F Aquatic Ecology Assessment




Kevin's Corner Project

Aquatic Ecology Assessment

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PHOTO PLATES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

ºC	degrees Celsius
%	percent
AARC	AustralAsian Resource Consultants Pty Ltd
ACARP	Australian Coal Association Research Program
ACTFR	Australian Centre for Tropical Freshwater Research
AnaBat™	Analyse a bat call Trade Mark
ANZECC	Australia and New Zealand Environment and Conservation Council
ARD	Acid Rock Drainage
AS/NZS	Australian Standard / New Zealand Standard
AUSRIVAS	Australian River Assessment System
DEEDI	Department of Employment, Economic Development and Innovation
DERM	Department of Environment and Resource Management
DNR	Department of Natural Resources
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EC	Electrical Conductivity
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPCA	Exploration Permit (Coal) Application
EPT	Ephemeroptera, Plecoptera, and Trichoptera taxa
ESA	Environmentally Sensitive Area
FFG	Functional Feeding Group
HGPL	Hancock Galilee Pty Ltd
ISQG	Interim Sediment Quality Guidelines
km	kilometre(s)
LP Act	*Land Protection (Pest and Stock Route Management) Act 2002*

m	metre(s)
MDL	Mineral Development License
MLA	Mining Lease Application
mg/L	milligrams per Litre
mm	millimetre(s)
NMD	Neutral Mine Drainage
µS/cm	microSiemens per centimetre
n/a	not applicable
NA	not assessed
NATA	National Association of Testing Authorities
NC Act	*Nature Conservation Act 2002*
NCWR	*Nature Conservation (Wildlife) Regulation 2006*
NTU	Nephelometric Turbidity Units
SIGNAL	Stream Invertebrate Grade Number – Average Level
TDS	Total Dissolved Solids
WONS	Weed of National Significance

EXECUTIVE SUMMARY

AustralAsian Resource Consultants Pty Ltd conducted an Aquatic Ecology Assessment of the Hancock Galilee Pty Ltd Kevin's Corner Coal Mine Project (the Project) in March 2009 (wet season), March 2010 (wet season) and September 2011 (dry season). The additional September 2011 dry season aquatic ecology survey was specifically requested by the Department of Environment and Resource Management, in order to assess aquatic environmental values during dry periods. The same aquatic sampling locations were employed for each survey.

The following scope of works was developed for this assessment:

- Literature and database review of aquatic flora and fauna species of conservation significance;
- Aquatic field survey, employing standard methodologies to identify the aquatic flora and fauna species which inhabit the Project site;
- Assessment of aquatic habitat, surface water and stream sediment quality at each sampling location; and
- Preparation of an Aquatic Ecology Assessment report describing significant ecological features and possible management strategies, to reduce any foreseeable impacts associated with the proposed mining activities.

Database Search

A search of various databases (Department of Environment and Resource Management Wildlife Online database and Department Of Sustainability, Environment, Water Population and Communities Protected Matters Search Tool) for aquatic flora and fauna species that are listed under either the Queensland *Nature Conservation Act* (NC Act) or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) was conducted for Kevin's Corner. The search results returned eight fauna species, but no flora species listed as species of conservation significance under either or both Acts. Eleven listed Migratory Marine, Migratory Terrestrial, Migratory Wetland or Marine Overfly bird species were also identified in the EPBC Protected Matters search.

An assessment of wetland habitats in the local area was also conducted, based upon search results that were obtained from the Department of Environment and Resource Management interactive Wetland Maps (2009) database.

Field Survey Methodology

A total of 29 aquatic sites were assessed, in order to determine the overall condition of the available aquatic ecosystems within the Project site. Water samples were taken where surface water was present. The analytical results for surface water quality were compared with the Australian and New Zealand Environment Conservation Council Guideline trigger values (2000).

Macro-invertebrate sampling of waterbodies was undertaken and Stream Invertebrate Grade Number – Average Level bi-plots constructed (based on the family identification results), giving a broad scale measure of stream health based on the 'waterbug' pollution sensitivities.

Vertebrates were assessed via trapping, spotlighting, drag netting and incidental fauna observations.

An assessment of the local habitat was conducted using a modified version of the Australian River Assessment System protocols.

Results

The Project site contained drainage lines and creeks of a range of stream orders. Both lacustrine and riverine wetlands were also present within the Project site. The majority of the drainage lines held little to no water during the survey, despite recent rainfall events. This ephemerality is common in the region.

The surface water quality baseline survey for sampling sites both on and surrounding the Project site indicated that ANZECC (2000) Aquatic Ecosystems Guideline trigger values were exceeded at one or more sites for pH, Electrical Conductivity, Total Nitrogen, Total Phosphorous, Nitrate, Sulphate, Turbidity, Aluminium, Arsenic, Cadmium, Chromium, Copper, Lead, Manganese, Selenium, Zinc and Nickel. Further, Aluminium and Uranium concentrations exceeded the proposed trigger values provided in the ANZECC (2000) Livestock Drinking Water Guidelines for beef cattle.

The stream sediment results indicated low Interim Sediment Quality Guidelines levels were exceeded at AQ18 and AQ19 for Antimony. No other results exceeded the low or high guideline values.

Numerous introduced plant species were identified on the Project site within riparian habitat. However, only three declared floral pest species were found. These species included two Class 2 (Parkinsonia (*Parkinsonia aculeata*) and Parthenium (*Parthenium hysterophorus*)) and one Class 3 (Lantana (*Lantana camara*)) declared weed species under the *Land Protection (Pest and Stock Route Management) Act 2002*. Such species were either identified or known on the Project site within riparian habitats.

No Near Threatened or Threatened animal or plant species were identified during the survey. Many of the creeks were fringed by Regional Ecosystem 10.3.13 (River Red Gum (*Eucalyptus camaldulensis)* woodland with Moreton Bay Ash (*Corymbia tessellaris)* and Melaleuca *(Melaleuca sp*.) occasionally present) and Regional Ecosystem 10.3.14 (River Red Gum (*Eucalyptus camaldulensis)* woodland) present. These REs have “Of Concern” Department of Environment and Resource Management Biodiversity Status, due to weed infestation by species including Parkinsonia (*Parkinsonia aculeata*) and habitat degradation.

The Stream Invertebrate Grade Number - Average Level Index was developed by the National River Health Program as a tool for the bioassessment of water pollution and investigation of the taxonomic composition of the invertebrate assemblage in order to determine river ‘health’. Once plotted on an objective bi-plot graph, an indication of types of pollution and other physical / chemical factors can be interpreted and a basic estimate of river health can be determined. Results indicated that the majority of aquatic study sites fell within quadrants of the graph that indicate high salinity or nutrient levels (may be natural), or indicate urban, industrial or agricultural pollution. This is a likely result of numerous factors including the ephemeral nature of the broader catchment and disturbances by cattle grazing. The macro-invertebrate faunal composition was found to be dominated by predatory taxa.

A total of five amphibian species (one introduced), 12 birds (nine of which are listed under the Environment Protection and Biodiversity Conservation Act 1999 as Migratory and / or Marine), one mammal (introduced), two reptiles and seven fish species were identified during the aquatic surveys.

The one mammal that was identified on the Project site and associated with riparian habitat, Feral Pig (*Sus scrofa*), is listed as a Class 2 pest under the *Land Protection (Pest and Stock Route Management) Act 2002*.

Habitat assessments (based on the Australian River Assessment System model) showed that all of the survey sites assessed fell within the 'moderate' category. The relatively low scores are due to high erosion potential, lack of stable in-stream habitat and / or limited riparian vegetation.

Overall, AQ28 (a lagoon / palustrine wetland) exhibited the greatest species richness and health, in terms of fish and bird species, despite extensive cattle grazing surrounding the site.

Conclusions

The following conclusions were generated for this study:

- The Project site contains drainage lines and creeks of a range of orders, including lacustrine water bodies and riverine wetlands. The majority of the drainage lines held little-to-no water during the survey, despite recent rainfall events. Therefore, water retention in these waterways appears to be limited, even following rainfall events;

- The baseline survey of water quality on and surrounding the Project site showed that certain water quality parameters exceeded the ANZECC (2000) trigger values:

- No Near Threatened or Threatened animal or plant species were identified during the aquatic ecology assessment. The animal and plant species that were identified off the mining lease at aquatic survey locations upstream of the Project site, are presented in the results section of this report;

- Many of the creeks are fringed by Regional Ecosystem 10.3.14 river red gum (*Eucalyptus camaldulensis* woodland) and Regional Ecosystem 10.3.13 river red gum (River Red Gum (*Eucalyptus camaldulensis)* woodland with Moreton Bay Ash (*Corymbia tessellaris) and* Melaleuca *(Melaleuca sp*.) occasionally present) which have an Of Concern Department of Environment and Resource Management Biodiversity Status;

- SIGNAL scoring showed no sites fell within the "pristine" category of Quadrant 1. Sites within Quadrant 2 included AQ1, AQ2, AQ3, AQ5, AQ19, AQ23, AQ28, AQ29, AQ37 and AQ38. All other sites fell within Quadrant 4, probably as a result of numerous factors which include sub-optimal sampling during periods of flooding and disturbances by cattle grazing: and

- The relatively low AUSRIVAS habitat assessments that were determined for all sites (moderate category) are due to high erosion potential, lack of stable in-stream habitat and / or limited riparian vegetation.

The potential impacts of mining activities upon the aquatic environment both on and downstream of the Project site have been identified as follows:

- Land clearing and mining activities within riparian zones may lead to reduced availability of habitat for native species of aquatic flora and fauna, loss of habitat connectivity across the mine and habitat fragmentation;

- Land subsidence as a result of underground mining, which would lead to changes in water flow direction and velocities, loss of habitat and changes to aquatic flora and fauna community structure;

- Noise, vibration and dust associated with the construction and operational phases of the Project may mean that some species will avoid areas that they currently utilise;

- Earthworks may result in potential weed invasion, particularly along watercourses;

- Earthworks may result in increased sedimentation in riparian woodlands downstream of the mine. Higher levels of erosion can lead to a loss of morphological diversity in streams which in turn reduces habitat quality and may result in biodiversity losses in affected areas;

- Human occupation in an area could facilitate the increase in feral animal numbers (e.g. exposed landfill sites would provide food for feral pigs, feral cats, etc). An increase in feral animal numbers may impact upon the native aquatic animals, leading to a decrease in their population sizes;

- Potential spills of chemicals and hydrocarbons may enter waterways, resulting in environmental harm; and

- The proposed creek diversions (Middle Creek) and disturbance (Sandy Creek) will result in some impacts on the environmental values of the aquatic flora and fauna.

Recommendations

The following recommendations have been developed for the aquatic flora and fauna survey:

- Refer to the Pest Management Plan to control the pest species (plants and animals) identified within the Project site and to reduce the potential for infestation by new species;
- A monitoring program should be designed to collect ongoing baseline data for water quality and faunal assemblages. Collection of this data will allow for future detection of any deviation from the 'normal' state of the Project site. Sites for ongoing monitoring should be located upstream (control site), midstream (impact site), and downstream (impact site) of the Project boundary. Reference data can also be collected from similar creek systems not connected to the Project, e.g. upstream of any confluences between impact creeks and Native Companion Creek;
- Water quality will be monitored and site-specific trigger and target values will be developed, in line with the Queensland Water Quality Guidelines (2006) and as part of the EA negotiations; and
- General recommendations for the Project include minimising disturbance areas, and stabilising any disturbance adjacent to creeks that has arisen, as soon as possible.

1.0 INTRODUCTION

AustralAsian Resource Consultants Pty Ltd (AARC) was commissioned by Hancock Galilee Pty Ltd (HGPL) to conduct an Aquatic Ecology Assessment within the proposed Kevin's Corner Project (the Project).

The Kevin's Corner Project is a proposed open-cut and underground coal mining and export operation in Central Queensland, on Mining Lease Application (MLA) 70425. Hancock Prospecting Pty Ltd's proposed Alpha Coal Project is located directly south of MLA70425, on MLA70426.

Once the Kevin's Corner Project is operational, coal is proposed to be mined by draglines, shovels and trucks for the open cut areas and by longwall techniques for the underground mine, processed on site and then transported by rail to a proposed port at Abbot Point.

One of the waterways within the Project, Sandy Creek (Greentree Creek), will need to be partly diverted early in the life of the mine, as it limits the placement of infrastructure and the early development of steady-state dumping operations.

Three aquatic flora and fauna surveys were conducted from 16th to 21st March 2009 (wet season),the 15th to 22nd March 2010 (wet season) and the 19th to 23rd September 2011 (dry season) in order to assess the environmental values of watercourses upstream, within and downstream of the Kevin's Corner MLA during both the wet and dry seasons.

Note that the aquatic surveys were conducted upstream, on, and downstream of the Project site, in order to assess environmental values along the length of the waterways that were assessed. All sampling locations fell within the general catchment area.

Aquatic species that were identified off the Project site, but within the surrounding area were also noted.

1.1 SCOPE OF STUDY

To assess the ecological values of the watercourses on the Project site, the following scope of works was undertaken:

- A literature and database review to identify flora and fauna species of conservation significance known from the region (provided in Appendix A). This enabled these species to be targeted during the field survey component of the study;
- A field survey employing standard methodologies to determine the composition of aquatic flora and fauna species inhabiting the Project site; particularly species of conservation significance;
- Assessment of aquatic habitat, surface water and stream sediment quality at each sampling location; and
- The preparation of a report to HGPL describing the significant ecological features identified and outlining possible management strategies to reduce any foreseeable impacts associated with the proposed mining activities.

2.0 PROJECT DESCRIPTION

Sections 2.1 to 2.6 describe the relevant aspects of the Project site, including location, local geography, topography, local water courses, regional climate and current land uses.

2.1 PROJECT LOCATION

The Project site is located in Central Queensland approximately 420 kilometres (km) west of Rockhampton, 340 km southwest of Mackay, and 110 km west south-west of Clermont. The closest residential area to the Project is the township of Alpha, located approximately 65 km south south-east of the Project site. The location of the Project site is shown in Figure 1 below.

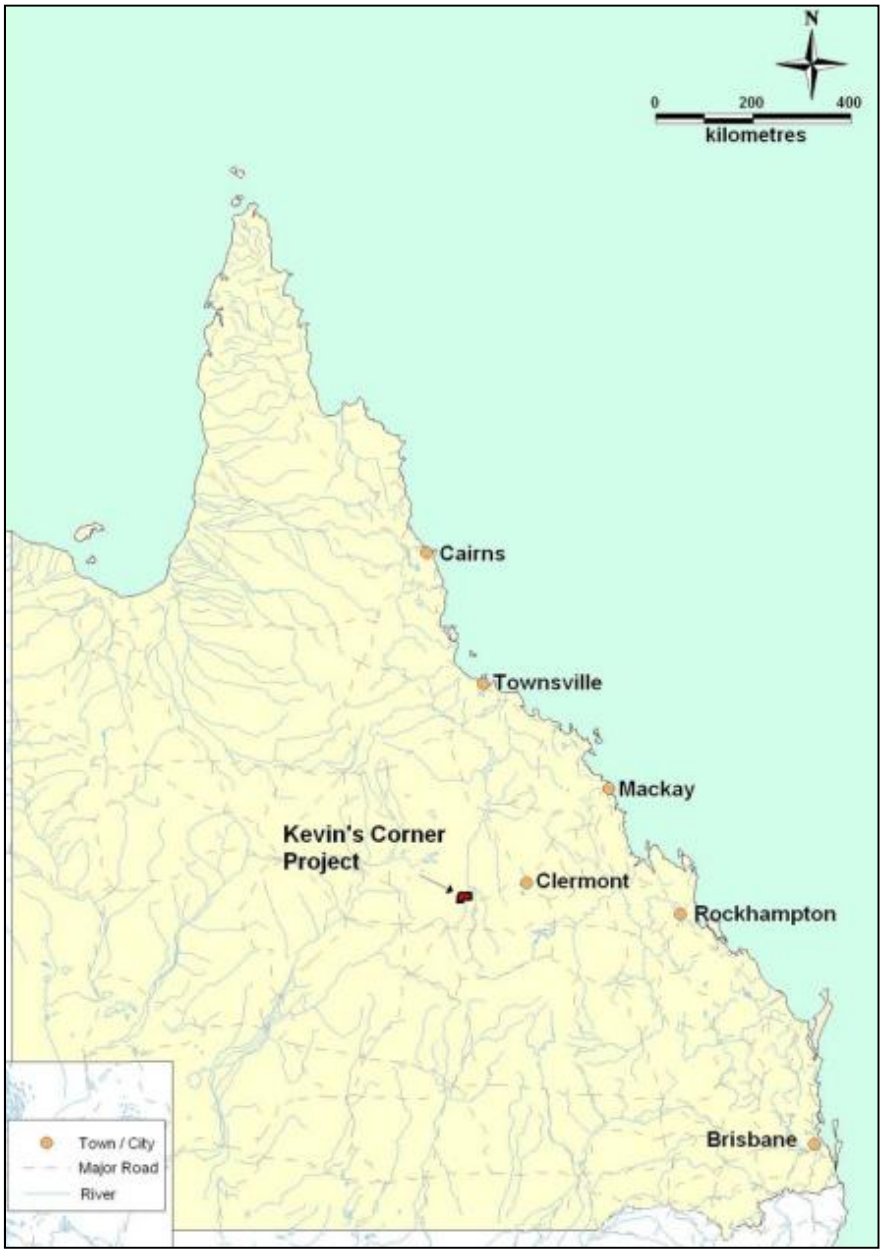


Figure 1**Project Location**

2.2 LOCAL TOPOGRAPHY AND WATERWAYS

The Project site is predominantly situated on flat plains, with vegetated rises occurring along the eastern boundary of the site. These rises ascend approximately 70 metres (m) above the plains.

The Project site lies within the Burdekin Catchment. This catchment includes the Burdekin River and its tributaries north from Greenvale and south to Alpha, together with coastal catchments between Giru and Bowen (Tropical Savannas CRC, 2008). The Burdekin Catchment is divided into sub-catchments, with the Project site falling in to the Belyando-Suttor Sub-catchment. This sub-catchment which extends from the south of Alpha, north to the Belyando Crossing. The Belyando-Suttor Sub-catchment (shown in Figure 2) is the largest within the Burdekin River Basin, covering 73,335 square kilometres (Australian Natural Resources Atlas, 2007).

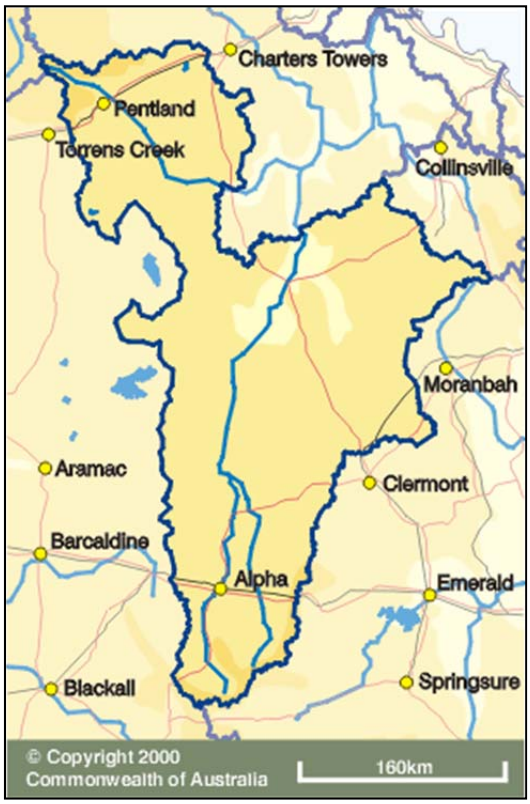


Figure 2**Belyando-Suttor Sub-Catchment**[1]

The distribution of the regional waterways is shown in Figure 3 below. The Native Companion Creek (which, at its closest point is seven km east of the Project site) flows in a northerly direction to join the Belyando River and then into the lower reaches of the Suttor River (Australian Natural Resources Atlas, 2007). Significant tributaries to the Belyando River include Alpha Creek, Mistake Creek, and Native Companion Creek.

[1] Sourced from Australian Natural Resources Atlas, 2007

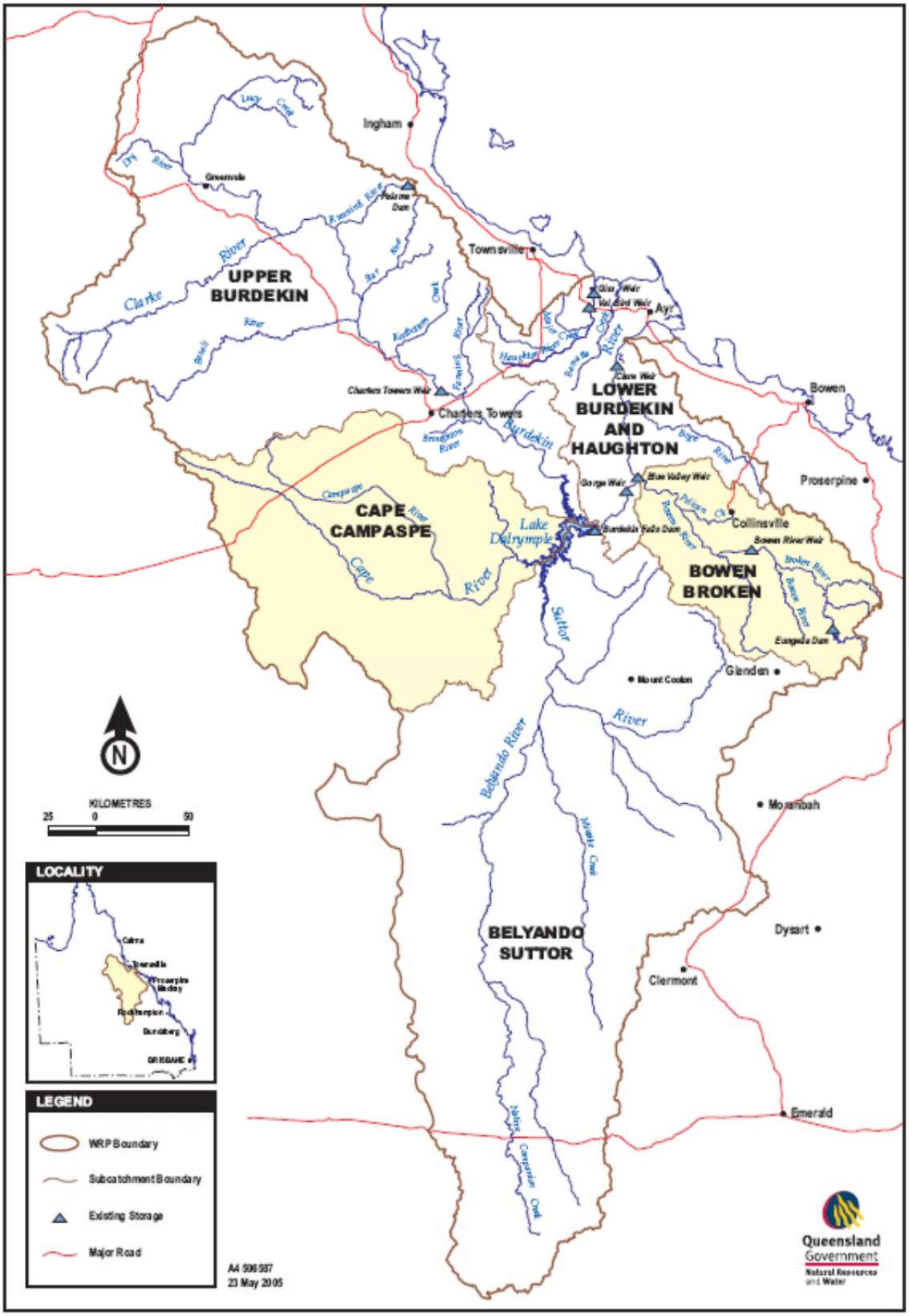


Figure 3**Regional Waterways**[2]

[2] Sourced from the Burdekin Basin Water Resource Plan (DERM, 2007)

The Project site is traversed by numerous ephemeral drainage lines and creeks as shown in Figure 4. Sandy Creek flows in a northerly direction the entire length of the Project site, with the tributaries Well Creek, Middle Creek, Rocky Creek and Little Sandy Creek joining it from the western side of the Project site. One lacustrine water body and one riverine wetland area is situated within the Project area (refer to Figure 7 for location details of these wetland areas). Surface water within the Project site is primarily used for stock drinking water.

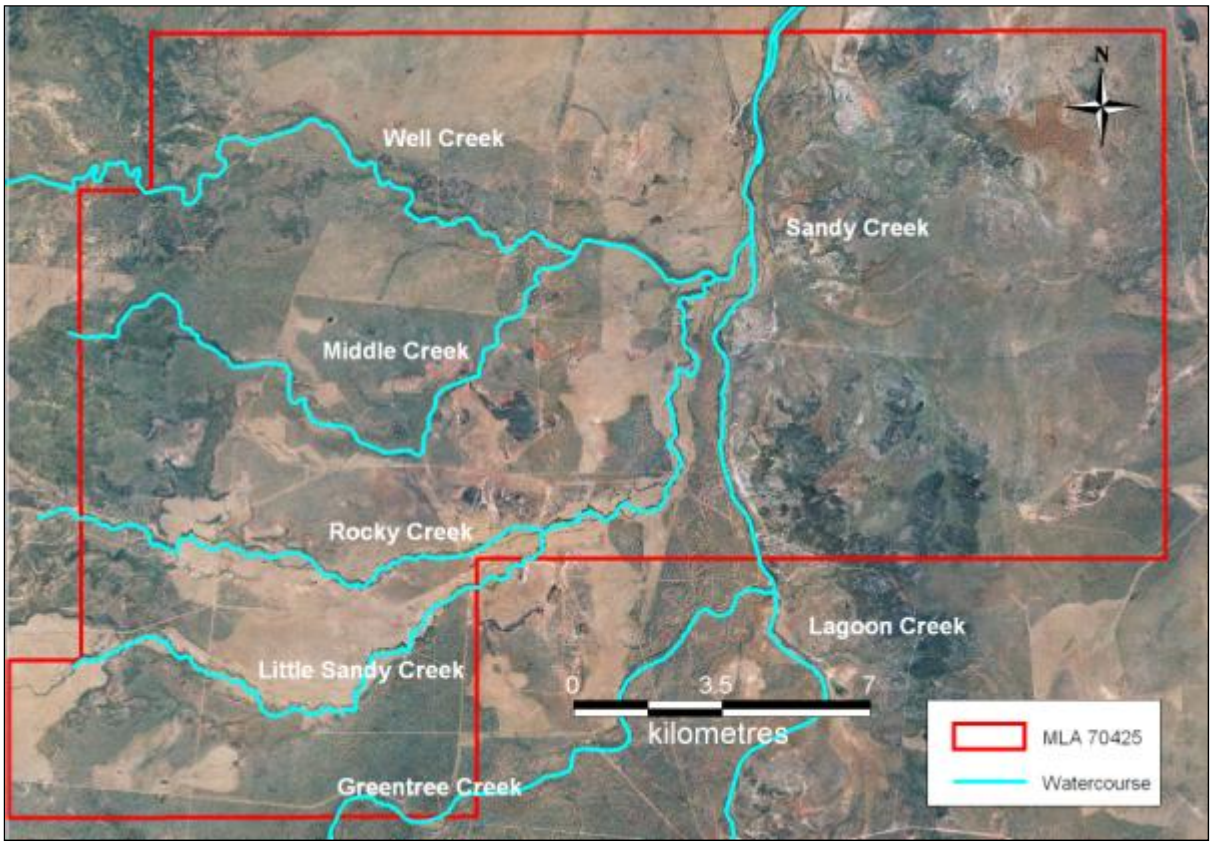


Figure 4**Local Waterways**

3.0 REGIONAL CLIMATE

This climatic description of the region in which the Project site is located has been compiled using the regional data collected by Australian Bureau of Meteorology (http://www.bom.gov.au). The data has been sourced from weather stations located in Clermont (Station 035019), Alpha (Station 035000) and Barcaldine (Station 036007).

Monthly rainfall data has been captured consistently since 1887 from the Alpha Post Office, representing the closest reliable rainfall gauge to the Project site (refer to Figure 5 for details). Rainfall data from the weather station at Alpha indicates that January and February exhibit the highest mean monthly rainfall, averaging 117.5 millimetres (mm) and 115 mm respectively. The driest months of the year are August and September, recording an average of 19.1 mm and 20.4 mm respectively.

The Project region experiences distinct wet and dry seasons. The wet season typically falls between the months of December and February. The remaining months make up the dry period, averaging around 30 mm per month. The average annual rainfall for the region is 664.3 mm per year

The surrounding regions of the Project site typically experience hot summer days, with mean maximum daylight temperatures in December-January of around 35 degrees Celsius (ºC). The coldest mean daily temperatures occur in July (9ºC). The temperature record for the period 1971 to 2011 is provided in Figure 5.

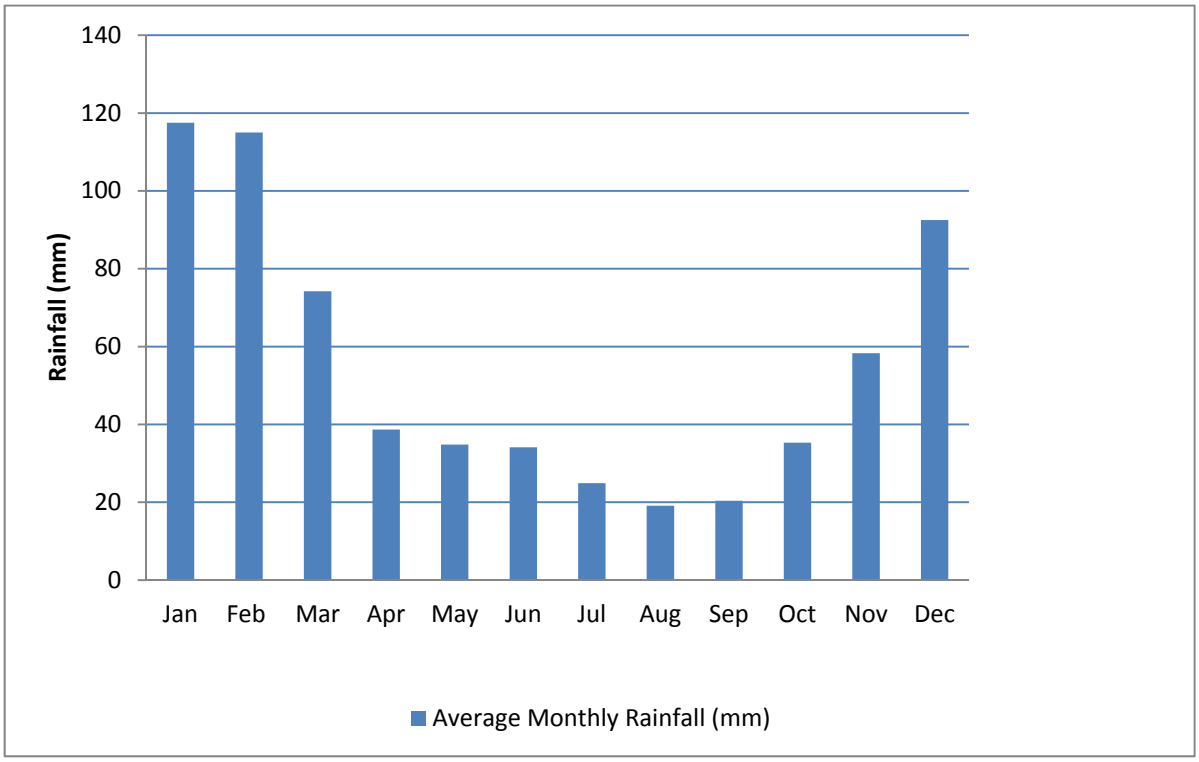


Figure 5**Rainfall Statistics for Alpha (1887 to 2011)**

Temperature data is sourced from the Clermont Station, and has been compiled since 1971. The coldest mean daily temperatures occur in July (8 degrees Celsius (ºC)), with November to January having a mean maximum temperature of 34ºC (shown in Figure 6).

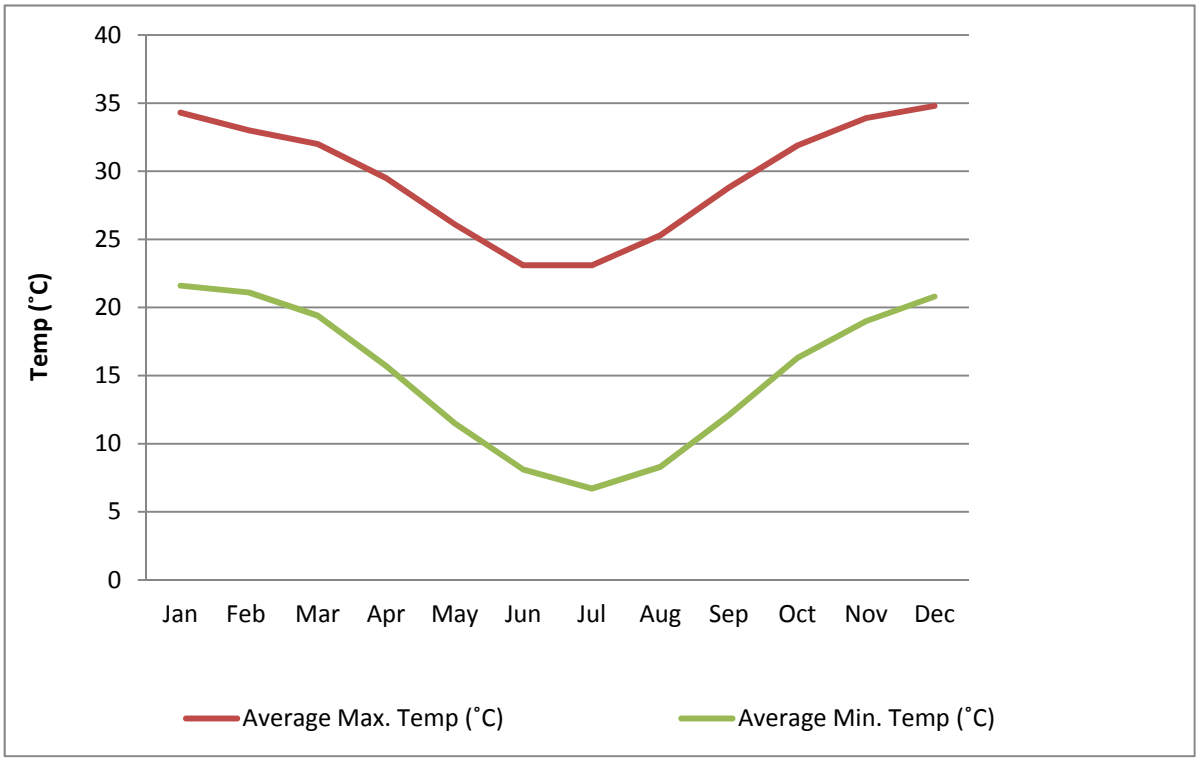


Figure 6**Temperature Statistics for the Alpha region (1971 to 2011)**

Humidity levels recorded at the Barcaldine Station show a mean monthly level of 54 percent (%) at 9:00 am and 33% at 3:00 pm, with the highest monthly humidity reaching 64% in June at 9:00 am and the lowest humidity reaching 26% in September at 3:00 pm. Humidity levels recorded at the Clermont weather station display the highest monthly humidity reaching an average of 71% in February and the lowest humidity reaching 29% in September.

3.1 CONDITIONS PRIOR TO AND DURING THE SURVEY

The timing of each survey was selected to the seasonal variation on site, namely; wet season surveys between February and March and the dry season survey (which was undertaken at the request of DERM) was undertaken in September. The dates of each survey and local climatic conditions are provided below.

March 2009 – Wet Season

A total of 26.2 mm of rain fell in the Alpha region (as measured at the Alpha Station) in the month of March 2009 and 148.4 mm of rainfall fell in February 2009. Temperatures (as measured at Clermont) ranged from 18.1ºC to 35.4ºC.

March 2010 – Wet Season

A total of 94.8 mm of rain fell in the Alpha region (as measured at the Alpha Station) in the month of March 2010 and 212.8 mm of rainfall fell in February 2010. Temperatures (as measured at Clermont) ranged from 19.7ºC to 30.1ºC.

September 2011 – Dry Season

A total of 1.0 mm of rain fell in the Alpha region (as measured at the Alpha Station) at the end of September 2011 (after the dry season survey had been completed) whilst 0.4 mm of rain fell during the month of August 2011. Temperatures (as measured at Clermont) ranged from 9.5 ºC to 29.8 ºC over this 2 month period.

3.2 CURRENT LAND USE

Low intensity cattle grazing and mineral exploration are the predominant land use activities on the Project site.

4.0 RELEVANT LEGISLATION

Legislation relevant to the assessment of aquatic flora, fauna and biodiversity on the Project site is discussed below.

4.1 QUEENSLAND NATURE CONSERVATION ACT 1992

The most relevant portions of the *Nature Conservation Act 1992* (NC Act) to the Project are the sections which pertain to Wildlife and Habitat Conservation. The classes of wildlife[3] to which the NC Act applies includes protected wildlife, which is defined as:

- Extinct in the wild wildlife;
- Endangered wildlife;
- Vulnerable wildlife;
- Near threatened wildlife; and
- Least concern wildlife.

Species listed under the above classes are published in the associated *Nature Conservation (Wildlife) Regulation 2006* (NCWR).

The NC Act defines 'threatening processes' as:

a) Threatening the survival of any protected area, area of major interest, protected wildlife, community of native wildlife or native wildlife habitat; or

b) Affecting the capacity of any protected area, area of major interest, protected wildlife, community of native wildlife or native wildlife habitat to sustain natural processes.

The NC Act is relevant to the Project should any flora or fauna species of conservation significance (as detailed in the NCWR) be found on the Project site.

4.2 COMMONWEALTH ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

Under the EPBC Act, an action will require approval from the Federal Environment Minister if the action has, will have, or is likely to have a significant impact on a matter of National Environmental Significance. Matters of National Environmental Significance include:

- World Heritage properties;
- National Heritage Places;
- RAMSAR wetlands of international importance;

[3] Under the *Nature Conservation Act 1992*, Wildlife is defined to be any taxon of an animal, plant, protista, procaryote or virus.

- Nationally Threatened species and communities;
- Migratory species protected under international agreements;
- Nuclear Actions;
- Great Barrier Reef Marine Park; and
- The Commonwealth marine environment.

Of the above matters of National Environmental Significance, only two are applicable to the Project site:

- Listed Threatened species and communities; and
- Migratory species protected under international agreements.

Consequently, should any species/communities listed as Threatened or Migratory be found on the Project site, the Project will be assessed under guidelines provided in the EPBC Act.

In addition, the EPBC Act provides for the identification and listing of key threatening processes.

4.3 QUEENSLAND LAND PROTECTION (PEST AND STOCK ROUTE MANAGEMENT) ACT 2002

The objectives of *the Land Protection (Pest and Stock Route Management) Act 2002* (LP Act) are to consolidate, amend and provide laws for the management, control, prohibition, and regulation of the introduction, spread and keeping of certain plants and animals declared under the Act. The LP Act is relevant to the Project with regard to the control and management of declared pest plant (weed) and animal species.

5.0 DATABASE SEARCH AND LITERATURE REVIEW

Database searches (Protected Matters Search Tool and Wildlife Online) have collated information on flora and fauna species identified in the region from previous surveys, community records and other sources. A review of such databases facilitated the formulation of specific field-survey techniques and the targeting of certain flora and fauna species, vegetation communities and habitat types known from the region.

The database search areas were limited to a square area 100 km x 100 km, with the centre of the search area located in the middle of Kevin's Corner MLA (Lat: -23.0595, Long: 146.4995 (23° 3' 34.1994 mS, 146° 29' 58.2" mE)).

The following databases were searched for historical records of flora and fauna within the vicinity of the Project site that have habitat requirements intrinsically linked to aquatic habitats. Note that although particular species may be identified from the database search, they are not necessarily present, nor likely to occur, on the Project site:

- EPBC Act Protected Matters Search Tool (Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)). This database provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act for a nominated area; and

- Wildlife Online Database (Department of Environment and Resource Management (DERM)): This database uses records collected from previous surveys, including the Queensland Museum surveys as well as records from the public.

5.1 FLORA

Review of the databases and previous surveys conducted in the region indicate a number of flora species of conservation significance, however none of these species are associated with aquatic ecosystems as indicated by the Queensland Herbarium No aquatic threatened ecological communities were identified from the EPBC database search.

5.2 FAUNA

Literature and database searches indicated that eight fauna species of conservation significance which are intrinsically linked to aquatic habitats and / or feed almost exclusively within aquatic habitats may occur within the database search area. These species are listed in Table 10 below.

A further 11species, listed under the EPBC Act as Migratory Marine, Migratory Terrestrial, Migratory Wetland or Marine Overfly, which have habitat requirements linked to aquatic areas were identified in the database searches. These species are presented in Table 2 below.

Table 1 Near Threatened and Threatened Fauna from the Kevin's Corner Project Area

Scientific Name	Common Name	Conservation Status	
		EPBC Act	NC Act
Birds			
Erythrotriorchis radiatus	Red Goshawk	Vulnerable	Endangered
Geophaps scripta scripta	Squatter Pigeon (southern)	Vulnerable	Vulnerable
Lophoictinia isura	Square-tailed Kite	-	Near Threatened
Melithreptus gularis	Black-chinned Honeyeater	-	Near Threatened
Neochmia ruficauda ruficauda	Star Finch (eastern), Star Finch (southern)	Endangered	-
Poephila cincta cincta	Black-throated Finch (southern)	Endangered	-
Rostratula australis	Australian Painted Snipe	Vulnerable	-
Reptiles			
Denisonia maculata	Ornamental Snake	Vulnerable	-

= not listed

Table 2 Migratory and Marine Fauna (Birds) potentially occurring in the Kevin's Corner Project area

Scientific Name	Common Name	Migratory Species			Listed Marine Species
		Migratory Marine Birds	Migratory Terrestrial Species	Migratory Wetlands Species	
Anseranas semipalmata	Magpie Goose				X
Apus pacificus	Fork-Tailed Swift	X			X
Ardea alba	Great Egret	X		X	X
Ardea ibis	Cattle Egret	X		X	X
Gallinago hardwickii	Latham's Snipe			X	X
Haliaeetus leucogaster	White-Bellied Sea-Eagle		X		X
Hirundapus caudacutus	White-throated Needletail		X		X
Merops ornatus	Rainbow Bee-eater		X		X
Myiagra cyanoleuca	Satin Flycatcher		X		X
Nettapus coromandelianus albipennis	Australian Cotton Pygmy-goose			X	X
Rostratula benghalensis s. lat	Painted Snipe			X	X

5.3 WETLAND HABITATS

A review of the DERM interactive Wetland Maps (2009) database[4] revealed the presence of lacustrine and riverine water bodies within the Project site (refer to Figure 7 for location details of these water bodies). However, these water bodies are not outlined within the Environmentally Sensitive Areas (ESAs) mapping for the Project area. ESAs mapping shows the Category A, B, and C areas of conservation significance, including those under international agreements (e.g. RAMSAR wetlands).

Lacustrine wetlands are wetlands and deepwater habitats situated in topographic depressions, dammed river channels, or artificial waterbodies i.e. lakes. Riverine wetlands (i.e. Well Creek) are wetlands and deepwater habitats contained within a channel. Due to scale constraints these areas may include fringing palustrine vegetation i.e. vegetated swamps. Further details of the locations of these wetlands are provided in Appendix A.

Further to wetland habitat mapping, ground-truthing of each wetland environment was conducted during the field survey component of the assessment to examine habitat value.

[4] Available at http://www.epa.qld.gov.au/wetlandinfo/site/MappingFandD/WetlandMapsAndData.html

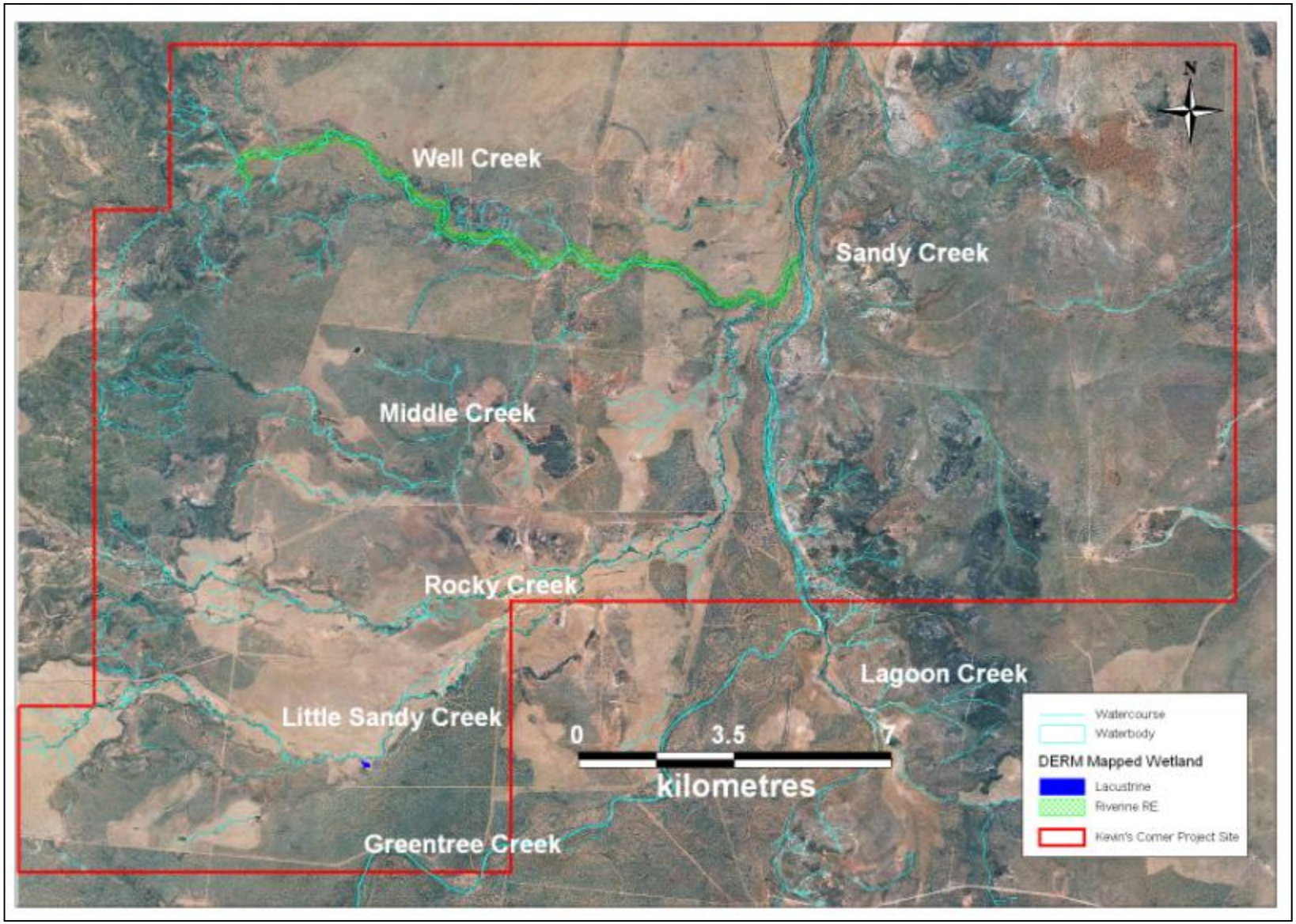


Figure 7**DERM Mapped Wetland Habitats for the Project Site**

6.0 SURVEY METHODOLOGY

6.1 SURVEY TIMING

The initial aquatic survey was undertaken in the wet season between the 16th and 21st of March 2009. Additional surveys were undertaken between the 15th and 22nd of March 2010 (wet season – habitat assessment for additional sampling locations AQ36 – AQ42 only) and between the 19th and 23rd of September 2011 (dry season). .The dry season sampling occurred at all of the sites that were employed in the wet season sampling in March 2009 and March 2010. However, dry season sampling only occurred at sites located within the Kevin's Corner tenement. No additional methodologies were employed in the dry season survey.The surveys were conducted at these times to account for the seasonal variation during the wet and dry seasons. Rainfall was sufficient both before and during March 2009 and March 2010 to allow for the local aquatic community to be fully expressed in terms of aquatic species diversity; ie. several weeks are required after initial hydration for frog eggs to develop into recognisable adults.

