HANCOCK PROSPECTING PTY LTD

Alpha Coal Project Environmental Impact Statement

F Nature Conservation

F1 Freshwater Aquatic Flora and Fauna

F2 Terrestrial Ecology

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Alpha Coal Project Environmental Impact Statement

F1 Freshwater Aquatic Flora and Fauna

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Hancock Prospecting Pty Ltd

Alpha Coal Project (Rail)

Freshwater Aquatic Flora and Fauna

August 2010

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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A Desktop Search Results

B Habitat Assessment Methodology

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Abbreviations

ABARE	Australian Bureau of Agricultural and Resource Economics
ACTFR	Australian Centre for Tropical Freshwater Research
ANZECC	Australian and New Zealand Environment Conservation Council
APSDA	Abbot Point State Development Area
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AUSRIVAS	Australian River Assessment System
BoM	Australian Bureau of Meteorology
BWQIP	Burdekin Water Quality Improvement Plan
DEEDI	Queensland Department of Employment, Economic Development and Innovation
DERM	Queensland Department of Environment and Resource Management
DEWHA	Australian Government Department of Environment, Water, Heritage and the Arts
DIP	Department of Infrastructure and Planning
EIS	Environmental Impact Statement
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999*
ERT	DERM Environmental Reporting Tool
MNES	Matters of National Environmental Significance
NCA	Queensland *Nature Conservation Act 1992*
NRM	Queensland Government Natural Resources and Mines
QR	Queensland Rail
QWQG	Queensland Water Quality Guidelines
SDPWOA	*State Development and Public Works Organisation Act 1971*
ToR	Terms of Reference
WildNet	DERM Wildlife Online Database
WONS	Weeds of National Significant

1. Introduction

1.1 Project Background

Hancock Prospecting Pty Ltd (Hancock) is proposing to construct a standard gauge, 495 km long railway line for the purposes of transporting processed coal from the Alpha coal mine site to the proposed Port of Abbot Point, Multi Cargo Facility in Bowen (refer to Figure 1). The proposed railway line is a vital piece of infrastructure that will enable export of 60 Mtpa of quality thermal coal to overseas markets.

In September 2009, GHD was commissioned by Hancock to undertake an Environmental Impact Statement (EIS) for the Alpha Coal Project's proposed rail line (herein referred to as the Project). One of the components of the EIS involves assessing the potential Project impacts on existing flora and fauna. This report summarises the findings of ecological assessments conducted along the proposed rail alignment.

Desktop and field surveys were undertaken to document the existing flora and fauna habitat values along the alignment, to assess the risks to flora and fauna, to identify any significant ecological constraints to development and recommend mitigation measures.

1.2 Study Area and Project Footprint

The Project stretches between the Alpha coal mine, 38 km northwest of the Alpha Township and the Abbot Point coal export terminal, 25 km north of Bowen. The alignment of the Project has been selected on the basis of several factors, primarily environmental, economic and geotechnical grounds. The rail corridor proceeds in a generally north-easterly direction from the Alpha mine, crossing the Belyando River and several of its tributaries in the first 100 km. The railway crosses generally relatively flat lowlands before commencing a gentle climb from near Eaglefield adjacent to the Suttor River, to a point near the existing Newlands mine. This is the highest point on the railway at approximately 300 m above sea level. In the vicinity of the Newlands mine, the railway runs parallel to the Queensland Rail (QR) Northern Missing Link railway for approximately 70 km through a pass in the Leichhardt Range and parallel to the Newlands Railway to a point near the Bowen River. The Railway then travels in a north westerly direction on crossing the Bowen River, then passing down the Bowen River valley through mostly grazing land toward Mt Herbert. The railway passes to the west of Mt Herbert through a pass in the Clarke Range. From this point, the railway travels north-easterly crossing the Bogie River, then finally in an easterly direction entering the Abbot Point area on its western boundary.

The railway passes approximately 70 km to the northeast of the town of Clermont, 55 km to the northeast of the town of Moranbah, 35 km to the east of Mt Coolon, 20 km to the west of Collinsville, and enters the Abbot Point area 25 km west of Bowen.

From Eaglefield through to Abbot Point, a revised alignment was proposed which avoided the town of Collinsville, the Suttor State Forest and the Clarke Range completely. The alignment as currently presented avoids all Reserves, National Parks and State Forests.

The *project footprint* considered in this assessment comprised:

- An easement 495 km long and 60 m wide;
- A series of laydown areas and construction nodes;
- Local construction access tracks (that will be used during construction only); and
- Local maintenance access tracks (that will be used and maintained through the operational phase).

For the purposes of this assessment, the *study area* refers to land along and up to 1 km adjacent to the rail corridor. Extending the width of the study area was necessary to maximise opportunities for assessment in representative habitats, given the lack of vehicle access to all parts of the corridor and prudent to consider possible regional impacts on habitats external to the corridor.

LEGEND

- Town
- Camp
- Marshalling Yards
- Depot
- Proposed Alignment
- State Road
- Existing Railway
- Local Government Area

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STUDY AREA

Figure: 1

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1.3 Assessment Context and Scope

On 21 October 2008, the Coordinator-General declared the Alpha Coal project as a 'significant project for which an EIS is required' under section 26(1) (a) of the *State Development and Public Works Organisation Act 1971* (SDPWOA). On 13 January 2009, the project was declared by the Commonwealth Government as a controlled action pursuant to the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). Consultation between the Queensland Department of Infrastructure and Planning (DIP) and Australian Government Department of Environment, Water, Heritage and the Arts (DEWHA), agreed that the environmental impact assessment under the SDPWOA and EPBC Act be conducted under a bilateral agreement based on one ToR and one EIS report.

Section 3.3.4 of the project ToR identifies the attributes and values of the freshwater aquatic environment that are to be specifically investigated in the EIS. This requires a description of environmental values including the fauna and flora present or likely to be present at any time of year in the project area. The ToR also require that potential impacts and mitigation measures be identified. Given the restricted ability to sample the expansive Project footprint year round (inaccessible during wet seasons, land holder access limitations) achievement of the Project ToR was supported by significant desktop research and targeted field investigations. Field investigations addressed a diversity of habitats and was informed by desktop assessments to provide an appropriate level of information to describe the site. To this end the following works were completed to address the ToR:

- **Description of environmental values -** a description of the aquatic flora and fauna[1] present or likely to be present at any time during the year in the project area. This included the following:
  - Desktop assessment of fish, aquatic mammals, aquatic reptiles and aquatic invertebrate species occurring in waterways;
  - Desktop assessment of aquatic (waterway) plants, including any declared pest plants;
  - The existence of conservation significant or otherwise noteworthy species or communities, including discussions on range, habitat, breeding, recruitment, feeding and movement requirements, and the current level of protection;
  - Characterisation and value of aquatic habitats including aquatic substrate and stream type;
  - Desktop assessment of wetlands listed by the Queensland Department of Environment and Resource Management (DERM) as areas of national, state or regional significance, and their values and importance;
  - Assessment of Ramsar wetlands of international importance in terms of proximity to proposal and likelihood of impacts; and

[1] For the purposes of this assessment, aquatic fauna are defined as animals that are entirely aquatic, or those that spend extended periods of time in the water (particularly for the purpose of foraging), and spend only limited periods of time in the terrestrial environment. This includes fish, freshwater turtles, crocodiles, aquatic macroinvertebrates and platypus. Amphibians and semi-aquatic species such as water birds are addressed in the terrestrial flora and fauna assessment report.

- A description of the habitat requirements and the sensitivity of aquatic flora and fauna species to changes in flow regime, water levels and water quality in the project areas.

Note: As discussed in Section 12 Groundwater, there is not considered to be a significant impact on groundwater resources within the Project footprint, hence an investigation of the presence and nature of stygofauna was not undertaken.

- **Identification of potential impacts and mitigation measures** - this includes direct and indirect impacts of the project on aquatic flora and fauna, as well as measures to mitigate the impact.

2. Assessment Approach

2.1 Summary

The aim of this aquatic flora and fauna assessment was to provide a sufficient amount of baseline information to enable identification and assessment of the potential impacts of the project on the existing environmental values of the project area. To achieve this objective, the following tasks were undertaken:

- Literature review: the literature review included a review of relevant scientific and grey literature[2], database searches and previously prepared technical reports. This assessment was conducted to document the known aquatic environmental values within the project area including a list of aquatic flora and fauna species that have been historically recorded or have the potential to occur within the area;
- Field assessment: a field survey was conducted at proposed major watercourse crossings during the wet season to characterise and document the freshwater ecosystems of the study area. This assessment included detailed habitat assessments and *in situ* water quality assessments; and
- Impact assessment: potential impacts including direct and indirect impacts of the projects as well as the likelihood and consequence of potential impacts which were identified and assessed. Mitigation measures that may be applied to avoid, reduce or mitigate the identified potential impacts were developed.

While the literature was used to make a general assessment across the study area, specific observations made at habitat assessment sites during the field assessment phase were used for more detailed descriptions of habitat and for the impact assessment phase.

2.2 Nomenclature

Scientific names for aquatic species are consistent with those used in the following sources:

- Freshwater Fishes of North-Eastern Australia (Pusey *et al*. 2004);
- A Field Guide to Reptiles of Queensland (Wilson 2009);
- The Mammals of Australia (Van Dyck and Strahan 2008); and
- Waterplants in Australia (Sainty and Jacobs 2003).

2.3 Literature Review

A literature review was conducted to document the known aquatic environmental values within the broad project area and to identify any aquatic flora and fauna species, including conservation significant species that have been historically recorded or have the potential to occur within the Burdekin catchment. The literature review included searches of:

[2] Grey literature includes non-peer reviewed published and unpublished technical reports, government published documents and information sourced from the internet.

- The DEWHA Environmental Reporting Tool (ERT) to identify species, and/or their habitats listed under the EPBC Act that are predicted to occur within the project area based on bioclimatic modelling and to identify invasive fauna species of national significance;
- The DERM Wildlife Online (WildNet) database to identify fauna species that have been historically recorded in or surrounding the project area, including threatened species listed under the Queensland *Nature Conservation Act 1992* (NCA);
- The Queensland DERM Essential Habitat mapping (Version 5.0, 2005) to identify essential habitats within the project area;
- The DEWHA Directory of Important Wetlands to identify any Nationally Important Wetlands recorded within the project area;
- Queensland Museum's specimen database to obtain a record of aquatic reptiles, fish, crustaceans and mammals previously recorded in the project area;
- The DERM Wetlandinfo database;
- Threatened species profiles and field guides;
- Scientific and grey literature on flora and fauna species likely to occur and/or previously recorded in the project area; and
- Previous studies and reports conducted in the Burdekin Catchment.

The results of the DEWHA ERT, DERM WildNet and Queensland museum searches are provided in Appendix A.

2.4 Field Assessment

Field assessments were conducted to determine the site-specific habitat characteristics of aquatic ecosystems within the project area and to assess surface water quality. Twenty-two field assessment sites were selected following a review of aerial photography and GIS watercourse mapping and a reconnaissance of the project area. These sites were selected to ensure aquatic ecosystems assessed:

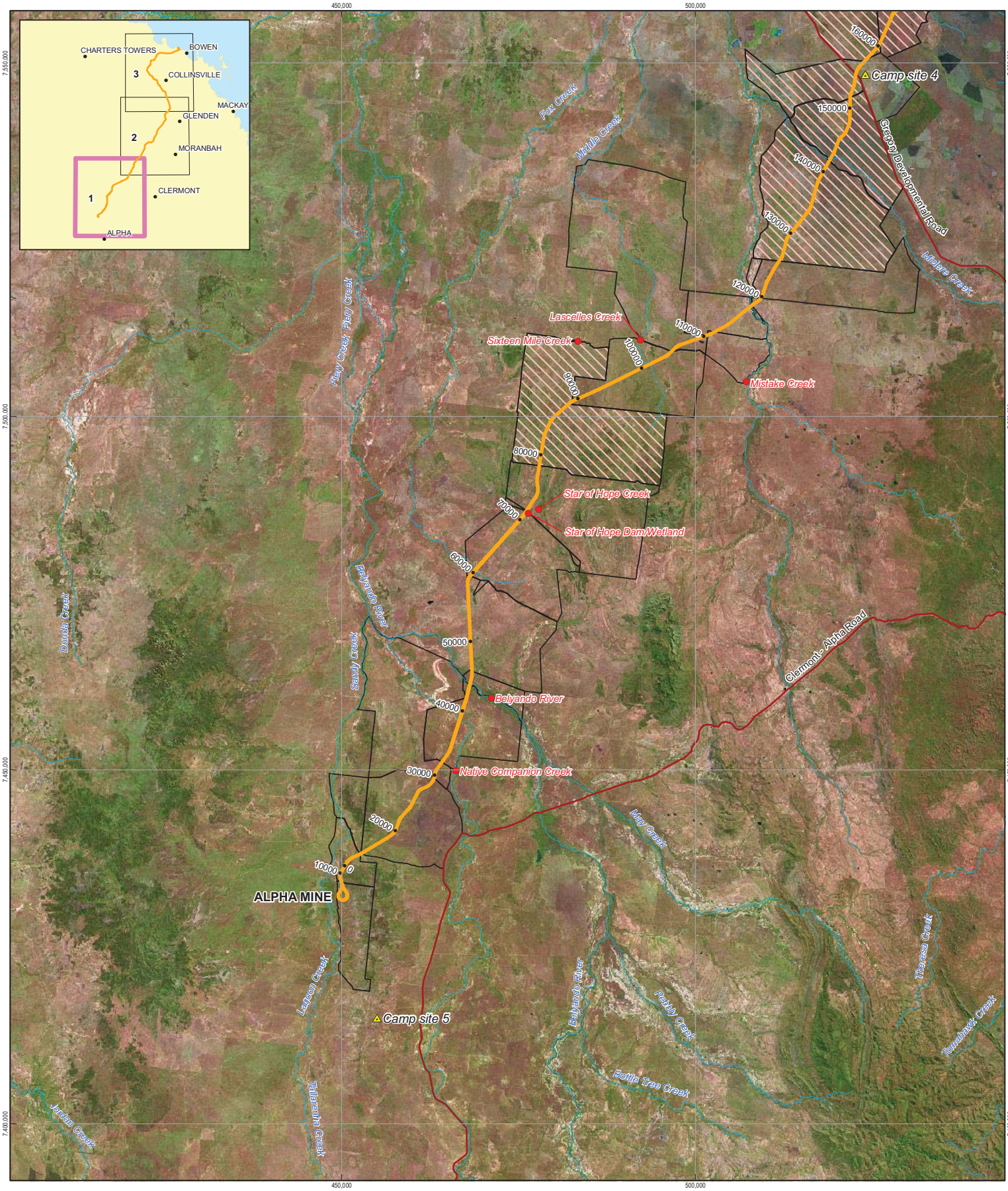
- Were representative of major aquatic habitats within the project area;
- Covered a geographical range of aquatic habitats;
- Correspond with proposed disturbance footprints of alignment crossings (based on preliminary alignment);
- Prioritised larger watercourses that are more likely to provide aquatic habitat for much of the year; and
- Were accessible (including landowner permissions - Figure 2 shows land parcels where no access was granted).

The field assessments were conducted between 15 – 21 April 2010. This survey period was selected to coincide as close as possible to the wet season when the aquatic ecosystems within the area are at their highest ecological productivity. Due to the extended wet season in 2010, access difficulties (i.e. as a result of high water levels and poor road access) hindered field assessments during the typical wet season summer period. The timing of the field

assessments are considered to represent post wet season conditions. A description of survey effort at each site is detailed in Table 1, while the location of the field assessment sites are illustrated in Figure 2.

Table 1 Field Assessment Survey Effort

Site	Habitat Assessment	Water Quality
Splitters Creek	✓	✓
Elliot River	✓	✓
Bogie River	✓	✓
Brigalow Creek	✓	Dry
Artificial Dam/Wetland	✓	✓
Gilgais	✓	✓
Capsize Creek	✓	✓
Herbert Creek	✓	Dry
King Creek	✓	✓
Cattle Creek	✓	Dry
Table Mountain Creek	✓	No Access
Pelican Creek	✓	✓
Suttor Creek	✓	✓
Eaglefield Creek	✓	✓
Myra Creek	✓	✓
Mistake Creek	✓	✓
Lascelles Creek	✓	Dry
Sixteen Mile Creek	✓	✓
Star of Hope Dam/Wetland	✓	✓
Star of Hope Creek	✓	✓
Belyando River	✓	✓
Native Companion Creek	✓	✓



LEGEND

- Town
- Camp
- Marshalling Yards
- Depot
- Aquatic Assessment Site
- Proposed Alignment
- State Road
- Existing Railway
- Watercourse
- Waterbody
- Cadastre
- No Land Access Permission

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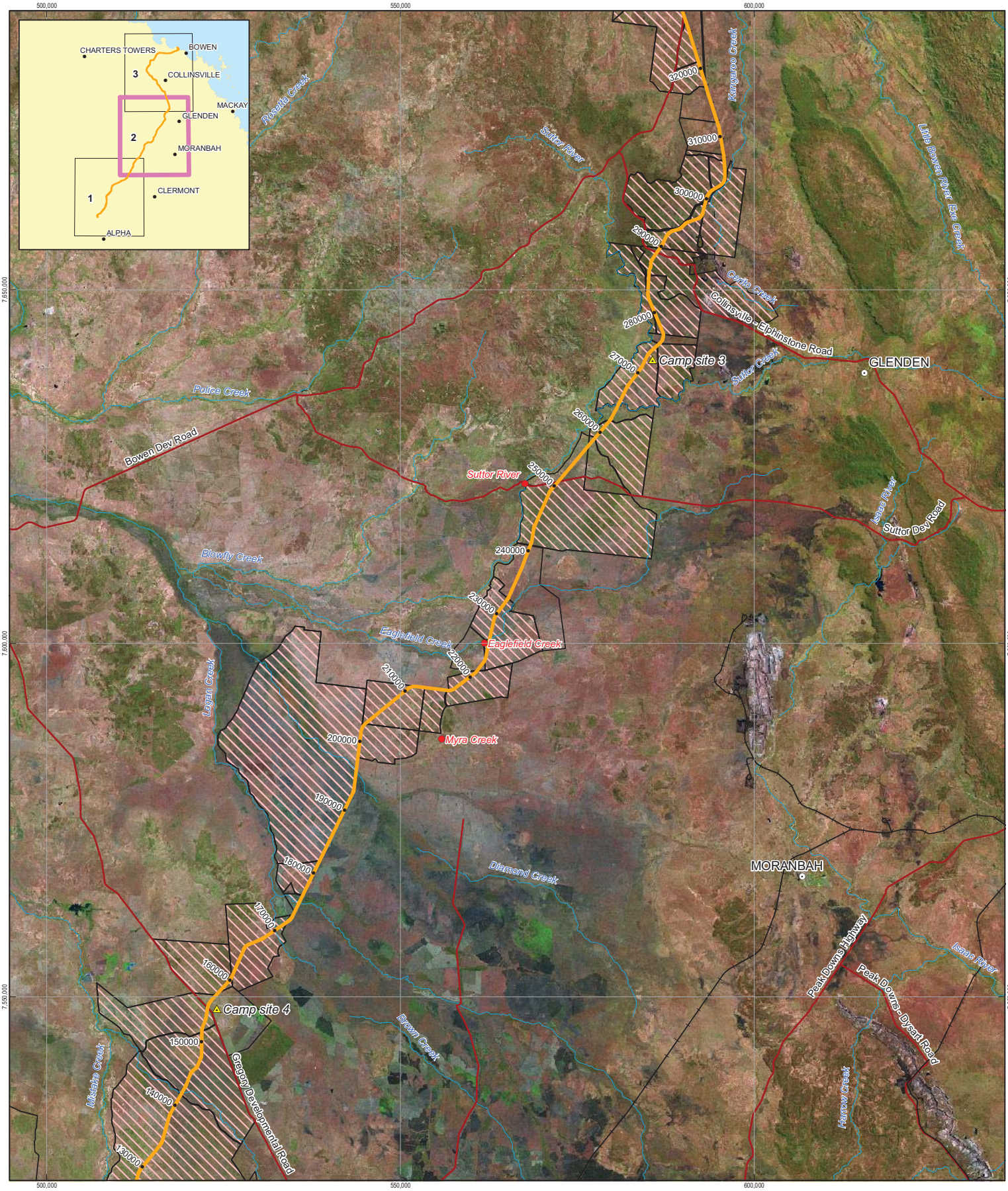

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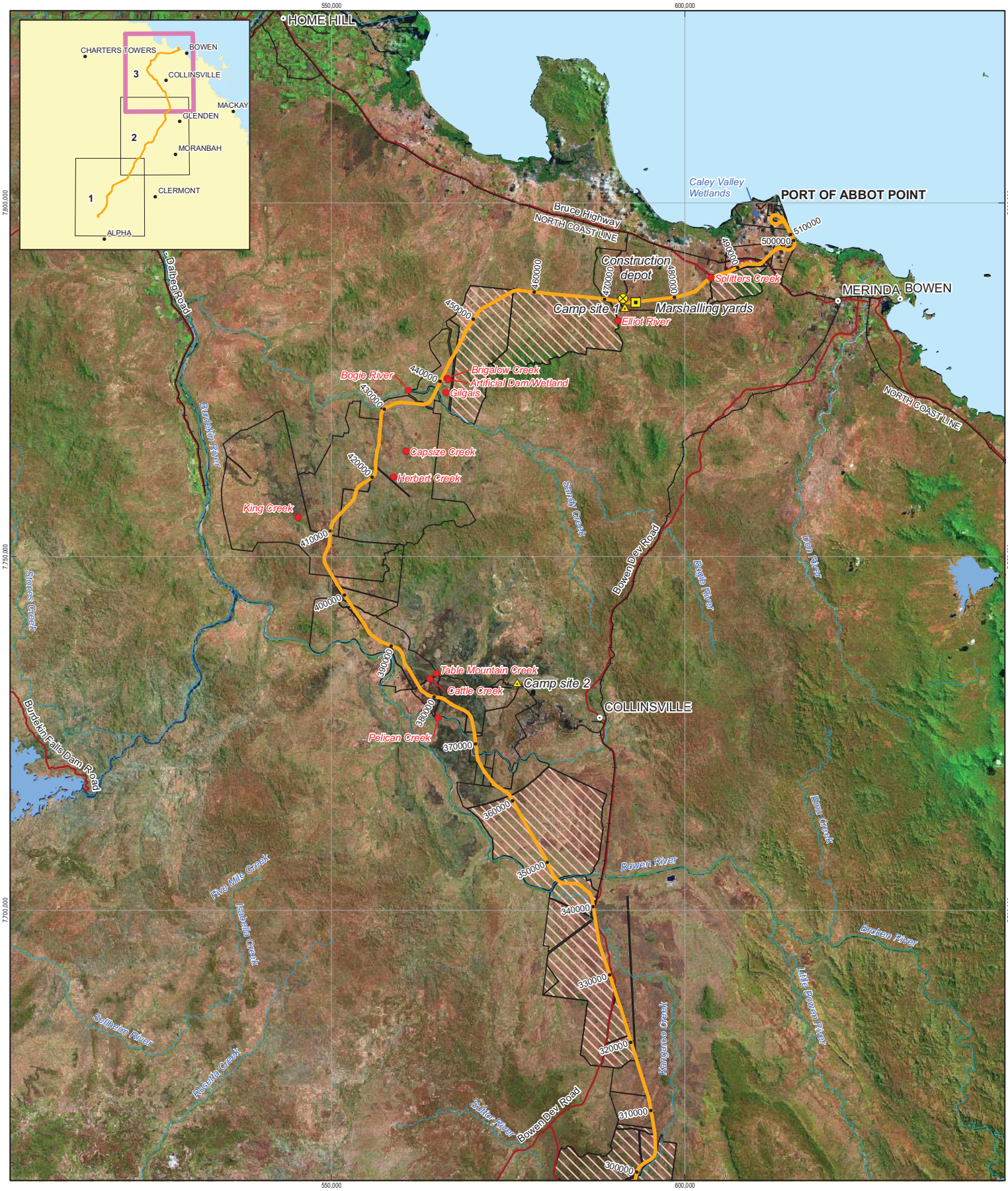

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2.4.1 Climatic Conditions

Weather conditions during the seven days of field assessments were warm and humid. During the assessment of the northern survey sites (15 – 18 April), overnight minimum temperatures ranged between 15.6ºC and 20.5ºC and daily maximums ranged between 27.2ºC and 33.4ºC in Collinsville. During the assessment of the southern survey sites (19 – 21 April), overnight minimum temperatures ranged between 15.6ºC and 18.7ºC and daily maximums ranged between 24.4ºC and 29.5ºC in Clermont. A total of 109.4 mm of rainfall was recorded for Collinsville in the month prior to survey and 1.2 mm in the week prior to survey. For Clermont, a total of 78.6 mm (0 – 47.2 mm) of rainfall was recorded in the month prior to survey and 62.4 mm (0 – 47.2 mm) was recorded in the week prior to the field assessments. A total of 0.8 mm of rainfall was recorded at Collinsville during the first four days of surveys, and no rain was recorded at Clermont during the assessment of the southern sites.

All climatic data was sourced from the Australian Bureau of Meteorology (BoM), recorded at the Collinsville Post Office weather station (station 033013) and Clermont Sirius St weather station (station 035019) (BoM 2010a). This data is considered to be indicative of the general climatic conditions in the study area, as required to be informative for this study, and it does not necessarily represent the precise meteorological conditions prevailing at survey sites when field surveys were undertaken.

2.4.2 Habitat Assessments

Habitat assessments were conducted at each of the 22 field assessment sites to describe the existing characteristics and values of the aquatic habitats within the project area. The assessments were conducted in accordance with the National River Health Program, Australian River Assessment System (AUSRIVAS) methodology. Using the AUSRIVAS survey and assessment methodology (i.e. 100 m sampling length), the following parameters were recorded at each site:

- Stream reach profile (i.e. longitudinal and cross-sectional);
- Stream channel and bank morphology (e.g. channel width; depth and bank height);
- Habitat types (e.g. pool; riffle; run; dry);
- Water velocity (i.e. deep and shallow areas) and flow level (i.e. no-flow; low; moderate; high; flood);
- Substrate description (i.e. bedrock; boulder; cobble; pebble; gravel; sand; silt/clay);
- Erosion and deposition;
- Snags and woody debris (i.e. detritus; sticks; branches; logs);
- Habitat attributes (e.g. algae; macrophytes; bank overhanging vegetation; trailing bank vegetation; blanketing silt; substrate anoxia);
- Presence of algae (i.e. on substrate, in water column) and macrophytes (i.e. submerged, floating, emergent);

- Riparian characteristics (e.g. width of stream side vegetation, overhanging and native vegetation);
- Adjacent land use; human impacts; degradation from pastoral animals; and
- Presence of pest/introduced flora and fauna species.

Habitat characteristics of each survey site were also assessed from excellent to poor according to criteria of the AUSRIVAS River Bioassessment Program (Appendix B).

2.4.3 Water Quality

Surface water quality was assessed *in-situ* from field sites that contained water at the time of survey (i.e. 18 of the 22 sites). The physicochemical water sampling was undertaken using a hand-held electronic multi-parameter water quality meter (TPS 90FLMV and TPS WP88A). Parameters recoded included:

- Temperature;
- pH;
- Dissolved oxygen;
- Conductivity;
- Turbidity; and
- Total dissolved solids (TDS).

Ten replicate water quality samples were recorded at a depth of 0.2 m below the water's surface. Where water levels were less than 0.2 m deep, a 5 - 10 L water sample was collected in a bucket and the water quality recoded ex-situ. The water quality meter was calibrated daily for accuracy and consistency in measurements.

In order to describe and assess the water quality characteristics of the survey sites, the water quality results of each site were compared to the Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) National Water Quality Guidelines (ANZECC/ARMCANZ 2000) and the Queensland Water Quality Guideline (QWQG) (DERM 2009a). The ANZECC/ARMCANZ values against which water quality data was assessed were for Tropical Australia while those for QWQG were for the Central Coast Queensland region. In accordance with the ANZECC/ARMCANZ and QWQG, the habitats within the study area were separated into:

- Lowland Habitats:
  - Splitters Creek;
  - Elliot River;
  - Bogie River;
  - Capsize Creek;
  - King Creek; and
  - Pelican Creek.
- Upland habitats:

- Suttor River;
- Eaglefield Creek;
- Myra Creek;
- Mistake Creek;
- Sixteen Mile Creek;
- Star of Hope Creek;
- Belyando River; and
- Native Companion Creek.

- Lacustrine/Palustrine Habitats:
  - Artificial Dam/Wetland;
  - Gilgais; and
  - Star of Hope Dam/Wetland.

In addition to the physicochemical water quality parameters, the following water quality characteristics were recorded based on the AUSRIVAS assessment methodology:

- Water colour (i.e. clear; green; opaque; tannin; other);
- Water odour;
- Substrate odour;
- Water surface (i.e. normal; slick; scum; foaming; other);
- Weather parameters (e.g. rain; cloud cover; wind);
- Algae (i.e. on substrate; in water column);
- Macrophytes (i.e. submerged; emergent; floating);
- Human impacts; degradation by pastoral animals; and
- Presence of pest/introduced flora and fauna species.

These parameters were included in the analysis of aquatic habitat characteristics and assisted in the assessment of habitat value.

2.4.4 Animal Ethics and Approvals

Aquatic field assessments were conducted under Section 52 of the Queensland *Animal Care and Protection Act 2001* (General Fisheries Permit - 113990) and supported by the Queensland Department of Employment, Economic Development and Innovation (DEEDI) animal ethics committee (formally Department of Primary Industries and Fisheries) (CA 2008/07/280).

2.5 Impact and Risk Assessment

An impact and risk assessment was undertaken to assess the risk of the proposed Project on the aquatic environmental values. Environmental risks associated with Project construction and operation were identified and classified into one of four risk categories (High, Medium, Low and Very Low). These classifications allowed priorities to be set for

addressing and mitigating environmental risks. The risk assessment process is outlined in detail below.

2.5.1 Stage 1: Identification of Risk

This included identification of all relevant risks, addresses all known activities and related environmental aspects of the Project.

2.5.2 Stage 2: Risk Analysis

An analysis of each risk was undertaken to determine the likelihood of occurrence and its consequences. A qualitative description of the likelihood and consequences for each risk enabled a semi-quantitative method to be used to calculate a 'score' for each risk.

Definitions and scales for consequence and likelihood ratings are shown in Table 2 and Table 3 while the risk assessment matrix is described in Table 4.

Table 2 Consequence Rating

Consequence	Rating	Description
Nil	0	No impact
Minor	1	Minor temporary environmental damage or disturbance
Moderate	2	Minor permanent environmental damage or disturbance
Significant	3	Reduction in habitat range/breeding success/abundance
Major	4	Significant loss of community or habitat potentially leading to the loss of a species
Critical	5	Total loss of a species or ecosystem

Table 3 Likelihood Rating

Likelihood	Rating	Likelihood Calculator
Rare	1	The risk may occur only in exceptional circumstances (The risk is not likely to occur in the next 25 years)
Unlikely	2	The risk could occur at some time (The risk is likely to occur once in the next 5-25 years)
Possible	3	The risk might occur at some time (This risk is likely to occur in the next 2-5 years)
Likely	4	The risk will probably occur in most circumstances (The risk is likely to occur in 1-2 years)
Almost Certain	5	The risk is expected to occur in most circumstances (The risk is likely to occur within the next 12 months)

Table 4 Risk Assessment Matrix

	Consequence					
Likelihood	**Critical (5)**	**Major (4)**	**Significant (3)**	**Moderate (2)**	**Minor (1)**	**Nil (0)**
Almost Certain (5)	High	High	High	Medium	Medium	Very Low
Likely (4)	High	High	Medium	Medium	Low	Very Low
Possible (3)	High	Medium	Medium	Low	Low	Very Low
Unlikely (2)	Medium	Medium	Low	Low	Very Low	Very Low
Rare (1)	Medium	Low	Low	Very Low	Very Low	Very Low

2.5.3 Stage 3: Calculation of Risk Level

Two levels of risk were used:

The **Primary Risk Level** is a conservative measure of risk, based on the most severe consequences across all the relevant criteria. Primary Risk Level was calculated according to the equation: Primary Risk Level = Likelihood Rating x Maximum Consequence Rating

The **Residual Risk Level** is a measure of the remaining risk, once mitigation and control measures have been implemented. Residual Risk Level was calculated according to the equation: Residual Risk Level = (Likelihood Rating x Maximum Consequence Rating) – Mitigation Measures

2.5.4 Stage 4: Determination of Options for Treatment of Risks

Following the analysis of a risk, options available for risk treatment were investigated and the option or options that provide the greatest cost benefit determined.

Risks were treated in one or a combination of ways:

- Avoiding a risk by preventing the activity that leads to the risk eventuating;
- Reducing the likelihood of the risk eventuating;
- Reducing the consequences if the risk does eventuate;
- Transfer the risk; and
- Retaining the risk.

3. Existing Environmental Values

3.1 Burdekin Catchment

The Burdekin Catchment is the second largest catchment on the east coast of Australia, covering an area of 136 000 km^2 (Australian Bureau of Agricultural and Resource Economics (ABARE) 2003) (Figure 3). The major regional centres within the catchment include: Townsville; Ayr; Bowen; Charters Towers and Collinsville (NRM 2002).

Three bioregions are represented in the Burdekin Catchment however the majority of the rail corridor is located within the Brigalow Belt bioregion. A small section at the southern extent of the alignment lies within the Desert Uplands bioregion. The Brigalow Belt bioregion covers 135,500 km^2 and includes coastal areas, rugged ranges and alluvial plains. The bioregion has a sub-humid to semi-arid climate. The Desert Uplands bioregion covers 70,300 km^2 and includes ranges and plains on Tertiary surface and Triassic sandstones. The bioregion has a semi-arid climate and most soils are weathered and nutrient-poor.

Land use within the Burdekin Catchment is dominated by cattle grazing, which covers over 96% of the catchment area. Additional land uses within the catchment include: sugar and horticulture cropping; aquaculture and mining. Water infrastructure is also a significant industry with twelve major dams and weirs occurring throughout the catchment (NRM 2002; ABARE 2003).

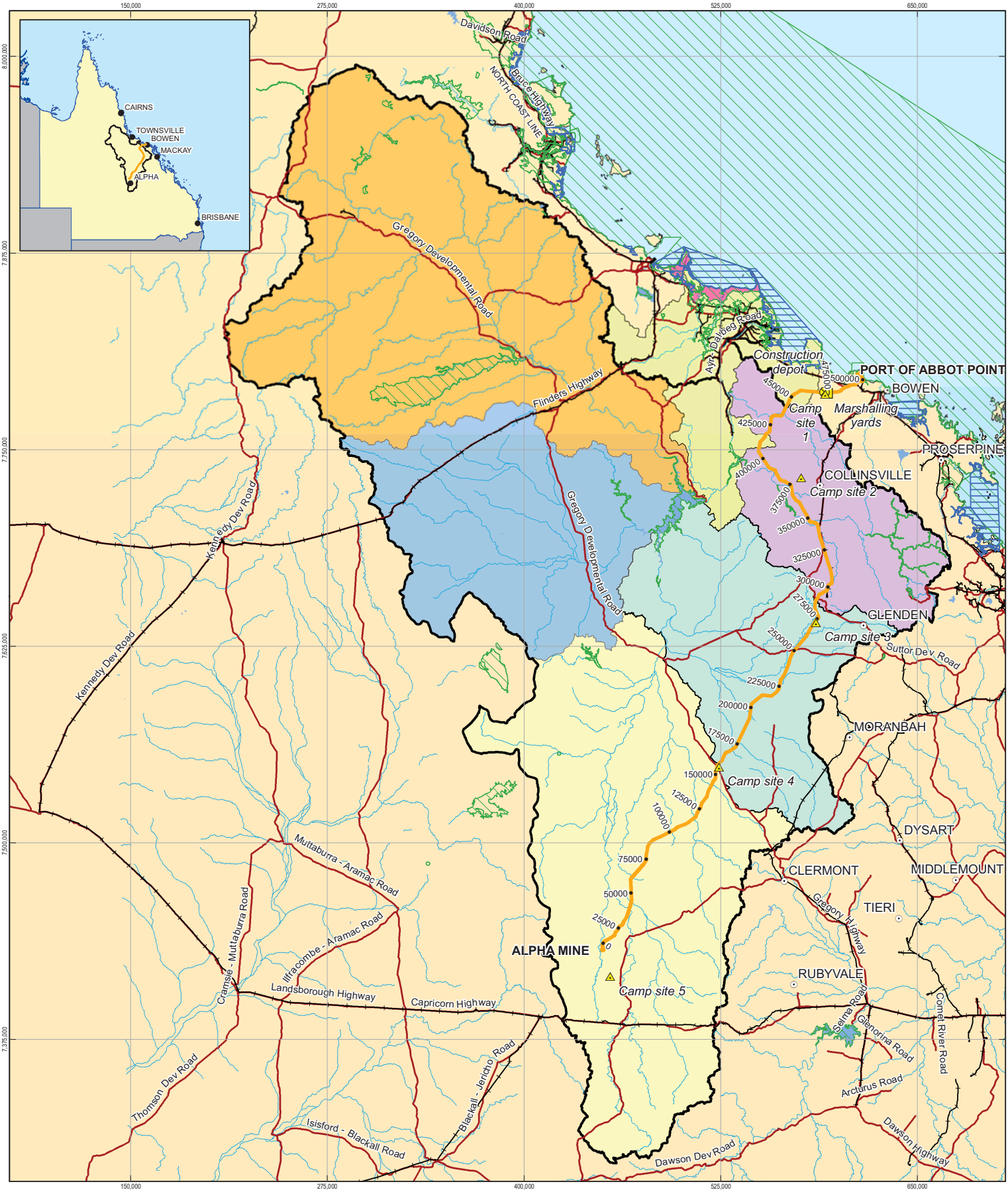
The Burdekin Catchment exhibits distinct seasonal climatic conditions with a pronounced wet summer and dry winter. Mean annual rainfall in the catchment ranges from less than 500 mm to over 2500 mm and is generally highest in the eastern coastal areas and lowest is the western and southern regions (Dight 2009; BoM 2010b). Water flows within the Burdekin Catchment are primarily influenced by the strong seasonality in rainfall and as such, mean annual discharge is highly variable both between and within years. Annual flows patterns within the catchment are generally characterised by short periods of increased flow between December and April, with little to no-flow occurring outside this period (NRM 2002; BoM 2010b). Severe flooding occasionally occurs within the Burdekin Catchment as a result of intensive rainfall events associated with severe storms, cyclones and tropical low pressure systems. Prolonged dry conditions and drought are also characteristic features of the highly variable catchment. Mean annual discharge from the catchment (Clare Weir, Lower Burdekin Basin) is approximately 9.4 million ML. These flows account for approximately 30% of the mean annual discharge into the Great Barrier Reef along the north Queensland coast (NRM 2002).

The Burdekin Catchment as a whole is divided into six major basins (Figure 3) and 48 sub-catchments. The proposed rail alignment is located within the following three basins:

- Bowen Broken Bogie Basin – the Bowen Broken Bogie Basin (Figure 3) covers approximately 9% of the Burdekin Catchment and includes seven sub-catchments: Bogie River; Bowen River; Broken River; Glenmore Creek; Little Bowen River; Pelican Creek; Rosella Creek. Land use in the Bowen Broken Bogie Basin is dominated by grazing (72.5%) however a large proportion of land area has been protected for conservation (24%). The majority of land within the basin has been assessed to be in poor to fair

condition while gully erosion is considered to be extensive in some areas (Dight 2009). Soil erosion within the basin is likely to be high resulting in moderately to highly elevated levels of suspended sediment. Hill slope erosion is considered the major source of sediment and particulate nutrients affecting water quality. Riparian habitat condition within the basin ranges from good to poor within overall condition declining in the last 30 years as a result of floodplain and streamside clearing (Dight 2009). Aquatic habitats diversity within the basin is relatively high and varies from small ephemeral sandy creeks to large permanently flowing rivers. Areas considered to contain High Ecological Value waters by the Burdekin Water Quality Improvement Plan (BWQIP) ecological values technical panel include: Mount Aberdeen National Park; Aberdeen Nature Refuge area; Eungella National Park; Gamma State Forest, Credition State Forest; Macartney State Forest; Criticon State Forest; Pelican Creek watershed (including Sonoma State Forest); Black Jack Mountain Nature Refuge. The Nationally Important Broken River: Birralee to Pelican Creek Wetland aggregation also occurs within the Bowen Broken Bogie Basin (Dight 2009).

