower Mooloolah estuary. Only Brightwater met all four characteristics and was confirmed to support active water mouse nest structures.

There is currently no mapping of habitat critical to the survival of the water mouse and there is no formal definition listed in the species' Conservation Advice. This is owing to the fact that suitable habitat for the water mouse is extensive and largely unsurveyed (DAWE, 2021). However, as the species' eligibility for listing reflects a restricted area of occupancy and a decline in habitat and quality, this suggests that all water mouse habitat are important for the long-term recovery of the water mouse.

Representative photographs of habitat critical to the survival of the water mouse are provided in Plate 4.9.



**Plate 4.9** *Habitat critical to the survival of the water mouse within the Project area – supralittoral banks (left) and potential nest structures (right)*

### 4.3 Important populations

The water mouse is considered one single, nationally important population (Benfer et al. 2014). Recent studies confirmed water mouse genetic diversity is very low across its known range, suggesting the species may have experienced a recent range expansion and constitutes a single evolutionarily significant unit (Benfer et al. 2014). Habitat suitability maps presented in the species’ referral guidelines indicate significant water mouse populations occur within the Central Queensland and Southeast Queensland bioregions (DERM, 2010). As such, the population residing within the Project area is likely to represent an important population. Further, the findings of the winter trapping event currently represent the only confirmed records within Mooloolah River catchment. As such, these findings are likely to represent a new population and an important population for the species conservation.

### 4.4 Surface water monitoring

Surface water monitoring was conducted at 2 locations within suitable habitat for the water mouse adjacent to the MRI Project area. Both sites were sampled at low and high tide over a period of twelve months in accordance with Condition 4A (b) (ii) of the EPBC 2008/4361. Data was compared against the predictor variables (pH, salinity and temperature) outlined in Kaluza et al (2016) (Table 4.1).

Temperature was within the suitable range (10.1 – 27.3°C), whilst both sites reported pH over the maximum range during high tides (Site 1 – 9.6 and Site 2 – 9.4) which is likely influenced with the increase in freshwater at high tide (highlighted in orange within Table 4-2). No data was obtained for salinity, however values for electrical conductivity have been included as a representation. Salinity is a measure of the dissolved salts present in the water, occurring in the form of positively and negatively charged ions (CWT, 2004). Conductivity is the ability of water to conduct an electrical current, which is directly influenced by the concentration of salt ions (CWT, 2004). All measures of electrical conductivity were within the typical range of lowland rivers of eastern Australia, as presented in Table 3.3.3 of the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000) - The Guidelines - Volume 1* (ANZECC, 2000).

A summary of the surface water monitoring conducted within water mouse habitat is provided in Table 4.2. The locations of surface water monitoring sites is presented in Figure 2.1.

Table 4.1 Range of predictor variables for water mouse activity (Kaluza et al., 2016).

Variable	Range		Mean value	Standard deviation
	Min	Max		
Salinity (g/kg)	5.5	33.5	19.5	+ - 14
pH level	3.9	9.3	6.6	+ - 2.7
Water temp (°C)	10.1	27.3	18.7	+ - 8.6

Table 4.2 Surface water monitoring data

Location	Variable	WQO			Summary statistics					
		Units	Min	Max	Min	Max	Median	Mean	20th %	20th %
<b>Site 1 - High tide</b>										
Low flow Conductivity >40.0 mS/cm	Temperature	°C	-	-	17.3	27.4	22.7	22.4	19.6	25.6
	Electrical Conductivity	mS/cm	-	-	40.2	64.2	46.8	49.1	45.4	52.0
	pH	Units	7.0	8.4	7.6	9.6	7.9	8.01	7.6	8.05
<b>Site 2 - High tide</b>										
Low flow Conductivity >40.0 mS/cm	Temperature	°C	-	-	17.2	28.1	22.6	22.7	20.00	26.5
	Electrical Conductivity	mS/cm	-	-	40.7	64.1	46.4	48.6	44.9	51.5
	pH	Units	7.0	8.4	7.5	9.4	7.8	7.97	7.73	7.9
<b>Site 1 - Low tide</b>										
Low flow Conductivity >40.0 mS/cm	Temperature	°C	-	-	18.03	29.10	23.80	24.00	20.59	28.19
	Electrical Conductivity	mS/cm	-	-	30.1	63.6	43.9	45.4	41.3	49.0
	pH	Units	7.0	8.4	7.52	8.73	7.71	7.86	7.59	7.99
<b>Site 2 - Low tide</b>										
Low flow Conductivity >40.0 mS/cm	Temperature	°C	-	-	17.20	29.00	23.80	23.75	20.09	28.21
	Electrical Conductivity	mS/cm	-	-	20.6	56.1	39.6	40.6	36.4	48.1
	pH	Units	7.0	8.4	7.10	8.22	7.47	7.57	7.35	7.78
Key to table: Orange represents values above the range reported in Kaluza et al., 2016.										



## 4.5 Habitat quality (BioCondition results)

BioCondition assessments were conducted at six locations, as well as one reference location (Table 4.3). All assessments were conducted outside of the Project area and within areas adjacent to the Project. Habitat quality criteria was derived by suitably qualified ecologists from the DJV. For each condition parameter, scores out of 25 were assigned (in accordance with the *Guide to Determining Terrestrial Habitat Quality* (DES 2020). These were then converted to a score out of 10 to align with the EPBC Act *Offsets Assessment Guide* (DSEWPaC 2012) scoring framework as detailed in the *Modified QLD Habitat Quality spreadsheet*.

The full methodology for assessing water mouse habitat quality is provided in Appendix B for consistency during future construction phase monitoring events. The DCCEEW *Modified QLD Habitat Quality spreadsheet* for water mouse is provided in Appendix D.

As per the Baseline Water Mouse Data Collection Program, BC REF02 scoring has been included to allow for comparison during future construction phase monitoring events. Continual and consistent monitoring of the reference site along with the water mouse habitat quality (BC) sites will provide an indication of whether habitat quality remains the same in areas not directly impacted by the Project.

The six BioCondition sites were distributed across three REs known to represent suitable habitat for the water mouse:

- RE 12.1.1 – Swamp oak (*Casuarina glauca*) woodland on margins of marine clay plains.
- RE 12.1.2 – Saltpan vegetation including grassland, herbland and sedgeland on marine clay plains.
- RE 12.1.3b – Mangrove shrubland to low closed forest on marine clay plains and estuaries.

One BioCondition site was conducted within RE 12.1.1, whilst two were conducted in RE 12.1.2 and three were conducted within RE 12.1.3b. Habitat quality within RE 12.1.2 received a relatively high adjusted score of 2.5 and 2.6 (out of 3) at BC05 and BC02 respectively. BC10 (RE 12.1.1) received an adjusted score of 2.18 (out of 3). Sites BC01, BC03 and BC04 (RE 12.1.3b) received scores of 2.15 across all sites. The low scores calculated for the above aforementioned sites were predominantly driven by:

- A lack of large trees
- Low canopy heights
- Limited canopy covers, and
- A lack of fallen woody debris.

BioCondition field data for each site is provided in Table 4.3. Adjusted scores derived from field data shown are presented in Table 4.4. The locations of BioCondition survey sites are presented in Figure 2.1. Representative photos of the start, middle and end of each BC plot is provided in Appendix C.

