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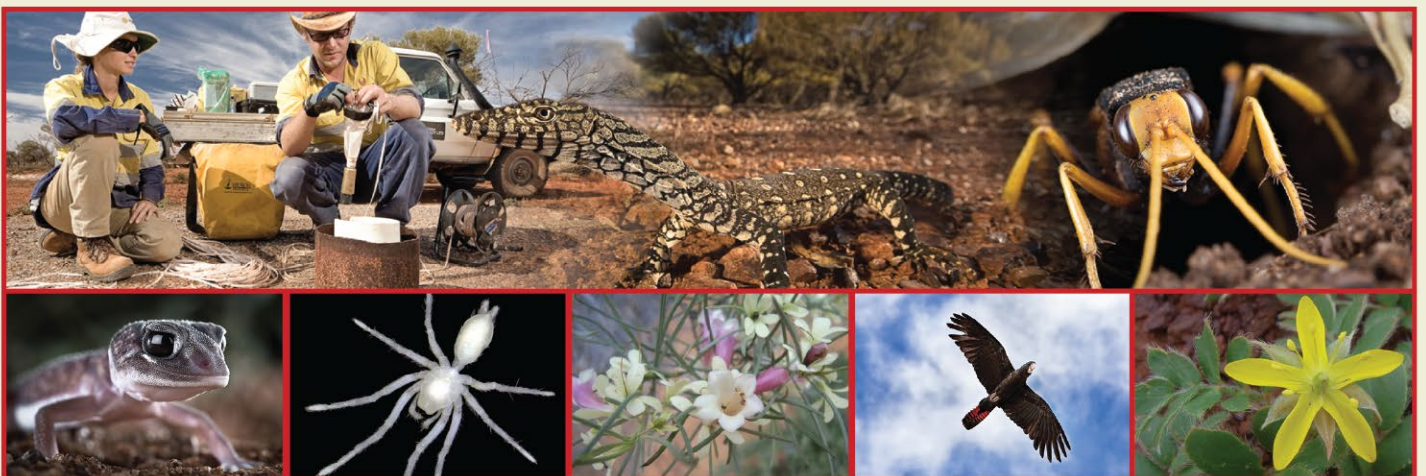
ENVIRONMENTAL SCIENCES

Short-range endemic and significant invertebrate desktop assessment for the Garden Street Extension Project

Prepared for City of Gosnells

July 2022

Final



Short-range endemic and significant invertebrate desktop assessment for the Garden Street Extension Project

Prepared for City of Gosnells

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EXECUTIVE SUMMARY

The City of Gosnells (the City) is proposing to undertake road extension works between the intersection of Garden and Harpenden Street, and the intersection of Holmes and Balfour Street, in Huntingdale (the Proposal), approximately 17 km south-east of Perth. The Development Envelope for the Proposal is situated within bushland reserved as 'Other Regional Roads' under the Metropolitan Region Scheme (MRS) and Town Planning Scheme No. 6 (TPS) and is under the management of the City.

The City commissioned Phoenix Environmental to undertake a short-range endemic (SRE) and significant invertebrate fauna assessment to support its referral to the Environmental Protection Authority (EPA) under section 38 (s38) of the Environmental Protection Act 1986 (EP Act) for its Garden Street Extension proposal. In May 2022, Phoenix was commissioned to undertake a desktop review of the study area to determine whether SRE and significant invertebrate fauna were likely to occur.

The desktop review identified a total of 62 taxa from ten invertebrate groups within the desktop search area comprising of 54 SREs and ten significant invertebrate species. Of the SREs, 12 are confirmed SRE species and 42 are potential SRE species. A further 75 widespread taxa from SRE groups were returned in the desktop review.

A total of ten Threatened or Priority species were identified within the desktop review comprising of three invertebrate species listed as Threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and *Biodiversity Conservation Act 2016* (BC Act), and seven Priority (P) species:

- Mygalomorph spiders
 - *Idiosoma sigillatum* (P3)
 - *Euoplos inornatus* (P3)
- Insects
 - *Neopasiphae simplicior*, a short-tongued bee (Critically Endangered (CR) under the EPBC Act, Endangered under the BC Act)
 - *Hesperocolletes douglasi*, Douglas' Broad-headed Bee (CR under the EPBC and BC Act)
 - *Leioproctus contrarius*, a short-tongued bee (P3)
 - *Leioproctus douglasiellus*, a short-tongued bee (CR under the EPBC Act, EN under the BC Act)
 - *Glossurocolletes bilobatus*, a short-tongued bee (P2)
 - *Synemon gratiosa*, Graceful Sun-moth (P4)
 - *Throscodectes xiphos*, Bush Cricket (P1)
- Springtail
 - *Australotomurus morbidus*, Guildford Cemetery springtail (P3).

None of the taxa identified in the desktop review have previously been recorded from the study area. Habitat mapping undertaken in 2020 by Biologic indicates most of the study area is not suitable SRE habitat as it shows signs of disturbance. However, a total of 1.4 ha of potential SRE habitat is present within the study area, comprising of *Banksia* woodland in Excellent condition. This habitat is not restricted to the study area; however, due to ongoing urbanisation on the Swan Coastal Plain, *Banksia* woodlands are becoming increasingly uncommon and isolated therefore this habitat may be considered

high potential SRE habitat. A further 0.6 ha of *Melaleuca* thicket may provide suitable habitat for two species of Threatened bees, *Leioproctus douglasiellus* and *Neopasiphae simplicior*.

Both *Banksia* woodland and *Melaleuca* thicket habitats would have historically been widespread across the Swan Coastal Plain, the many remnants within the Perth region are now fragmented due to urban development and potentially represent restricted habitats. *Banksia* woodland is typically not considered to have a high potential to support SREs due to lack of discreet habitat features that give rise to specialised SREs; however, on the Swan Coastal Plain, *Banksia* woodlands are becoming more isolated thus may represent High potential habitat. The low-lying *Melaleuca* thicket is considered a low potential SRE habitat due to its tendency to become inundated during winter and while SREs may occur in this habitat, it is unlikely to be primary SRE habitat.

Given potential SRE habitat exists within the study area and SRE invertebrate taxa are known from similar habitats on the Swan Coastal Plain within 40 km of the study area, it is possible that SREs occur within the study area. SRE habitat is not limited to the study area, with good quality potential SRE habitat also occurring in the Bush Forever to the east of west of the study area.

Considering the potential SRE habitat is not restricted to the study area, nor contains any restricted micro-habitats and is only a short distance to existing disturbance, any SREs, if present, are unlikely to be restricted to the 1.4 ha within the study area and therefore an SRE survey is not considered necessary.

The two Threatened bee species, *Leioproctus douglasiellus* and *Neopasiphae simplicior*, are only known from a single or very few locations nearby with limited areas of occupancy (20 ha and 100 ha respectively). A previous targeted bee survey conducted in the study area did not record presence of either species; however, the survey was conducted outside of the optimal sampling period and therefore we cannot rule out the possibility of presence based on this survey.

Given the difficulty in detecting significant invertebrate species, any habitat in Excellent or better condition with known habitat types and with known forage species present should be considered potential habitat for the Threatened bee species. If either of the Threatened bees are present within the study area, it is likely that they also occur in similar habitats (in Excellent or better condition) within the Bush Forever 125 site, directly adjacent to the study area.

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1 INTRODUCTION

The City of Gosnells (the City) is proposing to undertake road extension works between the intersection of Garden and Harpenden Street, and the intersection of Holmes and Balfour Street, in Huntingdale (the Proposal), approximately 17 km south-east of Perth. The Development Envelope is situated within bushland reserved as 'Other Regional Roads' under the Metropolitan Region Scheme (MRS) and Town Planning Scheme No. 6 (TPS) and is under the management of the City. The study area encompasses the full 'Other Regional Roads' boundary shown in Figure 1.

The City commissioned Phoenix Environmental to undertake a short-range endemic (SRE) and significant invertebrate fauna assessment to support its referral to the Environmental Protection Authority (EPA) under section 38 (s38) of the Environmental Protection Act 1986 (EP Act) for its Garden Street Extension proposal.

Several biological surveys have already been undertaken within the study area:

- Garden Street Extension Ecological Survey Report (Biologic 2022) – This included a two phase (spring 2020) detailed and targeted flora and vegetation survey, a single season (spring 2020) basic terrestrial vertebrate fauna survey and black cockatoo habitat assessment.
- Native bee survey of proposed Garden Street Extension (Spineless Wonders 2017) – Survey for Threatened bee species *Neopasiphae simplicior* (EN) and *Leioproctus (Andrenopsis) douglasiellus* (EN), Priority species *Leioproctus (Colletopsis) contrarius* and *Glossurocolletes bilobatus* and the newly described and poorly known (though currently unlisted) Megamouth Bee *Leioproctus (Ottocolletes) muelleri*, as well as non-target bees.
- Garden Street Road Reserve Environmental Assessment (Natural Area Holdings 2016a) – a level 2 (detailed) flora and fauna survey undertaken in October (flora) and November (fauna) within the study area.
- Holmes Street Bushland North: Revegetation and Weed Management Plan (Natural Area Holdings 2016b) – a level 2 (detailed) flora and fauna survey undertaken in October (flora) and November (fauna) for the Holmes Street Bushland North reserve.

1.1 SCOPE OF WORK

The scope and objective of the assessment was to gather contextual information on SRE and significant invertebrates, and if required, site specific data on the potential SRE and significant invertebrate habitats and species of the survey area to inform an environmental impact assessment for the Proposal. Recommendations for any follow up field surveys were to be provided, based on the findings on the desktop assessment.

1.2 STUDY AREA

The 4.8 ha study area is approximately 800 m in length and extends from the intersection of Garden and Harpenden Street in the north to Holmes and Balfour Street in the south (Figure 1).



	City of Gosnells Garden Street Extension Project		
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Study area

Figure 1
Project location and study area



2 LEGISLATIVE CONTEXT

The protection of fauna in WA is principally governed by three acts:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- State *Biodiversity Conservation Act 2016* (BC Act)
- State *Environmental Protection Act 1986* (EP Act).

2.1 COMMONWEALTH

Under the EPBC Act, actions that have, or are likely to have, a significant impact on a matter of national environmental significance (MNES), require approval from the Australian Government minister for the Environment. The EPBC Act provides for the listing of Threatened native fauna as MNES.

Few invertebrate taxa from WA are listed as MNES. Those that are mostly include species that have experienced significant range contractions and population declines due to habitat loss, for example the Margaret River Marron (*Cherax tenuimanus*) (Critically Endangered) and the Shield-backed Trapdoor Spider (*Idiosoma nigrum*) (Vulnerable) (DoEE 2018).

2.2 STATE

In WA, the BC Act provides for the listing of Threatened fauna species (Government of Western Australia 2018a, b)¹ in the following categories:

- Critically Endangered (CR) – species facing an extremely high risk of extinction in the wild in the immediate future²
- Endangered (EN) – species facing a very high risk of extinction in the wild in the near future²
- Vulnerable (VU) – species facing a high risk of extinction in the wild in the medium term future².

Species may also be listed as specially protected (SP) under the BC Act under the category of ‘species of special conservation interest’ (conservation dependent fauna, CD), including species with a restricted natural range.

The Department of Biodiversity, Conservation and Attractions (DBCA) administers the BC Act and maintains a non-statutory list of Priority fauna. Priority species are still considered to be of conservation significance – that is they may be Threatened – but cannot be considered for listing under the BC Act until there is adequate understanding of threat levels imposed on them. Species on the Priority fauna lists are assigned to one of four Priority (P) categories, P1 (highest) – P4 (lowest), based on level of knowledge/concern.

Few invertebrate taxa are currently listed under the BC Act and while there are several invertebrate species on DBCA’s Priority list (some of which are SRE taxa), these lists cannot be relied on as a complete guide to significant invertebrate taxa within a particular location. The most up-to-date listings of terrestrial invertebrates and their distribution are available through the WA Museum invertebrate databases.

¹ The *Wildlife Conservation (Specially Protected Fauna) Notice 2018* and the *Wildlife Conservation (Rare Flora) Notice 2018* have been transitioned under regulations 170, 171 and 172 of the *Biodiversity Conservation Regulations 2018* to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the BC Act.