The additional September 2011 dry season aquatic survey was specifically requested by the Department of Environment and Resource Management in order to assess aquatic environmental values during dry periods. However, it must be noted that water quality assessments could only be taken at sites that had sufficient water to obtain adequate samples.

The survey methods that were employed are discussed in Section 5.3. The locations of the Project aquatic survey sites are presented in Figure 8

6.2 PERSONNEL

A team of at least two suitably qualified and experienced ecologists undertook each field survey described above. For each survey AARC deployed one senior ecologist with at least five years of experience, along with at least one other ecologist with a minimum of 2 years of experience.

6.3 FIELD SURVEY METHODS

The location of each aquatic survey site was based upon database searches, location of Project site infrastructure (upstream/midstream/downstream of impacts), diversity in aquatics habitat (riffle/fun/pools) and accessibility to the survey site. Site selection aimed to ensure that the sites sampled were representative of all habitat types present in the Kevin's Corner Project Site. The level of assessment undertaken at each site is described in Sections 5.3.1 to 5.3.6, and tabulated in Table 3.

6.3.1 INITIAL SITE SCOPING

Site scoping was conducted using two methods. Firstly, aerial photography and topographic maps of the Project site were reviewed, in order to gain an overall perspective of the location of watercourses, and the direction of water flow.

Secondly, accessible areas of the Project site were broadly surveyed from a vehicle. This allowed the targeting of upstream, midstream, and downstream locations, as well as habitats potentially occupied by species of conservation significance.

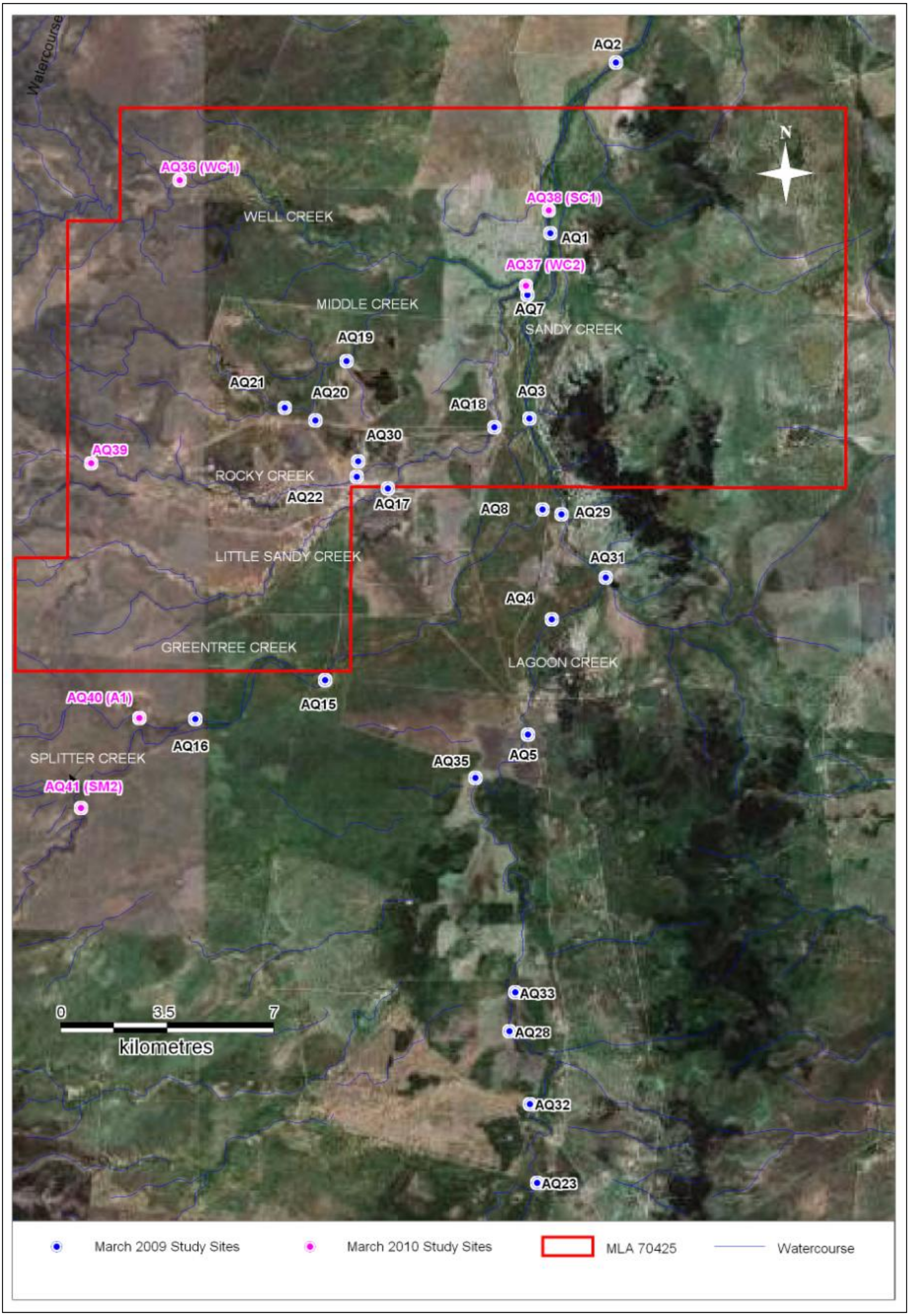


Figure 8**Aquatic Survey Site Locations**

6.3.2 SURFACE WATER QUALITY SAMPLING

An assessment of surface water quality was conducted at each site, at the same time as the aquatic flora and fauna assessment. Surface water data was acquired in order to identify any relationships that may exist between flora / fauna communities and water quality, since water chemistry can influence habitat quality and wildlife assemblages. This data also provides a pre-mining baseline for water quality and the structure and quality of aquatic flora and fauna on the Project site.

At each site where surface water was available, *in situ* recordings of pH, Electrical Conductivity (EC), and temperature within the water body was taken. Surface water samples were also collected from each site (where sufficient water was available), immediately refrigerated and sent to a National Association of Testing Authorities (NATA) accredited lab for analysis of the following parameters:

- Total Dissolved Solids (TDS)
- Total Nitrogen
- Total Phosphorous
- Nitrate
- Sulphate
- Fluoride
- Turbidity
- Aluminium
- Uranium
- Arsenic
- Boron
- Cadmium
- Calcium
- Copper
- Lead
- Manganese
- Mercury
- Molybdenum
- Antimony
- Nickel
- Selenium
- Zinc
- Chromium

Care was taken when obtaining samples that the sediment within the water body was not disturbed.

A total of 17 sites contained sufficient surface water for samples to be obtained and analysed.

6.3.3 AQUATIC AND RIPARIAN VEGETATION IDENTIFICATION

At each of the sites surveyed, a brief description of the riparian vegetation was recorded. This is captured more fully in the Terrestrial Flora and Fauna Report produced by AARC (2011) (also refer to Volume 2 Appendix L1, in the EIS). Where in-stream flora was observed, these species were also identified and their dominance recorded.

6.3.4 MACRO-INVERTEBRATE SAMPLING

The shallows of the waterbodies at 17 sites were kick-sampled (disturbing the stream bed and passing a D-frame net with a 100 micrometre mesh-size through the resulting plume, along 5-10 m sections of the water body). Various microhabitats within the stream were targeted. All macro-invertebrates, sampled over a 20 minute period, were placed in a preservative solution and identified to family or sub-family level. Samples collected during the March 2009 survey were identified at the Australian Centre for Tropical Freshwater Research, samples collected in March 2010 were identified by FRC Environmental and samples from the September 2011 survey were identified by ALS Environmental.

6.3.5 AQUATIC VERTEBRATE FAUNA SAMPLING

The aquatic vertebrate composition of each survey site was assessed via four methods: drag netting, baited traps, spotlighting and call recording. These are explained below. Electro fishing was considered as an additional aquatic sampling technique for the dry season survey but was not employed; any electro-fishing data collected during the dry season could not be compared with the trapping data collected during the wet season where electro-fishing was not employed.

6.3.5.1 DRAG NETTING

The water body at each survey site in which vertebrate fauna sampling was undertaken was swept using a 25 mm mesh-size drag net strung between two people as they walked slowly up sections of the water body. This method allows large sections of the watercourse to be sampled; however snags and benthic debris can allow fish to avoid the net. Watercourses too narrow / shallow to allow the net to extend were excluded from drag netting. A total of 9 sites were drag netted over the course of the field survey.

6.3.5.2 BAITED TRAPS

Opera-house and box traps were used at each site where trapping was to be undertaken to target carnivorous species. Traps were baited with either dry dog biscuits or bones to lure fish and other vertebrates into the traps. At each site where trapping was undertaken, four traps were left out for three nights each, and emptied at first light. All animals captured were identified, their abundances recorded and then released back into the water.

6.3.5.3 SPOTLIGHTING

Spotlighting was carried out at night along various sections of the water bodies in an attempt to observe nocturnal wildlife that are less likely to be detected by other survey methods, such as frogs and reptiles.

6.3.5.4 FAUNA CALL RECORDING

A Song Meter SM2 Digital Field Recorder was deployed overnight at each site where trapping was undertaken. It was programmed to record amphibian calls from 5.30pm to 6.30am the next morning. Any calls were analysed using Wildlife Acoustics Song Scope V4 software.

An AnaBat™ micro-bat call recorder was also deployed overnight at each site where trapping was undertaken. It was programmed to record from 5:30pm to 6:00am the next morning. The results were analysed by Balance Environmental, using AnaLookW V3.3q software.

6.3.6 HABITAT ASSESSMENT

A habitat assessment was performed at selected sites using a modified version of the Australian River Assessment System (AUSRIVAS) protocols developed by the Department of Natural Resources and Mines in 2002. AUSRIVAS is a nationally standardised method for giving an assessment of the biological health of inland rivers within Australia. Each surveyed site was given a score out of 135, with higher numbers indicating favourable habitats normally associated with healthy waterways. Habitat Assessments were conducted at a total of 26 sites as shown in Table 3.

Table 3 Assessment Level per Survey Location

Site	Assessment Level						
	Water Sampling	In situ water reading	Sediment Sample Taken	Macro-invertebrate Sampling	Drag Netting	Baited Trapping	Habitat Assessment
AQ1	X	X	X	X	X	X	X
AQ2	X	X	X	X			
AQ3	X	X	X	X	X	X	X
AQ4	X	X	X	X	X	X	X
AQ5	X	X	X	X	X	X	X
AQ7			X				X
AQ8			X				X
AQ15			X				X
AQ16			X				X
AQ17	X	X	X	X		X	X
AQ18	X	X	X	X		X	X
AQ19	X	X	X	X		X	X
AQ20			X				X
AQ21			X				X
AQ22			X				X
AQ23	X	X	X	X	X	X	X
AQ28	X	X	X	X	X	X	X
AQ29	X	X	X	X			
AQ30		X	X				
AQ31	X	X	X	X	X		X
AQ32			X				X
AQ33			X				X
AQ35			X				X

Site	Assessment Level						
	Water Sampling	In situ water reading	Sediment Sample Taken	Macro-invertebrate Sampling	Drag Netting	Baited Trapping	Habitat Assessment
AQ36	X	X	X	X	X	X	X
AQ37	X	X	X	X		X	X
AQ38	X	X	X	X	X	X	X
AQ39			X				X
AQ40	X	X	X	X			X
AQ41	X	X	X	X			X

6.4 DATA ANALYSIS

6.4.1 SURFACE WATER QUALITY

Data from the DERM (2007) watershed website for Native Companion Creek (measured at Violet Grove) was compiled and compared to the survey data (refer to Table 5 and Table 6 for details of the analytical data). Various parameters of this data have been collected between 1968 and 2006.

Results of the analysis conducted on the surface water samples obtained in the field were compared with ANZECC (2000) Guidelines for both Aquatic Ecosystems for 95% species protection levels and Livestock Drinking Water, where trigger levels exist for the analysed parameters.

6.4.2 MACRO-INVERTEBRATE SAMPLING

The resultant macro-invertebrate species list was analysed for the presence / absence of Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa. The EPT group of macro-invertebrates; Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddis flies) are three orders of insects that are especially sensitive to disturbance. Generally there are more EPT species in areas of higher water quality and available habitat than in degraded water bodies. When this information is looked at in conjunction with other data such as Stream Invertebrate Grade Number – Average Level (SIGNAL) Scores, water quality, etc, a basic estimate of river health can be determined.

The SIGNAL Index was developed by the National River Health Program as a tool for the bio-assessment of water pollution and looks at the taxonomic composition of the invertebrate assemblage to determine river 'health'. Each macro-invertebrate is given a grade number between 1 and 10 based on their sensitivity to various pollutants (Chessman, 2003), with a lower number indicating a higher tolerance to a range of conditions. The SIGNAL Index value is calculated by averaging the pollution sensitivity grade numbers of the families present at each site, and plotting them. Crustaceans captured in the baited traps do not contributed to the SIGNAL scoring process, as due to the catch-release nature of the trapping methodology accurate catch numbers over a given timeframe cannot be calculated, and the potential for recaptures exists.

Once plotted on a bi-plot, the SIGNAL Index and the number of invertebrate families found in a stream used together can provide an indication of the types of pollution and other physical and

chemical factors that affect macro-invertebrate communities (Chessman, 2003), depending on their position within the graph (refer to Figure 9 below for bi-plot interpretation).

Quadrant 3 Often indicating toxic pollution or harsh physical environments	**Quadrant 1** Indicates favourable habitat or chemically dilute water
Quadrant 4 Usually indicating urban, industrial, or agricultural pollution	**Quadrant 2** Often indicating high salinity or nutrient levels (may be natural)

Figure 9**SIGNAL 2 Bi-Plot Interpretation**

The results of the macro-invertebrate identification were reviewed to determine the Functional Feeding Groups (FFGs) present within each water body. The term Functional Feeding Group refers to the method by which each species of invertebrate obtains food, and the relative abundance of macro-invertebrate FFGs may reflect the in-stream processes of the habitat. The ideal 'healthy' aquatic habitat has representatives of each FFG. Dominance or loss of a particular FFG may indicate a change in the ecological status of the stream or pool. In the absence of degradation of habitat or water quality, there will always be a natural dominance in relation to natural food sources e.g. an abundance of leaf litter will be reflected by an abundance of shredders.

6.4.3 HABITAT ASSESSMENT

An assessment of each of the aquatic habitats encountered both on and off the Project site was conducted via the AUSRIVAS habitat assessment. Table 4 below provides a framework for interpreting the habitat assessment scores.

Table 4 Key to AUSRIVAS Habitat Assessment Scores and Interpretation of these Scores

Habitat Assessment Score	Interpretation
0 – 35	Habitat is poor. There is limited habitat availability for in-stream fauna. There is little variation in velocity and depth of water, and the creek bed consists of a single sediment type. The water body typically consists of a small, shallow pool. Streamside vegetation, if present, consists of grasses and sedges. There is moderate to significant erosion on the banks.
36 – 70	Habitat variety is moderate. This could be due to leaf litter and other vegetation or detritus in the water, or the presence of boulders and rocks. The streamside vegetation consists mainly of grasses and sedges. There is moderate evidence of bank erosion, and the percentage of vegetative cover on the banks is less than 50%.
71 – 100	Habitat is relatively good. The bank is stable, there is variety in depth and velocity within the water body and substrate type is variable and tending towards boulders and rocks. Streamside vegetation is of trees and shrubs, adding to the bank stability. The percentage of streamside cover by vegetation is relatively high.
101 – 135	Indicates a pristine and favourable habitat. There is no bank erosion and the dominant vegetation is trees. There is great variety in depth and velocity, and the habitat is quite complex, offering many types of protection for in-fauna. This is usually afforded by logs and branches, leaf litter, variety in substrate type, variety in water depth, and presence of vegetation living within the water body.

7.0 RESULTS AND DISCUSSION

A total of 29 sites were assessed for various elements of the aquatic survey. The results of each analysis are provided in Sections 6.1 to 6.6. Descriptions of each site are summarised in Appendix B.

7.1 STREAM MORPHOLOGY

A range of morphologies in creeks, drainage lines, riverine, and lacustrine areas were assessed during the course of the study. Photographs of each aquatic type are shown below in Photo Plate 1 to Photo Plate 6 and were taken at representative AARC sampling locations.

Photo Plate 1 Anabranch of 3rd Order Creek (AQ1)

Photo Plate 2 Dammed Section of 2nd Order Creek (AQ4)

Photo Plate 3 1st Order Drainage Line (AQ20)

Photo Plate 4 Lagoon / Palustrine Wetland (AQ28)

Photo Plate 5 Lacustrine Wetland (AQ31)

Photo Plate 6 Confluence of Two 1st Order Drainage Lines (AQ21)

7.2 SURFACE WATER

The surface water results that were generated for the Project site are presented in Table 5 and Table 6 and have been compared with both the ANZECC (2000) Aquatic Ecosystems Guidelines for 95% species protection for lowland river systems in Central Queensland and the ANZECC (2000) Livestock Drinking Water Guidelines for beef cattle. The laboratory analytical results for these surface water samples are provided in Appendix C.

The results from the baseline surveying of surface water quality on and surrounding the Project site show that water exceeds the trigger values provided in the ANZECC (2000) Aquatic Ecosystems Guidelines at one or more sites for pH, EC, Total Nitrogen, Total Phosphorous, Nitrate, Sulphate, Turbidity, Aluminium, Arsenic, Cadmium, Chromium, Copper, Lead, Manganese, Nickel, Selenium and Zinc. Further, Aluminium and Uranium concentrations exceeded the proposed trigger values provided in the ANZECC (2000) Livestock Drinking Water Guidelines.

Table 5 Surface Water Physico-Chemical Analysis Results

	Field pH		Field EC (microSiemens / centimetre)		Field Temperature (ºC)		TDS (milligrams / Litre (mg/L))		Total Nitrogen (mg/L)		Total Phosphorous (mg/L)		Nitrate (mg/L)		Sulphate (mg/L)		Fluoride (mg/L)		Turbidity (Nephelometric Turbidity Units (NTU))	
ANZECC Aquatic Ecosystems Values	6.5 – 8.0		125 – 2200		n/a		n/a		0.5		0.05		0.7		n/a		n/a		Jun-50	
ANZECC Livestock Drinking Water Values	n/a		n/a		n/a		4000		n/a		n/a		400		1000		2		n/a	
Season	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011
AQ1	6.88	ND	28.7	ND	28.2	ND	236	ND	1.42	ND	0.76	ND	1.29	ND	<0.01	ND	0.34	ND	47.9	ND
AQ2	7.11	ND	26.7	ND	26	ND	194	ND	1.9	ND	1.95	ND	1.19	ND	<0.01	ND	0.3	ND	106	ND
AQ3	7.25	ND	158	ND	31.4	ND	112	ND	1.22	ND	0.94	ND	1.19	ND	<0.01	ND	0.33	ND	37.8	ND
AQ4	7.27	ND	98.4	ND	29.6	ND	68	ND	10.83	ND	4.11	ND	10.56	ND	<0.01	ND	0.22	ND	230	ND
AQ5	7.15	ND	98.8	ND	26	ND	76	ND	10.53	ND	1.28	ND	10.26	ND	1	ND	0.11	ND	97.6	ND
AQ17	7.32	ND	265	ND	25.4	ND	152	ND	4.45	ND	7.68	ND	3.38	ND	1	ND	0.41	ND	638	ND
AQ18	7.24	7.22	144.4	189.2	27.5	16.6	92	476	4.13	5.6	3.16	0.83	3.91	0.02	<0.01	7	0.46	0.1	220	ND
AQ19	7.55	ND	171.3	ND	28.9	ND	114	ND	3.36	ND	11.17	ND	1.96	ND	<0.01	ND	0.35	ND	765	ND
AQ23	ND	ND	ND	ND	ND	ND	106	ND	4.18	ND	1.4	ND	4.08	ND	<0.01	ND	0.26	ND	51.6	ND
AQ28	ND	ND	ND	ND	ND	ND	96	ND	1.75	ND	0.68	ND	1.69	ND	<0.01	ND	0.16	ND	12.78	ND
AQ29	6.73	ND	104.9	ND	24.7	ND	122	ND	2.87	ND	1.01	ND	2.6	ND	<0.01	ND	0.22	ND	34.2	ND
AQ30	8.61	ND	315	ND	32.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	ND	n/a	ND	ND	ND
AQ31	8.8	ND	229	ND	30	ND	212	ND	54.48	ND	5.21	ND	53.76	ND	1	ND	0.25	ND	500	ND
AQ36	6.52	7.19	200	178.3	26.5	18.1	102	173	<0.1	0.8	n/a	0.07	<0.04	0.02	2	2	<0.01	0.3	ND	ND
AQ37	6.91	ND	240	ND	23	ND	141	ND	0.1	ND	n/a	ND	<0.01	ND	18	ND	<0.1	ND	ND	ND
AQ38	7.09	ND	180	ND	26	ND	324	ND	0.4	ND	n/a	ND	<0.01	ND	1000	ND	<0.1	ND	ND	ND
AQ40	7.37	ND	150	ND	26	ND	106	ND	0.4	ND	n/a	ND	<0.01	ND	3	ND	0.2	ND	ND	ND
AQ41	5.64	ND	70	ND	26	ND	122	ND	<0.1	ND	n/a	ND	<0.01	ND	12	ND	<0.1	ND	ND	ND
Native Companion Creek (Historical) range	6.5 – 8.8		52 – 392		10.8 – 34.1		32 - 224		0.85 – 1.53		0.026 – 0.54		0 – 9.1		0 - 17		0.06 – 0.6		1.2 - 2430	

-- = value is greater than the trigger value proposed in the ANZECC (2000) Aquatic Ecosystems Guidelines

n/a = parameter not assessed

ND = no data available

Table 6 Surface Water Dissolved Metals Analysis Results

	Al (mg/L)		U (mg/L)		As (mg/L)		Be (mg/L)		Cd (mg/L)		Cr (mg/L)		Ca (mg/L)		Cu (mg/L)		Pb (mg/L)		Mn (mg/L)	
ANZECC Aquatic Ecosystems Values	0.055		n/a		0.013		0.37		0.0002		0.001		n/a		0.0014		0.0034		1.9	
ANZECC Livestock Drinking Water Values	5.0		0.2		0.5		5.0		0.01		1.0		1000		1.0		0.1		n/a	
Season	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011
AQ1	3.087	ND	0.034	ND	0.016	ND	0.065	ND	0.002	ND	0.009	ND	39.37	ND	0.003	ND	0.008	ND	6.057	ND
AQ2	8.13	ND	0.035	ND	0.018	ND	0.075	ND	0.002	ND	0.011	ND	27.13	ND	0.004	ND	0.011	ND	4.275	ND
AQ3	1.462	ND	0.023	ND	0.011	ND	0.073	ND	0.001	ND	0.004	ND	11.91	ND	0.004	ND	0.008	ND	0.376	ND
AQ4	11.00	ND	0.035	ND	0.009	ND	0.072	ND	0.001	ND	0.011	ND	7.16	ND	0.005	ND	0.012	ND	0.147	ND
AQ5	10.71	ND	0.024	ND	0.008	ND	0.055	ND	0.001	ND	0.008	ND	7.04	ND	0.003	ND	0.006	ND	0.140	ND
AQ17	30.38	ND	0.131	ND	0.008	ND	0.113	ND	0.001	ND	0.018	ND	11.49	ND	0.007	ND	0.016	ND	0.695	ND
AQ18	19.21	0.05	0.060	<0.001	0.011	<0.001	0.053	<0.001	0.001	<0.05	0.012	0.3	8.58	6	0.005	3.4	0.008	<0.001	0.481	0.049
AQ19	0.075	ND	0.210	ND	0.006	ND	0.071	ND	0.001	ND	0.018	ND	15.88	ND	0.016	ND	0.023	ND	2.369	ND
AQ23	3.979	ND	0.018	ND	0.011	ND	0.081	ND	0.002	ND	0.007	ND	7.40	ND	0.004	ND	0.010	ND	0.234	ND
AQ28	0.531	ND	0.008	ND	0.009	ND	0.060	ND	0.002	ND	0.004	ND	5.54	ND	0.002	ND	0.008	ND	0.064	ND
AQ29	0.307	ND	0.063	ND	0.011	ND	0.052	ND	0.001	ND	0.004	ND	6.31	ND	0.002	ND	0.009	ND	0.586	ND
AQ30	n/a	ND	n/a	ND	n/a	ND	n/a	ND	n/a	ND	n/a	ND	n/a	ND	n/a	ND	n/a	ND	n/a	ND
AQ31	15.14	ND	0.074	ND	0.007	ND	0.112	ND	0.002	ND	0.022	ND	9.17	ND	0.009	ND	0.018	ND	0.199	ND
AQ36	0.19	0.06	ND	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0001	<0.05	<0.001	0.2	5	10	0.002	2.4	<0.001	<0.001	0.028	0.001
AQ37	0.02	ND	ND	ND	0.002	ND	<0.001	ND	<0.0001	ND	<0.001	ND	15	ND	<0.001	ND	<0.001	ND	2.19	ND
AQ38	0.08	ND	ND	ND	0.002	ND	<0.001	ND	<0.0001	ND	<0.001	ND	12	ND	0.001	ND	<0.001	ND	0.642	ND
AQ40	0.32	ND	ND	ND	<0.001	ND	<0.001	ND	<0.0001	ND	<0.001	ND	6	ND	0.002	ND	<0.001	ND	0.014	ND
AQ41	0.18	ND	ND	ND	<0.001	ND	<0.001	ND	<0.0001	ND	<0.001	ND	<1	ND	0.001	ND	<0.001	ND	0.03	ND
Native Companion Creek (historical) mean	0 – 1.9		n/a		n/a		0 – 0.1		n/a		n/a		4 – 28.1		0 – 0.08		n/a		0 – 0.03	

-- = value is greater than the trigger value proposed in the ANZECC (2000) Aquatic Ecosystems Guidelines

-- = value is greater than the trigger value proposed in the ANZECC (2000) Livestock Drinking Water Guidelines

n/a = parameter not assessed

ND = no data available

Table 6 Surface Water Dissolved Metals Analysis (continued)

	Hg (mg/L)		Mo (mg/L)		Sb (mg/L)		Ni (mg/L)		Se (mg/L)		Zn (mg/L)	
ANZECC Aquatic Ecosystems Values	0.0006		n/a		n/a		0.011		0.011		0.008	
ANZECC Livestock Drinking Water Values	0.002		0.15		n/a		1		0.02		20	
Season	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011	Wet 2010/11	Dry 2011
AQ1	<0.0001	ND	0.008	ND	0.116	ND	0.008	ND	0.01	ND	0.008	ND
AQ2	<0.0001	ND	0.008	ND	0.041	ND	0.009	ND	0.02	ND	0.004	ND
AQ3	<0.0001	ND	0.005	ND	<0.005	ND	0.004	ND	0.01	ND	<0.002	ND
AQ4	<0.0001	ND	0.006	ND	<0.005	ND	0.007	ND	0.01	ND	0.005	ND
AQ5	<0.0001	ND	<0.005	ND	<0.005	ND	0.005	ND	0.01	ND	0.003	ND
AQ17	<0.0001	ND	0.005	ND	<0.005	ND	0.01	ND	0.01	ND	0.008	ND
AQ18	<0.0001	<0.0001	<0.005	<0.001	<0.005	<0.001	0.009	0.002	0.01	0.5	0.003	<0.005
AQ19	<0.0001	ND	<0.005	ND	<0.005	ND	0.018	ND	<0.01	ND	0.022	ND
AQ23	<0.0001	ND	0.013	ND	<0.005	ND	0.007	ND	0.01	ND	<0.002	ND
AQ28	<0.0001	ND	0.005	ND	<0.005	ND	<0.004	ND	0.01	ND	<0.002	ND
AQ29	<0.0001	ND	<0.005	ND	<0.005	ND	0.005	ND	0.01	ND	<0.002	ND
AQ30	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AQ31	<0.0001	ND	0.008	ND	0.006	ND	0.017	ND	0.01	ND	0.011	ND
AQ36	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.002	0.001	<0.01	<0.2	0.012	<0.005
AQ37	<0.0001	ND	<0.001	ND	<0.001	ND	0.005	ND	<0.01	ND	<0.005	ND
AQ38	<0.0001	ND	<0.001	ND	<0.001	ND	0.003	ND	<0.01	ND	<0.005	ND
AQ40	<0.0001	ND	<0.001	ND	<0.001	ND	0.002	ND	<0.01	ND	<0.005	ND
AQ41	<0.0001	ND	<0.001	ND	<0.001	ND	0.001	ND	<0.01	ND	0.086	ND
Native Companion Creek (historical) mean	n/a		n/a		n/a		n/a		n/a		0 – 0.1	

-- = value is greater than the trigger value proposed in the ANZECC (2000) Aquatic Ecosystems Guidelines

-- = value is greater than the trigger value proposed in the ANZECC (2000) Livestock Drinking Water Guidelines

n/a = parameter not assessed

ND = no data available

The results from the baseline surveying of water quality on and surrounding the Project site show that water exceeds the trigger values provided in the ANZECC (2000) Aquatic Ecosystems Guidelines at one or more sites for pH, EC, Total Nitrogen, Total Phosphorous, Nitrate, Turbidity, Sulphate, Aluminium, Arsenic, Cadmium, Chromium, Copper, Lead, Manganese, Selenium, Zinc, and Nickel. Further, Aluminium, Selenium, Copper and Uranium levels exceeded the proposed trigger values provided in the ANZECC (2000) Livestock Drinking Water Guidelines.

The surface water heavy metal concentrations that exceed the ANZECC (2000) Aquatic Ecosystems Guidelines at particular aquatic sampling locations are most likely a result of elevated heavy metals present in the solid strata (rocks and sediment) over which the water flows.

7.2.1 PROPOSED MONITORING

It is proposed that water quality continue to be monitored prior to any Project activities occurring, throughout the life of the Project, and throughout decommissioning and rehabilitation. As background water quality exceeds parameters provided in the ANZECC Guidelines, it is necessary to set site-specific water quality targets.

The Queensland Water Quality Guidelines (2006) provide procedures for deriving local monitoring parameter values for aquatic ecosystem protection.

8.0 SEDIMENT

Analytical results produced for the sediment samples have been compared against ANZECC trigger values for stream sediment quality.

8.1 METAL CONCENTRATIONS

The results of the sediment analysis were screened against both high and low interim sediment quality guidelines (ISQG) for stream sediments, a summary of which is presented in Table 7.

Low ISQG levels were exceeded at AQ18 and AQ19 for Antimony. No other results exceeded the low or high ISQG values. It should be noted that Silver exhibits a limit of detection of 2mg/kg (which is above the low ISQG values for this metal) and therefore an assessment of silver in sediments against the low ISQG value cannot be conducted.

Table 7 Sediment Analysis Results – Total Metals

	Antimony (mg/kg)	Arsenic (mg/kg)	Barium (mg/kg)	Beryllium (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Cobalt (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Manganese (mg/kg)	Nickel (mg/kg)	Selenium (mg/kg)	Silver (mg/kg)	Vanadium (mg/kg)	Zinc (mg/kg)	Uranium (mg/kg)	Mercury (mg/kg)
ISQG-Low	2	20			1.5	80		65	50		21		1		200		0.15
ISQG - High	25	70			10	370		270	220		52		3.7		410		1
AQ01	<5	<5	<10	<1	<1	2	<2	<5	<5	62	<2	<5	<2	<5	<5	<0.1	<0.1
AQ02	<5	<5	<10	<1	<1	2	<2	<5	<5	45	<2	<5	<2	<5	<5	<0.1	<0.1
AQ03	<5	<5	<10	<1	<1	<2	<2	<5	<5	20	<2	<5	<2	<5	<5	<0.1	<0.1
AQ18	22	<5	100	<1	<1	24	9	9	9	606	9	<5	<2	44	13	0.4	<0.1
AQ19	6	9	160	1	<1	124	13	19	19	778	19	<5	<2	201	28	0.8	<0.1
AQ21	<5	<5	10	<1	<1	13	<2	<5	<5	29	<2	<5	<2	31	<5	<0.1	<0.1
AQ22	<5	<5	150	<1	<1	12	10	6	12	873	9	<5	<2	26	6	0.3	<0.1
AQ30	<5	<5	100	<1	<1	33	8	11	9	623	10	<5	<2	47	12	0.6	<0.1
AQ36	<5	<5	20	<1	<1	8	<2	<5	<5	121	2	<5	<2	12	7	0.1	<0.1
AQ37	<5	<5	<10	<1	<1	5	<2	<5	<5	80	<2	<5	<2	6	<5	<0.1	<0.1
AQ38	<5	<5	<10	<1	<1	12	<2	<5	<5	71	<2	<5	<2	20	<5	<0.1	<0.1
AQ39	<5	<5	40	<1	<1	10	4	<5	<5	218	4	<5	<2	22	<5	0.2	<0.1

8.2 PARTICLE SIZE

Stream substrates on the Project site are typically sands as illustrated in Table 8. AQ18, AQ19 and AQ30 exhibited higher fine sediment percentages than other sites (clay particles <2 micrometre (µm) and silt of 2 - 60 µm). AQ18 continued to have standing water during the dry season survey whilst AQ19 and AQ30 contained riparian flora species within the stream bed. This is a result of the fine sediments (with a larger clay component) permitting water to be retained for longer periods.

Table 8 Particle Size Distribution

Site	Unit	Fines (<75 µm)	Sand (>75 µm)	Gravel (>2mm)	Cobbles (>6cm)
AQ01	%	<1	88	12	<1
AQ02	%	<1	95	4	<1
AQ03	%	<1	88	11	<1
AQ18	%	36	57	7	<1
AQ19	%	17	54	29	<1
AQ21	%	1	82	16	<1
AQ22	%	3	76	21	<1
AQ30	%	78	18	4	<1
AQ36	%	2	88	10	<1
AQ37	%	<1	97	2	<1
AQ38	%	<1	85	15	<1
AQ39	%	4	89	7	<1

8.3 AQUATIC AND RIPARIAN VEGETATION

The riparian vegetation is described more fully in the Terrestrial Flora and Fauna report. The larger creeks, Well Creek and Sandy Creek, are vegetated as follows:

- Well Creek - river red gum (*Eucalyptus camaldulensis)* (open-woodland to woodland), moreton bay ash (*Corymbia tessellaris)* is occasionally present and Melaleuca (*Melaleuca* spp.) are frequently present in the mostly very sparse low tree layer (Regional Ecosystem 10.3.13); and

- Sandy Creek - river red gum (*Eucalyptus camaldulensis*) and / or coolibah (*E. coolabah)* found along open woodland along channels and on floodplain riparian woodland (Regional Ecosystem 10.3.14).

Smaller creeks and drainage lines are typically vegetated with the same Regional Ecosystem species as the surrounding areas (woodlands, grasslands, Brigalow community, etc).

8.3.1 COMMUNITIES OF CONSERVATION SIGNIFICANCE

The *Eucalyptus camaldulensis* woodland along drainage lines (Regional Ecosystem 10.3.13 and 10.3.14) is listed as Of Concern by the DERM Biodiversity Status. This listing is due to weed infestation and degradation. The Terrestrial Flora and Fauna Assessment by AARC mapped the extent of this Regional Ecosystem within the Project site.

8.3.2 PLANTS OF CONSERVATION SIGNIFICANCE

No plant species listed under either the NC Act or EPBC Act were identified during the course of the survey. A full plant species list of species identified during the survey from riparian and aquatic sites is provided in Appendix D.

8.3.3 INTRODUCED / WEED SPECIES

A number of introduced plant species were identified on the Project site within riparian habitat. These species are listed below in Table 9. The Department of Employment, Economic Development and Innovation (DEEDI) website was searched for the status of each introduced species against the declared species list and Weed of National Significance (WONS) list. Note that none of the species listed in Table 9 are ephemeral, wetland or aquatic in habit, however they were identified along the creek banks within riverine communities. Most of the smaller species (exceptMimosa Bush, Parthenium, Lantana or Prickly Pear) have the potential to inhabit, and even dominate, dry, sandy creek beds.

Under the LP Act pest species can be listed as Class 1, 2, or 3 declared species. Class 1 pest species are those that are not commonly present in Queensland, and, if introduced, would cause an adverse economic, environmental, or social impact.

Land owners must take reasonable steps to keep land free of Class 1 pests. Class 2 pest species are established in Queensland and have, or could have, an adverse economic, environmental, or social impact. Land owners must take reasonable steps to keep land free of Class 2 pests, and often a coordinated approach by land owners, local government, and the community is required. Class 3 pest species are those that are established in Queensland and have, or could have, an adverse economic, environmental, or social impact.

The primary objective of the Class 3 listing is to prevent the sale of the species, and therefore prevent their spread into new areas. Landholders are not required to keep land free of Class 3 pests, unless their land is adjacent to an environmentally significant area.

Table 9 Introduced Species Within the Riverine Community

Botanical Name	Common Name	Status under the LP Act
Acacia farnesiana	Mimosa Bush	Not listed
Bidens pilosa	Spanish Needle	Not listed
Chloris virgata	Feathertop Rhodes Grass	Not listed

Botanical Name	Common Name	Status under the LP Act
Pennisetum ciliare	Buffel Grass	Not listed
Cucumis anguria var. *anguria*	West-Indian Gherkin	Not listed
Cynodon dactylon	Couch Grass	Not listed
Digitaria ciliaris	Summer Grass	Not listed
Echinochloa colona	Awnless Barnyard Grass	Not listed
Imperata cylindrica	Blady Grass	Not listed
Malvastrum americanum	Spiked Malvastrum	Not listed
Melinis repens	Red Natal Grass	Not listed
Opuntia stricta	Prickly Pear	Class 2
Opuntia tomentosa	Velvety Tree Pear	Class 2
Passiflora foetida	Stinking Passionflower	Not listed
Portulaca pilosa	Hairy Pigweed	Not listed
Scoparia dulcis	Licorice Weed	Not listed
Senna occidentalis	Coffee Bush	Not listed
Sida rhombifolia	Paddy's Lucerne	Not listed
Sida spinosa	Paddy's Lucerne	Not listed
Stylosanthes scabra	Shrubby Stylo	Not listed
Verbena incompta	Purpletop	Not listed
Parkinsonia aculeata	Parkinsonia	Class 2, WONS
Parthenium hysterophorus	Parthenium	Class 2, WONS
Lantana camara	Lantana	Class 3, WONS

Parthenium (*Parthenium hysterophorus*), whilst not observed during the survey, has become a weed of major concern within the Project site due to its recent proliferation there and is listed as a Class 2 declared weed. Survey site AQ35 (up stream of MLA 70425) is located adjacent to an area which had recently been sprayed for Parthenium. Lantana (*Lantana camara*), a Class 3 declared weed and a WONS, has also been observed by the landowners within the Project site. Pest Fact Sheets sourced from DEEDI are provided in Appendix E for Parthenium, Parkinsonia and Lantana.

The state and regional distribution and abundance of the Class 2 and Class 3 pest weeds that may be present on the Project site within the Riverine Community (referred to in the above vegetation community assessments - Parkinsonia (*Parkinsonia aculeata* – also a WONS), Parthenium (*Parthenium hysterophorus*) and Lantana (*Lantana camara* – also a WONS)) has been obtained from the following sources:

- Biosecurity Queensland's Annual Pest Distribution Surveys, presented via the DEEDI website predictive maps (http://www2.dpi.qld.gov.au/extra/asp/IPA-maps/search.asp viewed on 24/06/11);
- Queensland Herbarium naturalised flora database; and
- Local Government Area Pest Management Plans (PMP).

The distribution and abundance of these weeds across Queensland is presented in Figure 10 to Figure 12 and a summary of the distribution of Class 2 pest weeds that may be present on the Project site is presented in Table 10.

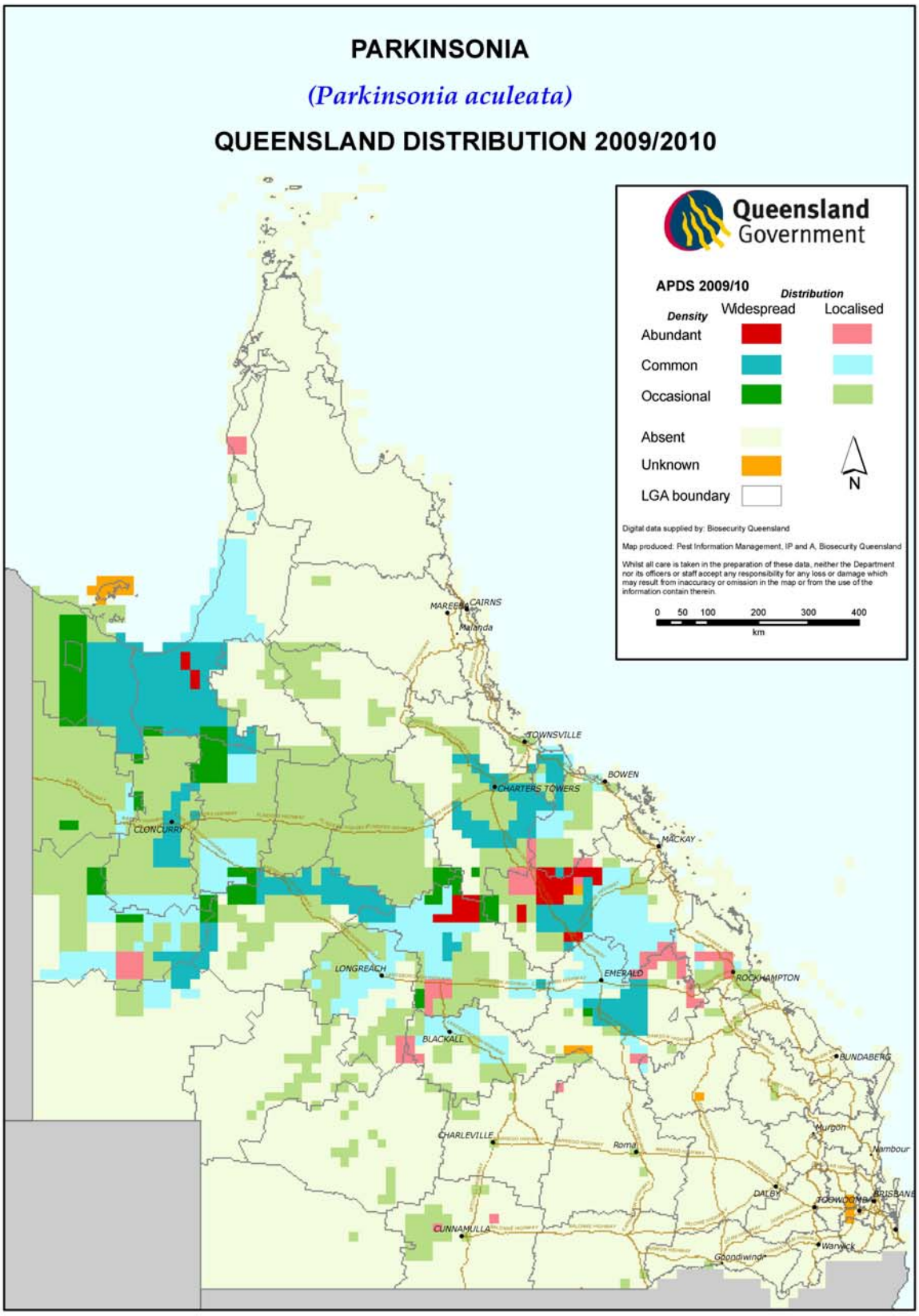
Table 10 Summary of the Distribution and Abundance of Class 2 Pest Weeds

Class 2 Pest Weed	Biosecurity Queensland's Annual Pest Distribution Surveys	Queensland Herbarium Naturalised Flora Database Record	Local Government Area PMPs- Jericho Shire (JS) and Barcaldine Regional Council (BRC) (Jericho Shire)
Parkinsonia (*Parkinsonia aculeata*)	Localised and occasional	South Kennedy Pastoral District	Listed in both JS and BRC PMPs as a high priority weed
Parthenium (*Parthenium hysterophorus*)	Localised and common	South Kennedy and Mitchell Pastoral Districts	Listed in both the JS and BRC PMP as a high priority weed
Lantana (*Lantana camara)*	Localised and occasional	South Kennedy Pastoral District	Listed in the JS PMP as a lower priority weed, but not referred to in the BRC PMP

Note: This table refers to data that has been recorded on a large scale and therefore, the proximity of each distribution and abundance record to the Project site is uncertain. The Barcaldine Regional Council Pest Management Plan has not been approved, but a draft copy has been made available to AARC for review.

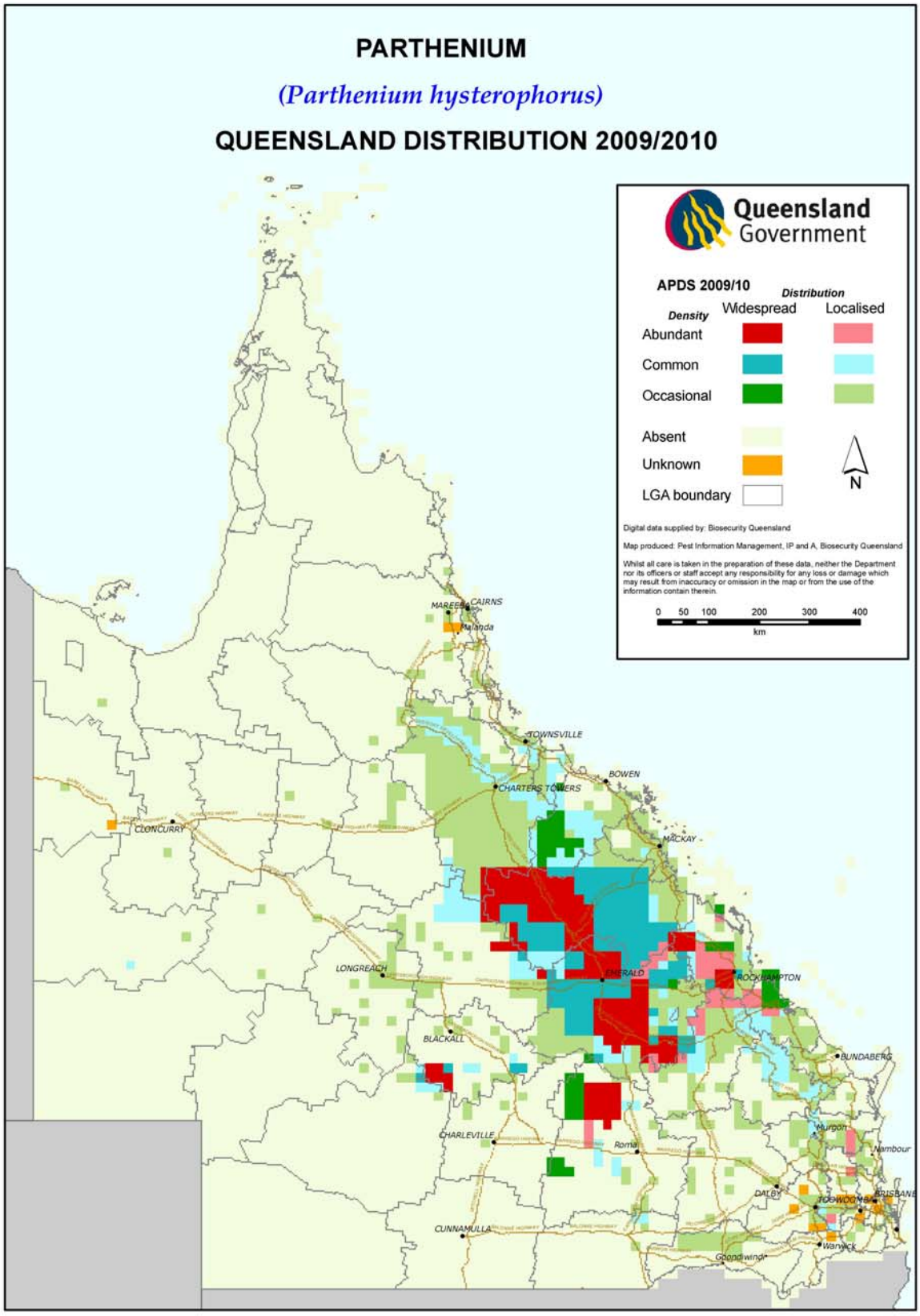
Therefore, the Biosecurity Queensland's Annual Pest Distribution Surveys, Queensland Herbarium Naturalised Flora Database Records and Local Government Area PMPs concur with the weed species that may occur on the Project site within the Riverine Community.

