Appendix L

Fauna and Aquatic Ecology

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Appendix L.1
Potentially Occurring Significant Fauna and Aquatic Ecology

L.1 Potentially Occurring Significant Fauna and Aquatic Ecology

Following a review of existing available data the following target species, including endangered, vulnerable, rare/threatened fauna, were identified from the region and likely to be present within the refinery and RSF study area. The potentially occurring EVR species are detailed in Table 1-1.

Table 0-1 EVR Species potentially occurring within the RSF and refinery study areas

Common Name	Scientific Name	Qld NCA	EPBC
Grey goshawk	*Accipiter novaehollandiae*	R	
Square-tailed kite	*Lophoictinia isura*	R	
Cotton pygmy-goose	*Nettapus coromandelianus*	R	M
Radjah shelduck	*Tadorna radjah*	R	
White-rumped swiftlet	*Collocalia spodiopygius*	R	
Glossy black-cockatoo	*Calyptorhynchus lathami*	V	
Black-necked stork	*Ephippiorhynchus asiaticus*	R	
Squatter pigeon	*Geophaps scripta scripta*	V	V
Black-chinned honeyeater	*Melithreptus gularis*	R	
Lewin's rail	*Rallus pectoralis*	R	
Painted snipe	*Rostratula benghalensis*	V	V
Eastern curlew	*Numenius madagascariensis*	R	
Powerful owl	*Ninox strenua*	V	V
Black-breasted button-quail	*Turnix melanogaster*	V	V
Eastern long-eared bat	*Nyctophilus timoriensis*	V	V
Koala (southeast Queensland bioregion)	*Phascolarctos cinereus (southeast Queensland bioregion)*	C	
Little pied bat	*Chalinolobus picatus*	R	
Dunmall's snake	*Furina dunmalli*	V	V
Brigalow scaly-foot	*Paradelma orientalis*	V	V
Yakka skink	*Egernia rugosa*	V	V
Cooloola Snake-skink	*Ophioscincus cooloolensis*	R	
Rusty monitor	*Varanus semiremex*	R	

Source: Environmental Protection Agency Wildnet database (EPA 2006) and EPBC Protected Matters Report, 1 May 2006.

L.2 Terrestrial Fauna Survey Methodology

The fauna survey of the Refinery and RSF study areas was undertaken between 25 May 2006 and 7 June 2006 and on 12 June 2006. An additional area in the RSF study area was surveyed between the 29 June and 6 July 2006. A total of nine survey sites for the refinery and RSF study sites (refer to Table 2-1) were systematically sampled. General observations from other RSF sites and areas were also compiled. Standard biological survey techniques were used during field surveys, including a number of live capture/release trapping techniques, standard and general observational and habitat searches, as well as methods to indirectly detect the presence of terrestrial fauna. The survey focussed on terrestrial vertebrate taxa.

Table 0-1 Survey Sites

Site No	Location
1	Refinery
2	Refinery
3	Refinery
4	Refinery
5	Refinery
6	RSF
7	RSF
8	RSF
11	RSF

The survey design was based on the methodology used for the Queensland Systematic Vertebrate Fauna Survey Project in the South East Queensland Bioregion (CRA Queensland/RFA Steering Committee 1997). The methodology was modified to target EVR/threatened species such as *Xeromys myoides* (False Water-rat) in potential habitat and EVR/threatened reptiles, birds and mammals throughout the study area. Increased survey effort was applied to the assessment of these target species and less survey effort spent on surveying small ground mammals in terrestrial habitats. **Table 0-2** provides a summary of the standard and non-standard methods and survey effort undertaken for this study.

Table 0-2 Summary of Fauna Survey Effort: Refinery and RSF

Survey Method	Survey Effort	Survey location	Total Survey Effort
Standard Methods			
Timed area bird surveys	80 minutes x 5 sites (Refinery) 80 minutes x 4 sites (RSF) 80 minutes @ RSF dams	Refinery & RSF	12 hours + 80 minutes additional survey
Diurnal Searches	3 x 20 minute searches x 5 Sites (Refinery)	Refinery & RSF	9 hours

Survey Method	Survey Effort	Survey location	Total Survey Effort
	3 x 20 minute searches x 4 Sites (RSF)		
Nocturnal Searches	3 x 20 minute searches x 5 Sites (Refinery) 3 x 20 minute searches x 4 Sites (RSF)	Refinery & RSF	9 hours
Nocturnal Call Play Back	1 call playback session x 5 Sites (Refinery) 1 call playback session x 4 Sites (RSF)	Refinery & RSF	9 sessions
Spotlighting	1 person hour x 5 Sites (Refinery) 1 person hour x 4 Sites (RSF)	Refinery & RSF	9 hours
Ultrasonic microbat detection	1 overnight x 5 Sites (Refinery) 1 overnight x 4 Sites (RSF) + 8 nights targeted anabat detection at freshwater dams in the RSF study area where high levels of bat activity were observed	Refinery & RSF	17 nights (204 monitoring hours)
Ground Mammal Elliot Trapping	25 traps/100 trap nights x 1 Transect in targeted *Xeromys myoides* habitat (S1) 7 traps/28 trap nights x 4 Transects (Refinery) 7 traps/28 trap nights x 4 Transects (RSF)	Refinery & RSF	100 trap nights 224 trap nights Total 324 trap nights
Arboreal Mammal Trapping	5 traps/20 trap nights x 4 Transects (Refinery)* *Arboreal mammal trapping was not conducted at one site (S1) in Mangrove woodland due to unsuitable arboreal habitat. 5 traps/20 trap nights x 4 Transects (RSF)	Refinery & RSF	160 trap nights
Pitfall Trapping	10 traps/4 trap nights x 4 sites (Refinery)* *Pitfall trapping was not conducted at one site (S1) in Mangrove/saltmarsh due to tidal inundation. 10 traps/4 trap nights x 4 sites (RSF)	Refinery & RSF	320 trap nights
Wire Cage Traps	1 trap/4 trap nights x 5 Transects (Refinery) 1 trap/4 trap nights x 4 Transects (RSF)	Refinery & RSF	36 trap nights
Non-standard Methods			
Non- predator scat collection	40 mins search per site x 5 sites (Refinery) 40 mins search per site x 4 sites	Refinery & RSF	360 minutes