Table 4.3 Findings of the BioCondition surveys

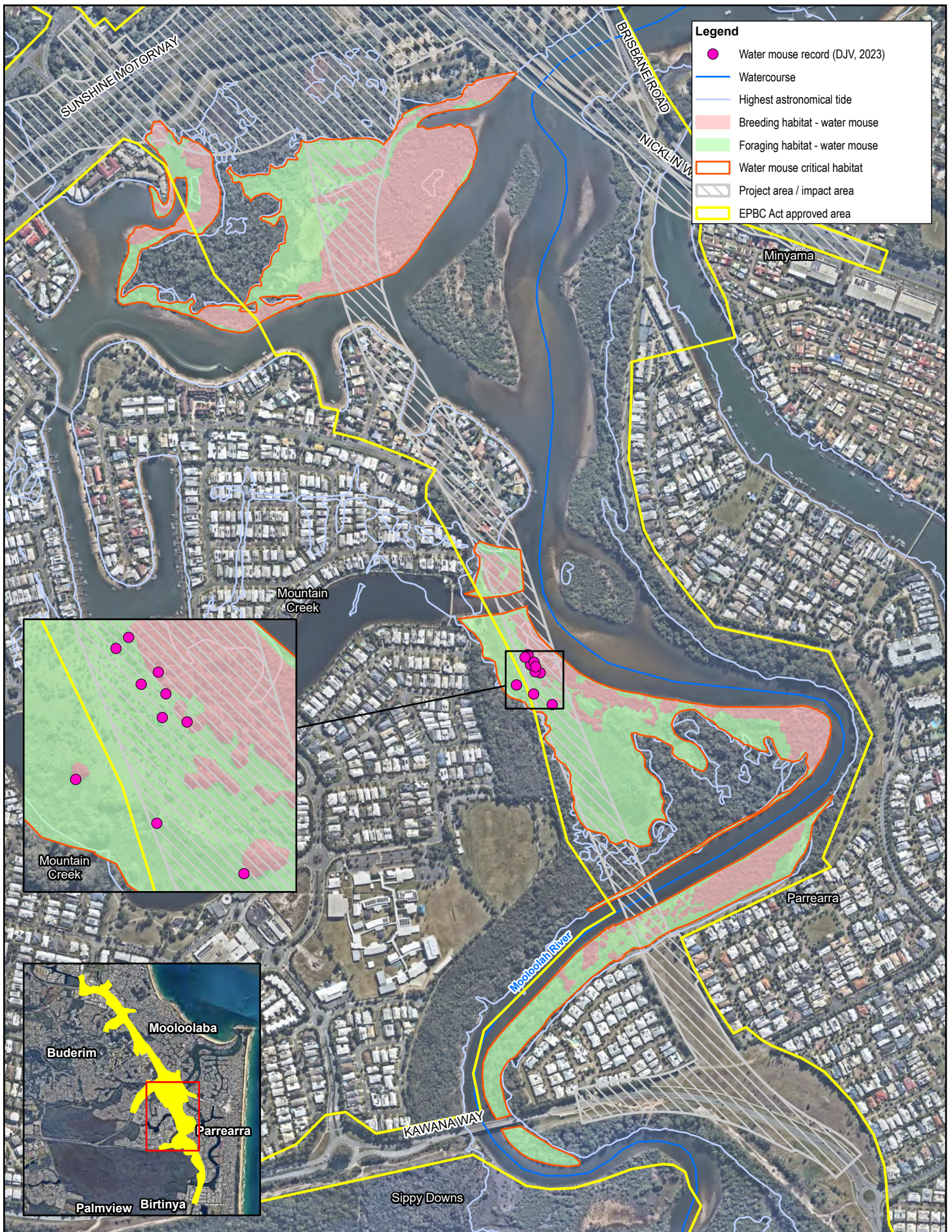
BioCondition variable	RE 12.1.1		RE 12.1.2			RE 12.1.3			
	BM*	BC 10	BM	BC02	BC05	REF02**	BC01	BC03	BC04
<b>Large Trees (stems/ha)</b>									
Eucalypts	-	-	-	-	-	-	-	-	-
Non-eucalypts	92	30	-	-	-	200	32	68	8
Total	92	30	-	-	-	200	32	68	8
<b>Tree height (m)</b>									
Emergent	-	-	-	-	-	-	-	-	-
Canopy	12	15	-	-	-	8	7	6	9
Subcanopy	7	8	-	-	-	5	3	0	5
<b>Tree Cover (%)</b>									
Emergent	-	-	-	-	-	-	-	-	-
Canopy	67	30.6	-	-	-	78	28.8	27.9	9.40
Subcanopy	23	67.6	-	-	-	5	18.0	37.4	14.0
Shrub Cover (%)	5	8.6	-	-	-	6	36.8	13.5	17.4
Recruitment of canopy trees (%)	100	100	-	-	-	100	100	100	100
Coarse woody debris (m/ha)	360	27	-	-	-	152	0.0	36.0	0.0
<b>Native plant species richness (n)</b>									
Tree	1	3	-	1	-	1	2	3	2
Shrub	1	5	-	0	-	2	4	4	4
Grass	2	4	1	1	2	-	-	-	-
Other	3	6	3	1	1	-	-	-	-
Non-native plant cover (%)	0	0	0	0	0	0	0	0	0
Native perennial grass cover (%)	85	0	35	73.8	68.6	-	-	-	-
Litter Cover (%)	5	82.8	-	1.2	-	-	-	-	-
*BM – Benchmark data, as presented in Version 3.2 (December 2021) at the time of the survey (Queensland Herbarium, 2021).									
** No benchmark data exists for RE 12.1.3. Instead, a reference site was established in accordance with <i>Method for the establishment and survey of reference sites for BioCondition</i> (Eyre et al., 2017).									



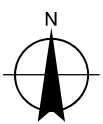
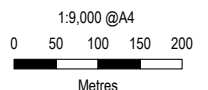
Table 4.4 Adjusted BioCondition scoring from field surveys

RE	12.1.1	12.1.2		12.1.3b			
Site Code	BC10	BC02	BC05	REF02	BC01	BC03	BC04
Large Trees	5.0	-	-	5.0	5.0	5.0	5.0
Tree height (m)	5.0	-	-	5.0	5.0	5.0	5.0
Tree Cover (%)	5.0	-	-	5.0	5.0	3.0	5.0
Shrub Cover (%)	5.0	-	-	5.0	3.0	3.0	3.0
Recruitment of dominant canopy trees (%)	5.0	-	-	5.0	5.0	5.0	5.0
Coarse woody debris (m/ha)	0.0	-	-	5.0	0.0	2.0	0.0
Native plant species richness-Tree	5.0	-	-	5.0	5.0	5.0	5.0
Native plant species richness-Shrub	5.0	-	-	5.0	5.0	5.0	5.0
Native plant species richness -Grass	5.0	5.0	5.0	-	-	-	-
Native plant species richness -Other	5.0	5.0	2.5	-	-	-	-
Non-native plant cover (%)	10.0	-	-	10.0	10.0	10.0	10.0
Native perennial grass cover (%)	0.0	3.0	5.0	-	-	-	-
Litter Cover (%)	3.0	-	-	-	-	-	-
Total	58.0	13.0	12.5	60.0	43.0	43.0	43.0
<b>Max. Score</b>	<b>80.0</b>	<b>15</b>	<b>15</b>	<b>60.0</b>	<b>60.0</b>	<b>60.0</b>	<b>60.0</b>
<b>Adjusted (out of 3)</b>	<b>2.18</b>	<b>2.6</b>	<b>2.5</b>	<b>3.0</b>	<b>2.15</b>	<b>2.15</b>	<b>2.15</b>





- Legend**
- Water mouse record (DJV, 2023)
  - Watercourse
  - Highest astronomical tide
  - Breeding habitat - water mouse
  - Foraging habitat - water mouse
  - Water mouse critical habitat
  - Project area / impact area
  - EPBC Act approved area



Department of Transport and Main Roads  
 Mooloolah River Interchange  
 Water Mouse Monitoring Report

Project No. 12553095  
 Revision No. 0  
 Date 1/10/2024

**Findings of the field surveys**

**FIGURE 4-1**



## 4.5.1 Water mouse habitat scoring

### 4.5.1.1 Quality and availability of food and habitat required for foraging

The results of the foraging habitat scoring for the water mouse is presented in Table 4.5. Representative photographs of foraging habitat within the impact area are provided in Plate 4.10.

