Native fish and amphibian survey

Murray Drainage and Water Management Plan and Associated Studies

This report was prepared for the Department of Water

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Executive Summary

GHD has been commissioned by the Department of Water (DoW) to prepare a Drainage and Water Management Plan (DWMP) for the Murray area. As part of the planning process, a scientific understanding of surface and groundwater regimes and the Ecological Water Requirements (EWR's) of each selected wetland is critical for identifying potential impacts on the natural environment. This plan will provide guidance to the Department of Planning, the Shire of Murray, land owners and potential developers to inform future land use planning processes in the area.

Amphibians are well known to be considered environmental indicators of healthy environments and can be used as a long term tool to monitor wetland heath. Native fish species that persist in the wetlands can be used to monitor long term population dynamics by recording changes in presence and abundance over time. The purpose of this investigation was to undertake monitoring to obtain baseline data on the diversity of amphibians and native fish of the Murray water drainage basin as well as an inventory of the general fauna of the area.

The field survey was undertaken between winter and spring 2009 and autumn 2010. The surveys consisted of an amphibian assessment and native fish survey. An opportunistic survey in conjunction with the targeted species investigation was also conducted. Nine wetlands were chosen by GHD and the Department of Water as long term study areas.

The following is a summary of the findings of the amphibian and fish survey:

- Eight of the 13 possible species of amphibians were recorded over the nine wetlands during the survey period. The maximum number of amphibian species at one wetland was seven (UFI 5724) and the minimum was two (UFI 7029 and UFI 3945);
- No fish were captured at any of the wetlands. During fish sampling, many water invertebrates and tadpoles were captured;
- Fish species were recorded in the modified wetland adjacent to UFI 7096 and included: Gallaxids, Pygmy Perch (*Edelia vittata*), Carp (*Cyprinus carpo*) and Mosquitofish (*Gambusia holbrooki*) with the later two being introduced;
- Fauna taxa recorded during the opportunistic field surveys included: two reptiles, one native mammal, two non-native mammals, 44 birds and 16 water invertebrates;
- During the field investigation one significant fauna species, Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*) was observed in wetland UFI 5032;
- Four introduced fauna species were observed within the study areas: two mammals (fox and European rabbit), one water invertebrate (Pond Snail) and one bird (Laughing Kookaburra); and
- The wetlands in this study range from native vegetation with relatively pristine areas to heavily disturbed agricultural lands; however, all study areas contain sufficient habitat to maintain several species of amphibians.

1. Introduction

1.1 Aim of Study

GHD has been commissioned by the Department of Water (DoW) to prepare a Drainage and Water Management Plan (DWMP) for the Murray area. This plan will provide guidance to the Department of Planning, the Shire of Murray, land owners and potential developers to inform future land use planning processes in the area.

A scientific understanding of surface and groundwater regimes and the Ecological Water Requirements (EWR's) of wetland biosystems in the study area is required as part of the planning process. The purpose of this investigation was to undertake monitoring to obtain baseline data on the diversity of amphibians and native fish of the Murray water drainage basin as well as an inventory of the general fauna of the area. Within the Murray water drainage basin 13 species of amphibians (Tyler and Doughty 2009) and five species of native fish are predicted to be present (Allen *et al. 2002*). Amphibians are well known to be considered environmental indicators of healthy environments and can be used as a long term tool to monitor wetland heath. Native fish species that persist in the wetlands can be used to monitor long term population dynamics by recording changes in presence and abundance over time.

There is limited information in fauna databases of the regional potential because the area is heavily disturbed through agricultural practices. The information available on fauna databases in this region is limited, as most of the land in this region is privately owned and has not been surveyed for fauna.

1.2 Study Areas

Nine wetlands were chosen by GHD and the Department of Water as long term study areas (Figure 1). The wetlands are approximately 55 kilometres south of Perth, from Elliott Road in Keysbrook south and east to Pinjarra and west to Lake Barragup. The wetlands (UFI: 7046, 7029, 5032, 4835, 5033, 5724, 5180, 3945 and 5056) are a mix of private and government managed owned lands, ranging in size and shape.

1.3 Scope of Work

This fauna assessment included both desktop and field assessments. The desktop assessment included:

- A review of the Department of Environment and Conservation (DEC) *NatureMap* Fauna database; and
- A review of the Department of the Environment, Water, Heritage and Arts (DEWHA) database for Fauna listed under the *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*).

The field survey aimed to identify the presence of native fish species and amphibians within the wetlands. The field survey included the following:

- Fish netting surveys at selected points at each wetland;

- Amphibian surveys at each of the wetlands using call identification;
- Measuring densities of amphibians using calls over one season;
- Compiling an inventory of the vertebrate and water invertebrate fauna species in the study area through targeted searches and opportunistic recording of species present; and
- Reviewing fauna species considered to be rare or in need of special protection.

2. Existing Environment

2.1 Climate

The Bureau of Meteorology (BOM) weather station located nearest to the study area is at Mandurah Park. Recorded climatic data is summarised below:

- Mean Daily Maximum Temperature: 29.6°C (Feb) – 17.3°C (July)
- Mean Daily Minimum Temperature: 17.0°C (Feb) – 8.6°C (July and Aug)
- Mean Annual Rainfall: 882.2mm
- Mean Annual Rain Days: 82.3 days

(Source: BoM, 2010)

2.2 Reserves and Conservation Areas

2.3 Environmentally Sensitive Areas

The DEC's online Native Vegetation Viewer was searched to determine the location of any Environmentally Sensitive Areas (ESAs) within the vicinity of the Study Area, as declared by a Notice under Section 51B of the *Environmental Protection Act 1986*.

With the exception of one resource enhancement wetland, all of the wetlands in the study area are conservation category wetlands and therefore covered by an ESA. The resource enhancement wetland UFI 5180 also has an ESA associated with it. A portion of this wetland is an Environmental Protection Policy (EPP) Lake. EPP Lakes are also ESA's.

2.4 Vegetation

2.4.1 Bioregional Context

Western Australia supports 53 biogeographical subregions. The study area is located in the Perth Subregion of the Swan Coastal Plain. The Swan Coastal Plain Bioregion is a low-lying coastal plain, mainly covered with woodlands. It is dominated by Banksia (*Banksia* sp.) or Tuart (*Eucalyptus gomphocephala*) on sandy soils, Swamp Sheoak (*Casuarina obesa*) on outwash plains and Paperbark (*Melaleuca* sp.) in swampy areas.

The Perth Subregion includes a complex series of seasonal wetlands and also includes the many islands found offshore from Perth (McKenzie *et al.*, 2002).

2.4.2 Beard Mapping

According to Beard (1979), the vegetation of the study area is located within the Drummond Botanical Subdistrict of the Swan Coastal Plain Subregion. All of the selected wetlands of the study area occur

within Beard's Vegetation complex 1000 which is described as a swampy plain with a mosaic of *Eucalyptus marginata*, *Corymbia calophylla* woodland, *Banksia attenuata* , *Banksia menziesii* low woodland and a low forest of *Melaleuca rhaphiophylla* or *M. cuticularis*.

2.4.3 Vegetation Complexes

According to mapping by Heddle *et al.* (1980), the vegetation complex of the all but one of the selected wetlands (i.e. UFI 5718) and surrounding areas is considered to be Bassendean Complex Central and South. This vegetation complex is characterised by: Woodland of *E. marginata - C. calophylla* with well defined second storey of *Allocasuarina fraseriana* and *Banksia grandis* on the deeper soils and a closed scrub on the moister sites. The understorey species reflect similarities with adjacent vegetation complexes.

UFI 5718 occurs within the Southern River Complex. This vegetation complex is characterised by: Open woodland of *Corymbia calophylla – Eucalyptus marginata – Banksia* species with fringing woodland of *Eucalyptus rudis – Melaleuca rhaphiophylla* along creek beds.

2.4.4 Threatened Ecological Communities

Ecological communities are defined as 'naturally occurring biological assemblages that occur in a particular type of habitat' (English and Blythe, 1997). TECs are ecological communities that have been assessed and assigned to one of four categories related to the status of the threat to the community, i.e. Presumed Totally Destroyed, Critically Endangered, Endangered, and Vulnerable.

Some TECs are protected under the *EPBC Act* (DEWHA, 2010). Although TECs are not formally protected under the State *Wildlife Conservation Act 1950 (WC Act),* the loss of, or disturbance to, some TECs triggers the *EPBC Act*. The Environmental Protection Authority's (EPA's) position on TECs states that proposals that result in the direct loss of TECs are likely to require formal assessment.

Possible TECs that do not meet survey criteria are added to the DEC's Priority Ecological Community (PEC) Lists under Priorities 1, 2 and 3. These are ecological communities that are adequately known; are rare but not threatened, or meet criteria for Near Threatened. PECs that have been recently removed from the threatened list are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

A search of the DEC's Threatened and Priority Ecological Communities database was conducted for the study area prior to undertaking the field survey. One of the wetlands was identified as having an occurrence of a TEC. UFI 5056 has an occurrence of SCP 9 which is "*dense shrublands on clay flats*". This TEC is listed as vulnerable by the WA State Government.

2.4.5 Vegetation Types

The vegetation types observed within the surveyed wetlands are listed in Table 8 to Table 16, Appendix D. Generally, the wetland vegetation consisted of an upland zone supporting Banksia woodland with Tuart, Jarrah and Marri. This vegetation unit, to a large extent, has been significantly altered by land clearing, grazing and weed encroachment. This is evident in the vegetation community descriptions that

identify weeds as the dominant herb layer in the upland vegetation of most of the wetlands. The wetland vegetation is predominantly *Melaleuca preissiana*, *Melaleuca rhaphiophylla* or *Melaleuca cuticularis* with a shrublayer of *Kunzea glabrescens* and *Astartea scorpia* over *Lepidosperma longitudinale* and mixed herbs. A number of the wetlands had open water bodies with floating and submergent aquatic plants.

2.4.6 Vegetation Condition

The vegetation condition of the study areas were assessed using the vegetation condition rating scale developed by Keighery (1994) that recognises the intactness of vegetation, which is defined by the following:

- Completeness of structural levels;
- Extent of weed invasion;
- Historical disturbance from tracks and other clearing or dumping; and
- The potential for natural or assisted regeneration.

The scale therefore consists of six rating levels as outlined below in Table 1.

Table 1 Vegetation Condition Rating Scale (after Keighery, 1994).

Vegetation Condition Rating	Vegetation Condition	Description
1	*Pristine or Nearly So.*	No obvious signs of disturbance.
2	*Excellent*	Vegetation structure intact, disturbance affecting individual species, and weeds are non-aggressive species.
3	*Very Good*	Vegetation structure altered, obvious signs of disturbance.
4	*Good*	Vegetation structure significantly altered by very obvious signs of multiple disturbances retains basic vegetation structure or ability to regenerate it.
5	*Degraded*	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not in a state approaching good condition without intensive management.
6	*Completely Degraded*	The structure of the vegetation is no longer intact and the area is completely or almost without native species.