- Suttor Basin – the Suttor Basin (Figure 3) covers approximately 13% of the Burdekin Catchment and includes six sub-catchments: Diamond Creek; Logan Creek; Lower Suttor River; Rosella Creek; Sellheim River; Upper Suttor River. Land use in the Suttor Basin is dominated by grazing (90.9%) with small areas of conservation and minimal use, dryland agriculture and water. The majority of land within the basin is considered to be in poor to fair condition with poor riparian habitat (Dight 2009). Hill slope erosion is considered the major source of sediment and particulate nutrients affecting water quality. A small section of the Nairana National Park is the only area within the Suttor River Basin considered to contain High Ecological Value waters by the BWQIP ecological values technical panel (Dight 2009).
- Belyando Basin – the Belyando Basin (Figure 3) covers approximately 26% of the Burdekin catchments and includes seven sub-catchments: Belyando floodplain; Carmichael River; Fox Creek; Mistake Creek; Native Companion Creek; Sandy Creek; Upper Belyando River. Land use in the Belyando Basin is dominated by grazing (94.4%) with small areas of conservation, production forestry and dryland agriculture. The majority of land within the Basin is considered to be in fair condition with extensive areas of highly vulnerable and marginal condition land occurring in places (Dight 2009). Floodplain clearing has resulted in the significant degradation of riparian habitat. Water quality within the Belyando Basin is predicted to have elevated levels of suspended sediment. Areas considered to contain High Ecological Value waters by the BWQIP ecological values technical panel include: Nairana National Park; Wilanspey Conservation Park; Epping Forest National Park Scientific Area; Narrien Range National Park (Dight 2009).



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- Watercourse
- Waterbody
- Fish Habitat
- RAMSAR Wetlands
- Directory of Important Wetlands
- Burdekin River Basin
- Suttor Basin
- Belyando Basin
- Lower Burdekin Basin
- Upper Burdekin Basin
- Cape Campaspe Basin
- Bowen Broken Bogie Basin

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BURDEKIN CATCHMENT

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3.2 Protected Areas

3.2.1 Great Barrier Reef World Heritage Area

The Burdekin Catchment flows into the Great Barrier Reef World Heritage Area (Figure 3). As a World Heritage Area, the Great Barrier Reef is protected as a Matter of National Environmental Significance under the EPBC Act. The Great Barrier Reef covers a total area of 348 000 km^2 and supports a variety of habitats including: seagrass beds; mangrove forests; sandy and muddy seabed communities; inter-reefal areas; deep oceanic water and island communities (DEWHA 2008).

3.2.2 Bowling Green Bay Ramsar Wetland

The Ramsar Convention is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The aim of the Ramsar Convention is to achieve sustainable wetland development throughout the world (Ramsar COP8 2002).

The Burdekin Catchment flows into the Bowling Green Bay Ramsar Wetland via the Haughton River (Figure 3). The Bowling Green Bay Wetland is located 21 km north east of Ayr and has a total area of 35 500 ha. The wetland aggregation contains a diversity of habitats including: seagrass beds; coastal sand dues; tidal flats; mangrove forests; highly saline supratidal salt pans; brackish to freshwater marshes; and lakes. The Bowling Green Bay Wetland is an internationally significant habitat for wader birds and provides important breeding and nursery habitat for commercially and recreationally important fish species such as barramundi. The marine areas of the wetland support and provide habitat for a number of EPBC listed species including substantial populations of marine megafauna and the estuarine areas provide habitat for the estuarine crocodile (DEWHA 2010a)[3]. The Bowling Green Bay Wetland is located more than 100 km from the northern end of the proposed rail alignment.

3.2.3 Nationally Important Wetlands

The Australian Government's Directory of Important Wetlands (Environment Australia, 2001) is an inventory of important wetland areas throughout Australia. The directory aims to protect important wetland habitat by providing information on wetland values and locations. A total of 35 nationally important wetlands are located in the Burdekin Catchment. The Caley Valley Wetland and the Bowen River: Birralee – Pelican Creek Wetland aggregation are located within the study area (Figure 3).

- **Caley Valley Wetland** - the Caley Valley Wetland covers an area of around 5 150 ha and is located immediately adjacent to the Abbot Point Coal Terminal facility, approximately 21 km north northwest of Bowen. The wetland system comprises a mixture of permanent estuarine waters, intertidal mud and sand flats, mangroves, saltmarshes, freshwater marshes and freshwater impoundments. The site has a high importance for waterbirds and migratory species due to its mix of permanent water, a wide range of wetland habitats, very rich food resources and sheltered roosting and breeding sites (DEWHA 2010b).

  The wetland experiences distinct seasonal changes, with wet-season filling driving a freshwater system that provides habitat for a number of aquatic species, including freshwater fish and turtles.

[3] With respect to matters of NES. These habitats provide for a range of flora and fauna species not listed under the EPBC Act.

The drying out period (during the dry season) creates a more saline environment, and restricts freshwater areas to pools that may persist depending on the duration of the dry season. The estuarine tidal channels provide potential habitat for EPBC listed species such as the estuarine crocodile.

Extensive grazing occurs across the wetland complex and the adjacent Coal Terminal is listed as a disturbance to the site. Inappropriate grazing has lead to severe impacts on beach scrub communities and feral pig populations have some impacts on wetland margins (DEWHA 2010b). The proposed rail loop linking the rail corridor to the X110 Coal Stockpiles will partially encroach upon by the Caley Valley Wetlands. Refer Section 4.2.1 for further detail on the extent of encroachment.

- **Bowen River: Birralee - Pelican Creek Wetland Aggregation** - the Bowen River: Birralee - Pelican Creek Aggregation is a 15 km section of the Bowen River covering an area of 1 342 ha approximately 27 km west of Collinsville. This site provides a range of aquatic habitats including: rapids, sand, rock or rubble bars, terraces, small waterholes, macrophytes beds, emergent wetlands and flooded palustrine evergreen forest. The main feature of this wetland is a large permanent clear waterhole in the central part of the site approximately 3.4 km in length and about 150 m wide at its widest point (DEWHA 2010c). The large permanent waterhole is likely to provide an important dry season refuge for many fauna species (DEWHA 2010c). Eight species of conservation significance have been recorded on the site including the estuarine crocodile. A large number of migratory bird species have also been previously recorded (DEWHA 2010c). This wetland site is approximately 3.5 km away from the proposed railway alignment.

3.2.4 Fish Habitat Areas

Inshore and estuarine fish habitat areas which play a key role in sustaining local and regional fisheries values are declared Fish Habitat Areas and are protected under the Queensland Government *Fisheries Act 1994*. Fish Habitat Areas located within the Burdekin Catchment include: Bohle River; Bowling Green Bay; Burdekin River and Cleveland Bay (Figure 3). There are no Fish Habitat Areas located within or adjacent to the Project footprint.

3.3 Aquatic Habitats

Aquatic ecosystems within the Burdekin Catchment can be divided into the following four broad habitat types:

- Estuarine;
- Lacustrine;
- Palustrine; and
- Riverine.

The number and size of these habitat types within the Burdekin Catchment is detailed in Table 5 while a description of the habitat types within the Project footprint is provided below:

Table 5 Aquatic Habitat Types within the Burdekin Catchment

Habitat Type	Number of Habitats	Area (km^2)	% of Total Habitat	% of Total Area
Estuarine	278	2605.61	37.0%	1.8%
Lacustrine	2165	535.50	7.6%	0.4%
Palustrine	2532	575.11	8.2%	0.4%
Combined Lacustrine and Palustrine	9	69.21	1.0%	0.0%
Riverine	1995	3251.85	46.2%	2.2%
Total	6979	7037.28	100.0%	4.8%

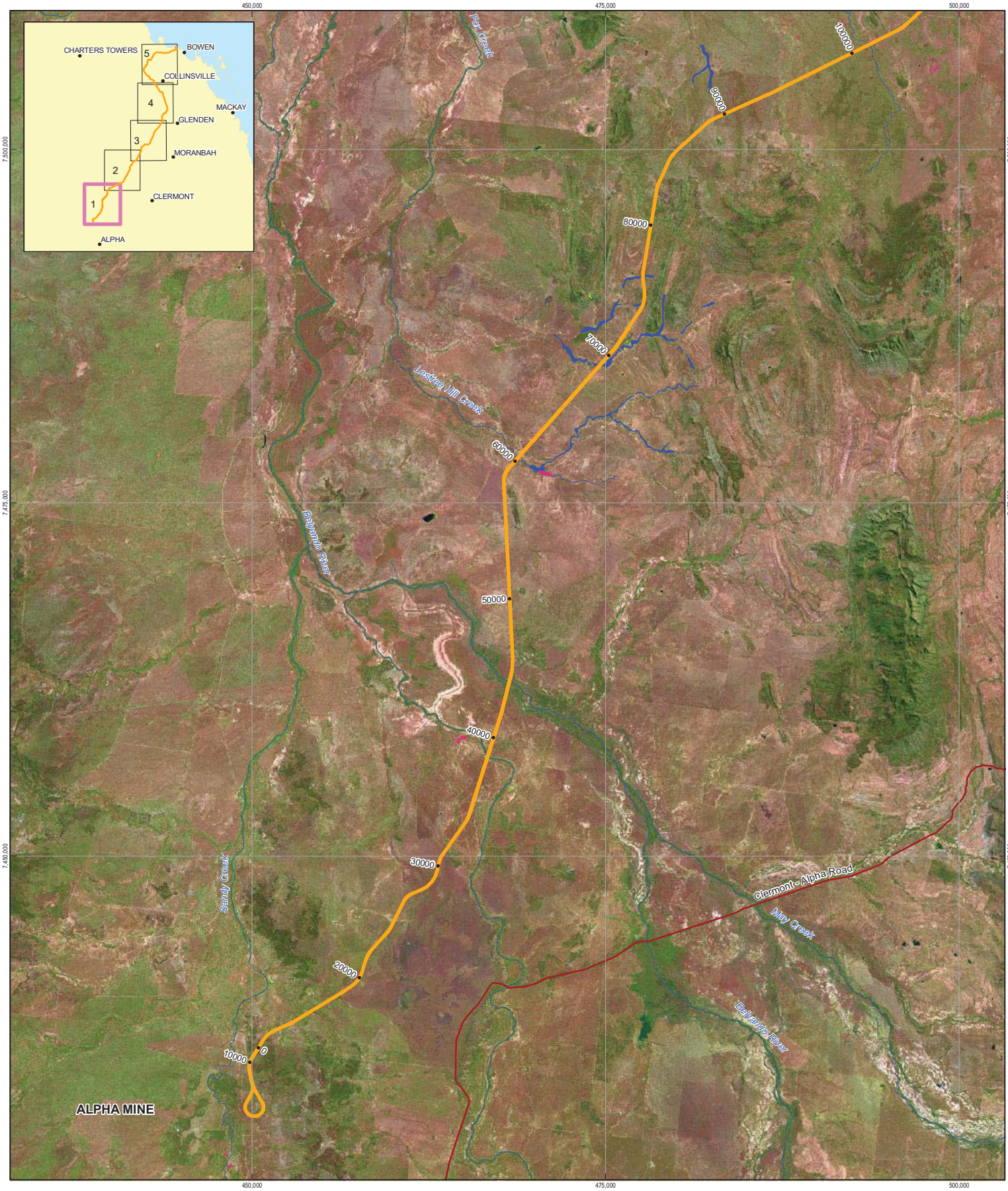
Source: Burdekin NRM Region Wetland Summary Information (DERM 2010a)

3.3.1 Estuarine Habitats

Estuarine habitats occur where freshwater from riverine habitats mixes with oceanic waters to produce a brackish environment (DERM, 2009b). Estuarine habitats within the study area include mangrove and saltwater wetlands (which includes mudflats, samphire and saline lakes) and adjacent tidal creeks (Figure 4). These habitats are located within the Caley Valley Wetland, at the northern end of the proposed rail alignment.

The Caley Valley Wetland experiences distinct seasonal changes in aquatic habitat conditions. During the wet season, the wetland receives freshwater from Six Mile Creek, Goodbye Creek and Saltwater Creek. This input creates a predominately freshwater system that provides habitat for a range of aquatic flora and fauna species. During the dry season, tidal water movement begins to dominate and saline water enters the area from Curlewis Bay (Blackman *et al*. 1999; Blackman *et al*. 2002). Towards the end of the dry season, much of the wetland dries out leaving cracking soils and salt pans supporting saltmarsh vegetation. The Caley Valley Wetland is subject to degradation primarily as a result of grazing. Cattle degradation is particularly high during the dry season when cattle have direct access to the wetland (GHD 2010).

The estuarine habitats within the study area provide important spawning, breeding and nursery habitats for many fish species. Species recorded in the Caley Valley Wetland during the Abbot Point Multi Cargo Facility EIS (GHD 2010) included: spangled perch (*Leipotherapon unicolour*); crescent perch (*Terapon jarbua*); sea mullet (*Mugil cephalus*); spotted scat (*Scatophagus argus*); banded scat (*Selenotoca multifasciata*) and Agassiz's glassfish (*Ambassis agassizii*). The wetland habitats and adjacent tidal creeks also provide important habitat for commercially and recreationally important species such as barramundi (*Lates calcarifer*) and mangrove jack (*Lutjanus argentimaculatus*).



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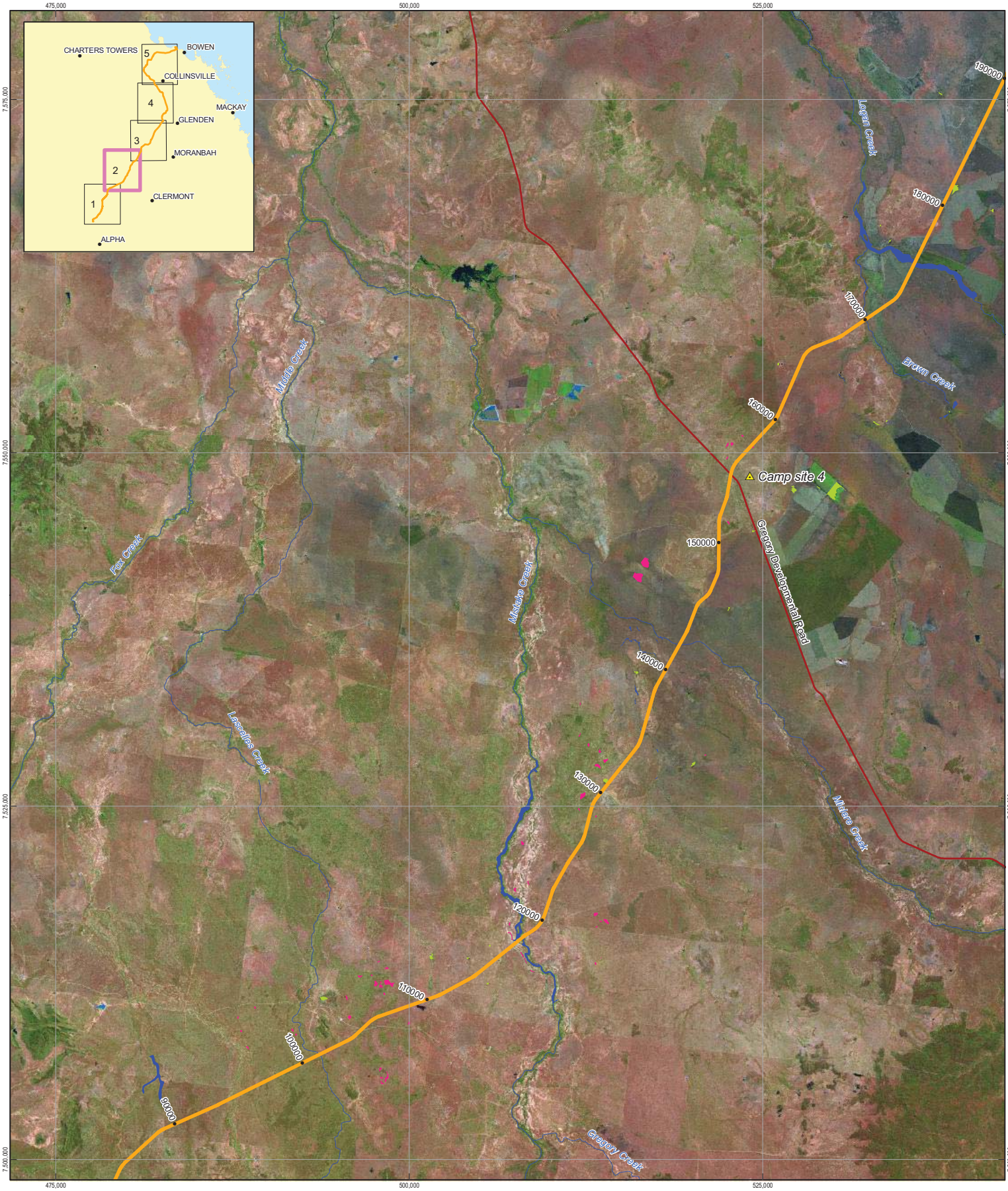

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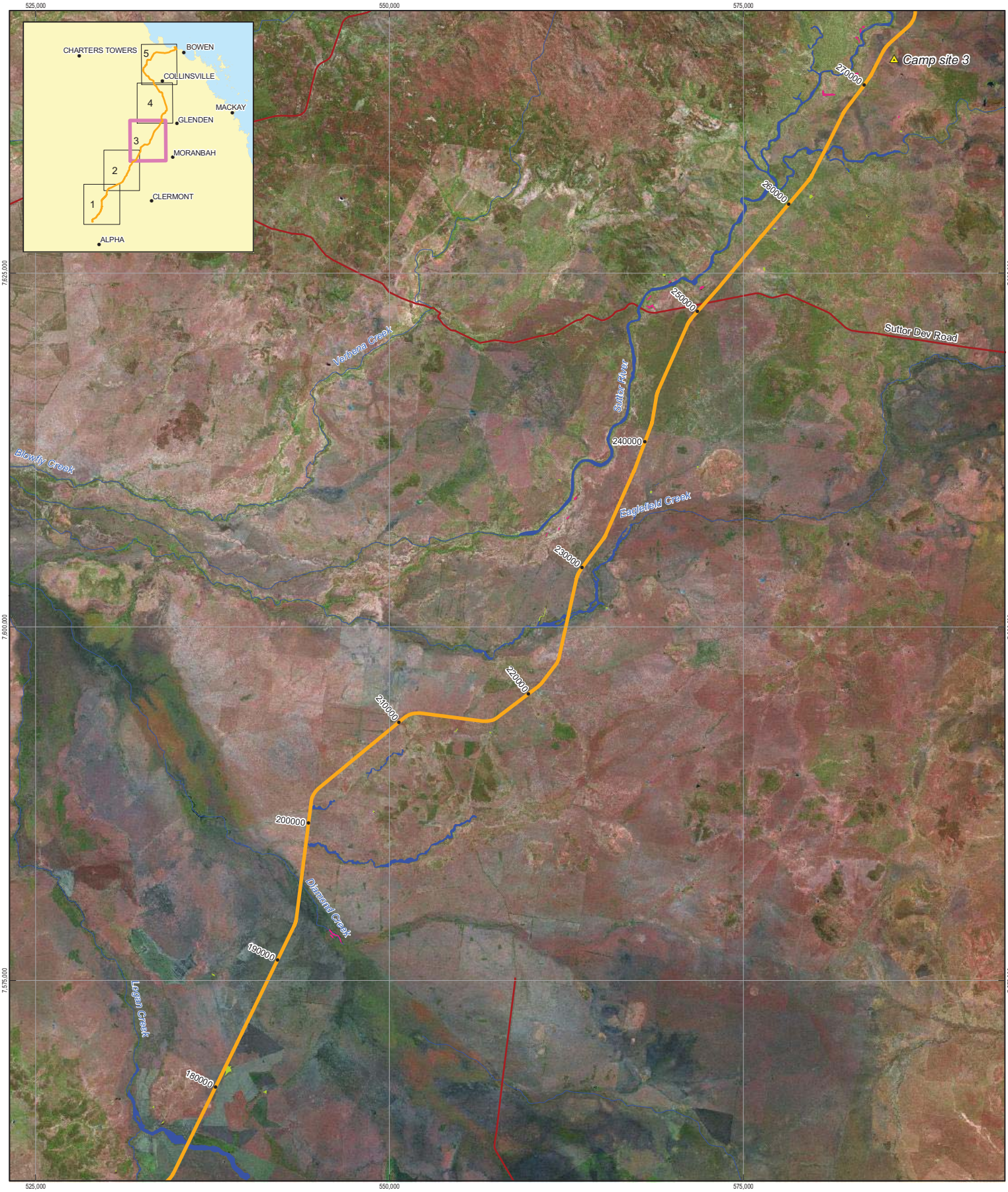

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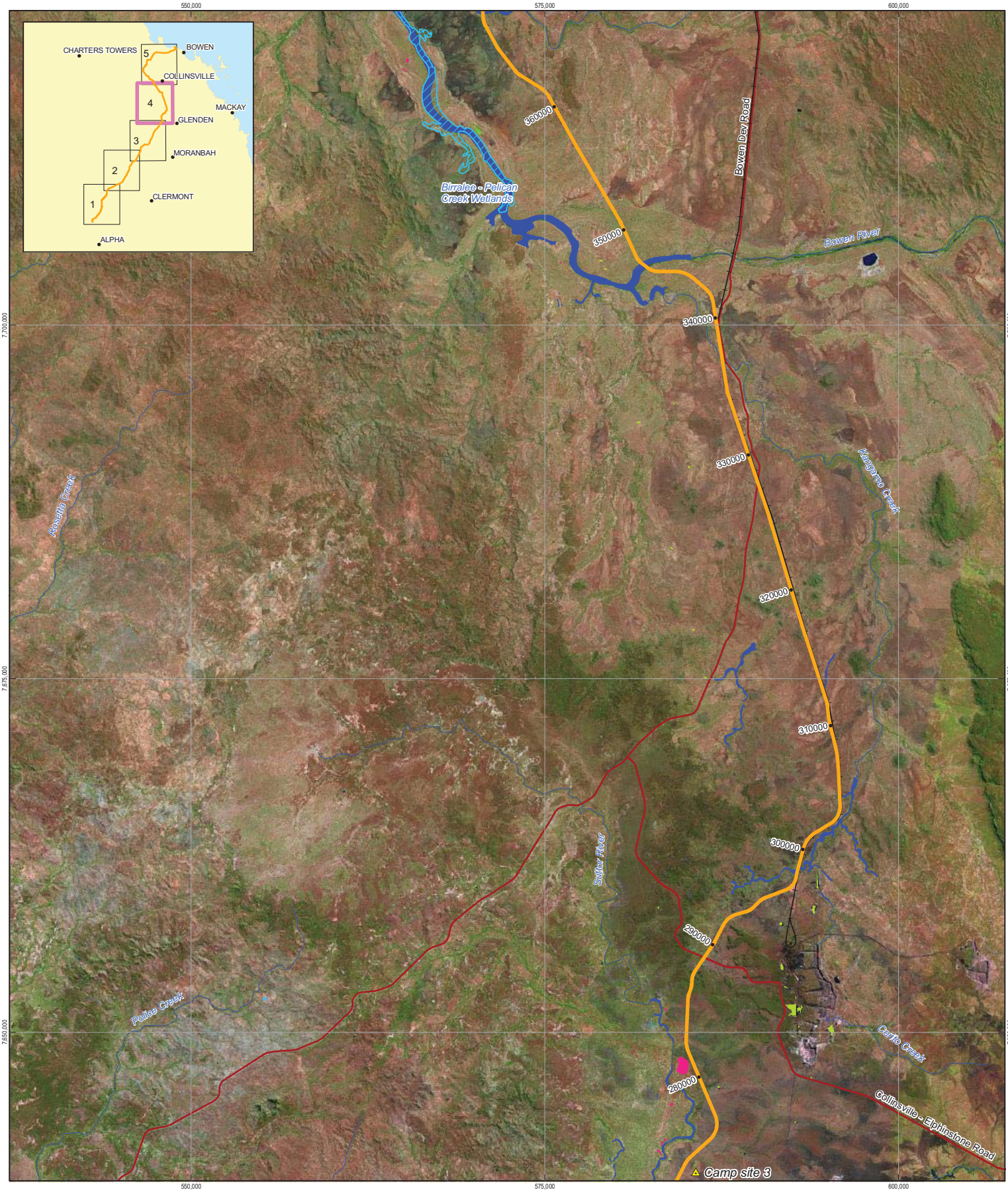

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LEGEND

- Town
- Camp
- Marshalling Yards
- Depot
- Proposed Alignment
- State Road
- Existing Railway
- Watercourse
- Directory of Important Wetlands
- Wetland System
  - Estuarine Waterbody
  - Lacustrine Waterbody
  - Palustine Waterbody
  - Riverine Waterbody

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1:250,000 (at A3)

0 1.25 2.5 5 7.5 10 12.5

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

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HANCOCK PROSPECTING PTY LTD

Alpha Coal Project
Environmental Impact Statement

AQUATIC HABITAT LOCATIONS

Job Number	41-22090
Revision	A
Date	04-08-2010

Figure: 4
Sheet 5 of 5

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3.3.2 Lacustrine and Palustrine Habitats

Lacustrine habitats are large, open, water bodies such as lakes and artificial dams. These habitats are generally deep and still or slow-flowing. Palustrine habitats are primarily off-stream habitats that support a high abundance of emergent vegetation.

Lacustrine and palustrine habitats located within the study area are presented in Figure 4. The specific site description of lacustrine and palustrine habitats surveyed during the field assessment are detailed in Table 6.

Lacustrine and palustrine habitats represent an important resource for many aquatic species. Due to their large size and deep water depth, lacustrine habitats are generally permanent water bodies that contain water throughout the year. These habitats provide an important refuge for fauna during the dry season when many of the other aquatic habitats have dried out. Aquatic fauna species likely to utilise these habitats include: Pacific short-finned eel (*Anguilla obscura*) western carp gudgeon (*Hypseleotris klunzingeri*) and black catfish (*Neosilurus ater*). Lacustrine habitats are also likely to provide important habitat for many terrestrial species that depend on dry season water resources (e.g. waterbirds and amphibians).

Palustrine habitats include gilgai's, swamps, billabongs and wetland (DERM 2009b). Gilgai's are a type of palustrine habitat that forms in the cracking clay soils of brigalow forests. During the wet season, these small rounded depressions fill with water and become extensively covered with a high diversity of aquatic macrophytes. Aquatic fauna that are likely to utilise these habitats include: macroinvertebrates such as crustaceans and small-bodies fish. Gilgai's have limited value for aquatic fauna during the dry season when they completely dry out to cracking clay soils.

Palustrine habitats such as wetland and billabongs are generally seasonally inundated during the wet season and gradually dry out as rainfall declines and water levels in the main river channel subside (depending on the area and depth, these habitats may or may not completely dry out). Due to their shallow depth and still water conditions, palustrine habitats generally support a relatively high diversity of macrophytes and in-stream habitat in form of detritus, fallen branches and logs. The high abundance of microhabitats within these environments provide seasonal breeding and larval habitat for diverse communities of aquatic and terrestrial macroinvertebrates. Palustrine habitats may also provide breeding and nursery habitat for fish species and the breeding season of a number of species (i.e. barramundi (*Lates calcarifer*), long-finned eel (*Anguilla reinhardtii*), oxeye herring (*Megalops cyprinoides*), spangled perch (*Leiopotherapon unicolor*), eastern rainbowfish (*Melanotaenia splendida splendida*) and empire gudgeon (*Hypseleotris compressa*)) is known to occur during the wet season when flows within the river are increased and the off-stream palustrine habitats are connected to the river system facilitating access to these environments (Reynolds 1983; Pusey *et. al.* 2004; Stuart and Berghuis 1997). Palustrine habitats within the study area may also provide habitat for long-necked turtles (e.g. Cann's long-necked turtle (*Chelodina canni*)). These species show a preference for shallow, turbid habitats such as billabongs, and have the ability to move considerable distances overland in response to declining water levels in isolated, ephemeral water bodies (Cann 1998).

Palustrine habitats within the study area include the Caley Valley Wetland (chainage 505000) and the Bowen River: Birralee - Pelican Creek Aggregation (located ~3.5 km from the alignment adjacent to chainage 355000 to 382000). These habitats are listed as nationally important wetlands under the Australian Government's Directory of Important Wetlands (Environment Australia, 2001) (see Section 3.2.3).

Table 6 Site Descriptions of Lacustrine and Palustrine Habitats within the Study Area

Assessment Site	General Habitat Characteristics	Habitat Value Assessment	Comments	Photos
Artificial Dam/Wetland Adjacent to chainage 437000	Stream channel morphology - average width of stream channel ~50 m dam, ~40 m wetland; average bank height ~3 m right bank; average water depth >1 m dam, ~ 10 cm wetland. Habitat types – deep pool and shallow wetland. Velocity – no flow. Substrate description – 100% silt/clay. Erosion and deposition – little erosion; no deposition. Snags and wood debris – little in wetland. Habitat attributes – no overhanging vegetation; no trailing bank vegetation; no undercut banks. Moderate algae on substrate and in water column; moderate emergent, submerged and floating macrophytes. Riparian characteristics – no riparian zone, dam/wetland located adjacent to mixed open woodland and *Brigalow* forest; moderate grass; some bare ground and trees >10 m; little shrubs and trees <10 m. Adjacent land use – moderate grazing. Introduced species – moderate to extreme	Bottom substrate/available cover – Poor (1) Embeddedness – Poor (1) Velocity/depth category – Fair (6) Channel alteration – Excellent (15) Bottom scouring and deposition – Excellent (15) Pool/riffle, run/bend ration – Fair (4) Bank stability – Good (6) Bank vegetation stability – Good (7) Streamside cover – Fair (3)	Artificial dam extends into shallow wetland. Dam is deep with relatively clear water. Terrestrial grass; emergent, submerged and floating macrophytes abundant along margins. Moderate level of algae on substrate and within water column. Small fish and diving beetles present at dam margins. Crab holes, bivalves and mussels observed in low abundance on banks. High level of cattle degradation along dam margins. Wetland is typically shallow with high abundance of macrophytes and terrestrial grasses. High level of cattle degradation resulting in water and substrate odour. High abundance of flies. Waterbirds observed foraging in wetland. Frogs calling from margins.	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment	Comments	Photos
	pastoral animal disturbance; moderate terrestrial weeds; cane toad tadpoles observed.			
Gilgais Adjacent to chainage 438000	Stream channel morphology - average width of stream channel ~6 m; average bank height ~ 0.5 - 1 m; average water depth <1 m. Habitat types – gilgie pools connected with shallow, narrow channels. Velocity – no flow. Substrate description – 100% silt/clay. Erosion and deposition – no erosion; no deposition. Snags and wood debris – moderate detritus; some sticks and branches; little logs. Habitat attributes – little overhanging vegetation and trailing bank vegetation; no undercut banks. Some algae on substrate and in water column; moderate emergent, submerged and floating macrophytes. Riparian characteristics – no riparian zone, gilgais located within *Brigalow* forest; moderate grass and trees <10 m; some shrubs; bare ground and trees <10 m. Adjacent land use – moderate grazing.	Bottom substrate/available cover – Poor (1) Embeddedness – Poor (1) Velocity/depth category – Fair (6) Channel alteration – Excellent (15) Bottom scouring and deposition – Excellent (15) Pool/riffle, run/bend ration – Fair (4) Bank stability – Excellent (10) Bank vegetation stability – Excellent (9) Streamside cover – Fair (3)	Gilgais are positioned throughout the Brigalow forest in a connected network. Larger gilgais (~6 m x ~10 m) are connected to smaller gilgais (~1 m x ~1m) by narrow (< 1 m wide) channels. Channels have low banks with dense grass cover and some emergent macrophytes. Macrophytes are present within gilgais and abundance is positively related to gilgie size. Moderate level of detritus and some sticks and branches present. At time of survey, larger gilgais contained water but smaller gilgais and connecting channels were dry. When completely full, gilgais would cover ~60% of forest substrate. Dead crabs are abundant within dry gilgais while crabs holes were evident along margins of larger gilgais. High abundance and diversity of juvenile frogs observed. High abundance of terrestrial insects foraging on macrophytes. *Brigalow* forest has very open	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment	Comments	Photos
	Introduced species – some pastoral animal disturbance; some terrestrial weeds; low abundance of cane toads observed.		grassy understorey with some patches of shrubs. High abundance of leaf litter on substrate.	
Star of Hope Dam/Wetland Chainage 72000	Stream channel morphology - average width of stream channel ~70 m dam, ~150 m wetland; average bank height ~ 2 m dam; water depth >1 m dam, deep + shallow wetland areas. Habitat types – deep pool, deep wetland, shallow wetland. Velocity – no flow. Substrate description – 80% silt/clay; 20% pebble (potentially artificial from dam wall). Erosion and deposition – no erosion; no deposition. Snags and wood debris – some detritus in dam, moderate to extensive detritus in wetland; some sticks in dam, moderate to extensive sticks in wetland; little to some branches and logs. Habitat attributes – some overhanging vegetation and trailing bank vegetation; no undercut banks. Moderate algae on substrate and in water column; moderate to extensive emergent, submerged and floating macrophytes.	Bottom substrate/available cover – Poor (3) Embeddedness – Poor (2) Velocity/depth category – Fair (9) Channel alteration – Excellent (15) Bottom scouring and deposition – Excellent (15) Pool/riffle, run/bend ration – Fair (6) Bank stability – Excellent (10) Bank vegetation stability – Excellent (10) Streamside cover – Good (6)	Large artificial dam (~ 70 m wide) extending into a large wetland. Difficult to assess full extent of wetland but >150 m x ~200 m. Dam has relatively clear deep water. Dense layer of macrophytes (dominated by *Persicaria attenuata*) at dam edge (~6 m wide). Dam wall ~ 2 m high and dominated by grass. Surface of wetland ~80% covered with macrophytes. Dead stags present in middle of wetland while live tree vegetation occurs predominately on the margins where wetland enters woodland. Wetland joins Brigalow forest and gilgais on left bank. Few water birds at time of survey, some frogs calling.	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment	Comments	Photos
	Riparian characteristics – ~ 10 m of vegetation surround dam margin, wetland extend into woodland; moderate to extensive grass; some to moderate trees <10 m; little shrubs; bare ground and trees <10 m. Adjacent land use – moderate grazing; cattle holding yard; windmill with pipe to dam. Introduced species – some pastoral animal disturbance; some terrestrial weeds.			

little = 1-10%; some = 10-50%; moderate = 50-75%; extensive = >75%.

3.3.3 Riverine Habitats

Riverine habitats include all aquatic habitat types that occur within a channel (i.e. natural or artificial). Riverine habitats may be periodically or permanently inundated by flowing water (DERM 2009b). Riverine habitats are the predominant habitat type within the study area. The locations of these habitats are illustrated in Figure 4.

In comparison to creek habitats, rivers are generally characterised by a wide river channel, deep water depth and high flood flows. River habitats generally support a range of in-stream habitats such as pools, riffles and runs. Pool habitats are defined as relatively deep, still/very slow flowing water over variable substrates (i.e. silt, sand, stony or rocky) (DEWHA 2001). These habitats provide a range of sheltering and foraging resources for aquatic fauna and those that persist during the dry season are particularly important as refuge habitats. In comparison to pools, riffle and run habitats are generally characterised by flowing waters. Riffles are generally shallow (<0.3 m), fast-flowing (>0.2 m/s) and occur of over a stony substrate while run habitats are relatively deep and occur over a sandy, stony or rocky substrate (DEWHA 2001). Due to their fast flows and rocky substrate, riffle zones generally support a range of specialist macrophytes and macroinvertebrate species that do not occur in the other in-stream habitats.

River habitats in the study area were relatively uniform and supported a low abundance and diversity of in-streams habitats. River channels in the Elliot, Bogie and Belyando Rivers were predominately dry at the time of survey. The Elliot and Bogie Rivers were dominated by sandy/gravel substrate and contained only very shallow water flows in the microhabitat low flow channels. These rivers are considered likely to support run habitats for short periods during times of increased water depth and flow. No pool or riffle habitats were evident within these rivers at the survey locations. The Belyando River was relatively narrow compared to the other river habitats assessed and supported two small isolated pools at the time of survey. Narrow sections of the river channel were considered likely to support runs during increased water levels and flows. The Suttor River was the only river surveyed that contained a large, deep, pool habitat. This river was dominated by silt/clay substrate. Due to their ephemeral nature, river habitats within the study area generally provide low value habitat for aquatic fauna during the dry season. Habitat value during the wet season is also considered relatively low due to the low abundance and diversity of in-stream habitat features such as fallen logs and branches. The Elliot and Bogie rivers were considered to contain a particularly low abundance of microhabitats. Macrophytes were low in abundance throughout the river habitats and were dominated by semi-aquatic emergent species growing on the channel margins.

A 15 km stretch of the Bowen River located adjacent to chainage 355000 to 382000 is listed as a nationally important wetland (see Section 3.2.3). This site contains a range of unique aquatic habitats that are unavailable in the other riverine habitats within the study area. Of particular habitat importance is a large permanent clear waterhole in the central part of the site approximately 3.4 km in length and about 150 m wide at its widest point (DEWHA 2010c). The large permanent waterhole provides an important dry season refuge for many fauna species including the estuarine crocodile.

Creek habitats generally contain areas of shallower water and slower flow. They often support a more diverse array of aquatic and fringing vegetation, significant amounts of in-stream structure (woody debris) and undercut banks. The generally shallow, slow-flowing aquatic habitats associated with creeks have the potential to support faunal assemblages which are less prevalent in river habitats.

Creek habitats within the study area did not conform to the general description above. Creeks were generally dry; supported very shallow waters in microhabitat channels or contained small isolated pools.

Only Mistake Creek and Table Mountain Creek contained large pool habitats capable of supporting aquatic fauna. Due to the lack of water availability in creek habitats during the dry season, these pools are considered particularly important habitat areas. Similar to the river habitats, the creeks within the study area generally contained a sandy/gravel substrate within a uniform river channel. Very little undulations occurred within the river bed and the growth of vegetation within or immediately adjacent to the river bed suggest many of these habitats only contain flowing water during flooding. The width of the creek habitats were generally smaller than that of the rivers (some exceptions, e.g. Pelican Creek) however riparian vegetation was relatively degraded resulting in low overhanging vegetation. In-stream habitat features in the form of fallen logs, undercut banks and detritus was observed in very low abundance. Due to the ephemeral nature of creek habitats within the study area, these habitats are considered to provide low value habitat for aquatic fauna during the dry season. The pool habitats that do occur in the larger creeks are likely to act as a refuge for aquatic species during these periods and provide important population sources from which the ephemeral habitats can be re-colonised during flow conditions.

The specific site descriptions of riverine habitats surveyed during the field assessment are detailed in Table 7.