Note that additional, terrestrial weed species listed within the LP Act have also been recorded on the Project site (the Prickly Pear (*Opuntia stricta*) and the Velvet Tree Pear (*Opuntia tomentosa*) are Class 2 listed pests).



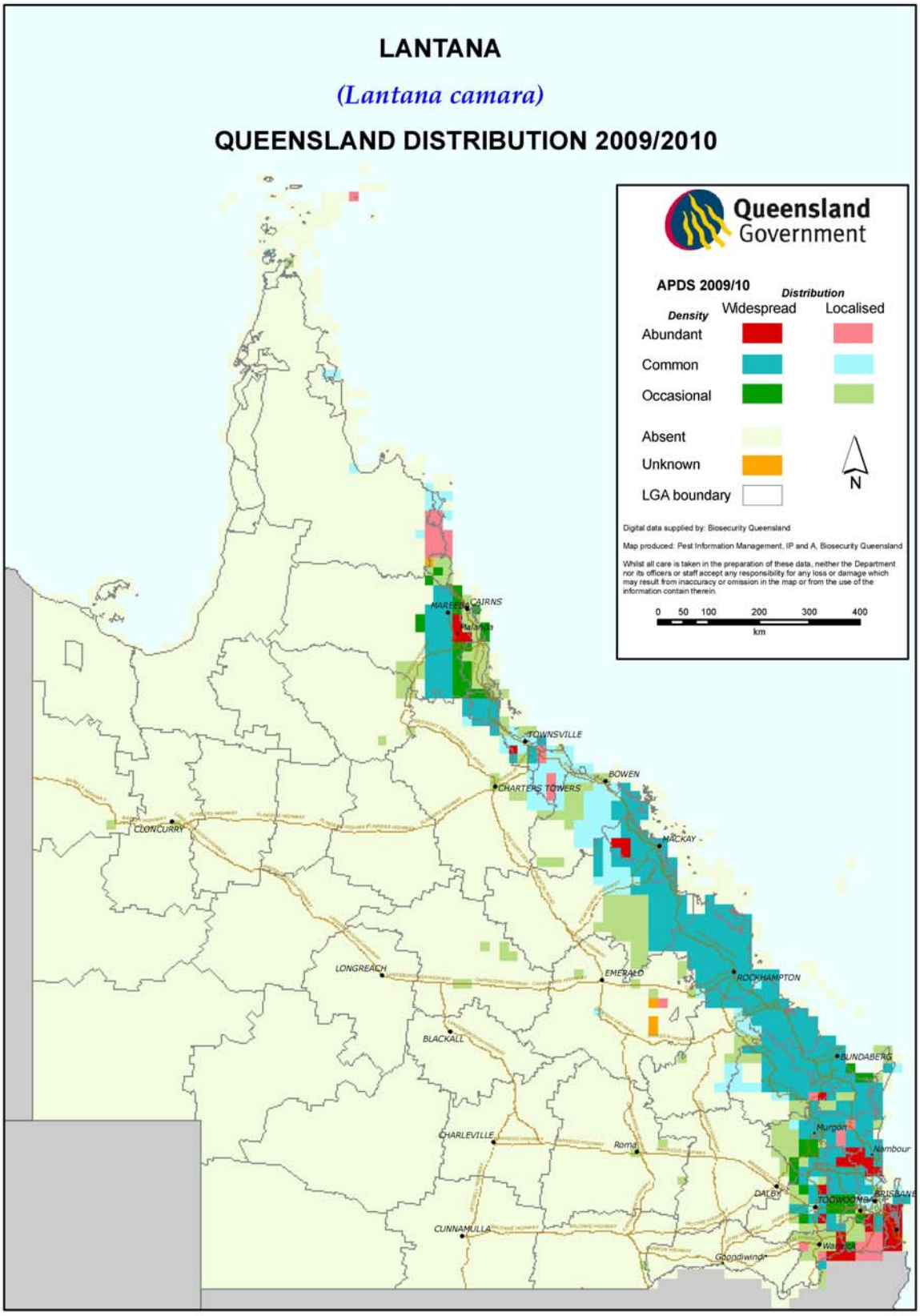
Source: Biosecurity Queensland's Annual Pest Distribution Surveys

Figure 10 **Queensland Distribution of Parkinsonia (*Parkinsonia aculeata* - 2009 / 2010)**



Source: Biosecurity Queensland's Annual Pest Distribution Surveys

Figure 11 **Queensland Distribution of Parthenium (*Parthenium hysterophorus* - 2009 / 2010)**



Source: Biosecurity Queensland's Annual Pest Distribution Surveys

Figure 12 **Queensland Distribution of Lantana (*Lantana camara*- 2009 / 2010)**

8.3.4 PLANT SPECIES RECORDED OFF THE MLA

It should be noted that the following plant species have been recorded upstream of the Project MLA; these species inhabit waterways that drain into the MLA:

Acacia harpophylla

Carissa lanceolata

Cenchrus sp.

Echinochloa colona

Eleocharis acuta

Eucalyptus populnea

Leptochloa digitata

Monochoria cyanea

Nymphoides crenata

Poaceae sp

Alternanthera angustifolia

Bothriochloa bladhii

Cyperus difformis

Echinochloa colona

Eleocharis acuta

Eleocharis philippensis

Eragrostis elongatus

Fimbristylis littoralis

Fimbristylis sp

Marsilea mutica

Nymphaea immutabilis

Nymphoides crenata

Salsola kali

Schoenoplectus dissachanthus

Senna occidentalis

Xanthium pungens

Cyperus dactylotes

Cyperus difformis

8.4 MACRO-INVERTEBRATES

Macro-invertebrates are invertebrates that can be seen with the naked eye. The types and numbers of macro-invertebrates found in a river or creek can be used as biological indicators (bio-indicators) of the health of that environment for the following reasons (Chessman, 2003):

- They are generally sensitive to the cumulative impacts of a wide range of disturbances and pollutants;
- They are abundant in freshwater systems;
- They are relatively easy to identify; and
- They are easy to collect.

A total of 52 macro-invertebrate taxa were identified during the survey. The complete taxa lists of the macro-invertebrates identified in the aquatic surveys are presented in Appendix F. Some of the more

commonly encountered macro-invertebrates included water boatmen (Hemiptera: Corixidae), Diptera: Chironomidae larvae, and mayfly pupae (Ephemeroptera: Baetidae).

Of these 52 taxa, the abundances of 45 were used for the SIGNAL scoring. SIGNAL scoring excluded freshwater crabs (*Holthuisana* spp.), two species of freshwater crayfish (*Cherax* sp.), and two species of shrimp due to the non-standardised method of capturing them (i.e. they were captured in baited traps, captures were not timed as for the live-picking method when dip-netting, and potential for re-captures exists due to the catch-release method utilised).

Although crustacea were excluded from SIGNAL scoring, the species that were captured possess grade numbers of 3 – 4 which indicates species that are not particularly sensitive to poor water conditions. Grade numbers range from 1 to 10; low grade numbers mean that macroinvertebrates are tolerant of a range of environmental conditions (including common forms of water pollution), whilst high grade numbers mean that macroinvertebrates are sensitive to most forms of pollution (Chessman 2003).

The prevalence of relatively hardy crustacean species at the Project site does not reflect anthropogenic pollution, but rather natural conditions of waterways at these sample sites. The SIGNAL 2 score method is commonly used to assess the health of a river, by looking at the taxonomic composition of the macro-invertebrate assemblage. The SIGNAL 2 Index value is calculated by averaging the pollution sensitivity grade numbers of the macro-invertebrate families present at each site, and plotting it against the number of families.

Figure 13 below shows the result of the SIGNAL 2 assessment of macro-invertebrate assemblages within and surrounding the Project site during the March 2009 and March 2010 surveys. AQ36 was reassessed during the dry season survey in September 2011 and is also included.

No sites fell within the "pristine" category of Quadrant 1. Sites within Quadrant 2 are as follows:

- AQ1 (moderate amount of in-stream stable habitat on the Project site);
- AQ2 (situated approximately 3 km downstream of MLA 70425);
- AQ3 (two pools of water in Sandy Creek on the Project site):
- AQ5 (situated 8.2 km up stream of MLA 70425 in numerous small terrace pools in Lagoon Creek vegetated with lily pads (*Nymphoides* sp.) and inundated grass):
- AQ19 (small pool of water within a drainage line on the Project site);
- AQ23 (situated 23 km up stream of MLA 70425 but downstream of the confluence of saltbush and Lagoon Creeks in an area with trailing vegetation):
- AQ28 (situated 18 km within the Lagoon and up stream of MLA 70425);
- AQ29 (lacustrine area densely vegetated with water plants and grass species, situated approximately 1km up stream of MLA 70425);
- AQ36 (2011) (2 pools of water that remained during the dry season, one of which was still moderately deep at ~2m);
- AQ37 (located on Well Creek associated with small isolated pools on the Project site); and
- AQ38 (sandy stretch of Sandy Creek on the Project Site - refer to Figure 8 for survey site locations).

All other sites fell within Quadrant 4. Whilst this would normally indicate some form of industrial pollution, it should be noted that the Queensland AUSRIVAS Sampling and Processing Manual (Conrick and Cockayne, 2001) dictates that sampling should occur during the early wet season (when flow has been established for at least four weeks) and four to six weeks after any flooding has subsided. Due to recent rainfall events, the sample period was not entirely optimal and therefore, the normal definition of Quadrant 4 does not apply to the Project site.

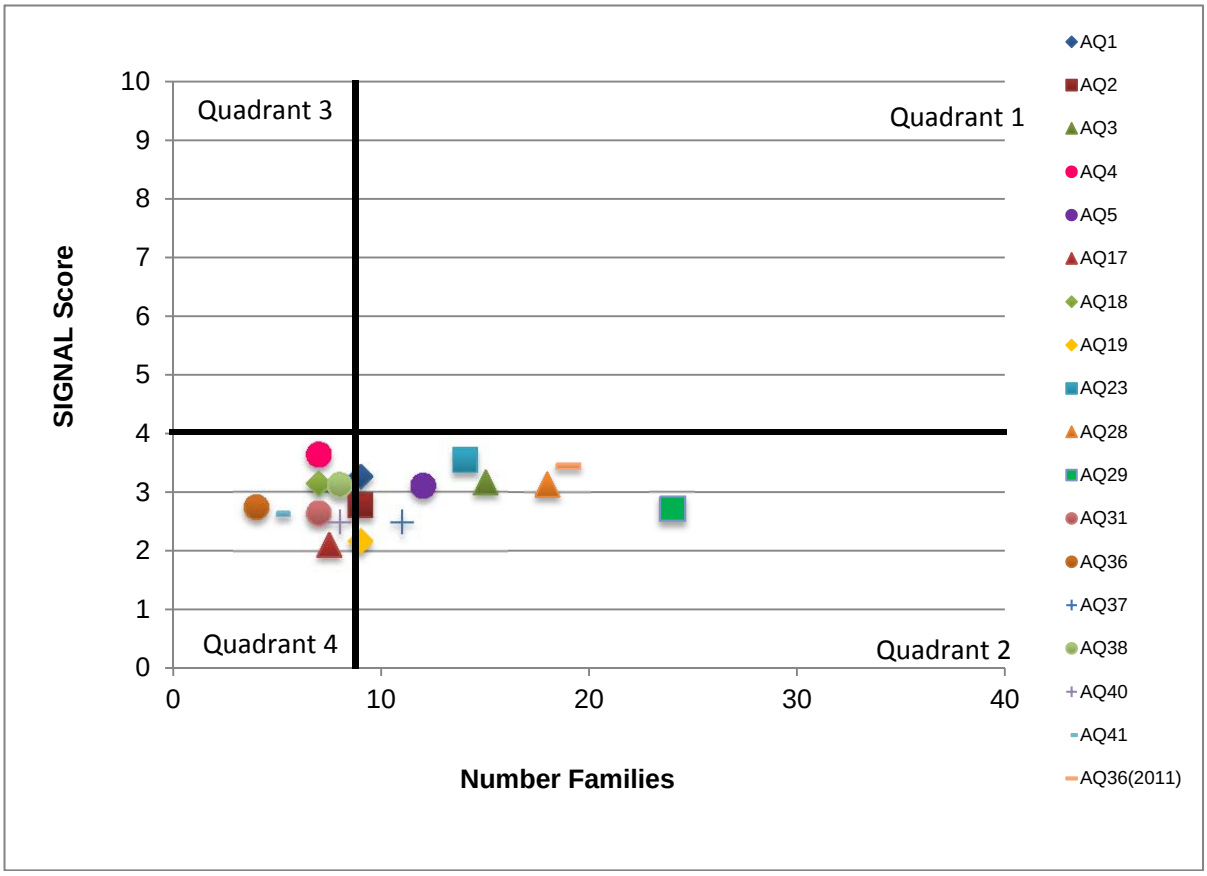


Figure 13 **SIGNAL 2 Score**

Figure 14 shows a comparison of the macro-invertebrate family richness across all sites that were sampled for these organisms. It can be seen that AQ28 and AQ29 (upstream of MLA 70425) and AQ36 (located on the Project site) had the highest family richness. These sites fell within Quadrant 2 of the bi-plot (refer to Figure 13 above), indicating a healthy and diverse habitat for macro-invertebrate fauna. AQ36 also recorded the lowest diversity during the March 2010 survey; the significant difference here may be the result of seasonal changes or unfavourable timing during the 2010 sampling period.

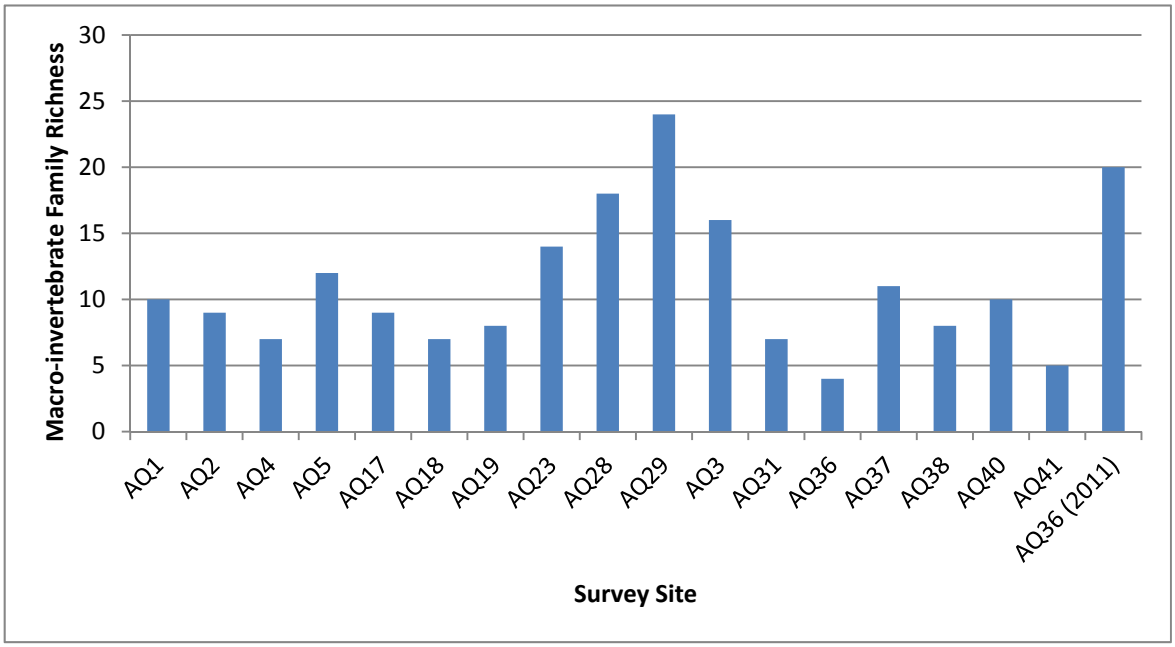


Figure 14 **Macro-invertebrate Family Richness**

There are numerous factors that affect the distribution and density of macro-invertebrates. Oldmeadow *et al* (1997) claim algal cover to be a significant variable in the distribution of macro-invertebrates. Fritz and Dodds (2005) state that flooding in intermittent streams is an important factor in macro-invertebrate density and richness, with their study showing that a greater than 50 year flood can reduce site richness by up to 97% immediately following the flood event. Bunn *et al.* (1999) found the accumulation of leaf litter and benthic debris within a stream channel to be an important factor for macro-invertebrate richness, as it forms the basis of the aquatic food web. Growns and Davis (1991) found that cattle grazing can lead to the reduction in some of the functional feeding roles (shredders, grazers, collectors, and predators) within a stream.

In line with the graphed results, sites such as AQ4 and AQ31 (which fell into Quadrant 4 of the SIGNAL bi-plot and lie up stream of MLA 70425) exhibited a low macro-invertebrate family diversity, which may be associated with the higher cattle grazing density and less in-stream habitat (straight pool of water, minimal depth change, little leaf litter, etc) at these locations.

The FFGs most commonly encountered were predators followed by scrapers (refer to Figure 15 for FFG details). This was reflected in the fact that sites surveyed for macro-invertebrates exhibited a larger composition of predatory taxa than any other FFG, and all sites having at least one predatory group of macro-invertebrates present in the faunal composition. Filtering collectors were the least encountered, being present at only four survey sites. When the FFGs per site were compared also with the position within the SIGNAL bi-plot, it can be seen that those sites falling within Quadrant 4 typically had a larger component of gathering collectors such as Diptera Chironominae larvae, Decapoda crustaceans, and Annelida Oligochaete worms. All sites within Quadrant 2 had a scraper (e.g. Gastropoda) component to their macro-invertebrate assemblage.

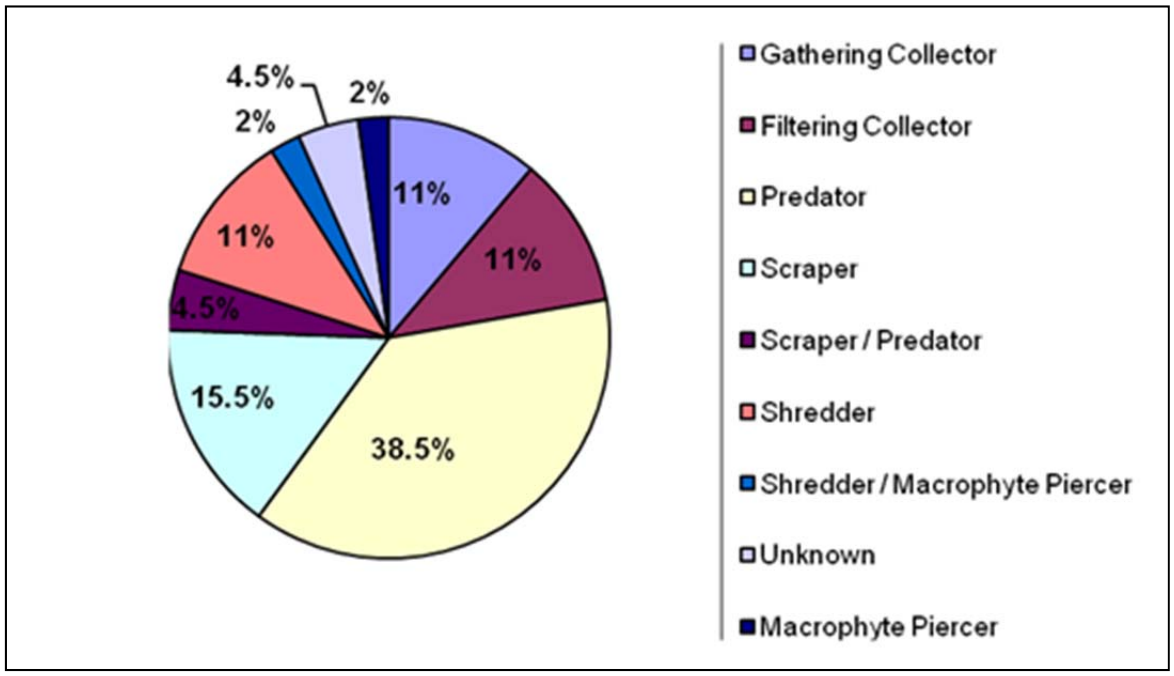


Figure 15 **Macro-invertebrate Functional Feeding Groups as a Percentage of the Total Identified**

Figure 16 shows that EPT taxa were identified at the majority of the survey sites where macro-invertebrate dip-netting was conducted. No taxa belonging to the Plecoptera order were identified at any of the sites and Ephemeropteran individuals were the most commonly encountered.

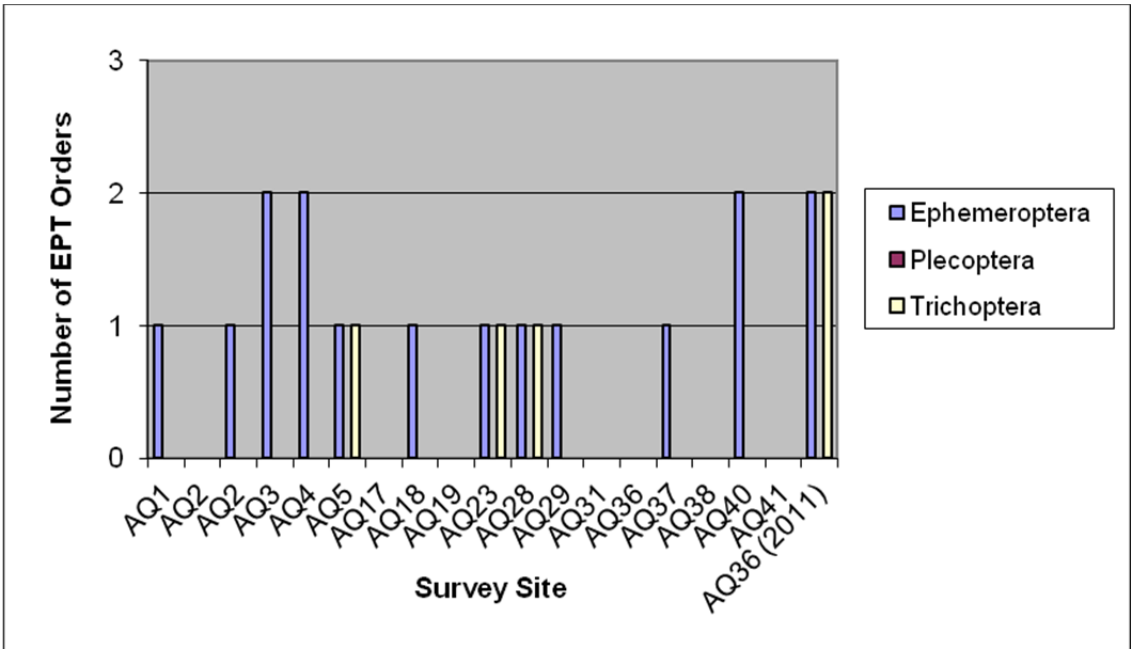


Figure 16 **EPT Richness Across Survey Sites**

EPT taxa are considered sensitive to environmental degradation, so the presence of such species can indicate broad-scale health of the waterway.

Whilst trapping within the Project site, numerous crustacean species that are not included in the SIGNAL scoring catalogue were encountered. These included two species of freshwater yabby

(*Cherax destructor* (Common Yabby) and *Cherax quadricarinatus* (Redclaw Yabby)) shown below in Photo Plate 7), two species of freshwater shrimp (*Macrobrachium* sp, and *Paratya australiensis*), and the freshwater crab (*Holthuisana* sp). Since these species are not particularly sensitive to surface water quality, their presence in local waterways cannot be used to indicate habitat quality.

Photo Plate 7 Common Yabby (*Cherax destructor*) and Redclaw Yabby (*Cherax quadricarinatus*)

The species richness for each site of these crustaceans is provided below in Figure 17. Figure 18 shows the relative abundance of each species trapped per site. It must be noted that as this study did not involve a mark-recapture element, there is a possibility that numerous individuals were captured more than once throughout the survey. The complete tally of crustaceans captured during the survey is given in Appendix F.

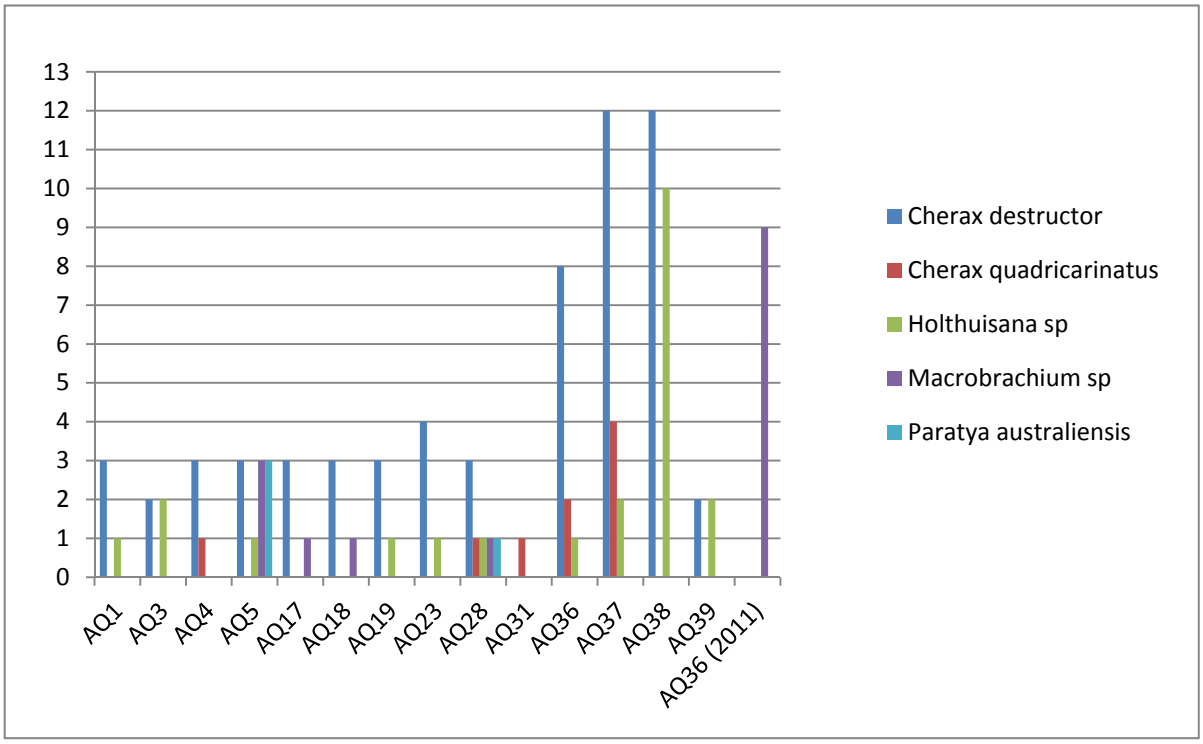


Figure 17 **Crustacean Species Richness per Survey Site**

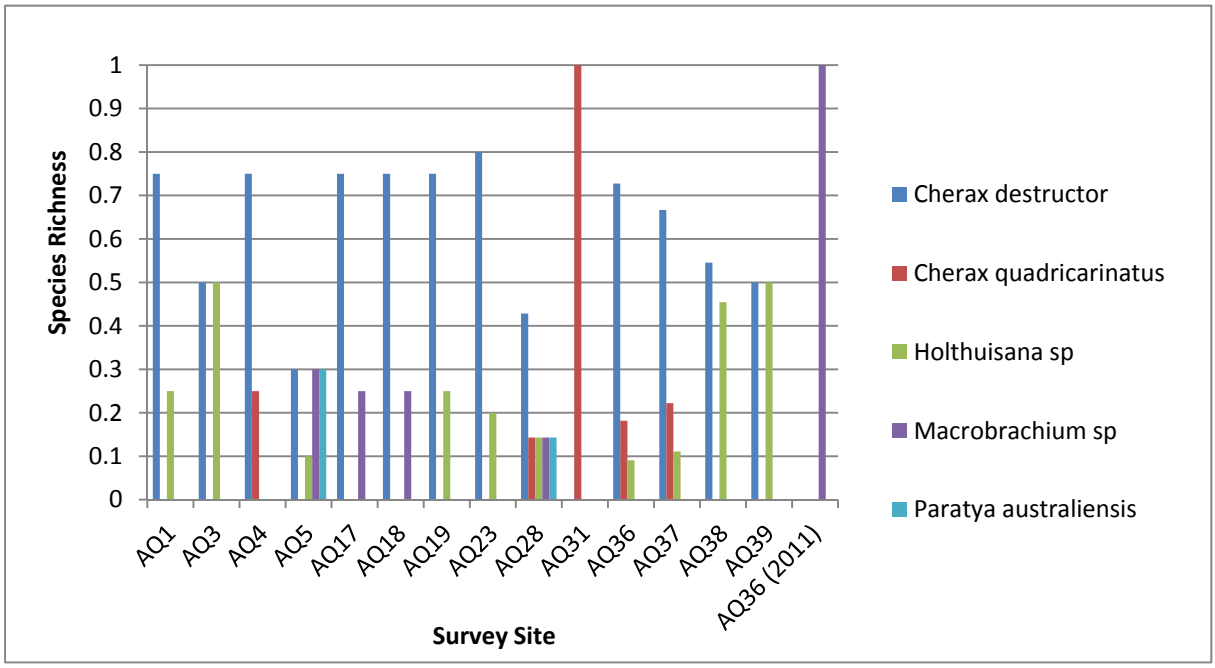


Figure 18 **Crustacean Relative Abundance per Survey Site**

8.5 AQUATIC VERTEBRATES

A total of seven fish species, five amphibians, one reptile, and 12 bird species were observed during the field survey. The AARC Terrestrial Flora and Fauna surveys have identified a further five amphibians, one mammal, all of which have habitat requirements intrinsically linked to aquatic areas. Each vertebrate group is discussed below.

8.5.1 FISH

Ephemeral streams are subject to wide physico-chemical fluctuations. This is reflected in the species composition of fish found in these types of waterways, and notably their tolerance to a wide range of water physico-chemical qualities (McNeil, 2005).

The fish species identified during the aquatic study included Spangled Perch (*Leiopotherapon unicolour*) (Photo Plate 8), Purple-Spotted Gudgeon (*Mogurnda adspersa*) (Photo Plate 8), Bony Bream (*Nematalosa erebi*), Glass Perch (*Ambassis agassizi*), Rainbowfish (*Melanotaenia splendida*), Hyrtl's Tandan (*Neosilurus hyrtlii*), and Carp Gudgeon (*Hypseleotris compressa*).

Photo Plate 8 Spangled Perch (left) and Purple-spotted Gudgeon (right)

It should be noted that only one species of fish has been recorded upstream of the Project MLA, but not identified within the MLA, this species is the bony bream (*Nematalosa erebi*).

The expected water quality tolerances of fish are provided in Table 11.

Table 11 Expected Water Quality Tolerances of the Identified Fish Species

Species	pH Tolerance	Thermal Tolerance (ºC)	Dissolved Oxygen Tolerance (mg/L)
Range during the survey	**6.88 – 8.8**	**24.7 – 32.2**	**Not assessed**
Spangled Perch	4 – 10.2[1]	5 – 44[1]	n/a
Bony Bream	4.8 – 8.6[1]	9 – 38[1]	Intolerant of hypoxia[1]
Glass Perch	6.3 – 9.9[3]	11 – 33.6[3]	0.3 – 19.5levels[3]
Purple-spotted Gudgeon		5 - 32[2]	Can withstand short periods of low oxygen levels[2]
Rainbowfish	5 – 9.2[5]	12 – 36[5]	n/a
Hyrtl's Tandan	<9.1[4]	>8, and up to ~35[4]	Can withstand mildly hypoxic conditions (>1.5 mg/L)[4]
Carp Gudgeon	5 – 9.1[1]	<35[1]	n/a

[1] = obtained from Allen *et al*., 2003
[2] = obtained from Native Fish Australia (2008)
[3] = obtained from Pusey *et al*., 2004
[4] = obtained from BMA (2008)
[5] = obtained from Tappin (2009)

From the water quality results, it would be expected that bony bream would be excluded from some of the sample sites due to water pH being above their tolerance, and Purple-spotted Gudgeons due to temperature. These exceedances were seen at sites AQ30 (on the Project site) and AQ31 (up stream of MLA 70425). No sampling of fauna was undertaken at sites where water availability and therefore aquatic condition was deemed unsuitable. Drag netting was conducted at AQ31, a lacustrine wetland. Bony Bream were caught at this site, despite the water quality. Fish will actively avoid areas of adverse water conditions, however, due to the shallow (<1.2 m), contained nature of AQ31 (located up stream of MLA 70425), coupled with regular cattle access, it is likely that the site would not remain a viable Bony Bream habitat for long.

Figure 19 shows the species richness of fish at each site. Highest species diversity was recorded at AQ4, AQ5 and AQ28 (all located up stream of MLA 70425), while AQ19 and AQ37 (located on the Project site) recorded no captures or observations. The dry season sampling at AQ36 during September 2011 recorded the same species richness as during March 2010.

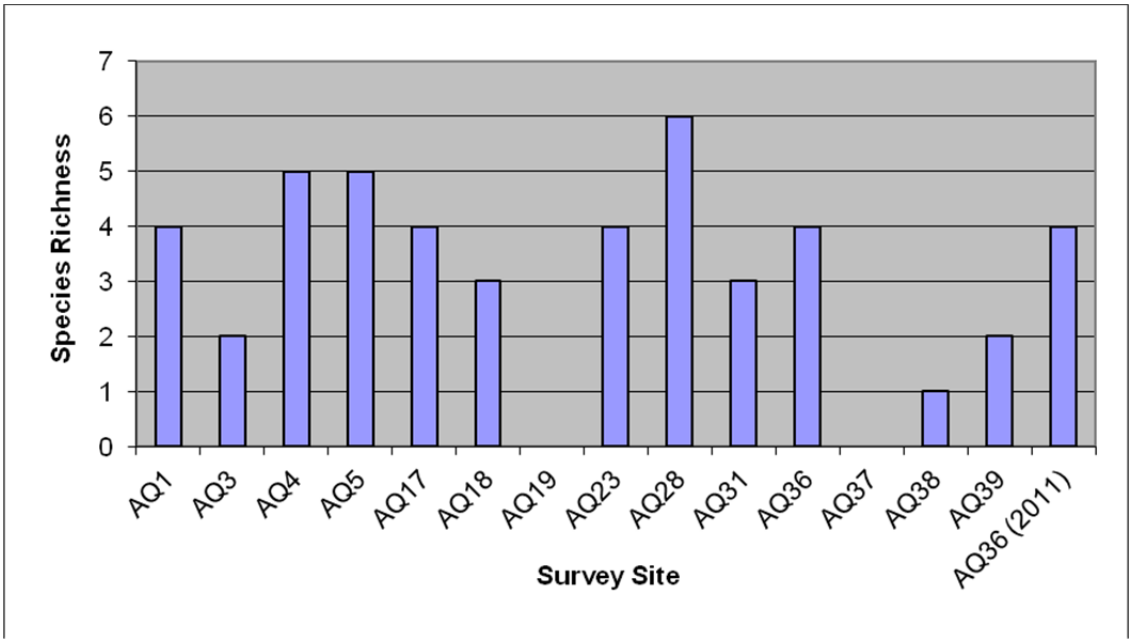


Figure 19 **Fish Species Richness per Site**

The relative abundance of fish species identified at each site has been calculated, and is provided below in Figure 20. Dry season sampling at AQ36 during September 2011 recorded the same species as had previously been discovered during March 2010, with the exception of the Hyrtls' Tandan (*Neosilurus hyrtlii*). Several captures at AQ36 during the dry season were unidentified due to their small size; however it is suspected that they are juvenile Rainbowfish (*Melanotaenia splendida*). Further trends in abundance and richness can be determined with future surveys.

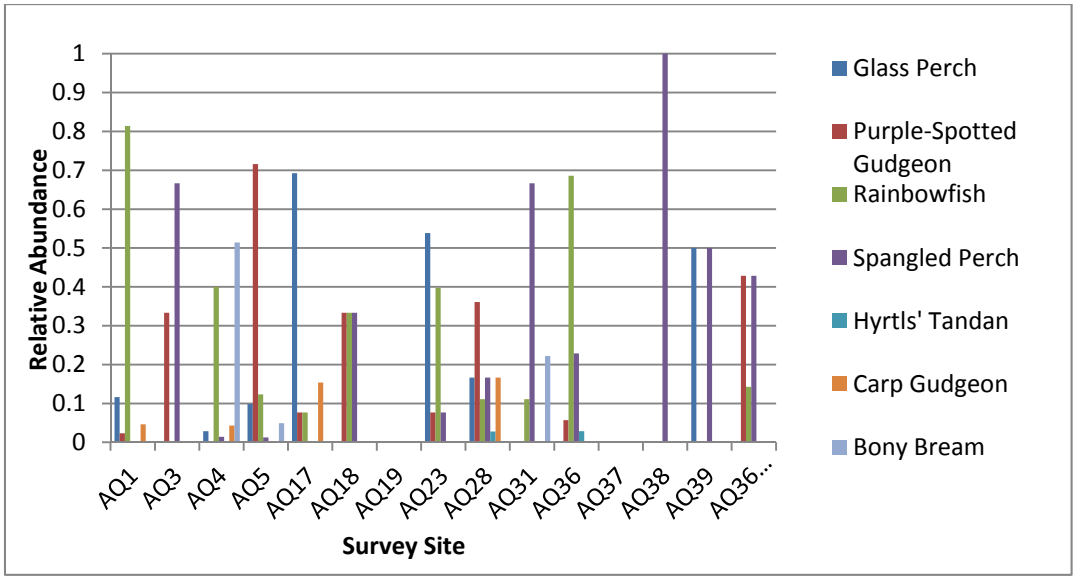


Figure 20 **Relative Abundance of Fish Species at each Site**

All species identified are native, and are considered common throughout their ranges. The tally of fish at each site is provided in Appendix G.

8.5.2 TERRESTRIAL VERTEBRATES

8.5.2.1 BIRDS

Fourteen bird species with habitat requirements linked to aquatic areas were observed either in or upstream of the Project site during the course of the survey. The presence of these species at each survey site is presented in Figure 21. The Pacific Black Duck (*Anas superciliosa*) was the most commonly observed species, being seen at five sites, and in large numbers. The Masked Lapwing (*Vanellus miles*) was also observed at three sites. AQ28 (located up stream of MLA 70425) had the highest diversity of bird species linked to aquatic habitats, as can be seen in Figure 22 below. AQ28 was the palustrine lagoon site, which had abundant in-stream vegetation, roosting sites, and a stable water level. This site was considered quite good aquatic species habitat, despite the high level of cattle disturbance on the banks.

Of the 14 bird species identified within or upstream of the Project site during the survey, ten are listed as either Migratory or Marine under the EPBC Act (as shown in below in Table 12). The full list of vertebrate fauna identified within aquatic and riparian habitats of the Project site is provided in Appendix H.

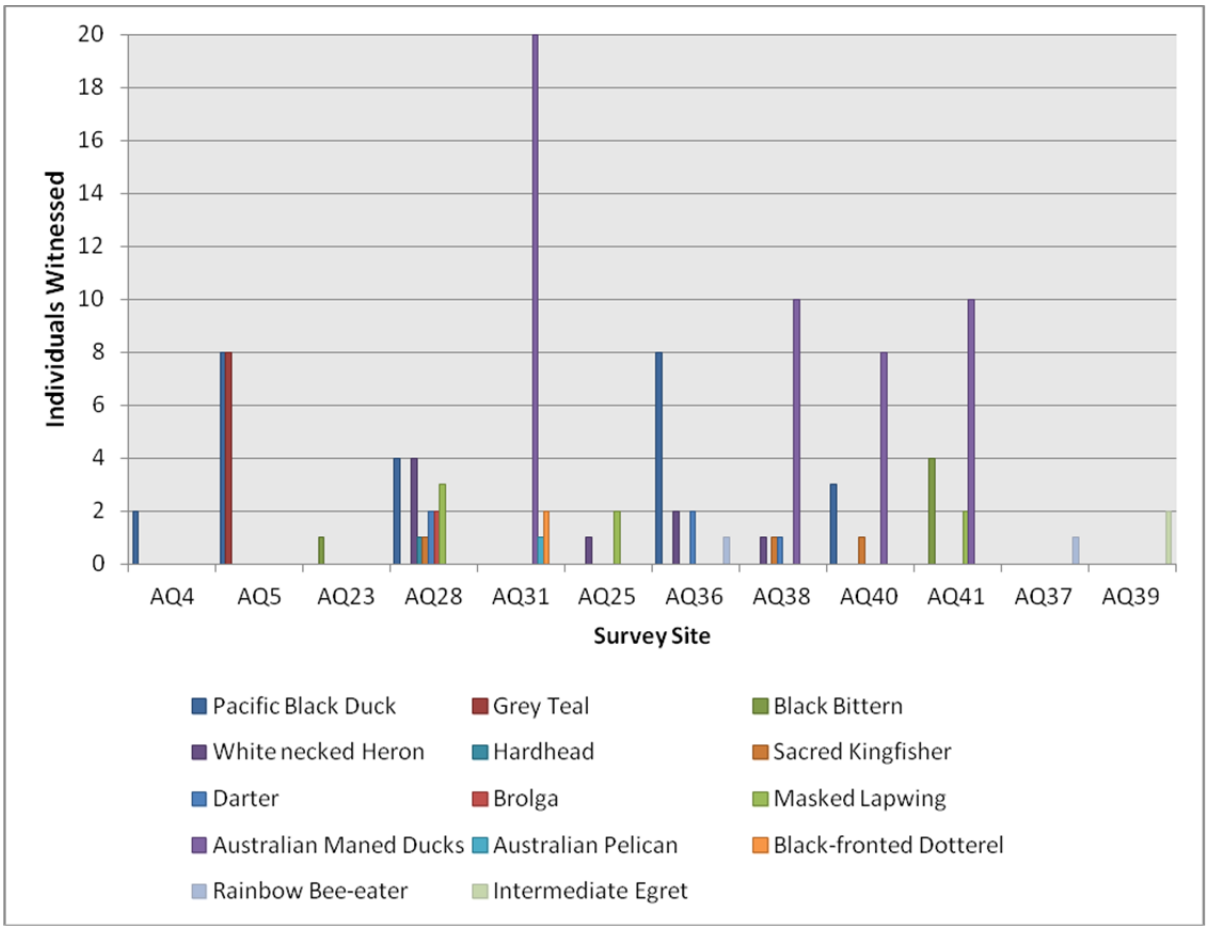


Figure 21 **Bird Species Observed on the Project Site**

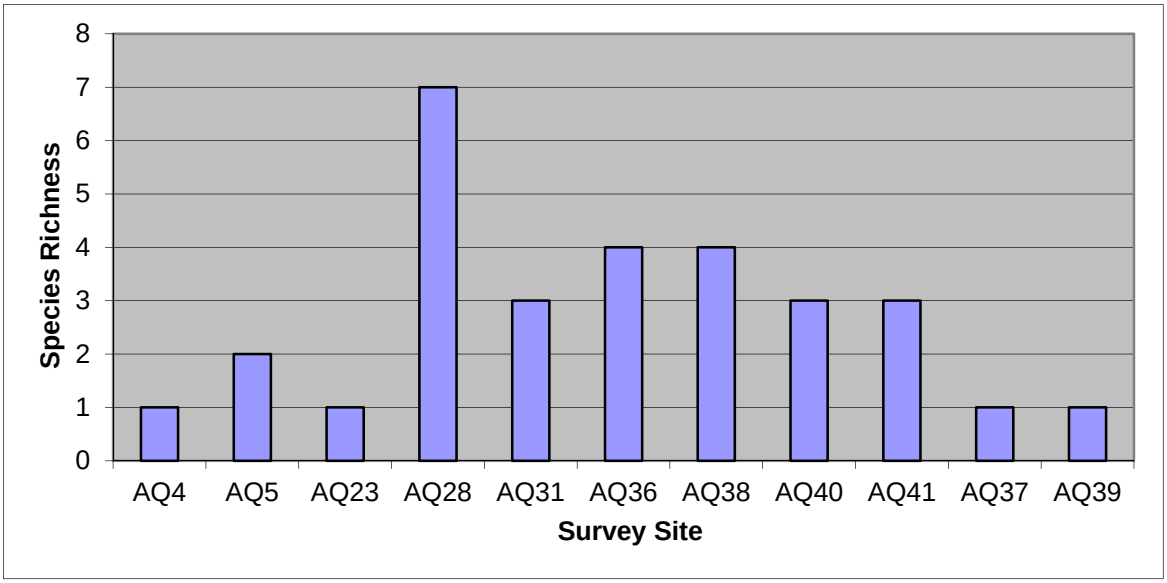


Figure 22 **Bird Species Richness per Site**

Table 12 Migratory and Marine Birds Identified Within the Project Site

Species	Migratory	Marine
Pacific black duck – *Anas superciliosa*	X	-
Grey teal – *Anas gracilis*	X	-
Hardhead – *Aythya australis*	X	-
Australian maned duck – *Chenonetta jubata*	X	-
Sacred kingfisher – *Todiramphus sanctus*	-	X
Masked lapwing – *Vanellus miles*	X	-
Australian pelican – *Pelecanus conspicillatus*	-	X
Black-fronted dotterel – *Charadrius melanops*	X	-
Brolga – G*rus rubicunda*	X	-
Rainbow bee-eater – *Merops ornatus*	X	-

A further six bird species (which are either aquatic and/or partly dependent upon wetlands/waterways) were identified during the Terrestrial Flora and Fauna surveys, including the Little Black Cormorant (*Phalacrocorax sulcirostris*), Whistling Kite (*Haliastur sphrenus*), Great Egret (*Ardea alba*), Intermediate Egret (*Ardea intermedia*), Nankeen Night Heron (*Nycticorax caledonicus*), and the

Straw-necked Ibis (*Threskiornis spinicolis*). All except the Little Black Cormorant are listed under the EPBC Act as Marine, and the Whistling Kite is further listed as Migratory under the EPBC Act.

The distribution of these species is widespread throughout eastern Queensland, and the local populations on the Project site are unlikely to constitute an 'ecologically significant proportion' of the total population of the species. Furthermore, the Project site is not at the limit of these species' range, nor are these species considered to be declining within the region. Therefore, it is unlikely the Project will have a significant impact on the regional populations of these species.

8.5.2.2 MAMMALS

The Feral Pig (*Sus scrofa*) was observed at AQ3, AQ19 (both located on the Project site) and AQ4 (up stream of MLA 70425). This species is a Class 2 declared animal under the LP Act. The Feral Pig is one of the most widespread and damaging pest animals in Queensland. They favour environments with permanent water bodies and have the potential to cause widespread ecological damage by spreading weeds and disease and spoiling riparian areas.

The full list of vertebrate fauna identified within aquatic and riparian habitats of the Project site is provided in Appendix H.

8.5.2.3 AMPHIBIANS

Many amphibian species that occur in Australia's drier regions are burrowing species capable of spending several years underground awaiting heavy rain, after which they come to the soil surface to feed and breed. This behaviour is referred to as aestivation and assists in water preservation and survival during prolonged drought (Withers, 1995). Consequently, the vast majority of amphibians from seasonally dry regions only occur in areas where the ground is soft enough to allow digging during wet periods.

Non-burrowing frog species also inhabit drier regions where they adopt different survival strategies, such as sheltering deep in tree hollows or cool rock crevices. However, these species are still typically associated with water sources.

Many of the creeks on the Project site were sandy and appeared soft enough for burrowing frogs. During the dry season some areas of standing water would remain viable amphibian habitat, in the form of pastoral dams and billabongs. During the wet season the creeks hold water after rainfall events, and low lying areas within grasslands become boggy.