² As determined in accordance with criteria set out in the ministerial guidelines.

2.3 OVERVIEW OF SRE INVERTEBRATES

SRE fauna are defined as animals that display restricted geographic distributions, nominally less than 10,000 km², that may also be disjunct and highly localised (Harvey 2002). EPA (2016a) identifies species with restricted distributions as being significant fauna in the context of environmental impact assessments (EIA). SRE fauna need to be considered in EIA as localised, small populations of species that are generally at greater risk of changes in conservation status due to environmental change than other, more widely distributed taxa. The EPA (2016b) summarises the taxonomic groups with known or likely SRE taxa in Western Australia (modified from Harvey (2002)):

- Mollusca
 - Bivalvia (Freshwater mussels)
 - Gastropoda (Freshwater snails)
 - Eupulmonata (land snails)
- Annelida (earthworms)
- Onychophora (velvet worms)
- Arachnida
 - Mygalomorphae (trapdoor spiders)
 - Pseudoscorpiones
 - Schizomida
 - Acari Mites
- Malacostraca (slaters)
- Decapoda (freshwater crayfish)
- Diplopoda (millipedes).

Short-range endemism in terrestrial invertebrates is believed to have evolved through two primary processes (Harvey 2002):

- Relictual – where the drying climate reduced the area of suitable habitat available to a species, forcing a range contraction. Such habitats typically maintain historic mesic conditions (e.g. south-facing rock faces or slopes of mountains or gullies)
- Habitat speciality – where species settled in particular isolated habitat types (e.g. rocky outcrops) by means of dispersal and evolved in isolation into distinct species.

However, SRE invertebrates have also been reported in more widespread habitats such as spinifex plains or woodlands, mainly in groups with low dispersal capabilities, for example mygalomorph spiders and millipedes (see for example Car & Harvey 2014; Rix *et al.* 2018).

There can be uncertainty in categorising a specimen as an SRE due to several factors including poor regional survey density, lack of taxonomic research and problems of identification, i.e. specimens that may represent SREs cannot be identified to species level based on the life stage at hand. For example, in contrast to mature males, juvenile and female millipedes, mygalomorph spiders and scorpions cannot be identified to species level. Molecular techniques such as ‘barcoding’ (Hebert *et al.* 2003a; Hebert *et al.* 2003b) are routinely employed to overcome taxonomic or identification problems.

Currently, there is no accepted system to determine the likelihood that a species is an SRE. The WA Museum applies four categories which were adopted in this assessment: confirmed, potential, uncertain and not SRE (Table 1). Confirmed SREs are taxa for which the distribution is known to be less than 10,000 km², the taxonomy is well known and the group is well represented in collections and/ or via comprehensive sampling (WAM 2013). Potential SREs include those taxa for which there is incomplete

knowledge of the geographic distribution of the group and its taxonomy, and the group is not well represented in collections.

Table 1 Short-range endemic categories

SRE category	Criteria
Confirmed	Distribution < 10,000 km ² . Taxonomy of the group is well known (but not necessarily published); group is well represented in collections, in particular from the region in question; high levels of endemism exists in documented species; inference is often possible from immature specimens.
Potential	Distribution < 10,000 km ² . Taxonomically poorly resolved group; patchy distribution, often common in certain micro-habitats, but no other regional records; congeners (= species in the same genus) often widespread.
Uncertain	Distribution < 10,000 km ² . Taxonomy cannot be resolved to species level and is therefore species distribution remains uncertain e.g. 'sp. indet.'
Widespread (not SRE)	Distribution >10,000 km ² .

3 EXISTING ENVIRONMENT

3.1 INTERIM BIOGEOGRAPHIC REGIONALISATION OF AUSTRALIA

The Interim Biogeographic Regionalisation of Australia (IBRA) classifies Australia’s landscapes into large ‘bioregions’ and ‘subregions’ based on climate, geology, landform, native vegetation and species information (Department of the Environment and Energy 2016). The study area is located in the Perth subregion (SWA02) of the Swan Coastal Plain bioregion, which is characterised as a low-lying coastal plain, mainly covered with woodlands. It is dominated by Banksia or Tuart on sandy soils, *Casuarina obesa* on outwash plains, and paperbark in swampy areas, while the plain rises to duricrust Mesozoic sediments dominated by jarrah (*Eucalyptus marginata*) woodland in the east (Mitchell *et al.* 2002; Williams & Mitchell 2001).

3.2 CLIMATE AND WEATHER

The climate of the Perth subregion is Warm Mediterranean, with cool wet winters and warm dry summers. The nearest Bureau of Meteorology (BoM) weather station to the study area with comprehensive data collection and recent historic climate data is Jandakot Aero (no. 009172, Latitude: -32.10°S Longitude: 115.88).

Jandakot Aero (1972 – 2022) records the highest mean maximum monthly temperature (31.6°C) in J February (lowest in July, 18.0°C) and the lowest minimum mean monthly temperature (7.1°C) in July and August, with the highest (17.2°C) in February (BoM 2022). The average annual rainfall at Jandakot is 818.4 mm, with July recording the highest monthly average of 174.7 mm.

3.3 LAND SYSTEMS AND SURFACE GEOLOGY

The study area intersects two land systems, the Bassendean and Pinjarra land system (Payne & Leighton 2004) (Table 2; Figure 2).

According to the Surface Geology of Australia 1:1,000,000 scale, Western Australia database (Stewart *et al.* 2008), the study area intersects one geological formation, Bassendean Sand, which is described as Basal conglomerate overlain by dune quartz sand with heavy mineral concentrations.

Table 2 Land systems and extent in the study area

Land system	Description	Area ha (%)
Bassendean System	Swan Coastal Plain from Busselton to Jurien. Sand dunes and sandplains with pale deep sand, semi-wet and wet soil. Banksia-paperbark woodlands and mixed heaths.	2.9 (60%)
Pinjarra System	Swan Coastal Plain from Perth to Capel. Poorly drained coastal plain with variable alluvial and aeolian soils. Variable vegetation includes Jarrah, marri, wandoo, paperbark, sheoak and flooded gum.	1.9 (40%)
TOTAL		4.8 (100%)

3.4 CONSERVATION RESERVES AND ENVIRONMENTALLY SENSITIVE AREAS

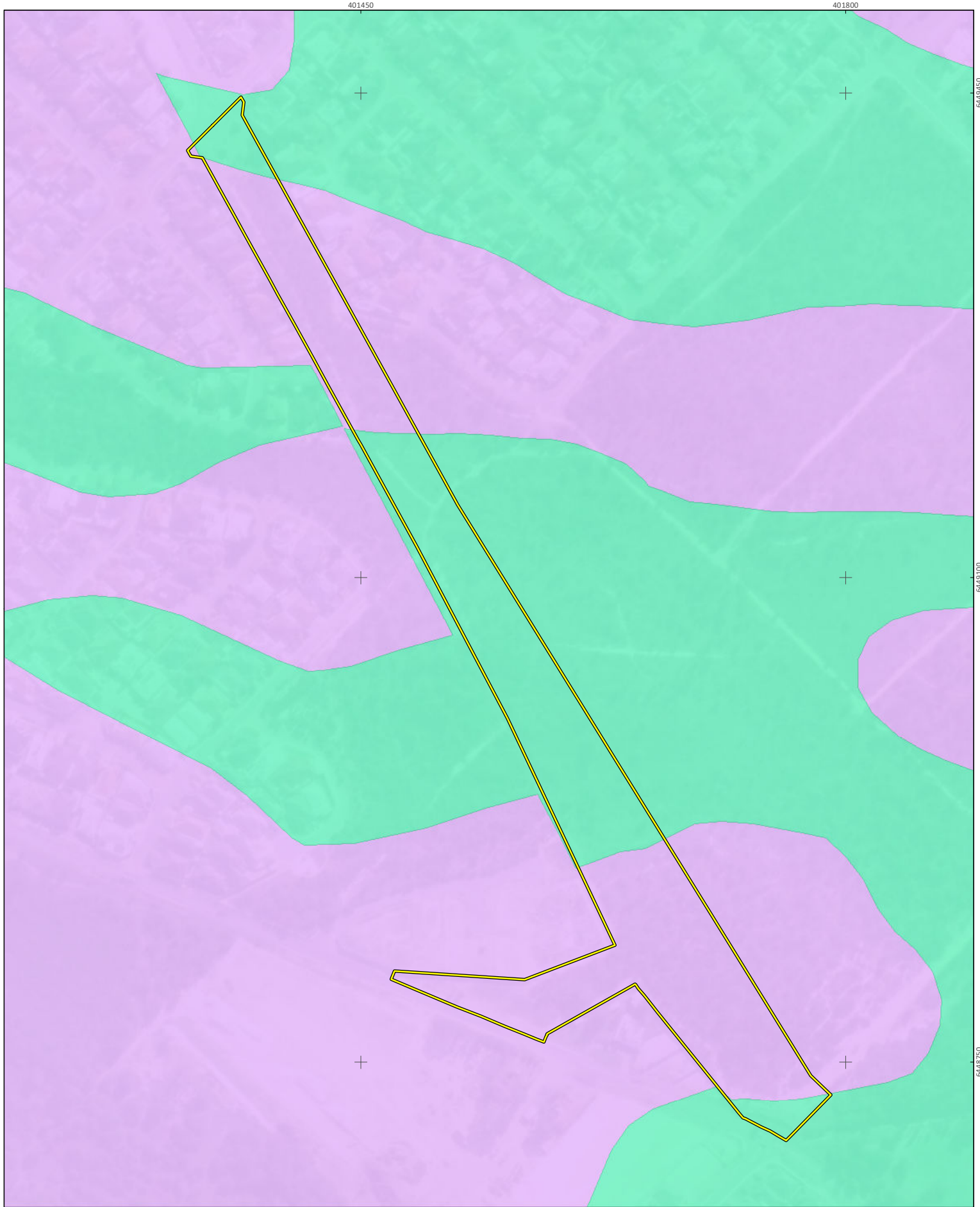
Part of the study area is located within the 140 ha Bush Forever site 125 (Figure 3). Bush Forever is aimed at protecting regionally significant high conservation value bushland within the Perth region of the Swan Coastal Plain (WAPC 2000). The study area intersects five Environmentally Sensitive Areas (ESAs) which collectively occupy 3.4 ha (71%; Figure 3). These correspond to the areas covering the Bush Forever sites.

The nearest tenures managed by DBCA are an unnamed Nature Reserve (WA49299), located 300 m north of the study area, and Balannup Lake, located 2.7 km south of the study area.

3.5 HYDROLOGICAL VALUES

The Swan Coastal Plain is dissected by the Swan-Canning Estuarine system which originates in the jarrah forests of the Perth Hills. The bioregion is typically flat and low-lying with chains of wetlands extending in a north-south direction and scattered wetlands throughout. Approximately 25% of the Swan Coastal Plain is considered wetland, and of these, 20% retain high ecological values (DBCA 2019). There is a very high incidence of degradation that has occurred on the Swan Coastal Plain, with many wetlands in the region succumbing to the effects of urban development. The nearest waterbody, Balannup Lake, is located 2.7 km south of the study area (Figure 3).

Approximately 1.7 ha (35%) of the study area overlaps a geomorphic wetland identified as a Sumpland (Figure 3-2), indicating it is subject to seasonal inundation during the winter months (DBCA 2021). The geomorphic wetland extends considerably outside of the study area, directly east, west and south. The study area is also recognised as “Land subject to inundation” by Geoscience Australia (Geoscience Australia 2020).