The majority of the vegetation within the wetlands varied from *Pristine* (1) to *Completely Degraded* (6). In general the bushland condition of the wetlands improved towards the centre of the wetlands where disturbances were minimised due to access being restricted by either high water levels or thick vegetation. The vegetation around the periphery was more likely to have been impacted by multiple

disturbances such as land clearing, weeds, grazing, uncontrolled access and altered hydrological regimes.

3. Desktop Fauna Searches

3.1 EPBC Protected Matters Searches

The DEWHA maintains a database of matters of national environmental significance that are protected under the *EPBC Act*. An *EPBC Act* Protected Matters Report was generated (administered by the DEWHA, 2010) for matters of national environmental significance that may occur in, or may relate to, the study area. The search identified the potential presence of eight birds, one invertebrate and three mammal species.

A search of the WA Museum and DEC's databases (NatureMap) for any rare and priority species that may occur in the study areas was also undertaken. From the DEC, WA Museum and DEWHA databases, a number of protected fauna species were identified as potentially occurring within the study area. These are shown in Table 6, Appendix C.

It should be noted that some species that appear in the *EPBC Act* Protected Matters Search Tool are often not likely to occur within the specified area, as the search provides an approximate guidance to matters of national significance that require further investigation. The records from the WA Museum provide more accurate information for the general area; however, some records of sightings or trappings can be dated and often misrepresent the current range of threatened species.

3.1.1 Commonwealth Legislation

The conservation of fauna species and their significance status is currently assessed under both State and Commonwealth Acts. The acts include the *WC* Act; *Wildlife Conservation (Specially Protected Fauna) Notice 2003,* and the *EPBC* Act.

The significance levels for fauna used in the *EPBC Act* are those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN). A description of Conservation Categories delineated under the *EPBC Act* is detailed in, Table 3, Appendix B and the circumstances under which a project will trigger referral to the DEWHA are described in Appendix B. The *WC* Act uses a set of Schedules but also classifies species using some of the IUCN categories. These Schedules are described in Table 4, Appendix B.

The *EPBC Act* also protects migratory species that are listed under the following International Agreements:

- Appendices to the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals) for which Australia is a Range State under the Convention;
- The Agreement between the Government of Australia and the Republic of Korea for the protection of migratory shorebirds and their habitat (ROKAMBA);
- The Agreement between the Government of Australia and the Government of the Peoples Republic of China for the Protection of Migratory Birds and their Environment (CAMBA); and
- The Agreement between the Government of Japan and the Government of Australia for the

Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA).

Listed migratory species also include species identified in other international agreements approved by the Commonwealth Environment Minister. The *EPBC* Act also protects marine species on Commonwealth lands and waters.

3.2 *NatureMap* data Search

The *NatureMap* online search (Department of Environment and Conservation, 2009) was conducted for a 10 km buffer of the study area. The search identifies terrestrial vertebrate species recorded in the collections of the Western Australian Museum and records from the DEC (and several other databases). The search identified the potential presence of four bird, six reptile, five invertebrates and four mammal species. A full list of species recorded from the *NatureMap* database is presented in Table 6, Appendix C.

It should be noted that some of the records of the Museum are historical and some of the recorded species may now be locally extinct. Additionally, these records may include species (particularly bird species) that are vagrants or present in the general area but not present within the study area due to lack of suitable habitat.

3.2.1 State Legislation

In Western Australia, the DEC also produces a supplementary list of Priority Fauna, these being species that are not considered Threatened under the *WC Act* but for which the DEC feels there is a cause for concern. These species have no special legislation protection, but their presence would normally be considered. Such taxa need further survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna. Levels of Priority are described in Table 5, Appendix B.

4. Methodology

The field survey was undertaken by GHD Zoologist Glen Gaikhorst and Ecologists between winter and spring 2009 and autumn 2010. The surveys consisted of an amphibian assessment and native fish survey. An opportunistic survey in conjunction with the targeted species investigation was also conducted.

4.1 Amphibians

The nine wetlands selected for the amphibian assessment are all ephemeral and dry out in the warmer months. Amphibians over this period become dormant and either aestivate underground or hide away in thick vegetation and come out to feed. Monitoring for amphibians is best done in the peak of breeding events, this is when environmental conditions suit particular species and males can be observed and recorded calling (all amphibian species have different calls). The timing of this project allowed the commencement of data collection in winter (July), which is the peak breeding period for most amphibians in the region. There are some species of amphibian which are unique and breed outside of the regular reproductive period. Some species commence in autumn and other species begin calling later in spring / early summer.

Field assessment involved visiting the study areas during the day and establishing long term study points (see Figure 2 to Figure 9, Appendix A). Once established, the study points were revisited during the night and data collected. This was achieved by standing at each point for a 10 minute period and recording what amphibian species were calling. Abundance of species is measured by ranking the level of calling per species. The ranking system is listed as follows:

- 0- no calling recorded;
- 1- individuals calling and can be counted;
- 2- calls overlap but individuals can be counted; and
- 3- calls overlap and individuals cannot be counted or distinguished (full chorus).

This measurement of calling species is very simple and can be competently undertaken by researchers who know the distinct calls of different amphibian species.

If amphibians are actively sighted around the wetlands, but not heard calling, then the species and numbers are recorded as present at the site.

4.2 Fish

All study areas were sampled for fish in August 2009. The sampling method used involved two people netting in the water for 30 minutes each (as per similar methodology used to survey for Black-Striped Minnow (*Galaxiella nigrostriata*) (K. Williams pers. Comm. 2009). Selected sample points were chosen at each wetland with a minimum of 1 hour spent using hand fish nets to catch fish. The nets are 50 cm equal sided triangular framed with a gauge mesh of 3 mm. Nets are placed in the water and used in a figure eight motion in front of the body while slowly walking around the Study Area. Different depths are

sampled during this process. Our target species were from the families Galaxidae and Nannopercidae. It was unlikely that large fish species found in the region (such as Freshwater Cobbler (*Tandanus bostocki)*) would be caught during this study due to the ephemeral nature of the wetlands.

4.3 Opportunistic Records

GHD's qualified Zoologist and Ecologists conducted the opportunistic survey in conjunction with the targeted species investigation.

The survey involved visual and aural surveys for any fauna species utilising the study areas. The study areas were also searched for any fauna signs such as tracks, scats, bones, diggings and indications of feeding and foraging.

Surveys also included searching across all habitat types, which is an effective method of surveying for many reptile species. This involved searching through microhabitats where reptiles are known to frequent, including turning over logs or rocks, turning over leaf litter and examining hollow logs. Reptiles were also sighted as they basked during the day.

The fauna survey did not involve any fauna trapping.

4.4 Nomenclature

Nomenclature used in this report follows that used by the DEC's *FloraBase* program and Western Australian Museum *NatureMap* program as they are deemed to contain the most up-to-date species information for Western Australia.

4.5 Limitations

Complete fauna assessments can require multiple surveys, at different times of year, and over a period of a number of years, to enable observation of all species present.

The fauna survey undertaken was a targeted survey and focussed on those groups identified. Tracks, scats, diggings and calls were recorded for opportunistic species. Many cryptic and nocturnal species would not have been identified during the survey. Extensive detailed fauna surveys, involving trapping are required to obtain a more comprehensive list of fauna species that may utilise the site.

5. Results

5.1 Amphibians

Sampling during the winter period commenced in July 2009 with all wetlands visited by early August. Autumn breeding species were surveyed in April 2010. During the survey periods, minimum temperatures were cool. Therefore, peak calling was straight after dusk before the temperature dropped. This enabled only one or two wetlands to be sampled in one evening. To date, eight of the thirteen possible species of amphibians have been recorded over the nine wetlands. The maximum number of species at one wetland was seven and the minimum was two, as seen in Table 2. A complete amphibian species list is found in Table 7, Appendix C.

Table 2 Amphibian Species Recorded at Each Wetland.

Wetlands	Number of Frog Species Recorded	Comments
UFI 7046	5	Species calling included: *Litoria adelaidensis, Crinia glauerti, C. insignifera, Lymnodynastes dorsalis* and *Heleioporus eyrei*.
UFI 7029	4	Species calling included: *Crinia glauerti, C. insignifera* and *Heleioporus eyrei.* One *Litoria moorei* was observed active in autumn.
UFI 5032	4	Species calling included: *Litoria adelaidensis, Crinia glauerti, C insignifera* and *C.georgiana.*
UFI 4835	5	Species calling included: *Litoria adelaidensis, Crinia glauerti, C. insignifera, C. georgiana* and *Heleioporus eyrie.*
UFI 5033	4	Species calling included: *Litoria adelaidensis, Crinia glauerti, C. insignifera* and *C. georgiana.*
UFI 5724	7	Species calling included: *Litoria adelaidensis, Crinia glauerti, C. insignifera, C. georgiana, Lymnodynastes dorsalis and Pseudophyne guentheri. Heleioporus eyrie* was active but not calling. This species was calling in autumn.
UFI 5180	6	Species calling included: *Litoria adelaidensis, Crinia glauerti, C. insignifera, C. georgiana and Pseudophyne guentheri. Heleioporus eyrei* was calling in Autumn.
UFI 3945	2	Species calling included: *Crinia insignifera*. *Heleioporus eyrei* was observed active during winter and calling in autumn.
UFI 5056	4	Species present included: *Litoria adelaidensis, Crinia glauerti, C. insignifera* and *Pseudophyne guentheri.*

Abundance of species is greatest at peak acoustics. This is often at night after a rain event with a slightly

elevated temperature. To get an accurate reflection of the true abundance of a species per site, multiple surveys are required. The abundance data to date should be used as a guide for future works.

Six species were recorded calling in July and August and most had a large calling number. *Crinia insignifera* is an endemic species to Western Australia and primarily lives on the Swan Coastal Plain. This species was the most prolific recorded, occurring in eight of the nine wetlands, with abundance rankings ranging from 1 to 3. *Litoria adelaidensis* was found in seven of the wetlands but had a lower recorded abundance rating of 1 and 2, reaching a rating of 3 at only one site (Plate 1). The remainder of the frog species: *Crinia georgiana, Crinia glauerti* and *Pseudophyne guentheri,* were found at five, five and three sites respectively and had fluctuating scores of 1 to 3. The least common calling was from *Lynodynastes dorsalis* which was only recorded at two sites with an abundance ranking of 1.

Amphibians not recorded calling in July and August were species that have breeding events (and calling) in the autumn season, therefore they were not recorded unless observed active at the wetlands. One of these species was *Heleioporus eyrie*, which was recorded active at two study areas, but not calling.

Autumn surveys were undertaken in April 2010 and recorded *Heleioporus eyrei* as the dominant species, with calling recorded at seven of the nine study areas. Abundance of this species was rated at either 1 or 2 over the study areas. Other species recorded at this time included: *Litoria adelaidensis* and *Crinia insignifera*, both at low ratings of 1. *Litoria moorei* was not heard calling over the study period, however was actively observed at wetland UFI 7029.

Plate 1 Calling Slender Tree Frog (*Litoria adelaidensis).*

5.2 Fish

No fish were captured at any of the wetlands. All wetlands were sampled at least once, with a minimum sampling time of one hour (Plate 2). During fish sampling, many water invertebrates and tadpoles were captured. Plate 3 shows water invertebrates and tadpoles collected. A complete water invertebrate list is found at Table 7, Appendix C.