Sixamphibian species were observed during the survey. These included the Ornate Burrowing Frog (*Ophisthodon ornatus*), Little Red Tree Frog (*Litoria rubella*), Broad-palmed Frog (*Litoria latopalmata*Striped Burrowing Frog (*Litoria alboguttata*) (Photo Plate 9), Floodplain Frog (*Litoria inermis*) and the Cane Toad (*Rhinella marina*) (Photo Plate 9).

Photo Plate 9 Striped Burrowing Frog (left) and Cane Toad (right)

The introduced Cane Toad was observed in large numbers at both AQ5 and AQ8 (both located up stream of MLA 70425), as can be seen below in Figure 23. The cane toad is a non-declared pest animal under the LP Act, so there is no legal requirement to control their numbers within the Project site. However, they can cause serious environmental harm, and it is recommended that the Project take steps to minimise their population growth. They were introduced in 1935 to control agricultural pests, but proved ineffective. They produce highly toxic venom, which can cause death if ingested by domestic and most native animals (DEEDI, 2008). They are voracious feeders, and will eat a wide variety of insects, frogs, small reptiles, mammals, and birds (DEEDI, 2008). A Pest Fact Sheet for the species is provided in Appendix E.

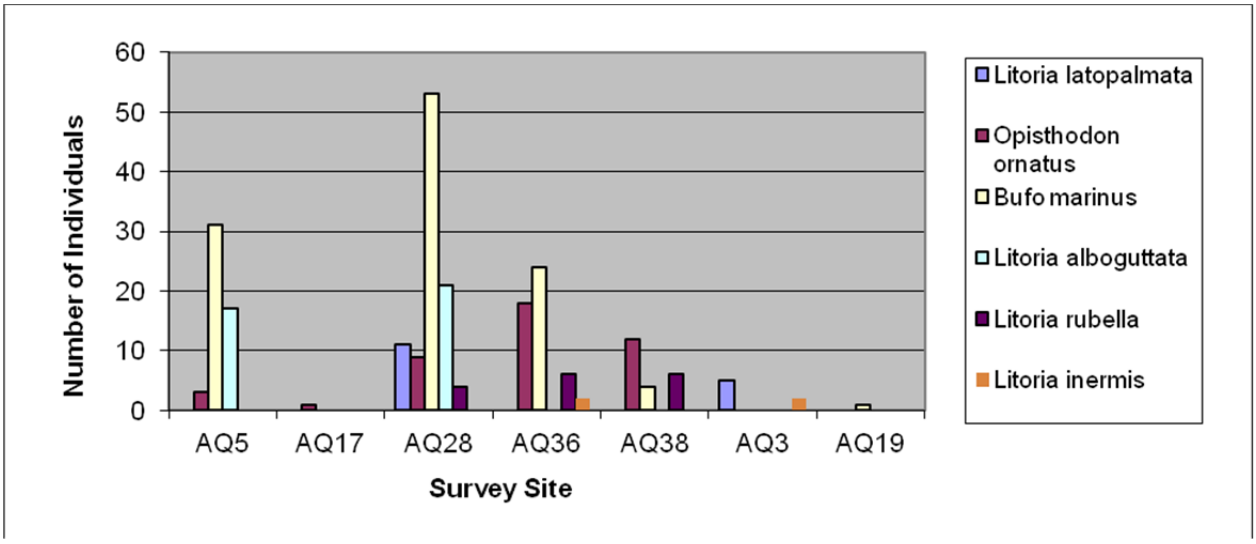


Figure 23 **Amphibian Species Observed at each Site**

In addition to the species listed above, the Terrestrial Flora and Fauna Surveys identified the following additional amphibian species: the Green Tree Frog (*Litoria caerulea*), Eastern Dwarf Tree Frog (*Litoria fallax*), Spotted Marsh Frog (*Limnodynastes tasmaniensis*), and the Eastern Burrowing Toadlet (*Uperoleia rugosa*). All of the species identified to date are considered common throughout their range.

The full list of vertebrate fauna identified within aquatic and riparian habitats of the Project site is provided in Appendix H.

8.5.2.4 REPTILES

The Eastern Snake-necked Turtle (*Chelodina longicollis*) was observed at the lagoon (AQ28) up stream of MLA 70425 (refer to Photo Plate 10). This species is common to the area and inhabits swamps, lakes, billabongs, and slow-moving rivers (Cogger, 2000). Note that this reptile was recorded upstream of the MLA and not within the MLA.

Photo Plate 10 Eastern Snake-necked Turtle

8.5.3 OTHER THREATENED SPECIES FROM THE REGION

This section presents aquatic and riparian species of conservation significance that are known from the broad region near Alpha but were not observed on the Project site by AARC. These species have been identified from wildlife database searches (Appendix A) and scientific literature searches. Table 13 provides an assessment of the likelihood of these species utilising the Project site.

Table 13 Species of Conservation Significance from the Region Not Identified Within the Site

Scientific Name Species Name	Conservation Status		Habitat	Notes
	EPBC Act	NCWR		
Erythrotriorchis radiatus Red Goshawk	V	E	Found over wooded and forested land with a mosaic of vegetation types in tropical and warm temperate climates in coastal and sub coastal areas (Marchant and Higgins 1993)	While the Project site offers a mosaic of vegetation types, this species is generally found closer to the coast in areas with permanent water. The Project will not disturb its favoured habitat and is unlikely have any adverse impacts on this species
Melithreptus gularis Black-chinned Honeyeater	-	NT	Often found in the upper levels of open forest and woodland dominated by box and ironbark eucalypts, also in riparian areas (Higgins *et al*., 2001).	Some suitable habitat may occur on the Project site however given the species' range and the availability of similar habitat in the region it is unlikely the Project will adversely affect it.
Gallinago hardwickii Latham's Snipe, Japanese Snipe	M L	-	Inhabits low vegetation around wetlands in shallows, sedges, and reeds (Morcombe 2002).	Due to the abundance of similar habitat type surrounding the Project Site, if the species was present in the region, the Project is unlikely to impact on the species.
Haliaeetus leucogaster White-bellied Sea-Eagle	M L	-	Usually coastal, the white-bellied sea-eagle will seasonally occur along flooded inland swamps and major rivers (Morcombe 2002).	The nearby creek system is ephemeral and as such it is unlikely the species would occur within the Project Site.
Hirundapus caudacutus White-throated Needletail	M L	-	Inhabits high open spaces, above almost any habitat (Morcombe 2002).	Grassy woodland and riparian habitats similar to those occurring on the Project Site are commonly represented in the wider area. It is considered unlikely that mining activities will result in adverse impacts on this species if it were to occur in local region.
Poephila cincta cincta Black-throated Finch (southern)	E	E	Inhabits open woodland, scrubby plains, pandanus flats with deep cover of grasses, never far from water.	Some suitable habitat may be available during the wet season
Ardea ibis Cattle Egret	M L	-	Inhabits stock paddocks, pastures, croplands, garbage tips, mudflats and drains (Pizzey & Knight 2006).	Due to the abundance of similar habitat type within the area, the Project is unlikely to impact on the species
Ardea alba Great Egret, White Egret	M L	-	Inhabits swamps and marshes; margins of rivers and lakes; damp or flooded grasslands, pastures or agricultural lands; reservoirs; sewage treatment ponds; drainage channels; salt pans and salt lakes; salt marshes; estuarine mudflats, tidal streams; mangrove swamps; coastal lagoons; and offshore reefs.	Due to the abundance of similar habitat type within the area, the Project is unlikely to impact on the species
Numenius minutus Little Curlew	M L	-	Inhabits dry grasslands of clay and black soil plains, river floodplains and grassy woodlands (Morcombe 2002).	It is considered unlikely that mining activities will result in adverse impacts on this species if it were to occur in the local region.
Rostratula australis Australian Painted Snipe	V	-	This species inhabits shallow inland wetlands, either permanent or temporary	Due to the abundance of similar habitat type surrounding the Project Site, if the species was present in the region, the Project is unlikely to impact on the species.
Rostratula benghalensis s. lat. Painted Snipe	M L	-	Inhabits the surrounds and shallows of wetlands that are well vegetated with low cover (Pizzey & Knight 2006).	Due to the abundance of similar habitat type surrounding the Project Site, if the species was present in the region, the Project is unlikely to impact on the species.

V = Vulnerable, E = Endangered, NT = Near Threatened, M L = Listed as Migratory and / or Marine

8.6 HABITAT ASSESSMENT

Table 14 below shows the Habitat Assessment scores for each of the survey sites. These scores have been based upon the AUSRIVAS rapid prediction system. All sites assessed fell within the moderate category (refer to Table 4 for interpretation of Habitat Assessment scores). These sites have low Habitat Assessment scores due to high erosion potential, lack of stable in-stream habitat and / or limited riparian vegetation.

Table 14 Habitat Assessment Results and Site Descriptions

Site	Description	Habitat Assessment Score out of a total score of 135
AQ1 (within disturbance area)	AQ1 had a moderate amount of in-stream stable habitat (undercut banks, submerged logs).The banks exhibited instability, with a large percentage of the bank showing evidence of recent erosion, and the dominant vegetation being grasses and sedges. In stream habitat was limited by the creek bed having a large percentage of fine sediment, evidence of bottom scouring and sediment deposition, and only occasional bends providing habitat.	54
AQ2 (2km downstream of MLA)	AQ2 was a large, sandy creek bed that presented a moderate amount of stable habitat including submerged logs and in-stream vegetation. The fine sediment (sand) in the creek bed and a lack of morphological diversity along the creek restricted potential habitat, lowering the habitat assessment score.	69
AQ3 (within disturbance area)	AQ3 had a large proportion of in stream available cover in the form of mid-channel vegetation and submerged logs. The dominant riparian vegetation was of tree form. The site habitat assessment score was lowered by it having a large portion of fine sediment, evidence of channel alteration and scouring, and high levels of bank erosion.	70
AQ4 (4.4 km up stream of MLA)	AQ4 had favourable habitat scores relating to variables such as channel alteration (as the site is located within a dammed section of the creek there was very little evidence of channelization, bottom scouring, or deposition), had variety in depth, and moderately stable banks. The score was lowered by the site having fine sediments, being a single pool, and having minimal vegetative cover on its banks.	50
AQ5 (8.2 km up stream of MLA)	AQ5 was characterised by numerous small terrace pools and one large pool. The stream bed was dominated by fine sediments, with evidence of channel alteration, and limited in-stream stable habitat. The large pool of water provided adequate depth, and the smaller pools provided habitat for in-fauna in the bends. There was little evidence of erosion, with the majority of the bank vegetated predominantly with grasses and sedges.	60
AQ7 (within disturbance	AQ7 was located on Wells Creek, upstream of a road crossing. The site was dry at the time of the survey. Stream sediments consisted	Not Assessed (NA)

Site	Description	Habitat Assessment Score out of a total score of 135
area)	of moderately coarse sands. Black tea trees and moreton bay ashes (*Corymbia tessellaris*) were present both in-stream and within the riparian zone. No photo available for this site	
AQ8 (0.8 km up stream of MLA)	AQ8 was located within Sandy Creek, upstream of a road crossing. The creek was dry at the time of the survey. The stream sediment was sand. The in-stream vegetation consisted of *Eucalyptus* species, and there was also a large sedge, herb, and grass component.	NA
AQ15 (0.3 km up stream of MLA)	AQ15 was located on Sandy Creek on the northern boundary of MLA 70426. The site was dry at the time of the survey. River red gums dominated the riparian vegetation. Mid-channel islands were vegetated with grasses, and Native Currant Bush (*Carissa lanceolata*). No weeds were visible	56
AQ16 (1.6 km up stream of MLA)	AQ16 was located downstream of the confluence of two creeks, along the western boundary of the Project site (upstream site). The site was characterised by fine sands, with a river red gum riparian community. No in-stream vegetation was present, and no sedges were noted.	59
AQ17 (0.1 km up stream of MLA)	AQ17 had limited stable in-stream habitat, with the sediment being predominantly fine-grained, and evidence of channel alteration present. The site consisted of a single pool. The banks were stable, with little evidence of erosion, and the majority of the bank vegetated with grasses and sedges to add to the stability.	48
AQ18 (within the disturbance area)	AQ18 had limited in-stream stable habitat. The non-flowing pool was intersected by a road. The stream sediment was mud, and there was only an occasional bend and bottom contour. The banks were highly unstable, with steep slopes and evidence of recent erosion. The dominant streamside vegetation was grasses and sedges.	42
AQ19 (within the disturbance area)	AQ19 was a small pool of water within a drainage line. The site had limited stable in-stream habitat, fine-grained stream sediments, obvious new deposition of sediments and channelisation, no riffle zones, and the banks were highly unstable. The banks were moderately vegetated with predominantly grasses and sedges to give some stability.	37
AQ20 (0.4 km from the disturbance area)	AQ20 was located at the head of a drainage line, within a non-remnant area. The site was adjacent to a road crossing and showed signs of extensive erosion. No riparian or wetland species were evident. The site was dry at the time of the survey, and the creek had an orange rock base with very fine sand overlaying it	37
AQ21	AQ21 was located at the confluence of two 1st order drainage lines. Some erosion was evident. The dry creek bed was characterised by	68

Site	Description	Habitat Assessment Score out of a total score of 135
(2.4 km from the disturbance area)	a rock base overlain with fine sand and occasional pebbles. River red gums dominated the riparian vegetation, with red natal grass and *Petalostigma* sp. present in stream. *Cyperus exaltatus* was present along the banks.	
AQ22 (within the disturbance area)	AQ22 was located within a dry 1st order drainage line. No aquatic or wetland species were noted at the site. The very narrow fringe of riparian vegetation consisted of brigalow, river red gum, native currant bush (*Carissa lanceolata*), and buffel grass (*Pennisetum ciliare*). The site was heavily utilised by cattle.	50
AQ23 (23 km up stream of MLA)	AQ23 was a sub-optimal habitat for in stream fauna. There was limited stable habitat, fine sediments, heavy deposition of fine materials, scouring, only an occasional bend to provide habitat, and moderate instability on the banks. The banks did have a moderate amount of vegetative cover, which were predominantly shrubs.	38
AQ28 (18 km up stream of MLA)	AQ28 had limited in stream stable habitat, and the stream sediments were predominantly fine-grained. The single, large pool of water did not have any evidence of channel alteration, or sediment deposition, and the banks were moderately stable and vegetated with grasses and sedges	59
AQ30 (within the disturbance area)	AQ30 was a small, shallow gully bisected by a road crossing in a non-remnant area of the Project site. The clay substrate was heavily cattle trodden. Several aquatic species including *Cyperus* spp, and *Juncus* spp. were located within the gully; however stable habitat was severely limited.	44
AQ31 (2.9 km up stream of MLA)	AQ31 was located in a partially dried lacustrine wetland. The site had a lack of stable in stream habitat, with fine-grained sediments, limited bottom contouring, and less than 50% of the stream bank was vegetated. The site had limited erosion, and relatively minor amounts of channelisation, scouring, and deposition.	52
AQ32 (20 km up stream of MLA)	AQ32 was a palustrine wetland. The site was dry at the time of the survey. Nardoo, E*nneapogon*, and sedge were present. A hard, clay sediment was characteristic of the area. No image is available for this study site	NA
AQ33 (16.5 km up stream of MLA)	AQ33 was a palustrine wetland according to database searches. There was no water at the time of the survey. A cracking-clay was characteristic of the site. There were no aquatic plants noted, barring occasional nardoo plants in lower areas. It is likely that this site would hold surface water for only a limited time following rainfall	NA
AQ35 (9.4 km up stream of MLA)	AQ35 was a dry palustrine area of the Project site. This site was located near a recorded parthenium patch, and adjacent to a brigalow community. Sedges, grasses, and *Alternanthera* sp. were present	NA

Site	Description	Habitat Assessment Score out of a total score of 135
AQ36 (WC1) (8 km from the disturbance area)	AQ36 – this 3rd order site was located in a rocky pool situated on Well Creek, in the western flank of the Project site. The site had steep rocky banks and was >2m deep in sections. The site was noted to have high fish assemblage and the overall aquatic health was considered good. This site continued to hold significant amounts of water (~2m deep) during the dry season, providing habitat for both vertebrate and invertebrate aquatic species. Spanish needle (*Bidens pilosa*) was observed along the banks.	87
AQ37 (WC2) (within the disturbance area)	AQ37 - this site was located on Well Creek, upstream of a road crossing. Small isolated pools were present at the time of survey. Stream sediments consisted of moderately coarse sands. Black tea trees and moreton bay ashes (*Corymbia tessellaris*) were present both in stream and within the riparian zone. Noogoora burr was noted at the site.	54
AQ38 (SC1) (within the disturbance area)	AQ38 – was located in a sandy stretch of Sandy Creek in the northern section of the Project site. The site was not flowing at the time of survey; however pools were significant, indicating recent flow events. Pools were <1m and contained a sand/vegetation detritus mixed benthic substrate. *Juncus* spp. was observed growing along the banks.	80
AQ39 (A1) (8 km from the disturbance area)	AQ39 – this site was located within a drainage line on the western boundary of the Project site. Although not flowing at the time of survey, the drainage held significant water, and was >1m deep at the study location. The vegetation surrounding the drainage line included river red gum. The sediment at the site ranged from fine sand to small pebbles. Some erosion was evident, however the site was considered to hold moderate ecological value.	78
AQ40 (SM1) (1.5 km up stream of the MLA)	AQ40 - located within a dry sandy creek bed in the western flank of the Project site. Vegetation present at the site included poplar box and silver-leafed ironbarks also present. A habitat assessment was performed, to help determine the aquatic habitat value of the site.	58
AQ41 (SM2) (4.5 km up stream of the MLA)	AQ41 - located within a dry sandy creek bed in the western flank of the Project site. Vegetation present at the site included poplar box and silver-leafed ironbarks also present. A habitat assessment was performed, to help determine the aquatic habitat value of the site.	56

*Note that certain on-site sampling locations are likely to be subjected to disruption due to mining activities.

*Approximate distances (km) from each aquatic survey site to either the MLA or disturbance area boundaries are presented.

9.0 CONCLUSIONS, POTENTIAL IMPACTS, AND MITIGATION STRATEGIES

9.1 CONCLUSIONS

The following conclusions have been developed for this aquatic ecology assessment:

- The Project site contains drainage lines and creeks of a range of orders, as classified by Conrick and Cockayne (2001). Lacustrine water bodies and riverine wetlands were also found to be present within the Project site;

- Aquatic flora and fauna sampling sites were located up stream, on and downstream of the Project site (MLA 70425). These locations facilitated the assessment of aquatic flora and fauna environmental values both on and around the Project site, before any mining activities occur;

- The majority of the drainage lines held little to no water during the survey, despite recent rainfall events. This ephemerality is common in the region;

- The results from the baseline surveying of water quality on and surrounding the Project site show that water exceeds trigger values provided in the ANZECC (2000) Aquatic Ecosystems Guidelines at one or more sites for pH, EC, Total Nitrogen, Total Phosphorous, Nitrate, Sulphate, Turbidity, Aluminium, Arsenic, Cadmium, Chromium, Copper, Lead, Manganese, Selenium, Zinc, and Nickel. Furthermore, Aluminium, Selenium, Copper and Uranium levels exceeded the proposed trigger values provided in the ANZECC (2000) Livestock Drinking Water Guidelines;

- A total of six amphibian species (one introduced), 12 birds (nine of which are listed under the EPBC Act as Migratory and / or Marine), one mammal (introduced), two reptiles and seven fish species were identified during the survey. The animal and plant species that were recorded at aquatic survey sites up stream of the MLA are presented in the results section of this report. It should be noted that although these species were not identified within the Project MLA they are associated with waterways that drain into the MLA;

- The Feral Pig, identified within riparian habitat, is listed as a Class 2 pest under the LP Act. AARC Terrestrial Flora and Fauna surveys have also identified the European Rabbit (Class 2) and the House Mouse (introduced, but not declared under the LP Act), which would also use riparian habitat for foraging. These pest species are anticipated to use this habitat and therefore need to be managed;

- One Class 2 (Parthenium (*Parthenium hysterophorus*)) and one Class 3 (Lantana (*Lantana camara*)) declared weed species under the LP Act were identified within riparian habitats. Numerous other non-declared weed species were identified, with Noogoora Burr (*Xanthium pungens*) being seen at many sites;

- No Near Threatened or Threatened animal or plant species were identified during the aquatic ecology assessment. Many of the creeks are fringed by Regional Ecosystem 10.3.14, River Red Gum (*Eucalyptus camaldulensis* woodland) and Regional Ecosystem 10.3.13, River Red Gum (*Eucalyptus camaldulensis)* woodland with Moreton Bay Ash (*Corymbia tessellaris* and Melaleuca (*Melaleuca sp.)* occasionally present, which has an 'Of Concern' DERM Biodiversity Status due to weed infestation and habitat degradation;

- SIGNAL scoring showed no sites fell within the “pristine” category of Quadrant 1. Sites within Quadrant 2 included AQ1, AQ3, AQ19, AQ36, AQ37, AQ38 (all of which are located on the Project site), AQ2 (Downstream of the Project site), AQ5, AQ23, AQ28, and AQ29 (located up stream of MLA 70425). All other sites fell within Quadrant 4, probably as a result of numerous factors including sub-optimal timing in regards to flooding (March 2009), and disturbances by cattle grazing; and

- Habitat assessments showed all sites assessed fell within the moderate category. The low scores are due to high erosion potential, lack of stable in-stream habitat and / or limited riparian vegetation.

9.2 POTENTIAL IMPACTS

The following potential impacts on nature conservation values may occur from the Project:

- Land clearing and mining activities may reduce the available habitat for native species of flora and fauna on the Project site;

- Clearing within riparian zones may lead to a loss of habitat connectivity across the mine, and habitat fragmentation;

- Clearing of large trees within the riparian zone may impact on species, which roost in tree hollows near water, by reducing available roosting habitat;

- Noise, vibration and dust associated with the construction and operational phases of the Project may mean some species stay clear of areas they currently utilise;

- Earthworks may results in potential weed invasion particularly along watercourses;

- Earthworks may result in increased sedimentation in riparian woodlands downstream of the mine. Higher levels of erosion can lead to a loss of morphological diversity in streams. This in turn reduces habitat quality and may result in biodiversity losses in affected areas;

- Human occupation in an area will often facilitate the increase in feral animal numbers (e.g. exposed landfill sites providing food for feral pigs, feral cats, etc). An increase in feral animal numbers may impact on the native animals, leading to a decrease in their population sizes;

- Potential spills of chemicals and hydrocarbons may enter waterways, resulting in environmental harm;

- The proposed diversion of Middle Creek may have an impact upon creek flow directions, velocities, habitat and aquatic flora and fauna. These impacts may be manifested as follows:

  – erosion and sedimentation as a result of changes in stream flow;

  – loss of riparian habitat and corridors as a result of creek diversion;

  – changes in the community structure of aquatic flora and fauna in response to the proposed creek diversion;

- The upper reaches of Sandy Creek (also called Greentree Creek) may incur some mining impacts upon environmental values of the aquatic flora and fauna as follows:

– Clearing of riparian vegetation may result in erosion and sedimentation-related impacts, especially in the early years after the mining, prior to re-establishment of foliage;

– Clearing of riparian vegetation may result in fragmentation of a valuable wildlife corridor, which, while not a major issue for mobile species (birds, bats), can be detrimental for the smaller terrestrial species;

– Works occurring in the creek during and immediately following periods of flow may impede fish movements; and

– Underground mining will result in changes in geomorphology (land subsidence). Although it is anticipated that such impacts upon local creeks will not be significant, remediation of creek systems will probably be required in terms of creek habitat, flow and morphological restoration.

Impacts of the creek diversions mentioned above will be mitigated by the design process ensuring that the stream profiles are not excessive. By applying mild gradients to constructed creek beds, stream power is reduced, which therefore reduces the likelihood of stream bank erosion. Any impacts that may occur will be short term and possible future impacts will be identified through ongoing monitoring.

Refer to the Interim Subsidence Management Plan for a detailed explanation of mitigation techniques (Appendix N of the SEIS).

9.3 MITIGATION STRATEGIES

Suggested strategies to minimise the impacts on native flora and fauna, and recommendations regarding rehabilitation of the Project site, are outlined below.

9.3.1 GENERAL FLORA AND FAUNA MANAGEMENT STRATEGIES

The following general flora and fauna management strategies are recommended for this Project:

- Although the riparian and in-stream vegetation within the Project site is well-represented in the wider region, in recognition of the intrinsic value of ecological habitat, every effort should be made to keep proposed disturbance areas to a minimum, and disturbances should be stabilised immediately on completion of work. A 50m buffer zone should be assessed and implemented where deemed appropriate around the 'Of Concern' Regional Ecosystem;

- To maintain the integrity of vegetated land that is not cleared, appropriate erosion and sediment controls are recommended to prevent sediment deposition in remaining habitat;

- Habitat clearing should be conducted only after:

  – the areas to be cleared have been clearly checked for aquatic wildlife, delineated and identified to equipment operators and supervisors; and

  – appropriate erosion and sediment control structures are in place.

- Infrastructure planning should avoid the creation of permanent, shallow water areas, such as septic and other tank overflows that form a permanent seep. These areas attract biting insects such as mosquitoes that can be disease vectors, and Cane Toads that are lethal to most snakes and other fauna species when ingested;

- Measures should be taken to minimise harm to affected aquatic fauna communities by inspecting the vegetation to be disturbed prior to clearing to ascertain whether any aquatic fauna are present. If aquatic fauna are present, it should be given the opportunity to move on naturally before clearing occurs;

- A segment of the Staff Induction Program should be allocated to informing staff of the conservation values on the Project site and surrounding areas to increase staff awareness of the species present. This could include photographs, brief descriptions and management requirements of native species;

- A Pest Management Plan should be developed to monitor the presence of pest species, and the success of any control strategies that are adopted for pest species within the Project site; and

- A rehabilitation strategy should be developed for the Project site. This strategy should embody the concepts and recommendations presented above and include provision for monitoring of rehabilitation progress over the life of the operation. The establishment of hollow-bearing tree species in riparian habitats should be included in the rehabilitation strategy.

9.4 MANAGEMENT OF PEST FLORA AND FAUNA

9.4.1 WEED MANAGEMENT STRATEGIES

One plant species declared under the LP Act was recorded in riparian areas during the survey:

1. Parkinsonia (*Parkinsonia aculeata*)
2. Prickly Pear (*Opuntia stricta*)
3. Velvety Tree Pear (*Opuntia tomentosa*)
4. Lantana (*Lantana camara*)

These species are listed as Class 2 pest plants (except for Lantana which is Class 3). Class 2 plants are those that are established in Queensland and have or could have an adverse economic, environmental or social impact. Landowners are expected to take reasonable steps to keep land free from Class 2 pests. Although not recorded during the survey, Parthenium (*Parthenium hysterophorus*) (Class 2 pest plant) is understood to have a presence on the Project site. Measures to control the spread of these weeds including vehicle wash-downs should be adopted across the Project.

It is recommended that the Pest Management Plan is referred to, to limit the spread of these species on the Project site. Staff should be informed of the species of weed likely to be encountered on the Project site, the location of known weed infestations (particularly Parthenium) and how to report the presence of new infestations.

Pest fact sheets for all declared weed species observed on the Project site are provided in Appendix E.

9.4.2 PEST FAUNA MANAGEMENT STRATEGIES

Four introduced pest fauna species were recorded during site surveys:

1. Feral Pig (*Sus scrofa*);
2. European Rabbit (*Oryctolagus cuniculus*);
3. House Mouse (*Mus musculus*); and
4. Cane Toad (*Rhinella marina*).

The Feral Pig and European Rabbit are listed as Class 2 pests under the LP Act. Class 2 pests are those that are established in Queensland and have or could have an adverse economic, environmental or social impact. Landowners are expected to take reasonable steps to keep land free from Class 2 pests. Control strategies should be in-line with the local shire council pest control strategies and the strategies suggested within the Pest Fact Sheets in Appendix E.

The Cane Toad and House Mouse are both non-declared under the LP Act, meaning that there is no legislative need for their control within the Project site. However, it is recommended that the activities within the Project site should not facilitate any increase in the population numbers of non-declared animals.

9.5 MANAGEMENT OF WATER QUALITY

It is recommended that water quality continue to be monitored both prior to any Project activities occurring, throughout the life of the Project and throughout decommissioning and rehabilitation of the Project. As background water quality exceeds parameters provided in the ANZECC Guidelines, it is necessary to set site-specific water quality targets.

The sampling program for surface water, ground water and sediment, including setting site-specific trigger and target values, will be developed according to the conditions agreed as part of the EA negotiations.

Should the ongoing water quality monitoring program detect concentrations downstream of Project activities higher than the trigger or limit values derived from the site-specific data, then an investigation into the likely causes should be initiated. The results of the investigation and mitigation strategies, if necessary, should be reported to DERM.

9.6 CREEK DIVERSION RECOMMENDATIONS

The creek diversion should ideally mimic the natural materials and geometry of Middle Creek. The Australian Coal Association Research Program (ACARP) has conducted research into 'Design and Rehabilitation Criteria for Bowen Basin River Diversions' (Earth Tech, 2002) and the Department of Natural Resources and Mines have created the 'Central West Water Management and Use Regional Guideline: Watercourse Diversions – Central Queensland Mining Industry' (undated). It is recommended that these be referred to for improved environmental performance of the Middle Creek diversion.

If possible, clearing of riparian vegetation for the proposed creek diversion should be conducted in a staged manner, to allow fauna to migrate to adjacent habitat areas.

If possible, works to divert Middle Creek should be conducted during the dry season when minimal (if any) water is present, so as to reduce impacts to fish movements.

The creek diversion rehabilitation should be monitored to ensure the vegetation is stable and self-sustaining.

9.7 RECOMMENDED MONITORING PROGRAM

It is recommended that water quality continue to be monitored both prior to any Project activities, throughout the life of the Project and throughout decommissioning and rehabilitation. As background surface-water quality exceeds parameters provided in the ANZECC Guidelines, it is necessary to set site-specific surface water quality targets for the Project site.

The Queensland Water Quality Guidelines (2009) provide procedures for deriving local monitoring parameter values for aquatic ecosystem protection. These guidelines recommend the collection of at least 18 samples per reference site within a 12 to 24 month period and setting the new triggers based on 20th and 80th percentile values.

It is recommended that reference sites established upstream, downstream, and midstream of the Project site are included in the water quality monitoring program.. These sites will enable background data to be collected, which may be used to set Environmental Authority limits.

9.7.1 WATER QUALITY

Water quality analysis results are recommended to be compiled into an Environmental Monitoring database. Reference data using indicators such as water quality parameters outlined in the ANZECC (2000) Guidelines will allow the environmental values outlined in the *Environmental Protection (Water) Policy 1997* to be identified and protected. Once sufficient data is available, the data should be reassessed and trigger levels for the Environmental Authority set as per the Queensland Water Quality Guidelines (2009), where site-specific contaminant limits are necessary.

9.7.2 FAUNA MONITORING

It is recommended that an annual monitoring program be established) at each reference site targeted toward the monitoring of water birds and invertebreate fauna. Water birds may be used as an indicator of ecosystem health as they are at the top of the food chain and therefore vulnerable to changes in prey populations and effective monitoring of changes in populations is easily achievable. This will allow detection and subsequent investigation into any disappearance (or appearance) of notable species within the Project site creek systems. Particular attention should be paid to the creek diversion areas, to ensure pre-diversion habitat values and faunal components persist.

SIGNAL bi-plots of the macro-invertebrates will permit the detection of upstream and downstream changes that may occur in macro-invertebrate communities, whilst analysis of subsequent bi-plots can be used to monitor seasonal fluctuations in macro-invertebrate numbers. Therefore the bi-plot data can be used to differentiate between seasonally and water-quality induced variations in macro-invertebrate populations.

9.7.3 FLORA MONITORING

Coupled with the fauna monitoring programme, an annual monitoring program of riparian flora should also be established at each reference site. This will allow detection and subsequent investigation into any disappearance (or appearance) of notable species within the Project site creek systems. Particular attention should be paid to the creek diversion areas, to ensure pre-diversion habitat values and flora components persist.

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Appendix A: Database Search Results

Australian Government
Department of the Environment, Water, Heritage and the Arts

Protected Matters Search Tool

You are here: Environment Home > EPBC Act > Search

8 June 2010 12:20

EPBC Act Protected Matters Report

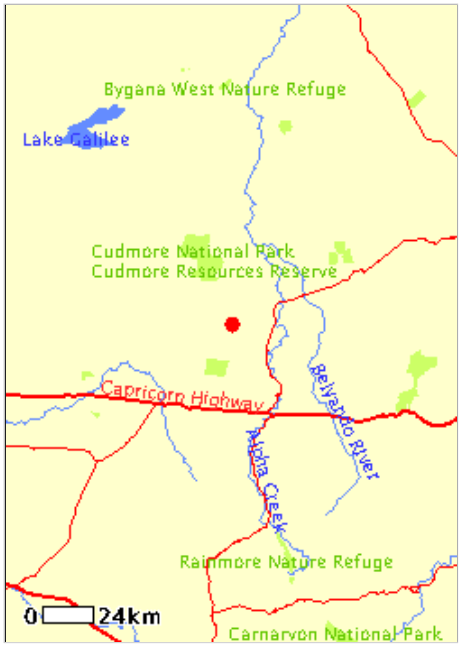
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

You may wish to print this report for reference before moving to other pages or websites.

The Australian Natural Resources Atlas at http://www.environment.gov.au/atlas may provide further environmental information relevant to your selected area. Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

Search Type: Point
Buffer: 100 km
Coordinates: -23.24,146.46

Report Contents:



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Significance: (Ramsar Sites)	2
Commonwealth Marine Areas:	None

Threatened Ecological Communities:	5
Threatened Species:	17
Migratory Species:	12

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html.

Please note that the current dataset on Commonwealth land is not complete. Further information on Commonwealth land would need to be obtained from relevant sources including Commonwealth agencies, local agencies, and land tenure maps.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.au/epbc/permits/index.html.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Places on the RNE:	2
Listed Marine Species:	11
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	4
Other Commonwealth Reserves:	None
Regional Forest Agreements:	None

Details

Matters of National Environmental Significance

Wetlands of International Significance [Dataset Information] (Ramsar Sites)		
COONGIE LAKES		Within same catchment as Ramsar site
SHOALWATER AND CORIO BAYS AREA		Within same catchment as Ramsar site
Threatened Ecological Communities [Dataset Information]	Status	Type of Presence

Brigalow (*Acacia harpophylla* dominant and co-dominant)	Endangered	Community known to occur within area
Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin	Endangered	Community likely to occur within area
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area
The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin	Endangered	Community known to occur within area
Weeping Myall Woodlands	Endangered	Community likely to occur within area
Threatened Species [Dataset Information]	Status	Type of Presence
Birds		
Erythrotriorchis radiatus Red Goshawk	Vulnerable	Species or species habitat likely to occur within area
Geophaps scripta scripta Squatter Pigeon (southern)	Vulnerable	Species or species habitat likely to occur within area
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern)	Endangered	Species or species habitat likely to occur within area
Poephila cincta cincta Black-throated Finch (southern)	Endangered	Species or species habitat likely to occur within area
Rostratula australis Australian Painted Snipe	Vulnerable	Species or species habitat may occur within area
Mammals		
Dasyurus hallucatus Northern Quoll	Endangered	Species or species habitat likely to occur within area
Lasiorhinus krefftii Northern Hairy-nosed Wombat, Yaminon	Endangered	Species or species habitat likely to occur within area
Nyctophilus timoriensis (South-eastern form) Greater Long-eared Bat, South-eastern Long-eared Bat	Vulnerable	Species or species habitat may occur within area
Sminthopsis douglasi Julia Creek Dunnart	Endangered	Species or species habitat may occur within area
Reptiles		
Denisonia maculata Ornamental Snake	Vulnerable	Species or species habitat likely to occur within area
Egernia rugosa Yakka Skink	Vulnerable	Species or species habitat likely to occur within area
Furina dunmalli Dunmall's Snake	Vulnerable	Species or species habitat may occur within area
Paradelma orientalis Brigalow Scaly-foot	Vulnerable	Species or species habitat likely to occur within area
Rheodytes leukops Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle	Vulnerable	Species or species habitat may occur within area
Plants		
Acacia ramiflora	Vulnerable	Species or species habitat may occur within area
Cadellia pentastylis Ooline	Vulnerable	Species or species habitat likely to occur within area
Dichanthium queenslandicum King Blue-grass	Vulnerable	Species or species habitat likely to occur within area
Migratory Species [Dataset Information]	Status	Type of Presence
Migratory Terrestrial Species		
Birds		

Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail	Migratory	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher	Migratory	Species or species habitat likely to occur within area

Migratory Wetland Species

Birds

Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Migratory	Species or species habitat may occur within area
Nettapus coromandelianus albipennis Australian Cotton Pygmy-goose	Migratory	Species or species habitat may occur within area
Rostratula benghalensis s. lat. Painted Snipe	Migratory	Species or species habitat may occur within area

Migratory Marine Birds

Apus pacificus Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Dataset Information]	Status	Type of Presence
Birds		
Anseranas semipalmata Magpie Goose	Listed - overfly marine area	Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Listed - overfly marine area	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Listed - overfly marine area	Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle	Listed	Species or species habitat likely to occur within area

Hirundapus caudacutus White-throated Needletail	Listed - overfly marine area	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher	Listed - overfly marine area	Species or species habitat likely to occur within area
Nettapus coromandelianus albipennis Australian Cotton Pygmy-goose	Listed - overfly marine area	Species or species habitat may occur within area
Rostratula benghalensis s. lat. Painted Snipe	Listed - overfly marine area	Species or species habitat may occur within area

Places on the RNE [Dataset Information]
Note that not all Indigenous sites may be listed.

Natural

Epping Forest National Park (1978 Boundary) QLD

Lake Galilee Wetlands QLD

Extra Information

State and Territory Reserves [Dataset Information]

Cudmore National Park, QLD

Cudmore Resource Reserve, QLD

Epping Forest National Park (Scientific), QLD

Narrien Range National Park, QLD

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the *Environment Protection and Biodiversity Conservation Act 1999*. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under "type of presence". For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the migratory and marine provisions of the Act have been mapped.

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites;
- seals which have only been mapped for breeding sites near the Australian continent.

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgments

This database has been compiled from a range of data sources. The Department acknowledges the following custodians who have contributed valuable data and advice:

- New South Wales National Parks and Wildlife Service
- Department of Sustainability and Environment, Victoria
- Department of Primary Industries, Water and Environment, Tasmania
- Department of Environment and Heritage, South Australia Planning SA
- Parks and Wildlife Commission of the Northern Territory
- Environmental Protection Agency, Queensland
- Birds Australia
- Australian Bird and Bat Banding Scheme
- Australian National Wildlife Collection
- Natural history museums of Australia
- Queensland Herbarium
- National Herbarium of NSW
- Royal Botanic Gardens and National Herbarium of Victoria
- Tasmanian Herbarium
- State Herbarium of South Australia
- Northern Territory Herbarium
- Western Australian Herbarium
- Australian National Herbarium, Atherton and Canberra
- University of New England
- Other groups and individuals

ANUCliM Version 1.8, Centre for Resource and Environmental Studies, Australian National University was used extensively for the production of draft maps of species distribution. Environment Australia is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

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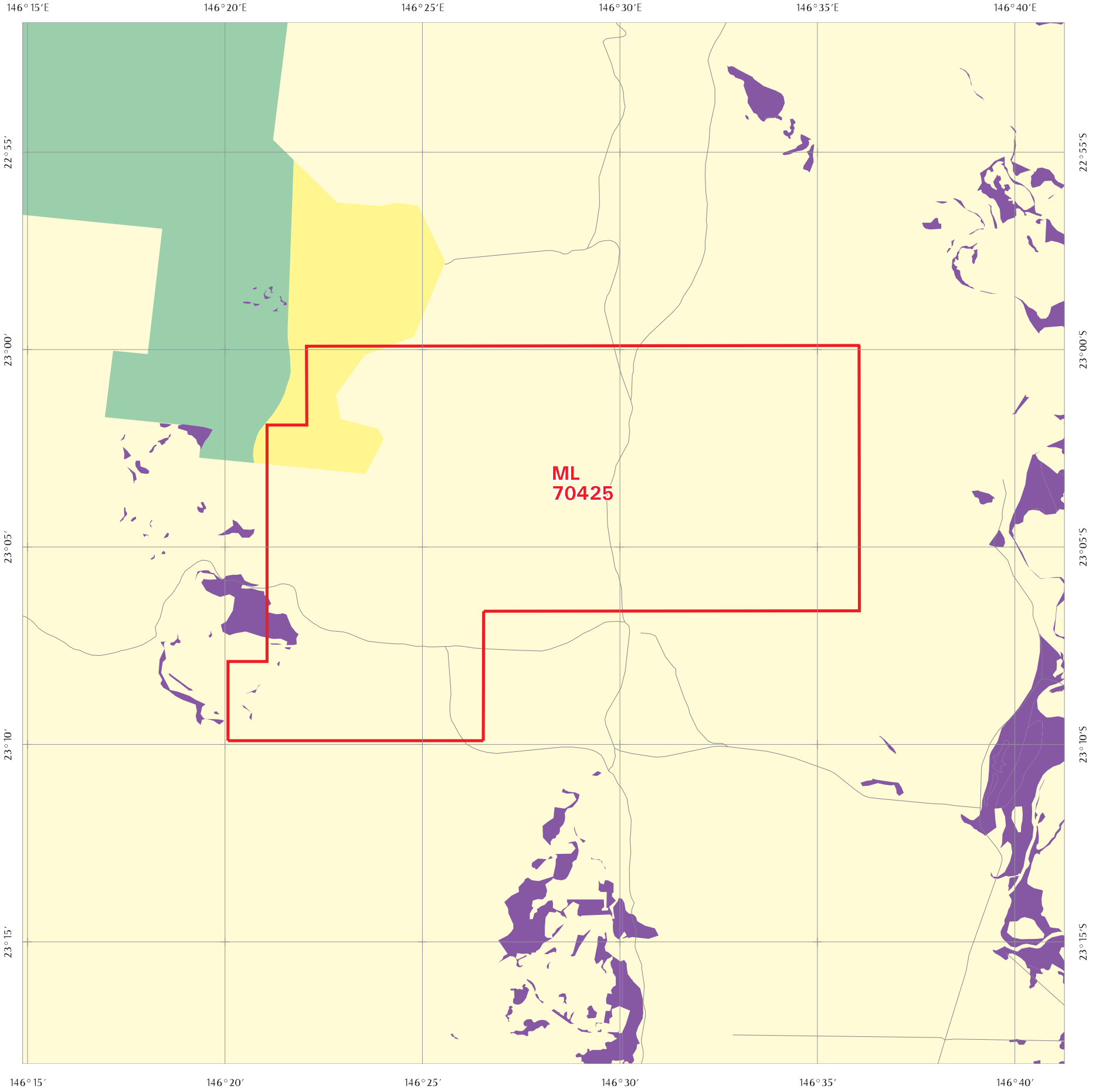
Last updated: Thursday, 20-Nov-2008 14:17:56 EST



ENVIRONMENTALLY SENSITIVE AREAS - Mining Activities

Requested By: DTAYLOR@AARC.NET.AU
Date: 31 Oct 11 Time: 12.51.08

Centered on Tenure:
ML 70425

Legend

- Selected Mining Lease

CATEGORY A

- National Parks
- Conservation Parks
- Forest Reserves
- Wet Tropics World Heritage Area
- Great Barrier Reef Marine Park Region
- Marine Parks other than General Use Zones

CATEGORY B

- World Heritage Areas
- Queensland Heritage Register Places
- Ramsar Sites
- Cultural Heritage Registered Areas and DLA's other than Stanbroke
- Special Forestry Areas
- Fish Habitat Areas
- Koala Plan
- Coordinated Conservation Areas
- Endangered Regional Ecosystems (Biodiversity Status)
- General Use Zones of Marine Parks
- Marine Plants

CATEGORY C

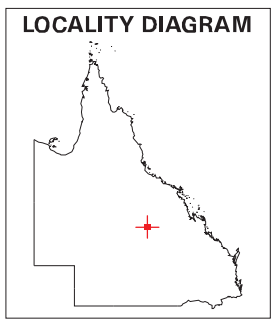
- Nature Refuges
- Resources Reserves
- Declared Catchment Areas
- Declared Irrigation Areas
- Drainage Areas
- River Improvement Areas
- Stanbroke DLA
- State Forests
- Timber Reserves
- Coastal Management Control Districts
- Dams and Weirs

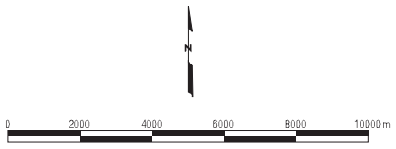
OTHERS

- Roads
- Towns
- Wild River Nominated Waterways
- Wild River High Preservation Areas
- Wild River Preservation Areas
- Mahogany Glider Habitat
- Directory of Important Wetlands
- Queensland

Queensland Government

LOCALITY DIAGRAM





This scale bar is approximate only
Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)
This product is unprojected and is not suitable for measuring distances

External contributors (non-government parties) of the data for this product are:
Great Barrier Reef Marine Park Authority
MapInfo Australia Pty Ltd

NOTE TO USER: Themes presented in this map are indicative only. Field survey may be required to verify the 'true' spatial extent and value. Not all environmentally sensitive areas are presented in this map. A user should refer to the particular circumstances relevant to their situation to assess the 'completeness' of themes provided.

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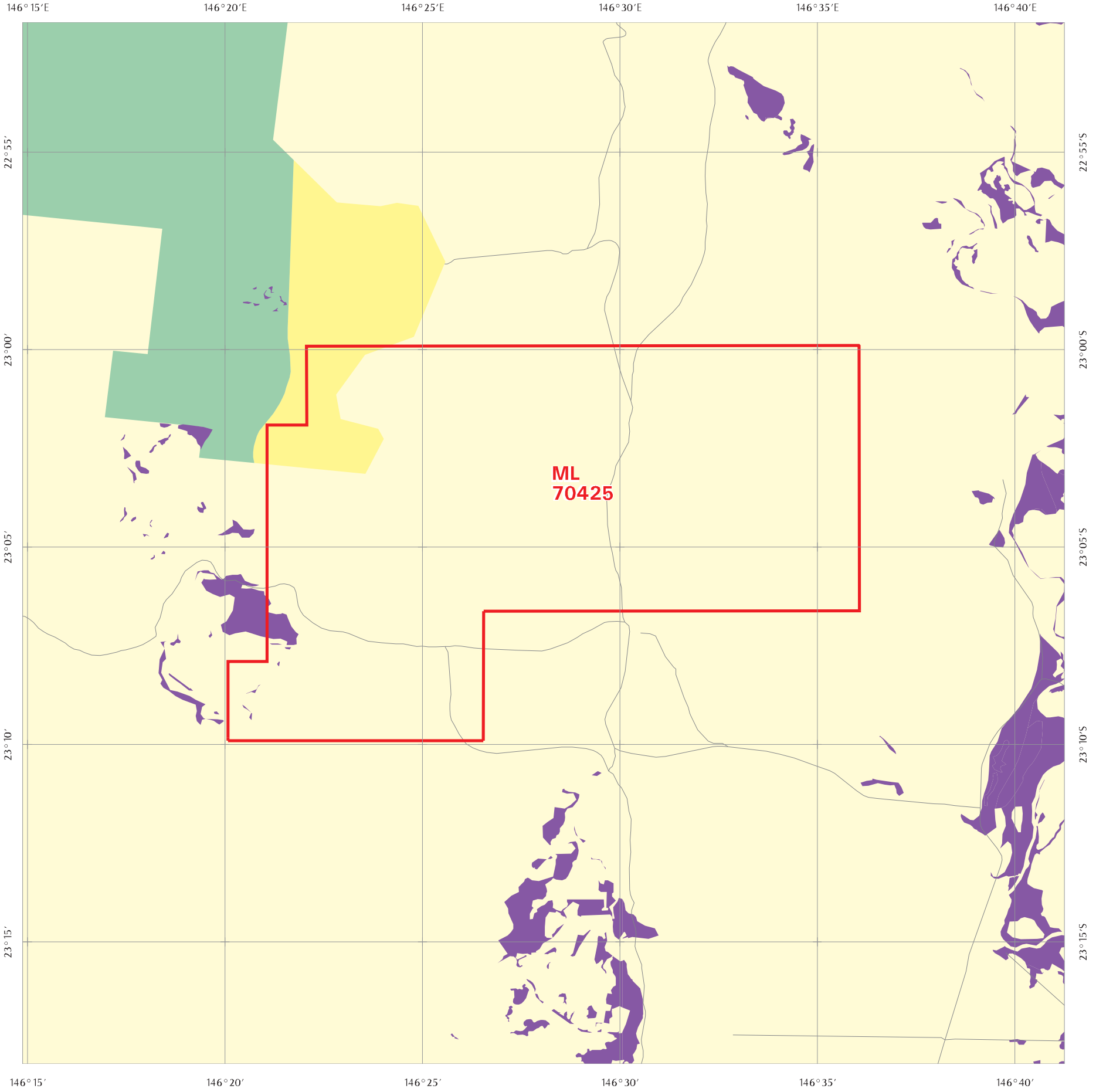
The user should be aware that due to multiple overlapping themes/ layers present, some themes/layers may be obscured by others. Ordering in the Legend does not accurately reflect the order by which themes/layers are displayed.