Survey Method	Survey Effort	Survey location	Total Survey Effort
	(Refinery)		
Hair Funnels	10 funnels per site x 5 sites x 9 nights (Refinery) 10 funnels per site x 3 sites x 9 nights (RSF)10 funnels per site x 1 site x 4 nights (RSF Site 11)	Refinery & RSF	760 funnel nights
Harp trapping	Opportunistic at suitable sites	Refinery & RSF	16 harp trap nights
Targeted yellow-bellied glider, koala Survey: Diurnal Searches, Spotlighting, Call Playback, Signs & Scats	Targeted survey in open forest and woodland habitats	Refinery & RSF	
Vehicle spotlighting	No standard effort	Refinery & RSF	While travelling in the study area between systematic sites and in the northern RSF
Predator scat collection	Opportunistic at suitable sites	Refinery & RSF	
Identification of animal tracks	Opportunistic during non-predator scat collection	Refinery & RSF	

L.2.1 Standard methods used at systematic sites

At each standard systematic survey site, the following standard methods were conducted.

Diurnal Bird Counts

Four 20 minute/2 ha timed area (1 hour 20 mins per site) diurnal bird counts were undertaken at each systematic site within representative habitat. Timed/area searches involved walking through a habitat area for 20 minutes actively pursuing calling birds and recording all bird species seen or heard within the broad habitat type. Bird counts were conducted between dawn and 0900 hours, with a minimum of one additional count in the late morning or late afternoon at each site. Additional bird counts (4 x 20 minute counts) were conducted at a number of dams within the RSF, to target squatter pigeons at these sites.

Diurnal Searches

One person-hour (3 x 20 minute searches) active diurnal searches were conducted at each systematic site. Active searching involved recording all individuals (small mammals, reptiles, amphibians) found active or sheltering underneath or within fallen woody debris, rocks, litter and decorticating bark. Frogs heard calling during the search were also recorded. Active searches were undertaken between 1000 and 1400 hours when reptiles were active.

Nocturnal Searches

One person-hour (3 x 20 minute searches) active nocturnal searches were undertaken at each systematic site. Active searches involved the use of Petzl Zoom headlamps and low watt spotlights, and recording all

individuals (small mammals, reptiles, amphibians) found active on the ground or up trees, or underneath fallen debris, rocks, litter and decorticating bark. Frogs heard calling at each site were also recorded during this time.

Nocturnal Call Play Back

One nocturnal call playback session was conducted at the centre point of each systematic survey site. Calls were played from a centre point at each systematic site, while two observers moved away from the centre point to listen for responses. Each call playback session involved an initial 10-minute listening period, where any calls from arboreal mammals and nocturnal birds were recorded. This was followed by the broadcasting of pre-recorded calls relevant to the habitat type being surveyed. Relevant calls were played from the following group of arboreal mammals, birds and amphibians: sugar glider, squirrel glider, koala, yellow bellied glider, sooty owl, powerful owl, southern boobook, barking owl, masked owl, barn owl, Australian owlet-nightjar and the tusked frog. Relevant calls were played for three minutes, followed by a two-minute listening period. After the calls were played, each observer scanned by spotlight the immediate area.

Spotlighting

Spotlighting census involved an observer within the study area with a 50-Watt spotlight for one person-hour per site at all 9 systematic sites (total 9 spotlight person hours) and additional spotlighting in the northern RSF study area. Incidental observations where also made while driving along tracks and entering and exiting the study area at night.

Ultrasonic Microbat Call Detection

Ultrasonic microbat call detection was used to sample microchiropteran bats. The ultrasonic detection was conducted at each systematic site for one night of remote sampling using Anabat detectors and CF Zcaim units, commencing at dusk and finishing at dawn (total nine nights remote detection, approximately 108 hours sampling). 8 additional nights of sampling were conducted adjacent to dams within the RSF where high levels of bat activity were observed (total 8 nights remote detection, approximately 96 remote monitoring hours). Recorded calls were analysed by Paul Barden, Ecological Management Services.

Elliott Trapping for Small Mammals

Elliot trapping effort was reduced due to past trapping from a number of surveys in the local area indicating a very low trap return for this group (eg Dames & Moore 1998; Connell Wagner 2002; Connell Hatch 2005). At each systematic site, 7 traps (5 Elliot ‘A’ type & 2 Elliot ‘B’ type) were set approximately 28 m apart along a 200 m transect. At one site (site 1 Mangroves) 25 traps (23 Elliot ‘A’ type & 2 Elliot ‘B’ type) were set approximately eight metres apart along a 200 m transect to target potential false water mouse *(Xeromys myoides)* habitat. Traps were generally baited with a peanut butter and oat mixture and left open for four nights. Additional bait was used in false water mouse habitat eg. garfish and aquatic invertebrates. Traps were left open for four nights, cleared early each morning, and trapped animals were temporarily marked so that recaptures could be identified.

Arboreal Mammal Trapping

Five arboreal traps were mounted on platforms and attached to trees at all systematic sites with the exception of site 1 as suitable habitat was not available. Trees selected were of various species and girths. Traps were spaced opportunistically at approximately 40 metre intervals. Traps were baited with honey and oat mixture and scent trails of honey and water were sprayed above the traps to assist in luring gliders. Traps were left open for four nights and checked for captures early each morning.