Plate 2 Fish and Sampling Murray Wetlands.

Plate 3 Invertebrates and Tadpoles Caught in a Fish Sample.

5.3 Opportunistic Fauna observations

Fauna taxa recorded during the opportunistic field surveys included: two reptiles, one native mammal, two non-native mammals, 44 birds and 16 water invertebrates. A complete fauna list is found in Table 7, Appendix C.

5.3.1 Observed Significant Fauna Species

During the field investigation one significant fauna species, Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*) was observed in wetland UFI 5032. Information on this species is provided below.

- **Carnaby's Black-Cockatoo, (*Calyptorhynchus latirostris)***

Carnaby's Black-Cockatoo, listed as Endangered under the *EPBC Act* and S1 under the *WC Act*, is distributed across the south-west of Western Australia in uncleared or remnant areas of *Eucalyptus* Woodland and Shrubland or Kwongan heath. Breeding usually occurs in the Wheatbelt region of Western Australia (WA), with flocks moving to the higher rainfall coastal areas to forage after the breeding season. These Cockatoos feed on the seeds of a variety of native plants, including *Allocasuarina, Banksia, Corymbia, Dryandra, Eucalyptus, Grevillea* and *Hakea,* and some introduced plants. They will also feed on the nectar from flowers of a number of species, and on insect larvae.

Over the last 50 years, most of the feeding habitat of Carnaby's Black-Cockatoo has been destroyed by agricultural clearing. Any suitable habitat that remains is fragmented, and often degraded by soil salinity and weed invasion. Feeding habitat is often so far away from nests that the growth rate and survival of nestlings is significantly reduced. The original food sources for Carnaby's Black-Cockatoo have been largely replaced by urban development and introduced pine plantations. These plantations however are to be removed in the future, increasing the threat to the Carnaby's Black-Cockatoo survival.

5.3.2 Observed Marine Bird Species

Six marine species were observed over the study areas, these being the Black-faced Cuckoo-Shrike, Pallid Cuckoo, Nankeen Kestrel, Australian White Ibis, Straw-necked Ibis and Swamp Harrier. All of these species are considered common in the South West region.

5.3.3 Potential Significant Fauna Species

The desktop survey indicated that a number of protected fauna may occur within the study area. None of these species were observed during the field survey. Information on these species is presented below:

- **Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso)***

Forest Red-tailed Black-Cockatoos are listed as Vulnerable under the *EPBC Act* and Schedule 1 under the *WC* Act. The species is essentially a cockatoo of the Jarrah forest (*Eucalyptus marginata)* but also uses Marri *(Corymbia calophylla)* and woodlands for foraging, with Marri seeds (along with Jarrah) being its principal food source (Johnstone and Kirkby 1999).

The Forest Red-tailed Black Cockatoo's range has reduced in the Swan Coast Plain due to habitat loss and now persists in the Jarrah forest of the South West.

- **Baudin's Cockatoo (*Calyptorhynchus baudinii*)**

Baudin's Cockatoo, also known as the Long-billed Black-Cockatoo, is found in the south-west of WA, in the forest and woodlands of Jarrah (*Eucalyptus marginata)*, Karri *(E. diversicolor)* and Marri *(Corymbia calophylla).* This species has been impacted by the removal of large Marri throughout its range as this tree is its principal food source. Baudin's Cockatoo has been listed as Vulnerable under the *EPBC Act* and Schedule 1 under the *WC Act*.

- **Chuditch (*Dasyurus geoffroii*)**

The Chuditch or Western Quoll formerly ranged over nearly 70 % of Australia but now retains only a patchy distribution through the Jarrah forest and mixed Karri / Marri / Jarrah forest of south-western WA. This reduction in range and decline in population numbers has been caused by habitat alteration, impacts from the introduction of foxes and cats, hunting and poisoning (Orell and Morris 1994). This species tends to now be restricted to the more open Jarrah forests and woodlands to the north of Manjimup (Orell and Morris 1994) and northern Jarrah forest (Orell and Morris 1994). This species is currently listed as Vulnerable under the *EPBC Act* and Schedule 1 under the *WC* Act.

It currently occurs in sclerophyll forests, heath and mallee shrublands of the south-west region of WA, and the southern Wheatbelt. The Chuditch occurs at low densities, even in quality habitats of coastal areas.

- **Southern Brown Bandicoot (*Isoodon obesulus fusciventer*)**

The Quenda, or Southern Brown Bandicoot, is an omnivorous marsupial that occurs in the south-west of Western Australia. This species prefers areas with dense understorey vegetation, particularly around swamps and along watercourses. However, it also occurs in woodlands and may use less ideal habitat where this habitat occurs adjacent to the thicker, more desirable vegetation.

The Quenda is a Priority 5 species, which means that it is not considered threatened but is subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years. Quenda populations on the Swan Coastal Plain are threatened by development in this region, which has resulted in loss of habitat. This species is relatively common in parts of the greater Perth and south-west region.

- **Mainland Quokka (*Setonix brachyurus*)**

The Quokka is a small macropod that inhabits low lying scrub or dense heath and swamps with dense vegetation (Maxwell *et al.* 1996). This species is classified as Vulnerable, Schedule 1 under the *WC Act*. This species is a browser, with peppermint (*Agonis flexuosa)* and *Thomasia* species being dominant in their diet (DEC, 2008). The range of the Quokka once extended across the south-west of WA; however, with the impact of colonization and the introduction of predators such as the fox, this range has been highly reduced.

- **Graceful Sun-moth (*Synemon gratiosa*)**

The Graceful Sun-moth (GSM), once widespread on the Swan Coastal Plain, is now only present in a few conservation areas located north of the Swan River, due to dramatically increased urban development destroying the day flying moth's habitat. The species is a Vulnerable, Schedule 1 listed

species under the *WC Act*, meaning it is rare or likely to become extinct. The Graceful Sun-moth is only active in autumn, unlike the majority of Lepidoptera which are most active during spring and summer months.

Although historically recorded from within the vicinity of the study areas, the GSM is presently only known from limited locations in the northern Perth metropolitan area. Adults of the GSM are not active during spring but evidence of habitat use is assessed using known foodplants (*Lomandra maritima*, and *L. hermaphrodita*) as a surrogate. The larvae of the GSM inhabit sandy soils and feed upon root mats formed by *Lomandra maritima* and *L. hermaphrodita (*Bishop *et al.* 2009*)*. GSM surveys are conducted in accordance with the methodology developed by DEC (Bishop *et al*. 2009).

- **Red-tailed Phascogale *(Phascogale calura)***

The Red-tailed Phascogale's range is currently restricted to the Wheatbelt of WA with the main populations around Wagin, Katanning and other small areas of remnant vegetation in the Wheatbelt namely Dryandra Forest, Tutanning, Boyagin, North Karlgarin, Bendering, Dongolocking, Pingeculling, Eat Yornaning and Yilliminning Nature Reserves (Burbidge 2004). The *EPBC* protected matters search tool includes this species in the Study Area but this is erroneous as there are no records of this species west of the Darling Range on the Swan Coastal Plain.

- **Eastern Curlew (*Numenius madagascariensis*)**

The Eastern Curlew is a large wader species that is listed in Western Australia as a Priority 4 species. It occurs around the entire coast of Australia (including Tasmania) in tidal mudflats, sand spits of estuaries, mangroves, lake shores and ocean beaches (Morcombe 2004). Feeding occurs by probing its long beak into the mud or sand to catch invertebrates. Its restricted habitat puts the species at conflict with human activities and is a species that requires population monitoring.

5.3.4 Potential Marine / Migratory Bird Species

A number of the species included in the list of significant fauna species that could potentially occur in the study areas are migratory terrestrial, marine and wetland species. There is the potential for migratory / marine bird species, such as the White-bellied Sea Eagle, White headed Petrel, Fork-tailed Swift, Great Egret, Cattle Egret and Rainbow Bee-eater to occur occasionally within the study area.

5.3.5 Introduced Fauna Species

Four introduced fauna species were observed within the study areas: two mammals (fox and European rabbit), one water invertebrate (Pond Snail) and one bird (Laughing Kookaburra).

6. Conclusion

Amphibians are well known to be indicators of a healthy environment and ecosystem. The wetlands in this study range from native vegetation with relatively pristine areas to heavily disturbed agricultural lands; however, all study areas contain sufficient habitat to maintain several species of amphibians. During the winter, spring and autumn surveys, nine species were identified out of a possible 13. With additional surveys over multiple years, this number may increase. This information however, is restricted to a one year sampling period, so no population analysis or assessment can be made without data from several sampling periods. However the presence / absence data could be useful in future assessments.

Native fish were not recorded at any of the wetlands during this assessment. Most of the wetlands in the area are ephemeral and are seasonally inundated. This may be the reason for the absence of fish species. However, some Gallaxid species are known to be able to aestivate in the mud once water systems dry up. In these wetlands, the timeframe between drying and refill may be too prolonged and, therefore, not suitable for native fish species.

It was noted however that the property neighbouring UFI 7096 (on the eastern side) had modified wetlands with permanent water. Fish species that were recorded in this modified wetland included: Gallaxids, Pygmy Perch (*Edelia vittata*), Carp (*Cyprinus carpo*) and Mosquitofish (*Gambusia holbrooki*) with the later two being introduced.

7. Report Limitations

This report presents the baseline data on the diversity of amphibians and native fish of the Murray water drainage basin as well as an inventory of general fauna of the area. It has been prepared for the purpose of this commission. The data provided herein relate only to the project and structures described herein and must be reviewed by a competent scientist/Ecologist before being used for any other purpose. GHD accepts no responsibility for other use of the data.

Where previous reports, fauna surveys and similar work have been performed and recorded by others the data is included and used in the form provided by others. The responsibility for the accuracy of such data remains with the issuing authority, not with GHD.

An understanding of site conditions depends on the integration of many pieces of information, some regional, some site specific, some structure specific and some experience based. Hence, this report should not be altered, amended or abbreviated, issued in part or incomplete in any way without prior checking and approval by GHD. GHD accepts no responsibility for any circumstances that arise from the issue of the report that has been modified in any way as outlined above.