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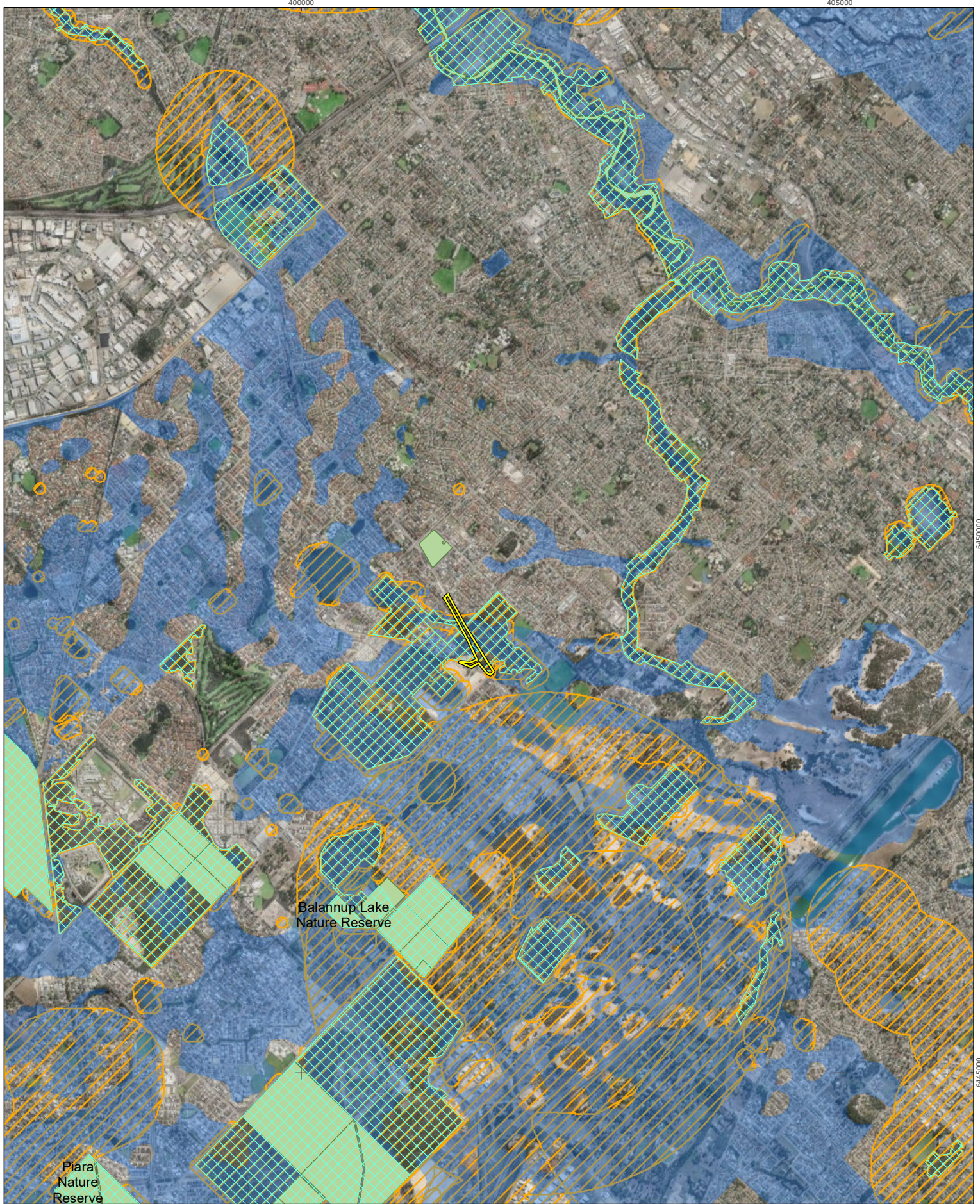
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- Study area
- Land system**
- Bassendean System
- Pinjarra System

Figure 2
Land systems in the study area





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	Study area
	Bush Forever
	DBCA managed land
	Geomorphic wetlands
	Environmentally sensitive areas

Figure 3

Conservation reserves and hydrological values in the study area

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4 METHODS

4.1 DESKTOP REVIEW

Searches of several biological databases were undertaken to identify records of SREs and significant terrestrial invertebrate fauna from the vicinity of the study area (Table 3). A literature search was conducted for accessible reports for biological surveys conducted within 40 km of the study area to build on the lists developed from the database searches (Table 4).

Table 3 Database searches conducted for the desktop review

Database	Target group/s	Search coordinates and extent
WA Museum Arachnid and Myriapod Database, Mollusca Database	Arachnid, myriapod and mollusc SREs	100 km ² search area encompassing the study area -31.206°S, 115.391°E (northwest corner) and -32.947°S, 116.94°E (southeast corner). This search area was then clipped to a 40 km radius buffer to the study area. The dataset was further clipped to Swan Coastal Plain bioregion.
WA Museum Entomology Database	Significant invertebrate fauna	40 km buffer of the study area
EPBC Protected Matters Search	Significant invertebrate fauna	40 km buffer of the study area
DBCA NatureMap and Threatened Priority fauna list	Significant invertebrate fauna	By species
Phoenix internal Fauna Database	Significant invertebrate fauna	40 km buffer of the study area
Atlas of Living Australia (ALA)	Significant invertebrate fauna	By species

Table 4 Survey reports included in the desktop review

Report author	Survey description	Project	Survey scope
Phoenix (2010)	Short-range endemic and targeted invertebrate baseline surveys	Roe Highway Extension Project	Single season survey for SRE, targeted repeat surveys for Graceful Sun-moth.
Invertebrate Solutions (2021)	Desktop review and impact assessment of SRE and conservation significant invertebrates	Byford Rail Extension Project	Desktop review
(Invertebrate Solutions 2020a)	Baseline SRE and conservation significant invertebrate survey	Malaga to Ellenbrook Works	Single season survey Methods: Active searches (foraging), litter sifts
Invertebrate Solutions (2020b)	SRE assessment	Maddington Kenwick Strategic Employment Area (MKSEA)	Single season survey Methods: Active searches (foraging), litter sifts

Report author	Survey description	Project	Survey scope
Invertebrate Solutions (2019)	Conservation significant and SRE desktop habitat assessment	Thornlie Cockburn Link Proposal	Desktop review Area: 165 ha
Phoenix (2020)	Reconnaissance significant bee survey undertaken at the Pinjarra Alumina Refinery	Pinjarra Alumina Refinery	Desktop review
Natural Area Holdings (2016a)	Garden Street Road Reserve Environmental Assessment	Garden Street Extension	Single season detailed survey Methods: dry pitfall traps, flight intercept traps, active searches
(Natural Area Holdings 2016b)	Holmes Street Bushland North: Revegetation and Weed Management Plan	Holmes Street Bushland North	Single season detailed survey Methods: dry pitfall traps, flight intercept traps, active searches
Spineless Wonders (2017)	Native bee survey	Garden Street Extension	Survey within the entire study area, March 2017.

4.2 HABITAT ASSESSMENT

Fauna habitat and vegetation condition mapping undertaken by Biologic (2022) within the study area were re-interpreted in relation to SRE invertebrates, based on factors considered important in defining fauna assemblages, including vegetation type and structure, substrate and position in the landscape. Each fauna habitat was then rated for its potential to support SREs (potential habitat rating; PHR) as follows:

- High – defined/known areas of habitat that contain elements that often give rise to specialisation or dependency in invertebrate fauna, such as aspect (e.g. south-facing slopes, geological features (e.g. granite), soil types that retain water (e.g. clay, loam)). These habitats may also include habitat isolates which have the capacity to restrict dispersal.
- Low – areas of largely in-tact native vegetation that occur broadly across the landscape, are less incised and typically link more restricted habitats. This includes land that was cleared but has since been rehabilitated or is in the process of being rehabilitated.
- None – land that has been previously cleared for other uses that no longer contains native vegetation.

Habitat suitability for the significant invertebrates was assessed based on their known habitat preferences.

The study area was ground-truthed on 19 May 2022 to inspect for micro-habitat features and to confirm habitat suitability for both SREs and significant invertebrates.

4.3 LIKELIHOOD OF OCCURRENCE ASSESSMENT

A likelihood of occurrence for each taxon identified in the desktop review was assessed and assigned to one of four ratings:

- recorded – species recorded within the study area by previous survey

- likely – study area within current known range of species, suitable habitat within the study area and home range of species intersects study area based on known records
- possible – study area within current known range of species, suitable habitat within the study area but home range of species does not intersect study area based on current (<20 year old) records
- unlikely – study area outside current known range of species or no suitable habitat present.

Habitat attributes important to SREs along the Swan Coastal Plain include assets such as vegetation cover, structural complexity, floral diversity, aspect, slope and soil type.

5 RESULTS

5.1 SPECIES ASSEMBLAGE

The desktop review identified a total of 62 taxa from ten invertebrate groups within the desktop search area (Figure 4; Table 5). Of these, 54 are SREs, of which 12 are confirmed (Cf.) SRE taxa and 42 are potential (Pot.) SRE taxa. A further 75 widespread taxa from SRE groups were returned in the desktop review (Table 6).

A total of ten Threatened or Priority species were returned in the desktop review: three species are listed as Threatened under the EPBC Act and BC Act, and seven are Priority invertebrate fauna (Table 5-2). Two of the Priority species are also potential SREs. The ten Threatened or Priority species identified within the area of the desktop review comprise two mygalomorph spiders, five bees, one moth, one cricket, and one springtail:

- Mygalomorph spiders
 - *Idiosoma sigillatum* (P3)
 - *Euoplos inornatus* (P3)
- Insects
 - *Neopasiphae simplicior*, a short-tongued bee (CR under the EPBC Act, EN under the BC Act)
 - *Hesperocolletes douglasi*, Douglas' Broad-headed Bee (CR under the EPBC and BC Act)
 - *Leioproctus contrarius*, a short-tongued bee (P3)
 - *Leioproctus douglasiellus*, a short-tongued bee (CR under the EPBC Act, EN under the BC Act)
 - *Glossurocolletes bilobatus*, a short-tongued bee (P2)
 - *Synemon gratiosa*, Graceful Sun-moth (P4)
 - *Throscodectes xiphos*, Bush Cricket (P1)
- Springtail
 - *Australotomurus morbidus*, Guildford Cemetery Springtail (P3).

Mygalomorph spiders represented the largest group of SREs, accounting for approximately one-third of all taxa, and 52% of all SRE (CF and Pot.) taxa. Millipedes and slaters were also well represented, comprising 25% of SRE taxa each (Table 6). Representatives of SRE pseudoscorpions, land snails and scorpions were also returned in the desktop searches.

Short-range endemic and significant invertebrate desktop assessment for the Garden Street Extension Project
Prepared for City of Gosnells

Ten of the 12 confirmed SREs are millipedes, most of which belong to the genus *Antichiropus*. The remaining two species are a scorpion (*Urodacus planimanus*) and land snail (*Bothriembryon serpentinus*). Three of the 12 confirmed taxa are formally described species: *Antichiropus whistleri*, *U. planimanus* and *B. serpentinus*. The remaining seven *Antichiropus* millipedes are undescribed but the genus is well known the support mostly range-restricted taxa (Car *et al.* 2013) and the species from the desktop review have only been recorded from the Swan Coastal Plain.

No SRE or significant invertebrate species have previously been recorded from within the study area.