High scores were generally associated with habitat connectivity, vegetation diversity and the location of the survey site within the intertidal zone. Whilst most sites scored highly for habitat connectivity, the presence of multiple disturbances (i.e. increased erosion, introduced predators and artificial light) reduced the quality in all the assessed areas within the impact area. Prey density also varied between sites, with tidal mudflats scoring higher (BC 1, BC 3 and BC 4) scoring higher than casuarina tidal woodlands (BC 10).

**Table 4.5** Quality of foraging habitat for the water mouse – impact area

Assessment criteria	Scores							Average
	REF02	BC01	BC02	BC03	BC04	BC05	BC10	
Habitat connectivity	4	5	10	4	10	4	4	5.9
Community diversity	2	2	6	2	6	6	6	4.3
Prey density	4	5	2	4	4	4	0	3.3
Total	10	12	18	10	20	14	10	13.4
<b>Adjusted score (out of 10)</b>	<b>2.7</b>	<b>4.0</b>	<b>6.0</b>	<b>2.7</b>	<b>6.7</b>	<b>4.7</b>	<b>3.3</b>	<b>4.3</b>



**Plate 4.10** High quality foraging habitat for the water mouse within the impact area

### 4.5.1.2 Quality and availability of habitat required for shelter and breeding

The results of the shelter / breeding habitat for the water mouse within the impact area is presented in Table 4.6. Representative photographs of shelter and breeding habitat within the impact area are provided in Plate 4.11.

Mangrove hollows were present at three of the six assessment sites, and ranged from 0 at BC 1, 2, and 5, to 3 and 4 at BC 4 and BC 3 respectively. The diversity of denning habitats and size of breeding habitat was highest at BC 1, which supported mangrove hollow, supralittoral banks and tidal flats conducive for mounds. Disturbance level was relatively stable across all sites, with the threat of introduced predators, increased erosion / wave action and artificial light being common.

Table 4.6 Quality of shelter / breeding habitat for the water mouse – impact area

Assessment criteria	Scores							Average
	REF02	BC01	BC02	BC03	BC04	BC05	BC10	
Density of denning sites	4	0	0	4	4	0	0	1.7
Diversity of denning habitat	6	10	2	2	2	2	2	3.7
Size of breeding habitat (m <sup>2</sup> )	3	10	0	3	5	5	0	3.7
Disturbance level	4	8	6	4	4	4	4	4.9
Total	17	28	8	13	15	11	6	14.0
<b>Adjusted score (out of 10)</b>	<b>4.3</b>	<b>7</b>	<b>2.0</b>	<b>3.3</b>	<b>3.8</b>	<b>2.8</b>	<b>1.5</b>	<b>3.5</b>



Plate 4.11 Breeding and shelter habitat for the water mouse within the impact area

#### 4.5.1.3 Quality and availability of habitat required for mobility

The quality and availability of mobility habitat for the water mouse is presented in Table 4.7.

Table 4.7 Species mobility capability – water mouse

Attribute	Scores						
	REF02	BC01	BC02	BC03	BC04	BC05	BC10
Behavioural deterrents from adjacent areas	6	8	7	6	9	7	5
Habitat connectivity	6	10	8	6	10	8	5
Physical deterrents to movement	6	8	8	6	8	7	6
Total	18	26	23	18	27	24	16
<b>Adjusted score (out of 10)</b>	<b>6</b>	<b>8.7</b>	<b>7.6</b>	<b>6</b>	<b>9</b>	<b>8</b>	<b>5.3</b>

#### 4.5.2 Absence of threats

Threats for the water mouse are prevalent within the impact area, with the risk of coastal development, recreational activities, coastal pollution and introduced predators ranking highly at all sites (Table 4.8). The two threats that scored the lowest (smallest threat) were rising sea levels and pesticide application.

Absence of threats scores for the water mouse within the impact area are provided in Table 4.8.

Table 4.8 Absence of threats – water mouse impact area

Attribute	Scores						
	REF02	BC01	BC02	BC03	BC04	BC05	BC10
Risk of coastal development	10	6	6	10	8	8	6
Recreational activity	8	6	6	8	8	6	6
Rapid sea-level rise with climate change	10	8	8	10	10	10	8
Pesticide application	10	8	8	10	10	10	10
Introduced species	8	6	6	8	8	6	6
Coastal pollution	8	6	6	8	8	8	6
<b>Lowest score</b>	<b>8</b>	<b>6</b>	<b>6</b>	<b>8</b>	<b>8</b>	<b>6</b>	<b>6</b>

### 4.5.3 Summary

Habitat quality scores varied between AUs, AU1 (RE 12.1.1) received the lowest weighted score of 0.23, AU2 (RE 12.1.2) has a weighted score of 1.79 and AU3 (RE12.1.3) had the greatest weighted score of 4.28. The baseline weighted habitat quality score for the Project was 6.30, a summary of the breakdown of results is provided in Table 4.9 with the full modified QLD Habitat Quality spreadsheet for the water mouse provided in Appendix D.

Table 4.9 Summary of habitat scores per assessment unit

Final habitat quality score (weighted)	AU 1 12.1.1	AU 2 12.1.2	AU3 12.1.3	Average	Total
Site Condition score (out of 3)	1.87	1.76	1.93	1.88	NA
Site Context Score (out of 3)	1.07	1.27	1.3	1.21	NA
Species Stocking Rate Score (out of 4)	3.14	3.14	3.14	3.14	NA
Habitat Quality score (out of 10)	6.08	6.17	6.37	6.17	NA
Assessment Unit area (ha)	0.25	1.94	4.50	6.69	NA
Total impact area (ha) for this MNES	6.69	6.69	6.69	6.69	NA
Size Weighting	0.037	0.290	0.673	1.00	NA
<b>Weighted Habitat Quality Score</b>	<b>0.23</b>	<b>1.79</b>	<b>4.28</b>	<b>NA</b>	<b>6.30</b>



## 5. Recommendation for future monitoring events

Survey methods utilised for the baseline monitoring of water mouse has proven to be successful, as water mouse individuals were confirmed present during the winter trapping event. Therefore, while some flexibility in survey design is required for future monitoring events (i.e., animal ethics during trapping events may result in slight alterations to trap numbers set and location to allow for safe trapping of fauna around tidal movements), the trapping method and design is suitable for future construction phase monitoring of the species.

As per the approved Baseline Water Mouse Data Collection Program, '*BC1, BC3 and BC4 are located within areas to be retained/avoided by the Project and will be compared against results from the Reference Site (REF-BC-2)*'. This is achieved within this report, with baseline data collection occurring at these sites to allow comparison during future monitoring events. However, as the results of this baseline survey confirmed the presence of an important population of water mouse within the Project area, which had historically not been recorded from the Mooloolah River, it is recommended that an additional reference site is established during the construction phase monitoring program to provide a more robust dataset for comparison to this important population.