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8. References

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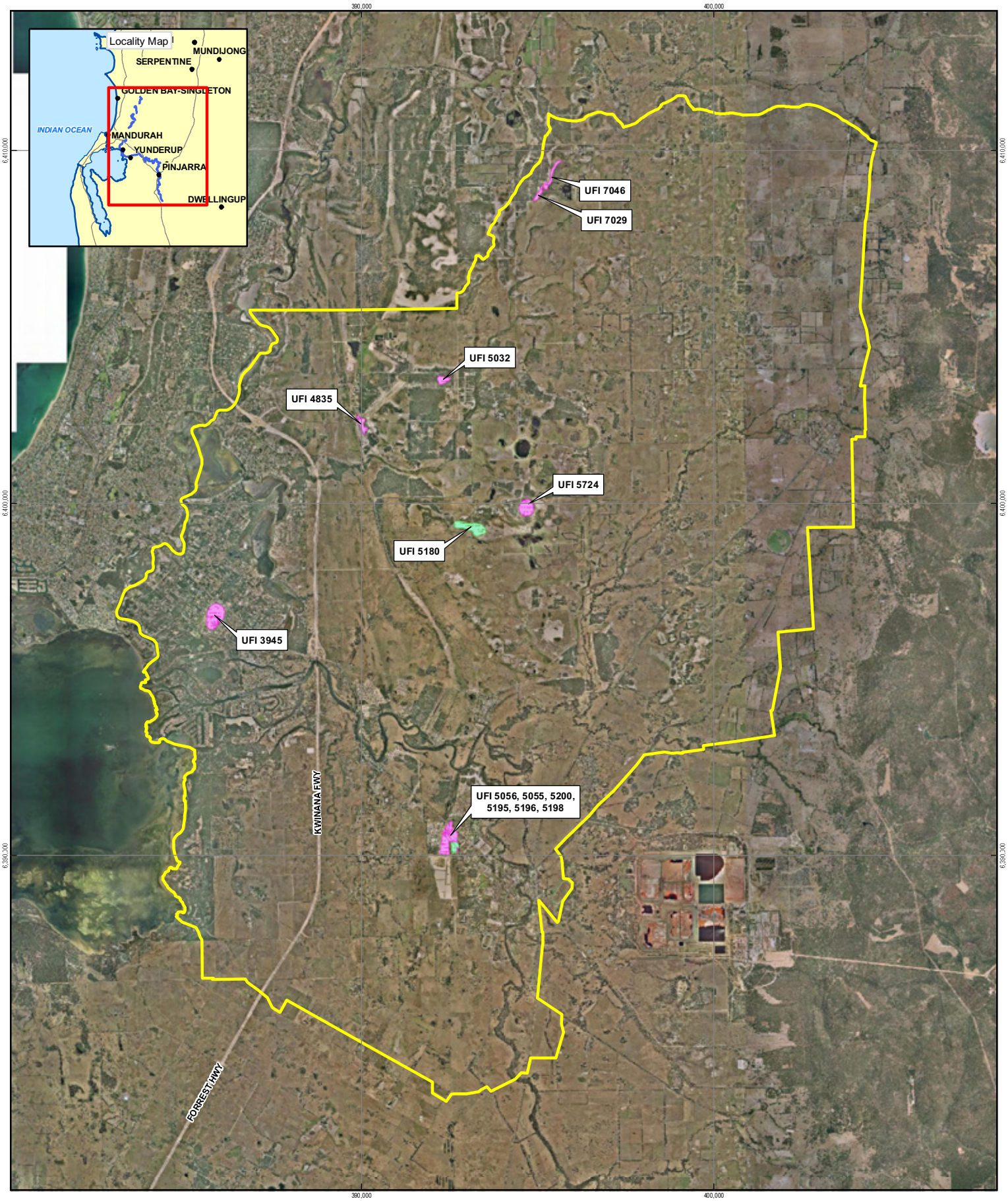
Appendix A

Figures



LEGEND

Study Area

Geomorphic Wetlands
- Conservation
- Resource Enhancement
- Multiple Use
- Not Assessed
- Not Applicable

1:100,000 (at A3)

0 0.5 1 2 3 4 5

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

N

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Water Management Study

Aerial Overview of Wetland Locations

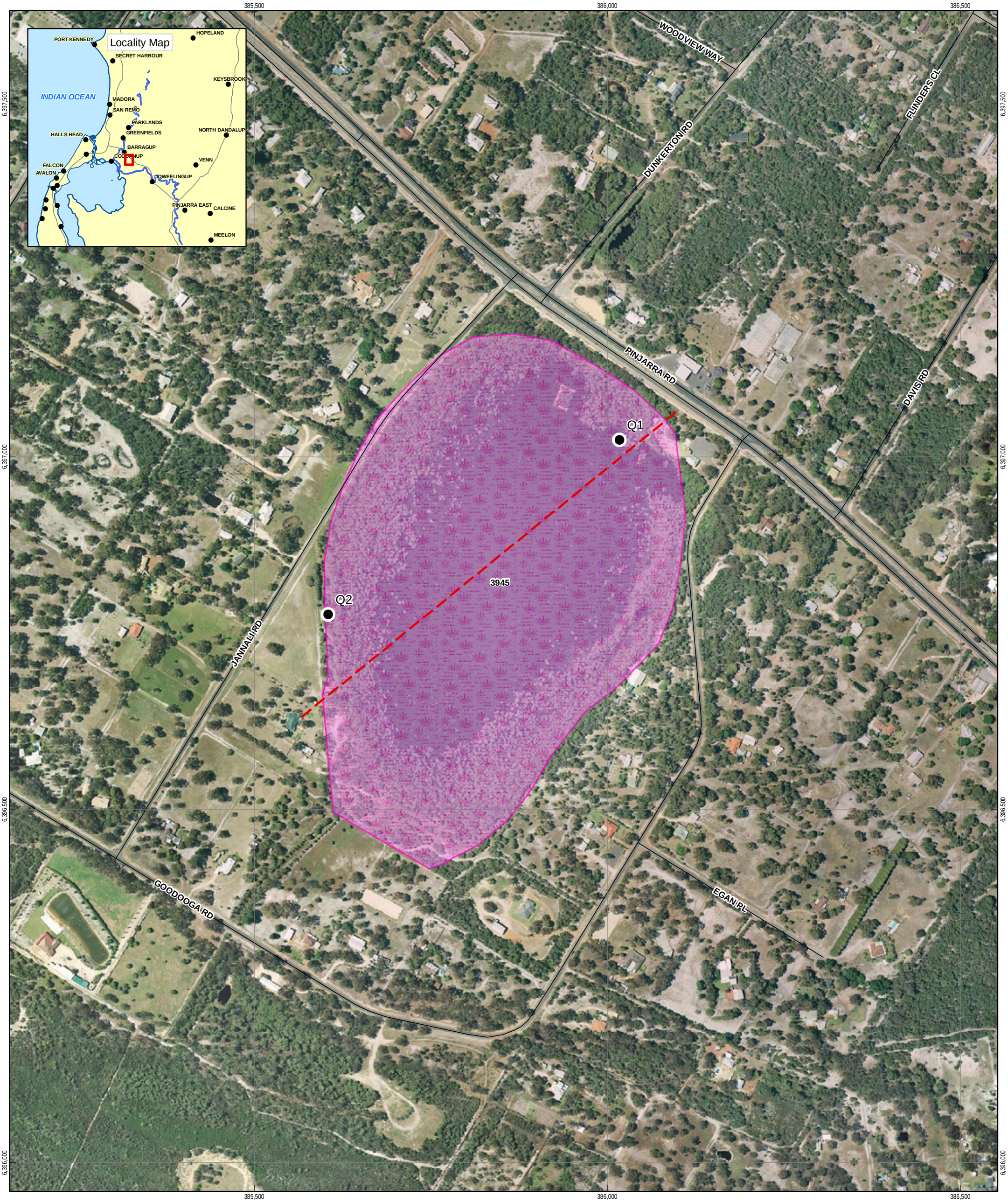
Job Number	61-2393704
Revision	A
Date	22 JUN 2010

Figure 1

G:\61\2393706\GIS\mxds\612393704-G003 Figure 1.mxd

GHD House, 239 Adelaide Terrace Perth WA 6004 **T** 61 8 6222 8222 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

Data Source: DOW: Study Area - 20081202; Landgate (SLIP): Metro South 2009 Mosaic - SLIP 20090627; DEC: Geomorphic Wetlands, Swan Coastal Plain - 20070319. Created by: Nik Fadhil, xntan, kdiralu, jhchen



LEGEND

- Roads
- Approximate Transect Line

Geomorphic Wetlands

- Conservation
- Resource Enhancement
- Multiple Use
- Not Assessed
- Not Applicable

Coordinates of Sample location (MGA Z50):
Q1 - Easting: 386017, Northing: 6397024
Q2 - Easting: 385604, Northing: 6396777

1:5,000 (at A3)

0 25 50 100 150 200 250

Meters

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

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Job Number 61-2393703
Revision O
Date 30 AUG 2010

Fish and Frog Assessment
Map Sheet 1 - UFI 3945

Figure 2

G:\61\2393706\GIS\mxds\612393703-G001_revB_QAd.mxd
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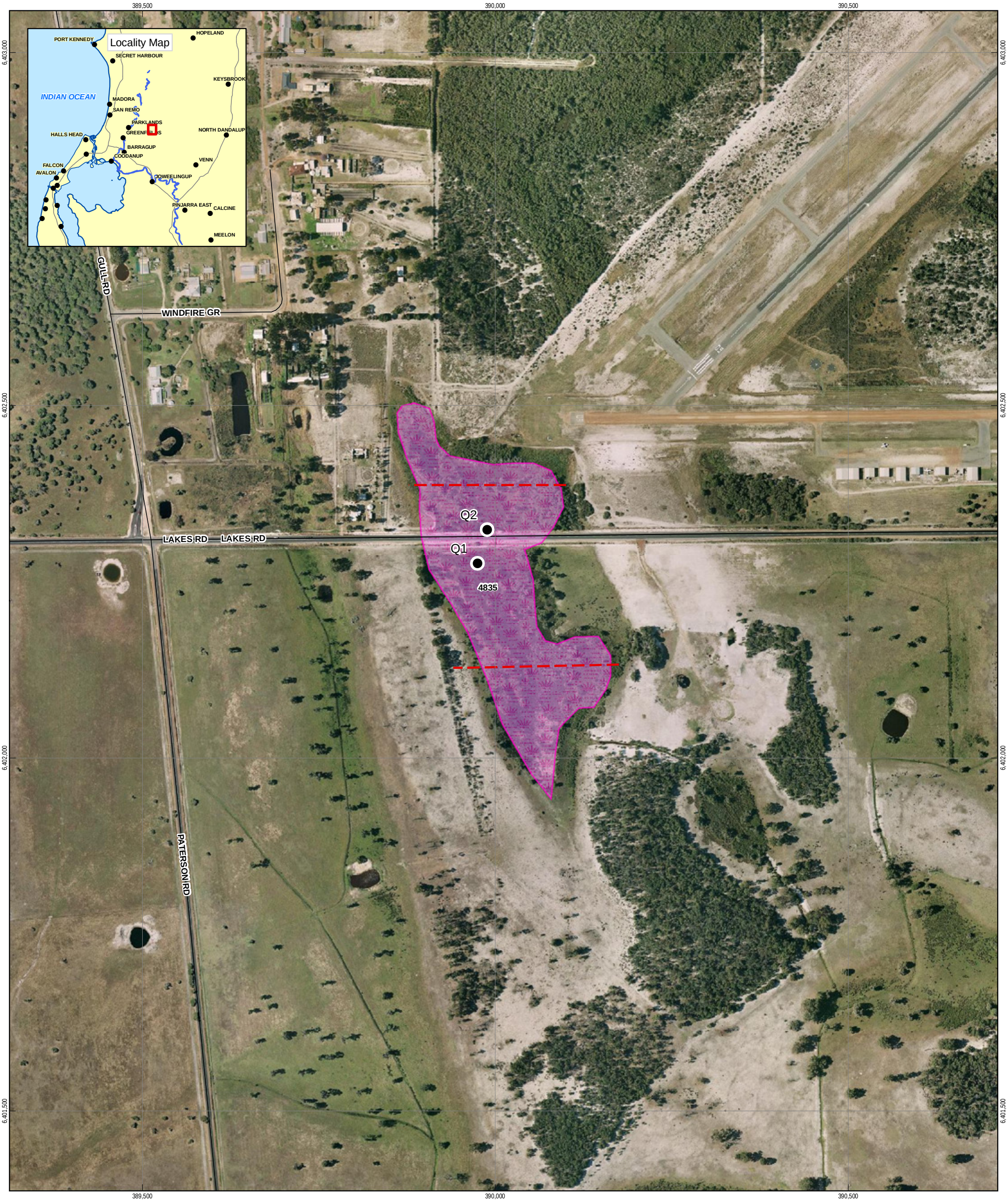
Data Source: DEC: Geomorphic Wetlands, Swan Coastal Plain - 20070319; GHD: Approximate Transect Lines - 20090624; Landgate (SLIP): Metro South 2009 Mosaic - SLIP 20090627, Roads - SLIP 20090625; GHD: Frog and Fish Assessment points - 20090817. Created by: Nik Fadhil, xntan, croach2, mludovico, mdalton2, jhchen