Table 7 Site Descriptions of Riverine Habitats within the Study Area

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
Elliot River Near chainage 472000	Stream channel morphology - average width of stream channel ~25 m; average width to top of bank ~100 m; average bank height ~15 m right bank, ~10 m left bank; average water depth <10 cm. Habitat types – shallow runs with small microhabitat riffles. Velocity – low flow, ~0.3 - 0.4m/s. Substrate description – 80% gravel; 10% pebble; 10% sand. Erosion and deposition – little erosion; deposition – sand. Snags and woody debris – little. Habitat attributes – little overhanging vegetation; moderate trailing bank vegetation; no undercut banks. Some algae; no macrophytes. Riparian characteristics – width of riparian zone +50 m left bank, ~2 m right bank; moderate grass and trees >10 m; little bare ground, shrubs, and trees <10 m. Adjacent land use – moderate grazing; low use track. Introduced species – some pastoral	Bottom substrate/available cover – Poor (4) Embeddedness – Poor (2) Velocity/depth category – Poor (5) Channel alteration – Fair (7) Bottom scouring and deposition – Good (11) Pool/riffle, run/bend ration – Fair (4) Bank stability – Good (8) Bank vegetation stability – Excellent (10) Streamside cover – Good (8)	Moderate size river channel (~25 m) with fine gravel substrate. River primarily dry with only very shallow (<10 cm) water remaining in micro-low flow channels (river bed undulations). Very little in-stream habitat within main stream channel. High flow channels located on the left behind initial bank. High flow channels contain extensive in-stream debris and terrestrial vegetation indicating inundation of these areas is likely to be infrequent but high velocity. Eastern rainbowfish (*Melanotaenia splendida splendida*) observed within the shallow runs.	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
	animal disturbance; moderate terrestrial weeds.			
Bogie River Adjacent to chainage 434000	Stream channel morphology - average width of stream channel ~100 m; average width to top of bank ~150 m; average bank height ~10 m right bank, ~12 m left bank; average water depth <0.1cm, up to ~1m in small pools below road crossing. Habitat types – shallow runs upstream; small pools and small riffles downstream of road crossing. Velocity – low flow, 0.3 m/s in pool below road crossing. Higher flows adjacent to culverts. Substrate description – 90% fine sandy gravel; 10% boulder, cobble and pebble immediately downstream of road crossing. Erosion and deposition – little. Snags and wood debris – little. Habitat attributes – moderate overhanging vegetation along margins; moderate trailing bank vegetation; no undercut banks. Moderate algae on substrate and in water collum; little submerged macrophytes.	Bottom substrate/available cover – Poor (5) Embeddedness – Poor (2) Velocity/depth category – Fair (8) Channel alteration – Fair (7) Bottom scouring and deposition – Good (11) Pool/riffle, run/bend ration – Fair (7) Bank stability – Excellent (10) Bank vegetation stability – Excellent (10) Streamside cover – Fair (5)	Wide river channel (~100 m) with predominately fine gravel/sandy substrate. Very little in-stream habitat within channel. Good overhanging vegetation at margins extends ~2 m from bank. River predominately dry with low flow runs remaining in micro-low flow channels (river bed undulations). Deeper pools and riffles forming below road crossing where substrate is boulder, cobble and pebble. High velocities occur through road culverts. Low vegetated islands have formed within channel indicating water depth within channel is generally shallow and remains high for low periods. Two rock-ramp fishways have been installed at road crossing. Juvenile spangled perch (*Leiopotherapon unicolor*) captured by DEEDI using fishways. Moderate abundance of small	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
	Riparian characteristics – width of riparian zone ~10 m initial then open woodland behind; moderate to extensive grass; some trees <10 m; little shrubs and trees >10 m; no bare ground. Adjacent land use – moderate grazing; road crossing. Introduced species – some pastoral animal disturbance; moderate terrestrial weeds.		fish observed congregating below road crossing.	
Suttor River Near chainage 248000	Stream channel morphology - average width of stream channel ~25 m; average width to top of bank ~50 m; average bank height ~6 m right bank, ~12 m left bank; water depth - deep pool. Habitat types – deep pool and shallow run. Velocity – no to very low flow. Substrate description – 50% silt/clay; 50% sand. Erosion and deposition – little erosion; moderate silt/clay deposition on banks; sand deposition at bend. Snags and wood debris – some. Habitat attributes – some overhanging vegetation along margins; some trailing bank vegetation; no undercut banks.	Bottom substrate/available cover – Poor (2) Embeddedness – Poor (0) Velocity/depth category – Fair (6) Channel alteration – Fair (5) Bottom scouring and deposition – Good (8) Pool/riffle, run/bend ration – Good (10) Bank stability – Good (6) Bank vegetation stability – Fair (4) Streamside cover – Good (6)	Moderate size river (~25 m) wide with silt/clay and sandy substrate. Majority of river is a still to slow flowing pool. Pool is very turbid and relatively deep. Sand deposits observed downstream at bend where a shallow run is created adjacent. Moderate layer of silt deposits on bridge structures and banks up to the high flow mark. Initial banks very steep and bare. No macrophytes or algae visible. Exposed roots on bank would provide habitat when water levels higher. Flood debris observed in trees approximately 6 m above current water level. Krefft river turtles (*Emydura*	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
	No algae or macrophytes observed. Riparian characteristics – width of riparian zone ~10 m initial then open woodland behind; moderate to extensive grass and trees >10 m; some bare ground particularly on initial bank; some trees <10 m; little shrubs. Adjacent land use – moderate grazing; bridge road crossing. Introduced species – some pastoral animal disturbance; moderate terrestrial weeds.		*krefftii*) (N>2) and a keelback snake (*Tropidonophis mairii*) observed in pool.	
Belyando River Adjacent to chainage 44000	Stream channel morphology - average width of stream channel ~3 m; average width to top of bank ~8 m; average bank height ~2.5 m; average water depth <0.5 m. Habitat types – shallow isolated pools. Velocity – no flow. Substrate description – 100% silt/clay. Erosion and deposition – moderate erosion; some silt/clay deposition on banks. Snags and wood debris – some detritus, sticks and logs; moderate branches. Habitat attributes – little overhanging vegetation; moderate trailing bank	Bottom substrate/available cover – Fair (6) Embeddedness – Poor (1) Velocity/depth category – Fair (9) Channel alteration – Fair (5) Bottom scouring and deposition – Fair (7) Pool/riffle, run/bend ration – Fair (7) Bank stability – Fair (3) Bank vegetation stability – Fair (3) Streamside cover – Fair (3)	River relatively narrow (~8 m) with silt/clay substrate. River consists of isolated shallow pools with turbid water and anoxic substrate. At higher water levels, runs would form in narrow sections. Channelling occurs within river bed with deep sections interspersed with vegetated islands. Trees roots and branches provide in-stream habitat. Emergent macrophytes occur at pool margins. Banks are relatively low, steep and support little vegetation. Erosion channels indicate high	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
	vegetation; no undercut banks. Little algae on substrate; little emergent macrophytes around pool margins. Riparian characteristics – width of riparian zone minimal, open woodland behind; moderate bare ground and grass; some trees <10 m; some shrubs and trees >10 m. Adjacent land use – moderate to heavy grazing; low use track downstream. Introduced species – moderate pastoral animal disturbance; some pig tracks observed in river bed; some terrestrial weeds.		velocities occur during flooding. Large flood plain exists on top of bank and smaller high flow channels have formed parallel to the main channel. Crab holes and snails observed around pool margins. High abundance of green-striped borrowing frogs (*Cyclorana alboguttata*).	
Splitters Creek Chainage 486000	Stream channel morphology - average width of stream channel ~6 m; average width to top of bank ~25 m; average bank height ~4 m left bank, ~6 m right bank; average water depth <0.5 m. Habitat types – shallow runs with microhabitat riffles. Velocity – low flow 0.3-0.6 m/s. Substrate description – 90% sand; 5% gravel; 5% pebble. Erosion and deposition – little erosion on upper bank; some sand deposition on banks. Snags and wood debris – some detritus	Bottom substrate/available cover – Poor (5) Embeddedness – Poor (3) Velocity/depth category – Fair (6) Channel alteration – Excellent (12) Bottom scouring and deposition – Excellent (14) Pool/riffle, run/bend ration – Poor (3) Bank stability – Good (7) Bank vegetation stability – Good (7)	Relatively narrow (~ 6 m) creek with predominately sandy substrate. Creek consist of clear, shallow, flowing runs with small microhabitat riffles in areas of increased pebble substrate. Little in-stream habitat. Low sloping initial banks are dominated with large *Melaleuca* vegetation. This vegetation provides overhanging stream habitat and in-stream root mass habitat when water levels are higher. Secondary banks have some	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
	and sticks; little branches and logs. Habitat attributes – moderate overhanging vegetation and trailing bank vegetation; no undercut banks. No algae; little macrophytes. Riparian characteristics – width of riparian zone ~ 10 m grazing land behind; moderate bare ground and trees >10 m; some grass and trees <10 m; no shrubs. Adjacent land use – moderate grazing; highway crossing downstream. Introduced species – some pastoral animal disturbance; moderate terrestrial weeds.	Streamside cover – Good (9)	erosion and are predominately grass and weed covered. Barred grunter (*Amniataba percoides*); juvenile spangled perch (*Leiopotherapon unicolor*) and *Macrobrackium sp* observed.	
Brigalow Creek Chainage 440000	Stream channel morphology - average width of stream channel ~5 m; average width to top of bank ~7 m; average bank height ~1 m left bank, ~0.5 m right bank; average water depth - dry. Habitat types – currently dry; shallow runs likely to form during flooding. Velocity – no flow. Substrate description – 50% sand; 50% gravel. Erosion and deposition – little sand deposition.	Bottom substrate/available cover – Poor (3) Embeddedness – Poor (3) Velocity/depth category – Poor (3) Channel alteration – Good (11) Bottom scouring and deposition – Excellent (14) Pool/riffle, run/bend ration – Poor (3) Bank stability – Good (8) Bank vegetation stability – Good	Relatively narrow (~5 m) sandy creek with fine gravel/sandy substrate. Creek is currently dry and only likely to contain water for short periods during flood conditions. Very little in-stream habitat in main channel. At increased water levels, terrestrial vegetation would provide some root mass habitat along margins. Banks very low and dominated by rubbervine (*Cryptostegia*	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
	Snags and wood debris – little. Habitat attributes – some overhanging vegetation and trailing bank vegetation; no undercut banks. No algae; little emergent macrophytes. Riparian characteristics – width of riparian zone ~ 15 m left bank, 2 m right bank; some grass and shrubs; little bare ground, trees >10 m and trees <10 m. Adjacent land use – moderate grazing; low use track crossing. Introduced species – some pastoral animal disturbance; some terrestrial weeds.	(7) Streamside cover – Good (9)	*grandiflora*). Side flow channel forms at bend upstream and rejoins creek ~ 50 m downstream.	
Capsize Creek Adjacent to chainage 424000	Stream channel morphology - average width of stream channel ~4 m; average width to top of bank ~10 m; average bank height ~3 m left bank, ~5 m right bank; average water depth <0.5 m in isolated pool. Habitat types – predominately dry; one isolated pool remains; shallow runs likely to form during flooding. Velocity – no flow. Substrate description – 75% gravel; 20% pebble; 5% cobble. Erosion and deposition – little erosion;	Bottom substrate/available cover – Fair (9) Embeddedness – Fair (6) Velocity/depth category – Poor (5) Channel alteration – Excellent (14) Bottom scouring and deposition – Excellent (14) Pool/riffle, run/bend ration – Fair (4) Bank stability – Good (7) Bank vegetation stability – Fair (4)	Creek substrate predominately gravel with small amounts of pebble and cobble particularly at road crossing (likely to be a result of road base). Only one isolated pool remaining upstream of road crossing. Pool is highly degraded by cattle and has algae on substrate and within water column. A narrow (~2 m) side creek enters Capsize Creek at pool location. Remainder of creek is dry and has little in-stream habitat.	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
	some fine gravel deposition. Snags and wood debris – little. Habitat attributes – some overhanging vegetation and trailing bank vegetation; no undercut banks. Little algae on substrate and in water collum; no macrophytes. Riparian characteristics – width of riparian zone ~ 8 m left bank, ~3 m right bank; some bare ground and grass; little shrubs, trees >10 m and trees <10 m. Adjacent land use – moderate grazing; medium use road crossing. Introduced species – moderate pastoral animal disturbance; some terrestrial weeds.	Streamside cover – Fair (4)	Moderate level of flood debris evident ~ 4 m above river bed. Right bank is relatively steep in places and composed of compacted gravel. Little evidence of erosion and deposition on left bank erosion.	
Herbert Creek Adjacent to chainage 420000	Stream channel morphology - average width of stream channel ~4 m; average width to top of bank ~6 m; average bank height ~3 m left bank, ~4 m right bank; average water depth - dry. Habitat types – currently dry; shallow runs and small pools likely to form during flooding. Velocity – no flow. Substrate description – 60% gravel; 38% pebble; 2% bedrock.	Bottom substrate/available cover – Fair (7) Embeddedness – Fair (10) Velocity/depth category – Poor (5) Channel alteration – Excellent (14) Bottom scouring and deposition – Excellent (12) Pool/riffle, run/bend ration – Poor (3) Bank stability – Good (6)	Creek assessed is a small unnamed creek that joins Herbert Creek. Creek is relatively narrow (~4 m) with a predominately gravel substrate. Low flows have created small channels and microhabitat pools (~1m wide) within the creek bed. These pool are likely to retain water following flooding. Flood debris evident ~ 2 m	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
	Erosion and deposition – little erosion; little deposition. Snags and wood debris – little. Habitat attributes – little overhanging vegetation and trailing bank vegetation; no undercut banks. No algae or macrophytes. Riparian characteristics – minimal riparian zone extending into sparse open woodland; moderate grass; some shrubs and trees <10 m; little bare ground and trees >10 m. Adjacent land use – moderate grazing; medium use road crossing. Introduced species – some pastoral animal disturbance; some terrestrial weeds.	Bank vegetation stability – Good (7) Streamside cover – Fair (3)	above creek bed. Minimal riparian zone dominated by grass. Growth of grass and trees within the creek bed suggest the creek is not inundated for long periods.	
King Creek Near chainage 410000	Stream channel morphology - average width of stream channel ~6 m low flow channel, 8 m high flow channel; average width to top of bank ~35 m; average bank height ~5 m; water depth range <10 cm to ~1 m. Habitat types – shallow runs and deeper pools; artificial riffle downstream of road crossing. Velocity – low flow 0.4 m/s in shallow run.	Bottom substrate/available cover – Fair (10) Embeddedness – Fair (10) Velocity/depth category – Fair (8) Channel alteration – Good (8) Bottom scouring and deposition – Excellent (12) Pool/riffle, run/bend ration – Fair (6)	Creek (~15 m wide) with predominately gravel substrate. Creek is partially dry with shallow runs remaining in microhabitat low flow channels. A deeper (<1 m) pool occurs immediately upstream of the road crossing. Little macrophytes are present along the margins and little algae evident in the stagnant pools.Creek contains some in-	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
	Substrate description – 70% gravel; 20% pebble; 10% cobble. Erosion and deposition – little erosion; little deposition in high flow channel. Snags and wood debris – some, particularly in high flow channel. Habitat attributes – little overhanging vegetation; some trailing bank vegetation; no undercut banks. Little algae on substrate and in water column; little emergent and submerged macrophytes. Riparian characteristics – ~10 m extending into open woodland behind; extensive shrubs; moderate grass; some trees <10 m and trees > 10 m; little bare ground. Adjacent land use – moderate grazing; medium use road crossing; powerline easement. Introduced species – some pastoral animal disturbance; extensive terrestrial weeds.	Bank stability – Good (8) Bank vegetation stability – Good (8) Streamside cover – Fair (5)	stream debris in the form of fallen logs and branches. Leaf litter is abundant within the low flow channel. A high flow channel (~ 8 m wide) occurs on the right bank. Cobble and pebble are the dominate substrate in the high flow channel and in-stream debris is abundant. The presence of vegetation within the high flow channel suggests that this channel is not inundated for long periods. Right bank is predominately grass while left bank has extensive covering of rubbervine and lantana. Juvenile spangle perch (*Leiopotherapon unicolor*) and carp gudgeons (*Hypseleotris sp*) observed in pool upstream of road crossing. Crab holes and snails observed along pool margins. Some sponge observed in low abundance.	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
Table Mountain Creek Near chainage 380000	Stream channel morphology - average width of stream channel ~25 m low flow channel, 8 m high flow channel; average width to top of bank ~40 m; average bank height ~3 m; water depth – deep pool. Habitat types –deep and shallow pools; riffles likely to form downstream of road crossing when flows increase. Velocity – low flow. Substrate description – 50% sandy gravel; 50% bedrock and boulder. Erosion and deposition – little erosion; little deposition. Snags and wood debris – little. Habitat attributes – some overhanging vegetation and trailing bank vegetation; no undercut banks. Some algae on substrate and in water column; little emergent and submerged macrophytes particularly around road crossing. Riparian characteristics – ~2 m extending into open grazing land behind; moderate grass; some bare ground, shrubs and trees >10 m; little trees > 10 m. Adjacent land use – heavy grazing;	Bottom substrate/available cover – Good (14) Embeddedness – Fair (10) Velocity/depth category – Fair (10) Channel alteration – Good (11) Bottom scouring and deposition – Excellent (15) Pool/riffle, run/bend ration – Good (8) Bank stability – Good (6) Bank vegetation stability – Excellent (9) Streamside cover – Good (6)	Creek has bedrock and boulder substrate downstream of road crossing. This area is likely to form a riffle zone during increased flows. Boulders provide in- stream habitat. Macrophytes and algae present. Sandy gravel substrate upstream with large, slow flowing pool habitat. Overhanging vegetation occurs at margins (~1-2 m from bank). Scum layer covering ~40% of water surface. Riparian vegetation predominately one tree layer wide. Grazing land behind. High level of disturbance on banks from earthworks.	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
	medium use road crossing; earthworks on upper banks. Introduced species – some pastoral animal disturbance; some terrestrial weeds.			
Cattle Creek Near chainage 380000	Stream channel morphology - average width of stream channel ~3 m; average width to top of bank ~12 m; average bank height ~4 m left bank, ~2 m right bank; water depth – dry. Habitat types –currently dry, shallow runs likely to occur during flooding. Velocity – no flow. Substrate description – 80% gravel; 10% pebble; 10% sand. Erosion and deposition – little erosion Snags and wood debris – little. Habitat attributes – little overhanging vegetation and trailing bank vegetation; no undercut banks. No or macrophytes. Riparian characteristics – ~2 m extending into open grazing land behind; extensive grass; some bare ground and trees <10 m; little shrubs and trees > 10 m. Adjacent land use – heavy grazing;	Bottom substrate/available cover – Poor (3) Embeddedness – Poor (3) Velocity/depth category – Poor (2) Channel alteration – Good (8) Bottom scouring and deposition – Good (10) Pool/riffle, run/bend ration – Poor (3) Bank stability – Good (8) Bank vegetation stability – Excellent (9) Streamside cover – Fair (4)	Creek primarily a dry drainage line. Substrate gravel with small amounts of pebble and sand. Channel ~ 6 m at widest then divides into smaller channels with vegetated islands between. No in-stream habitat within channels. Banks predominately grass covered with narrow row of larger trees. Open grazing land behind. Likely to only flow during flooding.	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
	medium use road crossing. Introduced species – moderate pastoral animal disturbance; some terrestrial weeds.			
Pelican Creek Near chainage 377000	Stream channel morphology - average width of stream channel ~50 m; average width to top of bank ~80 m; average bank height ~4 m left bank, ~10 m right bank; average water depth ~ 10 cm. Habitat types –predominately dry, shallow runs and small riffles remaining. Velocity – low flow 0.4-0.6 m/s. Substrate description – 80% gravel; 15% pebble; 5% cobble. Erosion and deposition – little. Snags and wood debris – some, particularly in narrow channels between vegetated islands. Habitat attributes – some overhanging vegetation and trailing bank vegetation; no undercut banks. Little algae on substrate and in water column; little emergent and submerged macrophytes. Riparian characteristics – ~10 left bank, ~15 m right bank, extending into open woodland behind; moderate grass; some shrubs, trees <10 m and trees > 10 m;	Bottom substrate/available cover – Fair (7) Embeddedness – Poor (5) Velocity/depth category – Fair (6) Channel alteration – Good (10) Bottom scouring and deposition – Excellent (12) Pool/riffle, run/bend ration – Fair (6) Bank stability – Excellent (9) Bank vegetation stability – Excellent (9) Streamside cover – Good (6)	Relatively wide creek (~50 m) with primarily gravel substrate. Multiple vegetated islands occur within creek channel downstream of sampling point. Islands are densely vegetated with trees, grass and weeds. Small channels remain between islands. These channels have higher abundance of in-stream habitat than main channel. Overhanging vegetation covers 100% of smaller channels. Some channels contain cobble and pebble forming riffle zones. Upstream of vegetated island, channel is wide with little in-stream habitat. This section of the creek is predominately dry and only small runs remain in microhabitat low flow areas. Flood debris observed ~6 m above creek bed. Banks have dense weedy understorey with moderate level of pig disturbance.	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
	little bare ground. Adjacent land use – moderate grazing; medium use road crossing downstream. Introduced species – moderate pastoral animal disturbance; some terrestrial weeds; moderate pig disturbance; low abundance of cane toads; dog tracks observed within creek bed.		Barred grunter (*Amniataba percoides*); carp gudgeons (*Hypseleotris sp*), juvenile spangled perch (*Leiopotherapon unicolor*), ornate borrowing frog (*Platyplectrum ornatum*); keelback snake (*Tropidonophis mairii*); crab holes observed.	
Eaglefield Creek Chainage 226000	Stream channel morphology - average width of stream channel ~10 m; average width to top of bank ~15 m; average bank height ~2 m; average water depth < 1 m. Habitat types – isolated pools. Shallow runs would occur under flowing conditions. Velocity – no flow. Substrate description – 95% silt/clay; 5% sand. Erosion and deposition – little erosion; little sand deposition. Snags and wood debris – little detritus, sticks and logs; some branches. Habitat attributes – little overhanging vegetation; some trailing bank vegetation; no undercut banks. Little algae on substrate and in water	Bottom substrate/available cover – Poor (2) Embeddedness – Poor (2) Velocity/depth category – Fair (9) Channel alteration – Good (8) Bottom scouring and deposition – Good (8) Pool/riffle, run/bend ration – Fair (6) Bank stability – Good (6) Bank vegetation stability – Good (7) Streamside cover – Fair (3)	Creek ~10 m wide with silt/clay substrate. Isolated pools (<1 m deep) are connected by dry narrow runs. Pools contain turbid water with little-some in-stream habitat at margins. Emergent macrophytes present at waters edge. Runs contain no in-stream habitat and have increased level of erosion on banks compared to pools. High abundance of flood debris on banks ~2 m above current water level. Crab holes and dead crabs seen on banks. Banks contains some areas of bare ground, particularly around tree roots, but predominately grass covered. Open *Brigalow* forest adjacent to creek. Some	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
	column; little emergent macrophytes. Riparian characteristics – minimal riparian zone, creek located within open *Brigalow* forest; moderate to extensive grass; some bare ground and trees <10 m; little shrubs and trees > 10 m. Adjacent land use – moderate grazing; National Park; low use road crossing. Introduced species – moderate pastoral animal disturbance; some terrestrial weeds.		die back observed on right bank. High abundance of green-striped burrowing frog (Cyclorana *alboguttata*), low abundance of New Holland Frog (*Cyclorana novaehollandiae*).	
Myra Creek Near chainage 215000	Stream channel morphology - average width of stream channel ~5 m; average width to top of bank ~6 m; average bank height ~0.5 m; average water depth < 0.5 m. Habitat types – predominately dry with isolated pools. Shallow runs would occur under flowing conditions. Velocity – no flow. Substrate description – 95% silt/clay; 5% gravel/pebble. Erosion and deposition – some erosion; little deposition. Snags and wood debris – little detritus, sticks and logs; some branches. Habitat attributes – no overhanging vegetation; little trailing bank vegetation;	Bottom substrate/available cover – Poor (2) Embeddedness – Poor (2) Velocity/depth category – Fair (6) Channel alteration – Fair (7) Bottom scouring and deposition – Good (11) Pool/riffle, run/bend ration – Fair (4) Bank stability – Good (6) Bank vegetation stability – Good (7) Streamside cover – Fair (3)	Creek is predominately a shallow drainage line within sparse open regrowth woodland. Road crossing has created a small pool of water upstream. Pool is shallow and contains emergent macrophytes and terrestrial grass. High abundance of dead crabs and crab holes along banks. Downstream of crossing, creek is completely dry and splits into three smaller channels. Channels are very narrow (~1 m wide) with low banks (<1 m). Erosion is evident at bends of channels. Extensive dieback of vegetation	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
	no undercut banks. Little algae on substrate; little emergent macrophytes. Riparian characteristics – minimal riparian zone, creek located within sparse regrowth open woodland with extensive tree dieback; extensive grass; some trees <10 m; little bare ground; no shrubs or trees > 10 m. Adjacent land use – moderate grazing; medium use road crossing. Introduced species – moderate pastoral animal disturbance; some terrestrial weeds.		evident.	
Mistake Creek Near chainage 112000	Stream channel morphology - average width of stream channel ~30 m; average width to top of bank ~50 m; average bank height ~3 m; water depth – deep pool. Habitat types – Large deep pool upstream of crossing. Dry riffle zone and run downstream of crossing. Velocity – no flow. Substrate description – 40% bedrock; 2% cobble; 25% pebble; 30% gravel; 3% sand. Erosion and deposition – some erosion; little sand/gravel deposition.	Bottom substrate/available cover – Good (12) Embeddedness – Good (14) Velocity/depth category – Good (15) Channel alteration – Excellent (12) Bottom scouring and deposition – Excellent (14) Pool/riffle, run/bend ration – Good (10) Bank stability – Good (7) Bank vegetation stability – Good	Relatively large deep pool upstream of road crossing. Pool has scum layer on surface near road. Little overhanging vegetation at margins. Large areas of macrophytes/terrestrial grass extending into the pool along the right bank. Few large fallen logs observed protruding from water. Large dry bedrock flat dominates habitat downstream of crossing. One medium size pool remaining adjacent to the left bank. Large vegetated bank adjacent to pool. Dry gravel run habitat present on	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
	Snags and wood debris – some detritus, little sticks, branches and logs. Habitat attributes – little overhanging vegetation; little to some trailing bank vegetation; no undercut banks. Little algae on substrate and in water column; little emergent macrophytes. Riparian characteristics – riparian zone ~10 m left bank, ~20 m right bank; moderate grass and trees <10 m; some bare ground; little shrubs and trees > 10 m. Adjacent land use – moderate grazing; medium use road crossing. Introduced species – moderate pastoral animal disturbance; some terrestrial weeds.	(6) Streamside cover – Fair (4)	right of vegetation island. Additional small vegetated islands surround runs and provide overhanging habitat. Evidence of erosion adjacent to road crossing. Moderate human disturbance in the form of rubbish, discarded crab traps. Fish observed in pools.	
Lascelles Creek Adjacent to chainage 102000	Stream channel morphology - average width of stream channel ~6 m; average width to top of bank ~15 m; average bank height ~1 m; water depth – dry. Habitat types – predominately dry, only one very small pool remains at road crossing. Shallow runs likely to occur during flowing conditions. Velocity – no flow. Substrate description – 100% fine sandy gravel.	Bottom substrate/available cover – Poor (1) Embeddedness – Poor (1) Velocity/depth category – Poor (2) Channel alteration – Excellent (12) Bottom scouring and deposition – Excellent (14) Pool/riffle, run/bend ration – Poor (2)	Creek ~6 m wide with fine sand/gravel substrate. No in-stream habitat within channel. Banks extremely low and predominately grass covered with one line of larger *Eucalyptus*. Creek would only support low flows then spill out onto floodplain. Little erosion on banks adjacent to the road crossing.	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
	Erosion and deposition – some erosion; little sand/gravel deposition. Snags and wood debris – little. Habitat attributes – no overhanging vegetation or trailing bank vegetation; no undercut banks. Little algae on substrate; little emergent macrophytes. Riparian characteristics – one line of large eucalypts along creek edge extending into open woodland, no understorey vegetation; moderate grass; little bare ground and trees >10 m; no shrubs or trees < 10 m. Adjacent land use – moderate grazing; medium use road crossing. Introduced species – some pastoral animal disturbance; some terrestrial weeds.	Bank stability – Good (8) Bank vegetation stability – Excellent (9) Streamside cover – Fair (3)	Some emergent macrophytes at creek margins.	
Sixteen Mile Creek Adjacent to chainage 93000	Stream channel morphology - average width of stream channel ~25 m; average width to top of bank ~30 m; average bank height ~2 m; average water depth <0.5 m. Habitat types – predominately dry, only small, shallow pools remain in microhabitat low flow channels. Shallow runs likely to occur during flowing	Bottom substrate/available cover – Fair (8) Embeddedness – Fair (10) Velocity/depth category – Fair (6) Channel alteration – Good (11) Bottom scouring and deposition – Good (11)	Creek contains small (~6 m wide) low flow channel with high flow channel ~ 0.5 m higher on right bank. Low flow channel predominately dry with only small isolated pools remaining in microhabitat low flow channels. Emergent macrophytes located on margins. Algae on substrate and tree roots. Isolated pools	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
	conditions. Velocity – no flow. Substrate description – 50% sand; 25% gravel; 25% pebble. Erosion and deposition – some erosion; little sand/gravel deposition. Snags and wood debris – little detritus, sticks and logs; some branches. Habitat attributes – little to some overhanging vegetation and trailing bank vegetation; no undercut banks. Little algae on substrate; some emergent macrophytes. Riparian characteristics – riparian zone ~2 m at low flow channel edge. Upper bank riparian vegetation extends into open woodland; moderate grass and trees <10 m; some bare ground; little shrubs and trees. Adjacent land use – moderate grazing; medium use road crossing. Introduced species – some pastoral animal disturbance; some terrestrial weeds. Dog track observed in creek bed.	Pool/riffle, run/bend ration – Fair (4) Bank stability – Good (6) Bank vegetation stability – Good (7) Streamside cover – Fair (3)	contain high abundance of fish, predominately juvenile spangled perch (*Leiopotherapon unicolor*). High flow channel has a sandy substrate with *Melaleuca* and *Eucalyptus* vegetation. Presence of terrestrial grass suggests high flow channel is not inundated for long periods. Banks are dominated by grass and extend into open woodland. Flood debris observed ~1.5 m above low flow channel bed.	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
Star of Hope Creek Adjacent to chainage 72000	Stream channel morphology - average width of stream channel ~8m; average width to top of bank ~40 m; average bank height ~2 m; average water depth <0.5 m. Habitat types – predominately dry, only one shallow pool remains. Shallow runs likely to occur during flowing conditions. Velocity – no flow. Substrate description – 70% gravel; 15% sand; 10% pebble; 5% cobble. Erosion and deposition – some erosion; little sand deposition on banks. Snags and wood debris – moderate detritus; some sticks and branches; little logs. Habitat attributes – little overhanging vegetation and trailing bank vegetation; no undercut banks. Little algae on substrate; little to some emergent macrophytes. Riparian characteristics – one line of eucalyptus along creek edge, extending into open woodland behind; moderate grass; some bare ground, shrubs, trees <10 m and trees >10 m. Adjacent land use – moderate grazing; low use track crossings upstream.	Bottom substrate/available cover – Fair (8) Embeddedness – Fair (6) Velocity/depth category – Poor (3) Channel alteration – Good (8) Bottom scouring and deposition – Excellent (12) Pool/riffle, run/bend ration – Fair (4) Bank stability – Good (8) Bank vegetation stability – Good (8) Streamside cover – Fair (3)	Fine gravel/sandy creek with some areas of pebble and cobble. Creek predominately uniform dry bed, only one shallow pool remaining. Very little in-stream habitat. Pool has moderate abundance of detritus and water appears tannin in colour. Fine black sediment deposits are evident in places. Algae occurs on the substrate and tree roots while emergent macrophytes are present along the margins. Banks are relatively low and water spills out into adjacent channels at high flows. Adjacent channels have moderate sand deposition and high abundance of flood debris. Diving beetles and juvenile spangled perch (*Leiopotherapon unicolor*) evident within pool.	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
	Introduced species – some pastoral animal disturbance; some terrestrial weeds; dog tracks evident within creek bed.			
Native Companion Creek Adjacent to chainage 32000	Stream channel morphology - average width of stream channel ~5m; average width to top of bank ~30 m; average bank height ~4 m; average water depth <0.5 m. Habitat types – shallow runs with deeper pools. Velocity – low flow ~0.6 m/s. Substrate description – 80% silt/clay; 15% gravel; 5% sand. Erosion and deposition – some erosion; little sand deposition on banks. Snags and wood debris – little detritus, sticks and logs; some branches. Habitat attributes – some to moderate overhanging vegetation; little to some trailing bank vegetation; no undercut banks. Little algae on substrate; little to some emergent macrophytes. Riparian characteristics – riparian zone ~2-3 m wide extending into open woodland behind; moderate bare ground and trees <10 m; some grass and trees	Bottom substrate/available cover – Fair (6) Embeddedness – Poor (3) Velocity/depth category – Fair (8) Channel alteration – Good (11) Bottom scouring and deposition – Excellent (12) Pool/riffle, run/bend ration – Fair (6) Bank stability – Fair (5) Bank vegetation stability – Fair (5) Streamside cover – Fair (3)	Creek ~5 m wide. Shallow flowing runs dominate habitat with deeper pool areas. Substrate is gravel but covered with silt/clay. Some emergent macrophytes along banks above current water level. In-stream habitat present in the form of branches and logs along margins. Relatively high abundance of overhanging vegetation. Banks are 50% bare on initial banks with a ~2-3 m wide *Melaleuca* layer. Open woodland with large hollow tress behind. Erosion/drainage channels enter creek on right bank. High cattle degradation at crossing point. Crab holes evident on banks. Green-stripped burrowing frogs (*Cyclorana alboguttata*) and green-tree frogs (*Litoria caerulea*) observed along banks	

Assessment Site	General Habitat Characteristics	Habitat Value Assessment Score	Comments	Photos
	>10 m; little shrubs. Adjacent land use – moderate grazing; low use track crossing downstream. Introduced species – some pastoral animal disturbance; some terrestrial weeds.			

little = 1-10%; some = 10-50%; moderate = 50-75%; extensive = >75%.

3.3.4 Habitat Dynamics

Aquatic habitats within the study area are dynamic and vary over a temporal scale in association with catchment climatic conditions. Water flows within the Burdekin Catchment are primarily influenced by the strong seasonality in rainfall and as such, mean annual discharge is highly variable both between and within years. Annual flow patterns within the catchment are generally characterised by short periods of increased flow between December and April, with little to no-flow occurring outside this period (NRM 2002; BoM 2010b). Severe flooding occasionally occurs within the Burdekin Catchment as a result of intensive rainfall events associated with severe storms, cyclones and tropical low pressure systems. Prolonged dry conditions and drought are also characteristic features of the highly variable catchment.

During periods of high rainfall, the river habitat within the Burdekin Catchment primarily exists as deep fast-flowing channels in which many of the in-stream aquatic microhabitats (e.g. pools) are inundated as a result of a significant increase in water depth and velocity. Creek habitats also experience increased water depths and flows and for many of the ephemeral creeks, this period represents the only inundation of these habitats. Palustrine habitats may also be inundated during flooding events as river levels rise above bank height. This periodic flooding is important to recharge water levels, provide flushing and allow for biological connectivity with the main stream. As water levels recede, some of the river and creek channels are transformed into a series of pool-run sequences and the palustrine habitats again become separated from the main river channel. As the dry season continues, many of the aquatic habitats dry out and much of the system exists as a series of small isolated non-flowing pools. These isolated pools act as refugia for aquatic fauna during the dry season, however they are often highly competitive systems with limited foraging resources and often exhibit reduced water quality conditions. Many of the river and creek habitats within the study area do not contain suitable channel conditions to support pool habitats and as a result these habitats completely dry out when flows cease.

3.4 Water Quality

The key parameters influencing water quality within the Burdekin Catchment are directly influenced by water flows and as such water quality varies significantly between wet and dry seasons (CSIRO 2002). During periods of high water flow, water quality is relatively constant throughout the river and the main influences on water quality are associated with sedimentation and the input of nutrients. Export from the Burdekin Catchment is dominated by very high levels of fine suspended sediment. This sediment is derived from grazing related erosion that occurs throughout the catchment (ACTFR 2003). Total suspended sediment concentrations in areas affected by grazing generally range from 25 – 960 mg/L. Areas that have been particularly affected by the loss of riparian vegetation (e.g. Pelican, Creek, Bowen River and Burdekin River) have medium total suspended sediment concentrations as high as 3 000 – 6 000 mg/L (Bainbridge *et al*. 2006a,b). The QWQG for suspended sediment for lowland habitats is 10 mg/L. The majority of sediment discharged into the Great Barrier Reef from the Burdekin Catchment is deposited within approximately 10 km of the Burdekin Delta (ACTFR 2003).

Inputs of dissolved nutrients (i.e. Nitrogen and Phosphorous) also occur within the Burdekin catchment during high flows. Overall the concentration of nutrients within the catchment is relatively low however high concentrations can occur in areas affected by irrigated cropping (i.e. lower Burdekin Basin and small areas of the Suttor and Belyando Basins) (ACTFRA 2003).

Outside of flooding conditions, water flows within the Burdekin Catchment generally cease or are slow flowing. Water quality during these no/low flow conditions is highly variable on a temporal and spatial

scale and is largely influenced by local conditions (CSIRO 2002). The key parameters influencing water quality during this period are turbidity; pH; temperature; salinity; oxygen levels and nutrient and contaminant levels. Land use is considered to be the main influence on these parameters at a local scale and cattle loitering in waterholes and within riparian vegetation is known to be particularly degrading to water quality (CSIRO 2002). Disturbance to the banks and surrounds of waterholes by cattle (e.g. hoof prints) in the study area was common and widespread and indicated heavy use of such resources by local cattle.

Salinity is currently one of the main water quality issues within the Burdekin Catchment and conditions are expected to worsen in the future as a result of vegetation clearing and its effects on the hydrological balance of the region. Dryland salinity occurs when deep-rooted native trees are replaced with shallow-rooted annual agricultural plants. Often these shallow-rooted annuals use less water than the natives they replace leading to a rise in the water table, bringing dissolved salts that were previously stored deep in the soil to the root zone of plants (Robertson *et al.* 2009). This rise in dissolved salts stunts the growth of many plants and can lead to widespread mortality. The key area of concern with respected to dryland salinity is the south-eastern area of the Belyando Basin (CSIRO 2002). Potential impacts as a result of dryland salinity include: loss of soil productivity; reduced water quality and loss of biodiversity. Vegetation clearing is suspected as the cause of dryland salinity in this area however there is little data available to confirm the extent and severity of this risk (CSIRO 2002).

Additional impacts on water quality within the Burdekin Catchment are associated with land degradation and include soil erosion; invasion of terrestrial weeds; loss of riparian vegetation and loss of palustrine habitats. These impacts are primarily driven by grazing management practises (CSIRO 2002). Overgrazing and inadequate fire regimes have resulted in a reduction in ground cover and increase in soil damage. These impacts have resulted in an increase in erosion with hillslope erosion the main source of sedimentation in the catchment (CSIRO 2002).

Terrestrial and aquatic weeds have also increased as a result of grazing which can open up the vegetation cover and allow invasive weeds to establish. A number of Weeds of National Significance and declared weeds under the QLD *Land Protection (Pest and Stock Route Management) Act 2002* occur throughout the catchment. These weeds degrade riparian and aquatic habitats and out-compete native species that provide sheltering and foraging resources for aquatic fauna.

Clearing of riparian vegetation for the purposes of gazing has occurred on a wide scale throughout the catchment. The loss of riparian vegetation has a direct impact on water quality as a result of increased channel and bank erosion, increased weed infestation and increased input of nutrients (CSIRO 2002). The loss of riparian vegetation also reduces the diversity and abundance of in-stream habitats in the form of under cut banks and decreases foraging resources (e.g. riparian seeds and berries) available for aquatic fauna.

The water quality of palustrine habitats is also influenced by the loss of riparian vegetation through exposure to increased sunlight and temperatures and increased input of sediments and nutrients due to reduced buffering. Direct access of cattle into palustrine habitats has also contributed significantly to the degradation of these habitats. Many of the palustrine habitats within the Burdekin Catchment, particularly in the coastal regions, have been destroyed or modified as a result of land use practises (CSIRO 2002).

The water quality conditions recorded at each of the survey sites are discussed below and detailed in Appendix C.

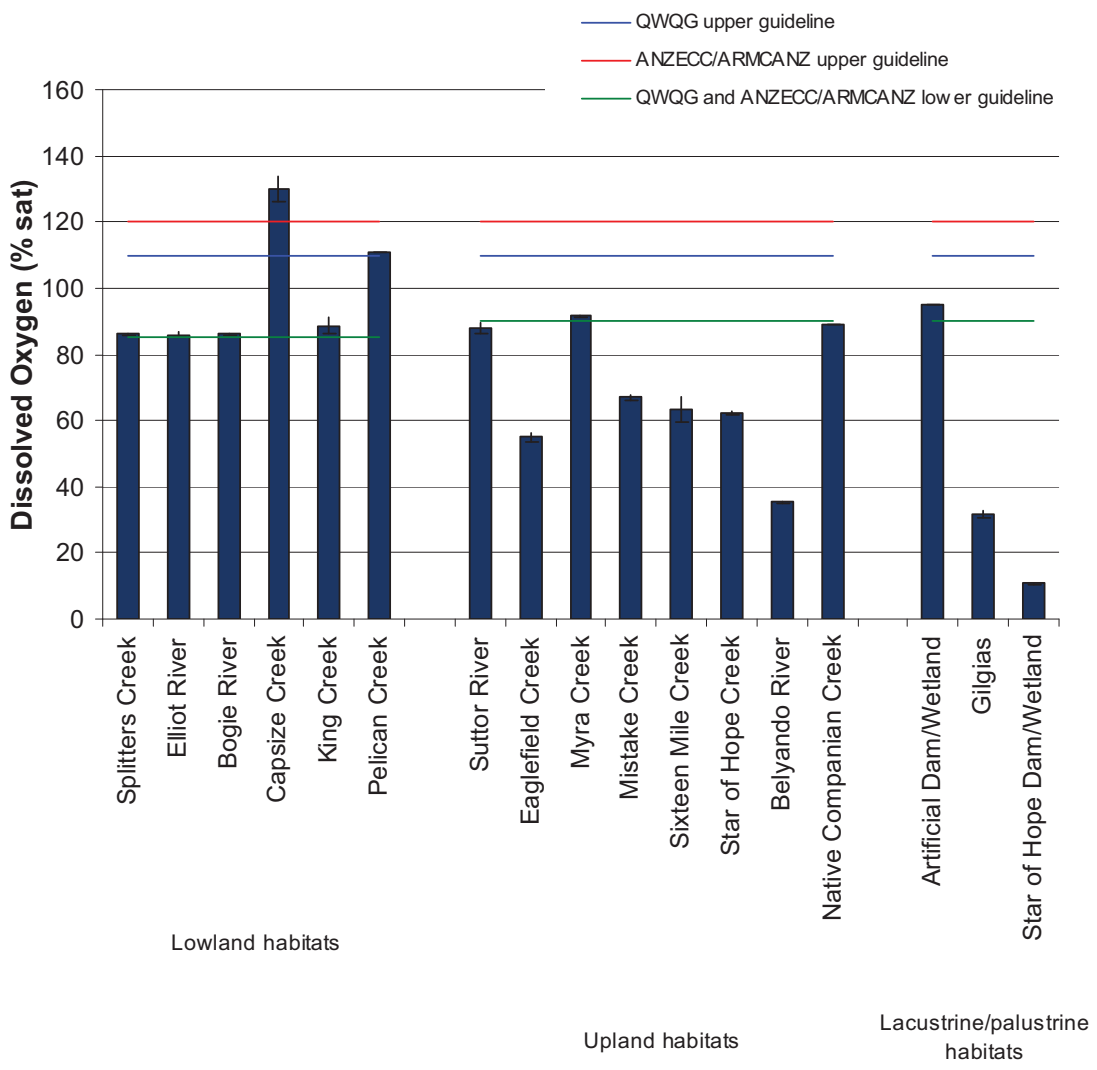
3.4.1 Dissolved Oxygen

Dissolved oxygen levels within the study area ranged from a mean (± standard error) of 10.89 ± 0.28% in the Star of Hope Dam/Wetland to 130.01 ± 4.03% in Capsize Creek (Figure 5). The dissolved oxygen levels of the upland habitats were generally lower than those of the lowland habitats with the exception of Suttor River and Myra Creek.