## 6. Conclusions

The Mooloolah River Interchange (MRI) Project (Stage 1) holds an approval under the Commonwealth *Environment, Protection and Biodiversity Act 1999* (EPBC Act) (EPBC 2008/4361). Condition 4A (b) of EPBC 2008/4361 required a baseline data collection program to be established to determine:

1. The area of occupancy of the Water Mouse population within the project area
2. The water quality and salinity levels at high and low tide levels
3. The condition and extent of water mouse habitat to be retained/avoided by the action, for comparison against appropriate control sites.

The *Baseline Water Mouse Data Collection Program (dated 09 November 2022)* was approved by DCCEEW on 24 November 2022.

The baseline water mouse monitoring program utilised an integrated approach of habitat assessments, daytime active searches and night-time Elliott trapping in accordance with the aforementioned *Baseline Water Mouse Data Collection Program (dated 09 November 2022)*. Two trapping surveys have been conducted, incorporating a summer and a winter trapping event:

- Summer trapping – 5 night from 5- 10<sup>th</sup> December 2022
- Winter trapping – 5 night from 13 – 18<sup>th</sup> July 2023

In total, 1620 trap nights were conducted during the summer (n = 720) and winter (n = 900) trapping events. Trap configuration and survey effort exceeded the guidelines outlined in the Commonwealth survey guidelines.

The water mouse was confirmed present from 10 locations within the Project area during the 2023 winter survey event. The species was confirmed present from the Brightwater (eastern), with no individuals recorded within Serjata Way or from areas east of Brightwater Estate. Trapped individuals represented a mix of both male and female (4 male, 3 female, 3 unidentified), implying the population is relatively stable and self-sustaining. These findings represent the first records of the species within the Mooloolah River catchment (DES, 2023; ALA, 2023). The species was not confirmed present during the 2022 summer trapping event.

The area of occupancy was verified using confirmed records from the trapping survey and areas of habitat assessed as representing habitat critical to the survival of the species. Using this criteria, the area of occupancy represents 6.69 ha of habitat within Serjata Way, Brightwater (eastern) and from areas east of Brightwater Estate. These areas are likely to represent habitat critical to the survival of the species.

Additionally, this report presents baseline data for BioCondition (i.e. habitat quality) and baseline surface water quality results to be used as benchmark for ongoing monitoring of habitat quality and surface water quality within the Project area and adjacent water mouse habitat for future monitoring programs. This report therefore meets the requirements as set out in the *Baseline Water Mouse Data Collection Program (dated 09 November 2022)* and approved by DCCEEW on 24 November 2022.

Future construction phase monitoring is required by the EPBC 2008/4361 conditions, it is recommended that the methodology described and sites established within this report and the *Baseline Water Mouse Data Collection Program* are complied with during future monitoring events. Additionally, it is recommended that an additional reference site is established during the construction phase monitoring program to provide a more robust dataset for comparison during construction due to the confirmed presence of an important population.

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# **Appendix A**

**EPBC 2008/4361 Consolidated Conditions**



## Consolidated Notice:

### Multi-Modal Transport Corridor (MMTC), Sunshine Coast, Qld (EPBC 2008/4361)

This decision is made under section 145D and 143 of the *Environment Protection and Biodiversity Conservation Act 1999*.

#### Approved action

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**person to whom the approval is granted** Department of Transport and Main Roads

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**proponent's ABN (if applicable)** 39 407 690 291

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**approved action** The proposal involves the upgrade, extension and construction of approximately 10km of a Multi-Modal Transport Corridor (MMTC) up to 6 lanes (with provision for 8 lanes) and 2 railway lines between Caloundra and Maroochydore, on the Sunshine Coast, QLD as described in the referral document accepted by the Department on 30 July 2008 and the preliminary documentation published on 8 May 2010.

#### Approval

Controlling Provision	Decision
Listed threatened species and communities (sections 18 & 18A)	Approved

#### Conditions of approval

This approval is subject to the conditions specified below. This is a consolidated set of conditions.

#### Extension of Period of Effect of Approval

**Period for which approval is extended** The approval has been extended until 1 September 2040

**Date of effect** The extension has effect on the date the instrument is signed

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## Decision-maker

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**name and position** Shane Gaddes  
Assistant Secretary  
Compliance & Enforcement Branch

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**signature** 

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**date of decision** 28 August 2015

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## Conditions attached to the approval

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### conditions of approval

This approval is subject to the conditions specified below.

1. The person taking the action must not clear more than 4.2 hectares of habitat for the flora species *Acacia attenuata*, and 2.1 hectares of habitat for the Wallum Sedge Frog (*Litoria olongburensis*).

A report and maps verifying compliance with this condition must be submitted to the Minister within three months of the completion of construction.

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2. The person taking the action must submit a Biodiversity Offset Strategy to the Minister for approval. The strategy must address the following requirements:
    - a. The acquisition and conservation of 3 ha of land containing occupied habitat for the *Acacia attenuata* for every 1 ha of habitat cleared or degraded for the *Acacia attenuata*. The land acquired must contain habitat that is equal or greater in quality to that removed; and
    - b. In addition to land pertaining to 2(a), the acquisition and conservation of land containing a minimum of 3 ha of land which is potential habitat for the *Acacia attenuata* for every 1 ha of habitat cleared or degraded for the *Acacia attenuata* that will be revegetated to provide occupied habitat for this species, that is of equal or greater quality to that removed; and
    - c. Details of revegetation work required to achieve the requirements of condition 2(b). The works must be consistent with advice from a suitably qualified expert; and
    - d. The acquisition and conservation of land containing a minimum of 10 hectares of occupied habitat for the Wallum Sedge Frog (*Litoria olongburensis*) for every 1 ha of habitat cleared or degraded for the Wallum Sedge Frog, that is equal or greater quality to that removed; and
    - e. The acquisition and conservation of land containing a minimum 92.5 ha of foraging habitat for the Grey-headed Flying Fox that is of equal or greater quality to that removed for the Multi-Modal Transport Corridor at the Sunshine Coast; and
    - f. The land referred to in condition 2(a), 2(b), 2(d) and 2(e) must address the following:
      - i. provide connectivity to other large tracts of remnant vegetation, preferably existing protected areas; and
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- ii. be protected by a legal instrument under relevant nature conservation legislation, that ensures the land is conserved in perpetuity.
  - g. The strategy must include commitments to ongoing management of the land referred to in condition 2(a), 2(b), 2(d) and 2(e) for the life of the approved project; and
  - h. The strategy must include key milestones, performance indicators, corrective actions and timeframes for the completion of all actions outlined in the strategy; and

The approved strategy must be implemented.

The person taking the action must not clear any habitat for *Acacia attenuata* or the Wallum Sedge Frog until the Minister approves the strategy.