Pitfall Trapping

Pitfall traps were used to capture frog, reptile and small mammal species that are cryptic and difficult to detect, such as burrowing frogs and fossorial skinks. Pitfall traps were used at all systematic sites with the exception of site 1 due to potential tidal inundation at this site. Five pitfall lines consisting of four 15 litre buckets, one 20 litre bucket and five 10 litre buckets, with 50 m of drift fence (5 m for each bucket) were set at 8 systematic sites (total 320 pitfall trap nights). Pitfall lines were left open for four nights, and were checked for specimens early each morning and late afternoon, which were identified and released.

Wire Cage Trapping

At each systematic site one medium wire cage trap was set along a 200 m transect. The wire cage was baited and left open for four nights and checked for captures early each morning.

L.2.2 Non standard methods

Non-standard methods used within the survey area are described below:

Hair Funnels for Small to Medium-sized Mammals

Ten ground and tree based hair funnels (Faunatech) were set approximately 20 m apart along the 200 m transect at all systematic sites. The tubes were baited with a peanut butter and oat mixture, and left on site for nine nights at sites 1-8 and four nights at site 11. All hair samples obtained were sent to B. Triggs 'Dead Finish' via Genoa, Victoria, for analysis.

Harp Trapping for Microbats

Collapsible harp traps were used to capture low flying microchiropteran and small megachiropterans. Where possible harp traps were set on systematic sites. However harp trapping was not undertaken at some sites due to an absence of suitable flyways. Harp traps were left open for a minimum of two nights at each trap site (16 harp trap nights at 4 sites).

Vehicle Spotlighting

Vehicle spotlighting was conducted along tracks in the study area and while driving between survey sites at night to obtain incidental records and in the northern RSF study area.

Predator Scat Search

Predator scats found at sites and opportunistically elsewhere in the study area were collected for identification through analysis of grooming hairs by B. Triggs. Remains of prey species were identified where possible, from hairs and bones in the scat. Identification of species from scat samples was included if the species was identified as definite and distinguished in the species list with a 'P' if identified as probable.

Non-Predator Scat Collection, Tracks & Signs

Searches (40 minutes per systematic site) were conducted for non-predator scats, particularly for target species such as the yellow-bellied glider and the koala. Suitable food trees were searched along transects for signs of use/feeding and scats indicative of the presence of yellow-bellied gliders and koalas. Scats collected within the study area were collected for identification by analysis of grooming hairs by B. Triggs. Tracks and signs noted during the survey were inspected and identified. Identification of species from scat samples was included if the species was identified as definite and distinguished in the species list with a 'P' if identified as a probable.

L.2.3 Survey Limitations

Detailed sampling across a variety of seasonal changes has not been undertaken in the study area. The main survey was conducted during seasonal conditions when some species may have been inactive or seasonally absent from the study area. The main survey component was undertaken during seasonal conditions when most listed migratory wading and shore birds (DEH 2006) are absent from Australia during the southern hemisphere winter. Additional common bird species that are east coast or extra-limital migrants may also have been under-reported. The seasonal conditions encountered during the survey included a prolonged dry period prior to the survey, and cool nocturnal conditions, which may have reduced detection rates for some amphibians and reptiles.

At the time of the fauna survey and report preparation, vegetation mapping (URS 2006) was not available. In the absence of this data, existing Queensland Herbarium mapping was used to select field sampling sites. Access to some areas of the northern RSF area was limited at the request of GPN due to the presence of giant rat's tail grass, a declared weeds species. Following the field survey the study area boundaries were modified. These factors influenced the spread of sites across the wider study area and the areas assessed during the survey.

L.2.4 Site Selection and Habitats

The vegetation of the study area is described in a separate report (refer to section 8 and 9 of the EIS). The fauna survey was designed to sample representative broad habitat types, regional ecosystems and major vegetation communities present within the study area. Consequently, terrestrial fauna habitats and survey sites within the study area were selected following consideration of these broad habitats/regional ecosystems and soil/topography/gradient. Other factors affecting the distribution of fauna were

considered when assessing the fauna habitats present, including the proximity to creeks and standing water.

Eleven systematic sample sites were selected to survey representative habitats within the study area (Table 2.3). Systematic fauna sites were not located in previously cleared/modified agricultural grassland.

Table 0-3 Fauna Survey Site Locality and Broad Habitat Data

Site No	Location	UTM (AMG 94) Centrepoint	Dominant Canopy Species	Broad Habitat/Topography
1	Refinery	314910 7361137	Mangrove species	Mangrove and salt-marsh, marine clay plains
2	Refinery	314496 7359729	*Eucalyptus crebra, Corymbia intermedia, E. tereticornis*	Open forest with grassy groundcover, alluvial floodplain
3	Refinery	314348 7361154	*Eucalyptus tereticornis, Lophostemon suaveolens, Corymbia sp. Melaleuca spp.*	Open forest with a grassy groundcover, alluvial plains
4	Refinery	314203 7362034	*Eucalyptus tereticornis, Lophostemon suaveolens, E. crebra, Corymbia intermedia, Corymbia tessellaris, Melaleuca sp.*	Open forest alluvial plain
5	Refinery	313882 7360265	*Corymbia citriodora* and *Eucalyptus crebra*	Open forest/woodland on rocky rise/metamorphics
6	RSF	302105 7358089	*Eucalyptus crebra, Corymbia erythrophloia*	Woodland on low rises
7	RSF	304223 7353828	*Eucalyptus moluccana*	Open forest/woodland, grazing land, freshwater dam
8	RSF	303002 7355005	*Eucalyptus tereticornis, Corymbia tessellaris, Lophostemon suaveolens, E. crebra, Melaleuca spp.*	Open forest on alluvial plain, fringing drainage line, dry creek bed
11	RSF	302533 7356684	*Corymbia citriodora, E. crebra, E. exserta, Lophostemon suaveolens*	Open forest on low rise, dry creek bed, freshwater dam

L.2.5 Climatic Conditions during Survey Period

Minimum temperatures ranged between 9.5°C and 16.7°C and maximum temperatures ranged between 18.9°C and 27.7°C during the May-June field survey (Bureau of Meteorology 2006). A significant rainfall event occurred between 8 and 11 June 2006 with 102.4mm of rainfall recorded at the Gladstone station (Bureau of Meteorology 2006). During the July field survey of all the sites, no rainfall was recorded and minimum temperatures ranged between 11.8°C and 16.1°C and maximum temperatures ranged between 23.1°C and 26.6°C (Bureau of Meteorology 2006).