ENVIRONMENTALLY SENSITIVE AREAS - Mining Activities

Requested By: DTAYLOR@AARC.NET.AU
Date: 31 Oct 11 Time: 12.51.08

Centered on Tenure:
ML 70425

Legend

- Selected Mining Lease

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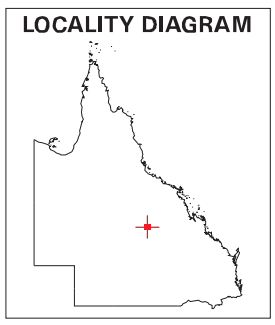
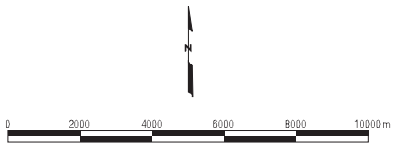
Queensland Government

LOCALITY DIAGRAM





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Queensland Government

Wildlife Online Extract

Search Criteria: Species List for a Defined Area
Species: All
Type: Native
Status: Rare and threatened species
Records: All
Date: All
Latitude: 22.6095 to 23.0595
Longitude: 146.0133 to 146.4995
Email: janemcpheefrew@gmail.com
Date submitted: Friday 19 Aug 2011 14:13:24
Date extracted: Friday 19 Aug 2011 14:16:04

The number of records retrieved = 6

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Accipitridae	*Lophoictinia isura*	square-tailed kite		NT		1
animals	birds	Columbidae	*Geophaps scripta scripta*	squatter pigeon (southern subspecies)		V	V	3
animals	reptiles	Scincidae	*Ctenotus capricorni*			NT		2/2
plants	higher dicots	Fabaceae	*Desmodium macrocarpum*			NT		2/1
plants	higher dicots	Myrtaceae	*Corymbia clandestina*			V	V	1
plants	monocots	Poaceae	*Sporobolus partimpatens*			NT		1/1

CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992.* The codes are Extinct in the Wild (PE), Endangered (E), Vulnerable (V), Near Threatened (NT), Least Concern (C) or Not Protected ( ).

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999.* The values of EPBC are Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Extinct in the Wild (XW) and Vulnerable (V).

Records – The first number indicates the total number of records of the taxon for the record option selected (i.e. All, Confirmed or Specimens).
This number is output as 99999 if it equals or exceeds this value. The second number located after the / indicates the number of specimen records for the taxon.
This number is output as 999 if it equals or exceeds this value.

Queensland Government

Wildlife Online Extract

Search Criteria: Species List for a Defined Area
Species: All
Type: All
Status: All
Records: All
Date: All
Latitude: 22.6095 to 23.0595
Longitude: 146.4995 to 146.9858
Email: janemcpheefrew@gmail.com
Date submitted: Friday 19 Aug 2011 14:14:22
Date extracted: Friday 19 Aug 2011 14:16:06

The number of records retrieved = 459

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	amphibians	Bufonidae	*Rhinella marina*	cane toad	Y			1
animals	amphibians	Hylidae	*Litoria rubella*	ruddy treefrog		C		1
animals	amphibians	Hylidae	*Litoria caerulea*	common green treefrog		C		3
animals	amphibians	Hylidae	*Litoria latopalmata*	broad palmed rocketfrog		C		1
animals	amphibians	Hylidae	*Cyclorana brevipes*	superb collared frog		C		1
animals	amphibians	Limnodynastidae	*Platyplectrum ornatum*	ornate burrowing frog		C		2
animals	birds	Acanthizidae	*Acanthiza apicalis*	inland thornbill		C		2
animals	birds	Acanthizidae	*Acanthiza chrysorrhoa*	yellow-rumped thornbill		C		3
animals	birds	Acanthizidae	*Chthonicola sagittata*	speckled warbler		C		1
animals	birds	Acanthizidae	*Smicrornis brevirostris*	weebill		C		10
animals	birds	Acanthizidae	*Gerygone albogularis*	white-throated gerygone		C		1
animals	birds	Accipitridae	*Aquila audax*	wedge-tailed eagle		C		2
animals	birds	Accipitridae	*Haliastur sphenurus*	whistling kite		C		2
animals	birds	Accipitridae	*Erythrotriorchis radiatus*	red goshawk		E	V	1
animals	birds	Accipitridae	*Accipiter fasciatus*	brown goshawk		C		2
animals	birds	Accipitridae	*Circus assimilis*	spotted harrier		C		1
animals	birds	Accipitridae	*Lophoictinia isura*	square-tailed kite		NT		1
animals	birds	Aegothelidae	*Aegotheles cristatus*	Australian owlet-nightjar		C		1
animals	birds	Anatidae	*Anas gracilis*	grey teal		C		1
animals	birds	Anatidae	*Chenonetta jubata*	Australian wood duck		C		2
animals	birds	Anatidae	*Anas superciliosa*	Pacific black duck		C		3
animals	birds	Anatidae	*Dendrocygna eytoni*	plumed whistling-duck		C		1
animals	birds	Anhingidae	*Anhinga novaehollandiae*	Australasian darter		C		2
animals	birds	Ardeidae	*Ardea pacifica*	white-necked heron		C		1
animals	birds	Ardeidae	*Egretta novaehollandiae*	white-faced heron		C		1
animals	birds	Artamidae	*Artamus minor*	little woodswallow		C		2
animals	birds	Artamidae	*Cracticus nigrogularis*	pied butcherbird		C		11
animals	birds	Artamidae	*Artamus superciliosus*	white-browed woodswallow		C		1
animals	birds	Artamidae	*Artamus leucorynchus*	white-breasted woodswallow		C		1
animals	birds	Artamidae	*Cracticus torquatus*	grey butcherbird		C		4
animals	birds	Artamidae	*Artamus cinereus*	black-faced woodswallow		C		3
animals	birds	Artamidae	*Strepera graculina*	pied currawong		C		8
animals	birds	Artamidae	*Cracticus tibicen*	Australian magpie		C		5
animals	birds	Cacatuidae	*Cacatua galerita*	sulphur-crested cockatoo		C		3
animals	birds	Cacatuidae	*Nymphicus hollandicus*	cockatiel		C		3
animals	birds	Cacatuidae	*Eolophus roseicapillus*	galah		C		3
animals	birds	Campephagidae	*Lalage sueurii*	white-winged triller		C		5
animals	birds	Campephagidae	*Coracina novaehollandiae*	black-faced cuckoo-shrike		C		6
animals	birds	Campephagidae	*Coracina tenuirostris*	cicadabird		C		3
animals	birds	Casuariidae	*Dromaius novaehollandiae*	emu		C		1
animals	birds	Charadriidae	*Elseyornis melanops*	black-fronted dotterel		C		2
animals	birds	Charadriidae	*Vanellus miles miles*	masked lapwing (northern subspecies)		C		1
animals	birds	Climacteridae	*Climacteris picumnus*	brown treecreeper		C		3
animals	birds	Columbidae	*Geopelia cuneata*	diamond dove		C		1
animals	birds	Columbidae	*Phaps chalcoptera*	common bronzewing		C		2
animals	birds	Columbidae	*Geopelia humeralis*	bar-shouldered dove		C		5

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Columbidae	*Ocyphaps lophotes*	crested pigeon		C		6
animals	birds	Columbidae	*Geopelia striata*	peaceful dove		C		5
animals	birds	Columbidae	*Geophaps scripta scripta*	squatter pigeon (southern subspecies)		V	V	1
animals	birds	Corcoracidae	*Struthidea cinerea*	apostlebird		C		4
animals	birds	Corcoracidae	*Corcorax melanorhamphos*	white-winged chough		C		1
animals	birds	Corvidae	*Corvus orru*	Torresian crow		C		11
animals	birds	Corvidae	*Corvus coronoides*	Australian raven		C		4
animals	birds	Cuculidae	*Chalcites lucidus*	shining bronze-cuckoo		C		1
animals	birds	Cuculidae	*Centropus phasianinus*	pheasant coucal		C		3
animals	birds	Cuculidae	*Scythrops novaehollandiae*	channel-billed cuckoo		C		2
animals	birds	Cuculidae	*Cacomantis flabelliformis*	fan-tailed cuckoo		C		1
animals	birds	Cuculidae	*Eudynamys orientalis*	eastern koel		C		1
animals	birds	Cuculidae	*Cacomantis pallidus*	pallid cuckoo		C		2
animals	birds	Estrildidae	*Neochmia modesta*	plum-headed finch		C		1
animals	birds	Estrildidae	*Taeniopygia bichenovii*	double-barred finch		C		6
animals	birds	Estrildidae	*Taeniopygia guttata*	zebra finch		C		2
animals	birds	Eurostopodidae	*Eurostopodus argus*	spotted nightjar		C		1
animals	birds	Eurostopodidae	*Eurostopodus mystacalis*	white-throated nightjar		C		1
animals	birds	Falconidae	*Falco berigora*	brown falcon		C		6
animals	birds	Falconidae	*Falco longipennis*	Australian hobby		C		2
animals	birds	Falconidae	*Falco cenchroides*	nankeen kestrel		C		2
animals	birds	Falconidae	*Falco peregrinus*	peregrine falcon		C		1
animals	birds	Halcyonidae	*Dacelo leachii*	blue-winged kookaburra		C		1
animals	birds	Halcyonidae	*Dacelo novaeguineae*	laughing kookaburra		C		4
animals	birds	Halcyonidae	*Todiramphus pyrrhopygius*	red-backed kingfisher		C		1
animals	birds	Halcyonidae	*Todiramphus sanctus*	sacred kingfisher		C		1
animals	birds	Hirundinidae	*Petrochelidon nigricans*	tree martin		C		1
animals	birds	Maluridae	*Malurus lamberti*	variegated fairy-wren		C		7
animals	birds	Maluridae	*Malurus melanocephalus*	red-backed fairy-wren		C		4
animals	birds	Megaluridae	*Cincloramphus mathewsi*	rufous songlark		C		2
animals	birds	Meliphagidae	*Entomyzon cyanotis*	blue-faced honeyeater		C		5
animals	birds	Meliphagidae	*Philemon citreogularis*	little friarbird		C		10
animals	birds	Meliphagidae	*Acanthorhynchus tenuirostris*	eastern spinebill		C		1
animals	birds	Meliphagidae	*Lichenostomus penicillatus*	white-plumed honeyeater		C		2
animals	birds	Meliphagidae	*Plectorhyncha lanceolata*	striped honeyeater		C		8
animals	birds	Meliphagidae	*Melithreptus albogularis*	white-throated honeyeater		C		5
animals	birds	Meliphagidae	*Acanthagenys rufogularis*	spiny-cheeked honeyeater		C		2
animals	birds	Meliphagidae	*Lichenostomus virescens*	singing honeyeater		C		7
animals	birds	Meliphagidae	*Lichenostomus plumulus*	grey-fronted honeyeater		C		1
animals	birds	Meliphagidae	*Lichmera indistincta*	brown honeyeater		C		5
animals	birds	Meliphagidae	*Philemon corniculatus*	noisy friarbird		C		14
animals	birds	Meliphagidae	*Lichenostomus chrysops*	yellow-faced honeyeater		C		1
animals	birds	Meliphagidae	*Lichenostomus leucotis*	white-eared honeyeater		C		2
animals	birds	Meliphagidae	*Melithreptus gularis*	black-chinned honeyeater		NT		2
animals	birds	Meliphagidae	*Manorina flavigula*	yellow-throated miner		C		7
animals	birds	Meropidae	*Merops ornatus*	rainbow bee-eater		C		8

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Monarchidae	*Myiagra rubecula*	leaden flycatcher		C		4
animals	birds	Monarchidae	*Grallina cyanoleuca*	magpie-lark		C		1
animals	birds	Motacillidae	*Anthus novaeseelandiae*	Australasian pipit		C		1
animals	birds	Nectariniidae	*Dicaeum hirundinaceum*	mistletoebird		C		2
animals	birds	Neosittidae	*Daphoenositta chrysoptera*	varied sittella		C		2
animals	birds	Oriolidae	*Oriolus sagittatus*	olive-backed oriole		C		2
animals	birds	Oriolidae	*Sphecotheres vieilloti*	Australasian figbird		C		1
animals	birds	Pachycephalidae	*Oreoica gutturalis*	crested bellbird		C		6
animals	birds	Pachycephalidae	*Colluricincla harmonica*	grey shrike-thrush		C		7
animals	birds	Pachycephalidae	*Pachycephala rufiventris*	rufous whistler		C		5
animals	birds	Pardalotidae	*Pardalotus striatus*	striated pardalote		C		9
animals	birds	Pardalotidae	*Pardalotus rubricatus*	red-browed pardalote		C		1
animals	birds	Petroicidae	*Microeca fascinans*	jacky winter		C		7
animals	birds	Petroicidae	*Petroica goodenovii*	red-capped robin		C		1
animals	birds	Phalacrocoracidae	*Microcarbo melanoleucos*	little pied cormorant		C		1
animals	birds	Phalacrocoracidae	*Phalacrocorax sulcirostris*	little black cormorant		C		1
animals	birds	Phasianidae	*Coturnix ypsilophora*	brown quail		C		2
animals	birds	Podargidae	*Podargus strigoides*	tawny frogmouth		C		1
animals	birds	Pomatostomidae	*Pomatostomus temporalis*	grey-crowned babbler		C		7
animals	birds	Psittacidae	*Platycercus adscitus*	pale-headed rosella		C		5
animals	birds	Psittacidae	*Aprosmictus erythropterus*	red-winged parrot		C		6
animals	birds	Psittacidae	*Trichoglossus haematodus moluccanus*	rainbow lorikeet		C		1
animals	birds	Psittacidae	*Melopsittacus undulatus*	budgerigar		C		4
animals	birds	Ptilonorhynchidae	*Ptilonorhynchus maculatus*	spotted bowerbird		C		3
animals	birds	Rallidae	*Fulica atra*	Eurasian coot		C		1
animals	birds	Rallidae	*Porphyrio porphyrio*	purple swamphen		C		1
animals	birds	Rhipiduridae	*Rhipidura albiscapa*	grey fantail		C		4
animals	birds	Rhipiduridae	*Rhipidura leucophrys*	willie wagtail		C		3
animals	birds	Strigidae	*Ninox boobook*	southern boobook		C		2
animals	birds	Turnicidae	*Turnix velox*	little button-quail		C		1
animals	mammals	Canidae	*Canis lupus dingo*	dingo				7
animals	mammals	Dasyuridae	*Dasyurus hallucatus*	northern quoll		C	E	1
animals	mammals	Dasyuridae	*Sminthopsis macroura*	stripe-faced dunnart		C		3
animals	mammals	Dasyuridae	*Planigale tenuirostris*	narrow-nosed planigale		C		1
animals	mammals	Felidae	*Felis catus*	cat	Y			1
animals	mammals	Leporidae	*Oryctolagus cuniculus*	rabbit	Y			2
animals	mammals	Macropodidae	*Macropus rufus*	red kangaroo		C		1
animals	mammals	Macropodidae	*Macropus giganteus*	eastern grey kangaroo		C		2
animals	mammals	Macropodidae	*Wallabia bicolor*	swamp wallaby		C		3
animals	mammals	Macropodidae	*Macropus robustus*	common wallaroo		C		2
animals	mammals	Macropodidae	*Petrogale herberti*	Herbert's rock-wallaby		C		5/2
animals	mammals	Muridae	*Mus musculus*	house mouse	Y			30
animals	mammals	Muridae	*Pseudomys desertor*	desert mouse		C		8
animals	mammals	Muridae	*Pseudomys delicatulus*	delicate mouse		C		4
animals	mammals	Phalangeridae	*Trichosurus vulpecula*	common brushtail possum		C		1
animals	mammals	Phascolarctidae	*Phascolarctos cinereus*	koala		C		1

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	mammals	Potoroidae	*Aepyprymnus rufescens*	rufous bettong		C		4
animals	mammals	Rhinolophidae	*Rhinolophus megaphyllus*	eastern horseshoe-bat		C		2
animals	mammals	Suidae	*Sus scrofa*	pig	Y			4
animals	mammals	Tachyglossidae	*Tachyglossus aculeatus*	short-beaked echidna		C		1
animals	mammals	Vespertilionidae	*Scotorepens sp.*					1
animals	mammals	Vespertilionidae	*Vespadelus vulturnus*	little forest bat		C		3
animals	reptiles	Agamidae	*Pogona barbata*	bearded dragon		C		2
animals	reptiles	Agamidae	*Diporiphora australis*			C		1
animals	reptiles	Agamidae	*Amphibolurus gilberti*	Gilbert's dragon		C		1
animals	reptiles	Boidae	*Aspidites melanocephalus*	black-headed python		C		2
animals	reptiles	Colubridae	*Dendrelaphis punctulata*	common tree snake		C		1
animals	reptiles	Elapidae	*Suta suta*	myall snake		C		1
animals	reptiles	Elapidae	*Demansia psammophis*	yellow-faced whip snake		C		2
animals	reptiles	Elapidae	*Pseudonaja textilis*	eastern brown snake		C		1
animals	reptiles	Gekkonidae	*Oedura monilis*			C		3
animals	reptiles	Gekkonidae	*Gehyra catenata*			C		6
animals	reptiles	Gekkonidae	*Heteronotia binoei*	Bynoe's gecko		C		9
animals	reptiles	Gekkonidae	*Diplodactylus conspicillatus*	fat-tailed diplodactylus		C		1
animals	reptiles	Gekkonidae	*Lucasium steindachneri*	Steindachner's gecko		C		2
animals	reptiles	Gekkonidae	*Diplodactylus vittatus*	wood gecko		C		1
animals	reptiles	Gekkonidae	*Oedura rhombifer*	zig-zag gecko		C		1
animals	reptiles	Pygopodidae	*Delma tincta*			C		1
animals	reptiles	Pygopodidae	*Lialis burtonis*	Burton's legless lizard		C		3
animals	reptiles	Scincidae	*Carlia sp.*					1
animals	reptiles	Scincidae	*Eulamprus sp.*					1
animals	reptiles	Scincidae	*Egernia rugosa*	yakka skink		V	V	1
animals	reptiles	Scincidae	*Menetia greyii*			C		1
animals	reptiles	Scincidae	*Lerista fragilis*			C		1
animals	reptiles	Scincidae	*Carlia schmeltzii*			C		1
animals	reptiles	Scincidae	*Ctenotus robustus*			C		7
animals	reptiles	Scincidae	*Egernia striolata*	tree skink		C		1
animals	reptiles	Scincidae	*Ctenotus leonhardii*			C		1
animals	reptiles	Scincidae	*Morethia boulengeri*			C		3
animals	reptiles	Scincidae	*Ctenotus pantherinus*			C		1
animals	reptiles	Scincidae	*Ctenotus taeniolatus*	copper-tailed skink		C		11
animals	reptiles	Scincidae	*Cryptoblepharus pannosus*	ragged snake-eyed skink		C		3
animals	reptiles	Varanidae	*Varanus gouldii*	sand monitor		C		1
animals	reptiles	Varanidae	*Varanus tristis*	black-tailed monitor		C		2
plants	ferns	Adiantaceae	*Cheilanthes distans*	bristly cloak fern		C		3/1
plants	ferns	Adiantaceae	*Cheilanthes nudiuscula*			C		1
plants	ferns	Adiantaceae	*Cheilanthes sieberi*			C		4
plants	higher dicots	Acanthaceae	*Brunoniella australis*	blue trumpet		C		1
plants	higher dicots	Acanthaceae	*Dipteracanthus australasicus*			C		2
plants	higher dicots	Acanthaceae	*Rostellularia adscendens*			C		3
plants	higher dicots	Amaranthaceae	*Alternanthera nana*	hairy joyweed		C		1
plants	higher dicots	Apocynaceae	*Parsonsia*			C		1

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	higher dicots	Apocynaceae	*Secamone elliptica*			C		2
plants	higher dicots	Apocynaceae	*Carissa lanceolata*			C		18
plants	higher dicots	Apocynaceae	*Cerbera dumicola*			NT		2/1
plants	higher dicots	Apocynaceae	*Carissa ovata*	currantbush		C		2
plants	higher dicots	Apocynaceae	*Alstonia constricta*	bitterbark		C		2
plants	higher dicots	Apocynaceae	*Parsonsia lanceolata*	northern silkpod		C		2
plants	higher dicots	Asteraceae	*Blumea mollis*			C		2/1
plants	higher dicots	Asteraceae	*Pluchea dentex*	bowl daisy		C		3/2
plants	higher dicots	Asteraceae	*Olearia xerophila*			C		3
plants	higher dicots	Asteraceae	*Olearia subspicata*			C		1
plants	higher dicots	Asteraceae	*Pterocaulon redolens*			C		1
plants	higher dicots	Asteraceae	*Coronidium glutinosum*			C		7/2
plants	higher dicots	Asteraceae	*Wedelia spilanthoides*			C		1
plants	higher dicots	Asteraceae	*Pterocaulon serrulatum var. serrulatum*			C		1/1
plants	higher dicots	Asteraceae	*Centipeda minima subsp. minima*			C		1/1
plants	higher dicots	Asteraceae	*Chrysocephalum apiculatum*	yellow buttons		C		2
plants	higher dicots	Asteraceae	*Cyanthillium cinereum*			C		1
plants	higher dicots	Asteraceae	*Xanthium occidentale*		Y			1
plants	higher dicots	Asteraceae	*Rutidosis leucantha*			C		1/1
plants	higher dicots	Asteraceae	*Calotis cuneifolia*	burr daisy		C		1
plants	higher dicots	Asteraceae	*Pluchea dunlopii*			C		1/1
plants	higher dicots	Asteraceae	*Cassinia laevis*			C		2
plants	higher dicots	Boraginaceae	*Ehretia membranifolia*	weeping koda		C		3
plants	higher dicots	Boraginaceae	*Heliotropium cunninghamii*			C		1/1
plants	higher dicots	Byttneriaceae	*Waltheria indica*			C		2
plants	higher dicots	Byttneriaceae	*Melochia pyramidata*		Y			1
plants	higher dicots	Cactaceae	*Opuntia tomentosa*	velvety tree pear	Y			2
plants	higher dicots	Caesalpiniaceae	*Senna aciphylla*	Australian senna		C		2/1
plants	higher dicots	Caesalpiniaceae	*Senna artemisioides*			C		3
plants	higher dicots	Caesalpiniaceae	*Lysiphyllum carronii*	ebony tree		C		7
plants	higher dicots	Caesalpiniaceae	*Senna artemisioides subsp. coriacea*			C		1
plants	higher dicots	Caesalpiniaceae	*Senna artemisioides subsp. filifolia*			C		1
plants	higher dicots	Caesalpiniaceae	*Lysiphyllum hookeri*	Queensland ebony		C		4
plants	higher dicots	Caesalpiniaceae	*Cassia brewsteri*			C		2
plants	higher dicots	Capparaceae	*Capparis*			C		1
plants	higher dicots	Capparaceae	*Apophyllum anomalum*	broom bush		C		2
plants	higher dicots	Capparaceae	*Capparis mitchellii*			C		1
plants	higher dicots	Capparaceae	*Capparis loranthifolia var. bancroftii*			C		1/1
plants	higher dicots	Capparaceae	*Capparis canescens*			C		6
plants	higher dicots	Capparaceae	*Capparis lasiantha*	nipan		C		4
plants	higher dicots	Celastraceae	*Denhamia oleaster*			C		2
plants	higher dicots	Celastraceae	*Maytenus cunninghamii*	yellow berry bush		C		7
plants	higher dicots	Chenopodiaceae	*Chenopodium*			C		1
plants	higher dicots	Chenopodiaceae	*Sclerolaena*			C		2
plants	higher dicots	Chenopodiaceae	*Enchylaena tomentosa*			C		2
plants	higher dicots	Cleomaceae	*Cleome viscosa*	tick-weed		C		2

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plants	higher dicots	Combretaceae	*Terminalia aridicola*			C		2
plants	higher dicots	Combretaceae	*Terminalia oblongata*			C		5
plants	higher dicots	Convolvulaceae	*Bonamia media*			C		1
plants	higher dicots	Convolvulaceae	*Evolvulus alsinoides*			C		3
plants	higher dicots	Droseraceae	*Drosera peltata*	pale sundew		C		1/1
plants	higher dicots	Ericaceae	*Melichrus urceolatus*	honey gorse		C		1/1
plants	higher dicots	Erythroxylaceae	*Erythroxylum australe*	cocaine tree		C		11
plants	higher dicots	Euphorbiaceae	*Acalypha eremorum*	soft acalypha		C		1
plants	higher dicots	Euphorbiaceae	*Euphorbia tannensis subsp. eremophila*			C		1/1
plants	higher dicots	Euphorbiaceae	*Croton phebalioides*	narrow-leaved croton		C		1
plants	higher dicots	Fabaceae	*Hovea*			C		1
plants	higher dicots	Fabaceae	*Indigofera*			C		3
plants	higher dicots	Fabaceae	*Glycine tabacina*	glycine pea		C		1
plants	higher dicots	Fabaceae	*Hovea parvicalyx*			C		2/2
plants	higher dicots	Fabaceae	*Mirbelia aotoides*			C		1/1
plants	higher dicots	Fabaceae	*Tephrosia sp. (Pannikan Springs A.R.Bean+ 5612)*			C		1/1
plants	higher dicots	Fabaceae	*Hardenbergia perbrevidens*			C		2/1
plants	higher dicots	Fabaceae	*Gastrolobium grandiflorum*			C		2/1
plants	higher dicots	Fabaceae	*Jacksonia rhadinoclona*	Miles dogwood		C		5/2
plants	higher dicots	Fabaceae	*Jacksonia ramosissima*			C		2/1
plants	higher dicots	Fabaceae	*Erythrina vespertilio*			C		2
plants	higher dicots	Fabaceae	*Desmodium brachypodum*	large ticktrefoil		C		1/1
plants	higher dicots	Fabaceae	*Indigofera australis*			C		1
plants	higher dicots	Fabaceae	*Cajanus acutifolius*			C		2/1
plants	higher dicots	Fabaceae	*Indigofera colutea*	sticky indigo		C		1/1
plants	higher dicots	Fabaceae	*Tephrosia rufula*			C		1/1
plants	higher dicots	Fabaceae	*Hovea lanceolata*			C		4
plants	higher dicots	Fabaceae	*Daviesia filipes*			C		2/1
plants	higher dicots	Goodeniaceae	*Velleia paradoxa*	spur velleia		C		1/1
plants	higher dicots	Goodeniaceae	*Goodenia viridula*			C		1/1
plants	higher dicots	Goodeniaceae	*Dampiera adpressa*			C		2/1
plants	higher dicots	Goodeniaceae	*Goodenia grandiflora*			C		1/1
plants	higher dicots	Lamiaceae	*Clerodendrum floribundum*			C		2
plants	higher dicots	Lamiaceae	*Prostanthera leichhardtii*			C		1/1
plants	higher dicots	Loganiaceae	*Logania albiflora*			C		1/1
plants	higher dicots	Loranthaceae	*Amyema quandang*			C		1
plants	higher dicots	Loranthaceae	*Amyema quandang var. bancroftii*	broad-leaved grey mistletoe		C		1/1
plants	higher dicots	Malvaceae	*Sida*			C		2
plants	higher dicots	Malvaceae	*Abutilon auritum*	Chinese lantern		C		1/1
plants	higher dicots	Malvaceae	*Gossypium sturtianum*			C		2/1
plants	higher dicots	Malvaceae	*Hibiscus sturtii*			C		3
plants	higher dicots	Malvaceae	*Sida filiformis*			C		1
plants	higher dicots	Malvaceae	*Abutilon*			C		1
plants	higher dicots	Malvaceae	*Hibiscus*			C		1
plants	higher dicots	Meliaceae	*Owenia acidula*	emu apple		C		3
plants	higher dicots	Mimosaceae	*Acacia harpophylla*	brigalow		C		10

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plants	higher dicots	Mimosaceae	*Acacia multisiliqua*			C		3/1
plants	higher dicots	Mimosaceae	*Acacia bancroftiorum*			C		4/1
plants	higher dicots	Mimosaceae	*Acacia hyaloneura*			C		1/1
plants	higher dicots	Mimosaceae	*Acacia farnesiana*	mimosa bush	Y			2
plants	higher dicots	Mimosaceae	*Acacia catenulata*	bendee		C		7
plants	higher dicots	Mimosaceae	*Acacia leiocalyx*			C		1
plants	higher dicots	Mimosaceae	*Acacia amblygona*	fan-leaf wattle		C		6/2
plants	higher dicots	Mimosaceae	*Acacia shirleyi*	lancewood		C		14/1
plants	higher dicots	Mimosaceae	*Acacia salicina*	doolan		C		3
plants	higher dicots	Mimosaceae	*Acacia julifera*			C		1
plants	higher dicots	Mimosaceae	*Acacia cambagei*	gidgee		C		3
plants	higher dicots	Mimosaceae	*Acacia excelsa*			C		12
plants	higher dicots	Mimosaceae	*Acacia angusta*			C		1/1
plants	higher dicots	Mimosaceae	*Acacia sp. (Ronlow Park E.J.Thompson+ 61)*			C		1/1
plants	higher dicots	Mimosaceae	*Acacia julifera subsp. curvinervia*			C		5/1
plants	higher dicots	Mimosaceae	*Acacia nilotica subsp. indica*	prickly acacia	Y			1
plants	higher dicots	Mimosaceae	*Archidendropsis basaltica*	red lancewood		C		4
plants	higher dicots	Mimosaceae	*Acacia sericophylla*			C		3
plants	higher dicots	Mimosaceae	*Acacia longispicata*			C		1
plants	higher dicots	Mimosaceae	*Acacia dietrichiana*			C		3/1
plants	higher dicots	Mimosaceae	*Acacia leptostachya*	Townsville wattle		C		8/1
plants	higher dicots	Moraceae	*Ficus platypoda*			C		1
plants	higher dicots	Moraceae	*Ficus microcarpa var. hillii*			C		2
plants	higher dicots	Myoporaceae	*Myoporum montanum*	boobialla		C		1
plants	higher dicots	Myoporaceae	*Eremophila longifolia*	berrigan		C		1
plants	higher dicots	Myoporaceae	*Eremophila mitchellii*			C		16
plants	higher dicots	Myoporaceae	*Eremophila deserti*			C		1
plants	higher dicots	Myrtaceae	*Melaleuca*			C		1
plants	higher dicots	Myrtaceae	*Corymbia blakei*			C		2
plants	higher dicots	Myrtaceae	*Melaleuca nodosa*			C		1
plants	higher dicots	Myrtaceae	*Eucalyptus whitei*	White's ironbark		C		1
plants	higher dicots	Myrtaceae	*Corymbia leichhardtii*	rustyjacket		C		11/1
plants	higher dicots	Myrtaceae	*Corymbia lamprophylla*			C		9/1
plants	higher dicots	Myrtaceae	*Corymbia clarksoniana*			C		2
plants	higher dicots	Myrtaceae	*Corymbia tessellaris*	Moreton Bay ash		C		2
plants	higher dicots	Myrtaceae	*Corymbia dallachiana*			C		1
plants	higher dicots	Myrtaceae	*Corymbia brachycarpa*			C		1
plants	higher dicots	Myrtaceae	*Melaleuca bracteata*			C		1
plants	higher dicots	Myrtaceae	*Eucalyptus tenuipes*	narrow-leaved white mahogany		C		1/1
plants	higher dicots	Myrtaceae	*Eucalyptus populnea*	poplar box		C		12
plants	higher dicots	Myrtaceae	*Lysicarpus angustifolius*	budgeroo		C		1/1
plants	higher dicots	Myrtaceae	*Eucalyptus drepanophylla*			C		1/1
plants	higher dicots	Myrtaceae	*Eucalyptus camaldulensis*			C		5
plants	higher dicots	Myrtaceae	*Melaleuca trichostachya*			C		2/1
plants	higher dicots	Myrtaceae	*Leptospermum lamellatum*			C		4/2
plants	higher dicots	Myrtaceae	*Eucalyptus melanophloia*			C		6

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plants	higher dicots	Myrtaceae	*Melaleuca linariifolia*	snow-in summer		C		1
plants	higher dicots	Myrtaceae	*Lophostemon suaveolens*	swamp box		C		2
plants	higher dicots	Myrtaceae	*Eucalyptus orgadophila*	mountain coolibah		C		1
plants	higher dicots	Myrtaceae	*Corymbia erythrophloia*	variable-barked bloodwood		C		1
plants	higher dicots	Myrtaceae	*Melaleuca tamariscina*			C		4/1
plants	higher dicots	Myrtaceae	*Melaleuca leucadendra*	broad-leaved tea-tree		C		1
plants	higher dicots	Myrtaceae	*Eucalyptus thozetiana*			C		7/2
plants	higher dicots	Myrtaceae	*Eucalyptus cambageana*	Dawson gum		C		2
plants	higher dicots	Myrtaceae	*Eucalyptus coolabah*	coolabah		C		2
plants	higher dicots	Myrtaceae	*Corymbia intermedia*	pink bloodwood		C		1
plants	higher dicots	Myrtaceae	*Melaleuca uncinata*			C		1
plants	higher dicots	Myrtaceae	*Eucalyptus exserta*	Queensland peppermint		C		1
plants	higher dicots	Myrtaceae	*Eucalyptus brownii*	Reid River box		C		2
plants	higher dicots	Myrtaceae	*Corymbia polycarpa*	long-fruited bloodwood		C		1
plants	higher dicots	Myrtaceae	*Calytrix microcoma*			C		1/1
plants	higher dicots	Myrtaceae	*Melaleuca nervosa*			C		5/1
plants	higher dicots	Myrtaceae	*Eucalyptus crebra*	narrow-leaved red ironbark		C		10
plants	higher dicots	Myrtaceae	*Corymbia papuana*	ghost gum		C		9
plants	higher dicots	Olacaceae	*Ximenia americana*			C		1
plants	higher dicots	Oleaceae	*Jasminum simplicifolium subsp. australiense*			C		1
plants	higher dicots	Oleaceae	*Jasminum didymum*			C		3
plants	higher dicots	Onagraceae	*Ludwigia octovalvis*	willow primrose		C		1
plants	higher dicots	Pentapetaceae	*Melhania oblongifolia*			C		1
plants	higher dicots	Phyllanthaceae	*Sauropus rigens*			C		4/2
plants	higher dicots	Phyllanthaceae	*Phyllanthus fuernrohrii*			C		1
plants	higher dicots	Phyllanthaceae	*Phyllanthus carpentariae*			C		1/1
plants	higher dicots	Phyllanthaceae	*Phyllanthus maderaspatensis*			C		1
plants	higher dicots	Phyllanthaceae	*Phyllanthus sp. (Pentland R.J.Cumming 9742)*			C		1/1
plants	higher dicots	Picrodendraceae	*Petalostigma banksii*			C		1
plants	higher dicots	Picrodendraceae	*Petalostigma pubescens*	quinine tree		C		11
plants	higher dicots	Pittosporaceae	*Bursaria incana*			C		3
plants	higher dicots	Polygalaceae	*Comesperma pallidum*			C		2/1
plants	higher dicots	Proteaceae	*Grevillea*			C		1
plants	higher dicots	Proteaceae	*Grevillea sessilis*			C		2
plants	higher dicots	Proteaceae	*Grevillea pteridifolia*	golden parrot tree		C		8/2
plants	higher dicots	Proteaceae	*Grevillea decora subsp. decora*			C		4/1
plants	higher dicots	Proteaceae	*Grevillea parallela*			C		7/1
plants	higher dicots	Proteaceae	*Persoonia falcata*			C		8/1
plants	higher dicots	Proteaceae	*Grevillea striata*	beefwood		C		8
plants	higher dicots	Rhamnaceae	*Cryptandra rigida*			C		2
plants	higher dicots	Rhamnaceae	*Ventilago viminalis*	supplejack		C		4
plants	higher dicots	Rhamnaceae	*Cryptandra speciosa subsp. strigosa*			C		1/1
plants	higher dicots	Rhamnaceae	*Alphitonia excelsa*	soap tree		C		10/1
plants	higher dicots	Rubiaceae	*Pomax umbellata*			C		1
plants	higher dicots	Rubiaceae	*Psydrax oleifolia*			C		9
plants	higher dicots	Rubiaceae	*Oldenlandia galioides*			C		1/1

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plants	higher dicots	Rubiaceae	*Pogonolobus reticulatus*			C		6
plants	higher dicots	Rubiaceae	*Oldenlandia mitrasacmoides subsp. trachymenoides*			C		1/1
plants	higher dicots	Rubiaceae	*Psydrax odorata forma buxifolia*			C		1
plants	higher dicots	Rubiaceae	*Psydrax attenuata*			C		2
plants	higher dicots	Rubiaceae	*Psydrax odorata*			C		3
plants	higher dicots	Rutaceae	*Geijera parviflora*	wilga		C		7/1
plants	higher dicots	Rutaceae	*Flindersia dissosperma*			C		3
plants	higher dicots	Santalaceae	*Santalum lanceolatum*			C		3
plants	higher dicots	Sapindaceae	*Alectryon connatus*	grey birds-eye		C		1
plants	higher dicots	Sapindaceae	*Atalaya hemiglauca*			C		5
plants	higher dicots	Sapindaceae	*Alectryon oleifolius*			C		5
plants	higher dicots	Sapindaceae	*Dodonaea lanceolata*			C		1
plants	higher dicots	Sapindaceae	*Dodonaea filifolia*			C		5/1
plants	higher dicots	Sapindaceae	*Dodonaea stenophylla*			C		2
plants	higher dicots	Sapindaceae	*Dodonaea viscosa subsp. spatulata*			C		1
plants	higher dicots	Sapindaceae	*Alectryon oleifolius subsp. elongatus*			C		1/1
plants	higher dicots	Sapindaceae	*Dodonaea lanceolata var. lanceolata*			C		2
plants	higher dicots	Sapindaceae	*Cupaniopsis anacardioides*	tuckeroo		C		1
plants	higher dicots	Scrophulariaceae	*Scoparia dulcis*	Scoparia	Y			1/1
plants	higher dicots	Solanaceae	*Solanum ellipticum*	potato bush		C		2
plants	higher dicots	Solanaceae	*Solanum parvifolium*			C		1
plants	higher dicots	Sparrmanniaceae	*Grewia latifolia*	dysentery plant		C		3
plants	higher dicots	Sterculiaceae	*Brachychiton populneus subsp. trilobus*			C		2
plants	higher dicots	Stylidiaceae	*Stylidium*			C		1
plants	higher dicots	Stylidiaceae	*Stylidium eriorhizum*			C		2/1
plants	higher dicots	Stylidiaceae	*Stylidium eglandulosum*			C		4/2
plants	higher dicots	Ulmaceae	*Trema tomentosa var. aspera*			C		1
plants	higher dicots	Verbenaceae	*Lantana camara*		Y			1/1
plants	higher dicots	Violaceae	*Hybanthus enneaspermus*			C		1/1
plants	higher dicots	Zygophyllaceae	*Roepera*			C		1
plants	monocots	Amaryllidaceae	*Crinum flaccidum*	Murray lily		C		1
plants	monocots	Cyperaceae	*Cyperus haspan*			C		1
plants	monocots	Cyperaceae	*Fimbristylis dichotoma*	common fringe-rush		C		1
plants	monocots	Cyperaceae	*Cyperus gunnii subsp. novae-hollandiae*			C		1
plants	monocots	Cyperaceae	*Cyperus haspan subsp. haspan*			C		1/1
plants	monocots	Cyperaceae	*Cyperus polystachyos*			C		1
plants	monocots	Cyperaceae	*Scleria brownii*			C		1
plants	monocots	Cyperaceae	*Cyperus aquatilis*			C		1/1
plants	monocots	Cyperaceae	*Cyperus difformis*	rice sedge		C		2/1
plants	monocots	Cyperaceae	*Scleria sphacelata*			C		1
plants	monocots	Hemerocallidaceae	*Dianella revoluta*			C		1/1
plants	monocots	Hemerocallidaceae	*Dianella brevipedunculata*			C		1
plants	monocots	Juncaceae	*Juncus usitatus*			C		1
plants	monocots	Laxmanniaceae	*Laxmannia gracilis*	slender wire lily		C		1
plants	monocots	Laxmanniaceae	*Lomandra longifolia*			C		1
plants	monocots	Laxmanniaceae	*Lomandra confertifolia*			C		1

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plants	monocots	Laxmanniaceae	*Lomandra multiflora subsp. multiflora*			C		2/1
plants	monocots	Laxmanniaceae	*Lomandra confertifolia subsp. pallida*			C		3
plants	monocots	Orchidaceae	*Cymbidium canaliculatum*			C		2
plants	monocots	Poaceae	*Aristida*			C		2
plants	monocots	Poaceae	*Enneapogon*			C		1
plants	monocots	Poaceae	*Eragrostis*			C		1
plants	monocots	Poaceae	*Leptochloa*			C		1
plants	monocots	Poaceae	*Sporobolus*			C		1
plants	monocots	Poaceae	*Eulalia aurea*	silky browntop		C		1
plants	monocots	Poaceae	*Sarga plumosum*			C		1/1
plants	monocots	Poaceae	*Panicum effusum*			C		1/1
plants	monocots	Poaceae	*Triodia pungens*			C		3
plants	monocots	Poaceae	*Themeda triandra*	kangaroo grass		C		5
plants	monocots	Poaceae	*Aristida calycina*			C		1
plants	monocots	Poaceae	*Digitaria brownii*			C		1
plants	monocots	Poaceae	*Triodia bitextura*			C		10
plants	monocots	Poaceae	*Astrebla pectinata*	barley mitchell grass		C		1/1
plants	monocots	Poaceae	*Chrysopogon fallax*			C		2
plants	monocots	Poaceae	*Eriachne mucronata*			C		10
plants	monocots	Poaceae	*Triodia mitchellii*	buck spinifex		C		1
plants	monocots	Poaceae	*Cymbopogon obtectus*			C		2
plants	monocots	Poaceae	*Digitaria ramularis*			C		1
plants	monocots	Poaceae	*Enneapogon gracilis*	slender nineawn		C		1/1
plants	monocots	Poaceae	*Enteropogon ramosus*			C		1
plants	monocots	Poaceae	*Eragrostis elongata*			C		2/1
plants	monocots	Poaceae	*Paspalidium distans*	shotgrass		C		1
plants	monocots	Poaceae	*Paspalidium gracile*	slender panic		C		3/1
plants	monocots	Poaceae	*Cymbopogon refractus*	barbed-wire grass		C		1
plants	monocots	Poaceae	*Eragrostis lacunaria*	purple lovegrass		C		5/1
plants	monocots	Poaceae	*Aristida jerichoensis*			C		3
plants	monocots	Poaceae	*Cymbopogon bombycinus*	silky oilgrass		C		5
plants	monocots	Poaceae	*Eragrostis parviflora*	weeping lovegrass		C		2/1
plants	monocots	Poaceae	*Heteropogon contortus*	black speargrass		C		2
plants	monocots	Poaceae	*Aristida caput-medusae*			C		1
plants	monocots	Poaceae	*Aristida inaequiglumis*			C		2/1
plants	monocots	Poaceae	*Arundinella nepalensis*	reedgrass		C		1
plants	monocots	Poaceae	*Bothriochloa ewartiana*	desert bluegrass		C		2/1
plants	monocots	Poaceae	*Chrysopogon oliganthus*			C		1
plants	monocots	Poaceae	*Cleistochloa subjuncea*			C		1
plants	monocots	Poaceae	*Enneapogon lindleyanus*			C		2/1
plants	monocots	Poaceae	*Paspalidium caespitosum*	brigalow grass		C		1/1
plants	monocots	Poaceae	*Sporobolus actinocladus*	katoora grass		C		1/1
plants	monocots	Poaceae	*Austrochloris dichanthioides*			C		1/1
plants	monocots	Poaceae	*Aristida holathera var. holathera*			C		2/1
plants	monocots	Xanthorrhoeaceae	*Xanthorrhoea johnsonii*			C		10

CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992.* The codes are Extinct in the Wild (PE), Endangered (E), Vulnerable (V), Near Threatened (NT), Least Concern (C) or Not Protected ( ).

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999.* The values of EPBC are Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Extinct in the Wild (XW) and Vulnerable (V).

Records – The first number indicates the total number of records of the taxon for the record option selected (i.e. All, Confirmed or Specimens).
This number is output as 99999 if it equals or exceeds this value. The second number located after the / indicates the number of specimen records for the taxon.
This number is output as 999 if it equals or exceeds this value.

Queensland Government

Wildlife Online Extract

Search Criteria: Species List for a Defined Area
Species: All
Type: Native
Status: Rare and threatened species
Records: All
Date: All
Latitude: 23.0595 to 23.5095
Longitude: 146.0133 to 146.4995
Email: janemcpheefrew@gmail.com
Date submitted: Friday 19 Aug 2011 14:14:52
Date extracted: Friday 19 Aug 2011 14:16:11

The number of records retrieved = 5

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	higher dicots	Apocynaceae	*Cerbera dumicola*			NT		2/1
plants	higher dicots	Euphorbiaceae	*Bertya pedicellata*			NT		2/1
plants	higher dicots	Fabaceae	*Desmodium macrocarpum*			NT		4/4
plants	higher dicots	Mimosaceae	*Acacia spania*			NT		1/1
plants	higher dicots	Myrtaceae	*Micromyrtus rotundifolia*			V		2/1

CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992.* The codes are Extinct in the Wild (PE), Endangered (E), Vulnerable (V), Near Threatened (NT), Least Concern (C) or Not Protected ( ).

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999.* The values of EPBC are Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Extinct in the Wild (XW) and Vulnerable (V).

Records – The first number indicates the total number of records of the taxon for the record option selected (i.e. All, Confirmed or Specimens).
This number is output as 99999 if it equals or exceeds this value. The second number located after the / indicates the number of specimen records for the taxon.
This number is output as 999 if it equals or exceeds this value.

Queensland Government

Wildlife Online Extract

Search Criteria: Species List for a Defined Area
Species: All
Type: Native
Status: Rare and threatened species
Records: All
Date: All
Latitude: 23.0595 to 23.5095
Longitude: 146.4995 to 146.9858
Email: janemcpheefrew@gmail.com
Date submitted: Friday 19 Aug 2011 14:15:22
Date extracted: Friday 19 Aug 2011 14:16:14

The number of records retrieved = 1

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Meliphagidae	*Melithreptus gularis*	black-chinned honeyeater		NT		1

CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992.* The codes are Extinct in the Wild (PE), Endangered (E), Vulnerable (V), Near Threatened (NT), Least Concern (C) or Not Protected ( ).

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999.* The values of EPBC are Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Extinct in the Wild (XW) and Vulnerable (V).

Records – The first number indicates the total number of records of the taxon for the record option selected (i.e. All, Confirmed or Specimens).
This number is output as 99999 if it equals or exceeds this value. The second number located after the / indicates the number of specimen records for the taxon.
This number is output as 999 if it equals or exceeds this value.