With the exception of two sites (Myra Creek and Artificial Dam/Wetland) all were below guideline values for Upland and Palustrine/Lacustrine habitats. Two of the three lacustrine and palustrine habitats (i.e. Gilgai's and Star of Hope Dam/Wetland) were substantially below the water quality guidelines for these habitat types (QWQG and ANZECC/ARMCANZ lower - 90%; QWQG upper - 110%; ANZECC/ARMCANZ upper -120%.

All Lowland habitats were within guideline values except one (Capsize Creek) which was above.

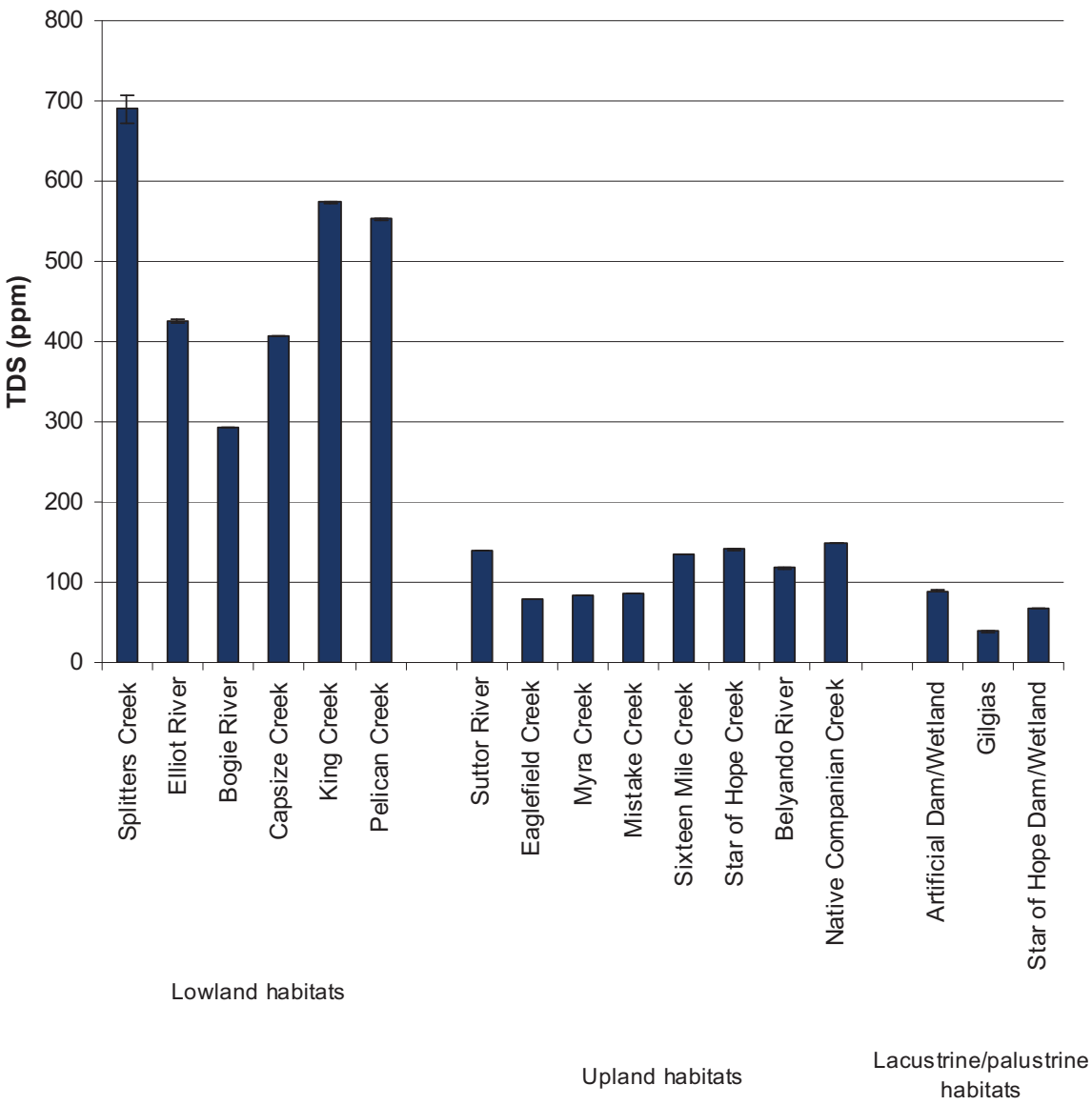
Figure 5 Dissolved Oxygen Level (%) of Aquatic Habitats in the Study Area



3.4.2 Total Dissolved Solutes

Mean (± standard error) total dissolved solutes (TDS) in aquatic habitats within the study area varied between habitat types (Figure 6). Lowland habitats recorded the highest levels of TDS and ranged from a low of 293.30 ± 0.45 ppm in the Bogie River to a high of 690.30 ± 17.42 ppm in Splitters Creek. Total dissolved solute concentrations were substantially lower in the upland and lacustrine/palustrine habitats. Values in these habitats ranged from 38.81 ± 1.25 ppm in the Gilgais to 148.50± 0.17 ppm in Native Companion Creek.

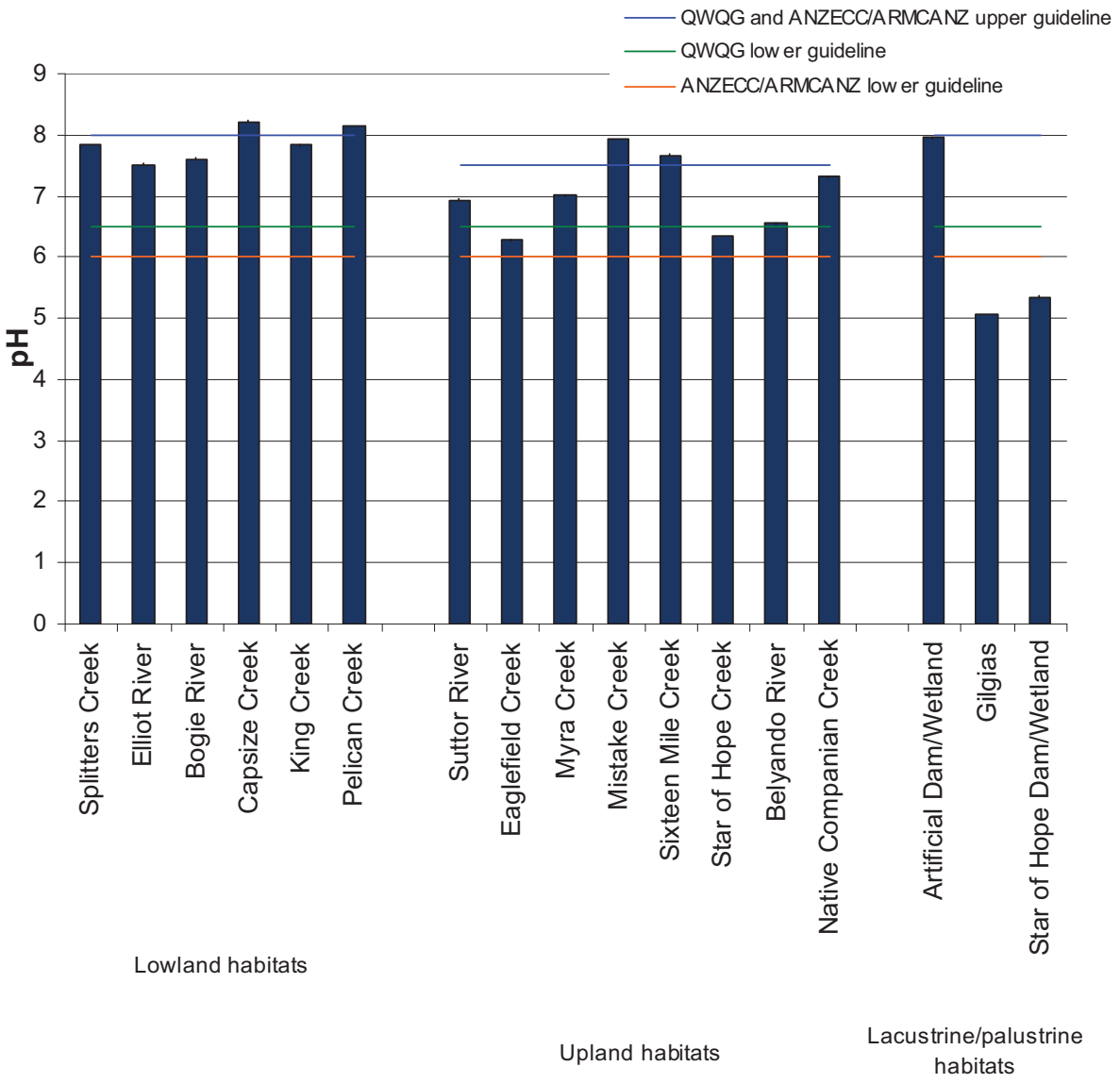
Figure 6 TDS (ppm) of Aquatic Habitats in the Study Area



3.4.3 pH

The pH of aquatic habitats within the study area ranged from a mean (± standard error) of 5.065 ± 0.010 in the Gilgais to 8.218 ± 0.010 in Capsize Creek (Figure 7). Overall pH was relatively stable between habitats, particularly the lowland habitats in which pH across all six habitats varied by a maximum of 0.627. The pH of the lowland habitats were all within the QWQG and ANZECC/ARMCANZ water quality guidelines for lowland habitats (QWQG lower - 6.5; ANZECC/ARMCANZ lower - 6; QWQG and ANZECC/ARMCANZ upper - 8) except for Capsize and Pelican Creeks which were both above the upper guidelines values (i.e. 8). The pH of the upland habitats was generally lower than that of the lowland habitats. Upland habitats recorded pH values below the QWQG lower guidelines (i.e. 6.5) in Eaglefield Creek and Star of Hope Creek and above the QWQG and ANZECC/ARMCANZ upper guidelines (i.e. 7.5) in Mistake Creek and Sixteen Mile Creek. The pH values of the Gilgais and Star of Dam/Wetland habitats were substantially lower than all other aquatic habitats and were much lower than both the lower QWQG and ANZECC/ARMCANZ guidelines for these habitats types (i.e. QWQG lower - 6.5; ANZECC/ARMCANZ lower - 6; QWQG and ANZECC/ARMCANZ upper - 8).

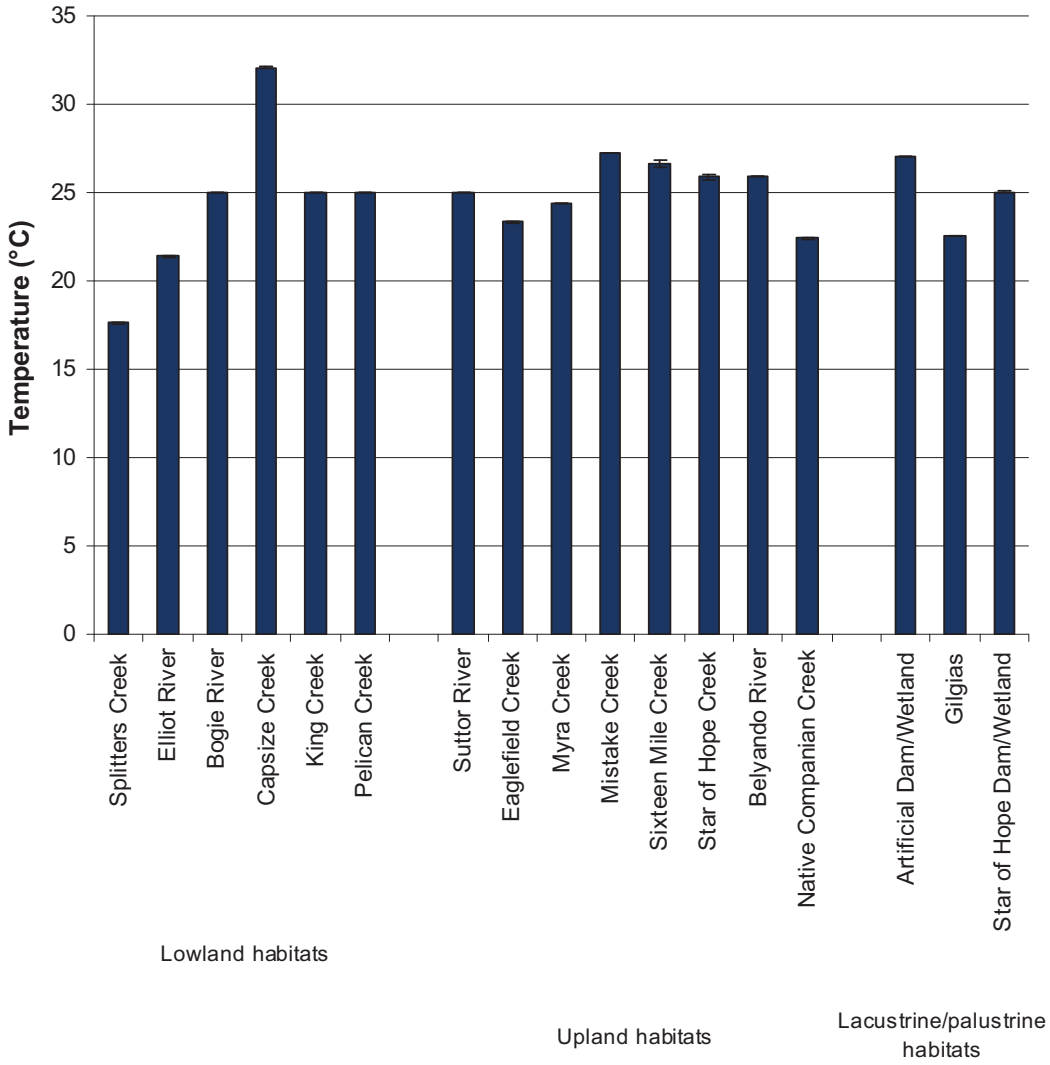
Figure 7 pH of Aquatic Habitats in the Study Area



3.4.4 Temperature

Mean temperature (± standard error) within the study area ranged from a low of 17.61 ± 0.03°C in Splitters Creek, to a high of 32.08 ± 0.02°C (Figure 8). Due to the low water depths within the majority of aquatic habitats surveyed, air temperature had a significant influence on water temperature measures.

Figure 8 Temperature (°C) of Aquatic Habitats in the Study Area

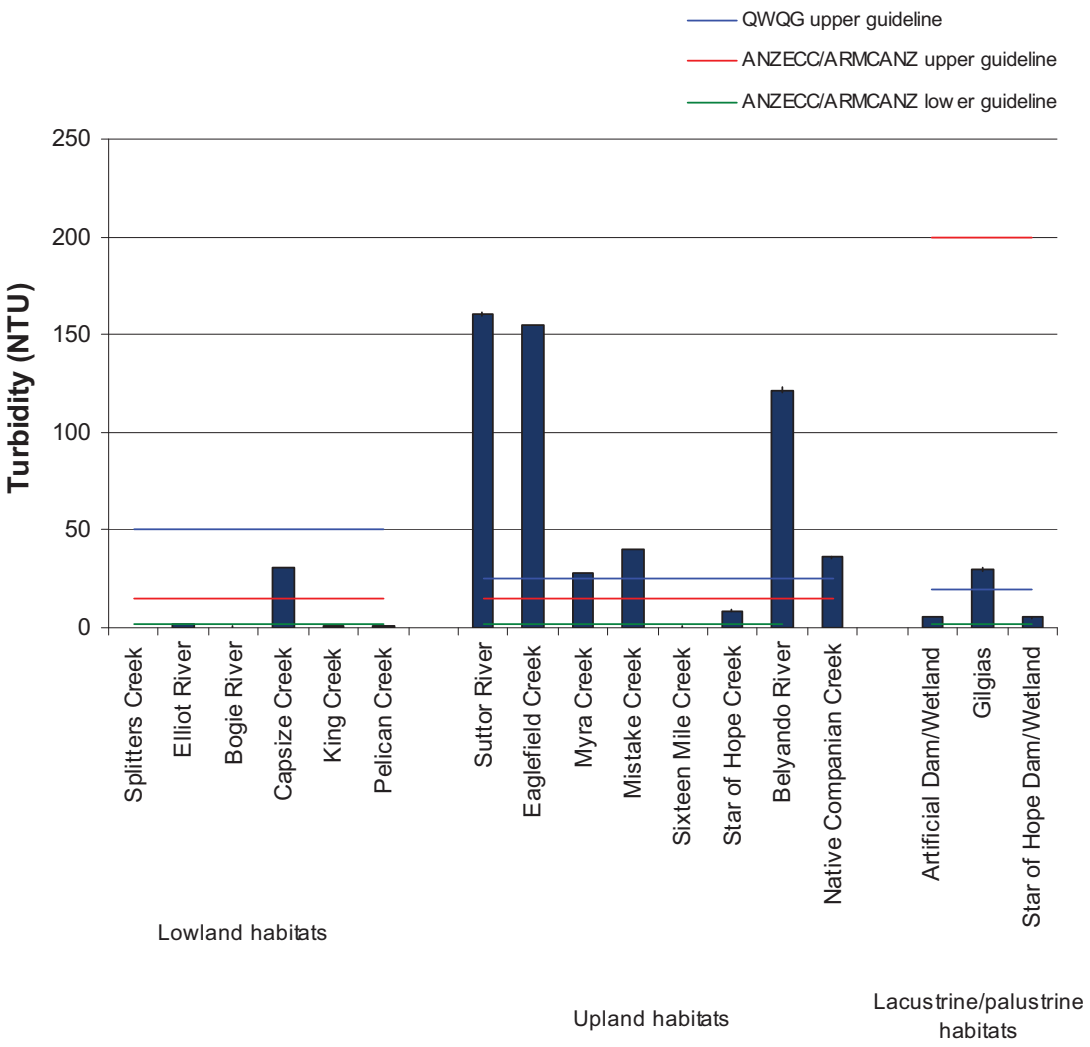


3.4.5 Turbidity

Turbidity values within the study areas varied substantially between lowland, upland and lacustrine/palustrine habitats (Figure 9). Turbidity within the lowland habitats was generally low and below QWQG and ANZECC/ARMCANZ upper water quality guidelines which are 50 NTU and 15 NTU, respectively. The one exception was Capsize Creek which recorded a turbidity value of 30.88 ± 0.27 NTU. This value was above the ANZECC/ARMCANZ guideline. Turbidity within the upland habitats was

generally substantially higher than lowland and lacustrine/palustrine habitats. Sixteen Mile Creek and Start of Hope Creek were the only upland habitats that recorded turbidity levels below the QWQG and ANZECC/ARMCANZ upper guidelines (QWQG - 25 NTC; ANZECC/ARMCANZ - 15 NTU). Turbidity was particularly high in the Suttor River; Eaglefield Creek and Belyando River. Two of three lacustrine and palustrine habitats within the study area recorded turbidity levels below QWQG and ANZECC guidelines (QWQG - 1-20 NTU; ANZECC - 2-200 NTU). Turbidity within the Gilgais was 29.7 ± 0.65 NTU. This value is above the QWQG guidelines but substantially below the ANZECC value.

Figure 9 Turbidity (NTU) of Aquatic Habitats in the Study Area

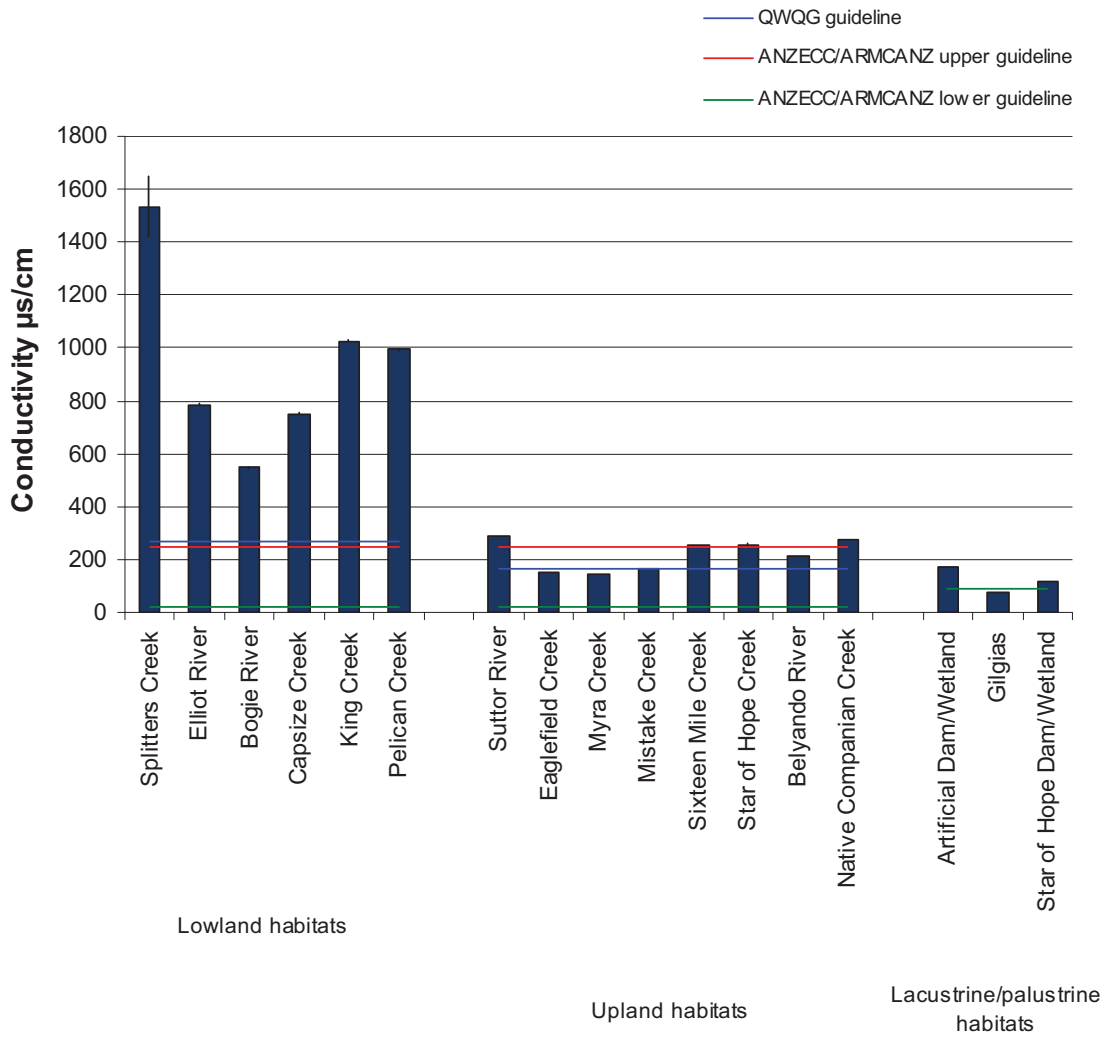


3.4.6 Conductivity

Conductivity of aquatic habitats within the study area was substantially higher in the lowland habitats than that recorded in the upland and lacustrine/palustrine habitats (Figure 10). Conductivity within the lowland habitats ranged from 546.2 ± 0.6 µs/cm in the Bogie River to 1535 ± 114 µs/cm in Splitters Creek. These

values are all above the QWQG guideline value for the Burdekin-Bowen (i.e. 271 µs/cm) and the ANZECC/ARMCANZ upper guideline value (i.e. 250 µs/cm). Conductivity within the upland habitats was lower and generally less variable than those in the lowland habitats, however, only three and four of the eight sites were below the QWQG guideline values for the Belyando-Suttor Rivers (i.e.168 µs/cm) and ANZECC/ARMCANZ upper guideline value (i.e. 250 µs/cm), respectively. The Suttor River recorded the highest conductivity of the upland habitats with a value of 286.0 ± 0.0 µs/cm. Conductivity of the lacustrine/palustrine habitats was generally similar to slightly lower than that of the upland habitats. The Gilgais had the lowest conductivity with a measure of 75.7 ± 0.1 µs/cm. This value was below the ANZECC/ARMCANZ lower guideline value for wetland habitats (i.e. 90 µs/cm) (no upper guideline defined).

Figure 10 Conductivity (µs/cm) of Aquatic Habitats in the Study Area



3.5 Species Diversity

3.5.1 Fish

A total of 55 fish species have been previously recorded or are predicted to occur within the study area. These species include two endemic species, the soft-spined catfish (*Neosilurus mollespiculum*) and the small-headed grunter (*Scortum parviceps*); one translocated native species, the golden perch (*Macquaria ambigua*); and four introduced exotic species, Mozambique tilapia (*Oreochromis mossambicus*), spotted tilapia (*Tilapia mariae*), guppy (*Poecilia reticulata*) and mosquitofish (*Gambusia holbrooki*). No listed-threatened species have been previously recorded or are predicted to occur in the study area.

Two additional native species (eel-tailed catfish (*Tandanus tandanus*) and swamp eel (*Ophisternon bengalense*)) and 14 introduced exotic species are known to occur within the broader Burdekin Catchment. These species have a relatively restricted range within the catchment and are not known to occur within the study area. The leathery grunter (*Scortum hillii*); fork-tailed catfish (*Arius leptaspis*) and firetail gudgeon (*Hypseleotris galii*) have been previously reported in the catchment however it is believed that these species were misidentified (Cater and Tait 2008).

Fish community structure within the Burdekin Catchment is comprised of diadromous; potamodromous and marine vagrant species. Diadromous fish species migrate between the marine and freshwater environment while potamodromous species migrate wholly within freshwater. Marine vagrant species are primarily marine fish species that occasionally inhabit estuarine and freshwater habitats (Cater and Tait 2008).

Diadromous fish species can be distinguished between those that live in freshwater and migrate to the marine environment to breed (catadromous species); those that live in the marine environment and migrate to the freshwater to breed (anadromous) and those that migrate between the marine and freshwater environment but not for the purpose of breeding (amphidromous). The community composition of diadromous fish species in the Burdekin Catchment include: six catrodromous; one anadromous and seven amphidromous species (Table 8).

The distribution of diadromous fish species within the Burdekin Catchment is directly influenced by both natural and artificial barriers to fish passage (Pusey *et al*. 1998). The Burdekin Gorge and Falls in the lower Burdekin Catchment, is a natural barrier that prevents the colonisation of upstream habitats by diadromous species. Artificial impoundments such as Clare Weir have also effected the distribution of these species. As a result of these barriers, diadromous fish species are primarily restricted to the lower Burdekin Catchment resulting in low fish diversity in the upper reaches (Pusey *et al*. 1998). Within the study area, diadromous fish species are predicted to occur in the aquatic habitats north of Bowen River (e.g. Pelican Creek; Bogie River; Elliot River).

The diversity of potamodromous fish species (26 species) within the Burdekin Catchment is relatively low compared to smaller catchments in northern Queensland (Pusey *et al*. 1995; 1998). The two main factors influencing fish diversity and distribution in the catchment include: hydrology and habitat diversity. Flows within the Burdekin Catchment are characterised by short periods of high flows interspersed by long dry periods. Historical periods of extended drought (e.g. 5 years) are likely to have prevented the colonisation of the catchment by specialist species and those with low tolerance to changing environmental conditions (Pusey *et al*. 1998). Habitat diversity is one of the most important factors influencing fish species diversity in Australia (Gorman and Karr, 1978; Pusey *et al*. 1995). Overall the Burdekin Catchment supports a low diversity of aquatic habitats and microhabitats with the system primarily characterised by open shallow

water with a sandy/gravel substrate and little in-stream debris or macrophytes (This Study; Pusey *et al*. 1998). This environment provides habitat for generalist species but supports little resources for specialist species resulting in low species richness. The degradation of aquatic habitats as a result of land use practises (refer to Section 3.1 and 3.4) has further reduced the availability of habitat resources for fish species throughout the catchment.

A total of 14 marine vagrant species are predicted to occur within the estuarine and lower freshwater reaches in the lower Burdekin Catchment. The estuarine wetland at the Caley valley and adjacent tidal creeks are likely to provide habitat for these species within the study area. Species confirmed within these habitats during the Abbot Point Multi Cargo Facility EIS (GHD 2010) included barramundi (*Lates calcarifer*); crested perch (*Terapon jarbua*), sea mullet (*Mugil cephalus*), spotted scat (*Scatophagus argus*) and banded scat (*Selenotoca multifasciata*).

The barramundi is a key target of the Queensland East Coast Inshore Fin Fish Fishery (DEEDI 2009). While commercial fishing does not occur within the study area, the individuals that occur within the Caley Valley Wetland are considered a potential component of the commercial fishery. Other commercially-important species occurring/potentially occurring in the northern section of the proposed alignment (i.e. Caley Valley Wetland) include sea mullet (*Mugil cephalus*); mangrove jack (*Lutjanus argentimaculatus*) and long-finned eel (*Anguilla reinhardtii*). Important recreational species include barramundi, mangrove jack; jungle perch (*Kuhlia rupestris*); golden perch (*Macquaria ambigua*); blue catfish (*Arius graeffei*); black catfish (*Neosiluris ater*); sleepy cod (*Oxyeleotris lineolata*); sooty grunter (*Hephaestus fuliginosus*); oxeye herring (*Megalops cyprinoides*); snub-nosed garfish (*Arrhamphus sclerolepis*); pikey black bream (*Acanthopagrus berda*); seven-spot archerfish (*Toxotes chatereus*).

The fish species that do occur in the Burdekin Catchment are adapted to the highly dynamic and variable nature of the system and this is represented in the specific foraging, breeding and sheltering preferences of the species. A review of the ecology of fish species known to occur within the Burdekin Catchment revealed that most species prefer (or are tolerant of) the still or slow flowing conditions that are present for much of the year (Pusey *et al.* 2004; Allen *et al.* 2003). Within the study area, the larger rivers such as the Suttor and Bowen Rivers, which contain turbid waters with a higher abundance of in-stream debris, provide habitat for larger-bodied pelagic (e.g. freshwater longtom (*Strongylura krefftii*), golden perch (*Macquaria ambigua*)) and benthic (e.g. Rendahl's catfish (*Porochilus rendahli*)) species. In comparison, the shallow, ephemeral creeks are likely to be primarily inhabited by small species that have a preference for sandy substrates (e.g. western carp gudgeon (*Hypseleotris klunzingeri*); eastern rainbowfish (*Melanotaenia splendida splendida*) and spangled perch (*Leiopotherapon unicolor*)). Juvenile spangled perch were observed in high abundance in these habitats during field surveys (Plate 1).

Foraging and breeding of the majority of fish species is associated with in-stream microhabitats in the form of fallen logs, undercut banks, root masses, complex substrates (e.g. cobble) and macrophytes. Lacustrine and palustrine habitats generally contain a relatively high diversity of in-stream microhabitats and as a result provide habitat for a range of species including black catfish (*Neosilurus ater*) and purple-spotted gudgeon (*Mogurnda adspersa*). Off-stream water bodies also provide breeding and nursery habitat for fish species (particularly diadromous species) and the breeding season of a number of species (i.e. barramundi (*Lates calcarifer*), long-finned eel (*Anguilla reinhardtii*), oxeye herring (*Megalops cyprinoides*) and empire gudgeon (*Hypseleotris compressa*)) is known to occur during the wet season when flows within the river are increased and the off-stream water bodies are connected to the river system facilitating access to these microhabitat environments (Reynolds 1983; Pusey *et. al.* 2004; Stuart

and Berghuis 1997). Water flows are recognised as one of the most important factors influencing the migration of tropical river fish communities (Baran 2006; Sheaves *et al.* 2007).

A species specific description of the ecology, including distribution, habitat preferences, dietary requirements, movement behaviours and environmental tolerance of the 55 species predicted to occur within the study area is provided in Table 8.

Plate 1 Spangled perch (*Leiopotherapon unicolor*) captured from small isolated pool within Sixteen Mile Creek

Table 8 Ecology of the Fish Species in the Study Area

Family	Species	Distribution within the Study Area	Habitat Preferences	Diet	Movement Behaviour	Environmental Tolerance
Catadromous						
Anguiillidae	Long-finned eel (*Anguilla reinhardtii*)	Historically distributed throughout the Burdekin Catchment but is now uncommon upstream of the Burdekin Falls Dam Distribution source: Pusey *et al*. 2004; QLD Museum; WildNet; Carter and Tait 2008	Prefers high gradients, shallow depths and high velocities in riffles and runs however will inhabit lakes, swamps, flood plains and impoundments. Adults most commonly occur around 100 km upstream of the river month while juveniles are generally found at lower elevations Oceanic waters are required for breeding	Omnivorous - juveniles and sub-adults predominantly take invertebrate prey, whilst adults feed on fish, aquatic and terrestrial invertebrates and vegetation matter	Adults – catadromous, migrate from sea during late summer – autumn for spawning. Also move within the river for habitat and dispersal. Passage between freshwater and saltwater habitats an obligatory component of species' life history Juveniles (elvers) – migrate from the sea to coastal rivers during spring - summer	Rising flows and increasing water temperature suspected as cues for movement Possess a significant hypo-osmoregulatory ability Tolerance to hypoxic conditions Notoriously hardy species
Anguiillidae	Pacific short-finned eel (*Anguilla obscura*)	Historically distributed throughout the Burdekin Catchment but is now uncommon upstream of the Burdekin Falls Dam. May also occur in the Bowen River Distribution source: Carter and Tait 2008	Lower reaches of rivers and brackish coastal lagoons. Also known to occur in streams, swamps and impoundments Juveniles commonly occur in estuarine areas Oceanic waters are required for breeding	Omnivorous - juveniles and sub-adults predominantly take invertebrate prey, whilst adults feed on fish, aquatic and terrestrial invertebrates and vegetation matter	Catadromous - passage between freshwater and saltwater habitats an obligatory component of species' life history Downstream migration thought to peak during summer and autumn months (November – May)	Notoriously hardy species *A. obscura* recorded over wide range of water quality conditions Rising flows and increasing water temperature suspected as cues for movement
Centropomidae	Barramundi (*Lates calcarifer*)	Recorded in the lower Burdekin River and Elliot River. Have been	Variety of freshwater, brackish and coastal habitats. Prefers areas	Carnivorous - feed on micro- and macro-invertebrates	Adults – catadromous, migrate from the river to the sea to spawn.	Require elevated salinity and temperature in order to

Family	Species	Distribution within the Study Area	Habitat Preferences	Diet	Movement Behaviour	Environmental Tolerance
		stocked above Burdekin Falls Dam; Clare Weir and in the Bowen River Distribution source: WildNet; Carter and Tait 2008	with submerged logs and rock ledges River months are required for breeding Floodplain habitats highly important for larvae	and fish	Passage between freshwater and saltwater habitats an obligatory component of species' life history Juveniles move upstream from estuarine nursery habitats for dispersal. Peak movement occurs October - December	breed Tolerant of elevated turbidity Recorded over a pH range of 4.0 to 7.2 Rising flows and increasing water temperature suspected as cues for movement
Eleotridae	Snakehead gudgeon *(Giurus margaritacea)*	Expected to occur in the lower Burdekin Catchment Distribution source: Pusey *et al*. 2004; DERM Wetlandinfo; Carter and Tait 2008	Actively selects habitats with woody debris in areas of very low flow velocity. Also areas with undercut banks and macrophytes Museum records of occurrence in the Burdekin	Limited information. Known to eat aquatic invertebrates	Potentially Catadromous – little information known however larvae have been observed in marine and estuarine environments	Tolerant to low levels of dissolved oxygen Generally observed in clear flowing streams suggesting potential low tolerance to turbidity
Gobiidae	Flathead goby (*Glossogobius giuris*)	Recorded from the lower Burdekin Catchment Distribution source: WildNet; Pusey *et al*. 2004; Carter and Tait 2008	The species has mainly been collected from sandy substrates near macrophytes	Feed mainly on aquatic macroinvertebrates	Catadromous – adults migrate to the sea to breed Know to navigate fishways	Preference for well-oxygenated water Can tolerate marine environments
Kuhliidae	Jungle perch *(Kuhlia rupestris)*	Has been recorded in the Burdekin River below Clare Weir. No longer exists in the Broken/Bowen Rivers	Prefers streams with large amounts of cover including macrophyte beds, leaf litter and woody debris. No preference for substrate	Carnivorous: Terrestrial and aquatic insects	Catadromous Highly mobile species travelling extensively in a single day	Only recorded in well oxygenated water Can survive in slightly acidic waters

Family	Species	Distribution within the Study Area	Habitat Preferences	Diet	Movement Behaviour	Environmental Tolerance
		Distribution source: Pusey *et al*. 2004; DERM Wetlandinfo; Carter and Tait 2008	types Generally associated with fast flowing waters. Captured in deeper parts of rivers		Spawning takes place in brackish habitats Barriers to movement implicated in demise of species from many rivers	Generally occurs in clear water streams. Not likely to tolerate turbid waters for long periods. *K rupestris* is a visual predator and poor water clarity is likely to reduce food intake Population has undergone a dramatic reduction
Amphidromous						
Ariidae	Blue catfish (*Arius graeffei*)	Recorded in the lower Burdekin Catchment and Bowen River. Distribution source Pusey *et al*. 1998; QLD Museum; WildNet; Carter and Tait 2008	Variety of habitats including coastal marine waters, estuaries, and freshwater rivers. Also known to inhabit impoundments. Utilise off-channel floodplain habitats	Omnivorous generalist feeder, bulk of diet comprising invertebrate prey	Amphidromous – although adults can complete entire life cycle in river Movement can occur on range of flows but mostly during low flows. Little movement is thought to occur in winter months	Tolerate a range in water clarity but prefer clear waters Rising flows and increasing water temperature are suspected as cues for movement
Belonidae	Freshwater longtom (*Strongylura krefftii*)	Known to occur in the lower Burdekin Catchment below the Burdekin Falls Distribution source Pusey *et al*. 1998; QLD Museum; WildNet; Carter and Tait 2008	Various freshwater habitats including rivers, creeks and lagoons. Occurs in still and slow flowing water. A pelagic species that often ambushes prey on the surface. Aquatic macrophytes thought to be important spawning site	Carnivorous ambush predator – small fish are the major prey item	Amphidromous - predominantly a freshwater species that rarely occurs in marine estuarine environments. As spawning is thought to occur in freshwater, does not necessarily need access to marine environment as part of life history requirements Spawning thought to	Collected from areas with low conductivity and generally high water clarity. High water clarity important due to ambush hunting technique which is dependent on vision Increasing water temperature suspected as a cue for movement