LEGEND

- Approximate Transect Line
- Roads

Geomorphic Wetlands

- Conservation
- Resource Enhancement
- Multiple Use
- Not Assessed
- Not Applicable

Coordinates of Sample location (MGA Z50):
Q1 - Easting: 389975, Northing: 6402276
Q2 - Easting: 389988, Northing: 6402324

1:5,000 (at A3)

0 25 50 100 150 200 250

Meters

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

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Job Number 61-2393703
Revision O
Date 30 AUG 2010

Fish and Frog Assessment
Map Sheet 2 - UFI 4835

Figure 3

G:\61\2393706\GIS\mxds\612393703-G002_revB_QAd.mxd

GHD House, 239 Adelaide Terrace Perth WA 6004 **T** 61 8 6222 8222 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

Data Source: DEC: Geomorphic Wetlands, Swan Coastal Plain - 20070319; GHD: Approximate Transect Lines - 20090624; Landgate (SLIP): Metro South 2009 Mosaic - SLIP 20090627, Roads - SLIP 20090625; GHD: Frog and Fish Assessment points - 20090817. Created by: Nik Fadhil, xntan, croach2, mludovico, mdalton2, jhchen

392,000 392,500 393,000

6,404,000 6,404,000

READHEADS RD

5032

1

GREYHOUND RTT

BUSH RTT

6,403,500 6,403,500

6,403,000 6,403,000

392,000 392,500 393,000

LEGEND

Roads

Approximate Transect Line

Geomorphic Wetlands

Conservation

Resource Enhancement

Multiple Use

Not Assessed

Not Applicable

Coordinates of Sample location (MGA Z50):
1 - Easting: 392375, Northing: 6403415

1:5,000 (at A3)

0 25 50 100 150 200 250

Meters

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

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Job Number 61-2393703
Revision O
Date 30 AUG 2010

Fish and Frog Assessment
Map Sheet 3 - UFI 5032

Figure 4

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GHD House, 239 Adelaide Terrace Perth WA 6004 **T** 61 8 6222 8222 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

Data Source: DEC: Geomorphic Wetlands, Swan Coastal Plain - 20070319; GHD: Approximate Transect Lines - 20090624; Landgate (SLIP): Metro South 2009 Mosaic - SLIP 20090627, Roads - SLIP 20090625; GHD: Frog and Fish Assessment points - 20090817. Created by: Nik Fadhil, xntan, croach2, mludovico, mdalton2, jhchen

391,500 392,000 392,500

6,403,000 6,402,500 6,402,000

5033

Q1

Q2

GREYHOUND RTT

LEGEND

- Approximate Transect Line
- Roads

Geomorphic Wetlands

- Conservation
- Resource Enhancement
- Multiple Use
- Not Assessed
- Not Applicable

Coordinates of Sample location (MGA Z50):
Q1 - Easting: 392001, Northing: 6402348
Q2 - Easting: 391976, Northing: 6402319

1:5,000 (at A3)

0 25 50 100 150 200 250

Meters

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

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Murray Drainage and Water Management Study

Job Number 61-2393703
Revision O
Date 30 AUG 2010

Fish and Frog Assessment
Map Sheet 4 - UFI 5033

Figure 5

G:\61\2393706\GIS\mxds\612393703-G004_revB_QAd.mxd
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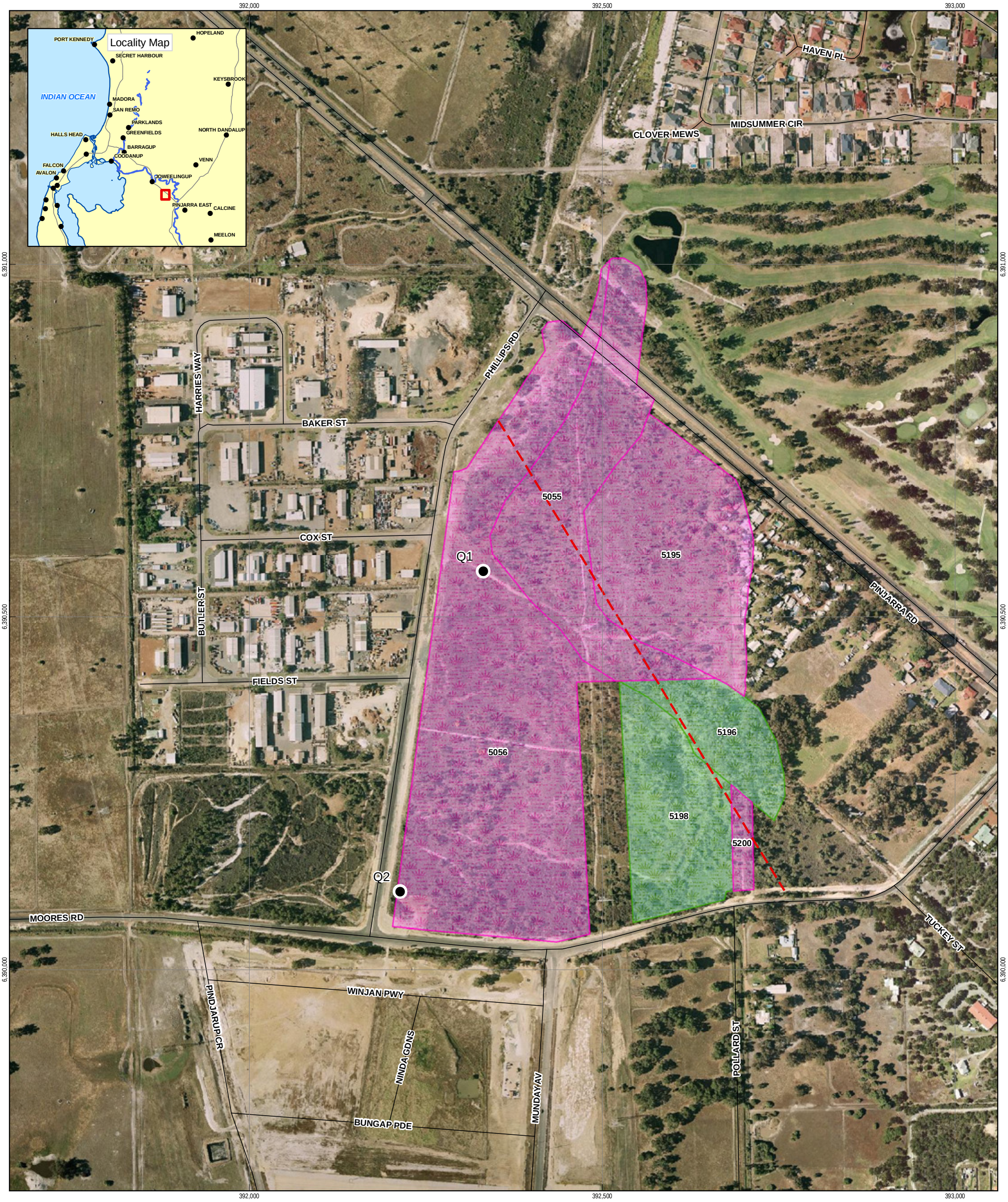
Data Source: DEC: Geomorphic Wetlands, Swan Coastal Plain - 20070319; GHD: Approximate Transect Lines - 20090624; Landgate (SLIP): Metro South 2009 Mosaic - SLIP 20090627, Roads - SLIP 20090625; GHD: Frog and Fish Assessment points - 20090817. Created by: Nik Fadhil, xntan, croach2, mludovico, mdalton2, jhchen



LEGEND

- Approximate Transect Line
- Roads

Geomorphic Wetlands

- Conservation
- Resource Enhancement
- Multiple Use
- Not Assessed
- Not Applicable

Coordinates of Sample location (MGA Z50):
Q1 - Easting: 392332, Northing: 6390565
Q2 - Easting: 392213, Northing: 6390111

1:5,000 (at A3)

0 25 50 100 150 200 250

Meters

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

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Job Number 61-2393703
Revision O
Date 30 AUG 2010

Fish and Frog Assessment

Map Sheet 5 - UFI 5055, 5056, 5200, 5195, 5196, 5198

Figure 6

G:\61\2393706\GIS\mxds\612393703-G005_revB_QAd.mxd
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Data Source: DEC: Geomorphic Wetlands, Swan Coastal Plain - 20070319; GHD: Approximate Transect Lines - 20090624; Landgate (SLIP): Metro South 2009 Mosaic - SLIP 20090627, Roads - SLIP 20090625; GHD: Frog and Fish Assessment points - 20090817. Created by: Nik Fadhil, xntan, croach2, mludovico, mdalton2, jhchen

392,500 393,000 393,500

6,400,000 6,399,500 6,399,000 6,398,500

BENDEN RD

BENDEN RD

Q2

Q1

5180

LEGEND

- Approximate Transect Line
- Roads

Geomorphic Wetlands

- Conservation
- Resource Enhancement
- Multiple Use
- Not Assessed
- Not Applicable

Coordinates of Sample location (MGA Z50):
Q1 - Easting: 393440, Northing: 6399316
Q2 - Easting: 393145, Northing: 6399390

1:5,000 (at A3)

0 25 50 100 150 200 250

Meters

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

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Revision O
Date 30 AUG 2010

Fish and Frog Assessment
Map Sheet 6 - UFI 5180

Figure 7

G:\61\2393706\GIS\mxds\612393703-G006_revB_QAd.mxd

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Data Source: DEC: Geomorphic Wetlands, Swan Coastal Plain - 20070319; GHD: Approximate Transect Lines - 20090624; Landgate (SLIP): Metro South 2009 Mosaic - SLIP 20090627, Roads - SLIP 20090625; GHD: Frog and Fish Assessment points - 20090817. Created by: Nik Fadhil, xntan, croach2, mludovico, mdalton2, jhchen