Table 5 SRE and significant invertebrate taxa identified in the desktop review

Family	Species	SRE status	Nearest record to study area	Habitat records (indicative as not all records have habitat details)	Source
Arachnida (Mygalomorph spiders)					
Actinopodidae	<i>Missulena hoggi</i>	Potential	4 km E.	Tuart woodland	WAM
Anamidae	<i>Aname</i> `MYG405`	Potential	17 km SW.		WAM
Anamidae	<i>Aname</i> `MYG496`	Potential	13 km NW.	Urban areas (two records 33 km apart)	WAM
Anamidae	<i>Aname</i> `MYG633`	Potential	12 km W.		WAM
Anamidae	<i>Aname</i> `UBS sp. 2`	Potential	22 km NW.		WAM
Anamidae	<i>Aname</i> `UBS Cat sp. 126`	Potential	31 km N		WAM
Anamidae	<i>Kwonkan</i> `MYG060`	Potential	12 km N.		WAM
Anamidae	<i>Kwonkan</i> `UBS Cat sp. 124`	Potential	30 km NNW.		WAM
Anamidae	<i>Kwonkan</i> `UBS Cat sp. 126`	Potential	8.5 km w		WAM
Anamidae	<i>Proshermacha</i> `MYG449`	Potential	7.5 km S.	Wetland with <i>Melaleuca</i> & marri	WAM
Anamidae	<i>Teyl</i> `MYG249`	Potential	20 km W.	<i>Melaleuca</i> woodland, Rottnest	WAM
Anamidae	<i>Teyl</i> `UBS Cat sp. 148`	Potential	27 km N.		WAM
Anamidae	<i>Teyl</i> `UBS Cat sp. 149`	Potential	24.6 km N.		WAM
Anamidae	<i>Teyl</i> `waldockae`	Potential	20 km W.	Tuart woodland, <i>Melaleuca/Banksia</i> woodland, coastal	WAM
Barychelidae	<i>Idiommata</i> `UBS Cat sp. 123`	Potential	22.5 km N.		WAM
Barychelidae	<i>Synothele mullaloo</i>	Potential	26.5 km N.	Tuart	WAM
Barychelidae	<i>Synothele rastelloides</i>	Potential	6.7 km NW.		WAM
Idiopidae	<i>Idiosoma</i> `MYG188`	Potential	20.5 km NW.	Jarrah/Marri forest with Wandoo woodland; Jarrah-Marri forest	WAM
Idiopidae	<i>Eucyrtops latior</i>	Potential	6 km E.	Also known from the Jarrah Forest	WAM
Idiopidae	<i>Euoplos inornatus</i>	Potential/P3	8 km SE.	Mesic, usually riparian habitat in Jarrah Forest	WAM
Idiopidae	<i>Idiosoma sigillatum</i>	Potential/P3	5 km N,E,W,S	<i>Banksia</i> woodland and heathland on sandy soils. Many records	WAM, ROE
Arachnida (pseudoscorpions)					
Chernetidae	`Genus indet.` `tarsus IV without tactile seta`	Potential	18 km NW.		WAM
Chernetidae	`PSEAAF` `PSE130`	Potential	18 km NW.		WAM

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Family	Species	SRE status	Nearest record to study area	Habitat records (indicative as not all records have habitat details)	Source
Arachnida (scorpions)					
Buthidae	<i>Lychas `majerorum`</i> (`majeri`)	Potential	6 km S.	<i>Banksia</i> woodland	WAM
Buthidae	<i>Lychas `prendinii`</i>	Potential	5 km NE.		WAM
Urodacidae	<i>Urodacus planimanus</i>	Confirmed	7 km E.	Bare areas; rock outcrops; Jarrah/Marri forest with Wandoo woodland; Jarrah/Marri forest, <i>Banksia</i> woodland and <i>Melaleuca</i> woodland; Jarrah/Marri forest. Also recorded from Northern Jarrah Forest.	WAM
Urodacidae	<i>Urodacus `woodwardii`</i>	Potential	6 km NE/NW.		WAM
Diplopoda (millipedes)					
Lulomorphidae	<i>Podykipus collinus</i>	Potential	12 km W.	Jarrah/Marri forest with Wandoo woodland; Jarrah/Marri forest, <i>Banksia</i> woodland and <i>Melaleuca</i> woodland	WAM, ROE
Lulomorphidae	<i>Dinocambala ingens</i>	Confirmed	6 KM E.	Jarrah/Marri forest with Wandoo woodland; Jarrah/Marri forest, granite	WAM
Paradoxosomatidae	<i>Antichiropus `DIP022, 21ruino`</i>	Confirmed	18 km NW.	Urban areas	WAM
Paradoxosomatidae	<i>Antichiropus</i> `DIP082/DIP172, GI/UBS1`	Confirmed	20 km N.	<i>Melaleuca/Banksia</i> woodland, Tuart woodland, <i>Acacia/Xanthorrhoea</i> shrubland	WAM
Paradoxosomatidae	<i>Antichiropus</i> `DIP112, Norman Road 1`	Confirmed	16.5 km S.		WAM
Paradoxosomatidae	<i>Antichiropus</i> `DIP126, accinctus`	Confirmed	13 km W.		WAM
Paradoxosomatidae	<i>Antichiropus</i> `DIP126, UBS2, disgregus`	Confirmed	5 km E.	<i>Melaleuca/Banksia</i> woodland, Tuart woodland, <i>Acacia/Xanthorrhoea</i> shrubland, Marri woodland	WAM, ROE
Paradoxosomatidae	<i>Antichiropus</i> `DIP127, UBS3`	Confirmed	8 km S.	<i>Melaleuca</i> woodland, Marri woodland, <i>Acacia</i>	WAM, ROE
Paradoxosomatidae	<i>Antichiropus</i> `DIP141, UBS1/GI`	Confirmed	21 km W.	Tuart woodland	WAM
Paradoxosomatidae	<i>Antichiropus</i> `DIP172, rotnnest`	Confirmed	20 km W.	Tuart woodland	WAM
Paradoxosomatidae	<i>Antichiropus whistleri</i>	Confirmed	18.7 km NW.	Bushland, woodland, urban areas	WAM
Polydesmida	<i>Sphaerotrichopus ramosus</i>	Potential	6.5 km E.		WAM

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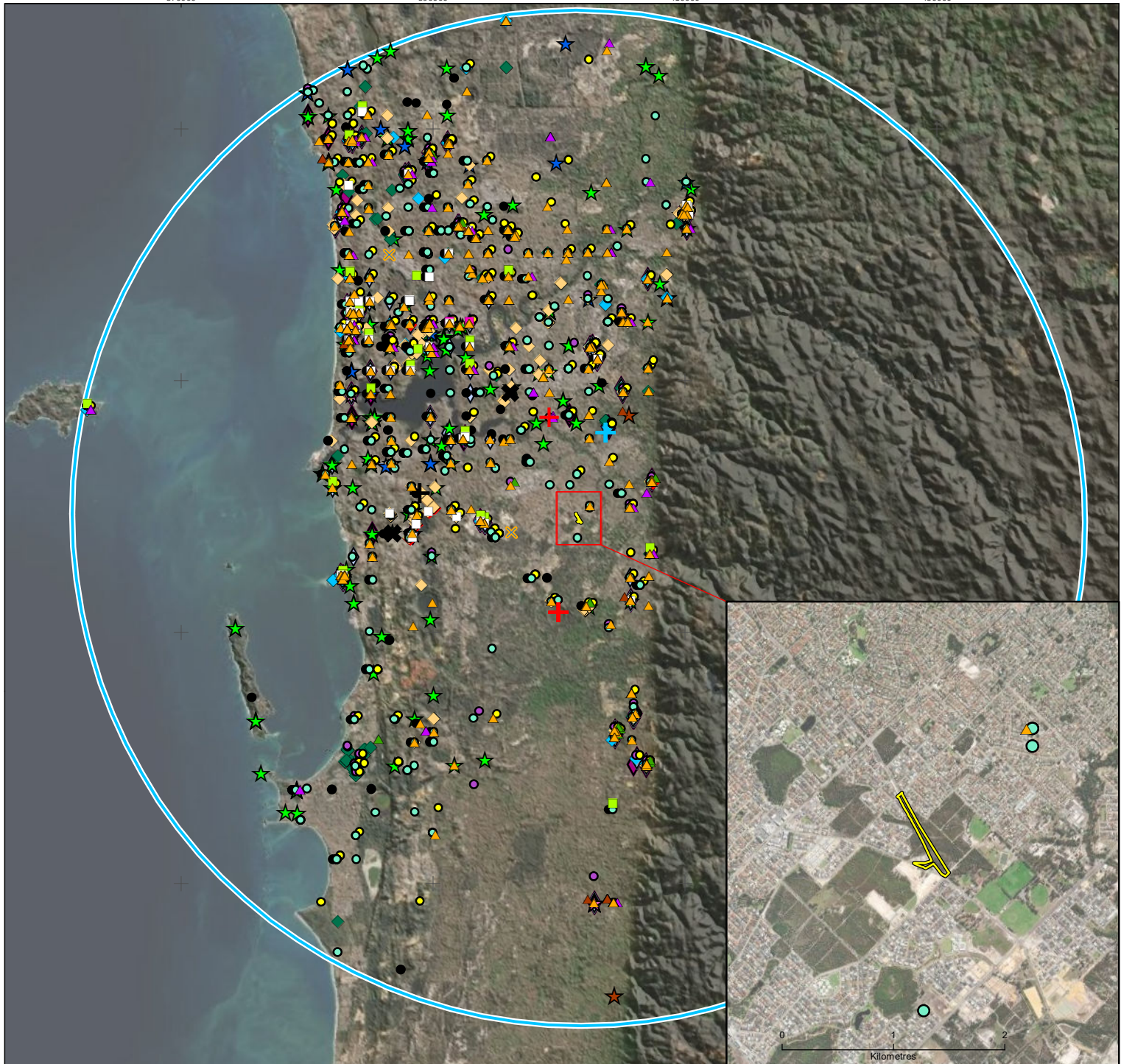
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Family	Species	SRE status	Nearest record to study area	Habitat records (indicative as not all records have habitat details)	Source
Gastropoda (snails)					
Bothriembryontidae	<i>Bothriembryon serpentinus</i>	Potential	29 km S.	Jarrah/Marri forest with Wandoo woodland; Jarrah/Marri forest, <i>Banksia</i> woodland and <i>Melaleuca</i> woodland; Jarrah/Marri forest; Jarrah/Marri forest on laterite; Wandoo woodland in valleys, Swamps with <i>Melaleuca</i> and <i>Banksia</i> . Only known from the Serpentine region.	WAM
Charopidae	<i>Epiniicum restifer</i>	Potential	21 km NNW.	Jarrah/Marri forest with Wandoo woodland	WAM
Charopidae	<i>Luinodiscus sublestus</i>	Potential	17 km NW.	Cliffs and slopy ground near river	WAM
Isopoda (slaters)					
Armadillidae	<i>Buddelundia</i> `sp. 1 (Judd)`	Potential	31 km S.		WAM
Armadillidae	<i>Buddelundia</i> `sp. 3 (Judd)`	Potential	18 km NW.		WAM
Armadillidae	<i>Buddelundia</i> `sp. 4 (Judd)`	Potential	6.6 km E.	<i>Banksia/Allocasuarina</i> Litter	WAM
Armadillidae	<i>Buddelundia</i> `sp. 7 (Judd)`	Potential	7.3 km W.		WAM, ROE
Armadillidae	<i>Buddelundia cinerascens</i>	Potential	8 km N.	<i>Dryandra sessilis</i> thicket	WAM
Armadillidae	<i>Buddelundia inaequalis</i>	Potential	16 km W.		WAM
Armadillidae	<i>Buddelundia nigripes</i>	Potential	19 km NW.		WAM, ROE
Armadillidae	<i>Cubaris</i> `sp. 1 (Judd 2002)`	Potential	7.5 km SE.		WAM
Armadillidae	<i>Cubaris</i> `sp. 2 (Judd 2002)`	Potential	22 km NW.		WAM
Armadillidae	<i>Spherillo</i> `sp. 2`	Potential	7.5 km W. & S.; 8 km N.	Woodland	WAM, MKSEA, MEW
Armadillidae	<i>Pseudodiploexochus</i> `sp A`	Potential	8 km N.	Woodland	MKSEA
Armadillidae	<i>Pseudodiploexochus</i> `sp B`	Potential	8 km N.	Riparian vegetation	MKSEA
Insecta (insects)					
Colletidae	<i>Glossurocolletes bilobatus</i> (Bee)	P2	7 km N.	Jarrah Forest, granite, creeklines, limestone. Recorded from Kenwick from the same date in 1981. Houston (2018) reports the species is confined to the Perth region east to York. <i>Gompholobium aristatum</i> (Yellow-flowering Pea).	WAM
Colletidae	<i>Hesperocolletes douglasi</i> (Bee)	CR (EPBC/EP)	40 km W.	<i>Banksia</i> woodland in pristine condition, Rutaceae: <i>Philothea spicata</i> , <i>Patersonia occidentalis</i> , <i>Stylidium hesperium</i> . <i>S. rigidulum</i> , <i>Stylidium</i> sp.,	WAM