Appendix B: Site Summary

AQ1 – this site is located within the Project boundary on a 3rd order creek. The survey area consisted of a non-flowing pool with a maximum depth of 50 cm, and a length of >200 m. The stream sediment ranged from mud through to coarse sand. The banks were notably eroded and undercut in areas. Some in stream debris was present (branches and leaf litter), and sedges were present along the banks. Trailing roots in the water provided additional in stream habitat. Benthic algae were noted. Noogoora Burr was noted at the site.

Photo Plate 11 AQ1 Upstream and Downstream

AQ2 – this site was located north (downstream) of the Project. Occasional small, shallow, stagnant pools were present within the three channels of the creek bed. The site was located along a section of Sandy Creek, vegetated with River Red Gums and Black Tea Trees (*Melaleuca bracteata*). Occasional grasses were present on the banks, but sedges were notably absent. Noogoora Burr was noted at the site.

Photo Plate 12 AQ2 Upstream and Downstream

AQ3 – this survey site was located within the Project site on Sandy Creek along the southern boundary of MLA 70425. The site contained a large non-flowing pool (approximately 60 m by 10 m), as well as a smaller pool. This site contained a lot of in stream vegetation, predominately Black Tea Trees. The stream sediments ranged from mud (where water was held) through to moderately coarse sand in the dry areas of the creek bed. There was evident of some erosion on the banks. Mid-channel vegetation included Black Tea Trees and juvenile Myrtaceae individuals, and Noogoora Burr was noted at the site. The water had an oily film on the surface, and the pools contained a lot of debris. There was a maximum depth of 1 m in the pools, and brown / red benthic algae were noted.

Photo Plate 13 AQ3 Upstream and Downstream

AQ4 – this site was located within a dammed section of Lagoon Creek (2nd order). This site will be impacted by the proposed creek diversion. This site contained a non-flowing, highly turbid pool of water, 10 m by 200 m. The stream sediment consisted of a white clay. The banks were moderately stable, and there was no evidence of any recent significant flow event. There were many fallen trees within the pool, which had a maximum depth of 1.2 m. There was no living in-stream vegetation. The riparian vegetation consisted of a single tree width River Red Gum community.

Photo Plate 14 AQ4 Upstream and Downstream

AQ5 – this site was located along Lagoon Creek, upstream of the Wendouree Homestead. This site was characterised by two distinct habitats - a large non-flowing pool with a maximum depth of 1.4 m, and numerous small, shallow, terrace pools heavily vegetated by Wavy Marshwort (*Nymphoides crenata*), *Marsilea mutica*, and grasses. The riparian vegetation was an open Brigalow (*Acacia harpophylla*) woodland with limited ground cover. Cattle access was evident at the site. Stream sediment consisted of a loamy mud.

Photo Plate 15 AQ5 Upstream and Downstream

AQ7 – this site was located on Wells Creek, upstream of a road crossing. The site was dry at the time of the survey. Stream sediments consisted of moderately coarse sands. Black Tea Trees and Moreton Bay Ashes (*Corymbia tessellaris*) were present both in stream and within the riparian zone. Noogoora Burr was noted at the site. No photo available for this site.

AQ8 – this site was located within Sandy Creek, upstream of a road crossing. The creek was dry at the time of the survey. The stream sediment was sand. The in stream vegetation consisted of *Eucalyptus* species, and there was also a large sedge, herb, and grass component.

Photo Plate 16 AQ8 Site

AQ15 – this site was located on Sandy Creek just south of MLA 70425. The site was dry at the time of the survey. River Red Gums dominated the riparian vegetation. Mid-channel islands were vegetated with grasses, and Native Currant Bush (*Carissa lanceolata*). No weeds were visible.

Photo Plate 17 AQ15 Upstream and Downstream

AQ16 – this 3rd order site was located downstream of the confluence of two creeks, south of the Project site (upstream site). The site was characterised by fine sands, with a River Red Gum riparian community. No in stream vegetation was present, and no sedges were noted.

Photo Plate 18 AQ16 Upstream and Downstream

AQ17 was located within a very narrow, highly turbid section of non-flowing water. The riparian vegetation consisted of Brigalow, and Poplar Box. This 2nd order site had a muddy substrate, and a maximum depth of 50 cm. Noogoora Burr was noted.

Photo Plate 19 AQ17 Upstream and Downstream

AQ18 – this 2nd order site was located along a muddy / clayey, bendy section of creek with a Brigalow riparian community. A road intersected the site, so the two non-flowing pools were sampled. The water was highly turbid. The banks were noted to be unstable, and Velvety Tree Pear was present.

Photo Plate 20 AQ18 Upstream and Downstream

AQ19 – this site was located towards the centre of the Project site, within a mixed species woodland. The site was within a small drainage line holding a pool of water. The banks were eroded, with exposed root systems of the riparian trees evident. The site was a cattle watering point. Sedges and *Ludwigia octovalvis* were present on the banks.

Photo Plate 21 AQ19 Upstream and Downstream

AQ20 – this site was located at the head of a drainage line, within a non-remnant area. No riparian or wetland species were evident. The site was dry at the time of the survey, and the creek had an orange rock base with a layer of very fine sand overlaying it.

Photo Plate 22 AQ20 Site

AQ21 – this site was located at the confluence of two 1st order drainage lines. Some erosion was evident. The dry creek bed was characterised by a rock base overlain with fine sand and occasional pebbles. River Red gums dominated the riparian vegetation, with Red Natal grass and *Petalostigma* sp. present in stream.

Photo Plate 23 AQ21 Upstream and Downstream

AQ22 was located within a dry 1st order drainage line. No aquatic or wetland species were noted at the site. The very narrow fringe of riparian vegetation consisted of Brigalow, River Red Gum, Native Currant Bush (*Carissa lanceolata*), and Buffel Grass (*Pennisetum ciliare*).

Photo Plate 24 AQ22 Upstream and Downstream

AQ23 was located downstream of the confluence of Saltbush Creek and Lagoon Creek. The site consisted of a large, turbid pool of water. Lots of grasses and sedges were present on the banks, and trailing in to the water. The riparian vegetation consisted of mixed Eucalypt species woodland, bordered by non-remnant vegetation.

Photo Plate 25 AQ23 Upstream and Downstream

AQ28 – located south and upstream of MLA 70425, the site was characterised by a large lagoon (>200 m long) vegetated with various lily species. The sediment at the site was clay. The water level appeared stable (did not appear to fluctuate much), and was turbid. The banks were severely degraded, and cattle were present. Soft Roly Poly (*Salsola kali*) and Chenopodiaceae sp. were present on the banks.

Photo Plate 26 AQ28 Site

AQ29 – marshy palustrine area located south of MLA 70425. Some standing water was present, as very shallow pools. Water plants were present including *Monochoria cyanea*, *Cyperus polystachyos*, and Mud Grass (*Pseudoraphis spinescens*).

Photo Plate 27 AQ29 Site

AQ30 – this site was located on a drainage line / depression area in non-remnant grassland. An algal film was present on the stagnant water at the site. Cattle access was evident.

Photo Plate 28 AQ30 Upstream and Downstream

AQ31 was located within a lacustrine wetland to the south of MLA 70425. The large semi-dry lake was a cattle watering point. The sediment was a grey cracking-clay, and plants common to disturbed areas were prevalent. Parkinsonia was noted at the site. The water was turbid, and had a maximum depth of 1.6 m. Submerged logs were present in the water body, and there were no in stream plants. A green benthic alga was noted.

Photo Plate 29 AQ31 Site

AQ32 – palustrine wetland. The site was dry at the time of the survey. Nardoo, *Enneapogon*, and Sedge were present. A hard clay-sediment was characteristic of the area. No image is available for this study site.

AQ33 – palustrine wetland according to database searches. There was no water at the time of the survey. A cracking-clay was characteristic of the site. There were no aquatic plants noted, barring occasional Nardoo plants in lower areas. It is likely that this site would hold surface water for only a limited time following rainfall.

Photo Plate 30 AQ33 Site

AQ35 – dry palustrine area south of the Project site. This site was located near a recorded Parthenium patch, and adjacent to a Brigalow community. Sedges, grasses, and *Alternanthera* sp. were present.

Photo Plate 31 AQ35 Site

AQ36 (WC1) – this 3rd order site was located in a rocky pool situated on Well Creek, in the western flank of the Project site. The site had steep rocky banks and was >2m deep in sections. The site was noted to have high fish assemblage and the overall aquatic health was considered good. Given the volume of water at the pool, it is believed the site holds water during both the wet and dry seasons.

Photo Plate 32 AQ36 (WC1) Upstream and Downstream

AQ37 (WC2) - this site was located on Wells Creek, upstream of a road crossing. Small isolated pools were present at the time of survey. Stream sediments consisted of moderately coarse sands. Black Tea Trees and Moreton Bay Ashes (*Corymbia tessellaris*) were present both in stream and within the riparian zone. Noogoora Burr was noted at the site.

Photo Plate 33 AQ37 (WC2) Downstream

AQ38 (SC1) – was located in a sandy stretch of Sandy Creek in the northern section of the Project site. The site was not flowing at the time of the survey, however pools were significant, indicating recent flow events. Pools were <1m and contained a sand/vegetation detritus mixed benthic substrate.

Photo Plate 34 AQ38 (SC1) Upstream and Downstream

AQ39 (A1) – this site was located within a drainage line on the western boundary of the Project site. Although not flowing at the time of survey, the drainage held significant water, and was >1m deep at the study location. The vegetation surrounding the drainage line included River Red Gum. The sediment at the site ranged from fine sand to small pebbles. Some erosion was evident, however the site was considered to hold moderate ecological value.

Photo Plate 35 AQ39 (A1) Upstream and Downstream

AQ40 (SM1) - located within a dry sandy creek bed south of the Project site. Vegetation present at the site included Poplar Box and Silver-leafed Ironbarks also present. A habitat assessment was performed, to help determine the aquatic habitat value of the site. No photograph is available for this site.

AQ41 (SM2) - located within a dry sandy creek bed south of the Project site. Vegetation present at the site included Poplar Box and Silver-leafed Ironbarks also present. A habitat assessment was performed, to help determine the aquatic habitat value of the site. No photograph is available for this site.

Appendix C: Water Quality Analysis Results

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EB1119940**	Page	: 1 of 8
Client	: **AUSTRALASIAN RESOURCE CONSULTANTS**	Laboratory	: Environmental Division Brisbane
Contact	: MR PAUL JACKSON	Contact	: Customer Services
Address	: SUITE 5B 1 SWANN ROAD TARINGA QLD, AUSTRALIA 4068	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: pjackson@aarc.net.au	E-mail	: Brisbane.Enviro.Services@alsglobal.com
Telephone	: +61 07 3217 8772	Telephone	: +61 7 3243 7222
Facsimile	: +61 07 32178775	Facsimile	: +61 7 3243 7218
Project	: HPPL KEVINS CORNER	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 28-SEP-2011
Sampler	: DT/JS	Issue Date	: 07-OCT-2011
Site	: ----		
		No. of samples received	: 12
Quote number	: BN/279/10/BN/232/10	No. of samples analysed	: 12

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Dianne Blane	Laboratory Supervisor	Newcastle
Eric Chau	Metals Team Leader	Melbourne Inorganics
Nikki Stepniewski	Senior Inorganic Instrument Chemist	Melbourne Inorganics
Xingbin Lin	Senior Organic Chemist	Melbourne Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: AQ1	AQ2	AQ37	AQ30	AQ3
				Client sampling date / time: 19-SEP-2011 17:00	19-SEP-2011 16:00	20-SEP-2011 09:50	21-SEP-2011 10:15	20-SEP-2011 11:00
				EB1119940-001	EB1119940-002	EB1119940-003	EB1119940-004	EB1119940-005
EA150: Particle Sizing								
+75µm	----	1	%	**100**	**100**	**99**	**22**	**100**
+150µm	----	1	%	**100**	**100**	**99**	**13**	**99**
+300µm	----	1	%	**93**	**95**	**96**	**8**	**91**
+425µm	----	1	%	**78**	**83**	**77**	**8**	**76**
+600µm	----	1	%	**62**	**61**	**44**	**7**	**59**
+1180µm	----	1	%	**36**	**26**	**11**	**5**	**32**
+2.36mm	----	1	%	**12**	**4**	**2**	**4**	**11**
+4.75mm	----	1	%	<1	<1	<1	**2**	**2**
+9.5mm	----	1	%	<1	<1	<1	<1	<1
+19.0mm	----	1	%	<1	<1	<1	<1	<1
+37.5mm	----	1	%	<1	<1	<1	<1	<1
+75.0mm	----	1	%	<1	<1	<1	<1	<1
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	<1.0	<1.0	<1.0	**2.8**	<1.0
EA150: Soil Classification based on Particle Size								
Fines (<75 µm)	----	1	%	<1	<1	<1	**78**	<1
Sand (>75 µm)	----	1	%	**88**	**95**	**97**	**18**	**88**
Gravel (>2mm)	----	1	%	**12**	**4**	**2**	**4**	**11**
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	<1
EG005T: Total Metals by ICP-AES								
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg	<10	<10	<10	**100**	<10
Beryllium	7440-41-7	1	mg/kg	<1	<1	<1	<1	<1
Cobalt	7440-48-4	2	mg/kg	<2	<2	<2	**8**	<2
Manganese	7439-96-5	5	mg/kg	**62**	**45**	**80**	**623**	**20**
Selenium	7782-49-2	5	mg/kg	<5	<5	<5	<5	<5
Silver	7440-22-4	2	mg/kg	<2	<2	<2	<2	<2
Vanadium	7440-62-2	5	mg/kg	<5	<5	**6**	**47**	<5
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	<5	<5
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	**2**	**2**	**5**	**33**	<2
Copper	7440-50-8	5	mg/kg	<5	<5	<5	**11**	<5
Lead	7439-92-1	5	mg/kg	<5	<5	<5	**9**	<5
Nickel	7440-02-0	2	mg/kg	<2	<2	<2	**10**	<2
Zinc	7440-66-6	5	mg/kg	<5	<5	<5	**12**	<5
EG020T: Total Metals by ICP-MS								
Uranium	7440-61-1	0.1	mg/kg	<0.1	<0.1	<0.1	**0.6**	<0.1

Analytical Results

Sub-Matrix: SOIL			Client sample ID	AQ1	AQ2	AQ37	AQ30	AQ3
			Client sampling date / time	19-SEP-2011 17:00	19-SEP-2011 16:00	20-SEP-2011 09:50	21-SEP-2011 10:15	20-SEP-2011 11:00
Compound	CAS Number	LOR	Unit	EB1119940-001	EB1119940-002	EB1119940-003	EB1119940-004	EB1119940-005
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: AQ22	AQ18	AQ19	AQ38	AQ21
				Client sampling date / time: 20-SEP-2011 16:50	21-SEP-2011 09:30	21-SEP-2011 15:00	19-SEP-2011 16:30	21-SEP-2011 13:50
				EB1119940-006	EB1119940-007	EB1119940-008	EB1119940-009	EB1119940-010
EA150: Particle Sizing								
+75µm	----	1	%	**97**	**64**	**83**	**99**	**99**
+150µm	----	1	%	**97**	**52**	**80**	**99**	**98**
+300µm	----	1	%	**95**	**41**	**72**	**99**	**86**
+425µm	----	1	%	**89**	**34**	**68**	**95**	**69**
+600µm	----	1	%	**76**	**28**	**65**	**81**	**52**
+1180µm	----	1	%	**48**	**16**	**52**	**44**	**31**
+2.36mm	----	1	%	**21**	**7**	**29**	**15**	**16**
+4.75mm	----	1	%	**4**	**3**	**10**	**3**	**9**
+9.5mm	----	1	%	<1	<1	**4**	<1	**3**
+19.0mm	----	1	%	<1	<1	<1	<1	<1
+37.5mm	----	1	%	<1	<1	<1	<1	<1
+75.0mm	----	1	%	<1	<1	<1	<1	<1
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	<1.0	**10.6**	**2.7**	**1.0**	<1.0
EA150: Soil Classification based on Particle Size								
Fines (<75 µm)	----	1	%	**3**	**36**	**17**	<1	**1**
Sand (>75 µm)	----	1	%	**76**	**57**	**54**	**85**	**82**
Gravel (>2mm)	----	1	%	**21**	**7**	**29**	**15**	**16**
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	<1
EG005T: Total Metals by ICP-AES								
Antimony	7440-36-0	5	mg/kg	<5	**22**	**6**	<5	<5
Barium	7440-39-3	10	mg/kg	**150**	**100**	**160**	<10	**10**
Beryllium	7440-41-7	1	mg/kg	<1	<1	**1**	<1	<1
Cobalt	7440-48-4	2	mg/kg	**10**	**9**	**13**	<2	<2
Manganese	7439-96-5	5	mg/kg	**873**	**606**	**778**	**71**	**29**
Selenium	7782-49-2	5	mg/kg	<5	<5	<5	<5	<5
Silver	7440-22-4	2	mg/kg	<2	<2	<2	<2	<2
Vanadium	7440-62-2	5	mg/kg	**26**	**44**	**201**	**20**	**31**
Arsenic	7440-38-2	5	mg/kg	<5	<5	**9**	<5	<5
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	**12**	**24**	**124**	**12**	**13**
Copper	7440-50-8	5	mg/kg	**6**	**9**	**19**	<5	<5
Lead	7439-92-1	5	mg/kg	**12**	**9**	**19**	<5	<5
Nickel	7440-02-0	2	mg/kg	**9**	**9**	**19**	<2	<2
Zinc	7440-66-6	5	mg/kg	**6**	**13**	**28**	<5	<5
EG020T: Total Metals by ICP-MS								
Uranium	7440-61-1	0.1	mg/kg	**0.3**	**0.4**	**0.8**	<0.1	<0.1

Analytical Results

Sub-Matrix: SOIL			Client sample ID	AQ22	AQ18	AQ19	AQ38	AQ21
			Client sampling date / time	20-SEP-2011 16:50	21-SEP-2011 09:30	21-SEP-2011 15:00	19-SEP-2011 16:30	21-SEP-2011 13:50
Compound	CAS Number	LOR	Unit	EB1119940-006	EB1119940-007	EB1119940-008	EB1119940-009	EB1119940-010
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: AQ39	AQ36	----	----	----
				Client sampling date / time: 20-SEP-2011 15:15	20-SEP-2011 07:50	----	----	----
				EB1119940-011	EB1119940-012	----	----	----
EA150: Particle Sizing								
+75µm	----	1	%	**96**	**98**	----	----	----
+150µm	----	1	%	**94**	**96**	----	----	----
+300µm	----	1	%	**80**	**86**	----	----	----
+425µm	----	1	%	**60**	**68**	----	----	----
+600µm	----	1	%	**44**	**52**	----	----	----
+1180µm	----	1	%	**21**	**30**	----	----	----
+2.36mm	----	1	%	**7**	**10**	----	----	----
+4.75mm	----	1	%	**3**	**3**	----	----	----
+9.5mm	----	1	%	<1	<1	----	----	----
+19.0mm	----	1	%	<1	<1	----	----	----
+37.5mm	----	1	%	<1	<1	----	----	----
+75.0mm	----	1	%	<1	<1	----	----	----
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	<1.0	**4.8**	----	----	----
EA150: Soil Classification based on Particle Size								
Fines (<75 µm)	----	1	%	**4**	**2**	----	----	----
Sand (>75 µm)	----	1	%	**89**	**88**	----	----	----
Gravel (>2mm)	----	1	%	**7**	**10**	----	----	----
Cobbles (>6cm)	----	1	%	<1	<1	----	----	----
EG005T: Total Metals by ICP-AES								
Antimony	7440-36-0	5	mg/kg	<5	<5	----	----	----
Barium	7440-39-3	10	mg/kg	**40**	**20**	----	----	----
Beryllium	7440-41-7	1	mg/kg	<1	<1	----	----	----
Cobalt	7440-48-4	2	mg/kg	**4**	<2	----	----	----
Manganese	7439-96-5	5	mg/kg	**218**	**121**	----	----	----
Selenium	7782-49-2	5	mg/kg	<5	<5	----	----	----
Silver	7440-22-4	2	mg/kg	<2	<2	----	----	----
Vanadium	7440-62-2	5	mg/kg	**22**	**12**	----	----	----
Arsenic	7440-38-2	5	mg/kg	<5	<5	----	----	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	----	----	----
Chromium	7440-47-3	2	mg/kg	**10**	**8**	----	----	----
Copper	7440-50-8	5	mg/kg	<5	<5	----	----	----
Lead	7439-92-1	5	mg/kg	<5	<5	----	----	----
Nickel	7440-02-0	2	mg/kg	**4**	**2**	----	----	----
Zinc	7440-66-6	5	mg/kg	<5	**7**	----	----	----
EG020T: Total Metals by ICP-MS								
Uranium	7440-61-1	0.1	mg/kg	**0.2**	**0.1**	----	----	----

Analytical Results

Sub-Matrix: SOIL								
			Client sample ID	AQ39	AQ36	----	----	----
			Client sampling date / time	20-SEP-2011 15:15	20-SEP-2011 07:50	----	----	----
Compound	CAS Number	LOR	Unit	EB1119940-011	EB1119940-012	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	----	----	----

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EB1119824**	Page	: 1 of 4
Client	: **AUSTRALASIAN RESOURCE CONSULTANTS**	Laboratory	: Environmental Division Brisbane
Contact	: MR PAUL JACKSON	Contact	: Customer Services
Address	: SUITE 5B 1 SWANN ROAD TARINGA QLD, AUSTRALIA 4068	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: pjackson@aarc.net.au	E-mail	: Brisbane.Enviro.Services@alsglobal.com
Telephone	: +61 07 3217 8772	Telephone	: +61 7 3243 7222
Facsimile	: +61 07 32178775	Facsimile	: +61 7 3243 7218
Project	: Kevins Corner	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 26-SEP-2011
Sampler	: J Stibbard &D Taylor	Issue Date	: 05-OCT-2011
Site	: ----		
		No. of samples received	: 2
Quote number	: BN/279/10/BN/232/10	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Greg Vogel	Laboratory Manager	Brisbane Inorganics
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics
Stephen Hislop	Senior Inorganic Chemist	Brisbane Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **EG094: An unpreserved aliquot from the natural bottle was used for analysis for sample EB1119824 #2.**
- **TDS by method EA-015 may bias high due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.**

Analytical Results

Sub-Matrix: **SURFACE WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: AQ36	AQ18	----	----	----
				Client sampling date / time: 21-SEP-2011 08:15	21-SEP-2011 09:30	----	----	----
				EB1119824-001	EB1119824-002	----	----	----
EA015: Total Dissolved Solids								
^ Total Dissolved Solids @180°C	GIS-210-010	5	mg/L	**173**	**476**	----	----	----
ED040F: Dissolved Major Anions								
Sulfate as SO4 2-	14808-79-8	1	mg/L	**2**	**7**	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**10**	**6**	----	----	----
ED093T: Total Major Cations								
Calcium	7440-70-2	1	mg/L	**10**	**10**	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.06**	**0.05**	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.001**	**0.049**	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.001**	**0.002**	----	----	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	----	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.49**	**14.7**	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.006**	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	**0.002**	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	**0.032**	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.056**	**1.36**	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.018**	----	----	----
Uranium	7440-61-1	0.001	mg/L	<0.001	**0.001**	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.006**	**0.028**	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS								
Selenium	7782-49-2	0.2	µg/L	<0.2	**0.5**	----	----	----
Cadmium	7440-43-9	0.05	µg/L	<0.05	<0.05	----	----	----
Chromium	7440-47-3	0.2	µg/L	**0.2**	**0.3**	----	----	----

Analytical Results

Sub-Matrix: SURFACE WATER				Client sample ID	AQ36	AQ18	----	----	----
				Client sampling date / time	21-SEP-2011 08:15	21-SEP-2011 09:30	----	----	----
Compound	CAS Number	LOR	Unit		EB1119824-001	EB1119824-002	----	----	----
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS - Continued									
Copper	7440-50-8	0.5	µg/L		**2.4**	**3.4**	----	----	----
EG094T: Total metals in Fresh water by ORC-ICPMS									
Selenium	7782-49-2	0.2	µg/L		**0.3**	**0.9**	----	----	----
Cadmium	7440-43-9	0.05	µg/L		<0.05	<0.05	----	----	----
Chromium	7440-47-3	0.2	µg/L		**0.8**	**27.6**	----	----	----
Copper	7440-50-8	0.5	µg/L		**3.0**	**27.5**	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.3**	**0.1**	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.02**	**0.81**	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L		<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
^ Nitrate as N	14797-55-8	0.01	mg/L		**0.02**	**0.02**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.02**	**0.02**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.8**	**5.6**	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.8**	**5.6**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.07**	**0.83**	----	----	----

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We go beyond our laboratory NATA/ISO/IEC accreditation and ISO9000 compliance. We will co-ordinate responses with you as well as with other specialists and GUARANTEE not to leave you on your own. We are available 7 days.

Report Ref. No. 090316_1 chem AARC

Amy Creighton and Julie Byrd
AustralAsian Resource Consultants Pty. Ltd.
Ph: (07) 4724 3555 Fax: (07) 4724 3811 Mob: 0428 748 722

Client Name: AustralAsian RC **Client Ref. AARC**	Sample Collection Date and Time: 16-21.03.09 *not stated* hours	Preliminary Report Dates:	Final Report Date: 08.04.09
Received Sample Date and Time 23.03.09 1030 hours	Sample Test Date and Time *Samples preserved*	Collection and Test Time Differential *Samples preserved*	Sample Collector

Table 1: Physico-chemical

Sample ID	pH (pH units)	Total dissolved Solids dried at 180°C (mg/L)	Total Nitrogen (mg/L)	Total Phosphorous (mg/L as P)	Nitrate as N (mg/L)	Sulphate (mg/L)	Fluride (mg/L)	Turbidity (NTU)
LOR	0.01	1	0.1	0.1	0.01	0.01	**0.01**	0.02
AQ1	NR	236	1.42	0.76	1.29	<0.01	0.34	47.9
AQ2	NR	194	1.90	1.95	1.19	<0.01	0.30	106
AQ3	NR	112	1.22	0.94	1.19	<0.01	0.33	37.8
AQ4	NR	68	10.83	4.11	10.56	<0.01	0.22	230.0
AQ5	NR	76	10.53	1.28	10.26	1	0.11	97.6
AQ9	NR	82	2.51	0.78	2.38	<0.01	0.37	36.0
AQ17	NR	152	4.45	7.68	3.38	1	0.41	638.0
AQ18	NR	92	4.13	3.16	3.91	<0.01	0.46	220.0
AQ19	NR	114	3.36	11.17	1.96	<0.01	0.35	765
AQ23	NR	106	4.18	1.40	4.08	<0.01	0.26	51.6
AQ25	NR	172	291.2	5.22	289.73	<0.01	0.52	>1000
AQ27	NR	96	1.18	0.72	1.10	1	0.28	7.65
AQ28	NR	96	1.75	0.68	1.69	<0.01	0.16	12.78
AQ29	NR	122	2.87	1.01	2.60	<0.01	0.22	34.2
AQ31	NR	212	54.48	5.21	53.76	1	0.25	500

Table 2: Metals

Sample ID	Al (mg/L)	U (mg/L)	As (mg/L)	B (mg/L)	Cd (mg/L)	Cr (mg/L)	Ca (mg/L)	Cu (mg/L)	Pb (mg/L)	Mn (mg/L)	*Hg (mg/L)	Mo (mg/L)	Sb (mg/L)	Ni (mg/L)	Se (mg/L)	Zn (mg/L)
LOR	0.003	0.004	0.006	0.05	0.001	0.001	0.02	0.002	0.003	0.001	0.0001	0.005	0.005	0.004	0.01	0.004
AQ1	3.087	0.034	0.016	0.065	0.002	0.009	39.37	0.003	0.008	6.057	<0.0001	0.008	0.116	0.008	0.01	0.008
AQ2	8.130	0.035	0.018	0.075	0.002	0.011	27.13	0.004	0.011	4.275	<0.0001	0.008	0.041	0.009	0.02	0.004
AQ3	1.462	0.023	0.011	0.073	0.001	0.004	11.91	0.004	0.008	0.376	<0.0001	0.005	<0.005	0.004	0.01	<0.002
AQ4	11.000	0.035	0.009	0.072	0.001	0.011	7.16	0.005	0.012	0.147	<0.0001	0.006	<0.005	0.007	0.01	0.005
AQ5	10.710	0.024	0.008	0.055	0.001	0.008	7.04	0.003	0.006	0.140	<0.0001	<0.005	<0.005	0.005	0.01	0.003
AQ9	2.163	0.012	0.009	0.089	0.004	0.010	3.66	0.003	0.010	0.066	<0.0001	<0.005	<0.005	0.007	0.01	<0.004
AQ17	30.380	0.131	0.008	0.113	0.001	0.018	11.49	0.007	0.016	0.695	<0.0001	0.005	<0.005	0.010	0.01	0.008
AQ18	19.210	0.060	0.011	0.053	0.001	0.012	8.58	0.005	0.008	0.481	<0.0001	<0.005	<0.005	0.009	0.01	0.003
AQ19	0.075	0.210	0.006	0.071	0.001	0.018	15.88	0.016	0.023	2.369	<0.0001	<0.005	<0.005	0.018	<0.01	0.022
AQ23	3.979	0.018	0.011	0.081	0.002	0.007	7.40	0.004	0.010	0.234	<0.0001	0.013	<0.005	0.007	0.01	<0.002
AQ25	41.330	0.231	0.011	0.104	0.001	0.039	29.66	0.042	0.036	2.728	<0.0001	0.006	<0.005	0.026	<0.01	0.075
AQ27	0.217	0.009	0.010	0.066	0.001	0.003	8.09	<0.002	0.007	0.040	<0.0001	0.005	<0.005	<0.004	0.01	<0.002
AQ28	0.531	0.008	0.009	0.060	0.002	0.004	5.54	0.002	0.008	0.064	<0.0001	0.005	<0.005	<0.004	0.01	<0.002
AQ29	0.307	0.063	0.011	0.052	0.001	0.004	6.31	0.002	0.009	0.586	<0.0001	<0.005	<0.005	0.005	0.01	<0.002
AQ31	15.140	0.074	0.007	0.112	0.002	0.022	9.17	0.009	0.018	0.199	<0.0001	0.008	0.006	0.017	0.01	0.011

NR = not requested; LOR = limit of reporting

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Report Ref. No. 090316_1 chem AARC

Analysis Methods: metals by ICP-OES according to APHA 3120B; pH APHA 4500H+B; turbidity APHA2130B; TDS APHA2540C; Alkalinity APHA2320B; Carbonates APHA2320B; Silica APHA4500C, chlorine APHA4500B, fluoride APHA4500D, sulphate APHA4500E, chloride APHA 4500-Cl B, nitrate APHA4500E, ammonia APHA4500F, TOC APHA5310C; phosphate APHA4500P-E, hardness APHA2340C, Total Suspended Solids APHA2540D, total N APHA 4500-N, total P APHA 4500P, TPH/TOG APHA 5520 B, TOC APHA 5310

Report Summary: Samples were analysed as received;
Note: Total metals were determined as acid digested metals.
The samples are indicative only at the time of sampling and further regular monitoring is recommended.

NOTE! (1) "SAMPLE IDENTIFICATION" obtained from container as received by our laboratory. We can not guarantee the water quality of each sample site based on these results; **(2)** * If requested, these analyses were conducted by Australian Laboratory Services in Brisbane, job reference number EB0904802 **(3)** The author reserves the right not to be responsible for the topicality, correctness, completeness or quality of the information provided. Liability claims regarding damage caused by the use of any information provided, including any kind of information which is incomplete or incorrect, will therefore be rejected. All offers are not-binding and without obligation. Parts of the pages or the complete publication including all offers and information might be extended, changed or partly or completely deleted by the author without separate announcement. This document and any attachments are intended solely for the named addressee and are confidential. The copying or distribution of them or any information they contain, by anyone other than the addressee is prohibited. This Report shall not be reproduced except in full! If you have received this document in error, please let us know by telephone (we will accept reverse charges) and delete all electronic copies from your computer system and all hard copies. It is the user's responsibility to check electronic copies and any attachments for viruses before use.

Dr. J. Catmull (PhD,BScHons,MASM,MACCS) Dr. Michael ten Lohuis (PhD,BScHons,MASM,MACCS)

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EB1005772**	Page	: 1 of 3
Client	: **AUSTRALASIAN RESOURCE CONSULTANTS**	Laboratory	: Environmental Division Brisbane
Contact	: MR BRENDAN MASSY	Contact	: Greg Vogel
Address	: SUITE 5B 1 SWANN ROAD TARINGA QLD, AUSTRALIA 4068	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: bmassy@aarc.net.au	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 32178772	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 32178775	Facsimile	: +61-7-3243 7218
Project	: HPPL Surface Water	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 31-MAR-2010
Sampler	: ----	Issue Date	: 16-APR-2010
Site	: ----		
		No. of samples received	: 5
Quote number	: BN/159/09	No. of samples analysed	: 5

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Stephen Hislop	Senior Inorganic Chemist	Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **It has been noted that the TDS for sample SC1 is less than the SO4.Both results have been confirmed by reanalysis. Turbimetric SO4 testing returned results of 898 mg/L.**
- **TDS by method EA-015 may bias high due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: A1	SC1	WC2	WC1	SM2
				Client sampling date / time: 17-MAR-2010 16:00	17-MAR-2010 11:45	17-MAR-2010 08:15	16-MAR-2010 12:00	20-MAR-2010 10:30
				EB1005772-001	EB1005772-002	EB1005772-003	EB1005772-004	EB1005772-005
EA015: Total Dissolved Solids								
^ Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	**106**	**324**	**141**	**102**	**122**
ED040F: Dissolved Major Anions								
Sulfate as SO4 2-	14808-79-8	1	mg/L	**3**	**1000**	**18**	**2**	**12**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**6**	**12**	**15**	**5**	<1
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.32**	**0.08**	**0.02**	**0.19**	**0.18**
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.002**	**0.002**	<0.001	<0.001
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.002**	**0.001**	<0.001	**0.002**	**0.001**
Cobalt	7440-48-4	0.001	mg/L	<0.001	**0.003**	**0.010**	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.003**	**0.005**	**0.002**	**0.001**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	**0.012**	**0.086**
Manganese	7439-96-5	0.001	mg/L	**0.014**	**0.642**	**2.19**	**0.028**	**0.030**
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	**0.05**	<0.05	**0.05**
Iron	7439-89-6	0.05	mg/L	**0.28**	**1.74**	**0.43**	**0.30**	**0.56**
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.2**	<0.1	<0.1	<0.1	<0.1
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.05	<0.01
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.4**	**0.4**	**0.1**	<0.1	<0.1
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	0.1	mg/L	**0.4**	**0.4**	**0.1**	<0.1	<0.1

Appendix D: Dominant Vegetation Species List

Botanical Name	AQ1	AQ2	AQ3	AQ4	AQ5	AQ7	AQ8	AQ15	AQ16	AQ17
Acacia cambagei										
Acacia harpophylla					X					X
Alphitonia excels			X							
Alternanthera angustifolia	X	X	X							
Carissa lanceolata								X		
Cenchrus sp.				X						
Pennisetum ciliare	X									
Centipeda cunninghamii			X							
Corymbia tesselaris						X				
Crinum sp.										
Cucumis anguria var. *anguria**										
Cyperaceae sp.										
Cyperus conicus var. *conicus*			X					X		
Cyperus dactylotes	X		X							
Cyperus dietrichiae			X							
Cyperus difformis	X									
Cyperus exaltatus			X							
Cyperus iria			X							
*Echinochloa colona**					X					
Eleocharis acuta					X					
Eragrostis elongatus										
Eragrostis speciosa		X	X				X			
Eucalyptus camaldulensis	X	X	X	X				X	X	
Eucalyptus melanophloia										
Eucalyptus populnea				X						X
Fimbristylis microcarya										
Fuirena incrassata										
Grewia retusifolia										
Ipomoea plebia	X									
Juncus sp.	X									
Juncus usitatus										

Botanical Name	AQ1	AQ2	AQ3	AQ4	AQ5	AQ7	AQ8	AQ15	AQ16	AQ17
Leptochloa digitata					X					
Lomandra longifolia	X		X							
Lomandra sp	X									
Ludwigia octovalvis										
Marsilea mutica					X					
Melaleuca bracteata	X	X	X			X				
Melaleuca trichostachya		X	X							
Melinis repens	X						X	X		
Monochoria cyanea					X					
Nymphoides crenata					X					
Opuntia tomentosa	X									
Panicum sp.	X									
Persicaria decipiens										
Poaceae sp.								X		
Potamogeton sp										
Pterocaulon sphacelatum			X							
*Ricinus communis**										
*Scoparia dulcis**			X							
Sida sp	X			X						
Spermacoce bracystema			X							
Sporobolus caroli										
Themeda sp	X									
Verbena incompta	X									
*Verbesina encelioides**	X		X	X						
Wahlenbergia gracilis	X									
*Xanthium pungens**		X	X			X				X

Botanical Name	AQ18	AQ19	AQ20	AQ21	AQ22	AQ23	AQ28	AQ29	AQ30	AQ31	AQ32	AQ33
Acacia harpophylla	X	X										
Alternanthera angustifolia						X	X					
Ammania multiflora						X		X				
Aristida sp			X									

Botanical Name	AQ18	AQ19	AQ20	AQ21	AQ22	AQ23	AQ28	AQ29	AQ30	AQ31	AQ32	AQ33
Basilicum polystachyon	X					X						
Bothriochloa bladhii						X						
Carissa lanceolata	X				X							
Carissa ovata												
Cenchrus sp			X									
Pennisetum ciliare		X	X									
Cyperaceae sp		X										
Cyperus dactylotes	X	X		X	X		X		X			
Cyperus difformis						X						
Cyperus exaltatus		X			X							
Cyperus iria									X			
Cyperus polystachyos								X				
Dichanthium sericeum	X											
*Echinochloa colona**							X		X			
Eleocharis acuta							X				X	
Eleocharis philippensis							X					
Enneapogon sp	X											
Eragrostis elongatus						X						
Eucalyptus camaldulensis				X		X						
Eucalyptus cambageana									X			
Eucalyptus melanophloia		X		X								
Eucalyptus populnea	X	X				X						
Fabaceae sp												
Fimbristylis littoralis							X					
Fimbristylis sp						X						
Gnaphalium polycaulon	X											
Juncus spp.		X										
Leptochloa digitata	X				X	X	X					
Leptochloa fusca				X				X	X			
Ludwigia octovalvis		X										
Lysiphyllum sp					X							

Botanical Name	AQ18	AQ19	AQ20	AQ21	AQ22	AQ23	AQ28	AQ29	AQ30	AQ31	AQ32	AQ33
Marsilea mutica							X					
Melaleuca bracteata												
Melinis repens				X								
Monochoria cyanea								X				
Najas tenuifolia												
Nymphaea immutabilis							X					
Nymphoides crenata							X					
Parkinsonia aculeata										X		
Petalostigma pubescens				X								
Poaceae sp	X						X					
Potamogeton sp							X					
Pseudraphis spinescens						X		X				
Salsola kali							X					
Schoenoplectus dissachanthus							X					
Senna occidentalis										X		
Triodia sp.			X									
*Xanthium pungens**						X						

Botanical Name	AQ36	AQ37	AQ38	AQ39	AQ40	AQ41
Acacia harpophylla	X			X		X
Alphitonia excels	X					
Alternanthera angustifolia			X			X
Ammania multiflora	X	X		X		
Archidendropsis basaltica				X		
Aristida sp			X	X		X
Basilicum polystachyon				X		
Bothriochloa bladhii	X		X			X
Carissa lanceolata		X		X		
Carissa ovata		X		X		
Cenchrus sp		X	X			X
Pennisetum ciliare	X					
Cynodon dactylon		X	X			

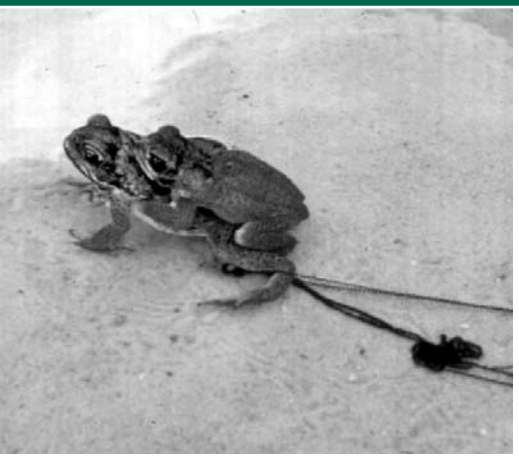
Botanical Name	AQ36	AQ37	AQ38	AQ39	AQ40	AQ41
Cyperaceae sp	X	X		X		
Cyperus dactylotes				X		X
Cyperus difformis				X		
Cyperus iria			X	X		
Cyperus polystachyos		X				X
Dichanthium sericeum		X	X	X		
*Echinochloa colona**		X	X			
Eleocharis acuta	X		X			
Eleocharis philippensis	X		X	X		
Enneapogon sp	X			X		
Eragrostis elongatus						
Eucalyptus camaldulensis	X	X	X	X	X	X
Eucalyptus populnea						
Fabaceae sp				X		X
Fimbristylis littoralis		X		X		
Fimbristylis sp		X	X	X		X
Juncus sp.		X	X			
Leptochloa digitata			X			XX
Leptochloa fusca		X	X	X		
Ludwigia octovalvis			X	X		
Lysiphyllum sp	X	X				X
Marsilea mutica						X
Melaleuca bracteata	X	X				X
Melaleuca trichostachya	X	X	X			
Melinis repens		X	X		X	
Monochoria cyanea	X		X		X	X
Najas tenuifolia	X			X		X
Nymphaea immutabilis	X				X	X
Nymphoides crenata		X			X	X
Parkinsonia aculeata	X	X	X			
Petalostigma sp	X		X	X	X	
Poaceae sp					X	
Potamogeton sp		X		X		
Pseudraphis spinescens		X				X
Salsola kali		X	X	X		
Schoenoplectus dissachanthus					X	

Botanical Name	AQ36	AQ37	AQ38	AQ39	AQ40	AQ41
Senna occidentalis						X
*Xanthium pungens**	X	X	X		X	

Appendix E: Pest Fact Sheets

Cane toads

Bufo marinus



The cane toad *(Bufo marinus) i*s not a declared pest in Queensland, so there is no legal requirement to control them.

Their original introduction in 1935 was to control agricultural pests, but they proved ineffective.

For the past 60 years, cane toads have been expanding their territory in Australia, and are capable of colonising at least four of the mainland Australian states.

As the toad's geographical range continues to expand, concern has increased about their detrimental environmental effects, particularly on the wetlands of the Northern Territory.

Studies into the feasibility of biological control have commenced.

History of introduction and spread

The cane toad or giant toad *(Bufo marinus)* is an amphibian, native to Central and South America. They have been introduced throughout the world as a biological control for insect pests of agriculture, most notably sugarcane.

A consignment of cane toads from Hawaii was released into Queensland cane fields in 1935. The introduction was surrounded by controversy as to the potential costs and benefits to Australia.

It was hoped that the toad would control Frenchi and greyback beetles—pests of economic importance to the sugarcane industry.

Queensland Government

PA21 September 2009

By 1941, however, it had become evident that the cane toad was exerting only limited control over its intended prey. There were two main reasons for this:

- Greyback beetles are only rarely in contact with the ground and Frenchi beetles invade cane fields at a time when the toads are absent due to a lack of protective cover.
- The cane toad has a wide-ranging and indiscriminate diet, and it was not solely dependant upon its intended prey.

The unlimited food source, suitable environment and low rates of predation allowed dynamic reproduction and spread. Toads were recorded in Brisbane only 10 years after release. The toad continues to thrive and has now invaded the Northern Territory and New South Wales (see Figure 1).

Figure 1 Current distribution of the cane toad

The cane toad's advance is only limited by environmental factors, such as the availability of water for breeding, tolerable temperatures, suitable shelter and an abundance of food

Toads at the frontier of their range of expansion may be larger than those in established populations. This is most probably due to greater food supply, combined with a lower incidence of disease.

Description and general information

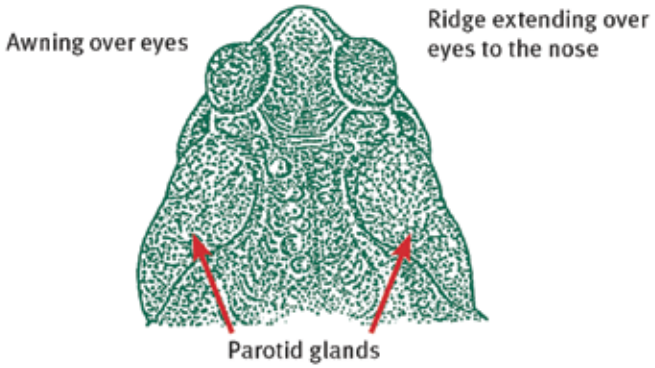
In comparison with native frog and toad species, adult cane toads have a distinctive head and face, and are large and heavily built creatures (adults may grow to 20 cm).

Following their aquatic larval stages (eggs and tadpoles), cane toads are generally encountered at night near any source of light. Cane toads are ground-dwelling—they are poor climbers and unable to jump very high.

A definite visor or awning extends over each eye and a high angular bony ridge extends from the eyes to the nose.

The parotid glands (see Figure 2) are perhaps the most characteristic feature of the adult cane toad. These glands are large, protuberant, and are situated on the head behind each ear. These glands carry a toxin.

Figure 2 Distinguishing features of the cane toad



The cane toad's hands and feet are relatively small and lack discs at the tips of the digits. Webbing is absent between the fingers but is distinct and leathery between the toes.

Colouring on the dorsal (upper) surface may be brown, olive-brown or reddish-brown. The ventral (under) surface varies from white to yellow and is usually mottled with brown.

Warts are present on all cane toads; however, males possess more than females. Warts are dark brown at the caps.

Mating

Mating can occur at any time of the year and depends only on available food and permanent water. The mating call is a continuous purring trill that sounds like a running motor.

In situations where females are scarce or absent, male cane toads may have the ability to undergo a sex change to become fertile females; however, this has not been proved.

Eggs

Both cane toads and native frogs spawn in slow-moving or still water, but their eggs can be easily distinguished.

Cane toad eggs are laid in long, gelatinous 'strings' with the developing tadpoles appearing as a row of small black dots along the length. The strings are unique to cane toads, with native frogs eggs laid in clusters, generally appearing as blobs of jelly attached to water plants or debris. Native frogs generally produce egg clusters as mounds of foam floating on the water surface.

Compared with native species, cane toad egg production is dynamic and a single clutch can contain up to 35 000 eggs. Remove any cane toad eggs found in the water and allow to dry out.

Figure 3 Drawing of toad spawn from *Wildlife of greater Brisbane*, page 166

Tadpoles

The cane toad is the only species in Australia that has a pure black tadpole. Native frogs have lighter-coloured undersides with a great range of colours and markings—cane toad tadpoles may turn paler colours to almost transparent at night.

Cane toad tadpoles are small and usually congregate in vast, slow-moving shoals. This 'shoaling' behaviour is uncharacteristic of most native species.

Unlike cane toad tadpoles, native species develop lungs at an early stage and periodically rise to the surface in order to exchange their lung gasses. Large groupings of tadpoles that do not break the water surface for air indicate cane toads.

Young toads

Following emergence from the water, the young toadlets usually congregate around the moist perimeter of the water body for about a week before they eventually disperse.

Young toads are very difficult to distinguish from the native *Uperoleiea* species, which also have parotid glands, but all *Uperolelea* species have bright red patches in the groin area.

Under ideal conditions toadlets may reach adult size within a year.

Toxicity

Bufo marinus produce venom in glands occurring in most of the skin on their upper surface. The venom is concentrated in the parotid glands as a creamy-white solution, which is released when the animal experiences extreme provocation or direct localised pressure (e.g. grasped by the mouth of a predator).

The parotid solution is highly toxic and when ingested it produces drastic acceleration of the heartbeat, shortness of breath, salivation and prostration. It is extremely painful if accidentally rubbed into the eye.

Ingestion of toads by domestic and most native animals can result in death. In some recorded cases, death has occurred within 15 minutes.

Field observations suggest that some predatory Australian species have learned how to feed safely on cane toads.