Family	Species	Distribution within the Study Area	Habitat Preferences	Diet	Movement Behaviour	Environmental Tolerance
					occur during northern Australian wet season (November – April)	
Gobiidae	Roman nose goby (*Awaous acritosus*)	Recorded from the lower Burdekin and Bowen Rivers Distribution source: Carter and Tait 2008	Slow flowing habitats with sandy substrate	Feeds predominately on aquatic plant matter including diatoms and desmids	Amphidronmous – thought to make downstream spawning migrations Adults move upstream during low flows for foraging	Prefers well oxygenated waters Low flows suspected as a cue for movement
Gobiidae	Speckled goby (*Redigobius bikolanus*)	Recorded from the lower Burdekin Catchment and Bowen River Distribution source: Pusey *et al*. 2004; DERM Wetlandinfo; Carter and Tait 2008	Broad range of habitat use including brackish and estuarine habitats, and freshwater rivers and streams. Thought to prefer open, sunny habitats over heavily vegetated areas	Predominantly carnivorous with aquatic insects the major food source	Amphidromous – eggs and larvae develop in downstream reaches of rivers with adults migrating upstream	Freshwater species however recorded in brackish waters Intolerant of low levels of dissolved oxygen
Hemiramphidae	Snub-nosed garfish (*Arrhamphys sclerolepis*)	Recorded in the lower Burdekin Catchment and the Elliot River Distribution source: Pusey *et al*. 1998; WildNet; Carter and Tait 2008	Shallow habitats in coastal and estuarine waters, lower reaches of freshwater systems, and freshwater impoundments. Can be found further inland in river systems with low average gradients such as the Burdekin River Found close to the surface in open stretches of river or large waterholes	Predominantly herbivorous, with filamentous algae representing a principle food source	Amphidromous – thought to breed in estuaries under natural conditions, but capable of completing entire life-cycle in freshwater impoundments	Limited information on this species environmental tolerances Increasing water temperature suspected as a cue for movement

Family	Species	Distribution within the Study Area	Habitat Preferences	Diet	Movement Behaviour	Environmental Tolerance
Megalopidae	Oxeye herring (*Megalops cyprinoides*)	Historically recorded upstream to the Bowen River. Distribution reduced in systems due to fish passage barriers Distribution source: Pusey *et al*. 1998; Pusey *et al*. 2004; Carter and Tait 2008	Coastal, estuarine and freshwater habitats. Juvenile fish may utilise smaller backwaters branching off larger rivers. Habitats with an abundance of macrophytes are preferred Estuarine and near-shore oceanic habitats required for breeding	Predominantly carnivorous, taking small fish, aquatic and terrestrial insects and crustaceans	Amphidromous - spawning occurs in estuarine and near-shore coastal environments. Juveniles move upstream into freshwater environment. Passage between freshwater and saltwater habitats is not considered essential for species' life cycle Adults migrate to marine environments to breed between December and March. Juveniles migrate upstream into freshwater habitats between January and May	The species is tolerant of hypoxic conditions due to its ability to extract oxygen from the air (facultative air-breather) Able to withstand abrupt transfer from fresh to brackish water Generally thought to be a hardy species adapted to seasonal wetlands with substantial fluctuations in physicochemical conditions Tolerant of elevated turbidity however may interfere with prey capture Increasing water temperature suspected as a cue for movement
Mugilidae	Sea mullet (*Mugil cephalus*)	Historically recorded within the lower Burdekin and Bowen Rivers however current distribution impacted by fish passage barriers Distribution source: Pusey *et al*. 2004; DERM Wetlandinfo; Carter and Tait 2008	In freshwater habitats tends to avoid fast flowing waters, with a preference for shallow waters with a soft benthos Oceanic waters required for breeding	Omnivorous, with algae and detritus the core components of the diet of this species	Amphidromous – as spawning occurs in the marine environment passage between freshwater and saltwater habitats an obligatory component of species' life history Spawning occurs in the sea – adults migrate in large schools to river mouths and adjacent coastlines during winter months. Juvenile fish	Tolerate both fresh and salt water

Family	Species	Distribution within the Study Area	Habitat Preferences	Diet	Movement Behaviour	Environmental Tolerance
					migrate up rivers during spring / summer months. 1 -2 year old fish occasionally make non-spawning related migrations to the marine environment	
Potamodromous						
Apogonidae	Mouth almighty (*Glossamia aprion*)	Known to occur throughout the lower Burdekin Catchment and the Bowen River Distribution source: Pusey *et al*. 1998; Pusey *et al*. 2004; Carter and Tait 2008	Most habitats with a preference for well-vegetated margins. Preference for submerged cover (leaf litter, root masses, aquatic macrophytes) in low flow environments. Uses structure as cover to launch ambush on prey	Largely carnivorous taking aquatic invertebrates and small fish	Potamodromous – a freshwater species that does not require access to estuarine or marine environment at any stage of life cycle	Is reasonably tolerant of a variety of environmental conditions Increasing water temperature suspected as a cue for movement
Atherinidae	Fly-specked hardyhead (*Craterocephalus stercusmuscarum*)	Occurs throughout the Burdekin Catchment however uncommon in more turbid areas such as Cape/Belyando/Suttor Rivers Distribution source Pusey *et al*. 1998; Carter and Tait 2008	Occurs in a variety of habitats including flood plains, billabongs, brackish estuaries and impoundments. Prefers slow-flowing areas dominated by aquatic vegetation and gravel substrates Aquatic root masses may be important for spawning	Feeds on small aquatic invertebrates and algae	Potamodromous - entire life-cycle (including spawning) occurs in freshwater. Undertakes local dispersal and colonisation movements	This species can tolerate temperatures in excess of 30°C The species has been collected over a fairly large range of physicochemical conditions Increasing water temperature suspected as a cue for movement
Chandidae	Agassiz's glassfish	Known to occur throughout the Burdekin	Well-vegetated areas in rivers, creeks, swamps	Largely carnivorous – microcrustaceans	Potamodromous - adults and juveniles move	Water quality data collected from locations were the

Family	Species	Distribution within the Study Area	Habitat Preferences	Diet	Movement Behaviour	Environmental Tolerance
	(*Ambassis agassizii*)	catchment Distribution source: Pusey *et al*. 1998; QLD Museum; Carter and Tait 2008	and ponds, generally in areas of little or no flow Macrophytes and submerged marginal vegetation preferred for spawning	and small aquatic insects the major prey items	upstream (September-February) for habitat and dispersal, possibly in response to flooding. A freshwater species that does not require access to estuarine or marine environment at any stage of life cycle	species occur suggest tolerance to a wide range of physicochemical conditions (temperature, DO, pH and salinity) Rising flows and increasing water temperature suspected as cues for movement
Chandidae	Sailfin glassfish (*Ambassis agrammus*)	Predicted to occur throughout the lower Burdekin Catchment Distribution source: Pusey *et al*. 2004; Carter and Tait 2008	Macrophytes required for spawning Primarily restricted to lower reach/floodplain habitats	Primarily carnivorous – diest consist of aquatic insects and microcrustaceans. Small amounts of algae and detritus are also consumed	Potamodromous – movement patterns relatively unknown. Juveniles more upstream. Adults may more downstream to spawn	Tolerant of high temperatures (30-40°C) Wide pH tolerance (3.8 – 8.4) Intolerance to low oxygen levels
Cichlidae	Mozambique tilapia* *(Oreochromis mossambicus)*	Introduced exotic species. Has been recorded in the upper Burdekin River Distribution source: Carter and Tait 2008	Inhabits slow flowing rivers and streams and still water habitats such as lakes and lagoons. Occurs in freshwater and brackish habitats	Predominately a benthic feeder on plant material including algae, macrophytes, terrestrial plants and detritus	Potamodromous	Tolerant to a wide range of environmental conditions including low oxygen levels, extreme pH, high and low salinity and high pollution
Cichlidae	Spotted tilapia* (*Tilapia mariae*)	Introduced exotic species. Has been recorded in the upper Burdekin River Distribution source: Carter and Tait 2008	Prefers still or flowing waters with rocky or mud substrate. Occurs in freshwater and estuarine habitats	Primarily a planktivore-opportunistic feeder on filamentous algae, cyanobacteria, detritus, invertebrate and fish eggs	Potamodromous	Can move between freshwater and estuarine habitats

Family	Species	Distribution within the Study Area	Habitat Preferences	Diet	Movement Behaviour	Environmental Tolerance
Clupeidae	Bony bream (*Nematalosa erebi*)	Known to occur throughout the Burdekin Catchment Distribution source: Pusey *et al*. 1998; QLD Museum; WildNet; Carter and Tait 2008	Prefers shallow waters with little or no flow, in creeks, streams and rivers In the Burdekin River abundance is negatively correlated to fast water velocity/gravel and cobble substrate	Omnivorous – detritus a major component of the diet	Potamodromous – adults and juveniles move upstream for dispersal. A freshwater species that does not require access to estuarine or marine environment at any stage of life cycle	Is tolerant of a range of environmental conditions including high turbidity Reductions in abundance observed in streams receiving mine effluents with elevated copper concentrations Increasing water temperature suspected as a cue for movement
Eleotridae	Empire gudgeon (*Hypseleotris compressa*)	Recorded in the lower Burdekin catchment and Bowen River Distribution source: Pusey *et al*. 1998; QLD Museum; WildNet; Carter and Tait 2008	Lower reaches of rivers, occasionally estuarine waters. Prefers still or slow-flowing waters with underwater structure Oviposition likely to occur on aquatic macrophytes, rocks and woody debris	Omnivorous – feeds on small invertebrate prey and vegetation matter	Potamodromous - a predominantly freshwater species where access to estuarine or marine environments is not an essential component of the life history Upstream migrations for spawning and juvenile dispersal occur in late spring and early summer	The species has been described as being tolerant of water quality degradation Species collected over a relatively wide range of physicochemical conditions Rising flows and increasing water temperature are suspected as cues for movement
Eleotridae	Flathead gudgeon (*Philypnodon grandiceps*)	Recorded in the Belyando River and the upper Burdekin River. Expected to occur in the lower Burdekin Catchment Distribution source: QLD Museum; Carter	Predominantly freshwater habitats (creeks, rivers, billabongs) with little or no flow, and underwater structure (vegetation, undercut banks, logs). Also occurs in brackish tidal environments	Predominantly carnivorous, with aquatic insects a favoured food item	Facultative potamodromous - a predominantly freshwater species where access to estuarine or marine environments is not an essential component of the life history. However	Species collected in a wide range of physicochemical conditions Tolerant of water quality and habitat degradation Rising flows and increasing water temperature are suspected as cues for

Family	Species	Distribution within the Study Area	Habitat Preferences	Diet	Movement Behaviour	Environmental Tolerance
		and Tait 2008	Know to inhabit riffle to slow flow environments. Prefers areas with abundant cover Rocks and woody debris are required for oviposition		known to move through a system for unknown reasons May move in response to periods of peak flow (August to April)	movement
Eleotridae	Midgley's carp gudgeon (*Hypseleotris species 1*)	Known to occur throughout the Burdekin Catchment Distribution source: Pusey *et al*. 1998; QLD Museum; Carter and Tait 2008	Streams, creeks, swamps, wetlands and ponds boasting underwater structure such as aquatic vegetation, rocks and logs. It is a benthic species that is often in direct contact with the substrate Hard surfaces near the substrate are preferred for oviposition	Predominantly carnivorous, with aquatic insects a favoured food item	Potamodromous - a freshwater species that does not require access to estuarine or marine environment at any stage of life cycle. However large schools undertake upstream dispersal Spawning peaks between September and January	Regarded as a hardy species that can tolerate poor water quality The species has been collected in heavily degraded habitats Present in inland desert drainages suggesting a high temperature Tolerance. Also tolerant of highly turbid environments Increased water temperature and day length are suspected as cues for movement
Eleotridae	Purple-spotted gudgeon (*Mogurnda adspersa*)	Widespread throughout the Burdekin Catchment Distribution source: Pusey *et al*. 1998; QLD Museum; Carter and Tait 2008	Avoids areas of high water flow. Generally seeks out aquatic vegetation in slow-flowing parts of rivers and streams, often with rocky substrate. Also noted in still water bodies including billabongs. The species	Predominantly carnivorous, with aquatic insects a favoured food item	Potamodromous - a freshwater species that does not require access to estuarine or marine environment at any stage of life cycle	Species collected over a relatively wide range of physicochemical conditions Increasing water temperature suspected as a cue for movement

Family	Species	Distribution within the Study Area	Habitat Preferences	Diet	Movement Behaviour	Environmental Tolerance
			is highly dependent on bank-side structure Aquatic macrophytes, rocks and woody debris required for oviposition			
Eleotridae	Sleepy cod (*Oxyeleotris lineolata*)	Translocated above Burdekin Falls and now widely distributed in the upper and lower catchment including the Bowen and Belyando Rivers Distribution source: Pusey *et al*. 1998; Pusey *et al*. 2004; QLD Museum; Carter and Tait 2008	Slow-flowing water amongst submerged structure (vegetation, timber) in rivers, creeks, lagoons and billabongs. Found in both river and upper floodplain environments. Thrive in a variety of locations Large woody debris is a key requirement for spawning and general cover	Predominantly carnivorous, with aquatic insects a favoured food item	Potamodromous – does not make substantial migrations and does not require access to estuarine or marine environment at any stage of life cycle	Tolerant of turbid conditions. Collected in muddy lagoons with mud substrate Species is not a powerful swimmer and is considered to be a still/slow flow species. Tolerant of hypoxia in still pools High thermal range (15°C – 38°C). Not tolerant of saline conditions and can only survive in freshwater Rising flows associated with rainfall and increasing water temperature are suspected as cues for colonisation movement
Eleotridae	Western carp gudgeon (*Hypseleotris klunzingeri*)	Known to occur throughout the Burdekin Catchment Distribution source: Carter and Tait 2008	Avoids areas of high water flow. Seeks out aquatic vegetation in slow-flowing parts of rivers and streams. Also still water bodies such as lakes and impoundments Aquatic macrophytes,	Predominantly carnivorous, with aquatic insects a favoured food item	Potamodromous - a freshwater species that does not require access to estuarine or marine environment at any stage of life cycle May move upstream to spawn during the wet	Increased water temperature and day length are suspected as cues for movement

Family	Species	Distribution within the Study Area	Habitat Preferences	Diet	Movement Behaviour	Environmental Tolerance
			submerged marginal vegetation and woody debris may be important for oviposition		season	
Melanotaeniidae	Eastern rainbowfish (*Melanotaenia splendida splendida*)	Recorded throughout the Burdekin Catchment Distribution source: Pusey *et al*. 1998; QLD Museum; WildNet; Carter and Tait 2008	A habitat generalist that occurs in a wide array of still to slow-flowing freshwater habitats. Includes creeks, swamps, wetlands, rivers and impoundments Most often collected in the middle two- quarters of the water column. Open-water species. Makes use of cover when threatened Aquatic vegetation and root masses preferred for oviposition	Omnivorous – algae and aquatic invertebrates the major component of this species' diet	Potamodromous – a freshwater species that does not require access to estuarine or marine environment at any stage of life cycle	*M. s. splendida* tolerates a large range of water quality conditions The species can tolerate moderate disturbance such as reductions in riparian canopy Tolerates water temperatures of 31°C in the Burdekin River Will not survive abrupt changes in salinity Rising flows and increasing water temperature are suspected as cues for movement
Percichthyidae	Golden perch[2] (*Macquaria ambigua*)	Translated into the Burdekin Catchment. Populations have established in the Belyando, Suttor and upper Burdekin Rivers. Have also been recorded in the lower Burdekin River. Distribution source: Carter and Tait 2008	Inhabits rivers, creeks, billabongs and lakes. Favours deeper, slow-flowing, turbid habitats with an abundance of in-stream debris and shade	Carnivorous – primarily preys on aquatic invertebrates and small fish	Potamodromous - a freshwater species that does not require access to estuarine or marine environment at any stage of life cycle Movement recorded in the Fitzroy River (through the Fitzroy Barrage) during spring and summer months	Tolerant to a wide range of temperatures and low oxygen levels Can move between freshwater and saline environments Tolerant to high turbidity levels Spawning and recruitment triggered by increased flows

Family	Species	Distribution within the Study Area	Habitat Preferences	Diet	Movement Behaviour	Environmental Tolerance
						and water temperatures above 23° C
Plotosidae	Black catfish (*Neosilurus ater*)	Widespread and abundant throughout the Burdekin Catchment Distribution source: Pusey *et al*. 1998; Pusey *et al*. 2004; WildNet; Carter and Tait 2008	A benthic species that prefers still/slow flowing waters in streams and rivers. Also occurs in wetlands, pools, and slow-flowing tributaries and side-channels of rivers. Benthic species in close association with substrate	Omnivorous, although diet dominated by aquatic invertebrates	Potamodromous – a freshwater species that does not require access to estuarine or marine environment at any stage of life cycle Migrations upstream thought to coincide with spawning at the outset of the wet season (January-February) Downstream migration of adults and juveniles post-spawning poorly understood	Can occur in intermittent tributary streams as well large rivers The species has barbels which allow the species to forage in elevated turbidity and low light conditions Rising flows and increasing water temperature are suspected as cues for movement
Plotosidae	Hyrtl's tandan (*Neosilurus hyrtlii*)	Widespread throughout the Burdekin Catchment Distribution source: Pusey *et al*. 1998; WildNet; Carter and Tait 2008	A benthic species that occurs in most freshwater habitats above estuarine reaches Tributary streams and gravel substrates may be important for spawning	Omnivorous, although diet dominated by aquatic invertebrates	Potamodromous – upstream migrations from dry season refugia thought to coincide with spawning	The species has barbels which allow the species to forage in elevated turbidity and low light conditions Rising flows suspected as cue for movement
Plotosidae	Rendahl's catfish (*Porochilus rendahli*)	Widely distributed throughout the catchment including the highly turbid Belyando/Suttor Rivers. However rare in the higher gradient Bowen	A benthic species inhabiting river channels and tributaries generally containing muddy substrate. Usually associated with muddy substrates	Omnivorous, although diet dominated by aquatic invertebrates	Potamodromous – adults migrate downstream to spawn in flooded lowland lagoons Upstream migration of adults and juveniles coincident with the start	Like other species of catfish can tolerate highly turbid water. Well developed tolerance to hypoxia

Family	Species	Distribution within the Study Area	Habitat Preferences	Diet	Movement Behaviour	Environmental Tolerance
		and Broken Rivers Distribution source: Pusey *et al*. 1998; WildNet; Carter and Tait 2008			of the dry season	
Plotosidae	Soft-spined catfish[1] *Neosilurus mollespiculum*	Endemic to the Burdekin Catchment. Reported in the Burdekin River; Belyando River and Bowen River Distribution source: Pusey *et al*. 2004; QLD Museum; Carter and Tait 2008	Sympatric with other plotosidae catfishes and has almost identical habitat requirements	Omnivorous, although diet dominated by benthic aquatic invertebrates	Potamodromous	Limited data Recorded in freshwater only. Not thought to tolerate elevated salinity Observed in both clear waters and areas with high sediment load
Poeciliidae	Guppy* (*Poecilia reticulata*)	Introduced exotic species known to occur in the lower Burdekin River Distribution source: Carter and Tait 2008	Still and slow-flowing water. Predominantly shoal around the margins of water bodies, amongst aquatic and overhanging bankside vegetation	Omnivorous	Potamodromous	Can tolerate a wide range of environmental conditions
Poeciliidae	Mosquitofish* (*Gambusia holbrooki*)	Introduced exotic species known to occur in the lower Burdekin Catchment Distribution source: Pusey *et al*. 1998; Carter and Tait 2008	Shallow, warm waters with little or no flow. Generally occurs along margins of stream bank	Omnivorous	Potamodromous	Hardy introduced species that can survive in degraded habitats Facultative air-breather
Pseudomugilidae	Pacific blue-eye (*Pseudomugil signifer*)	Known to occur in the lower Burdekin and Bowen Rivers (and their	Marine to freshwater environments. Usually frequents habitats	Omnivorous, although diet dominated by	Potamodromous - although this species is known to utilise	Collected over a wide range of physicochemical

Family	Species	Distribution within the Study Area	Habitat Preferences	Diet	Movement Behaviour	Environmental Tolerance
		tributaries) Distribution source: Pusey *et al*. 1998; Pusey *et al*. 2004; Carter and Tait 2008	boasting submerged structure, but may also occur in pools and clear streams. Shallow, flowing water is favoured by this species Breeding can occur in freshwater and saltwater habitats	aquatic invertebrates	estuarine and marine environments, access to saline habitats is not obligatory for survival Rapid recolonisation of previously dry river banks	conditions Intolerant of poor water quality Increased erosion and sediment may threaten spawning habitat and food resources Increasing water temperature suspected as a cue for movement
Terapontidae	Barred grunter (*Amniataba percoides*)	Common and widely distributed in the Burdekin River. Found in upstream tributary streams however absent from the south-west of the catchment (Belyando River). Known to occur in the Elliot River Distribution source: Pusey *et al*. 1998; Pusey *et al*. 2004; QLD Museum; WildNet; Carter and Tait 2008	Benthic species that occurs in still to fast-flowing water Collected in areas with a dominant substrate of sand. Not as associated with bank-side structure as other terapontids	Omnivorous, although diet dominated by aquatic invertebrates	Potamodromous – thought to move downstream in the wet season into lowland floodplains. Access to saline habitats is not obligatory for population viability in this species	Tolerant of highly variable temperature and pH Can tolerant some turbidity however absence from the turbid Belyando River Preference for fast-flowing riffle/run habitat suggests need for well-oxygenated water Recorded in freshwater only Movements associated with spawning correspond with increasing water temperatures and possibly increased day length
Terapontidae	Small-headed grunter[1] (*Scortum parviceps*)	Endemic to the Burdekin Catchment. Patchy distribution in low abundance. Most common in the main channel of the Burdekin	Most common in riverine reaches. Thought to prefer deep (>1m) habitats with a sand, fine gravel substrate and little or no flow	Omnivorous, although diet dominated by algae and macrophytes	Potamodromous – movement patterns relatively unknown however upstream migration prior to spawning is predicted	Recorded in freshwater only and unlikely to tolerate elevated salinity Tolerant of high turbidity levels

Family	Species	Distribution within the Study Area	Habitat Preferences	Diet	Movement Behaviour	Environmental Tolerance
		River and larger south-wet tributaries. Occurs in very low abundance below Burdekin Falls Distribution source: Pusey *et al*. 2004; QLD Museum;Carter and Tait 2008				
Terapontidae	Sooty grunter (*Hephaestus fuliginosus*)	Widely distributed below Burdekin Falls. Rarely found above waterfalls however recorded from Cape River and Suttor River. Not known to occur in the Belyando River Distribution source: Pusey *et al*. 1998; WildNet; Carter and Tait 2008	Large flowing waterways, particularly the upstream reaches of rivers. Prefers habitats boasting woody debris on a sandy or rocky substrate Fast-flowing habitats may be important for spawning	Omnivorous – feeds on aquatic invertebrates, algae and aquatic and terrestrial vegetation	Potamodromous - a freshwater species that does not require access to estuarine or marine environment at any stage of life cycle May migrate between wet season (August – February) spawning grounds (upstream in rapids) and dry season refugia	Found over a wide range of water acidities Preference for lotic habitats suggests need for moderately to well oxygenated water Can tolerant some turbidity however absent from the turbid Belyando River. Turbidity may reduce feeding efficiency (visual predator) Recorded in freshwater only
Terapontidae	Spangled perch (*Leiopotherapon unicolor*)	Known to occur throughout the Burdekin Catchment Distribution source: Pusey *et al*. 1998; QLD Museum; WildNet; Carter and Tait 2008	A generalist species that occurs in most permanent and temporary freshwater habitats including billabongs, bores, impoundments, rivers and streams Non-flowing, shallow habitats with soft substrate are preferred	Omnivorous – feeds on aquatic invertebrates, algae and aquatic and terrestrial vegetation	Potamodromous – depending on locality moves upstream or downstream within the freshwater environment to spawn Spawning migrations coincident with the wet season (October – April). This species may also undertake	Highly tolerant of environmental variability Can tolerant saline conditions but rarely encountered in estuarine areas Observed in pools containing very little water in Burdekin River Despite being a visual

Family	Species	Distribution within the Study Area	Habitat Preferences	Diet	Movement Behaviour	Environmental Tolerance
			for spawning		substantial movements away from dry season habitats as they recede	predator can survive in turbid inland drainages Rising flows and increasing water temperature are suspected as cues for movement
Toxotidae	Seven-spot archerfish (*Toxotes chatareus*)	Widely distributed in the Burdekin River. Once found in Belyando River but now thought to be absent due to highly turbid conditions Distribution source: Pusey *et al*. 1998; Pusey *et al*. 2004; Carter and Tait 2008	Inhabits large low gradient rivers. Not believed to frequent fast-flowing streams or streams with gradients steeper than 1%. Heavily reliant on intact riparian zones. Waterways associated with degraded riparian systems contain very few *T. chatareus*. Juveniles observed in macophyte beds. The fishes generally found in the top one third of the water column	Almost exclusively carnivorous taking mainly terrestrial and aquatic invertebrates	Disperses widely during the wet season. Does not require access to estuarine or marine environment at any stage of life cycle. However barriers to movement expected to have negative impact (reduced food dispersal and passive transport of juveniles downstream).	This species is a visual predator that has a low tolerance to turbidity. Slight increases in turbidity can cause reduction in species abundance Tolerant of a wide range of temperatures and dissolved oxygen levels
Anadromous						
Clupeidae	Southern spratt (*Herklotsichthys castelnaui*)	Inhabits estuarine and lower freshwater reaches between Townsville and Bowen Distribution source: Carter and Tail 2008	Adults predominately inhabit estuarine environments and move into freshwater riffles to breed Juvenilis inhabit lower reaches of freshwater streams and rivers		Adults migrate to freshwater riffle for spawning	Can move between freshwater and marine environments

Family	Species	Distribution within the Study Area	Habitat Preferences	Diet	Movement Behaviour	Environmental Tolerance
Marine vagrant						
Chanidae	Milkfish (*Chanos chanos*)	Occurs in estuarine habitats, streams and floodplain lagoons in the lower Burdekin Catchment. Historically recorded in the Bowen River Distribution source: Carter and Tait 2008	Inhabits estuaries, freshwater streams and floodplain lagoons		Moves between marine, estuarine and freshwater environments	Can move between marine and freshwater environments
Eleotridae	Spangled gudgeon (*Ophiocara porocephala*)	Occurs in estuarine habitats between Townsville and Bowen. Occasionally inhabits lower freshwater reaches Distribution source: Carter and Tail, 2008	Adults inhabit estuaries and lower freshwater creeks while juveniles generally occur in coastal habitats		Adults move into estuarine and lower freshwater habitats	Can move between marine and freshwater environments
Elopidae	Giant herring (*Elops hawaiensis*)	Historically recorded from the lower Burdekin and Bowen Rivers. Sub-adults occur in floodplain lagoons between Townsville and Bowen. Adults primarily marine Distribution source: Carter and Tait 2008	Juveniles inhabit floodplain lagoons while adults primarily inhabit costal marine waters		Juveniles move into coastal floodplain lagoons	Can move between marine and freshwater environments
Engraulidae	Anchovy (*Thryssa hamiltoni*)	Inhabits estuarine and lower freshwater habitats from Townsville	Inhabits estuarine and lower freshwater reaches		Moves between estuarine and lower freshwater habitats	Can move between brackish and freshwater environments

Family	Species	Distribution within the Study Area	Habitat Preferences	Diet	Movement Behaviour	Environmental Tolerance
		to Bowen Distribution source: Carter and Tait 2008				
Gerreidae	Common silver biddy (*Gerres subfasciatus*)	Known to occur in the estuarine and freshwater reaches of the lower Burdekin Catchment Distribution source: Carter and Tait 2008	Inhabits coastal marine waters, estuaries and lower freshwater habitats. Prefers sand and mud substrates	Small invertebrates	Move between marine and freshwater habitats	Can move between marine and freshwater environments
Gerreidae	Threadfin silver biddy (*Gerres filamentosus*)	Known to occur in the estuarine and freshwater reaches of the lower Burdekin Catchment Distribution source: Carter and Tait 2008	Inhabits marine, estuarine and lower freshwater habitats		Juveniles and sub-adults move into lower freshwater habitats	Can move between marine and freshwater environments
Lutjanidae	Mangrove jack (*Lutjanus argentimaculatus*)	Historically penetrated >100 km inland within the Burdekin Catchment. Currently occurs in the Burdekin River below Clare Weir. Distribution source: Carter and Tait 2008	Adults inhabit offshore reefs while mangrove estuaries and freshwater streams are preferred by juveniles	Feeds primarily of fish and crustaceans	Juveniles and sub-adults move from the sea into freshwater habitats	Salinity tolerant – can move between fresh and saline environments
Monodactylidae	Silver batfish (*Monodactylus argenteus*)	Known to occur in marine, estuarine and coastal freshwater streams between Townsville and Bowen Distribution source:	Marine, estuarine and coastal freshwater streams		Juveniles move from the sea to estuarine and freshwater habitats	Can move between marine and freshwater environments

Family	Species	Distribution within the Study Area	Habitat Preferences	Diet	Movement Behaviour	Environmental Tolerance
		Carter and Tait 2008				
Mugilidae	Bluetailed mullet (*Valamugil buchananii*)	Occurs within marine and estuarine waters from Townsville to Bowen Distribution source: Carter and Tait 2008	Inhabits marine and estuarine waters		Moves between marine and estuarine environments	Can move between marine and brackish waters
Mugilidae	Diamond-scale mullet (*Liza vaigiensis*)	Occurs within marine and estuarine waters from Townsville to Bowen Distribution source: Carter and Tait 2008	Inhabits marine and estuarine waters. Prefers shallow sandy areas and mangroves Estuarine dependent		Moves between marine and estuarine environments	Can move between marine and brackish waters
Scatophyagidae	Banded scat (*Selenotoca multifasciata*)	Recorded from floodplain habitats of the lower Burdekin Distribution source: Carter and Tait 2008	Juveniles enter freshwaters during summer months Estuarine dependent	Omnivorous	Moves between marine and estuarine environments	Can move between marine and brackish waters
Scatophyagidae	Spotted scat (*Scatophagus argus*)	Historically recorded in the Burdekin and Bowen Rivers. Currently known from estuarine habitats and coastal freshwater streams from Townsville to Bowen Distribution source: Carter and Tait 2008	Inhabits marine, estuarine and lower freshwater habitats	Omnivorous	Moves between marine and estuarine environments	Can move between marine and brackish waters
Sparidae	Pikey black bream	Inhabits marine and estuarine waters from	Marine and estuarine waters		Moves between marine and estuarine	Can move between marine and brackish waters

Family	Species	Distribution within the Study Area	Habitat Preferences	Diet	Movement Behaviour	Environmental Tolerance
	(*Acanthopagrus berda*)	Townsville to Bowen Distribution source: Carter and Tait 2008	Estuarine dependent		environments	
Terapontidae	Crescent perch (*Terapon jarbua*)	Inhabits marine, estuarine and lower freshwater reaches between Townsville and Bowen Distribution source: Carter and Tait 2008	Inhabits marine, estuarine and lower freshwater habitats		Juveniles migrate from the sea to estuarine and freshwater habitats	Can move between marine and freshwater environments

[1] endemic species; [2] translocated species; * introduced species

Ecological information in table sourced from: Allen *et al.* 2003; Pusey *et al.* 2004; Carter and Tait 2008.

3.5.2 Reptiles

Aquatic reptiles inhabiting the Burdekin Catchment include two crocodile and five freshwater turtle species. A species specific description of the ecology, including habitat preferences, dietary requirements, movement behaviours and environmental tolerances of each species is presented in Table 9 while a brief description is provided below.

Crocodile species known to inhabit the Burdekin Catchment include the estuarine crocodile (*Crocodylus porosus*) and freshwater crocodile (*Crocodylus johnstoni*). The estuarine crocodile is listed as 'Marine' and 'Migratory' under the EPBC Act and 'Vulnerable' under the NCA. Whilst this species is usually associated with tidal coastal and estuarine environments, the estuarine crocodile can occur well inland (hundreds of kilometres) in freshwater habitats such as rivers, creeks, swamps and billabongs (DERM 2009c). Within the Burdekin Catchment the estuarine crocodile has been recorded from tidal reaches including: Burrumbush Creek; Cromarty Creek; Haughton River; Barramundi Creek; Alligator Creek; Groper Creek and Rock Ponds Creek (DERM 2002). The estuarine crocodile has also been recorded in the Burdekin River up to as high as Burdekin Dam (i.e. 140 km from the river mouth). Overall, estuarine crocodile numbers within the Burdekin Catchment are considered low to very low (DERM 2002). Potentially suitable habitat for the estuarine crocodile within the study area is likely to be limited to the tidal creeks of Caley Valley Wetland and the large permanent pool habitats in the Bowen and Bogie Rivers.

The freshwater crocodile is listed as 'Marine' under the EPBC Act. In Queensland, this species primarily occurs in the northwest highlands; Gulp of Carpentaria; Einasleigh uplands and the Cape York Peninsula (Wilson 2009). Small populations also occur on the east coast as a result of translocation and introductions from the pet trade. A small breeding population of freshwater crocodiles has established in the Burdekin Catchment as a result of these introductions (DERM 2010b).

Freshwater turtle species known to occur within the Burdekin Catchment include: Cann's long-necked turtle (*Chelodina canni*); Krefft's turtle (*Emydura macquarii krefftii*); Irwin's turtle (*Elseya irwini*); saw-shelled turtle (*Elseya latisternum*) and snaked-necked turtle (*Chelodina longicollis*). The northern long-necked turtle (*Chelodina rugosa*), has also been reported in the catchment (DERM Wetlandinfo) however this records has not been verified. The northern long-neck turtle does not naturally occur within the Burdekin Catchment, however, it is possible that this species does occur in the system in low numbers as a result of spill over from adjacent catchments (C. Limpus pers.com.). Whilst no turtle species within the Burdekin Catchment are listed under the EPBC or NC Act, the Irwin's turtle is endemic to the Burdekin Catchment and has been listed as high priority for conservation under the DERM 'Back on Track' prioritisation framework for conservation management of Queensland's wildlife.

Habitat preferences vary considerably between the four turtle species and range from ephemeral waterholes and pools to structurally complex rivers and creeks. The Krefft's river turtle is the most generalist species occurring in all freshwater habitats except isolated farm dams (Wilson 2009). This species was opportunistically observed in the Suttor River during field assessments. The Cann's long-necked turtle and snaked-necked turtle are primarily encountered in off-stream habitats (Cann 2008). All lacustrine and palustrine habitats within the study area provide potential habitat for the Cann's long-necked turtle however the snake-necked turtle is primarily restricted to the southern reaches. Both of these turtle species have been recorded from the Caley Valley Wetland in the study area (GHD, 2010). The saw-shelled turtle is also known to inhabit palustrine habitats however this species is more commonly observed in upstream rivers and creeks that support and abundance of in-stream habitat (Cann 1998).

Within the Project footprint, Mistake Creek and Table Mountain Creek were identified as potential saw-shelled turtle habitat. The Irwin's turtle generally prefers sandy riverine habitats with an abundance of macrophytes and in-stream debris. This species has been recorded from the Burdekin, Bowen and Broken Rivers (Cann, 1998; 2008). Due to the ephemeral nature of aquatic habitats within the Burdekin Catchment, suitable habitat for the Irwin's turtle in the study area is primarily restricted to the Bowen and potentially the Bogie River. Tributaries of these rivers, such as Pelican Creek, may provide temporary habitat during the wet season.

Table 9 Ecology of Reptile Species Predicted to Occur within the Study Area

Species	Habitat Preference	Nesting Behaviour	Diet	Movement Behaviour	Environmental Tolerance
Estuarine crocodile (*Crocodylus porosus*)	Inhabits marine, tidal and freshwater environments including rivers, creeks, swamps and dams	Nesting occurs from December to April. Eggs are laid in a mound of vegetation and soil, which is constructed within close proximity of a permanent water body The nest is usually constructed amongst well above the water level Females aggressively defend nests	Opportunistic ambush predator. Juveniles take insects, crustaceans, frogs and small fish, whilst adult crocodiles consume fish, turtles, birds and mammals. Adult crocodiles will also readily scavenge carrion	Large scale migrations (100s of km) are known to occur however individuals generally remaining within a territorial home range Seasonal migrations from lotic habitats to ephemeral swamps and billabongs may occur during the wet season	Can more readily between fresh and saline environments Temperature dependent sex determination
Freshwater crocodile (*Crocodylus johnstoni*)	Freshwater habitats including rivers, creeks, billabongs and wetlands. Can also occur in estuarine environments	Pulse nesting occurs over a short period from August to September. Nests consist of a hole excavated in sandy substrate No parental guarding occurs	Opportunistic ambush predator. Diet consists of small animals including: insects; frogs; turtles; bats; birds and mammals	Territorial species with small home range. Annual movements generally less than 1 km Pubescent males may move large distances	Can tolerate low-medium salinity levels Temperature dependent sex determination
Cann's long-necked turtle (*Chelodina canni*)	Thought to prefer lagoons, billabongs and swamps however have also been seen in clear water creeks. Rarely recorded in rivers This species has been recoded aestivating under vegetation, timber and in the undergrowth when habitats dry out	Nesting is thought to occur between November and January	Carnivorous – diet includes small fish, aquatic and terrestrial insects, tadpoles and crustaceans	Home range size unknown, however known to travel long distances overland (1 km)	Can tolerate the low oxygenated waters in billabongs and swamps

Species	Habitat Preference	Nesting Behaviour	Diet	Movement Behaviour	Environmental Tolerance
Snake-necked turtle (*Chelodina longicollis*)	Most abundant in shallow ephemeral water bodies such as swamps, lagoons, man-made dams and billabongs Burdekin Catchment is at the upper limit of distribution for this species and as such individuals are likely to be restricted to southern habitats	Nesting is thought to occur in firm substrates during summer Nesting may occur up to 500 m from the waters edge	Opportunistically carnivorous –thought to primarily feed on aquatic insects and crustaceans however plankton, nekton, benthic macroinvertebrates and carrion may also be consumed	Home range size unknown Large scale movement may occur for dispersal, courtship and nesting and repositioning following flooding events Migrations may be triggered by rainfall Undertake long-distance overland migrations for nesting and dispersal	Can tolerate the low oxygenated waters in billabongs and swamps
Irwin's turtle (*Elseya irwini*)	This species is thought to prefer areas with a sandy substrate and a high abundance of macrophytes In-stream debris in the form of fallen logs and branches are preferred for sheltering Known to occur in the Burdekin, Broken and Bowen Rivers.	Nesting is thought to occur on the river banks between April and July however nesting has been observed as late as September	Omnivorous - adults turtle primarily feed on aquatic macrophytes and fruit and leaves from riparian vegetation. Aquatic snails also make up a large proportion of the diet. Juveniles are thought to be primarily carnivorous	Home range size unknown Large scale movement may occur for dispersal, courtship and nesting and repositioning following flooding events Migrations may be triggered by rainfall Movement over land only thought to occur over very short distances between adjacent pools	Due to reliance on aquatic respiration (expected to be medium – high reliance) this species is likely to be sensitive to changes in environmental conditions including dissolved oxygen levels, temperature and turbidity. Alteration of respiratory physiology and diving behaviour can lead to a reduction in foraging and breeding rates, and increase in predation levels May also be highly sensitive to chemicals such as pesticides

Species	Habitat Preference	Nesting Behaviour	Diet	Movement Behaviour	Environmental Tolerance
Saw-shelled turtle (*Elseya latisternum*)	Generally inhabits headwaters/upper reaches of larger rivers. May also occur in lagoons and billabongs Areas with abundant fallen logs, submerged rocks and undercut banks are important for sheltering	Nesting is thought to occur on the river banks during late spring-summer	Opportunistically omnivorous – adult turtles feed on crustaceans, frogs, aquatic and terrestrial insects and aquatic plants Juvenile turtles are primarily carnivorous	Home range size unknown Large scale movement may occur for dispersal, courtship and nesting and repositioning following flooding events Migrations may be triggered by rainfall Movement over land only known to occur over very short distances between adjacent pools	Due to reliance on aquatic respiration (medium reliance) this species is likely to be sensitive to changes in environmental conditions including dissolved oxygen levels, temperature and turbidity Alteration of respiratory physiology and diving behaviour can lead to a reduction in foraging and breeding rates, and increase in predation levels May also be highly sensitive to chemicals such as pesticides
Krefft's turtle (*Emydura macquarii krefftii*)	Inhabits a variety of still and flowing aquatic habitats including rivers, creeks, swamps, lagoons, lakes and dams	Extended nesting season occurs during spring and summer	Opportunistically omnivorous – variable diet including gastropods, bivales, terrestrial and aquatic insects, aquatic macrophytes, algae and sponge	Home range size unknown Large scale movement may occur for dispersal, courtship and nesting and repositioning following flooding events Migrations may be triggered by rainfall May move short distances overland	Due to reliance on aquatic respiration (low reliance) this species is likely to be sensitive to changes in environmental conditions including dissolved oxygen levels, temperature and turbidity Alteration of respiratory physiology and diving behaviour can lead to a reduction in foraging and breeding rates, and

Species	Habitat Preference	Nesting Behaviour	Diet	Movement Behaviour	Environmental Tolerance
					increase in predation levels May also be highly sensitive to chemicals such as pesticides

Ecological information in table sourced from: Cann 1998; Cann 2008; Rogers, 2000

3.5.3 Mammals

The platypus (*Ornithorhynchus anatinus*) is known to occur within the Burdekin Catchment and has been previously recorded in the study area (DERM WildNet). This species is listed as 'Special Least Concern' wildlife under the NCA. 'Special Least Concern' wildlife are those species considered as having inherent value and potential importance for the maintenance of ecosystem processes. 'Special Least Concern' fauna are also considered a source of genetic information integral to an understanding of the evolution of the Australian biota and a genetic resource of potential benefit to society. These species are also considered culturally significant.