394,000 394,500 395,000

6,400,500 6,400,000 6,399,500

BENDEN RD

Q1

5724

Q2

394,000 394,500 395,000

LEGEND

- Approximate Transect Line
- Roads

Geomorphic Wetlands

- Conservation
- Resource Enhancement
- Multiple Use
- Not Assessed
- Not Applicable

Coordinates of Sample location (MGA Z50):
Q1 - Easting: 394508, Northing: 6400002
Q2 - Easting: 394873, Northing: 6399824

1:5,000 (at A3)

0 25 50 100 150 200 250

Meters

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

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Revision O
Date 30 AUG 2010

Fish and Frog Assessment
Map Sheet 7 - UFI 5724

Figure 8

G:\61\2393706\GIS\mxds\612393703-G007_revB_QAd.mxd

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Data Source: DEC: Geomorphic Wetlands, Swan Coastal Plain - 20070319; GHD: Approximate Transect Lines - 20090624; Landgate (SLIP): Metro South 2009 Mosaic - SLIP 20090627, Roads - SLIP 20090625; GHD: Frog and Fish Assessment points - 20090817. Created by: Nik Fadhil, xntan, croach2, mludovico, mdalton2, jhchen

395,000 395,500 396,000

6,410,000 6,409,500 6,409,000 6,408,500

Q3

7046

Q2

Q1

Q1

7029

LEGEND

- Approximate Transect Line
- Roads

Geomorphic Wetlands

- Conservation
- Resource Enhancement
- Multiple Use
- Not Assessed
- Not Applicable

Coordinates of Sample location (MGA Z50):
UFI 7029 Q1 - Easting: 395113, Northing: 6408830

UFI 7046 Q1 - Easting: 395189, Northing: 6408981
Q2 - Easting: 395348, Northing: 6409168
Q3 - Easting: 395468, Northing: 6409624

1:5,000 (at A3)

0 25 50 100 150 200 250

Meters

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

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Murray Drainage and Water Management Study

Job Number 61-2393703
Revision O
Date 30 AUG 2010

Fish and Frog Assessment
Map Sheet 8 - UFI 7029, 7046

Figure 9

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Data Source: DEC: Geomorphic Wetlands, Swan Coastal Plain - 20070319; GHD: Approximate Transect Lines - 20090624; Landgate (SLIP): Metro South 2009 Mosaic - SLIP 20090627, Roads - SLIP 20090625; GHD: Frog and Fish Assessment points - 20090817. Created by: Nik Fadhil, xntan, croach2, mludovico, mdalton2, jhchen

Appendix B

Fauna Legislation

EPBC Act Fauna Conservation Categories

Table 3 Conservation Categories and Definitions for *EPBC Act* Listed Flora and Fauna Species

Table 4 *Western Australian Wildlife Conservation Act 1950* Conservation Codes

Table 5 DEC Priority Fauna Codes

EPBC Act Fauna Conservation Categories

Listed threatened species and ecological communities

An action will require approval from the Environment Minister if the action has, will have, or is likely to have a significant impact on a species listed in any of the following categories:

- Extinct in the wild,
- Critically Endangered,
- Endangered, or
- Vulnerable.

Critically endangered and endangered species

An action has, will have, or is likely to have a significant impact on a critically endangered or endangered species if it does, will, or is likely to:

- lead to a long-term decrease in the size of a population, or
- reduce the area of occupancy of the species, or
- fragment an existing population into two or more populations, or
- adversely affect habitat critical to the survival of a species, or
- disrupt the breeding cycle of a population, or
- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or
- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat*, or
- interfere with the recovery of the species.

**Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a critically endangered or endangered species by direct competition, modification of habitat, or predation.*

Vulnerable species

An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to:

- lead to a long-term decrease in the size of an important population of a species, or
- reduce the area of occupancy of an important population, or
- fragment an existing important population into two or more populations, or
- adversely affect habitat critical to the survival of a species, or

- disrupt the breeding cycle of an important population, or
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or
- result in invasive species that are harmful a vulnerable species becoming established in the vulnerable species' habitat*, or
- interferes substantially with the recovery of the species.

An important population is one that is necessary for a species' long-term survival and recovery. This may include populations that are:

- key source populations either for breeding or dispersal,
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

*Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a vulnerable species by direct competition, modification of habitat, or predation.

Listed migratory species

An action will require approval from the Environment Minister if the action has, will have, or is likely to have a significant impact on a listed migratory species. Note that some migratory species are also listed as threatened species. The criteria below are relevant to migratory species that are not threatened.

An action has, will have, or is likely to have a significant impact on a migratory species if it does, will, or is likely to:

- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species, or
- result in invasive species that is harmful to the migratory species becoming established* in an area of important habitat of the migratory species, or
- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.

An area of important habitat is:

1. habitat utilized by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, or
2. habitat utilized by a migratory species which is at the limit of the species range, or
3. habitat within an area where the species is declining.

Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an ecologically significant proportion of the population varies with the species (each circumstance will need to be evaluated).

*Introducing an invasive species into the habitat may result in that species becoming established. An

invasive species may harm a migratory species by direct competition, modification of habitat, or predation.

The Commonwealth marine environment

An action will require approval from the Environment Minister if:

- the action is taken in a Commonwealth marine area and the action has, will have, or is likely to have a significant effect on the environment, or
- the action is taken outside a Commonwealth marine area and the action has, will have, or is likely to have a significant effect on the environment in a Commonwealth marine area.

An action has, will have or is likely to have a significant impact on the environment in a Commonwealth marine area if it does, will, or is likely to:

- result in a known or potential pest species becoming established in the Commonwealth marine area*, or
- modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results, or
- have a substantial adverse effect on a population of a marine species or cetacean including its life cycle (eg breeding, feeding, migration behaviour, and life expectancy) and spatial distribution, or
- result in a substantial change in air quality** or water quality (including temperature) which may adversely impact on biodiversity, ecological integrity, social amenity or human health, or
- result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, social amenity or human health may be adversely affected.

*Translocating or introducing a pest species may result in that species becoming established.

**The Commonwealth marine area includes any airspace over Commonwealth waters.

Table 3 Conservation Categories and Definitions for *EPBC Act* Listed Flora and Fauna Species

Conservation Category	Definition
Extinct	Taxa not definitely located in the wild during the past 50 years
Extinct in the Wild	Taxa known to survive only in captivity
Critically Endangered	Taxa facing an extremely high risk of extinction in the wild in the immediate future
Endangered	Taxa facing a very high risk of extinction in the wild in the near future
Vulnerable	Taxa facing a high risk of extinction in the wild in the medium-term
Near Threatened	Taxa that risk becoming Vulnerable in the wild
Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classified as Vulnerable or more severely threatened.
Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
Least Concern	Taxa that are not considered Threatened

Table 4 *Western Australian Wildlife Conservation Act 1950* Conservation Codes

Conservation Code	Description
Schedule 1	"…fauna that is rare or likely to become extinct, are declared to be fauna that is in need of special protection."
Schedule 2	"…fauna that is presumed to be extinct, are declared to be fauna that is in need of special protection."
Schedule 3	"…birds that are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction, are declared to be fauna that is in need of special protection."
Schedule 4	"…fauna that is in need of special protection, otherwise than for the reasons mentioned [in Schedule 1 – 3]"

Table 5 DEC Priority Fauna Codes

(Species not listed under the *Wildlife Conservation Act 1950*, but for which there is some concern).

Conservation Code	Description
Priority 1	Taxa with few, poorly known populations on threatened lands.
Priority 2	Taxa with few, poorly known populations on conservation lands. Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown Land, water reserves, etc.
Priority 3	Taxa which are known from few specimens or sight records, some of which are on lands not under immediate threat of habitat destruction or degradation.
Priority 4	Rare taxa. Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5 – 10 years.
Priority 5	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Appendix C

Fauna Recorded

Table 6 Listing of Potentially Occurring Significant, Rare and Priority Fauna Species within 10 km of the Study Area, with Information Source

Family	Genus	Species	Common Name	Nature Maps	EPBC Special Matters Search	Conservation Listing
Birds						
Accipitridae	*Haliaeetus*	*leucogaster*	White-bellied Sea-eagle		X	Ma, Mi
Apodidae	*Apus*	*pacificus*	Fork-tailed Swift		X	Ma, Mi
Ardeidae	*Ardea*	*alba*	Great Egret		X	Ma, Mi
Ardeidae	*Ardea*	*ibis*	Cattle Egret		X	Ma, Mi
Meropidae	*Merops*	*ornatus*	Rainbow Bee-eater		X	Ma, Mi
Procellariidae	*Pterodroma*	*lessonii*	White-headed Petrel	X		Ma
Cacatuidae	*Calyptorhynchus*	*banksii naso*	Forrest Red-tail Black Cockatoo	X	X	Vu, S1
Cacatuidae	*Calyptorhynchus*	*baudinii*	Baudin's Black Cockatoo		X	Vu, S1
Cacatuidae	*Calyptorhynchus*	*latirostris*	Carnaby's Black Cockatoo		X	En, S1
Scolopacidae	*Numenius*	*madagascariensis*	Eastern Curlew	X		P4
Strigidae	*Ninox*	*novaeseelandiae ocellata*	Boobook Owl	X		
Reptiles						
Gekkonidae	*Christinus*	*marmoratus*	Marbled Gecko	X		
Scincidae	*Ctenotus*	*australis*	West Limestone Ctenotus	X		
Scincidae	*Egernia*	*napoleonis*	Napoleon Skink	X		
Scincidae	*Hemiergis*	*quadrilineata*	Two-toed Earless Skink	X		
Scincidae	*Menetia*	*greyii*	Common Dwarf Skink	X		
Scincidae	*Morethia*	*lineoocellata*	Western Pale-flecked Morethia	X		

Family	Genus	Species	Common Name	Nature Maps	EPBC Special Matters Search	Conservation Listing
Mammals						
Dasyuridae	*Dasyurus*	*geoffroii*	Chuditch	X		Vu, S1
Dasyuridae	*Phascogale*	*calura*	Red-tailed Phascogale		X	En, S1
Macropodidae	*Setonix*	*brachyurus*	Quokka		X	Vu, S1
Peramelidae	*Isoodon*	*obesulus fusciventer*	Southern Brown Bandicoot	X		P5
Pseudocheiridae	*Trichosaurus*	*vulpecula vulpecula*	Common Brushtail Possum	X		
Vespertilionidae	*Vespadelus*	*regulus*	Southern Forest Bat	X		
Invertebrates						
Aeshnidae	*Austroaeshna*	*anacantha*	dragonfly	X		
Caenidae	*Tasmanocoenis*	*tillyardi*	Tillyard's Mayfly	X		
Castniidae	*Synemon*	*gratiosa*	Graceful Sunmoth	X	X	En, S1
Curculionidae	*Catasarcus*	*griseus*	Weavel	X		
Gomphidae	*Armagomphus*	*armiger*	Western Dragonfly	X		
Gomphidae	*Austrogomphus*	*collaris*	Western Inland Hunter	X		
Ma- Marine	**Mi- Migratory**					
Vu- Vulnerable	**En- Endangered**					
S1- Schedule 1	**P- Priority fauna**					

Table 7 Fauna Observed at Each Study Area.