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3. The person taking the action must:

- a. undertake pre-construction surveys to identify and map the location, extent and quality of habitat for *Acacia attenuata* (including occupied habitat) that occurs adjacent to the MMTC corridor. This information should be provided to the Department prior to commencement of construction;
  - b. ensure that all habitat identified under condition 3(a) be retained and its extent and quality maintained to the same quality or better;
  - c. demonstrate compliance with b) above, through audit reports at intervals of 2, 5 and 10 years following completion of construction. These audit reports must be made immediately available to the Department in the event that the Department requests to view the report;
  - d. In the event that a reduction in the extent or quality of habitat for *Acacia attenuata* is detected, a report must be provided to the Department within 3 months of detection, that describes the deterioration of habitat, and outlines the measures that will be implemented to address the reduction in quality or extent;
  - e. In the event that the population occupying the habitat identified in 3(a) is declining or is determined to be no longer viable, the offset strategy outlined under condition 2 will be revised to take account of this further loss to achieve a similar additional ratio of outcomes achieved under condition 2(a) and 2(b).
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4. The person taking the action must:

- a. undertake pre-construction surveys to identify and map the location, extent, quality and level of occupancy of habitat for the Wallum Sedge Frog (including occupied habitat) that occurs adjacent to the MMTC construction footprint. This information should be provided to the Department prior to commencement of construction;
  - b. ensure that all habitat identified under condition 4(a) be retained and its extent and quality maintained to the same quality or better and that measures consistent with recommendations 2 and 3, outlined in the report prepared by Ingram & Agnew (2010), are implemented;
  - c. ensure that the level of occupancy of the Wallum Sedge Frog within all habitat pertaining to 4(a), remains the same or higher, unless the person taking the action can adequately demonstrate (e.g. with the use of control sites) that any decline is due to other factors unrelated to the construction and operation of the MMTC corridor;
  - d. demonstrate compliance with b) and c) above, through audit reports at
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intervals of 2, 5 and 10 years following completion of construction. These audit reports must be made immediately available to the Department in the event that the Department requests to view the report.

- e. In the event that a reduction in the extent or quality of habitat or in the level of occupancy for the Wallum Sedge Frog, is detected, a report must be provided to the Department within 3 months of the detection, that describes the deterioration of habitat or decrease in occupancy levels, and outlines the measures that will be implemented to address these.
  - f. In the event that the population occupying the habitat identified in 4(e) is declining and is determined to be no longer viable, the offset strategy outlined under condition 2 will be revised to take account of this further loss to achieve a similar additional ratio of outcomes achieved under condition 2(d).
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5. The person taking the action must ensure all reports, plans, strategies and programs required by the approval conditions are publicly available on the proponent's website within three months of finalisation of the report, plan, strategy or program.

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6. If the Minister believes that it is necessary or desirable for the better protection of listed threatened species and communities or migratory species, the Minister may request that the person taking the action make specified revisions to the plans, programs or strategies approved pursuant to condition 2 and submit the revised plan, program or strategy for the Minister's approval. The person taking the action must comply with any such request. If the Minister approves a revised plan, program or strategy pursuant to this condition, the revised approved plan, program or strategy must be implemented in place of the plan, program or strategy originally approved.

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7. If the person taking the action wishes to carry out any activity other than in accordance with a plan, program or strategy approved pursuant to condition 2 the person taking the action must submit for the Minister's approval a revised version of any such plan, program or strategy. If the Minister approves the revised plan, program or strategy so submitted, the person taking the action must implement that plan, program or strategy instead of the plan, program or strategy as originally approved.

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8. The person taking the action must maintain accurate records substantiating all activities associated with or relevant to the above conditions of approval and make them available upon request to the Department. Such records may be subject to audit by the Department or an independent auditor in accordance with section 458 of the EPBC Act, or used to verify compliance with the conditions of approval. Summaries of audits will be posted on the Department's website. The results of audits may also be publicised through the general media.

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9. If, at any time after 10 years from the date of this approval, the Minister notifies the person taking the action in writing that the Minister is not satisfied that there has been substantial commencement of the action, the action must not thereafter be commenced without the written agreement of the Minister.

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## Definitions

### *Acquisition*

The acquiring of land via the transfer of money or the transfer of ownership.

### *Clear*

To cut down, fell, thin, log, remove, kill, destroy, poison, ringbark, uproot or burn native vegetation.

### *Construction*

Includes all works in respect of the action other than survey, acquisitions, fencing, investigative drilling or excavation, building/road dilapidation surveys, minor clearing (except where threatened species, populations or ecological communities would be affected), establishing site compounds (in locations meeting the criteria of the conditions), or other activities determined by the Minister to have minimal environmental impact.

### *The Department*

The Australian Government Department responsible for the *Environment Protection and Biodiversity Conservation Act 1999*.

### *The Minister*

The Minister responsible for the *Environment Protection and Biodiversity Conservation Act 1999*.

### *Occupied Habitat*

Habitat that is occupied or used periodically by individuals of the subject species.

### *Potential Habitat*

Habitat that is not currently occupied or used by the subject species but has the potential to become occupied or used if rehabilitated or managed appropriately.

### *Substantial commencement*

When any construction (as defined above) has started, not including the clearing (as defined above) of any EPBC listed species or ecological communities.

### *Ingram & Agnew (2010)*

Appendix B of the Multi-Modal Transport Corridor – Supplementary Response to Information Request, February 2010. *Wallum Sedgefrog Litoria Olongburensis Surveys and Habitat Assessments Report* prepared on behalf of the Queensland Department of Main Roads (the proponent).



## VARIATION TO CONDITIONS ATTACHED TO APPROVAL

### Multi-Modal Transport Corridor, Sunshine Coast, Queensland (EPBC No 2008/4361)

This decision to vary a condition of approval is made under section 143 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

#### Approved action

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Person to whom the approval is granted	Queensland Department of Transport and Main Roads ABN: 57 836 727 711
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Approved action	Upgrade, extension and construction of approximately 10 km of a Multi-Modal Transport Corridor (MMTC) up to 6 lanes (with provision for 8 lanes) and 2 railway lines between Caloundra and Maroochydore, on the Sunshine Coast, Qld.
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#### Variation

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Variation of conditions of approval	The variation is: <ul style="list-style-type: none"><li>• Delete condition 1 attached to the approval and substitute with the condition specified below.</li><li>• Delete condition 2 attached to the approval and substitute with the condition specified below.</li><li>• Delete condition 4 attached to the approval and substitute with the condition specified below.</li><li>• Add condition 4A specified below to the approval</li></ul>
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Date of effect	This variation has effect on the date the instrument is signed
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#### Person authorised to make decision

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Name and position	Monica Collins Assistant Secretary Compliance & Enforcement Branch
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Signature

Date of decision

20 Dec. 2016

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## Conditions attached to the approval

1. The person taking the action must not clear more than 4.4 hectares of habitat for the flora species *Acacia attenuata*, and 2.6 hectares of habitat for the Wallum Sedge Frog (*Litoria olongburensis*).

A report and maps verifying compliance with this condition must be submitted to the Minister within three months of the completion of construction.

2. The person taking the action must submit a Biodiversity Offset Strategy to the Minister for approval. The strategy must address the following requirements:
  - a. The acquisition and conservation of 3 ha of land containing occupied habitat for *Acacia attenuata* for every 1 ha of habitat cleared or degraded for *Acacia attenuata*. The land acquired must contain habitat that is of quality equal to or greater than that removed; and
  - b. In addition to land pertaining to 2(a), the acquisition and conservation of land containing a minimum of 3 ha of land which is potential habitat for *Acacia attenuata* for every 1 ha of habitat cleared or degraded for *Acacia attenuata* that will be revegetated to provide occupied habitat for this species, that is of quality equal to or greater than that removed; and
  - c. Details of revegetation work required to achieve the requirements of condition 2(b). The works must be consistent with advice from a suitably qualified expert; and
  - d. To offset impacts to the Water Mouse and Wallum Sedge Frog (*Litoria olongburensis*) and ensure a conservation gain, the Approval holder must:
    - i. Secure a direct offset, under a legally binding mechanism, to compensate for the loss of 0.83 ha of water mouse habitat and 2.6 ha of Wallum Sedge Frog in accordance with the EPBC Act Environmental Offsets Policy for the duration of the impact;
  - e. The acquisition and conservation of land containing a minimum of 92.5ha of foraging habitat for the Grey-headed Flying-Fox that is of quality equal to or greater than that removed; and
  - f. The land referred to in sub-conditions 2.a., 2.b. and 2.e. must address the following:
    - i. Provide connectivity to other large tracts of remnant vegetation, preferably existing protected areas; and
    - ii. Be protected by a legal instrument under relevant nature conservation legislation, that ensures the land is conserved in perpetuity
  - g. The strategy must include commitments to ongoing management of the land referred to in sub-conditions 2.a., 2.b. and 2.e. for the life of the approved project; and
  - h. The strategy must include key milestones, performance indicators, corrective actions and timeframes for the completion of all actions outlined in the strategy;The approved strategy must be implemented.