L.3 Identified Fauna Species

Fauna species found within the RSF and refinery study areas are described below in Table 3-1. Identification of species from scat samples was included if the species was identified as definite or distinguished with a 'P' if identified as a probable identification

Table 0-1 Fauna species found within the RSF and refinery study areas

			Refinery survey sites					RSF survey sites				
Common Name	**Scientific Name**	**Abundance[1]**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**11**	**Pasture**
AMPHIBIANS												
Ornate Burrowing Frog	*Limnodynastes ornatus*	U						X				
Northern Banjo Frog	*Limnodynastes terraereginae*	U				X						
Great Broodfrog	*Pseudophryne major*	C				X				X	X	X
Green Tree Frog	*Litoria caerulea*	C			X							
Dwarf Tree Frog	*Litoria fallax*	U							X			
Ground Frog	*Litoria inermis*	C							X			
Ground Frog	*Litoria latopalmata*	U							X		X	
Rocket Frog	*Litoria nasuta*	U								X		
Purple Treefrog	*Litoria rubella*	U						X				
Cane Toad *	*Bufo marinus*	C			X	X			X		X	
Total Amphibians	**10**		**0**	**0**	**2**	**3**	**0**	**2**	**4**	**2**	**3**	**1**

			Refinery survey sites					RSF survey sites				
Common Name	**Scientific Name**	**Abundance[1]**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**11**	**Pasture**
REPTILES												
Tree Dtella	*Gehyra dubia*	C		X	X		X			X	X	
Binoe's Gecko	*Heteronotia binoei*	C		X	X	X	X	X		X	X	
Zigzag Gecko	*Oedura rhombifer*	U		X	X		X			X	X	
Eastern Two-line Dragon	*Diporiphora australis*	C		X	X					X	X	
Eastern Bearded Dragon	*Pogona barbata*	U									X	
Tree-base Rainbow-skink	*Carlia foliorum*	A		X	X	X	X		X	X	X	
Shaded-litter Rainbow-skink	*Carlia munda*	U							X			
			Refinery Yarwun SDA					RSF Aldoga SDA				
Common Name	Scientific Name	Abundance	1	2	3	4	5	6	7	8	11	Pasture
Open-litter Rainbow-skink	*Carlia pectoralis*	C			X	X	X	X	X		X	
Robust Rainbow-skink	*Carlia schmeltzii*	C		X		X		X			X	
Tussock Rainbow-skink	*Carlia vivax*	U									X	
Cream-striped Shinning-skink	*Cryptoblepharus virgatus*	C			X	X	X	X	X	X	X	
Copper-tailed Skink	*Ctenotus taeniolatus*	U						X			X	
Fine-spotted Mulch-skink	*Glaphyromorphus punctulatus*	U		X			X					

			Refinery survey sites					RSF survey sites				
Common Name	**Scientific Name**	**Abundance[1]**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**11**	**Pasture**
Keith's Skink	*Eulamprus martini*	U									X	
Dwarf Litter Skink	*Mentia timlowi*	U							X			
Carpet Python	*Morelia spilota*	U					X					
Freshwater Snake	*Tropidonophis mairii*	U							X			
Lesser Black Whipsnake	*Demansia vestigiata*	U									X	
Red-naped Snake	*Furina diadema*	U					X	X				
Bandy-bandy	*Vermicella annulata*	U				X						
Total Reptiles	**19**		**0**	**7**	**7**	**5**	**9**	**6**	**6**	**6**	**13**	**0**
BIRDS												
Emu	*Dromaius novaehollandiae*	U							X			X
Brown Quail	*Coturnix ypsilophora*	U			X			X		X		
Australian Wood Duck	*Chenonetta jubata*	U							X			
Pacific Black Duck	*Anas superciliosa*	U							X	X		
Australasian Grebe	*Tachybaptus novaehollandiae*	U							X			
Darter	*Anhinga melanogaster*	U	X									
White-faced Heron	*Egretta novaehollandiae*	U							X			

			Refinery survey sites					RSF survey sites				
Common Name	**Scientific Name**	**Abundance[1]**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**11**	**Pasture**
White-necked Heron	*Ardea pacifica*	U		X								
Great Egret	*Ardea alba*	U	X									
Striated Heron	*Butorides striatus*	U	X									
Nankeen Night-Heron	*Nycticorax caledonicus*	U		X								
Australian White Ibis	*Threskiornis molucca*	U	X									
Whistling Kite	*Haliastur sphenurus*	C	X	X	X	X				X		
Black-shouldered Kite	*Elanus axillaris*	U										X
Black Kite	*Milvus migrans*	U										X
			Refinery Yarwun SDA					RSF Aldoga SDA				
Common Name	Scientific Name	Abundance	1	2	3	4	5	6	7	8	11	Pasture
Wedge-tailed Eagle	*Aquila audax*	U								X		X
Brown Falcon	*Falco berigora*	U										X
Nankeen Kestral	*Falco cenchroides*	U										X
Australian Bustard	*Ardeotis australis*	U										X
Black-fronted Dotterel	*Elseyornis melanops*	U										X
Lesser Sand Plover	*Charadrius mongolus*	U	X									
Red-capped Plover	*Charadrius ruficapillus*	U	X									