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Family	Species	SRE status	Nearest record to study area	Habitat records (indicative as not all records have habitat details)	Source
				<i>Levenhookia stipitata</i> , <i>Bossiaea eriocarpa</i> , <i>Eremaea pauciflora</i> var. <i>pauciflora</i> , <i>Scaevola</i> sp. and other Fabaceae and Myrtaceae sp.	
Colletidae	<i>Leioproctus contrarius</i> (Bee)	P3	12.5 km W.	Woodland or shrubland on coastal plain; Goodeniaceae: <i>Leschenaultia floribunda</i> , <i>L. stenosepala</i> , <i>Scaevola</i> sp.; recorded from Geraldton, Moore R., Melville, Forrestdale, Bullsbrook, Armadale, Gingin, Wanneroo.	WAM
Colletidae	<i>Leioproctus douglasiellus</i> (Bee)	EN (EP), CR (EPBC)	7.5 km S.	Woodland, often near wetlands; has only been collected from <i>Goodenia filiformis</i> , <i>Anthotium junciforme</i> , recorded from three locations, Cannington, Forrestdale, Pearce.	WAM
Colletidae	<i>Neopasiphae simplicior</i> (Bee)	EN (EP), CR (EPBC)	7.7 km S and 8 km N	<i>Banksia</i> woodlands containing the associated flora species. Winter-wet depressions that develop carpets of flowers during spring. Goodeniaceae (<i>Goodenia</i> and <i>Velleia</i>), Asteraceae and Lobeliaceae. Have been collected from: <i>Goodenia filiformis</i> , <i>G. pulchella</i> , <i>Lobelia tenuior</i> , <i>Angianthus preissianus</i> , <i>Vellia</i> sp., <i>Siloxerus humifusus</i> , <i>Schoenus sculptus</i> , <i>Isolepis</i> sp., <i>Astartea 23ruinosus23is</i> , <i>Actinostrobilus pyramidalis</i> , <i>Cotula coronopifolia</i> . All on sandy soils, sand dunes, coastal limestone, low-lying winter-wet areas. Males roost on Asteraceae. <i>Leioproctus douglasi</i> , <i>Diuris purdiei</i> , <i>Drakaea elastica</i> , <i>Acacia</i> , <i>Villarsia</i> , <i>Drosera</i> , <i>Verticordia</i> and <i>Anthotium</i> .	WAM
Castniidae	<i>Synemon gratiosa</i> (Sun-moth)	P4	11 km NNW.	<i>Lomandra</i> spp.	ROE, ALA
Tettigonidae	<i>Throscodectes xiphos</i> (Cricket)	P1	5 km W.	<i>Banksia</i> woodland	ALA
Collembola (springtail)					
Entomobryidae	<i>Australotomurus morbidus</i>	P3	ca. 30 km N.		WAM

¹ WAM = WA Museum invertebrate database; MKSEA = *Maddington Kenwick Strategic Employment Area* (Invertebrate Solutions 2020b); MEW = *Malaga to Ellenbrook Works* (Invertebrate Solutions 2020a); ROE = *Roe Highway Extension Project* (Phoenix 2010); ALA = *Atlas of Living Australia* (ALA 2022).



SRE group and status

- | | | | | | |
|---|------------------------|---|----------------------------------|---|--------------------------------|
| + | Bee, CR (EPBC)/EN (EP) | ★ | Land snail, Uncertain | ○ | Mygalomorph spider, Widespread |
| + | Bee, P2 | ★ | Land snail, Widespread | ■ | Pseudoscorpiones, Potential |
| + | Bee, P3 | ◆ | Millipede, Confirmed | ■ | Pseudoscorpiones, Uncertain |
| × | Bush cricket, P1 | ◆ | Millipede, Potential | □ | Pseudoscorpiones, Widespread |
| ◆ | Isopod, Potential | ◆ | Millipede, Uncertain | ▲ | Scorpion, Confirmed |
| ◆ | Isopod, Widespread | ◆ | Millipede, Widespread | ▲ | Scorpion, Potential |
| ★ | Land snail, Confirmed | ● | Mygalomorph spider, Potential | ▲ | Scorpion, Uncertain |
| ★ | Land snail, Potential | ● | Mygalomorph spider, Potential/P3 | ▲ | Scorpion, Widespread |
| | | ● | Mygalomorph spider, Uncertain | ✖ | Sunmoth, P4 |



City of Gosnells Garden Street Extension Project	
Project No	1512
Date	18-Jul-22
Drawn by	AJ
Map author	AJ
1:442,536 (at A4) GDA 1994 MGA Zone 50	

Study area
 Desktop study area (40 km buffer)

Figure 4
Desktop records of SRE and significant invertebrate fauna



Table 6 Summary of SRE taxa from the desktop review

Group	Cf.	Pot.	CR	EN	P1	P2	P3	P4	W	Total
Mygalomorph spider		21					2*		11	32
Scorpion	1	3							7	11
Pseudoscorpion		2							9	11
Millipede	10	2							8	20
Slater		12							20	32
Land snail	1	2							20	23
Bee			1	2		1	1		n/a	5
Sun-moth								1	n/a	1
Cricket					1				n/a	1
Collembola							1		n/a	1
Total	12	42	1	2	1	1	2	1	75	137

*also Potential SREs.

5.2 HABITAT ASSESSMENT

Based on the vegetation and habitat mapping (Biologic 2022), two broad habitats occur within the study area (Figure 5):

- *Banksia* woodland is the most widespread potential SRE habitat, comprising 56.3% of the study area.
- *Melaleuca* thicket comprises 20.8% of the study area and occupies the area which is subject to inundation.

While both habitats would have historically been widespread across the Swan Coastal Plain, the many remnants within the Perth region are now fragmented due to urban development and potentially represent restricted habitats. *Banksia* woodland is typically not considered to have a high potential to support SREs due to lack of discreet habitat features that give rise to specialised SREs; however, on the Swan Coastal Plain, *Banksia* woodlands are becoming more isolated and for that reason was attributed a high Potential habitat rating. The low-lying *Melaleuca* thicket is considered a low potential SRE habitat due to its tendency to become inundated during winter and while SREs may occur in this habitat, it is unlikely to be primary SRE habitat. The remaining 22.9% of the study area is cleared.

Vegetation condition mapped in the study area by Biologic (2022) indicates that less than half (42.8%) is in Excellent condition (Table 7) indicating soils are in-tact and suitable for burrowing/aestivation, and there is sufficient cover for protection and for prey/food species to exist etc. The remaining 57.2% of the vegetation is rated as Completely Degraded to Very Good, indicating disturbance to vegetation and soils is present. SRE and significant invertebrate fauna are unlikely to occur in Completely Degraded to Very Good condition vegetation as weed infestation, degraded understory, and soil compaction all contributes to unsuitable habitat.

The site visit on 19 May 2022 confirmed the findings of the desktop habitat assessment, that the areas mapped as Excellent condition may be suitable for SRE and significant invertebrate fauna, including significant bees. No micro-habitats were observed within the *Banksia* woodland or *Melaleuca* thicket. Generally, the areas adjacent to the existing disturbed areas (pathways) tended to be less suitable habitat and areas further away from existing disturbance were more suitable. The areas of suitable habitat were bounded by similar quality habitat within the remainder of the reserve, including the site to the east and west of the study area (Natural Area Holdings 2016a), and therefore are not isolated occurrences of suitable habitat.

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Taking into account fauna habitat and vegetation condition, approximately 1.4 ha (29%) of the study area contains high potential habitat for SREs and some significant invertebrates. A further 0.6 ha (12.5 %) of Melaleuca thicket in Excellent condition may also be suitable habitat for species associated with seasonally wet areas such as native bees (Figure 5).



City of Gosnells
Garden Street Extension Project

Project No	1512
Date	18-Jul-22
Drawn by	AJ
Map author	AJ

0 60 120
Metres

1:3,200 (at A4) GDA 1994 MGA Zone 50

- Study area
- Fauna habitat**
- Banksia Woodland
- Melaleuca Thicket
- Cleared

- Vegetation condition**
- Excellent
 - Very Good
 - Good
 - Degraded
 - Completely Degraded
 - Cleared

Figure 5
Fauna habitat and vegetation condition in the study area (Biologic, 2021)

PHOENIX
ENVIRONMENTAL SCIENCES

All information within this map is current as of 18-Jul-22. This product is subject to COPYRIGHT and is property of Phoenix Environmental Sciences (Phoenix). While Phoenix has taken care to ensure the accuracy of this product, Phoenix make no representations or warranties about its accuracy, completeness or suitability for any particular purpose.

5.3 LIKELIHOOD OF OCCURRENCE

It is possible that some of the SRE and significant invertebrates occur in the 1.4 ha of suitable habitat within the study area, particularly those species known to occur in *Banksia* woodland habitats or that occur in a variety of habitats on the Swan Coastal Plain (Table 8). Taxa which are unlikely to occur are those associated with coastal limestone, drainage lines and forested areas, such as land snails.

It is difficult to make an assessment on many SRE and significant invertebrate species because habitat preferences are largely unknown, particularly where only one record exists. The likelihood of individual species to occur in the study area is presented in Table 8.

Table 7 Likelihood of occurrence

Species	SRE status ¹	Likelihood of occurrence
Arachnida (Mygalomorph spiders)		
<i>Missulena hoggi</i>	Pot.	Possible, suitable habitat is present, nearest record is 4 km E.
<i>Aname</i> `MYG405`	Pot.	Possible, very little is known about this species
<i>Aname</i> `MYG496`	Pot.	Possible, very little is known about this species
<i>Aname</i> `MYG633`	Pot.	Possible, very little is known about this species
<i>Aname</i> `UBS sp. 2`	Pot.	Possible, very little is known about this species
<i>Aname</i> `UBS Cat sp. 126`	Pot.	Possible, very little is known about this species
<i>Kwonkan</i> `MYG060`	Pot.	Possible, very little is known about this species
<i>Kwonkan</i> `UBS Cat sp. 124`	Pot.	Possible, very little is known about this species
<i>Kwonkan</i> `UBS Cat sp. 126`	Pot.	Possible, very little is known about this species
<i>Proshermacha</i> `MYG449`	Pot.	Possible, based on proximity of closest record (7.5 km S.)
<i>Teyl</i> `MYG249`	Pot.	Possible, <i>Melaleuca</i> present in study area, nearest record is 20 km W.
<i>Teyl</i> `UBS Cat sp. 148`	Pot.	Possible, very little is known about this species
<i>Teyl</i> `UBS Cat sp. 149`	Pot.	Possible, very little is known about this species
<i>Teyl</i> `waldockae`	Pot.	Possible, suitable habitat is present, nearest record is 20 km W.
<i>Idiommata</i> `UBS Cat sp. 123`	Pot.	Possible, very little is known about this species
<i>Synothele mullaloo</i>	Pot.	Unlikely, all known records known from north of Perth
<i>Synothele rastelloides</i>	Pot.	Unlikely, all known records known from north of Perth
<i>Idiosoma</i> `MYG188`	Pot.	Unlikely, all known records known from north of Perth
<i>Eucyrtops latior</i>	Pot.	Possible, suitable habitat is present, nearest record is 6 km E.
<i>Euoplos inornatus</i>	Pot./P3	Possible, nearest record is 10.8 km NW. of the study area from 2014. This species is also known from the Northern Jarrah Forest.
<i>Idiosoma sigillatum</i>	Pot./P3	Possible, this species has a total known range of 7,500 km ² . It is one of the most widely collected of the SREs on the Swan Coastal Plain; however, only a few records are from the last 20 years
Arachnida (pseudoscorpions)		
`Genus indet.` `tarsus IV without tactile seta`	Pot.	Possible, very little is known about this species
`PSEAAF` `PSE130`	Pot.	Possible, very little is known about this species
Arachnida (scorpions)		