Birds have been observed flipping toads over to avoid the parotid glands. Predatory reptiles may have more trouble adapting, being unable to remove a toad from the mouth once they start feeding.

Effects on wildlife

The cane toad is poisonous at all stages of its life cycle and most native frog larvae and many aquatic invertebrates are dramatically affected by their presence.

Cane toads are voracious feeders that consume a wide variety of insects, frogs, small reptiles, mammals and even birds. Perhaps the only limiting factor to the prey taken is the width of the cane toad's mouth.

It has been suggested that cane toad competition for food and breeding grounds has been responsible for reducing the populations of some native frogs. However, many native frogs are arboreal (tree-dwelling) and occupy different niches. Cane toads don't have the native frogs' ability to 'shut down' during dry seasons when resources are limited.

Pressure from cane toads may displace native animals (frogs and other species) where they already suffer due to manipulation of their habitat by humans and grazing animals. Animals that use waterholes as retreat sites during the dry season are especially vulnerable—toads will congregate here in large numbers.

Public health

Cane toads readily eat animal and human faecal material and, in areas of poor hygiene, they have been known to transmit disease such as salmonella.

Control

Control of the cane toad has never been enforced and has remained at the discretion of the individual. Recently, the Brisbane City Council established the Cane Toad Eradication Committee that urges residents to exercise greater control of the pest.

Freezing is the most humane form of treatment. As a reaction to cold, cane toads initiate dormancy and eventually die in their sleep.

Fencing is recommended to keep toads out of ponds intended for native fish and frogs; a height of 50 cm is sufficient. Bird wire with 1 cm holes may keep toads out of an area.

CSIRO are investigating organisms for biological control. However, exhaustive testing would be necessary to ensure that viral or bacterial agents are cane toad specific and not harmful to native species.

Injured or 'lost' frogs

Brisbane Forest Park	07 3300 4855
Wildlife Preservation Society of Queensland	07 3221 0194
Queensland Museum	07 3840 7555

WILVO's Wildlife Volunteer's Organistaion (check your local phone directory to see if a group operates in your area).

Further information

Further information is available from your local government office, or from your local primary industries and fisheries biosecurity officer: contact details are available through 13 25 23.

PR09_4541R

Invasive plants and animals

Feral pigs in Queensland

- distribution, ecology and impact

DECLARED CLASS 2

Domestic pigs *(Sus scrofa*) were introduced to Australia by early settlers. Subsequent accidental and deliberate releases resulted in the wild (feral) population establishing throughout Australia. Feral pigs damage crops, stock and property, spread weeds and transmit diseases such as Leptospirosis and Foot and Mouth. They also cause environmental damage, digging up large areas of native vegetation and spreading weeds.

Feral pigs are declared Class 2 pests under *Land Protection (Pest and Stock Route Management) Act 2002*. Declaration requires landholders to control declared pest on the land under their control. A local government may serve a notice upon a landholder requiring control of declared pests.

For information on Control of feral pigs see DPI&F Pest Fact PA7. For specific information of Feral Pig management in the wet tropics, see DPI&F Pest Fact PA8.

Description

Australian feral pigs have more in common with their Eurasian cousins than with domestic pigs. They are smaller, leaner and more muscular than domestic pigs, with well-developed shoulders and necks and smaller, shorter hindquarters. Their hair is sparse and longer and coarser than domestic pigs. Feral pigs also have longer, larger snouts and tusks, straight tails, smaller mostly pricked ears and much narrower backs.

Colouring is predominantly black, buff-coloured or spotted black and white. Some are agouti-patterned (dark hair with a lighter tip). Juveniles may be striped. Colours vary between and within areas.

Growth potential is similar to domestic pigs, although harsh environmental conditions tend to stunt development. The weight of an average adult female feral pig is roughly 50 to 60 kg, with the males usually weighing 80 to 100 kg. Exceptional animals have reached 260 kg.

Older boars (razorbacks) have massive heads and shoulders and a raised and prominent back bone which slopes steeply down to small hams and short hind legs. A keratinous plaque or shield up to three centimetres thick usually develops on their shoulders and flanks. This provides some protection from serious injury during fights with other boars.

Some boars develop a crest or mane of stiff bristles extending from their neck down the middle of their back, which stands straight on end when the animal is enraged.

Distribution

Feral pigs inhabit about 40% of Australia from subalpine grasslands to monsoonal floodplains and are found in all habitat types in Queensland – see figure 1.

Areas need supply only the basics of food, water and cover.

Estimations of numbers of feral pigs in Australia range up to 24 million. The greatest concentrations of feral pigs are on the larger drainage basins and swamp areas of the coast and inland.

Biology and behaviour

Feral pigs are capable of migrating considerable distances but they tend to stay in home ranges, with watering points the focus of activity, particularly during hot weather. Pigs have few sweat glands, so high temperatures require them to drink more often and wallow in water or mud to cool off. Dense cover is the preferred habitat, providing protection from the sun and their main predator, man.

Female and juvenile pigs usually live in small family groups with a home range of 2–20 km^2. Adult males are typically solitary, with a home range of 8–50 km^2. Range size varies with season, habitat, food availability and disturbance. Herds of 400 pigs have been recorded in Cape York.

Most pigs remain in their home ranges, even when subject to some disturbance such as infrequent hunting by people and dogs. Regular disturbance will drive them on.

Feral pigs are generally nocturnal, spending daylight hours sheltering in dense cover. They are shy animals and will avoid humans, making it easy to miss their presence or to drastically underestimate their numbers.

Pigs are omnivorous, eating plants and animal flesh. They are extremely opportunistic feeders, exploiting any temporarily abundant food. They prefer green feed and will eat grains, sugar cane and other crops, fruits and vegetables. They root extensively for tubers, worms and soil invertebrates. Small animals are preyed upon. Stock losses occur primarily with lambs but occasionally with newborn calves. Carrion (dead and rotting flesh) is also consumed.

Feral pigs have relatively high energy and protein requirements, particularly during pregnancy and lactation. These requirements are not available for all the year in all areas, so pigs often have to move to other parts of their home range during pregnancy.

This seasonal need for either more food, or high energy or protein-rich food, is often the reason for their impact on agricultural crops. It is also the weakness in their ecology that can be exploited for management purposes.

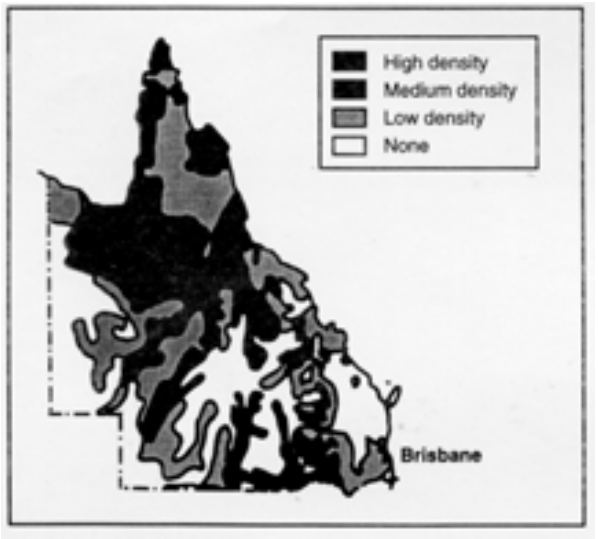


FIGURE 1 − DISTRIBUTION OF FERAL PIGS IN QUEENSLAND

Life cycle

The reproductive potential of feral pigs is more similar to rabbits than other large mammals in Australia. In good conditions feral pig populations may increase fivefold in a 12 month period.

Under favourable conditions breeding occurs all year. Adult females have a 21−day oestrus cycle, with a gestation period of about 113 days, producing a litter of four to 10 piglets, depending on the sow's age, weight and food supply.

Sows can make nests of available vegetation just before farrowing. Nests can be 3 m long by 1.5 m wide and up to 1 m high, with a domed roof.

Nests are usually less than 2 km from available water. Piglets normally spend the first 1–5 days of life inside the nest, with the sow inside or close by.

The next fertile mating can occur after 2–3 months of farrowing, allowing sows to produce two litters per year if good seasonal conditions prevail.

Weaning occurs after 2–3 months. Sexual maturity is reached when sows weigh about 25 kg, usually around 6 months of age.

Mortality of juveniles is high if the mother's dietary protein intake is low (up to 100% mortality in dry seasons). Adult mortality does not vary as much with seasonal conditions, but few animals live more than five years.

Estimating populations

Sightings are the least reliable guide to feral pig presence. Careful observation of the signs of pig activity will allow an experienced observer to estimate population densities. A beginner, however, may see nothing.

The following is a list of common pig signs that may be used to establish relative numbers and sizes:

- fresh digging or rooting of ground (causing a ploughed appearance) indicates recent pig activity, but the area affected gives little indication of numbers as large areas can be dug by a small number of pigs
- tracks and faeces on and off pads. Faeces size, shape and consistency vary with age and diet, but is typically 3–6 cm wide, 7–22 cm long and well formed. Close inspection can enable diet to be established – plant matter and seeds, egg shell and bone fragments, wool and marsupial hair
- mud or hair at holes in fences where pigs have pushed through
- wallows – distinctive oval depressions in mud
- tusk marking and mud rubs on trees and fence posts give an indication of pig size
- nests in vegetation made by sows before farrowing should only be approached with caution
- spotlighting, aerial survey, and use of dogs can be used for actual pig counts.

Impact on man and the environment

Feral pigs wide habitat range, omnivorous diet and potential for rapid population growth in good seasons mean that few agricultural pursuits are unaffected. Damage is estimated at $100 million annually.

Economic impact is of three types:

1. value of the direct losses to agricultural production
2. value of the continuing expenditure on pig control
3. value of lost opportunities to take profit from alternative investment of this expenditure.

Examples of direct agricultural losses:

Crops

Pigs can damage almost all crops from sowing to harvest, starting with uprooting seed and seedlings to feeding on or trampling mature crop.

They feed on seed and grain crops (except safflower), fruit (especially banana, mango, papaw, macadamia and lychee) and vegetable crops.

Most damage to sugar cane occurs during the dry season. Older cane with a high sugar content is preferred. Pigs can "camp" in a paddock for several weeks, causing substantial damage as sufficient moisture can be obtained from the cane.

Livestock

Predation on livestock is basically limited to lambs. Research has shown feral pigs can take up to 40% of lambs. This not only reduces income from the sale of lambs but also reduces the opportunity for herd improvement by limiting selection for optimum wool traits.

Pasture

Pastures are damaged by grazing and rooting. Pigs can also transport weeds and their diggings provide ideal conditions for weed establishment.

Fences and watering points

Wallowing pigs damage and foul the water in tanks and bore drains and silt up troughs. Rooting can weaken dam walls. Being large, powerful animals, pigs can breach fences, allowing passage of other pest animals.

Environmental concerns

Pig activity has a **dramatic** affect on creeks and lakes. In many areas concentrated rooting "ploughs" up to 20 m around the waterline.

Such disturbance of the soil and natural vegetation degrades water quality and the habitat for small animals of the land and water. It also creates erosion and allows the establishment of exotic weeds.

Predation of native fauna does occur and examination of faeces has shown remains of marsupials, reptiles and insects, ground-nesting birds and their eggs.

Diseases and parasites

Feral pigs can carry many infectious diseases and internal and external parasites. Some are endemic (already present) while others are still exotic to Australia.

Many of the diseases can not only spread to domestic pigs but to other livestock and humans. Diseases naturally transmitted from animal to man are called zoonoses.

Zoonoses currently in feral pigs in Australia:

- **Tuberculosis** (TB) – a serious disease of the lungs. Once common but now rare, it is contracted by eating inadequately cooked flesh of infected animals.
- **Brucellosis, Porcine and Bovine** – a bacterial disease causing severe long-term illness, undulant fever and possible infertility, both strains are contracted by handling raw meat. Porcine Brucellosis is rare in Queensland.

Feral pigs were blamed for the spread of TB and Bovine Brucellosis amongst cattle but both diseases have been eradicated from Queensland without directly targeting feral pigs.

- **Sparganosis** – a parasite that can infest the muscles of humans, forming encyst lumps, is common in pigs from swampy areas; contracted by ingesting raw meat.
- **Melioidosis** – a serious bacterial disease which causes abscesses.
- **Leptospirosis** – a serious bacterial disease; in humans called Weil's disease, causing very high temperatures, kidney trouble and jaundice; can be fatal. It is found in up to 20% of feral pigs in Queensland.
- **Q Fever** – this disease occurs in all animals and is well known by meat workers. It can cause very high temperature and result in heart problems; can be fatal.

Leptospirosis and Q Fever infection can occur through contact with blood, meat and urine through broken skin, intake of urine-contaminated food or water, and inhalation of infectious airborne organisms.

Brucellosis, Leptospirosis and Q Fever cause flu-like symptoms similar to Ross River Fever. Leptospirosis and Q Fever can be fatal.

To prevent contracting these diseases it is advisable to avoid handling feral pigs. Slaughtering and butchering should be undertaken only at licensed premises where there is a full-time meat inspector on duty to ensure that animals are free of the above diseases.

If you must handle feral pig meat use suitable protective clothing (mask, goggles, strong rubber gloves and plastic apron and boots) to minimise contamination with blood, urine and faeces.

Rare or undercooked meat should not be eaten; meat should be thoroughly cooked to avoid contracting pathogens.

Exotic livestock diseases

A major concern with feral pigs are their potential to harbour or spread exotic diseases. The cost to the Australian community if Foot and Mouth Disease were introduced to Australia is estimated at $3 billion in lost export trade, even if the outbreak were eradicated immediately. This would result in major social upheaval in rural Australia.

Other exotic diseases of concern:

- **Swine vesicular disease** – viral disease affecting only pigs
- **Aujeszky's disease** – highly contagious herpes viral disease affecting several animal species, killing up to 100% of affected piglets.
- **African swine fever** – highly contagious viral disease affecting only pigs, mortality rate high.
- **Classical swine fever** (CSF) or hog cholera, highly contagious viral disease of pigs, in acute form killing up to 90% of infected animals.

For more information on animal diseases contact your local DPI&F veterinarian.

Exotic zoonotic diseases and parasites

- **Japanese encephalitis** – a virus spread from pigs to humans by mosquitoes, causing acute severe problems of the nervous system – pain, sleepiness, and coma.
- **Rabies** – a serious disease affecting the brain - can be fatal.
- **Screw-worm fly** – maggots from this fly can attack healthy flesh and if untreated can cause massive wounds to animals and humans.
- **Trichinosis** – is a helminth (roundworm). All mammals are susceptible, with humans infected by eating improperly cooked meat.

North Queensland's popularity as a tourist destination is increasing. Many international visitors have travelled through countries infected with exotic diseases before entering Australia. Feral pigs are known to frequent rubbish tips around tourist lodges and to scavenge human waste.

There is a real danger that an exotic disease could enter Australia via this contact and remain undetected for some time. Such a time lapse could allow the disease to become widespread, making eradication difficult or even impossible.

Biosecurity Queensland gratefully acknowledge the contribution from Choquenot, D., McIlroy, J. and Korn T. (1996) *Managing Vertebrate Pests: Feral Pigs*, Bureau of Resource Sciences, AGPS, Canberra. Commonwealth of Australia copyright reproduced by permission.

Further information

Further information is available from animal control/environmental staff at your local government or, if your council does not have animal control staff, from your local Department Primary Industries and Fisheries Land Protection Officer: contact details available through 13 25 23.

Declared animals of Queensland



Several animals are declared as Class 1 or Class 2 pests under Queensland's *Land Protection (Pest and Stock Route Management) Act 2002*. Class 1 and 2 animals represent a threat to primary industries, natural resources and the environment.

A Class 1 pest is one that is not commonly present in Queensland, and if introduced would cause an adverse economic, environmental or social impact. Class 1 pests established in Queensland are subject to eradication from the state. Landowners must take reasonable steps to keep land free of Class 1 pests. Other powers of the Act apply.

A Class 2 pest is one that is established in Queensland and has, or could have, a substantial adverse economic, environmental or social impact. The management of these pests requires coordination and they are subject to local government-, community- or landowner-led programs. Landowners must take reasonable steps to keep land free of Class 2 pests. Other powers of the Act apply.

There is a third class of pests under the Act. Class 3 pests are established in Queensland and have, or could have, an adverse economic, environmental or social impact. A pest control notice can only be issued for these pests on land that is, or is adjacent to, an environmentally significant area. Thus, the adverse impact of species in this Class is primarily environmental. Only some of the other powers of the Act apply.

Declaration imposes a responsibility upon landowners to control pests—this includes all landowning state agencies. Large landowning state agencies are also required to develop and implement pest management plans.

Other than the above requirements, declaration does not mean that management of declared species becomes the responsibility of the state, although the state may engage in publicity and awareness activities, research, coordination of control activities, or assistance with some pests in strategic areas.

Powers are provided for Biosecurity Queensland and local governments to request landowner control and to carry out enforcement activities where necessary.

Species not declared under the *Land Protection (Pests and Stock Route Management) Act 2002* may still be declared at a local government level under local laws. Species declared as Class 3 may be subject to local law and control outside environmentally significant areas.

The *Land Protection (Pest and Stock Route Management) Act 2002* also describes certain activities relating to Class 1 and 2 pest animals that are offences under the Act.

These activities relate to:

- introducing a pest animal to the state
- feeding a declared pest animal
- keeping a declared pest animal (except under permit by bona fide zoos and wildlife parks)
- releasing a declared pest animal.

The Chief Executive of Biosecurity Queensland may make an emergency declaration for an animal for a period of up to three months. An emergency declaration could be activated in the event of a mouse plague, for example, or the discovery of a new and serious pest in Queensland.

Queensland Government

Declared animals of Queensland

The following are classified as declared animals in Queensland:

Class 1 declared pest animals

All mammals, reptiles and amphibians are Class 1 pests except:

1. Class 2 declared pest animals
2. mammals, reptiles and amphibians indigenous to Australia, including marine mammals of the orders Pinnipedia, Sirenia or Cetacea
3. and the following non declared animals:
   - alpaca (*Lama pacos*)
   - Asian house gecko (*Hemidactylus frenatus*)
   - axolotl (*Ambystoma mexicanum*)
   - Bali cattle (*Bos javanicus* and *B. sondaicus*)
   - bison or American buffalo (*Bison bison*)
   - black rat (*Rattus rattus*)
   - camel (*Camelus dromedarius*)
   - cane toad (*Bufo marinus*)
   - cattle (*Bos* spp.)
   - chital (axis) deer (*Axis axis*) other than feral chital deer
   - domestic cat (*Felis catus*)
   - domestic dog (*Canis familiaris*)
   - domestic goat (*Capra hircus*)
   - domestic pig (*Sus scrofa*)
   - donkey (*Equus asinus*)
   - European hare (*Lepus capensis*)
   - fallow deer (*Dama dama*) other than feral
   - guanicoe (*Lama guanicoe*)
   - guinea pig (*Cavia porcellus*)
   - hog deer (*Axis porcinus*)
   - horse (*Equus caballus*)
   - house mouse (*Mus musculus*)
   - llama (*Lama glama*)
   - mule (*Equus caballus* x *Equus asinus*)
   - red deer (*Cervus elaphus*) other than feral red deer
   - rusa deer (*Cervus timorensis*) other than feral rusa deer
   - sewer rat (*Rattus norvegicus*)
   - sheep (*Ovis aries*)
   - wapiti deer (*Cervus canadensis*)
   - water buffalo (*Bubalus bubalis*)

Class 2 declared pest animals

- Australian plague locust (*Chortoicetus terminifera*)
- cat, other than a domestic cat (*Felis catus*)
- dingo (*Canis familiaris dingo*)
- dog, other than a domestic dog (*Canis familiaris*)
- European fox *(Vulpes vulpes*)
- European rabbit (domestic and wild breeds) (*Oryctolagus cuniculus*)
- feral chital deer (*Axis axis*)
- feral rusa deer (*Cervus timorensis*)
- feral pig (*Sus scrofa*)
- goat, other than a domestic goat (*Capra hircus*)
- migratory locust (*Locusta migratoria*)
- spur-throated locust *(Austracris guttulosa)*

Class 3 declared pest animals

- feral fallow deer (*Dama dama*)
- feral red deer (*Cervus elaphus*)

Introduction and keeping of declared animals

The Act provides for permits to be issued for the introduction and keeping of some declared animals under certain conditions. Most declared animals can only be kept at universities and bona fide zoos and wildlife parks. The keeping of most species of declared animals as pets is illegal and subject to penalty.

Control

The responsibility for controlling a declared animal rests with the landholder. However, Biosecurity Queensland and local governments provide expertise and technical information to assist landowners.

Further information

Further information is available from your local government office, or by contacting Biosecurity Queensland (call 13 25 23 or visit our website at www.biosecurity.qld.gov.au).

PR10–5205

Declared plants of Queensland

What is a declared plant?

Pest plants targeted for control under state legislation are species that have, or could have, serious economic, environmental or social impacts. Pest management legislation aims to help protect Queensland's economy, biodiversity and people's lifestyles by:

- preventing the introduction and establishment of new pest plants in Queensland
- preventing the spread of established pest plants into new areas
- reducing the extent of existing infestations where feasible.

Declaration under the *Land Protection (Pest and Stock Route Management) Act 2002* imposes a legal responsibility for control by all landowners on land under their management. This includes all landowning state agencies. Large landowning state agencies are also required to develop and implement pest management plans.

Other than the above requirements, declaration does not mean that management of declared species becomes the responsibility of the state, although the state may engage in supplemental publicity and awareness activities, research, coordination of control activities, or assistance with some pests in strategic areas.

The Australian Quarantine and Inspection Service (AQIS) of the Department of Agriculture, Forestry and Fisheries (DAFF) has complementary legislation to restrict the importation of potential weeds not yet found in Australia. All plant nurseries and individuals should ensure they have an up-to-date list of declared plants of Queensland and prohibited plants in Australia.

Declared plants are listed under three different categories.

Categories

Class 1

A Class 1 pest is one that has the **potential** to become a very serious pest in Queensland in the future. We need to prevent the introduction, possession and sale of these species so that they can't escape to become pests.

Class 1 declared pest plant—Mexican feather grass (*Nassella tenuissima*)

All landholders are required by law to keep their land free of Class 1 pests. It is a serious offence to introduce, keep, release or sell Class 1 pests without a permit.

Class 2

A Class 2 pest is one that has **already spread** over substantial areas of Queensland, but its impact is so serious that we need to try and control it and avoid further spread onto properties that are still free of the pest.

By law, all landholders must try to keep their land free of Class 2 pests and it is an offence to possess, sell or release these pests without a permit.

Queensland Government

Class 2 declared pest plant—parthenium (*Parthenium hysterophorus*)

Class 3

A Class 3 pest is one that is **commonly established** in parts of Queensland but its control by landowners is not deemed to be warranted unless the plant is impacting, or has the potential to impact, on a nearby 'environmentally significant area' (e.g. a national park).

It is an offence to sell, introduce, release or supply a Class 3 pest.

Species not declared under the *Land Protection (Pests and Stock Route Management) Act 2002* may still be declared at a local government level under local laws.

Class 3 declared pest plant—cat's claw creeper (*Macfadyena unguis-cati*)

Reporting Class 1 plants

Please report the sale or presence of any Class 1 plants. Phone 13 25 23 to contact Biosecurity Queensland (part of the Department of Employment, Economic Development and Innovation).

Prompt action by everyone will protect our agricultural industries, natural resources and the environment from further destruction by introduced plants.

A maximum penalty of $80 000 applies to the introduction of any Class 1 plant.

Declared plants list

Plants in Queensland that are declared under the *Land Protection (Pest and Stock Route Management) Act 2002* are listed alphabetically on the following pages. Categories apply to the entire state unless otherwise specified.

Class 1 pest plants

- acacias non-indigenous to Australia ((*Acaciella* spp., *Mariosousa* spp., *Senegalia* spp. (other than *Senegalia albizoides*) and *Acacia* spp. (syn. *Vachellia* spp.) other than *Acacia nilotica* and *Acacia farnesiana*))
- alligator weed (*Alternanthera philoxeroides*)
- anchored water hyacinth (*Eichhornia azurea*)
- badhara bush (*Gmelina elliptica*)
- bitou bush (*Chrysanthemoides monilifera* subsp. *rotundata*)
- bridal creeper (*Asparagus asparagoides*)
- candleberry myrth (*Myrica faya*)
- Chilean needle grass (*Nassella neesiana*)
- cholla cactus (*Cylindropuntia* spp. and their hybrids, other than *C. spinosior, C. fulgida and C. imbricata*)
- Christ's thorn (*Ziziphus spina-christi*)
- Eurasian water milfoil (*Myriophyllum spicatum*)
- fanwort (*Cabomba* spp. other than *C. caroliniana*)
- floating water chestnuts (*Trapa* spp.)
- gorse (*Ulex europaeus*)
- harrisia cactus (*Harrisia* spp. syn. *Eriocereus* spp. other than *H. martinii, H. tortuosa* and *H. pomanensis* syn. *Cereus pomanensis*)

- honey locust (*Gleditsia* spp. including cultivars and varieties)
- horsetails (*Equisetum* spp.)
- hygrophila (*Hygrophila costata*)
- kochia (*Bassia scoparia* syn. *Kochia scoparia*)
- Koster's curse (*Clidemia hirta*)
- lagarosiphon (*Lagarosiphon major*)
- limnocharis or yellow burrhead (*Limnocharis flava*)
- Madras thorn (*Pithecellobium dulce*)
- mesquites (all *Prosopis* spp. and hybrids other than *Prosopis glandulosa*, *Prosopis pallida* and *Prosopis velutina*)
- Mexican bean tree (all *Cecropia* spp.)
- Mexican feather grass (*Nassella tenuissima*)
- miconia (*Miconia* spp.)
- mikania vine (*Mikania* spp.)
- mimosa pigra (*Mimosa pigra*)
- Peruvian primrose bush (*Ludwigia peruviana*)
- prickly pear (*Opuntia* spp. other than *O. ficus-indica, O. stricta, O. aurantiaca, O. monacantha, O. tomentosa* and *O. streptacantha*)
- red sesbania (*Sesbania punicea*)
- salvinia (*Salvinia* spp. other than *S. molesta*)
- Senegal tea (*Gymnocoronis spilanthoides*)
- serrated tussock (*Nassella trichotoma*)
- Siam weed (*Chromolaena* spp.)
- spiked pepper (*Piper aduncum*)
- thunbergia
    - annual thunbergia (*Thunbergia annua*)
    - fragrant thunbergia (*T. fragrans*)
    - laurel clockvine (*T. laurifolia*)
- water mimosa (*Neptunia oleracea* and *N. plena*)
- water soldiers (*Stratiotes aloides*)
- willow (*Salix* spp. other than *S. babylonica*, *S. humboldtiana* (syn. *S. chilensis*), *S. matsudana*, *S.* × *calodendron* and *S.* × *reichardtii*)
- witch weeds (*Striga* spp. other than native species).
- yellow ginger (*Hedychium flavescens*)

Class 2 pest plants

- African boxthorn (*Lycium ferocissimum*)
- annual ragweed (*Ambrosia artemisiifolia*)
- bellyache bush (*Jatropha gossypiifolia* and hybrids)
- cabomba (*Cabomba caroliniana*)
- chinee apple (*Ziziphus mauritiana*)
- cholla cactus
    - coral cactus (*Cylindropuntia fulgida*)
    - devil's rope pear (*C. imbricata*)
    - snake cactus (*C. spinosior*)
- fireweed (*Senecio madagascariensis*)
- gamba grass (*Andropogon gayanus)*
- giant sensitive plant (*Mimosa diplotricha* var. *diplotricha*)
- groundsel bush (*Baccharis halimifolia*)
- harrisia cactus (*Harrisia martinii* syn. *Eriocereus martinii, H. tortuosa and H. pomanensis* syn. *Cereus pomanensis*)
- hymenachne or Olive hymenachne (*Hymenachne amplexicaulis*)
- kudzu (*Pueraria montana* var. *lobata,* syn. *P. lobata, P. triloba*) other than in the Torres Strait Islands
- mesquites (*Prosopis glandulosa*, *P. pallida* and *P. velutina*)
- mother of millions (*Bryophyllum delagoense* syn. *B. tubiflorum, Kalanchoe delagoensis*)
- mother of millions hybrid (*Bryophyllum* × *houghtonii* (syn. *B. daigremontianum* × *B. delagoense, Kalanchoe* × *houghtonii*)
- parkinsonia (*Parkinsonia aculeata*)
- parthenium (*Parthenium hysterophorus*)
- pond apple (*Annona glabra*)
- prickly acacia (*Acacia nilotica*)
- prickly pear:
    - common pest pear, spiny pest pear (*O. stricta;* syn. *O. inermis*)
    - tiger pear (*O. aurantiaca*)
    - Westwood pear (*O. streptacantha*)
    - tree pears:
        - drooping tree pear (*O. monacantha* syn. *O. vulgaris*)
        - velvety tree pear (*O. tomentosa*)

- rat's tail grasses
- American rat's tail grass (*Sporobolus jacquemontii*)
    - giant Parramatta grass (*Sporobolus fertilis*)
    - giant rat's tail grass (*Sporobolus pyramidalis* and *S. natalensis*)
    - Parramatta grass (*Sporobolus africanus*)
- rubber vine (*Cryptostegia grandiflora*)
- salvinia (*Salvinia molesta*)
- sicklepods
    - sicklepod (*Senna obtusifolia*)
    - foetid cassia (*Senna tora*)
    - hairy cassia (*Senna hirsuta*)
- telegraph weed (*Heterotheca grandiflora*)
- thunbergia or blue thunbergia (*Thunbergia grandiflora*)
- tobacco weed (*Elephantopus mollis*)
- water hyacinth (*Eichhornia crassipes*)
- water lettuce (*Pistia stratiotes*)

Class 3 pest plants

- African fountain grass (*Pennisetum setaceum*)
- African tulip tree (*Spathodea campanulata*)
- aristolochia or Dutchman's pipe (*Aristolochia* spp. other than native species)
- asparagus fern (*Asparagus aethiopicus* 'Sprengeri', *A. africanus* and *A. plumosus*)
- athel pine (*Tamarix aphylla*)
- balloon vine (*Cardiospermum grandiflorum*)
- blackberry (*Rubus anglocandicans, Rubus fruticosus* agg.)
- broad-leaved pepper tree (*Schinus terebinthifolius*)
- camphor laurel (*Cinnamomum camphora*)
- Captain Cook tree or yellow oleander (*Cascabela thevetia* syn. *Thevetia peruviana*)
- cat's claw creeper (*Macfadyena unguis-cati*)
- Chinese celtis (*Celtis sinensis*)
- harungana (*Harungana madagascariensis*)
- kahili ginger (*Hedychium gardnerianum*)
- lantanas
    - lantana or common lantana (*Lantana camara*)
    - creeping lantana (*L. montevidensis*)
- Madeira vine (*Anredera cordifolia*)
- ornamental rubber vine (*Cryptostegia madagascariensis*)
- privets
    - broad-leaf privet or tree privet (*Ligustrum lucidum)*
    - small-leaf privet or Chinese privet (*L. sinense*)
- Singapore daisy (*Sphagneticola trilobata;* syn. *Wedelia trilobata*)
- white ginger (*Hedychium coronarium*)
- willows
    - pencil willow (*Salix humboldtiana* syn. *S. chilensis*)
    - tortured willow (*Salix matsudana*)
- yellow bells (*Tecoma stans*)

This list is current at November 2010, but new declarations of plants and/or changes in plant declaration can occur at any time.

Further information

Further information is available from your local government office, or by contacting Biosecurity Queensland (call 13 25 23 or visit our website at www.biosecurity.qld.gov.au).

PR11–5587

Lantana

Lantana camara

Currently, lantana covers more than 5 million ha of the east coast from southern New South Wales to Far North Queensland. Small infestations of lantana have also been found in central west Queensland, the Northern Territory, Western Australia, South Australia and Victoria. Efforts are under way to control these.

Lantana is mainly spread by people (as ornamental plants) and fruit-eating birds. It forms dense thickets that smother and kill native vegetation and are impenetrable to animals, people and vehicles.

Research indicates more than 1400 native species are negatively affected by lantana invasion, including many endangered and threatened species. As lantana is a woody shrub that has thin, combustible canes, its presence can also create hotter bushfires.

Declaration details

All lantana species are declared Class 3 plants under the *Land Protection (Pest and Stock Route Management) Act 2002*. Lantana species cannot be sold or distributed and landholders may be required to control these plants if they pose a threat to an environmentally significant area.

Description and general information

Lantana is a heavily branched shrub that can grow in compact clumps, dense thickets or as a climbing vine.

The stems are square in cross section, with small, recurved prickles. Most leaves are about 6 cm long and are covered in fine hairs. They are bright green above, paler beneath and have round-toothed edges. Leaves grow opposite one another along the stem. When crushed the leaves produce a distinctive odour.

Flowers appear throughout most of the year in clustered, compact heads about 2.5 cm in diameter. Flower colours vary from pale cream to yellow, white, pink, orange and red. Lantana produces round, berry-like fruit that turn from glossy green to purplish-black when ripe.

For rural producers, lantana poses problems of stock poisoning and invasion of desirable pasture. An economic impact assessment indicated lantana costs the Queensland grazing sector in excess of $70 million (2005–06 values) per year.It is now illegal to sell or distribute any variety of lantana in Queensland. However, garden plantings are still common in many areas and have the potential to cause problems of their own.

PP34 January 2011

Despite being sold and marketed as 'sterile' plants, research indicates some ornamental lantana varieties have the ability to set seed and can spread vegetatively. They also produce some viable pollen and have the potential to cross-pollinate with wild forms, creating new varieties that could naturalise in the environment.

If the number of naturalised varieties increases due to genetic drift from ornamental varieties it will make finding effective biological control agents even more difficult, and potentially extend the climatic tolerances and range of the weed's spread.

Habitat and distribution

Lantana is native to the tropical and subtropical regions of Central and South America.

It is found throughout most coastal and subcoastal areas of eastern Australia, from Far North Queensland to southern New South Wales. It grows in a wide variety of habitats, from exposed dry hillsides to wet, heavily shaded gullies.

Toxicity

Many lantana varieties are poisonous to stock. It is difficult to tell which varieties are toxic so it is better to treat all forms as potentially poisonous. The toxins in lantana include the triterpene acids, lantadene A (rehmannic acid), lantadene B, and their reduced forms.

Most cases of lantana poisoning occur when new stock are introduced into lantana-infested areas. Stock bred on lantana-infested country avoid lantana unless forced to eat it due to lack of other fodder. Young animals introduced to lantana areas are most at risk.

Symptoms of lantana poisoning depend on the quantity and type of lantana consumed and, under some circumstances, the intensity of light to which the animals are exposed.

Early symptoms of depression are noticeable, with head swaying, loss of appetite, constipation and frequent urination. After a day or two the eyes and the skin of the nose and mouth start yellowing with jaundice, and the muzzle becomes dry and warm. The eyes may become inflamed and have a slight discharge. The animal also becomes increasingly sensitive to light. Finally, the muzzle becomes inflamed, moist and very painful ('pink nose'). Areas of skin may peel and slough off. Death commonly occurs 1–4 weeks after symptoms occur. Death from acute poisoning can occur 3–4 days after eating the plant.

If animals show any of the early symptoms, they should be moved to lantana-free areas, kept in the shade and monitored. Veterinary treatment should be sought immediately. Some remedies may include intravenous fluids, treating skin damage with antibiotics, or drenching with an activated charcoal slurry.

Care should be taken when introducing new or young animals into a paddock if lantana is present. Ensure they have enough fodder to stop them eating lantana in quantities sufficient to result in poisoning. During drought, animals should not be placed in lantana-infested areas without alternative food.

Control

Using a mix (integration) of control methods gives the best results. Size, density and geographic location of infestations are important considerations for choosing which control methods to use. A general principle is to commence control programs in areas of light infestations and work towards the denser infestations.

For large lantana infestations, treatment with herbicides by foliar spraying is usually not economically feasible. However, fire, dozing/stick raking, slashing/cutting, aerial helicopter spraying can reduce dense infestations, making follow-up spot treatments with chemicals more economically viable.

Lantana seed banks remain viable for at *least* four years, so follow-up control to kill seedlings before they mature is vital to ensure initial management efforts to control the parent bush are not wasted.

Appropriate fire regimes may become part of a management program to ensure lantana invasiveness is reduced and pasture is maintained.

Removal of lantana within areas of remnant vegetation may require a permit under the *Vegetation Management Act 1999*. Further information should be sought from the Department of Environment and Resource Management before works commence.

Mechanical control

Stick raking or ploughing can be effective in removing standing plants. However, regrowth from stumps and/or increased seedling germination in disturbed soil is common and the site will require follow-up treatment.

Grubbing of small infestations—for example, along fence lines—can be a useful and effective method of removing plants, though this is time consuming.

Repeated slashing can also reduce the vigour of lantana, exhausting its stored resources and reducing its likelihood of re-shooting.

Some locations—for example, very steep inclines or gullies—are not suitable for mechanical control options because of the danger of overturning machinery and soil erosion.

Fire

Regular burning will reduce the capacity of plants to survive; however, initial kill rates are variable.

The effectiveness of this method will depend on the suitability of available fuel loads, fire intensity, temperature, relative humidity, soil moisture and season. Pasture re-establishment can then provide competition to inhibit lantana seed germination.

Fire is not recommended in non–fire tolerant vegetated areas such as rainforest, or wooded or plantation areas.

A typical control program for fire may include:

- exclude stock to establish a pasture fuel load
- burning (may require a permit)
- sow improved pastures—consult your local Biosecurity Queensland officer for advice
- continue to exclude stock until pasture has established and seeded
- burn again in summer before rain and spot spray lantana regrowth when › 0.5 m high and when it is actively growing (see Table 1).

Herbicide control

Herbicide recommendations for lantana are shown in Table 1. Users of herbicides have a legal obligation to read herbicide labels and use only the registered rates. Always use herbicides responsibly; adhere to legislation and safety requirements.

Variation in results can be a result of inconsistent application methods, mix rates or seasonal variation. Red-flowered and pink-edged red-flowered lantana are often considered the most difficult to control because their leaves are often smaller and tougher. However, herbicides can kill these varieties if you carefully follow application procedures.

For single-stemmed lantana, basal bark spraying and cut stump methods also give good results at any time of year (but best when the plant is actively growing). On multi-stemmed varieties, you will obtain best results by carefully applying herbicide to each stem.

When treating actively growing plants less than 2 m high, overall spraying of foliage to the point of run-off is recommended. Splatter gun techniques are also effective and particularly useful in hard-to-access areas. This is best done in autumn—when sap flows draw the poison down into the root stock, but before night temperatures get too cold.

Remove grazing animals from spray areas during and soon after treatment. Stress can cause increased sugar levels in the leaves of lantana plants, making them more palatable.

Landholders and contractors should check if the property is situated in a hazardous area. This prevents the use of some chemicals, as defined in the *Agricultural Chemicals Distribution Control Act 1966*.

Biological control

Since 1914, 31 biological control agents have been introduced into Australia in an attempt to control lantana. Seventeen have established, of which several insect species cause seasonal damage, reducing the vigour and competitiveness of lantana in some areas.

Biosecurity Queensland research programs continue to investigate agents suitable for release in Australia, and test the viability of these agents in an effort to identify more effective biological control agents.

It is important to remember that biological control alone should not be relied upon for managing lantana infestations. Consideration should be given to other available control techniques.

The four most important biological control agents are:

- **sap-sucking bug (*Teleonemia scrupulosa*)**
  Found in dry areas from Cooktown to Wollongong, this small, mottled, bug feeds on the underside of leaves, growing tips and flower buds, causing the leaves to drop early and stopping the plant from flowering.
- **leaf-mining beetle (*Uroplata girardi*)**
  Found in most lantana infestations from Cape Tribulation to Sydney as well as around Darwin, except in very dry or high altitude areas. The adult beetles are dark brown. They shelter in curled leaves and feed on the upper leaf surfaces. Larvae feed in leaves causing blotches to spread across the leaf. This beetle reduces plant vigour and can suppress flowering.
- **leaf-mining beetle (*Octotoma scabripennis*)**
  Found in most lantana infestations from Atherton to Wollongong. Adults of this species feed on the upper leaf surface, while larvae feed and mine the centre of the leaf and cause blotches. This activity reduces plant vigour and can suppress flowering.
- **seed-feeding fly (*Ophiomyia lantanae*)**
  Found from Cape Tribulation to Eden in New South Wales and also around Darwin and Perth. *Ophiomyia* is a small black fly that feeds on flowers and lays eggs on the green fruits. The maggots of the fly eat the seed and make the fruit unattractive to birds, reducing seed spread.

Other agents such as *Aconophora compressa* (a stem-sucking bug) and *Leptobyrsa decora* (a sap-sucking bug) have caused some damage in specific geographic areas.

Note: Landholders are advised not to consume their time collecting established insects for distribution. Due to their own ability to disperse, these insects will be periodically/seasonally present in areas that are climatically suitable for them.

Further information

Further information is available from your local government office, or by contacting Biosecurity Queensland (call 13 25 23 or visit our website at www.biosecurity.qld.gov.au).

Table 1. Herbicides for control of lantana

Method of application: active ingredient (trade name)[a]	Rate	Optimum time[b]	Remarks
Foliar (overall) spray			
Fluroxypyr (Starane® 200)	0.5 L to 1 L/100 L water	December to April	Thorough wetting of plants is required, higher rate should be used for larger plants
Glyphosate (Roundup® 360, Glyphosate 360®)	1 L/100 L water	October to April	Wet plant thoroughly. Glyphosate affects any green plant it comes into contact with. Glyphosate is available in a range of strengths
Picloram + 2,4-D (Tordon® 75-D)	0.65 L/100 L water	February to April	Wet plant thoroughly. Legumes are affected if sprayed
Dichlorprop (Lantana® 600)	0.5 L/100 L water	December to April	Must thoroughly wet all leaves. Please refer to product label for situation details
Picloram + triclopyr + aminopyralid (Grazon Extra®)	0.35 L to 0.5 L/100 L water	February to April	Wet plant thoroughly. Use the higher rate on larger plants. Legumes may be affected if sprayed
2,4-D amine (Amicide® 625)	0.32 L/100 L water	March to May	Red-flowered lantanas are more resistant to 2,4-D. Will kill young legumes
Metsulfuron methyl, (Brush-off®, Brushkiller® 600,Lynx® 600)	10 g/100 L water[b]	March to May	Results variable. Not found effective in tropics. Follow-up sprays are necessary
Metsulfuron methyl + glyphosate (Cutout®)	95 g/100 L water	March to May	Apply to bushes up to 2 m tall. Spray to thoroughly wet all foliage and stems. Spray to penetrate throughout the bush
Metsulfuron methyl + glyphosate (Trounce®)	173 g/100 L water	March to May	Apply when actively growing. Do not apply during periods of stress
Aminopyralid + fluroxypyr (Hotshot®)	0.5 L to 0.7 L/100 L water	October to April	Spray all foliage, including stems, to the point of run-off
(i) Basal bark (ii) Cut stump			
Triclopyr (Garlon 600®)	1 L/60 L diesel	Any time. Best results when actively growing	(i) Apply to lower 40 cm of every stem. Must ensure complete coverage around stem (ii) Cut close to ground level. Immediately apply herbicide
2,4-D ester (AF Rubber Vine Spray®)	2.5 L/100 L diesel	Any time. Best results when actively growing	As above
Picloram + Triclopyr (Access®)	1 L/60 L diesel	Any time. Best results when actively growing	As above
Picloram (Vigilant® Herbicide Gel)	3 mm to 5 mm gel	Any time. Best results when actively growing	(ii) If diameter of stump is › 20 mm, use a minimum of 5 mm gel thickness
Glyphosate (Roundup®, Weedmaster Duo®)	Neat	Any time. Best results when actively growing	Off-label permit
Splatter gun			
Glyphosate (Roundup® 360)	1:9 glyphosate +water	October to April	2 x 2 ml dose per 0.5 m height of lantana
Metsulfuron methyl (Brushkiller® 600, Lynx® 600)	2 g/L water	March to May	As above
Aerial			
Picloram + triclopyr + 2,4-D (Grazon® DS + 2,4-D amine 625 g/L)	1.5 L + 6 L/ha or 10 L/ha (Grazon®)	When plant actively growing	Helicopter only. Minimum of 200 L water per hectare. Follow-up re-spray will be required. Do not burn within six months of treatment
Dichlorprop(Lantana® 600)	6 L to 8 L L/ha	When plant actively growing	As above

a Only some common trade names provided.
b Optimum times are only a guide. Lantana must be actively growing for the herbicide to work.
® = Registered trade name.
Labels often recommend the additional use of a wetting agent or surfactant within the mix. Herbicides types vary in their selectivity against other species and soil residual.

PR11–5584

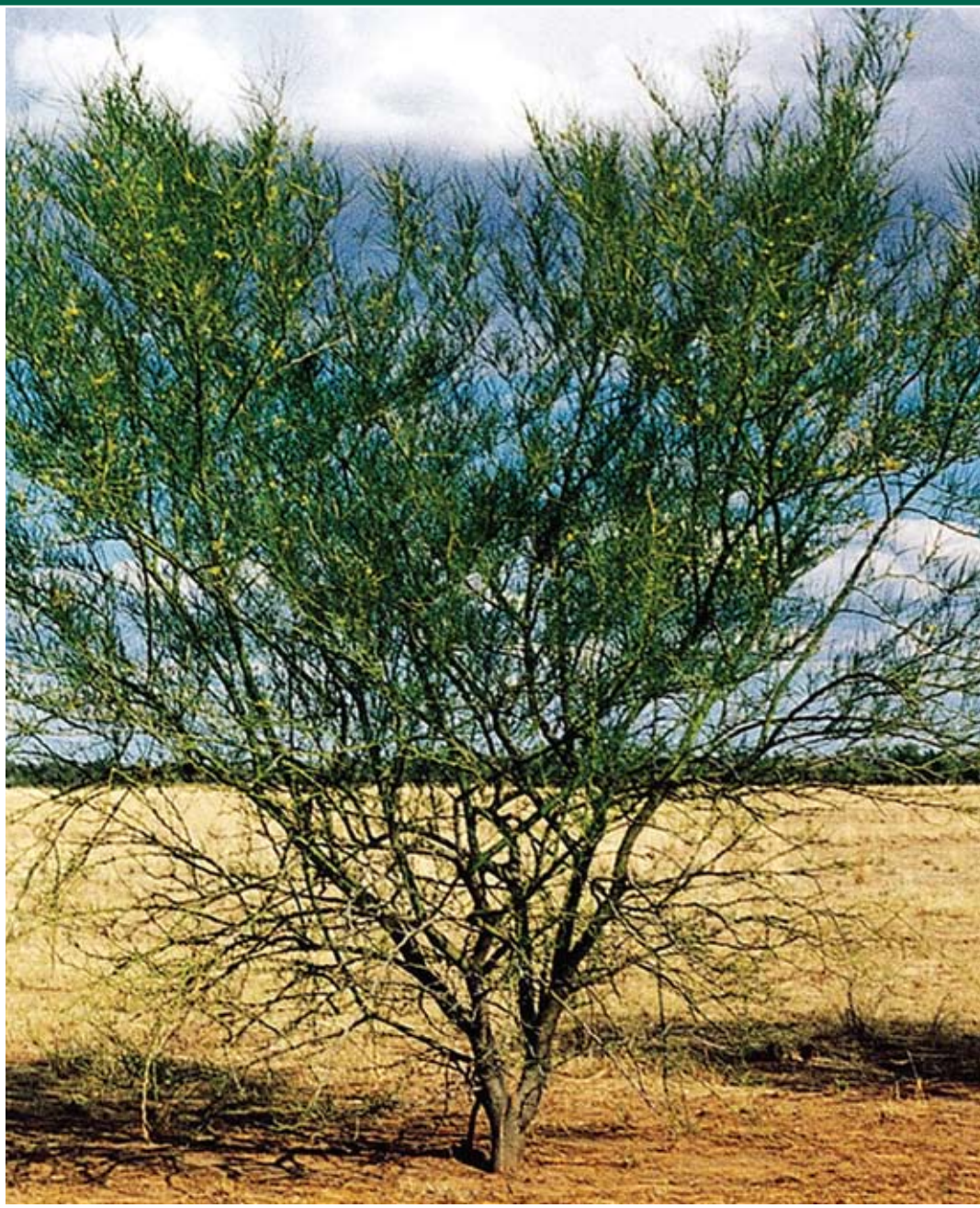
Fact sheet

DECLARED CLASS 2 PEST PLANT

Parkinsonia

Jerusalem thorn or jelly bean tree

Parkinsonia aculeata



Parkinsonia is thought to be native to tropical America but has spread throughout the world as an ornamental and shade tree. It has been recognised in Australia as a Weed of National Significance.