			Refinery survey sites					RSF survey sites				
Common Name	**Scientific Name**	**Abundance[1]**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**11**	**Pasture**
Masked Lapwing	*Vanellus miles*	C	X		X							
Bush Stone-curlew	*Burhinus grallarius*	U			X							
Silver Gull	*Larus novaehollandiae*	C	X									
Crested Tern	*Sterna bergii*	U	X									
Squatter Pigeon	*Geophaps scripta*	C							X	X	X	X
Peaceful Dove	*Geopelia striata*	C		X		X				X		
Bar-shouldered Dove	*Geopelia humeralis*	C			X	X						
Red-tailed Black-Cockatoo	*Calyptorhynchus banksii*	U								X		
Rainbow Lorikeet	*Trichoglossus haemotodus*	A		X	X	X	X		X	X	X	
Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*	A		X			X	X			X	
Little Lorikeet	*Glossopsitta pusilla*	C		X			X			X		
Pale-headed Rosella	*Platycercus adscitus*	U		X			X		X			
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	U										
Pheasant Coucal	*Centropus phasianinus*	U			X	X		X				
Powerful Owl	*Ninox strenua*	U		X			X			X	X	
Barking Owl	*Ninox connivens*	U		X	X	X	X			X		
Southern Boobook	*Ninox novaeseelandiae*	U		X								

			Refinery survey sites					RSF survey sites				
Common Name	**Scientific Name**	**Abundance[1]**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**11**	**Pasture**
Tawny Frogmouth	*Podargus strigoides*	U		X								
White-throated Nightjar	*Eurostopodus mystacalis*	U					X					
Australian Owlet Nightjar	*Aegotheles cristatus*	U		X	X							
Laughing Kookaburra	*Dacelo novaeguineae*	C		X		X	X	X	X	X	X	
Blue-winged Kookaburra	*Dacelo leachii*	U	X									
Forest Kingfisher	*Todiramphus macleayi*	U			X							
Collared Kingfisher	*Todiramphus chloris*	U	X									
Sacred Kingfisher	*Todiramphus sanctus*	U		X								
			Refinery Yarwun SDA					RSF Aldoga SDA				
Common Name	Scientific Name	Abundance	1	2	3	4	5	6	7	8	11	Pasture
Rainbow Bee-eater	*Merop ornatus*	C		X			X		X	X	X	
Red-backed Fairy-wren	*Malurus melanocephalus*	C		X	X			X		X	X	
Spotted Pardalote	*Pardalotus punctatus*	U									X	
Striated Pardalote	*Pardalotus striatus*	C	X	X	X	X	X		X	X	X	
White-browed Scrubwren	*Sericornis frontalis*	U								X		
Speckled Warbler	*Chthonicola sagittata*	U								X		
Weebill	*Smicrornis brevirostris*	C							X	X		

			Refinery survey sites					RSF survey sites				
Common Name	**Scientific Name**	**Abundance[1]**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**11**	**Pasture**
Mangrove Gerygone	*Gerygone laevigaster*	U	X									
White-throated Gerygone	*Gerygone olivacea*	C		X	X	X		X	X	X	X	
Noisy Friarbird	*Philemon corniculatus*	C					X		X		X	
Little Friarbird	*Philemon citreogularis*	C					X		X			
Blue-faced Honeyeater	*Entomyzon cyanotis*	U					X	X		X		
Noisy Miner	*Manorina melanocephala*	C						X			X	
Lewin's Honeyeater	*Meliphaga lewini*	U							X		X	
Mangrove Honeyeater	*Lichenostomus fasciogularis*	C	X		X							
Black-chinned Honeyeater	*Melithreptus gularis*	U								X		
White-throated Honeyeater	*Melithreptus albogularis*	A		X	X	X	X	X	X	X	X	
Brown Honeyeater	*Lichmera indistincta*	A	X	X	X	X	X		X	X	X	
Dusky Honeyeater	*Myzomela obscura*	U		X								
Scarlet Honeyeater	*Myzomela sanguinolenta*	A		X	X	X	X		X	X	X	
Grey-crowned Babbler	*Pomatostomus temporalis*	U								X		
Rufous Whistler	*Pachycephala rufiventris*	C		X	X	X	X	X	X	X	X	
Grey Shrike-thrush	*Colluricincla harmonica*	C	X	X		X		X	X	X	X	
Leaden Flycatcher	*Myiagra rubecula*	U		X	X	X			X		X	

			Refinery survey sites					RSF survey sites				
Common Name	**Scientific Name**	**Abundance[1]**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**11**	**Pasture**
Restless Flycatcher	*Myiagra inquieta*	U								X		
Magpie-lark	*Grallina cyanoleuca*	U							X			X
Grey Fantail	*Rhipidura fuliginosa*	C	X	X	X	X	X	X	X	X	X	
Willie Wagtail	*Rhipidura leucophrys*	C	X		X	X		X	X	X	X	
Spangled Drongo	*Dicrurus bracteatus*	U				X			X	X	X	
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	U		X	X	X	X		X	X	X	
White-bellied Cuckoo-shrike	*Coracina papuensis*	C					X	X			X	
Varied Triller	*Lalage leucomela*	U								X		
			Refinery Yarwun SDA					RSF Aldoga SDA				
Common Name	Scientific Name	Abundance	1	2	3	4	5	6	7	8	11	Pasture
Figbird	*Sphecotheres viridus*	U		X						X		
Little Woodswallow	*Artamus minor*	U								X		
Pied Butcherbird	*Cracticus nigrogularis*	U	X	X				X	X	X		
Australian Magpie	*Gymnorhina tibicen*	C	X	X			X	X	X	X	X	X
Pied Currawong	*Strepera graculina*	U		X			X					
Torresian Crow	*Corvus orru*	C	X	X	X	X	X	X	X			X
White-winged Chough	*Corcorax melanorhamphos*	U							X	X		