The person taking the action must not clear any habitat for *Acacia attenuata*, Wallum Sedge Frog or Water Mouse until the Minister approves the strategy.



4. The person taking the action must:

- a. Undertake pre-construction surveys to identify and map the location, extent and quality of habitat for the Wallum Sedge Frog (including occupied habitat) that occurs adjacent to the MMTC corridor. This information should be provided to the Department prior to the commencement of construction;
- b. Ensure that all habitat identified in condition 4.a. be retained and its extent and quality be maintained to the same quality or better and that measures consistent with recommendations 2 and 3 outlined in the report prepared by Ingram & Agnew (2010) are implemented;
- c. Ensure the level of occupancy of the Wallum Sedge Frog within all habitat pertaining to 4.a. remains equal or greater, unless the person taking the action can adequately demonstrate (e.g. the use of control sites) that any decline is due to factors unrelated to the construction and operation of the MMTC corridor;
- d. Demonstrate compliance with b. and c. above, through audit reports at intervals of 2, 5 and 10 years following completion of construction. These audit reports must be made available to the Department promptly in the event that the Department requests to view the report;
- e. In the event that a reduction in the extent or quality of habitat or in the level of occupancy for Wallum Sedge Frog is detected, a report must be provided to the Department within 3 months of such detection that describes the deterioration of habitat and outlines the measures that will be implemented to address these;
- f. In the event that the population occupying the habitat identified in 4.e. is declining and is determined to be no longer viable, revise the offset strategy required under condition 2 to take account of this further loss and apply the methodology outlined in condition 2.d. to determine an appropriate offset.

4A. The person taking the action must:

a. Apply design measures to:

- i. Maintain the natural volume, magnitude, frequency and duration of tidal water movements throughout retained Water Mouse habitat;
- ii. Provide opportunities to facilitate and maintain the safe passage of the Water Mouse between the associated supralittoral and sublittoral zones within the MMTC corridor.

b. Prior to commencing the action, establish a baseline data collection program to determine:

- i. The area of occupancy of the Water Mouse population within the project area;
- ii. The water quality and salinity levels at the high and low tide levels within the Water Mouse habitat to be impacted by the action;
- iii. The condition and extent of Water Mouse habitat to be retained/avoided by the action, for comparison against appropriate control sites;

c. Establish measures for the construction phase of the action that:

- i. Manage the impacts upon retained Water Mouse individuals and active nest sites;
- ii. Maintain the condition and viability of retained Water Mouse habitat in the MMTC corridor.

The baseline data collection program outlined in condition 4A.b. must be approved by the Department prior to the commencement of the action.

The person taking the action must implement a construction monitoring program which is consistent with all measures in sub-conditions 4A.b. and 4A.c..

# **Appendix B**

**Methodology for assessing water mouse  
habitat quality**

## Habitat quality scoring methods

The *Modified QLD Habitat Quality spreadsheet* (provided by DCCEEW) was used to input data obtained during field surveys and desktop analysis. Habitat scores were weighted with the ratios of site condition 30%, site context 30%, and species stocking rate 40%, consistent with recommendations provided by DCCEEW.

Site condition and site context scores were calculated using the *Guide to Determining Terrestrial Habitat Quality* (DES, 2020), including scores for fauna species habitat as per the *Modified QLD Habitat Quality spreadsheet*. Species stocking rates were informed by the results of targeted surveys of the impact area and published information on the ecology of each MNES species.

Species specific documentation is summarised below.

Author	Year	Title
Water mouse		
Department of Agriculture, Water and the Environment (DAWE)	2021	Conservation Advice for <i>Xeromys myoides</i> (Water Mouse).
DAWE	2022	Draft National recovery Plan for the water mouse.
Department of the Environment	2015	Referral guideline for the vulnerable water mouse ( <i>Xeromys myoides</i> ).
Kaluza	2016	The Distribution and Density of Water Mice ( <i>Xeromys myoides</i> ) in the Maroochy River of Southeast Queensland, Australia.
Kaluza	2018	The Great Sandy Strait Water Mouse Survey and Monitoring Project 2014–2018.
Kaluza	2019	The Ecology and Conservation of the Water Mouse ( <i>Xeromys myoides</i> ) Along the Maroochy River Catchment in Southeast Queensland.

A summary of the Assessment Units is provided below.

AU	RE	Reg veg class	Area (ha)	No of sites	BC plots*
Impact area					
IAU01	12.1.1	Remnant	0.25	1	BC10
IAU02	12.1.2	Remnant	1.94	2	BC02, BC05
IAU03	12.1.3b	Remnant	4.51	3	BC01, BC03, BC04

## Site condition assessment

Site condition was calculated for each assessment unit using the following criteria detailed in the EPBC Act Offsets Assessment Guide (DSEWPaC 2012b) as follows:

- BioCondition data consistent with the Guide to Determining Terrestrial Habitat Quality (DES, 2020)
- Quality and availability of food and foraging habitat using species-specific.
- Quality and availability of shelter using species-specific criteria.

## BioCondition plot methodology

Each BioCondition plot measured 100 m by 50 m and was established along the direction of the contour (i.e. along the slope rather than upslope or downslope). The location of the centre of each plot was marked with a GPS and representative photographs of the plot were taken in each aspect (i.e. north, east, south, west). Each plot was then divided into sub-plots, as illustrated by the plot layout diagram below, and the following attributes were recorded:

- 100 m transect:
  - Tree canopy cover.
  - Shrub canopy cover.
- 100 m by 50 m plot:





## Site context

For each assessment unit, site context scores were assigned based on the average of all plot scores for:

- Size of patch
- Connectedness
- Context
- Role of the site location to the overall population in the state
- Threats to the species
- Species mobility capacity.

## Site context attributes

The first four GIS attributes are size of patch, connectedness, context and ecological corridors were calculated as part of the desktop analysis using the *Guide to Determining Terrestrial Habitat Quality* (DES, 2020). This involved geospatial analysis to calculate the following indicators for each condition plot:

- **Patch size**, which involves measurement of the area of vegetation in which the assessment unit is contained and all other directly connecting areas of mapped remnant vegetation (total score of 10).
- **Connectedness**, which involves measurement of the length of remnant vegetation along the boundary of the site (total score of 5).
- **Context**, which involves measuring the percentage of remnant vegetation within a 1 km buffer around the site (total score of 5).

The information on each attribute was then used to determine the site context score in accordance with the framework provided by the *Guide to Determining Terrestrial Habitat Quality* (DES, 2020). These scores are then incorporated into the overall condition score for each assessment unit.