Declaration details

Parkinsonia is a declared Class 2 plant under *Land Protection (Pest and Stock Route Management) Act 2002*. Declaration requires landholders to control declared pests on the land and waters under their control. A local government may serve a notice upon a landholder requiring control of declared pests.

WEEDBUSTERS

Queensland Government

PP36 April 2009

Description and general information

Size and appearance

A hairless shrub or small tree that rarely grows any more than 10 m high, Parkinsonia has slender green photosynthetic zigzag branches armed with sharp spines.

Leaves

Its leaves have a short, spine-tipped stalk, with leaf branches 20–40 cm long, flattened with small, oblong leaflets along each edge.

Flowers

Parkinsonia flowers are yellow, fragrant, five petalled, each on a long, slender drooping stalk. Seeds are oval and hard, about 15 mm long, and borne in pencil-like pods 5–10 cm long, constricted between the seeds.

Lifecycle

Parkinsonia is fast growing and may flower in early summer of its second or third year of growth. Once established, flowering can occur opportunistically to exploit variable seasonal conditions. Pods mature in late summer, float on water and hence are readily dispersed by flood waters.

Seeds have a thick and extremely hard coat and so remain viable for many years to allow germination under favourable conditions. Seeds require wet soil conditions for several days to induce germination.

Habitat and distribution

As parkinsonia is adapted to an extremely wide range of soil types, there is little doubt that it will continue to spread through watercourses and adjoining areas throughout the sub-humid and semi-arid environments of Queensland.

The most vulnerable areas are the Gulf region, Channel Country and downstream into the Lake Eyre catchment.

Control

Biological control

Three species of insects have been introduced into Australia as biological control agents against parkinsonia.

Parkinsonia seed beetles *Penthobruchus germaini* and *Mimosetes ulkei*.

Both *Penthobruchus germaini* and *Mimosetes ulkei* are seed beetles that attack only parkinsonia and whose larvae destroy mature parkinsonia seeds.

Penthobruchus germaini is a small (5 mm – 6 mm long) brown beetle from Argentina. It was first released in 1995 and has established much more readily than *Mimosestes*. It has established readily at all release sites and spreads rapidly.

Penthobruchus exerts heavy pressure on parkinsonia seed banks and research has demonstrated up to 95% of seed destroyed at some sites. *Penthobruchus* may become a very important tool in the integrated management of this weed. In the field its presence is indicated by white eggs against the darker background of the pods. Round holes in the pods indicate that beetles have emerged.

Mimosestes ulkei is a small (about 5 mm long) two-tone grey beetle from the USA. While it is established at several sites, it does not establish as readily as *Penthobruchus*. It has potential to contribute to the destruction of parkinsonia seeds. In the field, round emergence holes are the only external indication of its presence.

Parkinsonia leaf bug *Rhinacloa callicrates* *Rhinacloa callicrates* is a small green bug (about 3 mm long) imported from the USA. It feeds on leaves and shoots of parkinsonia resulting in tiny round white spots where it destroys photosynthetic tissue. It is well established in Queensland but it has no significant impact on parkinsonia.

Mechanical control

Initial clearing by stick raking, blade ploughing or ripping is effective, however:

- it is restricted to reasonably level areas away from watercourses
- clearing will hasten seed germination, necessitating follow-up control either mechanically or chemically.

Establishing improved pasture will aid in managing parkinsonia by competition.

Fire will destroy seedlings if sufficient fuel load is present, but mature plants will usually survive.

Herbicide control

Herbicides registered for the control of parkinsonia are listed in Table 1.

Aerial application

Aerial application is undertaken by purpose-built applicators by helicopter. This is useful for dense, strategic infestations although it may be expensive on a broad scale.

Foliar (overall) spray

This is an effective control method for seedlings up to 1.5 m tall. Spray leaf and stems to point of runoff. A wetting agent must be used.

Basal bark spray

For stems up to 15 cm diameter, carefully spray around the base of the plant to a height of 30 cm above ground level. Larger trees may be controlled by spraying to a greater height, up to 100 cm above ground level.

Plants should be actively growing and preferably flowering. Field experience has shown that good soil moisture is essential for effective control.

Because parkinsonia infested areas are often subject to flooding, care is needed to ensure mud and flood debris does not prevent spray penetration to the bark. The trunk may need to be cleared before spraying. Addition of petrol or A-1 jet fuel will aid penetration.

Cut stump treatment

Cut stump treatment may be performed at any time of the year. Cut stems off horizontally as close to the ground as possible. Immediately (within 15 seconds) swab or spray the cut surface and associated stem with herbicide mixture.

Soil application

Use one dose of herbicide per metre of tree height. Place doses close to tree trunk, either with spot gun on clear bare ground, or underground with ground injector. Rain or sufficient soil moisture is required before herbicide is taken up by the plant.

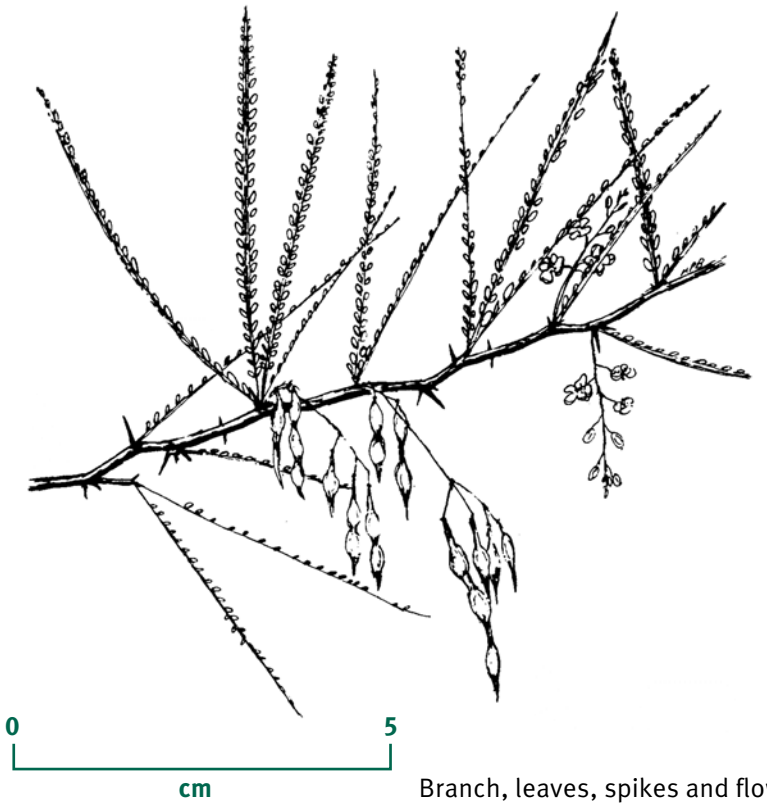
Do not use near watercourses or within a distance equal to at least twice the height of desirable trees.

Further information

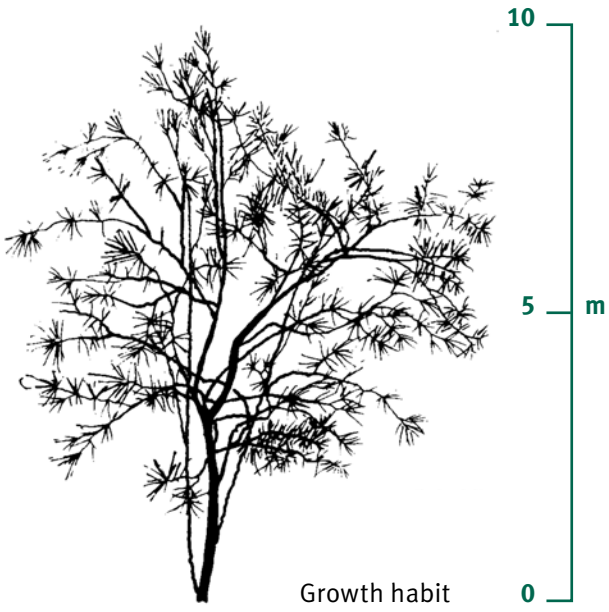
Further information is available from your local government office, or from your local primary industries and fisheries biosecurity officer: contact details are available through 13 25 23.

Table 1 Herbicides registered for the control of parkinsonia.

Situation	Herbicide	Rate	Optimum stage and time	Comments
Aerial application	Grazon DS®/picloram and triclopyr	3 L/ha	Seedlings 1–2 m tall, or 12–24 months old	Application by helicopter only. Addition of 1 L/ha of Uptake® wetting agent
	Reclaim®/hexazinone	1 kg/ha	Trees up to 3 m tall	Apply early in wet season, after initial rains but before inundation
Foliar (overall spray)	Grazon DS®/picloram and triclopyr	0.35 L/100 L water	Seedlings less than 2 m tall and actively growing	Wet plant thoroughly. Use wetting agent
Basal bark spray	Access®/triclopyr and picloram	1 L/60 L diesel	As above. Stems up to 5 cm diameter	Do not treat wet stems
Cut stump	Access®/triclopyr and picloram	1 L/60 L diesel	Any time of year	Cut close to ground level and treat **immediately**
Soil application	Velpar L®/hexazinone (via spotgun)	4 ml per spot—1 spot for each shrub/tree	Any time, but needs moisture to activate chemical	Shrubs/trees up to 5 m tall
	Graslan®/tebuthiuron	1 to 1.5 g/m^2	Any time, but needs moisture to activate chemical	Refer to label for critical comments



Branch, leaves, spikes and flowers



Growth habit

Fact sheets are available from Queensland Primary Industries and Fisheries service centres and the Queensland Primary Industries and Fisheries Business Information Centre (telephone 13 25 23). Check our website at www.dpi.qld.gov.au to ensure you have the latest version of this fact sheet. The control methods referred to in this pest fact should be used in accordance with the restrictions (federal and state legislation, and local government laws) directly or indirectly related to each control method. These restrictions may prevent the use of one or more of the methods referred to, depending on individual circumstances. While every care is taken to ensure the accuracy of this information, Queensland Primary Industries and Fisheries does not invite reliance upon it, nor accept responsibility for any loss or damage caused by actions based on it.

PR09_4542

Fact sheet

DECLARED CLASS 2 PEST PLANT

Parthenium weed

Parthenium hysterophorus

Parthenium costs the beef industry a total of $16.5 million per year and cropping industries several million dollars per year.

Declaration details

In Queensland, Parthenium is a Class 2 declared plant.

Under the *Land Protection (Pest and Stock Route Management) Act 2002*, Class 2 declaration requires landholders to control pests on the land and waters under their control. A local government may serve a notice upon a landholder requiring control of declared pests.

WEEDBUSTERS

Queensland Government

PP2 January 2011

Description and general information

Size

Parthenium weed is an annual herb with a deep tap root and an erect stem that becomes woody with age. As it matures, the plant develops many branches in its top half and may eventually reach a height of two metres.

Leaves

Its leaves are pale green, deeply lobed and covered with fine soft hairs.

Flowers

Small creamy white flowers occur on the tips of the numerous stems. Each flower contains four to five black seeds that are wedge-shaped, two millimetres long with two thin, white scales.

Lifecycle

Parthenium weed normally germinates in spring and early summer, produces flowers and seed throughout its life and dies around late autumn. However, with suitable conditions (rain, available moisture, mild temperatures), parthenium weed can grow and produce flowers at any time of the year. In summer, plants can flower and set seed within four weeks of germination, particularly if stressed.

Potential damage

Parthenium weed is a vigorous species that colonises weak pastures with sparse ground cover. It will readily colonise disturbed, bare areas along roadsides and heavily stocked areas around yards and watering points. Parthenium weed can also colonise brigalow, gidgee and softwood scrub soils. Its presence reduces the reliability of improved pasture establishment and reduces pasture production potential.

Parthenium weed is also a health problem as contact with the plant or the pollen can cause serious allergic reactions such as dermatitis and hay fever.

Habitat and distribution

Parthenium weed is capable of growing in most soil types but becomes most dominant in alkaline, clay loam soils.

The plant is well established in Central Queensland and present in isolated infestations west to Longreach and in northern and southern Queensland.

Infestations have also been found in northern and central parts of New South Wales and it is capable of growing in most states of Australia.

Control

Prevention and weed seed spread

As with most weeds, prevention is much cheaper and easier than cure. Pastures maintained in good condition, with high levels of grass crown cover, will limit parthenium weed colonisation. Drought, and the subsequent reduced pasture cover, creates the ideal window of opportunity for parthenium weed colonisation when good conditions return.

Parthenium seeds can spread via water, vehicles, machinery, stock, feral and native animals and in feed and seed. Drought conditions aid the spread of seed with increased movements of stock fodder and transports.

Vehicles and implements passing through parthenium weed infested areas should be washed down with water. Wash down facilities are located in Alpha, Biloela, Charters Towers, Emerald, Gracemere, lnjune, Monto, Moura, Rolleston, Springsure and Taroom. Particular care should be taken with earthmoving machinery and harvesting equipment. The wash down procedure should be confined to one area, so that plants that establish from dislodged seed can be destroyed before they set seed.

Extreme caution should be taken when moving cattle from infested to clean areas. Avoid movement during wet periods as cattle readily transport seed in muddy soil. On arrival, cattle should be held in yards or small paddocks until seed has dropped from their coats and tails prior to their release into large paddocks. Infestations around yards can be easily spotted and controlled whereas infestations can develop unnoticed in large paddocks.

Particular care should be taken when purchasing seed, hay and other fodder materials. Always keep a close watch on areas where hay has been fed out for the emergence of parthenium or other weeds.

Property hygiene is important. Owners of clean properties should ensure that visitors from infested areas do not drive through their properties. If your property has parthenium weed on it, ensure that it is not spread beyond the boundary or further within the property.

Pasture management

Grazing management is the most useful method of controlling large-scale parthenium weed infestations. Maintain pastures in good condition with high levels of ground and grass crown cover. This may require rehabilitation of poor pastures, followed by a sound grazing maintenance program.

Sown pasture establishment—Poor establishment of sown pastures can allow parthenium weed colonisation. pasture agronomist Aerial seeding prior to scrub pulling is normally beneficial.

Overgrazing—High grazing pressure caused by drought or high stock numbers decreases the vigour and competitiveness of pastures and allows the entry and spread of parthenium weed. Maintenance of correct stock numbers is most important in controlling parthenium weed. pasture agronomist

Pastures spelling—In situations of serious infestation, pasture spelling is essential for rehabilitation. Total spelling is much more effective than simply reducing the

stocking rate. However, overgrazing of the remainder of the property must be avoided.

The most appropriate time for pasture spelling is the spring–summer growing period, with the first 6–8 weeks being particularly important. If the condition of perennial grasses (native or sown) is low, spelling for the entire growing season may be required or introduced grasses may need to be re-sown. Herbicide treatment can hasten the rehabilitation process by removing a generation of parthenium seedlings and allowing grass seedlings to establish without competition. In the presence of parthenium weed, grass establishment is poor.

Grazing during winter should not increase the parthenium weed risk. Most tropical grasses are dormant and can tolerate moderate grazing during this period. However, parthenium weed may germinate and grow at this time.

Fencing—One of the main problems in controlling parthenium weed is the large paddock size and the variability of country within paddocks. The resulting uneven grazing pressures encourage parthenium weed to colonise the heavily grazed country. Ideally, similar land types should be fenced as single units. Fencing can be used to great effect to break up large paddocks, allowing more flexible management such as pasture spelling or herbicide application, options not available previously.

Burning—Burning is not promoted as a control strategy for parthenium weed. However, research suggests that burning for pasture management (e.g. woody weed control) should not result in an increased infestation if the pasture is allowed to recover prior to the resumption of grazing. Stocking of recently burnt areas known or suspected to contain parthenium decreases pasture competition and favours parthenium, ultimately creating a more serious infestation.

Herbicide control

Non-crop areas—Parthenium weed should be sprayed early before it can set seed. A close watch should be kept on treated areas for at least two years.

Small and/or isolated infestations should be treated immediately. Herbicide control will involve a knockdown herbicide to kill plants that are present and a residual herbicide to control future germinations. Repeated spraying may be required even within the one growing season to prevent further seed production.

Extensive infestations will require herbicide treatment in conjunction with pasture management. Timing of spraying is critical so that parthenium weed is removed when plants are small and before seeding has occurred. Grasses should be actively growing and seeding so that they can recolonise the infested area.

Table 1 shows the herbicides registered for parthenium weed control and application rates. Before using any herbicide always read the label carefully. All herbicides must be applied strictly in accordance with the directions on the label.

Cropping areas—Controlling parthenium weed in cropland requires selective herbicide use and/or crop rotations. For further information on parthenium weed control in crops consult your nearest Primary Industries and Fisheries extension agronomist.

Biological control

The combined effects of biological control agents reduced the density and vigour of parthenium weed and increased grass production.

There are currently a number of insect species and two rust pathogens that have been introduced to control parthenium weed—a selection of these are outlined below.

Epiblema strenuana is a moth introduced from Mexico established in all parthenium weed areas. The moth's larvae feed inside the stem, forming galls that stunt the plant's growth, reduce competitiveness and seed production.

Listronotus setosipennis is a stem-boring weevil from Argentina but is of limited success in reducing parthenium weed infestations.

Zygogramma bicolorata is a defoliating beetle from Mexico which is highly effective where present. It emerges in late spring and is active until autumn.

Smicronyx lutulentus (Mexico) lays eggs in the flower buds where the larvae feed on the seed heads.

Conotrachelus albocinereus (stem-galling weevil from Argentina) produces small galls and is still becoming established in Queensland.

Bucculatrix parthenica (leaf mining moth from Mexico) larvae feed on leaves, leaving clear windows in the leaf.

Carmentia ithacae is a stem boring moth from Mexico which is becoming established at favourable sites in the northern Central Highlands.

Puccinia abrupta is a winter rust from Mexico that infects and damages leaves and stems. It is currently established over a wide area from Clermont south. It requires a night temperature of less than 16 degrees and 5–6 hours of leaf wetness (dew). Sporadic outbreaks occur where weather conditions are suitable.

Puccinia melampodii is a summer rust from Mexico that weakens the plant by damaging the leaves over the summer growing season. It is currently established and spreading at a number of sites from north of Charters Towers to Injune in the south.

Manual control

Hand pulling of small areas is not recommended. There is a health hazard from allergic reactions and a danger that mature seeds will drop off and increase the area of infestation.

Further information

Further information is available from your local government office, or by contacting Biosecurity Queensland (call 13 25 23 or visit our website at www.biosecurity.qld.gov.au).

Table 1 Herbicides registered for parthenium weed.

Herbicide	Rate	Situation	Comments
2,4-D amine 500 g/L	0.4 L/100 L	Land—industrial, pastures; rights-of-way	Spot spray
atrazine 500 g/L	3.6–6 L/ha	Fields and fallow	Boom spray
max 3 kg/ha/yr	6 L/ha	Land—industrial, commercial, non-agricultural, roadside, right-of-way	Boom spray
atrazine 900 g/kg	2–3.3 kg/ha	Fields and fallow	Boom spray
max 3 kg/ha/yr	3.3 kg/ha	Land—non-agricultural, commercial, industrial	Boom spray
2,4-D + picloram (Tordon 75-D)	125 ml/100 L	Land—commercial, industrial, pastures, right-of-way	Spot spray
	3 L/ha	Land—commercial, industrial, pastures, right-of-way	Boom spray
2,4-D ester[1]	.025 L/10 L	Land—non-agricultural, pastures	Rosette stage
glyphosate (450 g/L)	0.8–1.2 L/ha	Fields and fallow	Spot spray
metsulfuron methyl	5–7 g/ha	Fields and fallow	Seedlings only
	5 g/100 L	Land—commercial, industrial, pastures, rights-of-way	Spot spray
hexazinone	3.5 L/ha or 7 L/10 L/20 m^2	Land—commercial, industrial, pastures, rights-of-way	Boom spray or spot spray
dicamba (200 g/L)	0.7–2.8 L/ha or 0.1–0.19 L/100L	Grass pastures	Boom spray or spot spray
(500 g/L)	0.28–1.1 L/ha or 0.40–0.76 L/100L	Grass pastures	Boom spray or spot spray
(700 g/kg)	200–800 g/ha or 30–60 g/100 L	Grass pastures	Boom spray or spot spray

[1]Use restricted in some areas of Central Queensland

Notes The registered rates are for non-crop uses. Consult label for in-crop recommendations.
For power hand spray or knapsack use, spray plants to the point of runoff.

PR11–5578

Fact sheet

DECLARED CLASS 2 PEST ANIMAL

The rabbit and its control

Oryctolagus cuniculus

Declaration details

The rabbit is a declared Class 2 animal under the *Land Protection (Pest and Stock Route Management Act) 2002*.

Description and general information

Rabbits are one of Australia's major agricultural and environmental animal pests, costing the country between $600 million and $1 billion annually. They compete with native animals, destroy the landscape and are a primary cause of soil erosion by preventing regeneration of native vegetation.

Pet rabbits

Introducing and selling rabbits in Queensland is not permitted (max. penalty $40 000). Limited numbers of permits for domestic rabbits are only available from Biosecurity Queensland for research purposes, public display, magic acts or circuses. Before a permit is granted, a number of guidelines need to be fulfilled.

Habitat

Rabbits are adaptable and sometimes live in close association with people. They live in built environments such as:

- in and under buildings
- old machinery and storage containers
- in old dumps.

In rural environments rabbits frequently live in:

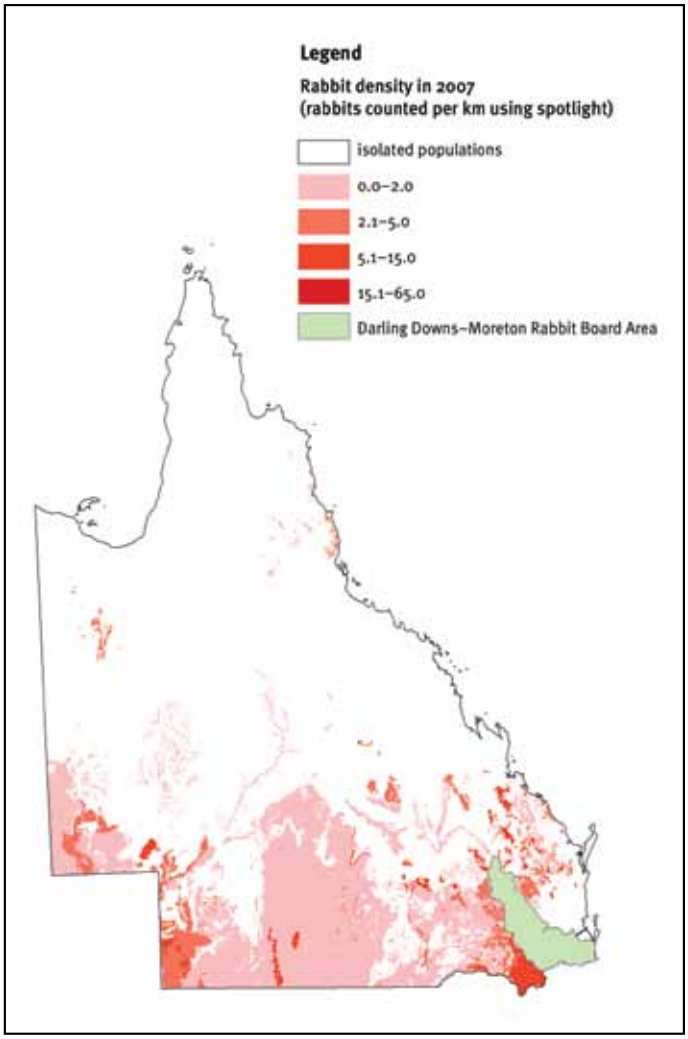
- felled timber and associated windrows
- tussock grasses and rocky areas
- warrens (if soils are easy to dig).

Rabbit warrens

Rabbits prefer to live in warrens as protection against predators and extremes in temperature. However, they will survive in above-ground harbours such as logs, windrows and dense thickets of scrub (e.g. blackberry and lantana) or under built harbour, old sheds and machinery etc. In newly colonised areas without warrens, rabbits tend to live in 'scrapes' (or 'squats').

Queensland Government

PA11 July 2010



Number of rabbits likely to be seen with a spotlight at night. Darker areas indicate more suitable rabbit habitat

Breeding

Does (females) are pregnant for 28–30 days, but are able to mate within hours of giving birth. The average litter is 3–4 kittens but varies from two in a young doe, up to eight or more in a mature doe, and depends on the amount and quality of food available. Five to six litters are possible in a good season.

Young does can breed at four months of age if conditions are suitable.

Where to start control

For effective long-term rabbit control, concentrate on destroying source areas. Source areas will all have well-established warrens or ready-made structures that are cool and provide protection from predators. A source area must also have a good supply of green feed during the cooler seasons.

Rabbits on a warren

Coordinating control

Rabbit control is best done as a joint exercise involving all land mangers in the district. Cost-effective, long-term results can be achieved in rabbit control by following the methods outlined below.

Effective rabbit control cycle

Control

Integrated control

Landholders should adopt an integrated control approach, incorporating appropriate strategies from those listed below. Landholders must understand that biological control agents such as myxomatosis and rabbit hemorrhagic disease virus (RHDV) are not a complete solution to rabbit problems. It is essential to incorporate them into a management strategy with other control techniques.

RHDV offers landholders a major opportunity to reduce rabbit numbers; however, failure to combine RHDV with other control strategies could cause rabbit immunity to develop (as occurred with myxomatosis).

Destroying a rabbit's home (e.g. warren) is the most effective method for long-term control.

Conventional control methods, such as fumigating, ripping warrens and harbour destruction, are essential for the continued long-term reduction of rabbit numbers.

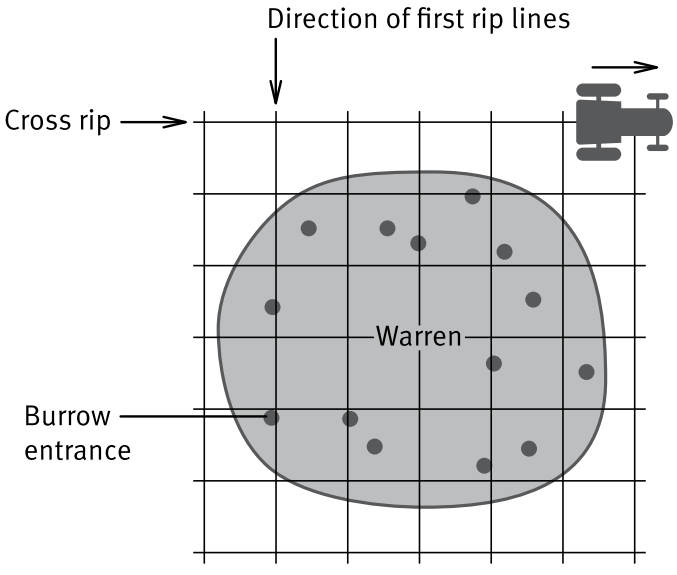
Warren ripping

In areas where rabbits live in warrens, ripping is the most effective method of long-term control. Ripping is so successful because warrens can rarely be reopened and rabbits are unable to recolonise these areas.

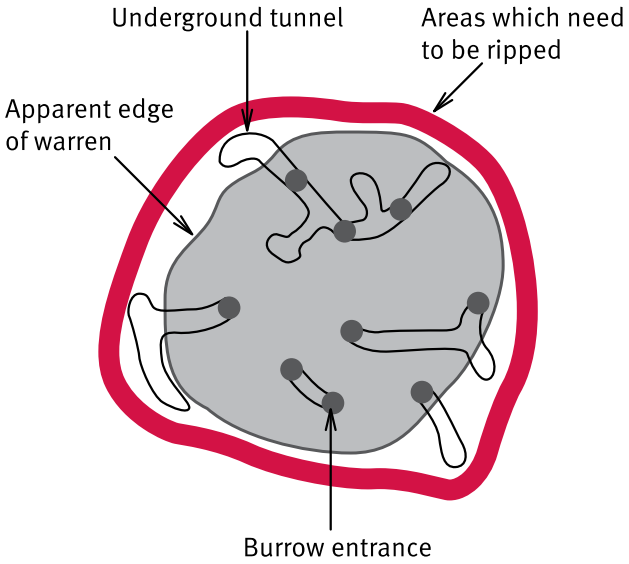
Tyne for ripping warrens (photo courtesy Mark Ridge)

To get the best results it is important to chase as many of the rabbits inside the warren as possible. Dogs can be used to drive rabbits into the warren before ripping starts.

The aim of ripping is to completely destroy the warren. It involves using a tractor with a tyned (sharp-pronged) implement—one tyne or many—that rips through the warren and collapses it. Larger tractors and dozers are more appropriate for properties with many warrens as they are able to move faster and rip wider.



Direction to rip warrens (illustration courtesy Will Dobbie)



Extent to rip warrens (illustration courtesy Will Dobbie)

Obviously, ripping is not suitable for warrens located underneath buildings or on steep rocky country. In such cases, other methods (poison baiting, releasing virus or fumigating burrows) should instead be used to reduce rabbit numbers. Warrens should then be either filled in or covered to stop rabbits from re-establishing. Burrows can be blocked with small boulders or rocks (see photo below).

Rock blocking rabbit hole

Harbour destruction

Where there is abundant surface harbour, a high proportion of rabbits may live above ground rather than in underground warrens. Rabbits can make their homes in windrows, dense thickets of shrubs (such as blackberries and lantana) and even in old machinery.

To eliminate these above-ground breeding areas, it may be necessary to:

- burn windrows and log piles
- remove noxious weeds through chemical and physical control
- remove movable objects (such as old machinery) from paddocks.

Sometimes removing harbour can expose warrens underneath. If this happens, the warrens need to be ripped.

Poison baiting

Baiting is not effective as a sole control method and will not eradicate an entire rabbit population. Numbers will quickly increase again, and you will have to continue baiting year after year with no permanent overall change in the rabbit population.

Rabbits can also become 'bait shy' and this method becomes less and less effective over time. Ideally, baiting is best used either before ripping/fumigation to reduce a population, or after ripping/fumigation as a 'mop-up'.

Baiting works best when rabbits are not breeding. During breeding season the majority of the population feeds over a larger-than-normal area, and it is the young rabbits that are most likely to take baits. While numbers will be reduced, animals of breeding age are not likely to be affected.

1080—sodium fluouroacetate

Pre-feeding is required when using 1080 because rabbits will not readily take new feed. The poison-free bait should be laid at least three times over a one-week period before the poisoned bait is laid. (1080-impregnated carrot baits are the most common form of bait used.) The practice helps to ensure that, when the poisoned bait is laid, it will be eaten by most of the rabbit population.

1080 can only be supplied through persons authorised under the Health Act. Your local Biosecurity officer or your local government office should be able to assist you.

Pindone

Pindone is an anticoagulant registered for rabbit control. This poison works by preventing blood from clotting. In Queensland, it is not recommended for broadacre use and is mainly used in urban areas and near farm buildings.

Pindone works best when given as a series of small doses/feeds over a period of three days. Although pre-feeding is not essential, it does enhance the bait uptake by shy rabbits as they get used to the feed prior to any poison bait being laid. To be effective, pindone requires multiple feeds so that the poison can build up to fatal levels in the rabbit's body. Feeding over a number of nights provides plenty of opportunity for most of the rabbit population to consume the required lethal dose. Rabbits poisoned with pindone will usually die within 10–20 days.

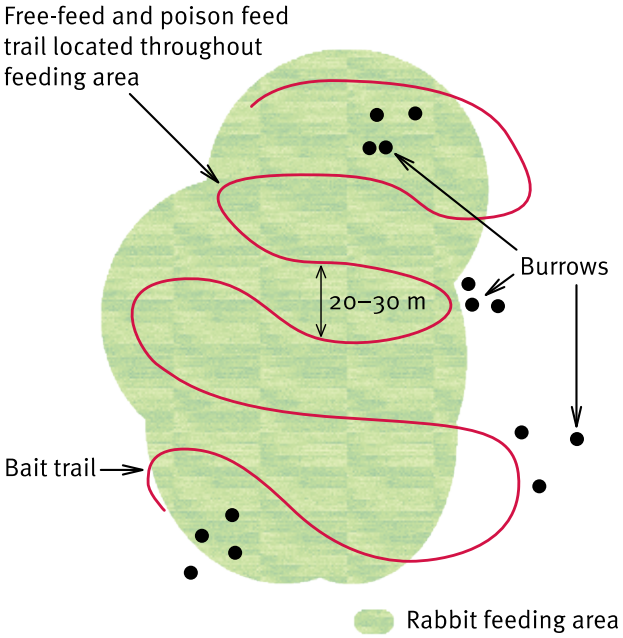
Pindone baiting does not work well when there is a lot of green pick around for rabbits.

Poison bait trails

It is important that bait trails are laid properly to ensure the best results. 'Baitlayers' make it easier to put out bait trails at the correct rate, and they can be towed behind most 4WD vehicles, quad bikes and tractors.

When scratching and laying a trail, consider the following:

- Rabbits like freshly scratched/disturbed soil—this may be because rabbits are territorial and inspect newly disturbed soil, and/or the disturbed vegetation smell attracts them.
- Lay trails around warrens and in the areas where rabbits most often feed.
- Laying trails on slopes and hills requires care—it can cause erosion in some soils types (e.g. granite and traprock). Trails are best laid in a zigzag pattern in steep terrain to minimise erosion.
- A trail that has been scratched for the first feed is easy to follow for the rest of the baiting program.
- The soil should be turned only enough to scratch the surface—don't plough the ground.
- A trail that has been scratched too deep will spook the rabbits because they will not have full sight of their predators.
- Where vegetation is thick, or it is difficult to find the main feeding areas, lay bait trails in a grid pattern across the site.
- As a general rule, avoid crossing the bait trail—it can cause confusion when you try to follow the same trail on subsequent occasions.



Method for laying a bait trail (illustration courtesy Animal Control Technologies)

Bait trials will be most effective if you follow these guidelines:

- Use good quality, non-contaminated bait material. (Simple rule: if you wouldn't eat it, the rabbit won't either.)
- Use enough feed to bait all the rabbits in the area. (The pre-feed will give an indication of the potential bait take.)

- Expect a greater uptake of pre-feed and bait material when vegetation is scarce, dried off or soured.
- Ensure that all the preparation equipment is clean and free of any chemical residues or smells—rabbits can be very shy of unusual odours.
- When there are kittens in a warren, lay the bait trail close to the warrens.

Fumigation

Fumigation is labour intensive and time consuming, and is not usually an effective method if used alone. However, as a 'mop-up' technique or control method for use in areas where ripping is not practical (e.g. steep and rocky terrain), it may be a good alternative.

Because this technique relies on directly affecting the rabbits, and does not affect the structure of the warren, it is crucial that as many rabbits as possible are underground when fumigation is carried out. Rabbits usually take refuge in their burrows from mid-morning to mid-afternoon and during hot weather so these are the best times to fumigate. Dogs can also be used to drive rabbits into their warrens.

For best results, fumigation should be carried out in two stages—initially, before the breeding season starts (as this reduces the breeding stock), and then again during the breeding season.

There are two types of warren fumigation—static and pressure. In Queensland, static fumigants are a more popular and safer option for controlling rabbits and will be explained below.

Static fumigation

This method is easy to use, and time- and cost-effective. Static fumigation comes in the form of aluminium phosphide (phosphine) tablets, which can be purchased from most agricultural suppliers. These tablets are small and round (about the size of a marble), and weigh 3 g. Trade names for phosphine include Pestex®, Quickphos® and Gastion®. General directions for the use of phosphine tablets appear below, but always refer to the manufacturer's specific recommendations for use.

To fumigate warrens using phosphine tablets:

1. Find all warren entrances—both active and inactive.
2. Cut back the warren entrance at right angles using a shovel.
3. Separately wrap two tablets in moistened absorbent paper (toilet paper/paper towels).
4. Insert the tablets as far down into the entrance as possible. (Polypipe and a push rod can be used to help push the tablets down.)
5. Push some scrunched-up newspaper down the hole to block the entrance and then cover it up with soil and, if possible, a rock.
6. Treat all entrances to the warren (active and inactive) the same way.
7. Check warrens about a week after fumigation and re-fumigate any reopened entrances.

Once in the warren, the moistened tablets react with air to release a toxic gas, which spreads quickly throughout the warren. The phosphine gas itself is invisible and odourless but leakages from the warren can be detected by the smell of ammonia. (This is a safety mechanism that is built into the tablet.) Any leakages need to be blocked immediately.

Biological controls

Rabbit hemorrhagic disease virus (also known as rabbit calicivirus disease)

RHDV is a virus specific to rabbits which works by infecting the lining of the throat, lungs, gut and liver.

RHDV relies primarily on direct rabbit-to-rabbit contact in order to spread. High rabbit numbers are therefore needed before this control method will be effective.

After RHDV has infected an area, it is important to use another method for follow-up control to increase the likelihood that the population is eradicated before it is able to develop resistance and increase its numbers again.

Resistance to RHDV depends primarily on the age of the rabbit. Therefore, it is better for RHDV to go through a rabbit population after rabbits have bred and the young are old enough to be affected by the virus. Rabbits that survive RHDV develop antibodies against the virus. Breeding females can also pass these antibodies on to the young (through antibodies in their milk), conferring temporary protection on rabbits up to 12 weeks old.

Myxomatosis

Myxomatosis is no longer produced as a laboratory strain but field strains are still known to recur and affect rabbit populations.

Trapping

Trapping is an extremely labour-intensive control method and requires a skilled operator to set the traps to successfully capture rabbits.

If you do plan to trap rabbits on your property, common sense and respect for animal welfare are essential. While there are currently no strict guidelines for the use of traps in Queensland, it is an area of growing concern for animal welfare advocates.

Cage trap

A cage trap has a lever that closes the cage when a rabbit steps on it. The rabbits are lured into the cage with bait—usually diced carrot. Traps need to be disabled and left open for two or three nights with bait leading into the cage. This entices rabbits to enter. A trap can be set once a rabbit has consumed a trail of bait all the way into that

trap. Traps should be checked and emptied regularly—usually a couple of times a night.

This effective and humane technique is most useful for removing any remaining rabbits from places like hay sheds and after the shed has been fenced to prevent additional rabbits from entering and leaving. Free-feed then trap, and keep the shed rabbit-proof to prevent rabbits recolonising.

Barrel trap

A barrel trap is designed specifically for rabbits. It is cylindrical, made of light mesh, and is about 1 m long and 15 cm in diameter. The trap has one open end with two hinged trap doors along its side. The open end is placed in the burrow, and the hinged gates close and trap the rabbit after it enters from the burrow.

The trap can be left in the burrow entrance for a number of days. However, it must be checked at least daily so that if a rabbit has been caught it does not suffer and animal welfare responsibilities are met.

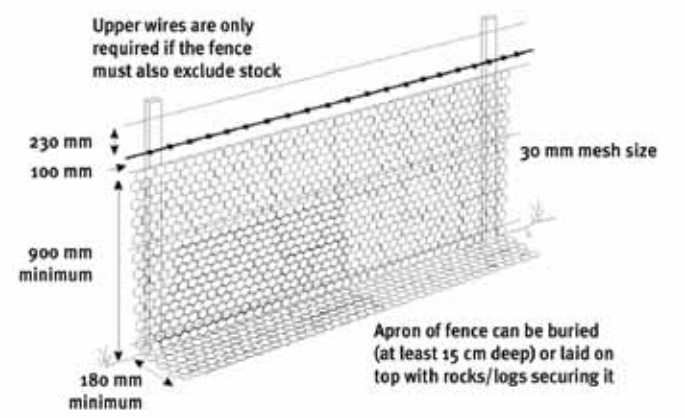
Barrel rabbit trap in hole

Exclusion fencing

Rabbit exclusion fences are built with the aim of keeping rabbits out of a particular area. It is appropriate for small, high-value areas that require protection. A fully fenced area will only remain rabbit-free in the long term if all rabbits are removed from the enclosed area after fencing and the fence is regularly maintained and checked for holes.

A rabbit-proof fence should be made of wire mesh netting (40 mm or smaller) and needs to be at least 900 mm high. The netting should also be buried to depth of at least 150 mm. Gates into the fenced area need to be rabbit-proof as well.

Electric fencing is a cheaper alternative, but it is not a complete physical barrier and is also prone to damage from other pest animals and stock.



Exclusion fence for rabbits (illustration courtesy DEWHA)

Shooting

Shooting is most useful when used to 'mop up' after other control methods (such as ripping). To get the best results, shoot at the time of day when rabbits are active. This is usually in the early morning, late afternoon or at night. The best and most economical firearm to use is a .22 calibre rifle.

If your property is within an urban area, you will need to comply with local government regulations and the *Police Powers and Responsibilities Act 2000*, which restrict the use of firearms.

Further information

For further detailed reading information on specific rabbit control techniques or costing your rabbit control please refer to Rabbit control in Queensland; a guide for land managers. Download from the Biosecurity Queensland website at www.biosecurity.qld.gov.au

Further information is available from your local government office, or by contacting Biosecurity Queensland (call 13 25 23 or visit our website at www.biosecurity.qld.gov.au).

PR10–5192

Appendix F: Macro-invertebrate Identification Results

March 2010 Macro-invertebrate Identification Results

ALS Laboratory Group
Water Sciences Group

ORDER	FAMILY	SIGNAL SCORE	AusRivAS taxa code	17/03/2010 MACRO-A1	20/03/2010 SM2	18/03/2010 SC1	17/03/2010 WG2	16/03/2010 WELL CREEK 1
Acarina	-	**6**	MM999999	1	0	0	0	0
Cladocera	-	**-**	OG999999	15	0	0	0	0
Coleoptera	Dytiscidae	**2**	QC099999	0	7	2	20	1
Coleoptera	Elmidae	**7**	QC349999	0	0	0	0	0
Coleoptera	Hydraenidae	**3**	QC139999	3	0	1	1	0
Coleoptera	Hydrochidae	**4**	QCAO9999	0	0	1	0	0
Coleoptera	Hydrophilidae	**2**	QC119999	2	3	3	0	0
Coleoptera	Spercheidae	**2**	-	0	0	2	1	1
Coleoptera	Staphylinidae	**3**	QC189999	0	0	1	0	0
Copepoda	-	**-**	OJ999999	5	0	0	0	0
Diptera	s-f Chironominae	**3**	QDAJ9999	0	0	0	3	0
Diptera	Culcidae	**1**	QD079999	0	0	0	3	0
Diptera	s-f Tanypodinae	**4**	QDAE9999	0	0	0	1	0
Ephemeroptera	Baetidae	**5**	QE029999	5	0	0	1	0
Ephemeroptera	Caenidae	**4**	QE089999	1	0	0	0	0
Hemiptera	Corixidae	**2**	QH659999	2	0	0	1	0
Hemiptera	Gerridae	**4**	QH579999	9	0	23	7	1
Hemiptera	Nepidae	**3**	QH619999	0	1	0	0	0
Hemiptera	Notonectidae	**1**	QH679999	0	0	0	20	0
Hemiptera	Veliidae	**3**	QH569999	1	19	13	16	1
Odonata	UL Family Complex	**4**	QO179999	0	1	0	0	0
ORDER	**OTHER**			0	0	0	0	0
Diptera	Terrestrial	-	Unidentified	0	0	0	0	1
Insect	Terrestrial		Unidentified	0	0	0	1	0

September 2011 Macro-invertebrate Identification Results

Taxa Code	Class/Order	Family/Sub-family	SIGNAL 2 Value	AARC/12/01	Weight Factor	Grade x Weight
LO999999	Oligochaeta	Oligochaeta	2	6	3	6
MM999999	Acarina	sp.	6	19	4	24
OJ999999	Crustacea	Copepoda	N/A	1	1	0
OT029999	Decapoda	Palaemonidae	4	7	3	12
QC099999	Coleoptera	Dytiscidae	2	15	4	8
QC119999	Coleoptera	Hydrophilidae	2	11	4	8
QC139999	Coleoptera	Hydraenidae	3	3	2	6
QCAO9999	Coleoptera	Hydrochidae	4	3	2	8
QD079999	Diptera	Culicidae	1	1	1	1
QD099999	Diptera	Ceratopogonidae	4	5	2	8
QDAE9999	Diptera	Tanypodinae	4	13	4	16
QDAJ9999	Diptera	Chironominae	3	17	4	12
QE029999	Ephemeroptera	Baetidae	5	5	2	10
QE089999	Ephemeroptera	Caenidae	4	11	4	16
QH569999	Hemiptera	Veliidae	3	1	1	3
QH619999	Hemiptera	Nepidae	3	1	1	3
QH659999	Hemiptera	Corixidae	2	1	1	2
QH689999	Hemiptera	Pleidae	2	5	2	4
QT089999	Trichoptera	Ecnomidae	4	1	1	4
QT259999	Trichoptera	Leptoceridae	6	7	3	18

Appendix G: Fish Results

Fish Species Recorded at Each Site

	AQ1	AQ3	AQ4	AQ5	AQ17	AQ18	AQ23	AQ28	AQ31	AQ36	AQ37	AQ38	AQ39
Glass Perch *Ambassis agassizi*	X		X	X	X		X	X					X
Purple-spotted Gudgeon *Mogurnda adspersa*	X	X		X	X	X	X	X		X			
Carp Gudgeon *Hypseleotris compressa*	X		X		X			X					
Rainbowfish *Melanotaenia splendida*	X		X	X	X	X	X	X	X	X			
Spangled Perch *Leiopotherapon unicolor*		X	X	X		X	X	X	X	X		X	X
Bony Bream *Nematalosa erebi*			X	X					X				
Hyrtl's Tandan *Neosilurus hyrtlii*				X				X		X			

Appendix H: Vertebrate Fauna Species List

COMMON NAME	SCIENTIFIC NAME	Status	AQ1	AQ3	AQ4	AQ5	AQ17	AQ18	AQ19	AQ23	AQ28	AQ31	AQ36	AQ37	AQ38	AQ39
MAMMALS																
Feral Pig	*Sus scrofa*	2		X					X							
REPTILES																
Eastern Snake-necked Turtle	*Chelodina longicollis*										X					
Native House Gecko	*Gehyra dubia*			X									X			
BIRDS																
Australian Maned Duck	*Chenonetta jubata*											X			X	
Australian Pelican	*Pelecanus conspicillatus*											X				
Masked Lapwing	*Vanellus miles*					X					X					
Black-fronted Dotterel	*Charadrius melanops*					X						X				
White-necked Heron	*Ardea pacifica*					X					X		X		X	
Pacific Black Duck	*Anas superciliosa*				X	X					X		X			
Grey Teal	*Anas gracilis*					X										
Black Bittern	*Ixobrychus flavicollis*									X						
Darter	*Anhinga melanogaster*										X		X		X	
White-eyed Duck	*Aythya australis*										X					
Brolga	*Grus rubicunda*										X					
Sacred kingfisher	*Todiramphus sancta*										X				X	
Rainbow Bee-eater	*Merops ornatus*	Ma/Mi												X		
Intermediate Egret	*Egretta intermedia*															X
AMPHIBIANS																

COMMON NAME	SCIENTIFIC NAME	Status	AQ1	AQ3	AQ4	AQ5	AQ17	AQ18	AQ19	AQ23	AQ28	AQ31	AQ36	AQ37	AQ38	AQ39
Broad-palmed Frog	*Litoria latopalmata*			X		X										
Striped Burrowing Frog	*Litoria alboguttata*					X					X					
Ornate Burrowing Frog	*Opisthodon ornatus*					X	X				X		X		X	
Little Red Tree Frog	*Litoria rubella*										X		X		X	
Floodplain Frog	*Litoria inermis*			X									X			
Cane Toad	*Rhinella marina*		*			X			X	X	X		X		X	