			Refinery survey sites					RSF survey sites				
Common Name	**Scientific Name**	**Abundance[1]**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**11**	**Pasture**
Richard's Pipit	*Anthus novaeseelandiae*	U			X				X			
Double-barred Finch	*Taeniopygia bichenovii*	C		X	X				X	X		
Mistletoebird	*Dicaeum hirundinaceum*	U	X	X		X	X					
Welcome Swallow	*Hirundo neoxena*	U						X				
Fairy Martin	*Hirundo ariel*	U		X								
Golden-headed Cisticola	*Cisticola exilis*	U		X								
Silvereye	*Zosterops lateralis*	C								X		
Total Birds	**93**		**23**	**37**	**25**	**21**	**24**	**18**	**33**	**40**	**25**	**12**
MAMMALS												
Echidna	*Tachyglossus aculeatus*	U					X	X	X			
Northern Brown Bandicoot	*Isoodon macrourus*	U	X	X	X	X		X				
Yellow-bellied Glider	*Petaurus australis*	U									X	
Squirrel Glider	*Petaurus norfolcensis*	U						X				
Greater Glider	*Petauroides volans*	C				X			X		X	
Common Ringtail Possum	*Pseudocheirus peregrinus*	U		X								
Common Brushtail Possum	*Trichosurus vulpecula*	C		X	X	X	X	X		X	X	X

			Refinery survey sites					RSF survey sites				
Common Name	**Scientific Name**	**Abundance[1]**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**11**	**Pasture**
Rufous Bettong	*Aepyprymnus rufescens*	U							X	X		X
Eastern Grey Kangaroo	*Macropus giganteus*	C	X		X	X		X	X	X	X	X
Whiptail Wallaby	*Macropus parryi*	C		X (P)			X	X	X (P)		X	X
Swamp Wallaby	*Wallabia bicolor*	U						X	X (P)		X	X
Black Flying-fox	*Pteropus alecto*	C		X			X					
Little Red Flying-fox	*Pteropus scapulatus*	A		X	X		X			X	X	
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	U	X		X				X			
Beccari's Free-tailed Bat	*Mormopterus beccarii*	U							X			
			Refinery Yarwun SDA					RSF Aldoga SDA				
Common Name	Scientific Name	Abundance	1	2	3	4	5	6	7	8	11	Pasture
Eastern Free-tailed Bat	*Mormopterus sp 2*	U							X			
White-striped Freetail-bat	*Nyctinomus australis*	U	X					X				
Little Bentwing-bat	*Miniopterus australis*	C		X	X	X	X	X	X	X	X	
Eastern Bent-winged Bat	*Miniopterus schreibersii*	U							X	X		
Long-eared Bat	*Nyctophilus sp.*	U			X	X						
Gould's Wattled Bat	*Chalinolobus gouldii*	C		X					X	X	X	
Hoary Wattled Bat	*Chalinolobus nigrogriseus*	U		X						X		

			Refinery survey sites					RSF survey sites				
Common Name	**Scientific Name**	**Abundance[1]**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**11**	**Pasture**
Water Rat	*Hydromys chrysogaster*	U	X	X								
Rodent	*Rattus sp.*	U		X								
Dingo/Dog *	*Canis lupus*	C	X	X	X		X		X	X		
Fox *	*Vulpes vulpes*	U	X		X	X						
Cat *	*Felis catus*	U					X					
Rabbit *	*Oryctolagus cuniculus*	C	X		X	X			X	X		X
Pig *	*Sus scrofa*	C							X	X	X	
Cattle *	*Bos spp.*	A							X	X	X	X
Total Mammals	**30**		**8**	**12**	**10**	**8**	**8**	**9**	**16**	**12**	**11**	**7**

1Abundance: A = Abundant, C = Common, U = Uncommon
Pasture = Species observed in modified pasture areas of the RSF area
* = Exotic species

L.4 Bird Species

Table 3-2 Birds - Mean Count per 20 minute Survey

Common Name	Survey Site Number					Total
	1	2	3	4	5	
Darter	0.25					0.05
Great Egret	0.25					0.05
Striated Heron	0.25					0.05
Australian White Ibis	0.5					0.1
Whistling Kite	0.5	0.5	0.25	0.25		0.3
Masked Lapwing	0.5					0.1
Silver Gull	0.25					0.05
Crested Tern	0.25					0.05
Peaceful Dove				0.5		0.1
Bar-shouldered Dove			0.25	0.75		0.2
Pale-headed Rosella		0.5			1.5	0.4
Rainbow Lorikeet		0.5		2.25	2	0.95
Scaly-breasted Lorikeet		2.25			9	2.25
Little Lorikeet		2			6.5	1.7
Pheasant Coucal				0.25		0.05
Laughing Kookaburra		0.5		0.75	1.25	0.5
Forest Kingfisher			0.25			0.05
Collared Kingfisher	0.75					0.15
Rainbow Bee-eater		1.75			3	0.95
Fairy Martin		0.25				0.05
Black-faced Cuckoo-shrike			0.25	0.25		0.1
White-bellied Cuckoo-shrike					0.5	0.1
Willie Wagtail	0.25		1.5	0.25		0.4
Grey Fantail	0.25	0.75	1.5	1	1	0.9
Leaden Flycatcher		0.25	0.5	0.25		0.2
Rufous Whistler		1	2	0.75	1	0.95
Grey Shrike-thrush	0.25	0.25		0.5		0.2
Red-backed Fairy-wren			0.75			0.15
White-throated Gerygone		1	2.5	0.5		0.8
Mangrove Gerygone	0.25					0.05
Mistletoebird	0.25			0.25	0.75	0.25
Striated Pardalote	1	1.75	1.75	0.5	0.25	1.05
Brown Honeyeater	1.75	3.75	3.25	1.75	3.5	2.8
Dusky Honeyeater		0.25				0.05
Scarlet Honeyeater		0.25	1.5	2	1.75	1.1
Mangrove Honeyeater	1.75		1			0.55
White-throated Honeyeater		1.5	3.25	3	2.5	2.05