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Species	SRE status ¹	Likelihood of occurrence
<i>Lychas `majerorum` (`majeri`)</i>	Pot.	Possible, suitable habitat is present, nearest record is 6 km S.
<i>Lychas `prendinii`</i>	Pot.	Possible, suitable habitat is present, nearest record is 5 km NE.
<i>Urodacus planimanus</i>	CF.	Possible, suitable habitat is present, nearest record is 7 km E.
<i>Urodacus `woodwardii`</i>	Pot.	Possible, based on proximity of closest record, (6 km NE/NW).
Diplopoda (millipedes)		
<i>Podykipus collinus</i>	Pot.	Possible, suitable habitat is present, nearest record is 12 km W.
<i>Dinocambala ingens</i>	CF.	Unlikely, suitable habitat not present
<i>Antichiropus `DIP022, 29ruino`</i>	CF.	Possible, suitable habitat is present, nearest record is 18 km N.
<i>Antichiropus `DIP082/DIP172, GI/UBS1`</i>	CF.	Possible, suitable habitat is present, nearest record is 20 km N.
<i>Antichiropus `DIP112, Norman Road 1`</i>	CF.	Possible, suitable habitat is present, nearest record is 16.5 km S.
<i>Antichiropus `DIP126, accinctus`</i>	CF.	Possible, suitable habitat is present, nearest record is 13 km W.
<i>Antichiropus `DIP126, UBS2, disgregus`</i>	CF.	Possible, suitable habitat is present, nearest record is 5 km E.
<i>Antichiropus `DIP127, UBS3`</i>	CF.	Possible, suitable habitat is present, nearest record is 8 km S.
<i>Antichiropus `DIP141, UBS1/GI`</i>	CF.	Unlikely, suitable habitat not present
<i>Antichiropus `DIP172, rotnest`</i>	CF.	Unlikely, suitable habitat not present
<i>Antichiropus whistleri</i>	CF.	Possible, suitable habitat is present, nearest record is 18.7 km NW.
<i>Sphaerotrichopus ramosus</i>	Pot.	Possible, based on proximity of closest record (6.5 km E.)
Gastropoda (snails)		
<i>Bothriembryon serpentinus</i>	Pot.	Unlikely, only occurs in the Serpentine region
<i>Epiniicum restifer</i>	Pot.	Unlikely, suitable habitat is not present
<i>Luinodiscus sublestus</i>	Pot.	Unlikely, suitable habitat is not present
Isopoda (slaters)		
<i>Buddelundia `sp. 1 (Judd)`</i>	Pot.	Possible, very little is known about this species
<i>Buddelundia `sp. 3 (Judd)`</i>	Pot.	Possible, very little is known about this species
<i>Buddelundia `sp. 4 (Judd)`</i>	Pot.	Possible, suitable habitat is present, nearest record is 6.6 km E.
<i>Buddelundia `sp. 7 (Judd)`</i>	Pot.	Possible, very little is known about this species
<i>Buddelundia cinerascens</i>	Pot.	Possible, suitable habitat is present, nearest record is 8 km N.
<i>Buddelundia inaequalis</i>	Pot.	Possible, suitable habitat is present, nearest record is 16 km W.
<i>Buddelundia nigripes</i>	Pot.	Possible, suitable habitat is present, nearest record is 6.6 km E.
<i>Cubaris `sp. 2 (Judd 2002)`</i>	Pot.	Possible, very little is known about this species
<i>Spherillo `sp. 2 (Judd 2002)`</i>	Pot.	Possible, very little is known about this species
<i>Pseudodiploexochus `sp `A`</i>	Pot.	Possible, very little is known about this species
<i>Pseudodiploexochus `sp B`</i>	Pot.	Possible, very little is known about this species
Insecta (insects)		
<i>Glossurocolletes bilobatus</i> (Bee)	P2	Unlikely – species has only been collected from Kenwick area, 6.8 km north of the study area in Jarrah and Wandoo woodland. These woodlands are not present in the study area. <i>Gompholobium aristatum</i> absent.
<i>Hesperocolletes douglasi</i> (Bee)	CR (EPBC/	Unlikely – Not within range. <i>Hesperocolletes douglasi</i> has only one known extant population record located 57 km north of

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Species	SRE status ¹	Likelihood of occurrence
	EP Act)	the study area in pristine condition <i>Banksia</i> woodland habitat. A 1938 record of this species exists from Rottnest Island.
<i>Leioproctus contrarius</i> (Bee)	P3	Unlikely, nearest record is 12.5 west of the study area was from 1978. Neither of the known flora association <i>Leschenaultia floribunda</i> or <i>L. stenosepala</i> were recorded in the Biologic (2022) survey; however, other members of Goodeniaceae were recorded (<i>L. expansa</i> , <i>G. pulchella</i> and <i>Dampiera linearis</i>)
<i>Leioproctus douglasiellus</i> (Bee)	EN (EP), CR (EPBC)	Possible, within range, nearest record is 7.5 km south of the study area. <i>Leioproctus douglasiellus</i> has only been collected from <i>Goodenia pulchella</i> (not <i>filiformis</i>) and <i>Anthotium junciforme</i> , <i>Goodenia pulchella</i> was recorded in the Biologic (2022) survey and <i>Anthotium junciforme</i> was noted by Spineless Wonders (2017). Both <i>G. pulchella</i> and <i>A. junciforme</i> are associated with winter-wet areas.
<i>Neopasiphae simplicior</i> (Bee)	EN (EP), CR (EPBC)	Possible, within range, nearest records are 8 km north and 7.5 km south of the study area; however, these records are historic (from 1985 and 1967 respectively) and only one extant population is known to exist near Forrestsdale Lake. While suitable habitat (<i>Banksia</i> woodland, winter-wet depressions) is present in study area, and many species associations were recorded in the Biologic (2022) survey (<i>G. pulchella</i> , <i>Lobelia tenuior</i> , <i>Siloxerus humifusus</i> , <i>Isolepis</i> spp. <i>Acacia</i> , <i>Drosera</i> and <i>Anthotium</i>)
<i>Synemon gratiosa</i> (Sun-moth)	P4	Unlikely – recorded from several locations on the Swan Coastal Plain, associated with <i>Lomandra hermaphrodita</i> and <i>L. maritima</i> , however neither of these were recorded from the study area.
<i>Throscodectes xiphos</i> (Cricket)	P1	Possible – <i>Banksia</i> woodland present within study area, nearest record is 5 km W.
<i>Australotomurus morbidus</i> (Springtail)	P3	Unlikely – not within known range

6 DISCUSSION

6.1 SREs

The desktop results indicate high diversity of SRE taxa occur on the Swan Coastal Plain, though many of the taxa have been sparsely collected and are very poorly understood. A high proportion of the SRE records within the desktop search area are undescribed; however, they have been morphologically distinguished as a distinct species by the WA Museum. The museum applies morpho-species codes (e.g. `MYG`, `DIP`) to distinguish between species that have not yet been formally described, therefore these are generally attributed an SRE status of potential.

Taxa from the SRE groups of pseudoscorpions and some genera of isopods are physically small in size and often remain undetected, therefore little is known about their distribution, biology and habitat requirements. Unlike mygalomorph spiders and *Antichiropus* millipedes, species from these groups cannot be readily distinguished based on the morphology of the male reproductive organs.

The high degree of urbanisation causing loss and fragmentation of habitat is likely to have had an impact on the distributions of the SRE and significant invertebrate species identified in the desktop review. Many species, particularly those that are known from one or a handful of records, or have not been recorded in recent years, are likely to have disappeared from highly urbanised areas altogether. In bushland areas where disturbances exist, more robust invertebrate species are more likely to persist over range-restricted taxa. For example, commonly found widespread mygalomorph spiders from the Swan Coastal Plain, such as *Proshermacha tepperi* which has been previously recorded in the study area (Natural Area Holdings 2016a), *Idiosoma sigillatum*, *Missulena granulosa*, *Idiommata blackwalli*, as well as common native isopods and introduced species *Porcellionoides 31ruinosus* (woodlouse), and *Ommatoiulus moreleti* (Portuguese millipede). This was demonstrated by the survey undertaken in 2015 by Natural Area Holdings (2016a) where only widespread, common and introduced invertebrate taxa were recorded.

A total of 1.4 ha of *Banksia* woodland is considered suitable habitat and has the capacity to support SREs within the study area (Figure 5); however, this area represents only a very small proportion of potential habitat, which extends outside of the study area, inclusive of the Bush Forever site 125 to the east and west of the study area (ENV Australia 2010; Natural Area Holdings 2016b)(Figure 7).

Considering the potential SRE habitat is not restricted to the study area, nor contains any restricted micro-habitats and is only a short distance to existing disturbance, any SREs, if present, are unlikely to be restricted to the 1.4 ha within the study area and therefore an SRE survey is not considered necessary.

6.2 SIGNIFICANT INVERTEBRATES

A total of five significant invertebrate species are considered to have potential to occur within this area of suitable habitat, two bees, two mygalomorph spiders and one bush cricket. Within the study area, approximately 1.4 ha of *Banksia* woodland is considered suitable habitat for significant invertebrate species, and a further 0.6 ha of Melaleuca thicket is considered suitable for significant bee species (Figure 6). While urbanisation has led to fragmentation and in some cases, degradation of remnant vegetation, neither *Banksia* woodland or Melaleuca thicket habitats are restricted to the study area. Both of these habitats (in Excellent or better condition) are well represented in close range outside of the study area (ENV Australia 2010; Natural Area Holdings 2016b), including the adjacent Bush Forever site 125, of which the study area occupies only a small proportion (3.4 % of the 140 ha Bush Forever site) (Figure 7).

6.2.1 Bees

The Swan Coastal Plain has recently been the subject of increased native bee surveys (Prendergast 2020); however, many species still remain poorly known. Dr Terry Houston has researched native bees since the 1980s, and several research projects have focused on bee taxa on the Swan Coastal Plain. Most of the bee records from the database searches are up to 50 years old, with most records from the 1980s. Records of Threatened and Priority bee species remain sparse, particularly within the Perth area where no new populations have been recorded within the last 20 years. The most recent records come from further afield on the Swan Coastal Plain in areas where less development has occurred (e.g. Pinjar, 50 km to the north of Perth; Pinjarra, 80 km to the south of Perth; and Moore River, 100 km north of Perth) (WAM 2022).

The difficulty in detecting some native bee species arises when these species emerge for a few weeks of the year and may only be active or detectable in favourable weather conditions. They are highly dependent on the flowering period of association flora (Houston 2018), thus it is critical areas that support known associated flora species are preserved. The native bee survey conducted in the study area by Spineless Wonders (2017) did not detect any significant bee species despite sampling when known forage species (*Goodenia pulchella* and *Anthotium junciforme*) were in flower; however, this survey was not conducted in the optimal survey period for native bees of between October to January (Houston 2000). The flowering of known forage species was triggered by late summer rain in 2017 and it is uncertain whether the bees have a secondary flying season related to out-of-season flowering events. The invertebrate survey undertaken in November 2015 within the Garden Street Reserve also did not detect any significant bee species.

Habitat for two species of native bees occurs within the study area, *Leioproctus douglasiellus* and *Neopasiphae simplicior*, discussed below.

6.2.1.1 *Leioproctus douglasiellus* – EN (EP), CR (EPBC)

Leioproctus douglasiellus is only known from three populations with a current extent of occurrence of 24.3 km², and an area of occupancy of 0.2 km² (20 ha) (DSEWPaC 2013) with the nearest population occurring at Forrestdale Lake, 7.5 km S. of the study area. No new populations have been recorded in the area in recent years (pers. comm Dr. Terry Houston).

Approximately 0.6 ha of suitable habitat (seasonally inundated winter-wet depressions) containing both known associated flora species *Goodenia pulchella* and *Anthotium junciforme* (Biologic 2022) (Spineless Wonders 2017) occurs within the study area. However, both *Goodenia pulchella* and *Anthotium junciforme* are widespread on the Swan Coastal Plain and their presence does not necessarily mean that *Leioproctus douglasiellus* will occur. If this species did occur within the study area, this would account for 3% of its known area of occupancy.

Leioproctus douglasiellus is thought to produce a single generation per year, with emergence of adults timed to coincide with flowering of the food-plants (DSEWPaC 2013) during summer, with observations of the species made in January. If present, it is possible that *L. douglasiellus* was active during the invertebrate surveys undertaken in November 2015 (Natural Area Holdings 2016a), however it is unlikely to have been active during the survey undertaken by Spineless Wonders (2017), therefore we cannot rule out the possibility that *L. douglasiellus* is present within the study area.

If present, this species is also likely to occur in similar habitat within the immediately adjacent areas of the Bush Forever site 125, where vegetation is in Excellent or better condition (Figure 6-2).

6.2.1.2 *Neopasiphae simplicior* – EN (EP), CR (EPBC)

Neopasiphae simplicior is known from a single extant population 7.3 km south of the study area. The extent of occurrence and area of occupancy of the species are estimated at 1 km² (100 ha) (DSEWPaC

2008). No new populations have been recorded in the area in recent years (pers. comm Dr. Terry Houston).