Within the study area, suitable habitat for the platypus is likely to be restricted to permanently inundated water bodies that provide habitat throughout the year (e.g. Bowen River; Suttor River). The spatial utilisation of habitat within these water bodies is expected to be restricted to reaches that support necessary resources for burrowing (i.e. earthen banks consolidated by the roots of riparian vegetation, overhanging vegetation, undercut banks (Grant and Temple-Smith 1998)). Clearing of riparian vegetation and degradation of banks from cattle have reduced platypus habitat suitability in many areas within the study area. Ephemeral rivers and creeks located adjacent to platypus habitat may provide additional foraging resources during the wet season.

The ecology of the platypus, including habitat preference, nesting behaviour, diet, movement behaviour and environmental tolerance, is presented in Table 10.

Table 10 Ecology of the Platypus

Species	Habitat Preference	Nesting Behaviour	Diet	Movement Behaviour	Environmental Tolerance
Platypus (*Ornithorhynchus anatinus*)	Inhabit lotic and lentic freshwater habitats, with a preference for areas that have steep, well vegetated banks	Sheltering and nesting occur in burrows constructed in the river bank just above the level of the water. The entrance to the burrow is usually concealed by overhanging vegetation or an undercut bank.	Benthic aquatic invertebrates constitute the significant majority of platypus prey	Platypus show fidelity to home ranges (up to several kilometres of river) Capable of limited overland movement	Platypus occupy a wide range of aquatic habitats, are tolerant of degraded systems, and show notable adaptability

Table reference: Grant and Temple-Smith 1998

3.5.4 Macroinvertebrates

Macroinvertebrate diversity and community composition within the Burdekin Catchment is characteristic of river systems with highly variable and unpredictable environmental conditions (PB 2009). Within these systems, macroinvertebrate diversity is relatively low and communities are dominated by generalist species with few pollution sensitive taxa.

A total of 57 macroinvertebrate taxa were recorded in the lower Burdekin Catchment during Water for Bowen EIS surveys (PB 2009). Dominant taxa included: mayfly nymphs (*Tasmanocoenis sp*); midge larvae (subfamily Chironominae); diving beetles (family Dytiscidae) and freshwater shrimps (family Atyidae). A number of these macroinvertebrates families were found to be widespread and abundant throughout the survey area (PB 2009). Macroinvertebrate abundance has also been reported to be high in the Burdekin River (Pearson 1991).

Macroinvertebrate diversity within the upper Burdekin Catchment is relatively unknown, however, predictions may be made based on analysis of similar habitats in the upper Fitzroy Catchment. A study by Duivenvoorden *et al*. (1996) at 11 sites in the Fitzroy Catchment recorded approximately 50 macroinvertebrate families. Dominate taxa included: Coleoptera; Diptera; Ephemeroptera; Hemiptera; Odonata; Trichoptera; Bivalvia; Gastropoda; Decapoda and Isopoda.

The Queensland Museum crustacean database identified a total of 41 crustacean species within the Burdekin Catchment. These taxa are dominated by marine and estuarine species with only four species of freshwater crustaceans recorded.

Macroinvertebrate families opportunistically observed during the field assessments include: Bivalvia (e.g. freshwater mussels (Plate 2)); Coleopteran (e.g. diving beetles); Gastropoda (e.g. snails) and Decapoda (e.g. crabs and prawns (Plate 3)). Freshwater crabs were the most abundant macroinvertebrate observed within the study area, with relatively large numbers of deceased individuals recorded in dried water bodies (Plate 4). Burrows (Plate 5) were also abundant along the margins of isolated pools.

Plate 2 Freshwater muscle (family Hyriidae) observed at the margin of an artificial dam

Plate 3 Freshwater prawn (*Macrobrachium sp*) observed in Splitters Creek

Plate 4 Deceased freshwater crabs observed in a dried Gilgai

Plate 5 Burrows adjacent to an isolated pool in the Belyando River

3.5.5 Aquatic Flora

A total of 55 native aquatic dependent flora species[4] are known to occur within the Burdekin Catchment (Inglis and Howell 2009) (Table 11). Nine of these species have been identified as priority species in the DERM Aquatic Conservation Assessment for the riverine wetlands of the Great Barrier Reef Catchment. The priority species include: *Ceratopteris thalictroides*; *Eucalyptus coolabah*; *Eucalyptus tereticornis*; *Hydrilla verticillata*; *Hymenachne acutigluma*; *Leersia hexandra*; *Lomandra hystrix*; *Melaleuca leucadendra* and *Vallisneria nana*. All species are listed as 'Least Concern' under the NC Act.

[4] Aquatic dependent flora are those species that are adapted to and dependent on living in wet conditions for at least part of their life cycle and found wither within or immediately adjoining a non-riverine or riverine wetland (DERM, 2009).

Table 11 Aquatic Dependent Flora Species in the Burdekin Catchment

Scientific Name	Common Name	Habitat
Acacia salicina	Doolan	
Acacia stenophylla	Belalie	Riparian
Aponogeton queenslandicus		Aquatic
Casuarina cunninghamiana		Riparian
Casuarina cunninghamiana subsp. cunninghamiana		
*Ceratopteris thalictroides**		Aquatic
Eleocharis acuta		
Eleocharis cylindrostachys		Semi-aquatic
Eriocaulon athertonense		Semi-aquatic
Eucalyptus camaldulensis		Riparian
Eucalyptus camaldulensis subsp. simulata		
Eucalyptus camaldulensis var. obtusa		
Eucalyptus camaldulensis x E. platyphylla		
*Eucalyptus coolabah**	Coolabah	Riparian
Eucalyptus raveretiana	Black ironbox	Riparian
*Eucalyptus tereticornis**		Riparian
Ficus racemosa		
Ficus racemosa var. racemosa		
Fimbristylis bisumbellata		Riparian
Gonocarpus chinensis		
Hibiscus tiliaceus	Cotton tree	Riparian
*Hydrilla verticillata**	Hydrilla	Aquatic
Hygrophila angustifolia		
*Hymenachne acutigluma**		Aquatic
*Leersia hexandra**	Swamp rice grass	Aquatic
Leptospermum brachyandrum	Weeping tea-tree	Riparian
Livistona decora		

Scientific Name	Common Name	Habitat
*Lomandra hystrix**		Semi-aquatic
Lophostemon grandiflorus		Riparian
Lophostemon grandiflorus subsp. riparius		Riparian
Lophostemon suaveolens	Swamp box	Riparian
Melaleuca bracteata	Black tea-tree	
Melaleuca dealbata	Swamp tea-tree	
Melaleuca fluviatilis		Riparian
*Melaleuca leucadendra**	Broad-leaved tea-tree	
Melaleuca linariifolia	Snow-in summer	Riparian
Melaleuca trichostachya		Riparain
Melaleuca viminalis		Riparian
Millettia pinnata		Riparian
Myriophyllum verrucosum	Water milfoil	Aquatic
Nymphoides crenata	Wavy marshwort	
Nymphoides indica	Water snowflake	Aquatic
Spirodela punctata	Thin duckweed	Aquatic
Syzygium angophoroides		Riparian
Syzygium australe	Scrub cherry	Riparian
Syzygium oleosum	Blue cherry	Riparian
Syzygium tierneyanum	River cherry	Riparian
Terminalia sericocarpa	Damson	Riparian
Triglochin procerum		Aquatic
Tristaniopsis exiliflora	Kanuka box	Riparian
Utricularia bifida		Aquatic
Utricularia caerulea	Blue bladderwort	
Utricularia uliginosa	Asian bladderwort	
*Vallisneria nana**		Aquatic

* DERM priority species. Table modified from Inglis and Howell 2009

The diversity and abundance of macrophytes within the study area was relatively low during field assessments. The majority of the riverine habitats assessed supported little (1-10%) to no macrophytes species. Macrophytes present were generally emergent species from the family Cyperaceae and in particular the genus *Cyperus*. Other species observed included: *Persicaria attenuata* (Plate 6) and *Typha sp* (Plate 7). Typical of habitats that experience pulses of high flow events followed by extended dry periods, the riverine habitats within the study area supported very few submerged and no floating macrophyte species. The lacustrine and palustrine habitats (i.e. Gilgai's, Artificial Dam/Wetland and Start of Hope Wetland) supported the highest diversity and abundance of macrophytes (moderate to extensive). Emergent, submerged and floating macrophyte species where all evident in these habitats. Dominant macrophyte species observed included: native waterlily (*Nymphaea violacea*) (Plate 8); water snowflake (*Nymphoides indica*) (Plate 9); water primrose (*Ludwigia peploides ssp. montevidensis*); onagraceae (*Ludwigia peruviana*); monochoria (*Monochoria cyanea*) (Plate 10) and caldesia (*Caldesia oligococca*).

Riverine habitats within the study area generally supported little (1-10%) algae in the water column and on the substrate. Algae most commonly occurred in the margins of drying pools (Plate 11) and habitats with moderate to extreme cattle degradation (e.g. Capsize Creek) evident from hoof prints in and around water bodies. The lacustrine and palustrine habitats supported the highest diversity and abundance of algae (i.e. moderate rating) in the study area.

Plate 6 *Persicaria attenuata* observed at Star of Hope Wetland

Plate 7 *Typha sp* observed at Table Mountain Creek

Plate 8 Native waterlily (*Nymphaea violacea*) observed in the Artificial Dam/Wetland habitat

Plate 9 Water snowflake (*Nymphoides indica*) observed within the Gilgai and wetland habitats

Plate 10 Monochoria (*Monochoria cyanea*) recorded within the Gilgai and wetland habitats

Plate 11 Algae recorded at the margin of a stagnant pool

A total of 17 exotic aquatic dependent flora species are known to occur in the Burdekin Catchment (Table 12). Cabomba (*Cabomba caroliniana*); hymenachne (*Hymenachne amplexicaulis*) and salina (*Salvinia molesta*) are listed as Weeds of National Significant (WONS). Siam weed (*Chromolaena odorata*) is listed as a Class 1 pest plant under Queensland's *Land Protection* (*Pest and Stock Route Management*) *Act 2002*. Eight of the aquatic dependent species are listed as Class 2 pest plants while two species are listed as Class 3 pest plants. Only rubber vine (*Cryptostegia grandiflora*) was observed in the study area.

Table 12 Exotic Aquatic Dependent Flora Species in the Burdekin Catchment

Scientific Name	Common Name	Status
Cabomba caroliniana var. caroliniana	Cabomba	WONS Class 2 pest plant
Centrosema molle		
Chromolaena odorata	Siam weed	Class 1 pest plant
Cryptostegia grandiflora	Rubber vine	Class 2 pest plant

Scientific Name	Common Name	Status
Eichhornia crassipes	Water hyacinth	Class 2 pest plant
Hymenachne amplexicaulis cv. Olive		WONS Class 2 pest plant
Leucaena leucocephala subsp. glabrata	Leucaena	
Leucaena leucocephala subsp. leucocephala	Leucaena	
Macfadyena unguis-cati	Cat's claw creeper	Class 3 pest plant
Megathyrsus maximus var. maximus	Guinea grass	
Myriophyllum aquaticum		
Parkinsonia aculeata	Jerusalem thorn	Class 2 pest plant
Salvinia molesta	Salvinia	WONS Class 2 pest plant
Sphagneticola trilobata		Class 3 pest plant
Thunbergia grandiflora	Sky flower	Class 2 pest plant
Urochloa mutica		
Ziziphus mauritiana	Indian jujube	Class 2 pest plant

Table modified from Inglis and Howell 2009

A marine plant is defined in s. 8 of the *Fisheries Act 1994* as a plant that usually grows on or adjacent to tidal land, whether is it is living or dead, or material of that plant, or a plant prescribed to be a marine plant. Marine plants are located in the estuarine habitats of the Caley Valley Wetland. Species present include: salt couch (*Sporobolus virginicus*), which is present in narrow fringing meadows in low lying overflow areas beside the tidal creeks and weeping paperbark (*Melaleuca leucadendra*), which is the main riparian species in this area. No other marine plants were observed although large meadows of *Tecticornia australasica* and *Sarcocornia quinqueflora* are known to occur in this area (Louise Johns, Dept. Fisheries. pers. comm. 20 May 2010).

3.6 Summary

The existing aquatic environment within the study area is dominated by riverine habitats with smaller areas of estuarine and lacustrine/palustrine habitats. Riverine habitats are primarily ephemeral and characterised by a uniform channel with a sandy/gravel substrate and little in-stream habitat. Due to their ephemeral nature, low abundance of habitat features and degradation from cattle and weeds, these rivers/creeks generally provide low value habitat for aquatic fauna. Riverine habitats that do provide important fauna values are primarily restricted to those that contain permanent pool habitats (i.e. Suttor River, Table Mountain Creek and

Mistake Creek). These habitats act as refuge habitats for aquatic species during the dry season and provide important population sources from which the ephemeral habitats can be re-colonised during flow conditions. Of particular habitat importance is the nationally important Bowen River: Birralee - Pelican Creek Aggregation. This river contains a range of unique aquatic habitats that are unavailable in other habitats within the study area.

Estuarine habitats within the study area include mangrove and saltwater wetlands and adjacent tidal creeks. These habitats are located within the nationally important Caley Valley Wetland, at the northern end of the proposed rail alignment. Although only covering a small area of the study area, this habitat provides important spawning, breeding and nursery habitats for many fish species and is particularly important habitat for waterfowl and shorebirds.

Lacustrine and palustrine habitats are scattered throughout the Project footprint and include the nationally important Caley Valley Wetland and the Bowen River: Birralee - Pelican Creek Aggregation (located ~3.5 km from the proposed alignment). These habitats support a high diversity and abundance of in-stream debris and macrophytes species and are known to provide important breeding habitat for many fish species.

Overall aquatic habitats within the study area are dynamic and vary over a temporal scale in association with catchment climatic conditions. Annual flow patterns within the catchment are generally characterised by short periods of increased flow between December and April, with little to no-flow occurring outside this period. During periods of high water flow, water quality is relatively constant throughout the river and the main influences on water quality are associated with sedimentation and the input of nutrients. Water quality during no/low flow conditions is highly variable on a temporal and spatial scale and is largely influenced by local land use. The loss of riparian vegetation as a result of cattle grazing has had a direct impact on water quality as a result of increased channel and bank erosion, increased weed infestation and increased input of nutrients.

Aquatic habitats within the study area provide habitat for a range of generalist fauna and flora species. A total of 55 fish species have been previously recorded or are predicted to occur within the study area. These species include two endemic species, the soft-spined catfish (*Neosilurus mollespiculum*) and the small-headed grunter (*Scortum parviceps*). No listed-threatened species have been previously recorded or are predicted to occur in the study area. The distribution of fish species throughout the study area is primarily influence by the Burdekin Gorge and Falls in the lower Burdekin Catchment.

Aquatic reptiles inhabiting the Burdekin Catchment include two crocodile and five freshwater turtle species. Crocodile species known to inhabit the Burdekin Catchment include the estuarine crocodile (*Crocodylus porosus*) and freshwater crocodile (*Crocodylus johnstoni*). The estuarine crocodile is listed as ‘Marine’ and ‘Migratory’ under the EPBC Act and ‘Vulnerable’ under the NCA. Potentially suitable habitat for the estuarine crocodile within the study area is likely to be limited to the tidal creeks of Caley Valley Wetland and the large permanent pool habitats in the Bowen and Bogie Rivers and potentially the Elliot River. The freshwater crocodile is listed as ‘Marine’ under the EPBC Act. Whilst no turtle species within the Burdekin Catchment are listed under the EPBC or NC Act, the Irwin’s turtle is endemic to the Burdekin Catchment and has been listed as high priority for conservation under the DERM ‘Back on Track’ prioritisation framework for conservation management of

Queensland's wildlife. This species prefers sandy riverine habitats with an abundance of macrophytes and in-stream debris. Although suitable habitat was identified during the field surveys, the overall low abundance of macrophytes observed suggests that in general the study area provides lower quality habitat for the species.

The platypus (*Ornithorhynchus anatinus*) is listed as 'Special Least Concern' wildlife under the NCA. Within the study area, suitable habitat for the platypus is likely to be restricted to permanently inundated water bodies that provide habitat throughout the year (e.g. Bowen River; Suttor River).

Macroinvertebrate diversity and community composition within the Burdekin Catchment is characteristic of river systems with highly variable and unpredictable environmental condition. Within these systems, macroinvertebrate diversity is relatively low and communities are dominated by generalist species with few pollution sensitive taxa.

A total of 55 native aquatic dependent flora species are known to occur within the Burdekin Catchment and nine of these species have been identified as priority species in the DERM Aquatic Conservation Assessment for the riverine wetlands of the Great Barrier Reef Catchment. The majority of the riverine habitats observed within the study area supported little (1-10%) to no macrophytes species. Marine plants, protected under the *Fisheries Act 1994*, are located in the estuarine habitats of the Caley Valley Wetland. Species present include: salt couch (*Sporobolus virginicus*) and weeping paperbark (*Melaleuca leucadendra*).

A total of 17 exotic aquatic dependent flora species are known to occur in the Burdekin Catchment and ten of these are listed as WONS and/or are listed as declared weeds under Queensland's *Land Protection* (*Pest and Stock Route Management*) *Act 2002*. Only rubber vine (*Cryptostegia grandiflora*) was observed in the study area. Similarly, four introduced exotic fish species have been previously recorded or predicted to occur in the study area. An additional 14 introduced exotic fish species are known to occur within the broader Burdekin Catchment though these species have a relatively restricted range within the catchment and are not known to occur within the study area.

4. Potential Impacts and Mitigation Measures

4.1 Introduction

The study area supports a variety of aquatic environmental values ranging from low value habitats and generalist species to high value nationally important wetlands and conservation significant species. The proposed Project has the potential to impact these aquatic environmental values as a result of construction and operational activities. The identification of these potential impacts and the development of targeted mitigation measures aim to reduced the risk of the Project to aquatic environmental values.

4.2 Construction Phase

Activities associated with the proposed construction of the rail corridor have the potential to cause a number of direct and indirect impacts to aquatic environmental values. These activities include:

- Removal of riparian vegetation at aquatic habitat crossings;
- Construction within the bed and banks[5];
- Movement of vehicles and plant to, from and around the construction site; and
- Flow diversion and control.

The potential impacts associated with these construction activities are discussed in detailed below.

4.2.1 Loss of Aquatic Habitat

Aquatic habitats located within the study area includes: estuarine habitat; riverine habitat (creeks and rivers) and lacustrine/palustrine habitat. The majority of habitats have a relatively low environmental value however those that contain permanent water bodies are considered locally important. The most significant aquatic habitats within the study area are the nationally important Caley Valley Wetland and the Bowen River: Birralee - Pelican Creek Aggregation. Clearance of vegetation and works within the bed and banks will result in the loss of aquatic habitats within the Project footprint.

Estuarine Habitat

Estuarine habitat within the Project footprint is restricted to the Caley Valley Wetland in the northern section of the alignment (i.e. near chainage 505000). This habitat is listed as a wetland of national importance under the Australian Government's Directory of Important Wetlands (Environment Australia, 2001). During the dry season, the estuarine habitat primarily consists of a saltwater wetland, including mudflats, samphire and saline lakes (Regional Ecosystem 11.2.2 – samphire forbland). This habitat is transformed to a freshwater/brackish wetland system during the wet season (GHD, 2010). The estuarine habitat within the Project footprint provides habitat for a range of aquatic flora and fauna

[5] For the purpose of this impact assessment, construction within the bed and banks refers to construction activities within all aquatic habitats including lacustrine and palustrine habitats.

species and is considered particularly important habitat for commercially and recreationally important fish species.

The proposed alignment of Port Loop Option 1 is partly located in existing cleared areas but will cross the Caley Valley Wetland which includes estuarine habitat. At this location the rail corridor will be primarily constructed on an embankment with two sections of elevated structures located to maintain wetland flows. This rail loop footprint currently intersects <1 ha of estuarine habitat however the actual area of lost habitat will be reduced somewhat with the installation of elevated structures in some of this area. The loss of estuarine habitat at the locations of the elevated structures will be limited to the small areas of the pylon footings. A small amount of additional estuarine habitat may also be temporary lost and/or damaged during the construction process. Mitigation measures managed through the CEMP such as minimising clearing outside the footprint and clearly identifying areas to be cleared on construction plan will assist in minimising this loss. Following construction these temporary areas should be re-instated.

The proposed alignment of Port Loop Option 2 will also transverse the estuarine habitat within the Caley Valley Wetland. The eastern section of Port Loop Option 2 will be constructed on an embankment. This section of the alignment has been located adjacent to the proposed Abbot Point Multi Cargo Facility haul road (GHD, 2010), with the aim of minimising the temporary loss and /or damage of additional estuarine habitat during the construction process. Without this mitigation measure there will be a temporary loss of estuarine habitat in this location. The northern section of Port Loop Option 2 will be constructed on an elevated structure. The loss of estuarine habitat based on this construction method will be limited to the small areas of the pylon footings. A relatively largely area of estuarine habitat will be loss/damaged during construction of the elevated structures however this habitat is expected to regenerate following completion of construction.

Riverine Habitat

Riverine habitats (i.e. creeks and rivers) are the dominant aquatic habitat type within the Project footprint. These habitats are relatively uniform and support a low abundance and diversity of in-streams habitats. The majority of habitats are ephemeral and dry out completely during the dry season. The larger habitats such as the Suttor River, Mistake Creek and Table Mountain Creek, which contain permanent water bodies, provide locally important dry season refuge habitats for many aquatic species. A 15 km stretch of the Bowen River located adjacent to chainage 355000 to 382000 contains a range of unique in-stream habitat features that are unavailable in other riverine habitats within the study area. This habitat is known to support conservation significant species including the estuarine crocodile. The Bowen River: Birralee - Pelican Creek Aggregation is listed as a wetland of national importance under Australian Government's Directory of Important Wetlands (Environment Australia, 2001).

The extent of aquatic habitat loss at each riverine habitat within the Project footprint is dependent upon the crossing infrastructure incorporated into the design. The design criteria for crossing infrastructure is defined in Section 11 Surface Water of the EIS. It defines flows that will require bridge crossings and those that will require either major or minor culverts. The direct loss of aquatic habitat at bridge crossing locations will generally be limited to a small area of riparian habitat for the rail footprint and small area of in-stream habitats and at the locations of the pylons. At these crossing the infrastructure will be rail only, i.e. no road

crossings. Additional habitat may be temporarily lost/damaged during the construction process however this impact will be restricted to the minimal amount necessary and habitat features (e.g. channel morphology etc) will be restored at the completion of construction. The loss of riparian and in-stream habitat at these locations will result in the permanent loss of aquatic fauna foraging and sheltering habitat though the impact will be localised and is not considered to impact upon species diversity and abundance outside the Project footprint. .

Major and minor culverts are proposed for the remainder of the riverine habitat crossings within the Project footprint. Project construction at these locations will result in the loss of all riparian and in-stream habitat within the corridor. The riverine habitats defined to require culvert crossings are considered to be primarily ephemeral, and the overall value of these habitats for aquatic flora and fauna is relatively low compared to permanently inundated habitats. The ecological consequence of this habitat loss will increase where culvert crossings result in the loss of permanent pool habitat. Permanent pool habitat is considered locally important habitat for flora and fauna species and is relatively limited throughout the study area. The ecological consequence of permanent pool habitat loss may include a local reduction in species abundance and diversity within the immediate area. Loss of permanent pool habitat could potentially occur at a small number of crossings (e.g. Mistake Creek) depending upon the location of the final alignment.

The proposed alignment will cross the Bowen River approximately 15 km upstream of the nationally important Bowen River: Birralee - Pelican Creek Aggregation. No loss of this habitat will occur.

Lacustrine and Palustrine Habitats

Lacustrine and palustrine habitats are scattered throughout the Project footprint and include the nationally important Caley Valley Wetland and the Bowen River: Birralee - Pelican Creek Aggregation (located ~3.5 km from the proposed alignment). These habitats support a high diversity and abundance of macrophytes species and are known to provide important breeding habitat for many fish species. As discussed above, construction of the Port Loop Option 1 will transverse the Caley Valley Wetland and will consist of a rail embankment with two sections of elevated structures located to maintain wetland flows. This rail loop footprint currently intersects 13.5 ha of palustrine habitat however the actual area of lost habitat may be smaller than this with the installation of the elevated structures sections. At these sections the loss habitat will be limited to the small areas of the pylon footings. The CEMP will incorporate measures to avoid un-necessary disturbance to stream bed as well as incorporate a Rehabilitation Plan that includes both riparian and in-stream habitat re-instatement (for example bank revegetation and channel morphology re-instatement) upon completion.

The proposed alignment of Port Loop Option 2 will also transverse the Caley Valley Wetland. Construction of the eastern rail embankment and northern aquatic bridge will also result in the loss of habitat. The temporary loss of wetland habitat as a result of the construction process will be minimised for both options with the potential use of the Abbot Point Multi Cargo Facility haul road further reducing these impacts along the eastern alignment of Port Loop Option 2.

Loss of lacustrine and palustrine habitat will also occur throughout the Project footprint. Given these habitats provide unique resources that are not available within the main riverine habitats, localised impacts to aquatic flora and fauna species would be expected to occur

where habitats are lost. The ecological significance of these impacts will be dependent upon the total area of habitat to be lost and the availability of similar habitat within the immediate area. By minimising the crossing of these habitats during the design phase, the total loss of lacustrine and palustrine habitat will be minimised.

The proposed alignment will not result in the loss of lacustrine and palustrine habitat within the nationally important Bowen River: Birralee - Pelican Creek Aggregation.

Summary and Mitigation Measures

Construction activities will result in the relatively small loss of aquatic habitat within the Project footprint, including <1 ha of estuarine habitat and approximately 13.5 ha of palustrine habitat (considering Loop Option 1 only) located within the Caley Valley Wetland. This loss of habitat has the potential to result in a significant ecological consequence as a result of reduced availability in foraging and breeding habitat. The mitigation measures proposed below have been designed to reduce the likelihood of this risk. The expected residual impact of habitat loss on aquatic environmental values is considered Medium (5, 2). Mitigation measures proposed include:

- Minimising the loss of aquatic habitat in the design phase by locating the rail corridor in areas that have been previously cleared or degraded by past land use practices;
- Minimising the loss of remnant *Acacia harpophylla* (brigalow) forest and woodland which support unique gilgais habitat;
- Minimising the loss of nationally important Caley Valley Wetland habitat;
- Bridging aquatic habitats as per the design criteria defined in Section 11 Surface Water of the EIS;
- Clearly identifying the extent of vegetation clearing and earthworks on construction plans and in the field. The extent of construction is to be restricted to the minimal amount necessary in all aquatic habitat locations;
- Locating any additional construction areas and construction sites, such as site offices, soil stockpiles, machinery/equipment storages and construction camps within existing cleared areas and away from aquatic habitats; and
- When unavoidable clearing of marine plants occurs in the estuarine habitat, offsets will be required. Note: the exact amount of certain vegetation types to be cleared is yet to be confirmed but will be required for the project.

4.2.2 Fauna Mortality

Aquatic fauna occurring within the study area includes three endemic species and two conservation significant species. Construction of the rail corridor may result in the direct mortality of these species if individuals are present when riparian vegetation is cleared and when construction works occur within the bed and banks. Construction within isolated pool habitats is likely to have the highest risk of fauna mortality due to the relatively high abundance of fauna species within these habitats and the inability of individuals to move away from the area. Fauna mortality as a result of construction activities has the potential to cause a significant reduction in fauna species abundance within the local area.

Semi-aquatic fauna species such as long-necked turtles (i.e. Cann's long-necked turtle (*Chelodina canni*) and snaked-necked turtle (*Chelodina longicollis*)) may also be at risk of fauna mortality. These species are known to undertaken long-distance overland migration in response to habitat degradation and nesting (Cann 1998) and as such may venture in active construction zones or across access tracks. A temporary increase in vehicular traffic and plant movement to, from and around the construction area has the potential to increase the incidence of turtle roadkill. Mitigation measures such as enforcing on-site speed limits, erecting temporary bunding around construction areas and engaging fauna spotters will reduce the likelihood of this impact.

Summary and Mitigation Measures

Construction activities have the potential to result in the mortality of aquatic fauna species within the project footprint. The ecological consequence of this impact may include a reduction in species abundance within the local area though not expected to reduce diversity if managed appropriately. The mitigation measures proposed below have been designed to reduce the likelihood of this risk. The expected residual impact of fauna mortality on aquatic environmental values is considered Medium (3, 3). Mitigation measures proposed include:

- Restricting construction within aquatic habitats during the wet season where possible. In the dry season the majority of habitats will be dry or supporting fewer fauna species;
- Engaging a fauna spotter to be present on site prior to and during all vegetation removal and initial construction within the bed and banks to identify, capture and relocate fauna within the construction area;
- Developing an aquatic fauna species relocation plan that describes relocation methodology for aquatic species;
- Erecting temporary bunding around aquatic habitats within the construction zone to exclude aquatic fauna;
- Educating employees of environmental responsibilities during inductions including treating all native fauna species as protected;
- Enforcing on-site speed limits to restrict the incidence of wildlife road kill; and
- Developing a fauna mortality register to determine the location, frequency of mortality, and types of species most susceptible, to enable additional mitigation measures to be implemented where necessary.

4.2.3 Alteration to In-stream and Floodplain Hydrology

Construction of the rail corridor within and adjacent to aquatic habitats within the Project footprint may result in the temporary alteration of in-stream and floodplain hydrology. This alteration has the potential to fragment aquatic habitats and restrict fauna movement. Movement of aquatic fauna between breeding, feeding and refuge habitats is considered a crucial life history component of many aquatic fauna species including fish; crocodiles and freshwater turtles (Marsden and Power 2007; Walsh and Whitehead 1993; Tucker 1999). Movement of aquatic fauna species within the Project footprint may include: upstream and downstream movement within riverine habitats; lateral movement between riverine and palustrine habitats; tidal movement within estuarine habitats and movement between

freshwater and saltwater environments. Construction of the rail corridor within and adjacent to aquatic habitats has the potential to temporarily restrict movement of aquatic fauna species as a result of physical habitat fragmentation, flow diversion and control and habitat disturbance. The potential consequences of temporarily restricting fauna movement may include a temporary loss of habitat and resources and disruption of breeding (Marsden and Power 2007). As the fauna species within the study area are adapted to the highly dynamic and variable nature of the system, movement behaviours, particularly breeding migrations, are associated with flow events. As a result, minimising construction during the wet season where possible will reduce the likelihood of fauna movement restriction. Construction within aquatic habitats during the dry season may however result in fauna species becoming isolated in ephemeral habitats. Maintaining water flows, including trickle flows, via a flow diversion can reduce the likelihood of this impact.

Alteration of in-stream and flood plain hydrology can also result in the degradation of habitats due to a decrease in water quality (Wheeler *et al*. 2005). Specific impacts may include increased sedimentation and reduced oxygen levels. The ecological consequences of reduced water quality are considered significant due to the potential for reduced habitat values and local species abundance (Bunn and Arthington 2002).

Summary and Mitigation Measures

Construction activities have the potential to result in the temporary alteration of in-stream and floodplain hydrology. The ecological consequences of this impact may include a temporary loss of habitat and resources, disruption of breeding and reduction in species abundance within the local area. The mitigation measures proposed below have been designed to reduce the likelihood of this risk. The expected residual impact of flow alteration on aquatic environmental values is considered Medium (4, 2). Mitigation measures proposed include:

- Restricting construction within aquatic habitats during the wet season where possible. In the dry season movement of fauna, particularly for breeding, is reduced;
- Maintaining in-stream flows via a flow diversion system;
- Engaging a fauna spotter/catcher to capture and relocate fauna species trapped in isolated habitats that become increasingly degraded as a result of construction activities; and
- Maintaining water quality (particularly turbidity, temperature and oxygen levels) in accordance with Queensland Water Quality Guidelines.

4.2.4 Increased Sedimentation, Run-off and Dust

The water quality of aquatic habitats within the study area is primarily influenced by cattle grazing. Habitats that are particularly influence by high levels of sedimentation include Pelican Creek, Bowen River and Burdekin River. Construction of the rail corridor within and adjacent to aquatic habitats could result in a further reduction in water quality as a result of point-source pollution from sedimentation, run-off and dust. Sedimentation of aquatic habitats can result in increased turbidity; decreased oxygen levels; reduced light penetration; change in channel morphology and alteration of substrate composition (Wood and Armitage 1997; Wheeler *et al*. 2005). These impacts may have a localised effect on aquatic flora and fauna

by reducing habitat value (e.g. amount of refuges, microhabitats and food availability) within the immediate downstream area. For example, impacts of sedimentation on aquatic flora species may include: reduced photosynthesis and primary production; abrasion of leaves and stems; smothering/suffocation and reduced habitat availability (Wood and Armitage 1997; Wheeler *et al*. 2005). Impacts to aquatic fauna may include: decrease in macroinvertebrate, fish and bimodally respiring turtle respiration (see Section 3.5.2); increase in macroinvertebrate drift; reduced suitability of fish spawning habitat and reduced foraging (Wood and Armitage 1997; Wheeler *et al*. 2005). These impacts are primarily restricted to the construction footprint and will reduce quickly downstream, particularly in low or no flow conditions. In high flows there is a greater likelihood that sediment will be mobilised, however as existing levels of sedimentation are high as a result of grazing related erosion, impacts of additional sedimentation are likely to be reduced.

Construction activities within and adjacent to aquatic habitats may also increase the levels of dust in the environment. Excessive dust settling on water bodies has the potential to decrease aquatic habitat value within the immediate and downstream areas primarily as a result of reduced water quality. Excessive dust may also influence riparian vegetation by limiting the photosynthesis potential of plants in close proximity to the construction area (Nanos and Ilias 2007).

Use of construction machinery in and around aquatic habitats also has the potential to result in the introduction of contaminants, such as fuels and lubricants. In severe cases, chemical pollution of the aquatic environment can result in long-term habitat degradation and widespread mortality of species. The development of a Waste and Hazardous Materials Management Plan will substantially reduced the likelihood of chemical contamination with the Project footprint.

Construction of the rail corridor at aquatic habitat crossings should be restricted where possible during the wetter months (especially in more sensitive areas such as the Caley Valley wetland) and as such impacts of sedimentation, run-off and dust will be minimised and contained within the immediate area. Habitats particularly sensitive to the impacts of sedimentation, run-off and dust will include dry season refuge pools in riverine habitats (e.g. Suttor River) and non-flowing palustrine habitats such as the Caley Valley Wetland. The implementation of an Erosion and Sedimentation Management Plan will further reduce the likelihood of impact in these areas.

Summary and Mitigation Measures

Construction activities have the potential to result in the degradation of aquatic habitats as a result of sedimentation, run-off and dust. The ecological consequence of this impact may include a reduction in foraging and breeding habitat and potential reduction in species abundance. The mitigation measures proposed below have been designed to reduce the likelihood of this risk. The expected residual impact of sedimentation, run-off and dust on aquatic environmental values is considered Medium (3, 3). Mitigation measures proposed include:

- Restricting construction within aquatic habitats during the wet season where possible;
- Preparing and implementing an Erosion and Sedimentation Management Plan which includes:

- Installing and maintaining sediment fences around all earthworks within and adjacent to aquatic habitats;
- Installing and maintaining temporary sediment traps and biofilters at key locations where run-off is expected throughout the course of the construction period;

- Rehabilitating disturbed ground surfaces as soon as is practical to minimise exposed surface periods;
- Incorporating dust suppression techniques into construction activities, e.g. tankers spraying down dirt roads;
- Appropriately storing and covering/locating soil stockpiles in areas not susceptible to wind erosion or run-off;
- Minimising vegetation clearing and the area of bare ground required for construction to only that which is necessary within and adjacent to aquatic habitats;
- Maintaining clean operating conditions in vehicles and machines;
- Restricting speed limits and other traffic control mechanisms to minimise the generation of dust;
- Developing a Waste and Hazardous Materials Management Plan which will include fuel and chemical storage protocols and spill responses; and
- Maintaining water quality (particularly turbidity, temperature and oxygen levels) in accordance with Queensland Water Quality Guidelines.

4.2.5 Noise, Light and Vibration Disturbance

Aquatic habitats within the study area support a range of generalist species and a small number of conservation significant species. Construction activities at aquatic habitat crossings are likely to impact these species as a result of a temporary and localised increase in noise, vibration and light disturbance. During the period of construction, there is expected to be constant (i.e. 24 hour) localised disturbance to aquatic fauna behaviours and dynamics (i.e. foraging, breeding and nesting) adjacent to the construction footprint. For example, impacts to fish species as a result of anthropogenic increases in noise level (e.g. pole driving) are known to include: disruption to fish behaviour; reduction in hearing; alteration of physiology and injury and mortality (Popper and Hastings 2009). Increased lighting may subject aquatic fauna to higher levels of predation and may result in excessive algae growth causing blooms.

Summary and Mitigation Measures

Construction activities have the potential to result in the degradation of aquatic habitats as a result of noise, vibration and light disturbance. The ecological consequence of this impact may include a temporary reduction a habitat and disruption to breeding. The mitigation measures proposed below includes a range of standard construction techniques that can be implemented to reduce the likelihood of this risk. The expected residual impact of noise, vibration and light disturbance on aquatic environmental values is considered Medium (3, 3). Mitigation measures proposed include:

- Restricting construction within aquatic habitats during the wet season where possible. In the dry season aquatic fauna species diversity and abundance is lowest and fish breeding

is reduced. This is particularly relevant for palustrine habitats, such as the Caley Valley Wetland, which provide breeding habitat for commercially and recreationally important fish species;

- Limiting lighting to that which is safe for operation and employing directional lighting with protective guards (particularly when adjacent to permanent pools); and
- Appropriately servicing and maintaining all plant and equipment to minimise machinery noise where possible.

4.2.6 Increase in Abundance and Diversity of Introduced Species

Vegetation clearing and soil disturbance as a result of Project construction may result in the introduction and spread of introduced flora and fauna species throughout the Project footprint. A total of 17 exotic aquatic dependent flora species are known to occur in the Burdekin Catchment (see Section 3.5.5) and ten of these are listed as WONS and/or are listed as declared weeds under Queensland's *Land Protection* (*Pest and Stock Route Management*) *Act 2002*. Rubber vine (*Cryptostegia grandiflora*) was observed at a number of aquatic habitats during field surveys. This species initially invades aquatic habitats but spreads rapidly into flood plains, pastures and hillsides. Impacts of rubber of freshwater ecosystems include: chocking of native riparian vegetation and subsequent reduction in species diversity; reduction in in-stream fauna habitat in the form of root mats and branches; increased risk of soil erosion and increase in introduced fauna species (NRM, 2004). During construction, weeds can be spread to the environment by machinery and vehicles or on workers clothing. Studies have found that weed species invade areas of spoil ground where road soil or construction waste is stored more readily than undisturbed areas (Dong *et al*. 2008). Weed introduction can also occur through the use of contaminated materials such as construction fill. The introduction and spread of introduced weed species at aquatic habitats has the potential to facilitate further spread of weeds into the wider region through the dispersal of seeds in downstream flows.

Project construction can also facilitate the introduction and spread of introduced fauna species through the creation of movement corridors along cleared rail corridors and associated tracks. Feral pests can impact on flora and fauna diversity by preying on or out competing native populations for resources and degrading habitats. Feral pigs (*Sus scrofa*) can cause substantial degradation of aquatic habitats through the disturbance of soil and increase risk of erosion; destruction of riparian vegetation; degradation of water quality and predation of freshwater turtle eggs (DPIF 2008). Feral pigs are declared a Class 2 pest under Queensland Legislation. Evidence of feral pig disturbance was observed at Pelican Creek during field surveys.

The ecological consequences of an increase in abundance and diversity of introduced weed and pest species can be major with the potential loss of species and/or communities. The development and implementation of a Weed and Pest Management Plan that includes strict control measures will reduce the likelihood of this impact from almost certain to possible.