### Site context scoring criteria

Site attribute	Criteria	Score	Max score
Size of patch	<5 ha remnant and/or regrowth	0	10
	≥5-25 ha remnant and/or regrowth	2	
	≥25-100 ha remnant or ≥25-200 ha remnant or regrowth	5	
	≥100-200 ha remnant or >200 ha remnant or regrowth	7	
	≥200 ha remnant	10	
Connectivity in the landscape	Low The assessment unit is not connected using any of the below descriptions.	0	5
	Medium The assessment unit is connected with adjacent remnant vegetation along >10% to <50% of its perimeter <b>OR</b> is connected with adjacent remnant vegetation along <10% of its perimeter <b>AND</b> is connected with adjacent regrowth native vegetation > 25% of its perimeter.	2	
	High The assessment unit is connected with adjacent remnant vegetation along 50% to 75% of its perimeter.	4	
	Very High The assessment unit is connected with adjacent remnant vegetation along >75% of its perimeter <b>OR</b> includes > 500 ha remnant vegetation	5	
Landscape context	Low <10% remnant vegetation <b>AND</b> <30% native regrowth vegetation	0	5
	Medium ≥10% to 30% remnant vegetation <b>AND</b> <30% regrowth or <10% remnant vegetation <b>AND</b> ≥30% regrowth	2	
	High ≥30% to 75% remnant vegetation <b>OR</b> ≥10% to 30% remnant vegetation <b>AND</b> ≥30% regrowth	4	

Site attribute	Criteria	Score	Max score
	Very High >75% remnant vegetation	5	
Ecological corridors	Not applicable		N/A

## Species habitat attributes

Habitat quality criteria for water mouse were derived by suitably qualified ecologists from the DJV. For each condition parameter, scores out of 25 were assigned (in accordance with the *Guide to Determining Terrestrial Habitat Quality* (DES, 2020). These were then converted to a score out of 10 to align with the EPBC Act *Offsets Assessment Guide* (DSEWPaC, 2012) scoring framework as detailed in the *Modified QLD Habitat Quality spreadsheet*.

## Quality and availability of food and habitat required for foraging

Three species-specific indicators were selected to assess the quality of foraging habitat for the water mouse. Indicators were selected following a review of relevant government and publicly available research, conservation and recovery advice as described below.

- **Habitat connectivity:** Connectivity at each AU was assigned based on a categorical criteria. Habitat connectivity assessed the presence of remnant or regrowth vegetation occurring immediately adjacent to the AU. Only vegetation that represents suitable habitat for the water mouse was included.
- **Community diversity:** Assessed the diversity of suitable habitat connected to the AU. Five estuarine vegetation communities were included when assessing community diversity. All five communities represent known habitat types utilised by the water mouse. These being:
  - Intertidal mudflats
  - Saltmarsh flats
  - *Casuarina glauca* woodland with sedge understory
  - Tidal mangrove forests
  - *Casuarina glauca* on supralittoral banks.
- **Density of prey species:** Prey density was assessed by counting the amount of crab holes within a 1 m<sup>2</sup> quadrat. Five locations were assessed each transect, with the final value being the average of all results.

A breakdown of the scoring criteria used to assess the foraging habitat quality for the water mouse is presented below.

### Assessment criteria for foraging habitat quality for the water mouse

Assessment criteria	Scores					
	0	2	4	6	8	10
Connectivity to breeding habitat	None	Low	Minor	Moderate	Good	Completely
Community diversity	Only one suitable community		Two suitable communities		Three suitable communities.	
	Score of 2		Score of 6		Score of 10	
Prey density (m <sup>2</sup> )	0	1-5	5-10	10-15	15-20	> 20

## Quality and availability of habitat required for shelter and breeding

Four species-specific indicators were selected to assess the quality of breeding habitat for the water mouse, as discussed below.

- **Density of suitable denning sites:** Denning sites included mangrove hollows, supralittoral banks and mud mounds. Suitable denning sites were quantified within each transect and multiple by 2 (per hectare).
- **Diversity of denning habitat:** The diversity of suitable denning habitat was assessed by counting the amount of alternative denning habitats connected to each assessment unit. Denning habitats included large mangrove



hollows, nesting mounds and supralittoral banks. A simplified scoring scheme (three variables) was used due to the limited number of scoring categories available.

- **Size of breeding habitat:** Represented areas of suitable habitat below the high astronomical tide. This was calculated using GIS software.
- **Disturbance level:** Common disturbances for the water mouse within urban areas include surrounding land use, presence of humans and introduced pests, altered hydrology, increased wave action and/or evidence of water quality degradation.

A breakdown of the scoring criteria used to assess the breeding habitat quality for the water mouse is presented below.

**Assessment criteria for shelter / breeding habitat quality for the water mouse**

Assessment criteria	Scores					
	0	2	4	6	8	10
Density of denning sites (per Ha)	0	1-2	3-5	5-8	8-12	12+
Diversity of denning habitat	0 denning habitat		1 type of denning habitat		> 2 denning habitats	
	Score of 2		Score of 6		Score of 10	
Size of breeding habitat (ha)	< 1 ha	1 – 2 ha	2 – 3 ha	3 – 4 ha	4 – 5 ha	> 5 ha
Disturbance level	Full	Highly	Moderate	Minor	Negligible	None

## Threats to each MNES species

At each assessment unit, threats were assessed based on an average of all plot scores using criteria detailed in the following sections. The absence of threats were calculated as a score out of 25 using the risk matrix detailed below, taken from the *Guide to Determining Terrestrial Habitat Quality* (DES 2020), with the absence of threat score assigned based on the lowest score assigned for any threat. The score was then adjusted to a score out of 10 to align with the EPBC Act *Modified QLD Habitat Quality spreadsheet*.

*Threat matrix used to score absence of threats*

Threat matrix			Severity				
			Very high	High	Medium	Low	Very low
Scope	Very high	1	1	2	3	4	5
	High	2	2	4	6	8	10
	Medium	3	3	6	9	12	15
	Low	4	4	8	12	16	20
	Very low	5	5	10	15	20	25

The primary threat to the survival of the water mouse is loss and fragmentation of habitat and adjacent areas due to coastal development, particularly along the central and southern Queensland coast (DAWE, 2022). Six additional threats are also known for the water mouse and considered during this assessment. Known threats faced by water mouse were scored out of 25, using the threat matrix above, scored for the following threats that are identified in the *Conservation Advice for Xeromys myoides (Water Mouse)* (DAWE, 2021a) and the *Draft National Recovery Plan* (DAWE, 2022) as relevant to the Offset areas:

- Habitat loss, fragmentation and degradation
- Changes in local hydrology
- Climate change
- Pesticide application
- Invasive species
- Predation by owls
- Coastal pollution.

# Species stocking rate assessment

Species stocking rates were calculated for the water mouse using criteria detailed below. The criteria presented was based on the scoring system in the *EPBC Act How to Use the Offsets Assessment Guide* and was calculated for each assessment unit within the impact area and Offset areas.

## Species stocking rate scoring criteria

Criteria	Score			
Presence detected on or adjacent to the Offset area	0	5		10
	No	Yes – adjacent		Yes – on site
Species usage of the Offset area	0	5	10	15
	Not habitat	Dispersal	Foraging	Breeding
Approximate density per ha	0	10	20	30
Role/importance of species population on Offset area	0	5	10	15
	0	5 – 15	20 – 35	40 – 45

Scores for species stocking rate were based on information on the likely presence and abundance of water mouse, based on the results of targeted assessments undertaken within the impact area and Offsets areas. As directed in the *Modified QLD Habitat Quality spreadsheet*, where information on changes in density is not available due to low density, these will be kept relatively constant and improvements in habitat quality will rely on increases in site condition scores (i.e. BioCondition, foraging habitat value, shelter habitat value, mobility habitat value and reduction in threat scores).