Approximately 2 ha of suitable habitat (*Banksia* woodland and seasonally inundated winter-wet depressions) containing known associated flora species including *G. pulchella*, *Lobelia tenuior*, *Siloxerus humifusus*, *Isolepis* spp. *Acacia* spp., *Drosera* spp. and *Anthotium* (Biologic 2022) occurs within the study area. Most of these are widespread on the Swan Coastal Plain and so are not reliable predictors of *N. simplicior* presence; however, it does mean that suitable habitat and resources exist.

As with *Leioproctus douglasiellus*, the recommended time to survey for this species is during the peak flowering period for its known flora species associations, which is between October and January (Houston 2000), with the WA Museum records occurring in October, November and December.

The targeted bee survey undertaken by Spineless Wonders (2017) was not undertaken during the period and therefore this species was unlikely to have been active, however, the invertebrate survey undertaken by Natural Area Holdings (2016a) was undertaken in November and it is possible *N. simplicior*, if present, was active during this time. Given suitable habitat exists within the study area, we cannot rule out the possibility that *N. simplicior* is present, however, if present, this species is also likely to occupy similar habitat in the immediately adjacent areas of the Bush Forever site 125, where vegetation is in Excellent or better condition (Figure 6).

6.2.2 Mygalomorph spiders

Mygalomorph spiders, more commonly known as trapdoor spiders due to their burrow which is created as juveniles and occupied their entire lives by females. Males may leave their burrows once they reach sexual maturity in order to mate; however, after this, their fate is death. It is for this reason that they are considered SREs. Due to their burrowing and nocturnal behaviours, they are cryptic and often difficult to locate. Mygalomorph spiders rely on habitats which provide attributes suitable for burrow construction (e.g., soils and leaf litter), as well as protection from predators. Some species may have adapted to burrowing in specialised habitats and are unable to distribute over long distances or geographical barriers.

6.2.2.1 *Euoplos inornatus* (P3)

Most records of *Euoplos inornatus* come from the Jarrah Forest bioregion, where it is relatively well distributed between Bullsbrook and Boddington; however, a relatively recent (2014) Swan Coastal Plain record of this species exists 10.8 km north-west of the study area. This species may have once been more common in the Perth region prior to large scale urbanisation. *Euoplos inornatus* has a range of habitat tolerances (e.g. Jarrah Forest laterite to *Banksia* woodland sandplains). Within the study area, 1.4 ha of *Banksia* woodland is suitable habitat for this species; however, given its wide habitat tolerances, the study area represents a negligible proportion of its range.

6.2.2.2 *Idiosoma sigillatum* (P3)

Idiosoma sigillatum total known range of 7,500 km² (Rix *et al.* 2018) and is one of the most widely collected of the SREs on the Swan Coastal Plain (WAM 2022). This species is well known to occur in *Banksia* woodland and heathland on sandy soils habitats, of which 1.4 ha of suitable habitat is present within the study area. Given the above, this area represents a very small proportion of known habitat for this species.

6.2.3 Cricket

6.2.3.1 *Throscodectes xiphos* (P1)

Throscodectes xiphos is known from one location in Jandakot, 5 km west of the study area in *Banksia* woodland where it was collected from within the axial leaf bases of a grass tree (*Xanthorrhoea preissii*). Very little else is known about this species. There is no evidence to suggest this species is reliant on grasstrees, rather, it is likely that this species inhabits general shrubland or woodland understories. The species may occur in the 1.4 ha of *Banksia* woodland in Excellent condition within the study area. However, if so, then it is also likely to occur within the wide range of *Banksia* woodland outside of the study area (Figure 6).



City of Gosnells
Garden Street Extension Project

Project No	1512
Date	18-Jul-22
Drawn by	AJ
Map author	AJ

0 60 120
Metres

1:3,200 (at A4) GDA 1994 MGA Zone 50

Study area

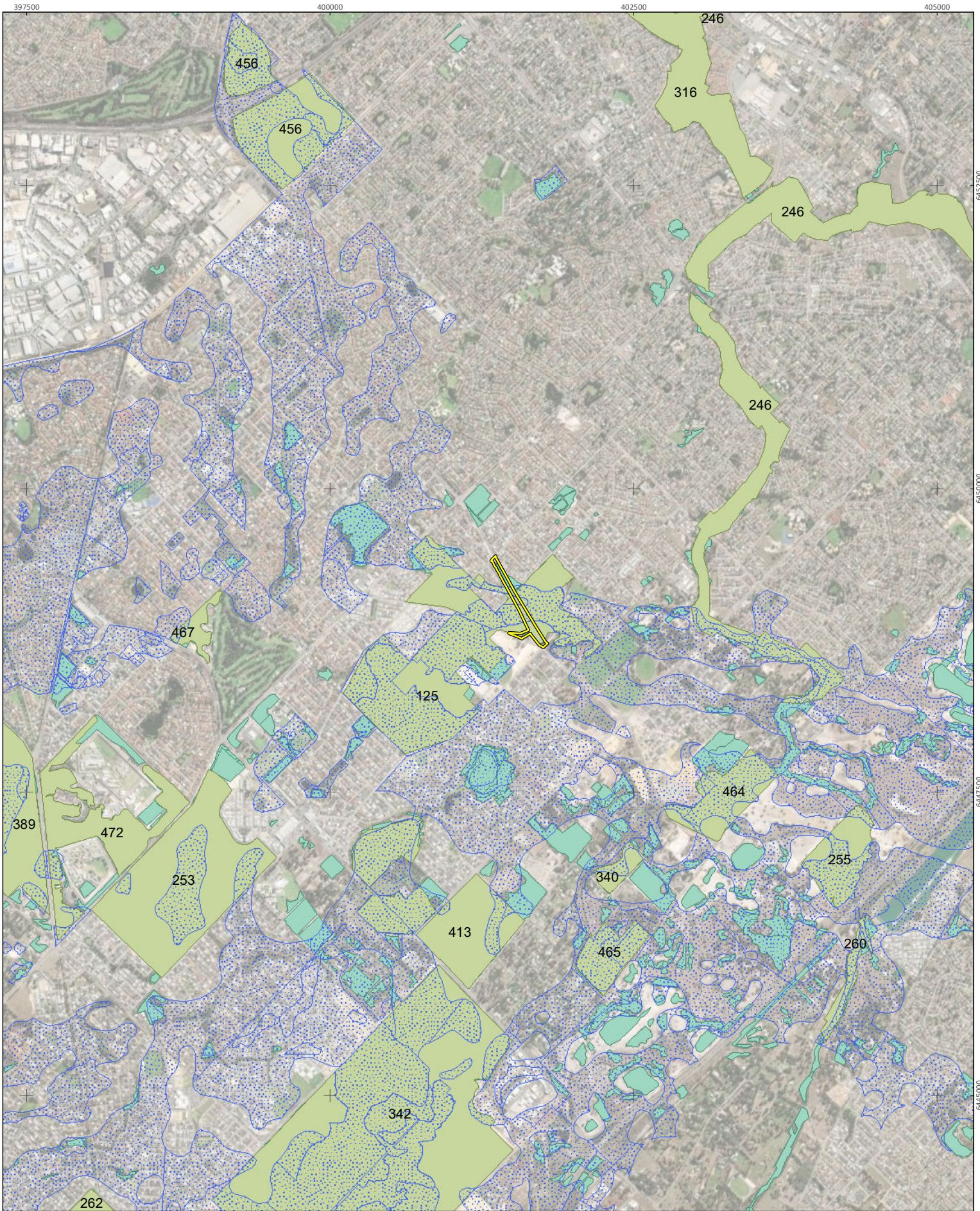
Potential habitat


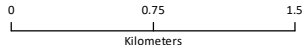
- Banksia woodland, Excellent condition (SRE invertebrates, *Throscodectes xiphos*, and *Neopasiphae simplicolor*)
- Melaleuca thicket, Excellent condition (*Neopasiphae simplicolor* and *Leioproctus douglasiellus*)

Figure 6

Potential SRE and significant invertebrate fauna habitat in the study area

PHOENIX
ENVIRONMENTAL SCIENCES



City of Gosnells Garden Street Extension Project	
Project No	1512
Date	18-Jul-22
Drawn by	AJ
Map author	AJ
	
	
1:40,000 (at A4) GDA 1994 MGA Zone 50	





-  Study area
-  Sumpland or dampland (Geomorphic wetlands)
-  Bush Forever site
-  Remnant vegetation (non-Bush Forever)

Figure 7
Potential SRE and significant invertebrate fauna habitat surrounding the study area



Short-range endemic and significant invertebrate desktop assessment for the Garden Street Extension Project
Prepared for City of Gosnells

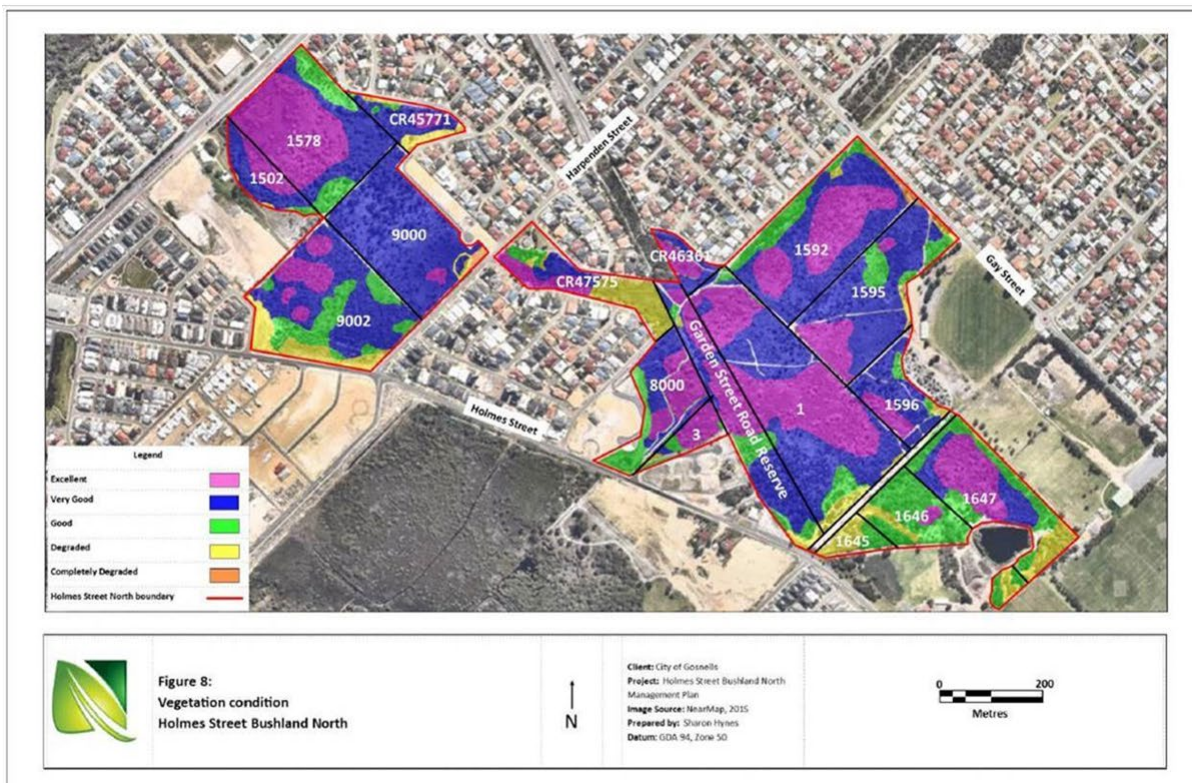
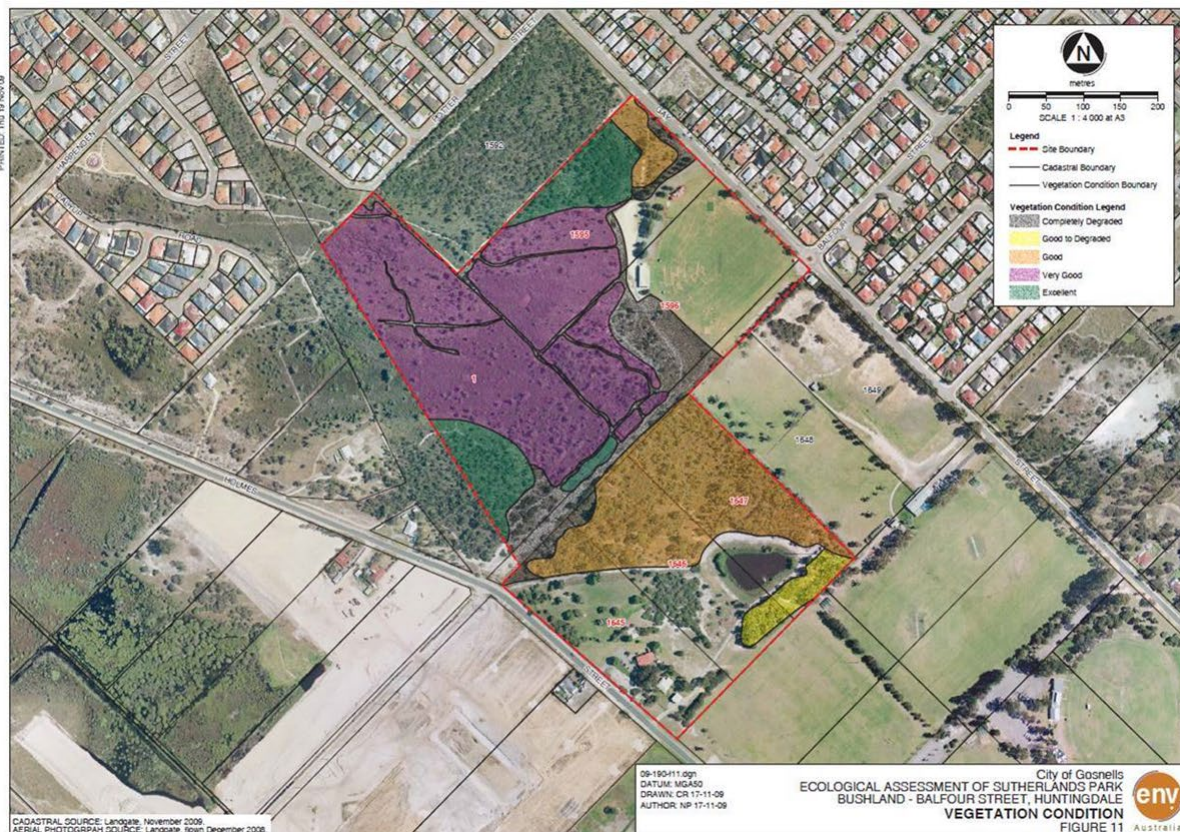