Summary and Mitigation Measures

Construction activities have the potential to result in the increase in abundance and diversity of introduced species. The ecological consequence of this impact is considered major due to

the potential for species and/or community loss. The mitigation measures proposed below have been designed to reduce the likelihood of this risk. The expected residual impact of an increase in abundance and diversity of introduced species on aquatic environmental values is considered Medium (3, 4). Mitigation measures proposed include:

- Developing a Weed and Pest Management Plan for implementation throughout the construction phase. Management actions will including:
  - Providing vehicle wash down stations along the alignment;
  - Regularly monitoring declared pest and weed species; and
  - Controlling pest and weed species where necessary.
- All construction machinery and materials brought onto site are to be weed, seed and mud free and have undergone a thorough inspection;
- Care is to be taken when disturbing soil in known weed infestation locations to limit seed spread to unaffected areas;
- Rehabilitating disturbed ground surfaces as soon as is practical; and
- Appropriately dispose of all rubbish and other refuse that may potentially attract introduced animals (i.e. food scraps) in sturdy waste disposal receptacles that are frequently emptied.

4.3 Operation Phase

The operation of the Project has the potential to cause a number of direct and indirect impacts on aquatic fauna and flora assemblages through the following aspects:

- Train operation; and
- Rail line infrastructure.

The potential impacts associated with these operation activities are discussed in detailed below.

4.3.1 Fauna Mortality

Direct mortality of aquatic fauna (primarily freshwater turtles) could occur during the operational phase of the Project through train strikes and maintenance vehicle strikes. Risk of turtle mortality is most likely to occur in the vicinity of large palustrine habitats and during rain events, when long-necked species undertake overland migrations. It is considered likely that a small number of turtles will be killed during the operation of the Project though population abundance is unlikely to be affected. The ecological consequence of these mortalities is considered minor.

Summary and Mitigation Measures

The operation of the Project is likely to result in the mortality of a small number of freshwater turtles. The mitigation measures proposed below have been designed to reduce the likelihood of this risk. The expected residual impact of turtle mortality on aquatic environmental values is considered Low (3, 1). Mitigation measures proposed include:

- Monitoring turtle mortality rates at large palustrine habitats (e.g. Caley Valley Wetland); and
- Developing and installing turtle exclusion barriers in areas that demonstrate high risk of mortality.

4.3.2 Alteration to In-stream and Floodplain Hydrology

The hydrology of aquatic habitats within the study area has been previously altered as a result of road crossings; impoundments and human made bund walls. The rail line infrastructure required for Project operation has the potential to further alter in-stream and floodplain hydrology resulting in the restriction of fauna movement and the degradation of habitat. As discussed in Section 4.2.3, movement of aquatic fauna within and between aquatic habitats is a critical life cycle component of many species and is particularly important for dispersal and breeding (Marsden and Power 2007; Walsh and Whitehead 1993; Tucker 1999). A long-term decrease in dispersal migrations within the river system may cause a reduction in gene flow resulting in the formation of genetically isolated populations. A restriction of dispersal migrations may also result in physically isolated populations becoming threatened with localised extinction due to a lack of immigration from neighbouring areas (Tucker, 1999; Bunn and Arthington 2002). These impacts are particularly relevant to aquatic fauna such as freshwater turtles and crocodiles that do not a larval dispersal phase.

Many fish species known to occur within the study undertake obligatory breeding migrations within and between habitats and water flows are recognised as one of the most important factors influencing the migration of these species (Baran 2006; Sheaves *et al.* 2007). For example, the breeding season of a number of species (i.e. barramundi; long-finned eel; oxeye herring and empire gudgeon) is known to occur during the wet season when flows within the river are increased and off-stream breeding and nursery habitats (i.e. palustrine habitats) are connected to the river system facilitating access to these environments (Reynolds 1983; Pusey *et. al.* 2004; Stuart and Berghuis 1997).

The ecological consequence of restricted fauna movement can include: declines in species abundance; species distribution truncation; localised extinct; and a reduction in species diversity (Marsden and Power 2007). This is already evident within the study area with the localised extinction of diadromous fish species upstream of the Burdekin Falls Dam (Pusey *et al*. 1998).

The bridging of aquatic habitats will have minimal impacts on in-stream flows and as such will reduce the likelihood of fauna movement restriction in these locations. Restriction of fauna movement at culvert locations is likely to be more prevalent. Water velocities through culverts are often greater than the maximum swimming ability of fish, particular small bodied species, and thus upstream movement can not occur. Other factors potentially limiting fauna movement at culvert locations include sedimentation of the culverts and reduced light availability. The design of any culvert crossings should consider appropriate passage requirements.

Alteration of in-stream and floodplain hydrology may also result in the degradation of aquatic habitats. Alteration of in-stream flows within riverine habitats can result in a reduction in water quality; decrease in the downstream transport of woody debris and change in channel

morphology as a result of increased sedimentation and erosion (Wheeler *et* al. 2005; Bunn and Arthington 2002). Only minor changes in channel morphology is expected to occur at the bridge habitats however larger scale impacts are expected at culvert locations where flows are influenced to a greater extent. As these locations are generally ephemeral the likelihood that these habitats will be impacted by habitat degradation is reduced.

Alteration of floodplain hydrology as a result of the rail line infrastructure has the potential to decrease in the inundation and connectivity of floodplain habitats (i.e. palustrine habitats). Alteration of floodplain hydrology has the potential to result in the degradation of these habitats and may also decrease the input of floodplain resources into the main river channel. The inclusion of culverts at key locations within floodplain habitats will reduce the likelihood of these impacts.

Summary and Mitigation Measures

The rail line infrastructure required for the operation of the Project has the potential to result in the alteration of in-stream and floodplain hydrology. The ecological consequences of this impact include restriction of fauna movement and habitat degradation. As these impacts have the potential of result in the loss of habitat and the potential localised loss of species, this impacts is considered a Major consequence. The mitigation measures proposed below have been designed to reduce the likelihood of this risk. The expected residual impact of altered in-stream and floodplain hydrology on aquatic environmental values is considered Medium (3, 4). Mitigation measures proposed include:

- Minimising the impact to estuarine and lacustrine/palustrine hydrology by avoiding the fragmentation of these habitats during the design phase;
- Bridging aquatic habitats and providing culverts in accordance with the design criteria defined in Section 11 Surface Water of the EIS; and
- Providing culverts at key areas within floodplain habitats (i.e. including estuarine and lacustrine/palustrine habitats).

4.3.3 Increased Sedimentation, Run-off and Dust

The degradation of water quality as a result of land use practises (i.e. cattle grazing and associated clearing of riparian vegetation) has resulted in a reduction in the environmental value of aquatic habitats within the study area. The operation of the Project has the potential to result in further degradation as a result of increased sedimentation, run-off and dust. The rail corridor and maintenance track are likely to collect small volumes of stormwater and direct increased run-off into aquatic habitats. Potential impacts to aquatic habitats as a result of increased sedimentation and run-off include: reduced water quality; increased bank erosion and introduction of contaminants or pollutants (Wood and Armitage 1997; Wheeler *et al*. 2005). The consequences of these impacts are considered significant due to the potential for a reduction in habitat value (e.g. amount of refuges, microhabitats and food availability) and decrease in species abundance (see Section 4.2.4 for a more detailed description of sedimentation and run-off impacts). As increased sedimentation and run-off will occur during rainfall events when riverine habitats are primarily flowing and existing levels of sedimentation are high, the likelihood of sedimentation and run-off impacts as a result of the Project are likely to be reduced. Lacustrine and palustrine habitats such as the Caley Valley Wetland, are

likely to be more susceptible to impacts of sedimentation and run-off due to the no/low flow conditions. The establishment of sediment traps and biofilters will reduced the likelihood of impact in these areas.

Project operation may also result in a minor increase in dust generation from the movement of maintenance vehicles along dirt access tracks, particularly during dry and windy conditions. Excessive dust settling on water bodies has the potential to decrease aquatic habitat value within the immediate and downstream areas primarily as a result of reduced water quality. Excessive dust may also influence riparian vegetation by limiting the photosynthesis potential of plants in close proximity to the construction area (Nanos and Ilias 2007). Due to the low frequency as which access tracks will be utilised, it is considered unlikely that dust deposition impacts will occur.

Summary and Mitigation Measures

Operation activities have the potential to result in habitat degradation as a result of sedimentation, run-off and dust. The ecological consequence of this impact is considered significant due to the potential reduction in foraging and breeding habitat. The mitigation measures proposed below have been designed to reduce the likelihood of this risk. The expected residual impact of sedimentation, run-off and dust on aquatic environmental values is considered Medium (4, 3). Mitigation measures proposed include:

- Establishing protective vegetation; sediment traps, silt fencing and biofilters at aquatic habitat locations to protect water bodies from sediment and pollutants;
- Cleaning and maintaining trains to minimise the introduction of contaminants such as oil and fuel;
- Development an Erosion and Sedimentation Management Plan which includes dust suppression techniques to address dust emissions from vehicles during the operational phase;
- Establishing a Water Quality Monitoring Plan (adequate baseline information will be required) to monitor the composition and condition of the nationally important Caley Valley Wetland; and
- Developing a Waste and Hazardous Materials Management Plan which will include fuel and chemical storage protocols and spill responses.

4.3.4 Coal Dust Emission

Operation of the Project has the potential to impact aquatic habitats through the emission of coal dust from loaded and unloaded trains. High levels of coal dust emission have the potential to increase dust deposition leading to a decrease in water quality and reduction in the photosynthetic potential of riparian vegetation. Contamination of aquatic habitats may also occur if heavy metals are associated with deposited coal dust particles (Swer and Singh 2003). Subsequent impacts to aquatic habitats are significant and include an overall reduction in aquatic and riparian habitat value and in extreme cases, potential mortality of fauna species and dieback of riparian vegetation.

Measures of coal dust deposition rates along an existing rail corridor have recorded maximum values of 90 mg/m²/day at approximately 3 m from the tracks. Deposition rates of 30

mg/m²/day were recorded approximately 10 metres from the tracks, indicating deposition rates decrease rapidly with increasing distance from tracks (Andrews and Skriskandarajah 1992). Values of coal dust deposition recorded along the rail corridor were well below proposed threshold level for adverse impacts on crops and vegetation (i.e. 500 mg/m²/day) (Andrews and Skriskandarajah 1992). These results suggest that the deposition of coal dust in aquatic habitats as a result of the Project will be low and hence the consequences to environmental values are considered moderate. Measures to reduce the likelihood of dust deposition in aquatic habitats will include the use of wagons that limit dust loss; construction of ballasted bridges over aquatic habitats; improved loading and unloading procures; regular train cleaning and development of an Erosion and Sedimentation Management Plan.

Summary and Mitigation Measures

Operation activities have the potential to result in the degradation of aquatic habitats due to coal dust emission. The ecological consequence of this impact is considered moderate due to the potential for permanent degradation of the aquatic environment. The mitigation measures proposed below have been designed to reduce the likelihood of this risk. The expected residual impact of coal dust emission on aquatic environmental values is considered Medium (4, 2). Mitigation measures proposed include:

- Utilising wagons that to minimise loss of coal particles;
- Constructing ballasted bridges over aquatic habitats to reduce direct input of coal dust particles into water bodies;
- Train operations are to be conducted in accordance with a Dust Management Plan;
- Developing an Erosion and Sedimentation Management Plan which includes measures to minimise run-off of coal dust into aquatic habitats;
- Improving coal loading and unloading procedures to minimise parasitic loads on sills etc.;
- Train cleaning is to be undertaken regularly; and
- Trains are not to be overloaded.

4.3.5 Noise, Light and Vibration Disturbance

Aquatic habitats that are considered important include the permanent water bodies within riverine and palustrine habitats, the Caley Valley Wetland and the Bowen River: Birralee - Pelican Creek Aggregation. These habitats provide particular foraging, breeding and sheltering resources that are unavailable in other areas. Light, noise and vibration disturbance as a result of Project operation has the potential to disrupt normal fauna behaviours in these areas resulting in a reduction in habitat value.

The main noise and vibration emissions during the operation phase of the project will be train movement. The frequency of trains utilising the rail corridor is likely to be seven trains moving along the rail line twice a day. Noise and vibration impacts from passing trains may interfere with communication, disrupt breeding and nesting or startle some fauna species displacing them into adjacent habitats. Nesting of crocodiles and freshwater turtles along adjacent river banks is likely to be most affected by noise disturbance however this will primarily be restricted to areas where the rail corridor crosses permanent pool habitat (e.g. Suttor River).

No critical nesting habitat for these species is known to occur within the study area. It is likely that some animals will adapt to the infrequent noise and vibration emissions. The platypus (*Ornithorhynchus anatinus*) is known to be particular tolerant of disturbed habitats and has been observed in habitats adjacent to major road crossings (Grant and Temple-Smith 1998).

The impact of operational lighting associated with the rail corridor infrastructure on aquatic fauna is generally considered negligible as minimal operational lighting will be required along much of the alignment. The only source of light disturbance in these areas will be from the high powered lights emitted by the trains travelling at night. Aquatic habitats located at or adjacent to road crossings; passing loops and the port loops are likely to have a higher level of light disturbance due to the additional operation lighting that is required in these locations. This impact has the potential to reduce the value of the habitat affected and species diversity and abundance in the localised area may decrease. The use of directional lighting with protective guards will limit the extent of affected habitat in these areas.

Summary and Mitigation Measures

- Where possible, operational lights, such as at signalling stations, should not be located within or adjacent to aquatic habitats;
- Employing directional lighting with protective guards (particularly when within or adjacent to permanent water bodies, the Caley Valley Wetland or Bowen River);
- Revegetating habitats disturbed during construction to create an environmental buffer to noise for surrounding habitats;
- Appropriately service and maintain trains to minimise machinery noise; and
- Restricting speed limits within the Caley Valley Wetland to limit noise disturbance.

4.3.6 Increased Abundance and Diversity of Introduced Species

Operation of the Project has the potential to result in an increase in the abundance and diversity of introduced species within the Project area. The maintenance of cleared land within the rail corridor is likely to facilitate the spread of riparian weed species (e.g. rubber vine) along the corridor. Train operation and movement of vehicles along the maintenance access track may also contribute to the spread of riparian weed species through seed transfer. An increase in the abundance and diversity of weed species within aquatic habitats may result in a reduction in native species diversity, reduction in in-stream fauna habitat in the form of root mats and branches and increased risk of soil erosion. Degradation of aquatic habitats by introduced flora species has been recorded extensively throughout the Project footprint as a result of grazing practices and the potential consequence of further impacts is considered Major. Implementation of measures such as vehicle and train wash down may reduce the likelihood of this impact.

Pest species that use the rail easement as a linear pathway for movement may become introduced into previously uncolonised habitats. Competition and predation by feral animals has the potential to reduce the abundance and diversity of local terrestrial and aquatic fauna.

Summary and Mitigation Measures

Operation activities have the potential to result in an increase in the abundance and diversity of introduced species within the study area. The ecological consequence of this impact is considered major due to the potential for species and/or community loss. The mitigation measures proposed below have been designed to reduce the likelihood of this risk. The expected residual impact of an increase in abundance and diversity of introduced species on aquatic environmental values is considered Medium (3, 4). Mitigation measures proposed include:

- Developing a Weed and Pest Management Plan for implementation throughout the operation phase. Management actions will including:
  - Providing vehicle wash down stations along the alignment;
  - Regularly cleaning trains to remove weeds, seed and mud;
  - Regularly monitoring declared pest and weed species; and
  - Controlling pest and weed species where necessary.

4.4 Protected Areas and Important Species

4.4.1 Matters of National Environmental Significance

Matters of National Environmental Significance (MNES) are protected under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act). The EPBC Act relates to projects that involve or impact upon matters of national environmental significance and addresses Australia's commitments to international environmental law and treaties.

MNES relating to aquatic environmental values that may be impacted by Project include the estuarine crocodile (*Crocodylus porosus*) and freshwater crocodile (*Crocodylus johnstoni*).

Estuarine Crocodile (*Crocodylus porosus*)

The estuarine crocodile is listed as 'Marine' and 'Migratory' under the EPBC Act and 'Vulnerable' under the NCA. Whilst this species is usually associated with tidal coastal and estuarine environments, the estuarine crocodile can occur well inland (hundreds of kilometres) in freshwater habitats such as rivers, creeks, swamps and billabongs (DERM 2009c). Within the Burdekin Catchment the estuarine crocodile has been recorded from tidal reaches including: Burrumbush Creek; Cromarty Creek; Haughton River; Barramundi Creek; Alligator Creek; Groper Creek and Rock Ponds Creek (DERM 2002). The estuarine crocodile has also been recorded in the Burdekin River up to as high as Burdekin Dam (i.e. 140 km from the river mouth). Overall, estuarine crocodile numbers within the Burdekin Catchment are considered low to very low (DERM 2002). Potentially suitable habitat for the estuarine crocodile within the study area is likely to be limited to the tidal creeks of Caley Valley Wetland and the large permanent pool habitats in the Bowen and Bogie Rivers.

Potential impacts of Project construction and operation on the estuarine crocodile are primarily associated with the degradation of potential habitat as a result of altered in-stream hydrology; increased sedimentation, run-off and dust; coal dust emission and increase noise, light and vibration disturbance. These impacts have been assessed against DEWHA's Significant Impact Guidelines for Listed Migratory Species (Table 13). Due to the extremely low abundance of estuarine crocodiles and potential estuarine crocodile habitat within the

study area, the residual impact of Project construction and operation on this MNES is considered low.

Table 13 MNES Significant Impact Criteria Assessment – Listed Migratory Species

MNES Significant Impact Criteria	Estuarine Crocodile (*Crocodylus porosus*)
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.	No important estuarine crocodile habitat occurs within the Project footprint. A small number of individuals may potentially occur in the Bowen and Bogie Rivers however permanent habitat does not occur at the locations of the rail crossings.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	The increase in abundance and diversity of introduced species within the Project footprint as a result of Project construction and operation is considered a Medium risk. An increase in weeds species within the riparian zone has the potential to decrease the suitability of nesting habitat for the estuarine crocodile however as nesting is unlikely to occur within the study area, the likelihood of impact is low.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	Habitat degradation, as a result of altered in-stream hydrology; increased sedimentation, run-off and dust; coal dust emission and noise, light and vibration disturbance, has the potential to disrupt estuarine crocodile behaviour within habitats adjacent to the rail corridor. As these habitats have a low value for the estuarine crocodile and are likely to support only a small number of individuals, the likelihood of impact is considered low.

Freshwater Crocodile (*Crocodylus johnstoni*)

The freshwater crocodile is listed as 'Marine' under the EPBC Act. In Queensland, this species primarily occurs in the northwest highlands; Gulp of Carpentaria; Einasleigh uplands and the Cape York Peninsula (Wilson 2009). Small populations also occur on the east coast as a result of translocation and introductions from the pet trade. A small breeding population of freshwater crocodiles has established in the Burdekin Catchment as a result of these introductions (DERM 2010b). Potentially suitable habitat for this species is likely to be limited to the large permanent pool habitats in the Bowen and Bogie Rivers.

Potential impacts of Project construction and operation on the freshwater crocodile are primarily associated with the degradation of potential habitat as a result of altered in-stream hydrology; increased sedimentation, run-off and dust; coal dust emission and increase noise, light and vibration disturbance. These impacts have been assessed against DEWHA's Significant Impact Guidelines for The Commonwealth Marine Environment (Table 13). Only those criteria relevant to marine species were assessed. Due to the extremely low abundance

of freshwater crocodiles and potential freshwater crocodile habitat within the study area, the residual impact of Project construction and operation on this MNES is considered low.

Table 14 MNES Significant Impact Criteria Assessment – The Commonwealth Marine Environment

MNES Significant Impact Criteria	Freshwater Crocodile (*Crocodylus johnstoni*)
Have a substantial adverse effect on a population of a marine species or cetacean including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution.	No important freshwater crocodile habitat occurs within the Project footprint. A small number of individuals may potentially occur in the Bowen and Bogie Rivers however these individuals have been introduced to the Catchment and are not an important component of the larger freshwater crocodile population.

4.4.2 Nationally Important Wetlands

The Australian Government's Directory of Important Wetlands (Environment Australia, 2001) is an inventory of important wetland areas throughout Australia. The directory aims to protect important wetland habitat by providing information on wetland values and locations. Nationally important wetlands located within the study area include the Caley Valley Wetland and the Bowen River: Birralee – Pelican Creek Wetland aggregation.

Caley Valley Wetland

The Caley Valley Wetland comprises a mixture of permanent estuarine waters, intertidal mud and sand flats, mangroves, saltmarshes, freshwater marshes and freshwater impoundments. The wetland experiences distinct seasonal changes, with wet-season filling driving a freshwater system that provides habitat for a number of aquatic species, including freshwater turtles and fish. The drying out period (during the dry season) creates a more saline environment, and restricts freshwater areas to pools that may persist depending on the duration of the dry season. The wetland provides important spawning, breeding and nursery habitats for many commercially and recreationally important fish species including barramundi (*Lates calcarifer*) and mangrove jack (*Lutjanus argentimaculatus*). The estuarine tidal channels provide potential habitat for the estuarine crocodile.

Port Loop Option 1 will cross the Caley Valley Wetland near chainage 505000, resulting in the footprint of <1 ha of estuarine habitat and approximately 13.5 ha of palustrine habitat. Port Loop Option 2 will also cross the Caley Valley Wetland. Additional potential impacts of Project construction and operation on the Caley Valley Wetland are discussed in detailed above. All potential construction phase impacts are considered to have a High risk to the Caley Valley Wetland prior to mitigation. The implementation of proposed mitigation measures will reduce these impacts to Medium risk. Potential operation phase impacts considered to have a High risk to the wetland include: alteration to in-stream and floodplain hydrology; increased sedimentation, run-off and dust and increase in abundance and diversity of introduced species. With mitigation, these impacts are reduced to Medium risk.

Bowen River: Birralee - Pelican Creek Aggregation

The Bowen River: Birralee - Pelican Creek Aggregation is located approximately 3.5 km away from the proposed railway alignment. This site provides a range of aquatic habitats including: rapids, sand, rock or rubble bars, terraces, small waterholes, macrophytes beds, emergent wetlands and flooded palustrine evergreen forest. The main feature of this wetland is a large permanent clear waterhole in the central part of the site approximately 3.4 km in length and about 150 m wide at its widest point (DEWHA 2010c). The large permanent waterhole is likely to provide an important dry season refuge for many fauna species. Eight species of conservation significance have been recorded on the site including the estuarine crocodile. A large number of migratory bird species have also been previously recorded (DEWHA 2010c).

Project construction and operation will not have a direct impact of the Bowen River: Birralee - Pelican Creek Aggregation. Potential indirect impacts may occur as a result of alteration to in-stream and floodplain hydrology and increased sedimentation, run-off and dust. Measures proposed to mitigation these impacts are discussed in Sections 4.2.3 and 4.2.4 (construction phase) and Sections 4.3.2 and 4.3.3 (operation phase). With the implementation of these mitigation measures the residual impact of Project construction and operation of the Bowen River: Birralee - Pelican Creek Aggregation is considered Low.

4.4.3 Commercially and Recreationally Important Fish Species

Commercial fishing does not occur within the study area however a number of fish species that inhabit the Caley Valley Wetland are considered a potential component of the Queensland East Coast Inshore Fin Fish Fishery (DEEDI 2009). These species include: barramundi (*Lates calcarifer*); sea mullet (*Mugil cephalus*); mangrove jack (*Lutjanus argentimaculatus*) and long-finned eel (*Anguilla reinhardtii*). Important recreational species include barramundi, mangrove jack; jungle perch (*Kuhlia rupestris*); golden perch (*Macquaria ambigua*); blue catfish (*Arius graeffei*); black catfish (*Neosiluris ater*); sleepy cod (*Oxyeleotris lineolata*); sooty grunter (*Hephaestus fuliginosus*); oxeye herring (*Megalops cyprinoides*); snub-nosed garfish (*Arrhamphus sclerolepis*); pikey black bream (*Acanthopagrus berda*); and seven-spot archerfish (*Toxotes chatereus*).

As the Caley Valley Wetland provides important spawning, breeding and nursery habitat for these species, potential impacts of Project construction and operation on commercially and recreationally important fish species is primarily associated with impacts to the Caley Valley Wetland (see Section 4.4.2).

4.4.4 Endemic Species

Three fauna species endemic to the Burdekin Catchment occur within the study area. These species are the soft-spined catfish (*Neosilurus mollespiculum*), small-headed grunter (*Scortum parviceps*) and Irwin's turtle (*Elseya irwini*). The Irwin's turtle is also listed as high priority for conservation the DERM 'Back on Track' prioritisation framework for conservation management of Queensland's wildlife.

Soft-spined Catfish (*Neosilurus mollespiculum*)

The soft-spined catfish is a benthic species that generally inhabits still/slow flowing waters in freshwater habitats. The diet is dominated by benthic aquatic invertebrates and movement is

restricted to the freshwater environment (Pusey *et al*. 2004). Potential habitat for this species within the Project study area is primarily restricted to those habitats that contain permanent water bodies (i.e. Suttor River and Mistake Creek). Potential impacts of Project construction and operation on this species are discussed in general in Sections 4.2 and 4.3. As this species has generalist habitat requirements and is tolerant to a range of environmental conditions, the mitigation measures proposed for the Project are considered to adequately reduce the risk of impact to Low.

Small-headed Grunter (*Scortum parviceps*)

The small-headed grunter primarily inhabits still/slow flowing river habitats. The species is thought to prefer deep water (> 1m) areas with a sandy, fine gravel substrate. The diet is dominated by algae and macrophytes and movement is restricted to the freshwater environment (Pusey *et al*. 2004). Potential habitat for this species within the Project study area is primarily restricted to those river habitats that contain deep permanent water bodies (i.e. Suttor River). Potential impacts of Project construction and operation on this species are discussed in general in Sections 4.2 and 4.3. As potential habitat for this species is relatively limited within the Project footprint, the mitigation measures proposed for the Project are considered to adequately reduce the risk of impact to Low.

Irwin's turtle (*Elseya irwini*)

The Irwin's turtle is only known to occur in the Burdekin, Broken and Bowen Rivers. Areas with a sandy substrate, high abundance of macrophytes and in-stream debris are preferred (Cann, 1998; 2008). Suitable habitat for the Irwin's turtle in the study area is primarily restricted to the Bowen and potentially the Bogie River. Tributaries of these rivers, such as Pelican Creek, may provide temporary habitat during the wet season. Due to a reliance on aquatic respiration, this species is likely to be sensitive to changes in environmental conditions including dissolved oxygen levels, temperature and turbidity. Potential impacts of Project construction and operation on this species are discussed in general in Sections 4.2 and 4.3. As potential habitat for this species is relatively limited within the Project footprint, the mitigation measures proposed for the Project are considered to adequately reduce the risk of impact to Low.

4.4.5 Marine Plants

Marine plants protected under the *Fisheries Act 1994*, are located in the estuarine habitats of the Caley Valley Wetland. Species present include: salt couch (*Sporobolus virginicus*), and weeping paperbark (*Melaleuca leucadendra*). Other species that are known to occur in the areas include *Tecticornia australasica* and *Sarcocornia quinqueflora*.

Offsets will be required to compensate for the clearance of these marine plants. An offsets package for the Project will be developed in consultation with DERM, DEEDI and DEWHA giving consideration to relevant state and Commonwealth policies relating to offsets.

Marine plants are discussed in further detail on the Terrestrial Ecology Technical Report.

5. Risk Assessment

An impact and risk assessment was undertaken to assess the risk of the proposed Project on the aquatic environmental values. Environmental risks associated with Project construction and operation were identified and classified into one of four risk categories (High, Medium, Low and Very Low). These classifications allowed priorities to be set for addressing and mitigating environmental risks. The risk assessment process is outlined in detail in Section 2.5.

Table 15 details the ecological risk for the Project. Six construction impacts were considered to have High risk prior to mitigation, these included:

- Loss of aquatic habitat;
- Fauna mortality;
- Alteration to in-stream and floodplain hydrology;
- Increased sedimentation, run-off and dust;
- Light, noise and vibration disturbance; and
- Increase in abundance and diversity of introduced species.

Following implementation of mitigation measures all construction phase risks were reduced to Medium risk.

Operational impacts considered to have High risk prior to mitigation included:

- Alteration to in-stream and floodplain hydrology;
- Increased sedimentation, run-off and dust;
- Increase in abundance and diversity of introduced species.

Following implementation of mitigation measures, all impacts were reduced to a Medium risk or lower (Table 15).

Table 15 Risk Assessment for Aquatic Environmental Values

Activity	Potential Impact	Preliminary Risk Level (Likelihood, Consequence)	Mitigation Measures	Residual Risk Level (Likelihood, Consequence)
Project Construction: Removal of riparian vegetation at aquatic habitat crossings; Construction within the bed and banks; Movement of vehicles and plant to, from and around the construction site; and Flow diversion and control.	Potential loss of aquatic habitat up to <1 ha of estuarine habitat and 13.5 ha of palustrine habitat located within the Caley Valley wetland (considering Loop Option 1 only).	5, 3 High	Minimising the loss of aquatic habitat in the design phase by locating the rail corridor in areas that have been previously cleared or degraded by past land use practices; Minimising the loss of remnant *Acacia harpophylla* (brigalow) forest and woodland which support unique gilgai's habitat; Minimising the loss of nationally important Caley Valley Wetland habitat; Bridging aquatic habitats in accordance with design criteria; Clearly identifying the extent of vegetation clearing and earthworks on construction plans and in the field. The extent of construction is to be restricted to the minimal amount necessary in all aquatic habitat locations; Locating any additional construction areas and construction sites, such as site offices, soil stockpiles, machinery/equipment storages and construction camps within existing cleared areas and away from aquatic habitats; and Minimising the loss of marine plants. When unavoidable clearing of marine plants occurs in the estuarine habitat, offsets will be required. Note: the exact amount of certain vegetation types to be cleared is yet to be	4, 3 Medium

Activity	Potential Impact	Preliminary Risk Level (Likelihood, Consequence)	Mitigation Measures	Residual Risk Level (Likelihood, Consequence)
			confirmed but will be required for the project.	
	Fauna mortality	5, 3 High	Restricting construction within aquatic habitats during the wet season where possible. In the dry season the majority of habitats will be dry or supporting fewer fauna species; Engaging a fauna spotter to be located on site prior to and during all vegetation removal and initial construction within the bed and banks to identify, capture and relocate fauna within the construction area; Developing an aquatic fauna species relocation plan that describes relocation methodology for aquatic species; Erecting temporary bunding around aquatic habitats within the construction zone to exclude aquatic fauna; Educating employees of environmental responsibilities during inductions including treating all native fauna species as protected; Enforcing on-site speed limits to restrict the incidence of wildlife road kill; and Developing a fauna mortality register to determine the location, frequency of mortality, and types of species most susceptible, to enable additional mitigation measures to be implemented where necessary.	3, 3 Medium
	Alteration to in-stream and floodplain hydrology	5, 3 High	Restricting construction within aquatic habitats during the wet season where possible. In the dry season	3,3 Medium

Activity	Potential Impact	Preliminary Risk Level (Likelihood, Consequence)	Mitigation Measures	Residual Risk Level (Likelihood, Consequence)
	resulting in the temporary restriction of fauna movement and habitat degradation		movement of fauna, particularly for breeding, is reduced; Maintaining in-stream flows via a flow diversion system; Providing a fauna spotter/catcher to capture and relocate fauna species trapped in isolated habitats that become increasingly degraded as a result of construction activities; and Maintaining water quality (particularly turbidity, temperature and oxygen levels) in accordance with Queensland Water Quality Guidelines.	
	Increased sedimentation, run-off and dust	5, 3 High	Restricting construction within aquatic habitats during the wet season where possible; Preparing and implementing an Erosion and Sedimentation Management Plan which includes: Installing and maintaining sediment fences around all earthworks within and adjacent to aquatic habitats; Installing and maintaining temporary sediment traps and biofilters at key locations where run-off is expected throughout the course of the construction period; Rehabilitating disturbed ground surfaces as soon as is practical to minimise exposed surface periods; Incorporating dust suppression techniques into construction activities, e.g. tankers spraying down dirt roads; Appropriately store and cover/locate soil stockpiles in	3,3 Medium

Activity	Potential Impact	Preliminary Risk Level (Likelihood, Consequence)	Mitigation Measures	Residual Risk Level (Likelihood, Consequence)
			areas not susceptible to wind erosion or run-off; Minimising vegetation clearing and the area of bare ground required for construction to only that which is necessary within and adjacent to aquatic habitats; Maintaining clean operating conditions in vehicles and machines; Restricting speed limits and other traffic control mechanisms to minimise the generation of dust; Developing a Waste and Hazardous Materials Management Plan which will include fuel and chemical storage protocols and spill responses; and Maintaining water quality (particularly turbidity, temperature and oxygen levels) in accordance with Queensland Water Quality Guidelines.	
	Noise, light and vibration disturbance	5, 3 High	Restricting construction within aquatic habitats during the wet season where possible. In the dry season aquatic fauna species diversity and abundance is lowest and fish breeding is reduced. This is particularly relevant for palustrine habitats, such as the Caley Valley Wetland, which provide breeding habitat for commercially and recreationally important fish species. Limiting lighting to that which is safe for operation and employing directional lighting with protective guards (particularly when adjacent to permanent pools); and Appropriately service and maintain all plant and	3, 3 Medium

Activity	Potential Impact	Preliminary Risk Level (Likelihood, Consequence)	Mitigation Measures	Residual Risk Level (Likelihood, Consequence)
			equipment is appropriately serviced and maintained to minimise machinery noise where possible.	
	Increased abundance and diversity of introduced species	5, 4 High	Developing a Weed and Pest Management Plan for implementation throughout the construction phase. Management actions will including: Providing vehicle wash down stations along the alignment; Regularly monitoring declared pest and weed species; and Controlling pest and weed species where necessary. All construction machinery and materials brought onto site are weed, seed and mud free to have undergone a thorough inspection; Care is to be taken when disturbing soil in known weed infestation locations to limit seed spread to unaffected areas; Rehabilitating disturbed ground surfaces as soon as is practical; and Appropriately dispose of all rubbish and other refuse that may potentially attract introduced animals (i.e. food scraps) in sturdy waste disposal receptacles that are frequently emptied.	3, 4 Medium
Project Operation:	Fauna mortality	4,1	Monitoring turtle mortality rates at large palustrine habitats (e.g. Caley Valley Wetland); and	3,1

Activity	Potential Impact	Preliminary Risk Level (Likelihood, Consequence)	Mitigation Measures	Residual Risk Level (Likelihood, Consequence)
Train operation; and Rail line infrastructure.		Low	Developing and installing turtle exclusion barriers in areas that demonstrate high risk of mortality.	Low
	Alteration to in-stream and floodplain hydrology resulting in the restriction of fauna movement and habitat degradation	5, 4 High	Minimising the impact to estuarine and lacustrine/palustrine hydrology by avoiding the fragmentation of these habitats during the design phase; Bridging aquatic habitats and providing culverts in accordance with design criteria; Providing culverts at key areas within floodplain habitats (i.e. including estuarine and lacustrine/palustrine habitats). Consider fish passage requirements in crossing and culvert design.	3, 4 Medium
	Increased sedimentation, run-off and dust	5, 3 High	Establishing protective vegetation; sediment traps, silt fencing and biofilters at aquatic habitat locations to protect water bodies from sediment and pollutants; Cleaning and maintaining trains to minimise the introduction of contaminants such as oil and fuel; Development an Erosion and Sedimentation Management Plan which includes dust suppression techniques to address dust emissions from vehicles during the operational phase; Establishing a Water Quality Monitoring Plan (adequate baseline information will be required) to monitor the composition and condition of the nationally important	4, 3 Medium

Activity	Potential Impact	Preliminary Risk Level (Likelihood, Consequence)	Mitigation Measures	Residual Risk Level (Likelihood, Consequence)
			Caley Valley Wetland; and Developing a Waste and Hazardous Materials Management Plan which will include fuel and chemical storage protocols and spill responses.	
	Coal dust emission	5, 2 Medium	Utilising wagons that to minimise loss of coal particles; Constructing ballasted bridges over aquatic habitats to reduce direct input of coal dust particles into water bodies; Conducting train operations are conducted in accordance with a Dust Management Plan; Developing an Erosion and Sedimentation Management Plan which includes measures to minimise run-off of coal dust into aquatic habitats; Improving coal loading and unloading procedures to minimise parasitic loads on sills etc.; Clean train regularly; and Do not overload.	4, 2 Medium
	Noise, light and vibration disturbance	5, 2 Medium	Where possible, any operational lights, such as at signalling stations, should not be located within or adjacent to aquatic habitats; Employing directional lighting with protective guards (particularly when within or adjacent to permanent water bodies, the Caley Valley Wetland or Bowen River);	4, 2 Medium

Activity	Potential Impact	Preliminary Risk Level (Likelihood, Consequence)	Mitigation Measures	Residual Risk Level (Likelihood, Consequence)
			Revegetating habitats disturbed during construction to create an environmental buffer to noise for surrounding habitats; Trains are to be appropriately serviced and maintained to minimise machinery noise; and Restricting speed limits within the Caley Valley Wetland to limit noise disturbance.	
	Increased abundance and diversity of introduced species	5, 4 High	Developing a Weed and Pest Management Plan for implementation throughout the operation phase. Management actions will including: Providing vehicle wash down stations along the alignment; Regularly cleaning trains to remove weeds, seed and mud; Regularly monitoring declared pest and weed species; and Controlling pest and weed species where necessary.	3, 4 Medium

6. Conclusion

The existing aquatic environment within the study area primarily supports a range of low value aquatic habitats and generalist flora and fauna species. Habitats considered locally important are restricted to those such as the Suttor River, Mistake Creek and the Star of Hope Wetland which support permanent riverine and palustrine water bodies. Nationally important aquatic habitats within the study area include the Caley Valley Wetland and Bowen River: Birralee - Pelican Creek Aggregation. The Caley Valley Wetland provides a range of habitats for aquatic flora and fauna species and provide high value habitat for commercially and recreationally important fish species.

Locally important fauna species potentially occurring within the study area included: the endemic soft-spined catfish (*Neosilurus mollespiculum*); small-headed grunter (*Scortum parviceps*) and Irwin's turtle (*Elseya irwini*). Irwin's turtles is also listed as high priority for conservation under the DERM 'Back on Track' prioritisation framework for conservation management of Queensland's wildlife. Conservation significant fauna species protected under the EPBC Act and/or NCA include the estuarine crocodile (*Crocodylus porosus*) and freshwater crocodile (*Crocodylus johnstoni*). A small number of these individuals potentially occur in the tidal creeks of Caley Valley Wetland (estuarine crocodile only) and the large permanent pool habitats in the Bowen and Bogie Rivers.

No conservation significant aquatic flora species are known to occur within the study area however nine species have been identified as priority species in the DERM Aquatic Conservation Assessment for the riverine wetlands of the Great Barrier Reef Catchment. The saltcouch and weeping paperbark that occur in the estuarine habitats are protected as marine plants under the *Fisheries Act 1994*. A total of ten flora species are listed as WONS and/or are listed as declared weeds under Queensland's *Land Protection* (*Pest and Stock Route Management*) *Act 2002*. Only rubber vine (*Cryptostegia grandiflora*) was observed in the study area.

The potential impacts of Project construction and operation on aquatic environmental values include:

Potential construction impacts:

- Loss of aquatic habitat;
- Fauna mortality;
- Alteration to in-stream and floodplain hydrology;
- Increased sedimentation, run-off and dust;
- Light, noise and vibration disturbance; and
- Increase in abundance and diversity of introduced species.

Potential operation impacts:

- Fauna mortality;
- Alteration to in-stream and floodplain hydrology;

- Increased sedimentation, run-off and dust;
- Coal dust emission;
- Light, noise and vibration disturbance; and
- Increase in abundance, diversity and distribution of introduced species.

These impacts can be effectively mitigated by restricting construction during the wet season where possible; bridging aquatic habitats and providing culverts suitable for fish passage at other aquatic habitats in accordance with the design criteria; maintaining water quality; and managing introduced species. Specific mitigation measures have been identified and will be included in the construction and environmental management plan for the Project to realise these measures.

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Appendix A

Desktop Search Results

DEWHA ERT

DERM WildNet

Queensland Museum

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

Environmental Reporting Tool

You are here: Environment Home > ERIN > ERT

26 November 2009 10:57

Database Report

This report includes places of national environmental significance that are registered in the Department of the Environment and Water Resources' databases, for the selected area. The information presented here has been provided by a range of groups across Australia, and the accuracy and resolution varies.