# **Appendix C**

**Reference photos of BioCondition sites**



Site Number	Start	Middle – North	Middle – East	Middle – South	Middle - West	End
BC01						
BC02						
BC03						
BC04						
BC05						
BC10						



Site Number	Start	Middle – North	Middle – East	Middle – South	Middle - West	End
REF BC2						

# **Appendix D**

**DCCEEW Modified QLD Habitat Quality  
spreadsheet for water mouse**



Assessment Unit - Regional Ecosystem Site Reference	AU 1 RE 12.1.1										AU 2 RE 12.1.2										AU 3 12.1.3										Total average % benchmark	Total average score
	12.1.1	BC 10			Average % benchmark	Average Score	12.1.2	BC 2			BC 5			Average % benchmark	Average Score	12.1.3b	BC 1			BC 3			BC 4			Average % benchmark	Average Score					
		Raw Data	% Benchmark	Score				Raw Data	% Benchmark	Score	Raw Data	% BM	Score				Raw Data	% BM	Score	Raw Data	% BM	Score	Raw Data	% BM	Score			Raw Data	% BM	Score		
<b>Site Condition</b>	100	100	100	5	100	5	-	-	-	-	-	-	-	-	100	100	100	5	100	100	5	100	100	5	100	5	100.0	5.0				
Recruitment of woody perennial species in EDL	1	3	300	5	300	5	-	-	-	-	-	-	-	-	1	2	200	5	3	300	5	2	200	5	233.3	5	266.7	5.0				
Native plant species richness - trees	1	5	500	5	500	5	-	-	-	-	-	-	-	2	4	200	5	4	200	5	4	200	5	200	5	350.0	5.0					
Native plant species richness - shrubs	2	4	200	5	200	5	1	1	100	5	2	200	5	5	5	-	-	-	-	-	-	-	-	-	-	-	102.5	5.0				
Native plant species richness - grasses	3	6	200	5	200	5	3	3	100	5	1	33.33333	2.5	3.75	3.75	-	-	-	-	-	-	-	-	-	-	-	101.9	4.4				
Native plant species richness - forbes	12/7	15/8	125/114	5	119.50	5	-	-	-	-	-	-	-	-	8/5	7/3	87.5/60	5	6/8	75/160	5	9/5	112.5/100	5	99.17	5	109.3	5.0				
Tree canopy height (average of emergent, canopy, sub-canopy)	67/23	30.6/67.6	45.6/293.9	5	169.70	5	-	-	-	-	-	-	-	-	78/5	28.8/18	36.9/360	5	27.9/37.4	35.8/748	3	9.4/14	12/280	5	245.45	4.3	207.6	4.7				
Tree canopy cover (average of emergent, canopy, sub-canopy)	5	8.6	172	5	172	5	-	-	-	-	-	-	-	-	6	36.8	613.3	3	13.5	225	3	17.4	290	3	376.11	3	274.1	4.0				
Shrub canopy cover	85	0	0	0	0	0	35	30	85.71428571	3	68.6	196	5	140.85714	4	-	-	-	-	-	-	-	-	-	-	-	70.4	2.0				
Native grass cover	5	82.8	1656	3	1656	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1656.0	3.0				
Organic litter	92	30	32.61	5	32.61	5	-	-	-	-	-	-	-	-	200	32	16	5	68	34	5	8	4	5	25	5	28.8	5.0				
Large trees (euc plus non-euc)	360	27	7.5	0	7.5	0	-	-	-	-	-	-	-	-	152	0	0	0	36	23.684211	2	0	0	0	7.89	0	7.7	0.0				
Coarse woody debris	0	0	0	10	0	10	-	-	-	-	-	-	-	-	0	0	0	10	0	0	10	0	10	10	0	10	0.0	10.0	10.0			
Non-native plant cover	Quality and availability of food and foraging habitat	10	3.3	3.3	3.3	3.3	-	18	6	14	4.7	5.35	5.35	4	12	4	10	2.7	20	20	6.7	6.7	6.7	6.7	6.7	4.47	4.4	4.4	4.4			
Quality and availability of shelter	5	1.5	1.5	1	1	1	-	8	2	11	2.8	2.8	2.8	7	28	7	13	3.3	15	15	3.8	3.8	3.8	3.8	3.8	4.70	3.4	3.4	3.4			
Site Condition Score				62.8	62.3	62.3				21	20	20.5	20.5					54	49	53.5	53.5	53.5	53.5	53.5	53.5	51.5						
MAX Site Condition Score				100	100	100				1.80	1.71	1.76	1.76					80	80	80	80	80	80	80	80	80						
Site Condition Score - out of 3																																
<b>Site context</b>																																
Size of patch		2	2	2	2	2		2	2	2	2	2	2		2	2	2	2	2	2	2	4	2	2	2	2	2	2.0	2.0			
Connectedness		5	5	5	5	5		5	5	5	5	5	5		4	4	4	0	4	4	4	4	4	4	4	2.67	3.8	3.8	3.8			
Context		2	2	2	2	2		2	2	2	2	2	2		4	4	4	4	4	4	4	4	4	4	4	4	4	3.0	3.0	3.0		
Role of site location to species overall population in the state		30	3.3	3.3	3.3	3.3		30	3.3	30	3.3	3.3	3.3		30	3.3	30	3.3	30	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3		
Threats to the species		4	2.4	2.4	2.4	2.4		6	3.6	6	3.6	3.6	3.6		6	3.6	6	3.6	8	4.8	8	4.8	4.8	4.8	4.8	4.8	4.4	3.8	3.8	3.8		
Species mobility capacity		13.3	5.3	5.3	5.3	5.3		19.2	7.7	20	8	7.85	7.85		21.6	8.6	15	6	22.5	9	9	9	9	9	7.87	7.4	7.4	7.4	7.4			
Site Context Score				20	20	20				23.6	23.9	23.8	23.8					25.5	20.1	27.1	27.1	27.1	27.1	27.1	27.1	24.2	23.4	23.4	23.4			
MAX Site Context Score				56	56	56				56	56	56	56					56	56	56	56	56	56	56	56	56	56	56.0	56.0	56.0		
Site Context Score - out of 3																																

Species Stocking Rate (SSR)				
Presence detected on or adjacent to site (neighbouring property with connecting habitat)	Score	0	5	10
	No	Yes - adjacent	Yes - on site	
Species usage of the site (habitat type & evidenced usage)	Score	0	5	10
	Not habitat	Dispersal	Foraging	Breeding
Approximate density (per ha)	Score	0	10	20
	0%			
Role/importance of species population on site*	Score	0	5	10
	0	5 - 15	20 - 35	40 - 45
Total SRR score (out of 70) 55				
SRR Score (out of 4) 3.14				

*SSR Supplementary Table		
*Key source population for breeding	Score	0
	No	Yes/ Possibly
*Key source population for dispersal	Score	0
	No	Yes/ Possibly
*Necessary for maintaining genetic diversity	Score	0
	No	Yes/ Possibly
*Near the limit of the species range	Score	0
	No	Yes

Final habitat quality score (weighted)	AU 1 12.1.1	AU 2 12.1.2	AU 3 12.1.3	Average
Site Condition score (out of 3)	1.87	1.76	1.93	1.88
Site Context Score (out of 3)	1.07	1.27	1.3	1.21
Species Stocking Rate Score (out of 4)	3.14	3.14	3.14	3.14
Habitat Quality score (out of 10)	6.08	6.17	6.37	6.17
Assessment Unit area (ha)	0.25	1.94	4.50	6.69
Total impact area (ha) for this MNES	6.69	6.69	6.69	6.69
Size Weighting	0.037	0.290	0.673	1.00
<b>Weighted Habitat Quality Score</b>	<b>0.23</b>	<b>1.79</b>	<b>4.28</b>	<b>6.30</b>



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