Appendix L.4
Bird Species

Common Name	Survey Site Number					Total
	1	2	3	4	5	
Little Friarbird					2	0.4
Blue-faced Honeyeater					1.75	0.35
Figbird		0.5				0.1
Spangled Drongo				0.5		0.1
Pied Butcherbird		0.5				0.1
Australian Magpie	0.5				1.25	0.35
Pied Currawong		0.25				0.05
Torresian Crow	0.75	1	0.75	0.25	1	0.75
Double-barred Finch		0.75	1.5			0.45
Total Species	19	23	17	20	18	46

L.5 Plates

Plate 1: Site 1 Mangrove and Salt Marsh

Plate 2 Site 2 E. crebra open forest

Plate 3 Eucalyptus tereticornis/Lophostemon suaveolens open forest

Plate 4 E. tereticornis, L. suaveolens, E. crebra open forest

Plate 5 Site 5 Corymbia citriodora/E. crebra open forest

Plate 6 Site 6 E. crebra, Corymbia erythrophloia woodland

Plate 7 Site 7 E. moluccana open forest

Plate 8 Site 8 E. tereticornis, C. tessellaris open forest

Plate 9 Site 11 C. citriodora, E. crebra open forest

Plate 10 Ornate Burrowing Frog (Limnodynastes ornatus)

Plate 11 Red-naped Snake (Furina diadema)

Plate 12 Squatter Pigeon (Geophaps scripta) RSF

Plate 13 Australian Bustard (Ardeotis australis) RSF

L.6 Aquatic Ecology Survey Methodology

L.6.1 Survey Methods

A review of available literature on the aquatic fauna of the project area was conducted prior to commencement of a field survey. The main sources of previous data include:

- Data from the Queensland Museum;
- Studies for the Aldoga Aluminum Smelter (Connell Wagner 2002);
- Environmental Data Collection and Monitoring of the Calliope and Boyne Rivers undertaken by SKM (1999);
- Surveys of freshwater fishes and macroinvertebrates undertaken for the Comlaco Aluminium Refinery and Tailings areas at Yarwun and Aldoga (Martin & Barden 1997, Dames & Moore 1998); and
- Aquatic ecology (limnology) baseline studies conducted within the Gladstone industrial lands, WBM Oceanics (1992).

In the field, sampling sites were chosen at representative locations in stream systems draining components of the RSF study area. Sites supporting freshwater were not present within the Refinery study area during the survey period. As a result, no fish or macroinvertebrate sampling was undertaken within the Refinery study area. Within the RSF study area environmental data was collected at each site, including water quality parameters and physical habitat descriptions.

Aquatic macroinvertebrates were sampled using a 250µm mesh triangular "kick net" with aperture 300 x 350 x 300 mm. Two samples were taken at each site, one from sweeps through vegetation or open water, and one from the substrate. All samples were obtained from lentic waterbodies as no riffle, run or glyde areas were present during the sampling period at any sites.

Sweep samples were obtained from a 10m surface sweep of the net through aquatic vegetation (or algal beds where no macrophytes were present) to sample invertebrates of the upper water column. One surface sweep sample was obtained at each site sampled. The base of the net was passed through the water at approximately 150 mm depth and the net contents were washed and transferred to a container with 70% ethanol. Benthic samples were obtained by manually disturbing an area of sediment in front of a 10m net sweep. The sampling net and contents of the sample were washed and filtered to remove larger debris and sediment and transferred to a container with 70% ethanol.

Fishes were sampled within the RSF study area at all sites using dip nets (300mm diameter), cast nets and a fine mesh seine net (5 m long x 1.5 m drop with 2 mm mesh). At each site a minimum of one fine mesh seine drag and 5 net casts were undertaken. Traps of two different sizes were set at all sites. These were fine meshed (2 mm) “Gansel” traps and medium mesh (18 mm) “opera house” traps. Three gansel and

two opera traps were set for a standard period of time (1 hour) at each site and were baited with fish and commercial fish attractant. These traps were used to sample fishes, crustaceans and freshwater turtles.

In the laboratory, specimens from the samples collected were cleaned, sorted and identified to family level.

Where water clarity permitted, bankside observations of fishes and other species were compiled during the day and at night with the aid of a spotlight.

A summary of methodology and survey effort is detailed below in **Table 0-1**.

Table 0-1 Sampling Efforts at Aquatic Sites, June-July 2006

	Site Number			
Method	Aq1	Aq2	Aq3	Aq4
Water Quality/Habitat Parameters	Yes	Yes	Yes	Yes
Macroinvertebrate Samples (10m Sweep)	2	2	2	2
Gansel Traps (1 hour set)	3	3	3	3
Opera House Traps (1 hour set)	2	2	2	2
Seine Net Drags	1	1	1	1
Cast Net Casts	5	5	5	5
General Observations	Yes	Yes	Yes	Yes

Habitat and environmental parameters recorded at each survey site are detailed in Table 4-2.