Figure 8 Vegetation condition in the surrounding area from flora and vegetation surveys undertaken by (Natural Area Holdings 2016b) and (ENV Australia 2010)

7 CONCLUSIONS

The study area contains 1.4 ha of suitable habitat for SREs in terms of vegetation structure, soil condition, and the presence of known forage species. However, due to the proximal nature of existing disturbances, the taxa that are more likely to occur in the study area and surrounding bushland are widespread species that are less susceptible to disturbance and have a higher propensity for dispersal (e.g. widespread species such as *Proshermacha tepperi*, *Idiosoma sigillatum*, and introduced species of isopods and millipedes). No SREs have been recorded within the study area, however 54 may potentially occur within the study area.

The areas within the study area that are considered suitable habitat are minor and only represent a small fraction of the actual potential habitat for these species on the Swan Coastal Plain, thus the removal of suitable habitat is unlikely to have a significant impact on SRE habitat.

No significant invertebrates have been recorded in the study area, however two Threatened bee species may potentially occur, *Leioproctus douglasiellus* and *Neopasiphae simplicolor*, both of which are associated with seasonally inundated, winter-wet habitats. A total of 0.6 ha of *Melaleuca* thicket which is subject to inundation is present within the study area. *Neopasiphae simplicolor* is also known from *Banksia* woodlands, therefore a total of 2 ha of suitable habitat exists in the study area for this species.

Given the difficulty in detecting significant invertebrate species, any habitat in Excellent or better condition with known habitat types and with known forage species present should be considered potential habitat. If either of the Threatened bee species are present within the study area, it is likely that they also occur in similar habitats within the Bush Forever 125 site, directly adjacent to the study area.

REFERENCES

- ALA. 2022. *Atlas of Living Australia*. Available at: <http://www.ala.org.au/>
- Biologic. 2022. *Garden Street Extension Ecological Survey Report*. Biologic Environmental Service, Perth, WA, Report prepared for City of Gosnells.
- BoM. 2022. *Climate statistics for Australian locations*. Commonwealth of Australia, Bureau of Meteorology. Available at: <http://www.bom.gov.au/climate/data/>
- Car, C. A. & Harvey, M. S. 2014. The millipede genus *Antichiropus* (Diplopoda: Polydesmida: Paradoxosomatidae), part 2: species of the Great Western Woodlands region of Western Australia. *Records of the Western Australian Museum* **29**: 20–77.
- Car, C. A., Wojcieszek, J. M. & Harvey, M. S. 2013. The millipede genus *Antichiropus* (Diplopoda: Polydesmida: Paradoxosomatidae), part 1: redefinition of the genus and redescription of existing species. *Records of the Western Australian Museum* **28**: 83–118.
- DBCA. 2019. *Wetlands*. Available at: <https://www.dpaw.wa.gov.au/management/wetlands>
- DBCA. 2021. *Geomorphic Wetlands Swan Coastal Plain*.
- Department of the Environment and Energy. 2016. *Maps: Australia's bioregions (IBRA)*. Department of the Environment and Energy, Canberra, ACT. Available at: <http://www.environment.gov.au/topics/land/national-reserve-system/science-maps-and-data/australias-bioregions-ibra>
- DoEE. 2018. *Species Profile and Threats Database*. Department of the Environment and Energy, Australian Government, Canberra, ACT. Available at: <http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl>
- DSEWPaC. 2008. *Approved Conservation Advice for Neopasiphae simplicior (a short-tongued bee)*. Australian Government, Canberra.
- DSEWPaC. 2013. *Approved conservation advice for Leioproctus douglasiellus (a short-tongued bee)*. Department of Sustainability, Environment, Water, Population and Communities, Parkes, ACT. A statement for the purposes of approved conservation advice (s266B of the Environment Protection and Biodiversity Conservation Act 1999).
- ENV Australia. 2010. *Ecological Assessment of Sutherlands Park Bushland*. Report prepared for City of Gosnells, Perth, WA.
- EPA. 2016a. *Environmental Factor Guideline: Terrestrial fauna*. Environmental Protection Authority, Perth, WA. Available at: http://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/Guideline-Terrestrial-Fauna-131216_3.pdf
- EPA. 2016b. *Technical Guidance: Sampling methods for terrestrial vertebrate fauna*. Environmental Protection Authority, Perth, WA. Available at: http://epa.wa.gov.au/sites/default/files/Policies_and_Guidance/Tech%20guidance-%20Sampling-TV-fauna-Dec2016.pdf
- Geoscience Australia. 2020. *GEODATA TOPO 250K Series 3 Topographic Data* Canberra, Australia.
- Government of Western Australia. 2018a. *Wildlife Conservation Act 1950 Wildlife Conservation (Rare Flora) Notice 2018*. Government Gazette, WA. Government of Western Australia, Perth, WA.
- Government of Western Australia. 2018b. *Wildlife Conservation Act 1950, Wildlife Conservation (Specially Protected Fauna) Notice 2018*. Government Gazette, WA, Perth, WA.
- Harvey, M. S. 2002. Short-range endemism among the Australian fauna: some examples from non-marine environments. *Invertebrate Systematics* **16**: 555–570.
- Hebert, P. D. N., A., C., Ball, S. L. & de Waard, J. R. 2003a. Biological identifications through DNA barcodes. *Proceedings of the Royal Society London B* **270**: 313–321.
- Hebert, P. D. N., Ratnasingham, S. & de Waard, J. R. 2003b. Barcoding animal life: Cytochrome c oxidase subunit 1 divergences among closely related species. *Proceedings of the Royal Society London B, Supplement* **270**: 96–99.
- Houston, T. 2018. *A guide to native bees of Australia*. CSIRO Publishing, Clayton South, VIC.

- Houston, T. F. 2000. Native Bees on Wildflowers in Western Australia. *Special Publication No. 2 of the Western Australian Insect Study Society Inc.*
- Invertebrate Solutions. 2019. *Conservation Significant and Short Range Endemic invertebrate desktop habitat assessment for Thornlie Cockburn Link Proposal, Perth, Western Australia.* Report prepared for the Public Transport Authority, Victoria Park, WA.
- Invertebrate Solutions. 2020a. *Baseline short-range endemic and conservation significant invertebrate survey for the Malaga to Ellenbrook Works.* Report prepared for the Public Transport Authority, Victoria Park, WA.
- Invertebrate Solutions. 2020b. *Short Range Endemic Invertebrate Assessment of Maddington Kenwick Strategic Employment Area (MKSEA).* Report prepared for the City of Gosnells, Victoria Park, WA.
- Invertebrate Solutions. 2021. *Desktop Review and Impact Assessment of Short Range Endemic and Conservation Significant Invertebrates for the Byford Rail Extension Project.* Report prepared for the Perth Transport Authority, Victoria Park, WA.
- Mitchell, D., Williams, K. & Desmond, A. 2002. Swan Coastal Plain 2 (SWA2—Swan Coastal Plain subregion). In: May, J. E. & McKenzie, N. L. (eds) *A biodiversity audit of Western Australia's 53 biogeographical subregions in 2002.* Department of Conservation and Land Management, Perth, WA, pp. 606–623.
- Natural Area Holdings. 2016a. *Garden Street Road Reserve Environmental Assessment.* Report Prepared for City of Gosnells.
- Natural Area Holdings. 2016b. *Holmes Street Bushland North: Revegetation and Weed Management Plan.* Report prepared for City of Gosnells, Whiteman, WA.
- Payne, A. L. & Leighton, K. A. 2004. Land systems. In: van Vreeswyk, A. M. E., Payne, A. L., Leighton, K. A. & Hennig, P. (eds) *Technical Bulletin 9. An inventory and condition survey of the Pilbara region, Western Australia.* Department of Agriculture, Government of Western Australia, South Perth, WA, pp. 175–384.
- Phoenix. 2010. *Short-range endemic and targeted invertebrate baseline surveys for the Roe Highway Extension Project.* Phoenix Environmental Sciences Pty Ltd, Balcatta, WA. Unpublished report prepared for South Metro Connect.
- Prendergast, K. S. M., M. H.; Dixon, K. W.; Bateman, P. W. 2020. *The relative performance of sampling methods for native bees: an empirical test and review of the literature.*
- Rix, M. G., Huey, J. A., Cooper, S. J. B., Austin, A. D. & Harvey, M. S. 2018. Conservation systematics of the shield-backed trapdoor spiders of the *nigrum*-group (Mygalomorphae, Idiopidae, *Idiosoma*): integrative taxonomy reveals a diverse and threatened fauna from south-western Australia. *Zookeys* **756**: 1–121 <http://dx.doi.org/10.3897/zookeys.756.24397>.
- Spineless Wonders. 2017. *Native Bee Survey of proposed Garden Street Extension.* Report prepared for City of Gosnells, Perth, WA.
- Stewart, A. J., Sweet, I. P., Needham, R. S., Raymond, O. L., Whitaker, A. J., Liu, S. F., Phillips, D., Retter, A. J., Connolly, D. P. & Stewart, G. 2008. *Surface geology of Australia 1:1,000,000 scale, Western Australia [Digital Dataset],* Canberra.
- WAM. 2013. *WAM short-range endemic categories and sub-categories.* Western Australian Museum, Welshpool.
- WAM. 2022. *WA Museum Arachnology/Myriapodology, Crustacea, Mollusa and Entomology database,* Welshpool, WA.
- WAPC. 2000. *Bush Forever: Volume 1: Policies, principles and processes.* Western Australian Planning Commission, Perth, WA.
- Williams, K. & Mitchell, D. 2001. Jarrah Forest 1 (JF1—Northern Jarrah Forest subregion). In: May, J. E. & McKenzie, N. L. (eds) *A biodiversity audit of Western Australia's biogeographical subregions in 2002.* Department of Conservation and Land Management, Perth, WA, pp. 369–381.