Family	Genus	Species	Common Name	UFI 7046	UFI 7029	UFI 5032	UFI 5033	UFI 4835	UFI 5724	UFI 5180	UFI 3945	UFI 5056	Fauna Listing
Birds													
Acanthizinae	*Acanthiza*	*chrysorrhoa*	Yellow Rumped Thornbill						X				
Acanthizinae	*Gerygone*	*fusca*	Western Gerygone						X				
Accipitridae	*Circus*	*approximans*	Swamp Harrier						X		X		Ma
Accipitridae	*Aquila*	*audax*	Wedge-tailed Eagle		X								
Alcedinidae	*Dacelo*	*novaeguineae*	Laughing Kookaburra			X							*
Anatidae	*Anus*	*superciliosa*	Pacific Black Duck	X	X	X	X	X	X	X	X		
Anatidae	*Chenonetta*	*jubata*	Australian Wood Duck	X		X				X		X	
Ardeidae	*Egretta*	*novaehollandiae*	White-faced Heron	X	X				X				
Artamidae	*Cracticus*	*torquatus*	Grey Butcherbird					X		X			
Artamidae	*Strepera*	*versicolor plumbea*	Grey Currawong		X								
Anatidae	*Cygnus*	*atratus*	Black Swan	X							X		
Campephagidae	*Coracina*	*novaehollandiae*	Black-faced Cuckoo-shrike						X	X			Ma
Columbidae	*Phaps*	*chalcoptera*	Common Bronze-wing						X				
Corvidae	*Corvus*	*coronoides perplexus*	Australian Raven	X	X	X	X	X	X	X		X	

Family	Genus	Species	Common Name	UFI 7046	UFI 7029	UFI 5032	UFI 5033	UFI 4835	UFI 5724	UFI 5180	UFI 3945	UFI 5056	Fauna Listing
Cracticidae	*Cracticus*	*tiibicen dorsalis*	Australian Magpie	X	X	X	X	X	X	X	X	X	
Cuculidae	*Cuculus*	*pallidus*	Pallid Cuckoo			X						X	Ma
Dricruridae	*Rhipidura*	*fuliginosa*	Grey Fantail				X		X	X			
Dricruridae	*Rhipidura*	*leucophrys*	Willie Wagtail		X	X	X			X	X		
Falconidae	*Falco*	*cenchroides*	Nankeen Kestrel									X	Ma
Hirundinidae	*Hirundo*	*neoxena*	Welcome Swallow								X		
Malurinae	*Malurus*	*splendens*	Splendid Fairy-wren	X	X	X	X		X	X	X		
Meliphagidae	*Anthochaera*	*carunculata*	Red Wattlebird	X	X	X			X	X			
Meliphagidae	*Lichenostomus*	*virescens*	Singing Honeyeater						X				
Meliphagidae	*Lichmera*	*indistincta*	Brown Honeyeater						X				
Meliphagidae	*Phylidonyris*	*novaehollandiae*	New Holland Honeyeater	X	X				X				
Pardalotinae	*Pardalotus*	*striatus substriatus*	Striated Pardalote			X							
Phalacrocoracidae	*Phalacrocorax*	*melanoleucos*	Little Pied Cormorant	X			X				X		
Podicipedidae	*Tachybaptus*	*novaehollandiae*	Australasian Grebe					X					
Cacatuidae	*Cacatua*	*roseicapilla*	Pink and Grey Galah	X	X	X		X	X	X	X		
Cacatuidae	*Calyptorhynchus*	*latirostris*	Carnaby's Black Cockatoo			X							En, S1

Family	Genus	Species	Common Name	UFI 7046	UFI 7029	UFI 5032	UFI 5033	UFI 4835	UFI 5724	UFI 5180	UFI 3945	UFI 5056	Fauna Listing
Podargadae	*Podargus*	*strigoides brachypterus*	Tawny Frogmouth	X									
Psittacidae	*Neophema*	*elegans carteri*	Elegant Parrot		X					X			
Psittacidae	*Platycercus*	*zonarius semitorquatus*	Twenty-eight Parrot		X	X	X	X	X	X	X	X	
Psittacidae	*Polytelis*	*anthopeplus anthopeplus*	Regent Parrot								X		
Psittacidae	*Purpureicephalus*	*spurius*	Red Capped Parrot	X	X						X		
Rallidae	*Fulica*	*atra*	Eurasian Coot	X			X				X		
Sylviidae	*Acrocephalus*	*australis*	Australian Reed-warbler					X					
Threskiornithidae	*Threskiornis*	*molucca*	Australian White Ibis	X				X	X		X		Ma
Threskiornithidae	*Threskiornis*	*spinicollis*	Straw-necked Ibis						X				Ma
Zosteropidae	*Zosterops*	*lateralis gouldi*	Silvereye	X	X	X			X		X		
Reptiles													
Scincidae	*Acritoscincus*	*trilineatus*	Western Tree-lined Skink	X									
Scincidae	*Hemiergis*	*quadrilineata*	Two-toed Earless Skink	X								X	
Amphibians													
Hylidae	*Litoria*	*adelaidensis*	Slender Tree Frog	X		X	X	X	X	X		X	
Hylidae	*Litoria*	*moorei*	Motorbike Frog		X								

Family	Genus	Species	Common Name	UFI 7046	UFI 7029	UFI 5032	UFI 5033	UFI 4835	UFI 5724	UFI 5180	UFI 3945	UFI 5056	Fauna Listing
Lymnodynastidae	*Heleioporus*	*eyrei*	Moaning Frog		X				X		X		
Lymnodynastidae	*Lymnodynastes*	*dorsalis*	Western Banjo Frog	X					X				
Myobatrachidae	*Crinia*	*georgiana*	Quacking Froglet			X	X	X	X	X			
Myobatrachidae	*Crinia*	*glauerti*	Rattling Froglet	X	X	X	X	X	X	X		X	
Myobatrachidae	*Crinia*	*insignifera*	Squelching Froglet	X	X	X	X	X	X	X	X	X	
Myobatrachidae	*Pseudophyne*	*guentheri*	Crawling Toadlet						X	X		X	
Mammals													
Canidae	*Vulpes*	*vulpes*	Fox	X									*
Leporidae	*Oryctolagus*	*cuniculus*	European Rabbit	X									*
Macropodidae	*Macropus*	*fuliginosus*	Western Grey Kangaroo	X	X	X	X		X	X			
Invertebrates													
Aeshnidae	*Austroaeshna*	*anacantha*	dragonfly	X	X							X	
Amphisopodidae	*Paramphisopus*	*palustris*	Aquatic Isopod	X	X			X	X	X			
Corixidae	*Cymatia*	spp	Water Boatman		X	X	X					X	
Culicidae	*Diptera*	spp.	Mosquito		X		X		X				
Daphniidae	*Daphnia*	spp.	water flea					X			X		
Dytiscidae	*Homoeodytes*	spp.	Water Beetle	X	X			X	X	X			
Dytiscidae	*Hyphydrus*	*elegans*	Diving Beetle	X	X			X	X	X			
Eylaidae	*Eylais*	spp.	Water Mite	X	X			X	X				

Family	Genus	Species	Common Name	UFI 7046	UFI 7029	UFI 5032	UFI 5033	UFI 4835	UFI 5724	UFI 5180	UFI 3945	UFI 5056	Fauna Listing
Hydrophilidae	*Enochrus*	spp.	Water Scavenger Beetle	X	X		X	X	X				
Lestidae	*Lestes*	spp.	Damslefly larvae	X	X			X	X	X			
Nepidae	*Ranatra*	spp.	Water Scorpion						X				
Oligochaeta	*Oligochaeta*	spp.	Worms	X									
Paraastacidae	*Cherax*	*quinquecarinatus*	Native Yabbie	X	X	X	X		X	X			
Physidae	*Physa*	spp.	Pond Snail	X						X		X	*
Planorbidae	*Glyptophysa*	spp.	Water Snail					X					
Planorbidae	*Gyraulus*	spp.	Freshwater Snail					X					
Sphaeriidae	*Sphaerium*	*kendricki*	Freshwater Clam	X									
Triopsidae	*Ntostraca*	spp.	Tadpole Shrimp	X	X								
Ma- Marine	**Mi- Migratory**												
Vu- Vulnerable	**S1- Schedule 1**												
En- Endangered	***- Introduced Fauna**												
P- Priority fauna													

Appendix D

Vegetation Types

Table 8 Vegetation Types Present Along the Survey Transect of UFI 3945

Vegetation community Name		Vegetation Community Description	Elevational Range (mHD)	Bushland Condition	Quadrat
*Ec *Rr		Closed grassland of **Ehrharta calycina, *Romulea rosea, *Bromus diandrus* and weed spp	1.7-1.7	6	Q4
Eg Mi		Open forest of *Eucalyptus gomphocephala* over tall shrubland of *Melaleuca incana* subsp *incana* over closed grassland of **Bromus diandrus*	0.9-1.7	5-6	Q5

Vegetation community Name		Vegetation Community Description	Elevational Range (mHD)	Bushland Condition	Quadrat
Mr *Psp		Open forest of *Melaleuca rhaphiophylla* over sedgeland, grassland of **Polypogon* sp. and scattered herbs of **Cotula coronopifolia*	0.5-0.9	4-5	Q6
Mr *Cd		Low open forest of *Melaleuca rhaphiophylla* over grassland of **Cynodon dactylon*	0.5-0.7	4-5	Q7
OW		Open water	0.0-0.5	-	

Vegetation community Name		Vegetation Community Description	Elevational Range (mHD)	Bushland Condition	Quadrat
Mc		Low woodland of *Melaleuca rhaphiophylla*, *Melaleuca incana* subsp *incana* and planted tree spp. over mowed grassland of weed sp.	1.8-2.7	5-6	Q1, Q2, Q3

Table 9 Vegetation Types Present Along the Survey Transect of UFI 5724

Vegetation community Name		Vegetation Community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
Em Ba		Low open forest of *Eucalyptus marginata* and *Banksia attenuata* over tall open scrub of *Melelaueca incana* subsp *incana* over sedgeland and grassland	15.5 15.6	4	Q1
Mp Kg		Open forest of *Melaleuca preissiana* over open shrubland of *Kunzea glabrescens* over open sedgeland with *Baumea articulata* and *Baumea pressii*	15.3- 15.5	2-3	Q2, Q3

Vegetation community Name		Vegetation Community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
Mp Kg Ba		Low open forest of *Melaleuca preissiana* over tall open scrub of *Kunzea glabrescens* over open sedgeland with *Baumea articulata* and *Baumea pressii*	13.5 -15.3	2	Q4
Mp Cp		Closed tall scrub of *Melaleuca preissiana* over herbland of *Cassytha* sp. over isolated sedges	13.5 – 12.9	1-3	Q6, Q7

Vegetation community Name		Vegetation Community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
Bm Ba		Low open woodland of *Banksia menziesii, Banksia attenuata* and *Eucalyptus marginata* over tall open shrubland of *Kunzea ericifolia* over grassland	14.5 -15.5	6	Q5