Table 4-2 Aquatic Survey Site Habitat Data

Parameter	Survey Site			
	AQ1	AQ2	AQ3	AQ4
Catchment	Farmer Creek	Larcom Creek	Farmer Creek	Farmer Creek
GPS Co-ordinates (UTM AMG 94)	56K 304238 7353797	56K 299565 7359376	56K 301416 7351674	56K 302525 7356599
Habitat Class	Dam in RSF Study Area	Large waterhole along ephemeral stream, downstream of RSF study area	Large waterhole along ephemeral stream, downstream of RSF study area	Dam in RSF study area
Date	6-Jun-06	7-Jun-06	12-Jun-06	5-Jul-06
Sample time	1400 hrs	1600 hrs	1100 hrs	1140 hrs
pH	7.3	7	7.6	7.43
D.O. (mg/L)	4	7.9	3.5	9.87
Electrical conductivity (µS/cm)	220	1140	168	180
Water temperature (°C)	20.3	18.2	16.4	16.4
Turbidity FTU	89	10	52	45

Parameter	Survey Site			
	AQ1	AQ2	AQ3	AQ4
Av. width (m)	20	3	10	18
Av. depth (m)	2	0.9	1.5	1.5
Max. depth (m)	2.5	0.5	2.5	2.3
Water flow/level	No flow	No flow	Low to mod flow	No flow
Water surface scum	Not present	Not present	Patchy, isolated	Not present
Sediments	Silt/fine clay/mud 100%	Sand/silt 60% Gravel/rock bed 40%	Sand 50% Rock bed 40% Woody debris 10%	Silt/clay/mud 100%
Bank Incline	Shallow	Shallow	Shallow	Steep
Surrounding vegetation	Cleared agricultural land, *E. moluccana* regrowth + open forest	Narrow band of riverine forest with *Eucalyptus tereticornis, Casuarina cunninghamiana* and *Callistemon viminalis,* remnant riparian open forest	Narrow band of riparian vegetation 8-10m dominated by *Casuarina cunninghamiana* + *Callistemon viminalis* low open forest	*E. crebra, Corymbia citriodora* open forest
Shade cover (%)	10%	30%	40%	10%
Aquatic vegetation	*Cyperus* sp *Typha domingensis* *Eleocharis acuta* *Nymphoides indica* *Marsilea mutica*	*Ludwigia peploides* *Hydrilla verticillata* *Chara spp* *Nitella spp* *Potamogeton crispus* *Vallisneria gigantea* *Urochloa mutica*	*Nymphoides indica*	None present
Algae – water column	None	None	None	Yes
Algae - substrate	None	None	None	None
Land use impacts	Moderate to high cattle disturbance, pig wallows, cane toads present	Moderate to heavy disturbance by cattle, clearing, weeds present	Moderate disturbance by cattle	
Weather	Fine, clear, Air temp 17.6^{o}C	Overcast, Air temp 25.2^{o}C	Fine, Air temp 17°C	Cool, clear, Air temp24.5^{o}C

L.7 Identified Aquatic Invertebrate Species

Table 4-3 Aquatic Invertebrate Species

	Catchment	**Farmer Ck**	**Larcom Ck**	**Farmer Ck**	**Farmer Ck**
	Site	**AQ1**	**AQ2**	**AQ3**	**AQ4**
	Sample (Net Sweep)	**2 x 10m**	**2 x 10m**	**2 x 10m**	**2 x 10m**
Scientific Name	**Common Name**				
Hirudinea					
Family Richardsonianidae	Aquatic Leeches	2	1		
Mollusca					
Family Hydriidae	Freshwater Mussels		4	3	
Family Planorbidae	Freshwater Snail	7	1	3	
Family Thiaridae	Freshwater Snail		11		
Family Hydriobiidae	Freshwater Snail	1			
Family Lymnaeidae	Freshwater Snail		2		
Arachnida					
Family Hydrachnidae	Water Mites	30			
Decapoda					
Family Atyidae	Freshwater Shrimp	3	300		3
Family Palaemonidae	Freshwater Prawn		17		22
Ephemeroptera					
Family Baetidae	Mayflies	52	42		
Odonata					
Family Coenagrionidae	Damselflies	32	15		
Family Aeshnidae	Dragonflies	5			
Family Libellulidae	Dragonflies	3			
Hemiptera					
Family Corixidae	Water Boatmen			20	4
Family Notonectidae	Back Swimmers	35		1	14
Family Pleidae	Pygmy Back Swimmers	40			
Family Veliidae	Small Water Striders				1
Family Mesoveliidae	Water Striders	2			
Family Naucoridae	Creeping Water Bugs	3			
Coleoptera					
Family Dytiscidae	Predacious Diving Beetles	8			7
Family Haliplidae	Crawling Water Beetles		1		

Appendix L.7
Identified Aquatic Invertebrate Species

	Catchment	**Farmer Ck**	**Larcom Ck**	**Farmer Ck**	**Farmer Ck**
	Site	**AQ1**	**AQ2**	**AQ3**	**AQ4**
	Sample (Net Sweep)	**2 x 10m**	**2 x 10m**	**2 x 10m**	**2 x 10m**
Scientific Name	**Common Name**				
Family Hydrophilidae	Scavenger Water Beetles	6			1
Family Hydraenidae	Minute Rove Beetles	3			
Diptera					
Family Chironomidae	Biting Midges	100	10		10
Family Culicidae	Mosquitos	1			
	No of Families	18	11	4	8
	No of Individuals	333	404	27	46
Signal Score	3.05	3.48	2.55	2.42	

L.8 Plates

L.8.1 Farmer Creek

Plate 14: AQ1 Dam Farmer Creek Catchment, RSF Study Area

Plate 15: AQ4 Dam, Upper Farmer Creek Catchment, RSF Study Area

Plate 3: Purple-spotted Gudgeon (Mogurnda adspersa), AQ1

L.8.2 Larcom Creek

Plate 4: AQ2 Larcom Creek

Plate 5: Mouth almighty (Glossamia aprion) AQ3

Plate 6: Spangled perch (Leiopotherapon unicolor) AQ3