Table 10 Vegetation Types Present Along the Survey Transect of UFI 5180

Vegetation community Name		Vegetation Community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
Mr Cr		Low open forest of *Melaleuca rhaphiohylla* with *Cassytha racemosa.*	10.8 -11.5	1-5	Q8, Q9, Q10, Q11, Q12
Mr La		Closed forest of *Melaleuca rhaphiohylla* over open heath with *Leucopogon australis* over closed sedgeland with *Meeboldina scariosa*	11.3 – 12.5	1	Q13, Q14

Vegetation community Name		Vegetation Community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
Em Kg		Open woodland of *Eucalyptus marginata* over tall open scrub of *Kunzea glabrescens* over herbland of *Dasypogon bromeliifolius* over grassland	12.5 -15.0	3-6	Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q15

Table 11 Vegetation Types Present Along the Survey Transect of UFI 7046

Vegetation community Name		Vegetation Community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
Ke Mt		Tall open scrub of Kunzea *ericifolia* and *Melaleuca thymoides* closed herbland and grassland	20.0 – 20.7	No	Q14, Q15
Ke Mt Af		Tall open scrub of *Melaleuca rhapiophylla* over very open herbland of aquatic *Azolla filiculoides* and *Lemna* sp.	20.3 - 20.8	No	Q6, Q7, Q8, Q9, Q10, Q11, Q12, Q13,

Vegetation community Name		Vegetation Community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
Mp Mr		Low open forest of *Melaleuca preissiana* and *Melaleuca rhaphiophylla* s over open heath of *Melaleuca osullivanii*. over herbland of *Cotula coronopifolia** and *Rumex* sp.	20.8 – 21.9	No	Q5,
*W		Herbland and open grassland of weeds	21.9 – 22.1	No	Q2, Q3, Q4

Vegetation community Name		Vegetation Community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
Bm Bi		Low woodland of *Banksia menziesii* and *Banksia ilicifolia* over herbland of *Desmocladus flexuosus* and *Ursinia anthemoides**	22.1 – 22.4	No	Q1,

Table 12 Vegetation Types Present Along the Survey Transect of UFI 7029

Vegetation community Name		Vegetation Community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
Bm Ba		Low open forest of *Banksia menzeisii Banksia attenuata* and *Banksia ilicifolia* over herbland of *Desmocladus flexuosus* and mixed herbs	22.3 – 23.7	2	Q1, Q2
Bm Ah		Isolated trees of *Banksia menziesii* and *Allocasuarina humilis* over open heath of *Regelia ciliata* over open herbland with *Desmocladus flexuosus* and *Dasypogon bromeliifolius* and grassland	21.5 - 22.3	4-5	Q3, Q4

Vegetation community Name		Vegetation Community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
As Rc		Open heath of *Astartea scoparia, Regelia ciliata* and *Hypocalymma angustifolium* subsp *Swan Coastal* over very open herbland and grassland	21.0 -21.5	2	Q5
Mp As		Open woodland of *Melaleuca preissiana* over tall scrub of *Astartea scoparia and Kunzea ericifolia* over open herbland and grassland.	21.1 -21.5	2-3	Q6, Q7, Q8, Q9,

Vegetation community Name		Vegetation Community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
As		Shrubland of *Astartea scoparia* over grassland of weeds and herbland of weeds.	21.5 – 21.7	4-6	Q10, Q11, Q12, Q13, Q14

Table 13 Vegetation Types Present Along the Survey Transect of UFI 4835 (north)

Vegetation community Name		Vegetation community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
*Pc*Pm		**Pennisetum clandestinum* and *Phlaris minor* grassland over very open herbland of weed species	8.9 -10.5	2-6	Q12, Q13, Q20, Q11, Q22, Q10, Q23, Q9
*Pc*Pe	No Photo Available	**Pennisetum clandestinum* closed grassland and open herbland with *Pteridium esculentum*	8.3 – 9.2	2-6	Q12, Q13, Q20, Q11, Q22, Q10, Q23, Q9

Vegetation community Name		Vegetation community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
Mp Mr		Low open forest of *Melaleuca preissiana* and *Melaleuca rhaphiophylla* over open shrubland of *Melaleuca lateritia* and *Astartea scoparia* over closed sedgeland of *Lepidosperma longitudinale* and *Juncus pallidus*	9.0 – 10.5	4	Q24
Mp Mr Ml		Low open woodland of *Melaleuca preissiana* and *Melaleuca rhaphiophylla* over open shrubland of *Melaleuca lateritia* and *Astartea scoparia* over closed sedgeland of *Lepidosperma longitudinale* and *Juncus pallidus*	14.9 -10.5	3-5	Q8, Q7

Table 14 Vegetation Types Present Along the Survey Transect of UFI 4835 (South)

Vegetation community Name		Vegetation Community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
Ca		Open herbland of *Conostylis aculeata* and weeds	10.8 -11.3	6	Q1
As Js		Open heath of *Astartea scorparia* and *Jacksonia sternbergiana* and weeds	9.7 -10.1	5-6	Q2

Vegetation community Name		Vegetation Community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
Kg Ll		Tall open scrub of *Kunzea glabrescens* over sedgeland with *Lepidosperma longitudinale* and *Microlaena stipoides*	9.2 – 9.7	4-5	Q3, Q16
Mr As		Low open forest of *Melaleuca rhaphiophylla* over open shrubland of *Astartea scoparia Melaleuca laterita* over closed sedgeland with *Lepidosperma longitudinale*	8.7 – 9.2	2	Q17

Vegetation community Name		Vegetation Community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
As Ml		Open heath of *Astartea scoparia Melaleuca laterita* over sedgeland with *Lepidosperma longitudinale*	8.7 – 9.6	3-4	Q6
Mp As		Closed tall scrub of *Melaleuca preissiana, Astartea scoparia* and *Hypocalymma angustifolium* sp. over closed sedgeland with *Meeboldia scariosa and Hypolaena exsulca*	9.7- 12.5	2-3	Q4, Q5,

Table 15 Vegetation Types Present Along the Survey Transect of UFI 5032

Vegetation community Name		Vegetation community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
Xp Kg		Tall open scrub of *Xanthorrhorea preissii* and *Kunzea glabrescens* over closed heath of *Dasypogon bromeliifolius* and *Laxmannia ramosa* with *Hypolaena exsulca, Phlebocarya ciliata* and *Lyginia barbarta* sedgeland	16.6 -16.9	1	Q2, Q1
Mp Kg		Low open forest of *Melaleuca preissiana* over open scrub *Kunzea glabrescens* and *adenanthos meisneri* of heath of *Dasypogon bromeliifolius* and *Laxmannia ramosa* with *Hypolaena exsulca, Phlebocarya ciliata* and *Lyginia barbarta* sedgeland	16.4-16.6	1	Q4, Q5, Q11, Q3

Vegetation community Name		Vegetation community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
Kg Ha		Closed tall scrub of *Kunzea glabescens* over closed heath of *Hypocalymma angustifolium, Pericalymma ellipticum* var *ellipticum* and *Euchilopis linearis* over sedgeland with *Hypolaena exsulca* and *Carex inversa*	16.0 – 16.5	1	Q6
Kg Ml		Tall open scrub with *Kunzea glabrescens* and open heath with *Melaleuca lateritia*, *Calothamnus lateralis* and *Astartea scorparia* over open sedgeland with *Leipdosperma pubisquameum* and *Meeboldia scariosa*	16.5-16.8	1	Q7, Q12, Q13, Q14, Q15

Vegetation community Name		Vegetation community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
Ml Mb		Closed tall scrub of *Melaleuca lateritia, Melaleuca brevifolia* and *Astartea scorpia* over an open sedgeland of *Lepidosperma longitudinale* and *Meeboldina scariosa*	16.8-17.3	2	Q18
Mp Bsp		Open woodland of *Melaleuca preissiana* and Banksia sp. and tall open shrubland of *Kunzea glabescens* and *Astartea scoparia* over closed low heath with *Hypocalymma angustifolium* and sedgeland with *Hypolaean exsulca*	17.3-17.6	1-2	Q16, Q17

Vegetation community Name		Vegetation community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
Kg		*Kunzea glabescens* shrubland	17.6 – 17.9	1	Q8
Bsp	No photo available	Low open forest of Banksia spp.	17.9 -18.2	5	Q10

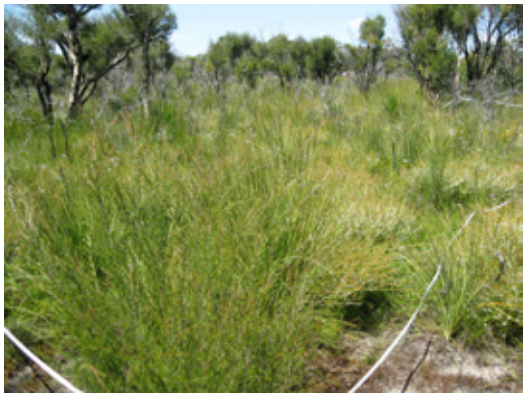
Table 16 Vegetation Types Present Along the Survey Transect of UFI 5056

Vegetation community Name		Vegetation Community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
Cc Mp		Open woodland *Corymbia calophylla, Melaleuca preissiana , Xanthorrhoea preissii, Hypocalymma angustifolium* and mixed herbs	8.3-8.5	3-5	Q17, Q18, Q19, Q20, Q21
Er Mp		Open woodland *Eucalyptus rudis, Melaleuca preissiana* and *Melaleuca rhaphiophylla* over *Lepidosperma longitudinale* and weeds	8.0-8.3	3-4	Q15, Q16, Q22

Vegetation community Name		Vegetation Community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
Cc Mp		Open woodland *Corymbia calophylla, Melaleuca preissiana, Xanthorrhoea preissii, Hypocalymma angustifolium* and mixed herbs	8.0-8.5	3	Q13, Q14
Af Ap		Open woodland *Allocasuarina fraseriana, Acacia pulchella* over mixed sedges and herbs	8.5-8.6	3	Q12

Vegetation community Name		Vegetation Community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
Cc Mp		Open woodland *Corymbia calophylla, Melaleuca preissiana , Xanthorrhoea preissii, Hypocalymma angustifolium* and mixed herbs	8.6-8.7	3	Q11
Af Ap		Open woodland *Allocasuarina fraseriana, Acacia pulchella* over mixed sedges and herbs	8.65-8.7	3	Q10

Vegetation community Name		Vegetation Community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
Cc Mp		Open woodland *Corymbia calophylla, Melaleuca preissiana , Xanthorrhoea preissii, Hypocalymma angustifolium* and mixed herbs	7.9-8.65	3-4	Q7, Q8, Q9
Mp Ll		Open woodland *Melaleuca preissiana* over *Lepidosperma longitudinale* and mixed herbs	7.9-8.0	3-5	Q4, Q5, Q6

Vegetation community Name		Vegetation Community Description	Elevation Range (mHD)	Bushland Condition	Quadrat
Cc Mp		Open woodland *Corymbia calophylla, Melaleuca preissiana , Xanthorrhoea preissii, Hypocalymma angustifolium* and mixed herbs	8.3- 8.0	5	Q3
*PW		Paddock weeds	8.3-9.1	6	Q1, Q2

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