Search Type:	Line
Buffer:	5 km
Coordinates:	-23.1847162,146.5128484, -23.1903458,146.5093907, -23.1917291,146.5091762, -23.1932572,146.5092993, -23.2050284,146.5118981, -23.2200067,146.518975, -23.170329,146.5249293, -23.1180432,146.5941025, -23.0696284,146.6389517, -22.9225706,146.7412367, -22.8420557,146.7411918, -22.7838949,146.7596713, -22.7187559,146.773842, -22.6817019,146.7820098, -22.5886105,146.8265975, -22.4626218,147.0836079, -22.3820239,147.1253401, -22.3045777,147.1698036, -22.2249616,147.220512, -22.1783649,147.2533726, -22.1053015,147.3168105, -22.0348402,147.3460074, -21.9140645,147.4002518, -21.8409031,147.426574, -21.8081694,147.4832132, -21.7930321,147.5048624, -21.7689311,147.5530146, -21.6761385,147.6082942, -21.6079363,147.6496451, -21.6060621,147.6506019, -21.5344289,147.6725867, -21.3108898,147.8403467, -21.2639785,147.873863, -21.1977931,147.835767, -21.1412987,147.8630564, -21.1099805,147.9219464, -20.9988781,147.849137, -20.9026482,147.8392581, -20.7937969,147.7797371, -20.7107777,147.7375999, -20.5429894,147.6206843, -20.4667178,147.5758609, -20.4195863,147.5044042, -

20.3328681,147.4593303, -
20.2204303,147.5502618, -
20.0408668,147.8830459, -
20.0225937,147.9061348, -
20.0243759,147.9389584, -
19.9920382,148.0047912, -19.9726026,148.064536

Report Contents: Summary >> Details >> Caveat >> Acknowledgment

Biodiversity

Threatened Species:	20
Migratory Species:	16
Listed Marine Species:	15
Invasive Species:	13
Whales and Other Cetaceans:	None
Threatened Ecological Communities:	4

Heritage

World Heritage Properties:	None
Australian Heritage Sites:	2

Wetlands

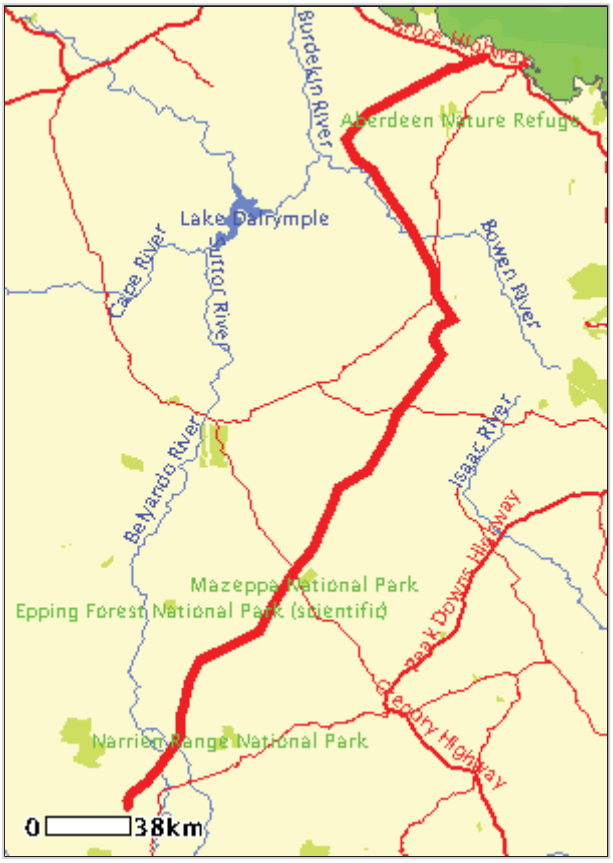
Ramsar sites: (Internationally important)	None
Nationally Important Wetlands:	2

National Pollutant Inventory

Reporting Facilities:	2
Airsheds:	None
Catchments:	None

Protected Areas

Reserves and Conservation Areas:	1
Regional Forest Agreements:	None



This map may contain data which are
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Biodiversity

Threatened Species [Dataset Information]	Status	Comments
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
Pteropus conspicillatus Spectacled Flying-fox	Vulnerable	Species or species habitat may occur within area
Xeromys myoides Water Mouse, False Water Rat	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
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
Plants		
Acacia ramiflora	Vulnerable	Species or species habitat may occur within area
Croton magneticus	Vulnerable	Species or species habitat likely to occur within area
Cycas ophiolitica	Endangered	Species or species habitat likely to occur within area
Dichanthium queenslandicum King Blue-grass	Vulnerable	Species or species habitat likely to occur within area
Digitaria porrecta Finger Panic Grass	Endangered	Species or species habitat likely to occur within area
Eucalyptus raveretiana Black Ironbox	Vulnerable	Species or species habitat likely to occur within area
Leucopogon cuspidatus	Vulnerable	Species or species habitat likely to occur within area
Ozothamnus eriocephalus	Vulnerable	Species or species habitat likely to occur within area
Taeniophyllum muelleri Minute Orchid, Ribbon-root Orchid	Vulnerable	Species or species habitat may occur within area
Migratory Species [Dataset Information]	Status	Comments
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
Hirundo rustica Barn Swallow	Migratory	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Migratory	Species or species habitat may occur within area

Monarcha melanopsis Black-faced Monarch	Migratory	Breeding may occur within area
Monarcha trivirgatus Spectacled Monarch	Migratory	Breeding likely to 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
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
Tringa stagnatilis Marsh Sandpiper, Little Greenshank	Migratory	Species or species habitat likely to 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
Migratory Marine Species		
Reptiles		
Crocodylus porosus Estuarine Crocodile, Salt-water Crocodile	Migratory	Species or species habitat likely to occur within area
Listed Marine Species [Dataset Information]	Status	Comments
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
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
Hirundo rustica Barn Swallow	Listed - overfly marine area	Species or species habitat may occur within area
Merops ornatus	Listed - overfly	Species or species habitat may

Rainbow Bee-eater	marine area	occur within area
Monarcha melanopsis Black-faced Monarch	Listed - overfly marine area	Breeding may occur within area
Monarcha trivirgatus Spectacled Monarch	Listed - overfly marine area	Breeding likely to 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
Tringa stagnatilis Marsh Sandpiper, Little Greenshank	Listed - overfly marine area	Species or species habitat likely to occur within area
Reptiles		
Crocodylus porosus Estuarine Crocodile, Salt-water Crocodile	Listed	Species or species habitat likely to occur within area
Invasive Species [Dataset Information]	Status	Comments
Selected Invasive Species: Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.		
Frogs		
Bufo marinus Cane Toad	Feral	Species or species habitat likely to occur within area
Mammals		
Capra hircus Goat	Feral	Species or species habitat may occur within area
Felis catus Cat, House Cat, Domestic Cat	Feral	Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit	Feral	Species or species habitat likely to occur within area
Sus scrofa Pig	Feral	Species or species habitat may occur within area
Vulpes vulpes Red Fox, Fox	Feral	Species or species habitat may occur within area
Plants		
Acacia nilotica subsp. *indica* Prickly Acacia	WoNS	Species or species habitat may occur within area
Cryptostegia grandiflora Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda	WoNS	Species or species habitat likely to occur within area
Hymenachne amplexicaulis	WoNS	Species or species habitat likely to

Hymenachne, Olive Hymenachne, Water Stargrass, West Indian Grass, West Indian Marsh Grass		occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage	WoNS	Species or species habitat may occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean	WoNS	Species or species habitat may occur within area
Parthenium hysterophorus Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed	WoNS	Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed	WoNS	Species or species habitat may occur within area

Threatened Ecological Communities [Dataset Information]	Status	Comments
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
Weeping Myall Woodlands	Endangered	Community likely to occur within area

Heritage

Australian Heritage Sites [Dataset Information]
Note that not all Indigenous sites may be listed.

Natural

Mazeppa National Park QLD

Mount Abbot QLD

Wetlands

Nationally Important Wetland Sites [Dataset Information]

Abbot Point - Caley Valley, QLD

Bowen River: Birralee - Pelican Creek, QLD

National Pollutant Inventory

Reporting Facility [Dataset Information]	Top Substance	Source

Substance emissions are ranked on a scale of 1-100: 1=lowest; 100=highest. Rankings are shown as: =0-25; =26-50; =51-75; =76-100.

Orica Australia (Newlands Plant - Orica Mining Services, Glenden QLD)	Total Volatile Organic Compounds [Low]	Dangerous goods (DG) storage depot for storage of Ammonium Nitrate (AN), Ammonium Nitrate Emulsion (ANE) and diesel to support bulk explosive delivery to

		mine
QFCO Pty Ltd (KR Fisher, Delta QLD)	Ammonia (total) [Low]	Pig Farming

Other

Reserves and Conservation Areas [Dataset Information]

Mazeppa National Park, QLD

Caveat

The information presented here has been drawn from a range of sources, compiled for a variety of purposes. Details of the coverage of each dataset are included in the metadata [Dataset Information] links above.

Acknowledgment

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. The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Fauna species returned in Wildlife Online search (for 3 search areas combined).

Kingdor	Class	Family	Scientific Name	Common Name	I	Q	A	Sighting Recs	Specimen Records	Marine/Migratory
animals	amphibians	Myobatrachidae	Crinia deserticola	chirping froglet		C		15	9	
animals	amphibians	Hylidae	Cyclorana alboguttata	greenstripe frog		C		9	5	
animals	amphibians	Hylidae	Cyclorana brevipes	superb collared frog		C		9	0	
animals	amphibians	Hylidae	Cyclorana cultripes	grassland collared frog		C		5	0	
animals	amphibians	Hylidae	Cyclorana novaehollandiae	eastern snapping frog		C		4	0	
animals	amphibians	Hylidae	Cyclorana platycephala	water holding frog		C		1	0	
animals	amphibians	Limnodynastidae	Limnodynastes peronii	striped marshfrog		C		2	2	
animals	amphibians	Limnodynastidae	Limnodynastes salmini	salmon striped frog		C		1	1	
animals	amphibians	Limnodynastidae	Limnodynastes tasmaniensis	spotted grassfrog		C		16	0	
animals	amphibians	Limnodynastidae	Limnodynastes terraereginae	scarlet sided pobblebonk		C		9	0	
animals	amphibians	Hylidae	Litoria bicolor	northern sedgefrog		C		2	1	
animals	amphibians	Hylidae	Litoria caerulea	common green treefrog		C		11	0	
animals	amphibians	Hylidae	Litoria fallax	eastern sedgefrog		C		8	1	
animals	amphibians	Hylidae	Litoria inermis	bumpy rocketfrog		C		20	7	
animals	amphibians	Hylidae	Litoria latopalmata	broad palmed rocketfrog		C		1	0	
animals	amphibians	Hylidae	Litoria nasuta	striped rocketfrog		C		1	1	
animals	amphibians	Hylidae	Litoria revelata	whirring treefrog		R		1	1	
animals	amphibians	Hylidae	Litoria rothii	northern laughing treefrog		C		17	5	
animals	amphibians	Hylidae	Litoria rubella	ruddy treefrog		C		7	0	
animals	amphibians	Limnodynastidae	Neobatrachus sudelli	meeowing frog		C		1	0	
animals	amphibians	Limnodynastidae	Notaden bennettii	holy cross frog		C		14	0	
animals	amphibians	Limnodynastidae	Platyplectrum ornatum	ornate burrowing frog		C		18	0	
animals	amphibians	Bufonidae	Rhinella marina	cane toad	Y			11	0	
animals	amphibians	Myobatrachidae	Uperoleia littlejohni	Einasleigh gungan		C		1	1	
animals	birds	Meliphagidae	Acanthagenys rufogularis	spiny-cheeked honeyeater		C		26	0	
animals	birds	Acanthizidae	Acanthiza apicalis	inland thornbill		C		13	0	
animals	birds	Acanthizidae	Acanthiza chrysorrhoa	yellow-rumped thornbill		C		40	2	
animals	birds	Acanthizidae	Acanthiza nana	yellow thornbill		C		3	0	
animals	birds	Acanthizidae	Acanthiza pusilla	brown thornbill		C		1	0	
animals	birds	Acanthizidae	Acanthiza reguloides	buff-rumped thornbill		C		5	4	
animals	birds	Meliphagidae	Acanthorhynchus tenuirostris	eastern spinebill		C		1	0	
animals	birds	Accipitridae	Accipiter cirrocephalus	collared sparrowhawk		C		2	0	

animals	birds	Accipitridae	Accipiter cirrocephalus	collared sparrowhawk		C	18	0	
animals	birds	Accipitridae	Accipiter fasciatus	brown goshawk		C	8	0	Ma
animals	birds	Acrocephalidae	Acrocephalus australis	Australian reed-warbler		C	1	0	
animals	birds	Scolopacidae	Actitis hypoleucos	common sandpiper		C	10	0	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Aegothelidae	Aegotheles cristatus	Australian owlet-nightjar		C	24	0	
animals	birds	Megapodiidae	Alectura lathami	Australian brush-turkey		C	2	0	
animals	birds	Psittacidae	Alisterus scapularis	Australian king-parrot		C	3	0	
animals	birds	Rallidae	Amaurornis cinerea	white-browed crake		C	1	0	
animals	birds	Rallidae	Amaurornis moluccana	pale-vented bush-hen		C	2	0	Ma
animals	birds	Anatidae	Anas castanea	chestnut teal		C	5	0	
animals	birds	Anatidae	Anas gracilis	grey teal		C	14	0	
animals	birds	Anatidae	Anas platyrhynchos	northern mallard	Y		17	0	
animals	birds	Anatidae	Anas rhynchotis	Australasian shoveler		C	5	0	
animals	birds	Anatidae	Anas superciliosa	Pacific black duck		C	14	0	
animals	birds	Anhingidae	Anhinga novaehollandiae	Australasian darter		C	7	0	
animals	birds	Laridae	Anous minutus	black noddy		C	2	2	Ma
animals	birds	Anseranatidae	Anseranas semipalmata	magpie goose		C	154	0	Ma
animals	birds	Motacillidae	Anthus novaeseelandiae	Australasian pipit		C	3	0	Ma
animals	birds	Psittacidae	Aprosmictus erythropterus	red-winged parrot		C	60	0	
animals	birds	Apodidae	Apus pacificus	fork-tailed swift		C	9	0	Ma, Mi (CAMBA, JAMBA, ROKAMBA)
animals	birds	Accipitridae	Aquila audax	wedge-tailed eagle		C	11	0	
animals	birds	Ardeidae	Ardea ibis	cattle egret		C	2	0	Ma, Mi (CAMBA, JAMBA)
animals	birds	Ardeidae	Ardea intermedia	intermediate egret		C	1	0	Ma
animals	birds	Ardeidae	Ardea modesta	eastern great egret		C	6	0	Ma, Mi (CAMBA, JAMBA)
animals	birds	Ardeidae	Ardea pacifica	white-necked heron		C	4	0	
animals	birds	Otididae	Ardeotis australis	Australian bustard		C	24	0	
animals	birds	Scolopacidae	Arenaria interpres	ruddy turnstone		C	12	0	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Artamidae	Artamus cinereus	black-faced woodswallow		C	23	0	
animals	birds	Artamidae	Artamus cyanopterus	dusky woodswallow		C	2	0	
animals	birds	Artamidae	Artamus leucorynchus	white-breasted woodswallow		C	3	0	
animals	birds	Artamidae	Artamus minor	little woodswallow		C	13	0	
animals	birds	Artamidae	Artamus personatus	masked woodswallow		C	2	0	
animals	birds	Artamidae	Artamus superciliosus	white-browed woodswallow		C	8	0	
animals	birds	Accipitridae	Aviceda subcristata	Pacific baza		C	1	0	
animals	birds	Anatidae	Aythya australis	hardhead		C	8	0	
animals	birds	Burhinidae	Burhinus grallarius	bush stone-curlew		C	6	1	

animals	birds	Ardeidae	Butorides striata	striated heron		C		31	0	
animals	birds	Cacatuidae	Cacatua galerita	sulphur-crested cockatoo		C		12	0	
animals	birds	Cacatuidae	Cacatua sanguinea	little corella		C		2	0	
animals	birds	Cacatuidae	Cacatua tenuirostris	long-billed corella	Y	C		3	0	
animals	birds	Cuculidae	Cacomantis flabelliformis	fan-tailed cuckoo		C		2	0	Ma
animals	birds	Cuculidae	Cacomantis pallidus	pallid cuckoo		C		15	0	Ma
animals	birds	Cuculidae	Cacomantis variolosus	brush cuckoo		C		1	0	
animals	birds	Scolopacidae	Calidris acuminata	sharp-tailed sandpiper		C		145	4	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Scolopacidae	Calidris alba	sanderling		C		2	0	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Scolopacidae	Calidris canutus	red knot		C		1	0	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Scolopacidae	Calidris ferruginea	curlew sandpiper		C		39	0	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Scolopacidae	Calidris melanotos	pectoral sandpiper		C		2	0	Ma, Mi (Bonn, JAMBA, ROKAMBA)
animals	birds	Scolopacidae	Calidris ruficollis	red-necked stint		C		49	0	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Scolopacidae	Calidris tenuirostris	great knot		C		6	0	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Cacatuidae	Calyptorhynchus banksii	red-tailed black-cockatoo		C		245	0	
animals	birds	Cacatuidae	Calyptorhynchus funereus	yellow-tailed black-cockatoo		C		6	0	
animals	birds	Cacatuidae	Calyptorhynchus lathami	glossy black-cockatoo		V		1	0	
animals	birds	Caprimulgidae	Caprimulgus macrurus	large-tailed nightjar		C		6	0	
animals	birds	Casuariidae	Casuarius casuarius johnsonii (sout	southern cassowary (southern population		E	E	1	0	
animals	birds	Cuculidae	Centropus phasianinus	pheasant coucal		C		8	0	
animals	birds	Alcedinidae	Ceyx azureus	azure kingfisher		C		3	1	
animals	birds	Cuculidae	Chalcites basalis	Horsfield's bronze-cuckoo		C		10	0	Ma
animals	birds	Cuculidae	Chalcites lucidus	shining bronze-cuckoo		C		1	0	Ma
animals	birds	Cuculidae	Chalcites minutillus minutillus	little bronze-cuckoo		C		7	0	
animals	birds	Cuculidae	Chalcites minutillus russatus	Gould's bronze-cuckoo		C		3	1	
animals	birds	Cuculidae	Chalcites osculans	black-eared cuckoo		C		1	0	Ma
animals	birds	Charadriidae	Charadrius leschenaultii	greater sand plover		C		12	0	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Charadriidae	Charadrius mongolus	lesser sand plover		C		6	0	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Charadriidae	Charadrius ruficapillus	red-capped plover		C		136	0	Ma
animals	birds	Anatidae	Chenonetta jubata	Australian wood duck		C		7	0	
animals	birds	Hirundinidae	Cheramoeca leucosterna	white-backed swallow		C		1	0	
animals	birds	Laridae	Chlidonias hybrida	whiskered tern		C		17	0	Ma
animals	birds	Laridae	Chroicocephalus novaehollandiae	silver gull		C		305	0	Ma
animals	birds	Acanthizidae	Chthonicola sagittata	speckled warbler		C		7	0	
animals	birds	Megaluridae	Cincloramphus cruralis	brown songlark		C		1	0	
animals	birds	Megaluridae	Cincloramphus mathewsi	rufous songlark		C		41	0	

animals	birds	Psophodidae	Cinclosoma punctatum	spotted quail-thrush		C	1	0	
animals	birds	Accipitridae	Circus approximans	swamp harrier		C	9	0	Ma
animals	birds	Accipitridae	Circus assimilis	spotted harrier		C	1	0	
animals	birds	Cisticolidae	Cisticola exilis	golden-headed cisticola		C	9	0	
animals	birds	Cisticolidae	Cisticola juncidis laveryi	zitting cisticola		C	1	0	
animals	birds	Climacteridae	Climacteris affinis	white-browed treecreeper		C	1	0	
animals	birds	Climacteridae	Climacteris picumnus	brown treecreeper		C	47	0	
animals	birds	Pachycephalidae	Colluricincla harmonica	grey shrike-thrush		C	31	0	
animals	birds	Pachycephalidae	Colluricincla megarhyncha	little shrike-thrush		C	52	0	
animals	birds	Columbidae	Columba livia	rock dove	Y		10	0	
animals	birds	Meliphagidae	Conopophila rufogularis	rufous-throated honeyeater		C	1	0	
animals	birds	Campephagidae	Coracina lineata	barred cuckoo-shrike		C	1	1	
animals	birds	Campephagidae	Coracina maxima	ground cuckoo-shrike		C	3	0	
animals	birds	Campephagidae	Coracina novaehollandiae	black-faced cuckoo-shrike		C	62	0	Ma
animals	birds	Campephagidae	Coracina papuensis	white-bellied cuckoo-shrike		C	3	0	Ma
animals	birds	Campephagidae	Coracina tenuirostris	cicadabird		C	3	0	Ma
animals	birds	Corcoracidae	Corcorax melanorhamphos	white-winged chough		C	1	0	
animals	birds	Corvidae	Corvus bennetti	little crow		C	9	0	
animals	birds	Corvidae	Corvus coronoides	Australian raven		C	18	0	
animals	birds	Corvidae	Corvus orru	Torresian crow		C	112	0	
animals	birds	Phasianidae	Coturnix pectoralis	stubble quail		C	5	0	Ma
animals	birds	Phasianidae	Coturnix ypsilophora	brown quail		C	8	0	
animals	birds	Artamidae	Cracticus nigrogularis	pied butcherbird		C	106	1	
animals	birds	Artamidae	Cracticus quoyi	black butcherbird		C	2	0	
animals	birds	Artamidae	Cracticus tibicen	Australian magpie		C	39	0	
animals	birds	Artamidae	Cracticus torquatus	grey butcherbird		C	55	0	
animals	birds	Cuculidae	Cuculus optatus	oriental cuckoo		C	5	0	
animals	birds	Anatidae	Cygnus atratus	black swan		C	3	0	
animals	birds	Halcyonidae	Dacelo leachii	blue-winged kookaburra		C	25	0	
animals	birds	Halcyonidae	Dacelo novaeguineae	laughing kookaburra		C	14	0	
animals	birds	Neosittidae	Daphoenositta chrysoptera	varied sittella		C	16	0	
animals	birds	Anatidae	Dendrocygna arcuata	wandering whistling-duck		C	121	1	Ma
animals	birds	Anatidae	Dendrocygna eytoni	plumed whistling-duck		C	4	0	
animals	birds	Nectariniidae	Dicaeum hirundinaceum	mistletoebird		C	16	0	
animals	birds	Dicruridae	Dicrurus bracteatus	spangled drongo		C	378	0	Ma
animals	birds	Casuariidae	Dromaius novaehollandiae	emu		C	18	0	

animals	birds	Columbidae	Ducula bicolor	pied imperial-pigeon	C		5	0	Ma
animals	birds	Ardeidae	Egretta garzetta	little egret	C		114	0	Ma
animals	birds	Ardeidae	Egretta novaehollandiae	white-faced heron	C		6	0	
animals	birds	Ardeidae	Egretta picata	pied heron	C		3	0	
animals	birds	Ardeidae	Egretta sacra	eastern reef egret	C		17	0	Ma, Mi (CAMBA)
animals	birds	Accipitridae	Elanus axillaris	black-shouldered kite	C		2	0	
animals	birds	Charadriidae	Elseyornis melanops	black-fronted dotterel	C		9	0	
animals	birds	Meliphagidae	Entomyzon cyanotis	blue-faced honeyeater	C		15	0	
animals	birds	Cacatuidae	Eolophus roseicapillus	galah	C		71	0	
animals	birds	Ciconiidae	Ephippiorhynchus asiaticus	black-necked stork	R		42	0	
animals	birds	Meliphagidae	Epthianura tricolor	crimson chat	C		1	0	
animals	birds	Charadriidae	Erythrogonys cinctus	red-kneed dotterel	C		12	0	
animals	birds	Accipitridae	Erythrotriorchis radiatus	red goshawk	E	V	2	0	
animals	birds	Burhinidae	Esacus magnirostris	beach stone-curlew	V		22	0	Ma
animals	birds	Cuculidae	Eudynamys orientalis	eastern koel	C		1	0	
animals	birds	Eurostopodidae	Eurostopodus argus	spotted nightjar	C		6	0	Ma
animals	birds	Eurostopodidae	Eurostopodus mystacalis	white-throated nightjar	C		1	0	Ma
animals	birds	Coraciidae	Eurystomus orientalis	dollarbird	C		21	0	Ma
animals	birds	Phasianidae	Excalfactoria chinensis	king quail	C		1	0	
animals	birds	Falconidae	Falco berigora	brown falcon	C		18	0	
animals	birds	Falconidae	Falco cenchroides	nankeen kestrel	C		41	0	Ma
animals	birds	Falconidae	Falco hypoleucos	grey falcon	R		1	0	
animals	birds	Falconidae	Falco longipennis	Australian hobby	C		2	0	
animals	birds	Falconidae	Falco peregrinus	peregrine falcon	C		1	0	
animals	birds	Falconidae	Falco subniger	black falcon	C		1	0	
animals	birds	Fregatidae	Fregata ariel	lesser frigatebird	C		1	0	Ma, Mi (CAMBA, JAMBA, ROKAMBA)
animals	birds	Rallidae	Fulica atra	Eurasian coot	C		3	0	
animals	birds	Scolopacidae	Gallinago hardwickii	Latham's snipe	C		1	0	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Rallidae	Gallinula tenebrosa	dusky moorhen	C		1	0	
animals	birds	Rallidae	Gallirallus philippensis	buff-banded rail	C		1	0	
animals	birds	Laridae	Gelochelidon nilotica	gull-billed tern	C		67	0	Ma
animals	birds	Columbidae	Geopelia cuneata	diamond dove	C		2	0	
animals	birds	Columbidae	Geopelia humeralis	bar-shouldered dove	C		12	0	
animals	birds	Columbidae	Geopelia striata	peaceful dove	C		10	0	
animals	birds	Columbidae	Geophaps scripta scripta	squatter pigeon (southern subspecies)	V	V	11	0	
animals	birds	Acanthizidae	Gerygone albogularis	white-throated gerygone	C		9	0	

animals	birds	Acanthizidae	Gerygone fusca	western gerygone	C	10	0	
animals	birds	Acanthizidae	Gerygone levigaster	mangrove gerygone	C	84	0	
animals	birds	Acanthizidae	Gerygone magnirostris	large-billed gerygone	C	2	1	
animals	birds	Acanthizidae	Gerygone mouki	brown gerygone	C	2	0	
animals	birds	Acanthizidae	Gerygone palpebrosa	fairy gerygone	C	4	0	
animals	birds	Monarchidae	Grallina cyanoleuca	magpie-lark	C	25	0	
animals	birds	Meliphagidae	Grantiella picta	painted honeyeater	R	1	0	
animals	birds	Gruidae	Grus rubicunda	brolga	C	39	0	
animals	birds	Haematopodidae	Haematopus fuliginosus	sooty oystercatcher	R	36	0	
animals	birds	Haematopodidae	Haematopus longirostris	Australian pied oystercatcher	C	76	2	
animals	birds	Accipitridae	Haliaeetus leucogaster	white-bellied sea-eagle	C	118	0	Ma, Mi (CAMBA)
animals	birds	Accipitridae	Haliastur indus	brahminy kite	C	166	1	Ma
animals	birds	Accipitridae	Haliastur sphenurus	whistling kite	C	11	0	Ma
animals	birds	Accipitridae	Hamirostra melanosternon	black-breasted buzzard	C	5	0	
animals	birds	Accipitridae	Hieraaetus morphnoides	little eagle	C	6	0	
animals	birds	Recurvirostridae	Himantopus himantopus	black-winged stilt	C	1	0	Ma
animals	birds	Apodidae	Hirundapus caudacutus	white-throated needletail	C	1	0	Ma, Mi (CAMBA, JAMBA, ROKAMBA)
animals	birds	Hirundinidae	Hirundo neoxena	welcome swallow	C	391	0	
animals	birds	Laridae	Hydroprogne caspia	Caspian tern	C	77	0	Ma, Mi (CAMBA, JAMBA)
animals	birds	Jacanidae	Irediparra gallinacea	comb-crested jacana	C	5	0	
animals	birds	Campephagidae	Lalage leucomela	varied triller	C	192	0	
animals	birds	Campephagidae	Lalage sueurii	white-winged triller	C	19	0	
animals	birds	Columbidae	Leucosarcia picata	wonga pigeon	C	2	0	
animals	birds	Meliphagidae	Lichenostomus chrysops	yellow-faced honeyeater	C	1	0	
animals	birds	Meliphagidae	Lichenostomus fasciogularis	mangrove honeyeater	C	49	0	
animals	birds	Meliphagidae	Lichenostomus flavus	yellow honeyeater	C	514	0	
animals	birds	Meliphagidae	Lichenostomus frenatus	bridled honeyeater	C	1	0	
animals	birds	Meliphagidae	Lichenostomus fuscus	fuscous honeyeater	C	1	0	
animals	birds	Meliphagidae	Lichenostomus leucotis	white-eared honeyeater	C	5	0	
animals	birds	Meliphagidae	Lichenostomus penicillatus	white-plumed honeyeater	C	7	0	
animals	birds	Meliphagidae	Lichenostomus plumulus	grey-fronted honeyeater	C	6	0	
animals	birds	Meliphagidae	Lichenostomus unicolor	white-gaped honeyeater	C	1	0	
animals	birds	Meliphagidae	Lichenostomus virescens	singing honeyeater	C	57	0	
animals	birds	Meliphagidae	Lichmera indistincta	brown honeyeater	C	30	0	
animals	birds	Scolopacidae	Limosa lapponica	bar-tailed godwit	C	31	0	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Scolopacidae	Limosa limosa	black-tailed godwit	C	10	0	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)

animals	birds	Estrildidae	Lonchura castaneothorax	chestnut-breasted mannikin		C	38	0	
animals	birds	Estrildidae	Lonchura punctulata	nutmeg mannikin	Y		36	0	
animals	birds	Accipitridae	Lophoictinia isura	square-tailed kite		R	1	0	
animals	birds	Columbidae	Lopholaimus antarcticus	topknot pigeon		C	1	0	
animals	birds	Columbidae	Macropygia amboinensis	brown cuckoo-dove		C	1	0	
animals	birds	Anatidae	Malacorhynchus membranaceus	pink-eared duck		C	3	0	
animals	birds	Maluridae	Malurus lamberti	variegated fairy-wren		C	41	0	
animals	birds	Maluridae	Malurus leucopterus	white-winged fairy-wren		C	1	0	
animals	birds	Maluridae	Malurus melanocephalus	red-backed fairy-wren		C	23	0	
animals	birds	Meliphagidae	Manorina flavigula	yellow-throated miner		C	97	0	
animals	birds	Meliphagidae	Manorina melanocephala	noisy miner		C	3	0	
animals	birds	Megaluridae	Megalurus gramineus	little grassbird		C	2	0	
animals	birds	Megaluridae	Megalurus timoriensis	tawny grassbird		C	14	0	
animals	birds	Megapodiidae	Megapodius reinwardt	orange-footed scrubfowl		C	3	0	
animals	birds	Petroicidae	Melanodryas cucullata	hooded robin		C	16	0	
animals	birds	Meliphagidae	Meliphaga lewinii	Lewin's honeyeater		C	17	0	
animals	birds	Meliphagidae	Meliphaga notata	yellow-spotted honeyeater		C	1	0	
animals	birds	Meliphagidae	Melithreptus albogularis	white-throated honeyeater		C	16	0	
animals	birds	Meliphagidae	Melithreptus brevirostris	brown-headed honeyeater		C	1	0	
animals	birds	Meliphagidae	Melithreptus gularis	black-chinned honeyeater		R	3	0	
animals	birds	Meliphagidae	Melithreptus lunatus	white-naped honeyeater		C	1	0	
animals	birds	Psittacidae	Melopsittacus undulatus	budgerigar		C	6	0	
animals	birds	Meropidae	Merops ornatus	rainbow bee-eater		C	37	0	Ma, Mi (JAMBA)
animals	birds	Phalacrocoracidae	Microcarbo melanoleucos	little pied cormorant		C	4	0	
animals	birds	Petroicidae	Microeca fascinans	jacky winter		C	52	1	
animals	birds	Petroicidae	Microeca flavigaster	lemon-bellied flycatcher		C	19	0	
animals	birds	Accipitridae	Milvus migrans	black kite		C	22	0	
animals	birds	Alaudidae	Mirafra javanica	Horsfield's bushlark		C	5	0	
animals	birds	Monarchidae	Monarcha melanopsis	black-faced monarch		C	6	0	Ma, Mi (Bonn)
animals	birds	Monarchidae	Myiagra cyanoleuca	satin flycatcher		C	2	0	Ma, Mi (Bonn)
animals	birds	Monarchidae	Myiagra inquieta	restless flycatcher		C	15	0	
animals	birds	Monarchidae	Myiagra rubecula	leaden flycatcher		C	13	0	
animals	birds	Meliphagidae	Myzomela obscura	dusky honeyeater		C	41	0	
animals	birds	Meliphagidae	Myzomela sanguinolenta	scarlet honeyeater		C	8	0	
animals	birds	Nectariniidae	Nectarinia jugularis	olive-backed sunbird		C	371	0	
animals	birds	Estrildidae	Neochmia modesta	plum-headed finch		C	1	0	

animals	birds	Estrildidae	Neochmia ruficauda	star finch		C	2	0	
animals	birds	Estrildidae	Neochmia temporalis	red-browed finch		C	1	0	
animals	birds	Anatidae	Nettapus coromandelianus	cotton pygmy-goose		R	1	0	Ma
animals	birds	Anatidae	Nettapus pulchellus	green pygmy-goose		C	2	0	Ma
animals	birds	Strigidae	Ninox boobook	southern boobook		C	18	0	Ma
animals	birds	Strigidae	Ninox connivens	barking owl		C	1	0	
animals	birds	Scolopacidae	Numenius madagascariensis	eastern curlew		R	95	0	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Scolopacidae	Numenius minutus	little curlew		C	7	0	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Scolopacidae	Numenius phaeopus	whimbrel		C	75	0	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Ardeidae	Nycticorax caledonicus	Nankeen night-heron		C	1	0	Ma
animals	birds	Cacatuidae	Nymphicus hollandicus	cockatiel		C	41	0	
animals	birds	Columbidae	Ocyphaps lophotes	crested pigeon		C	27	0	
animals	birds	Laridae	Onychoprion anaethetus	bridled tern		C	1	0	Ma, Mi (CAMBA, JAMBA)
animals	birds	Pachycephalidae	Oreoica gutturalis	crested bellbird		C	37	0	
animals	birds	Oriolidae	Oriolus sagittatus	olive-backed oriole		C	3	0	
animals	birds	Pachycephalidae	Pachycephala pectoralis	golden whistler		C	1	0	
animals	birds	Pachycephalidae	Pachycephala rufiventris	rufous whistler		C	72	0	
animals	birds	Accipitridae	Pandion cristatus	eastern osprey		C	96	0	Ma, Mi (Bonn)
animals	birds	Pardalotidae	Pardalotus punctatus	spotted pardalote		C	2	0	
animals	birds	Pardalotidae	Pardalotus rubricatus	red-browed pardalote		C	2	0	
animals	birds	Pardalotidae	Pardalotus striatus	striated pardalote		C	85	0	
animals	birds	Passeridae	Passer domesticus	house sparrow	Y		54	0	
animals	birds	Phasianidae	Pavo cristatus	Indian peafowl	Y		2	0	
animals	birds	Pelecanidae	Pelecanus conspicillatus	Australian pelican		C	2	0	Ma
animals	birds	Hirundinidae	Petrochelidon ariel	fairy martin		C	4	0	
animals	birds	Hirundinidae	Petrochelidon nigricans	tree martin		C	9	0	Ma
animals	birds	Petroicidae	Petroica goodenovii	red-capped robin		C	4	0	
animals	birds	Phalacrocoracidae	Phalacrocorax carbo	great cormorant		C	23	0	
animals	birds	Phalacrocoracidae	Phalacrocorax sulcirostris	little black cormorant		C	10	0	
animals	birds	Phalacrocoracidae	Phalacrocorax varius	pied cormorant		C	2	0	
animals	birds	Columbidae	Phaps chalcoptera	common bronzewing		C	16	0	
animals	birds	Columbidae	Phaps elegans	brush bronzewing		C	1	0	
animals	birds	Meliphagidae	Philemon buceroides	helmeted friarbird		C	379	0	
animals	birds	Meliphagidae	Philemon citreogularis	little friarbird		C	37	0	
animals	birds	Meliphagidae	Philemon corniculatus	noisy friarbird		C	43	0	
animals	birds	Threskiornithidae	Platalea flavipes	yellow-billed spoonbill		C	1	0	

animals	birds	Threskiornithidae	Platalea regia	royal spoonbill		C		5	0	
animals	birds	Psittacidae	Platycercus adscitus	pale-headed rosella		C		46	0	
animals	birds	Psittacidae	Platycercus adscitus palliceps	pale-headed rosella (southern form)		C		1	0	
animals	birds	Meliphagidae	Plectorhyncha lanceolata	striped honeyeater		C		37	0	
animals	birds	Threskiornithidae	Plegadis falcinellus	glossy ibis		C		21	0	Ma, Mi (Bonn, CAMBA)
animals	birds	Charadriidae	Pluvialis fulva	Pacific golden plover		C		11	0	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Charadriidae	Pluvialis squatarola	grey plover		C		3	0	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Podargidae	Podargus strigoides	tawny frogmouth		C		6	0	
animals	birds	Podicipedidae	Podiceps cristatus	great crested grebe		C		2	0	
animals	birds	Podicipedidae	Poliocephalus poliocephalus	hoary-headed grebe		C		2	0	
animals	birds	Pomatostomidae	Pomatostomus temporalis	grey-crowned babbler		C		62	0	
animals	birds	Rallidae	Porphyrio porphyrio	purple swamphen		C		1	0	
animals	birds	Psittacidae	Psephotus pulcherrimus	paradise parrot		PE	EX	1	0	Mi (JAMBA)
animals	birds	Columbidae	Ptilinopus regina	rose-crowned fruit-dove		C		2	0	
animals	birds	Columbidae	Ptilinopus superbus	superb fruit-dove		C		1	0	Ma
animals	birds	Ptilonorhynchidae	Ptilonorhynchus maculatus	spotted bowerbird		C		24	0	
animals	birds	Ptilonorhynchidae	Ptilonorhynchus nuchalis	great bowerbird		C		2	0	
animals	birds	Meliphagidae	Ramsayornis fasciatus	bar-breasted honeyeater		C		13	0	
animals	birds	Recurvirostridae	Recurvirostra novaehollandiae	red-necked avocet		C		66	0	Ma
animals	birds	Rhipiduridae	Rhipidura albiscapa	grey fantail		C		25	0	
animals	birds	Rhipiduridae	Rhipidura leucophrys	willie wagtail		C		68	0	
animals	birds	Rhipiduridae	Rhipidura rufifrons	rufous fantail		C		4	0	Ma, Mi (Bonn)
animals	birds	Cuculidae	Scythrops novaehollandiae	channel-billed cuckoo		C		20	0	Ma
animals	birds	Acanthizidae	Sericornis frontalis	white-browed scrubwren		C		3	0	
animals	birds	Acanthizidae	Smicrornis brevirostris	weebill		C		76	0	
animals	birds	Oriolidae	Sphecotheres vieilloti	Australasian figbird		C		4	0	
animals	birds	Stercorariidae	Stercorarius pomarinus	pomarine jaeger		C		1	1	Ma, Mi (CAMBA, JAMBA)
animals	birds	Laridae	Sterna hirundo	common tern		C		5	0	Ma, Mi (CAMBA, JAMBA, ROKAMBA)
animals	birds	Laridae	Sterna sumatrana	black-naped tern		C		11	0	Ma, Mi (CAMBA, JAMBA)
animals	birds	Laridae	Sternula albifrons	little tern		E		18	2	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Anatidae	Stictonetta naevosa	freckled duck		R		3	0	
animals	birds	Glareolidae	Stiltia isabella	Australian pratincole		C		1	0	Ma
animals	birds	Artamidae	Strepera graculina	pied currawong		C		11	0	
animals	birds	Columbidae	Streptopelia chinensis	spotted dove	Y			31	0	
animals	birds	Corcoracidae	Struthidea cinerea	apostlebird		C		19	0	
animals	birds	Sturnidae	Sturnus tristis	common myna	Y			1	0	

animals	birds	Sturnidae	Sturnus vulgaris	common starling	Y		2	0	
animals	birds	Meliphagidae	Sugomel niger	black honeyeater		C	1	0	
animals	birds	Sulidae	Sula leucogaster	brown booby		C	6	0	Ma, Mi (CAMBA, JAMBA, ROKAMBA)
animals	birds	Monarchidae	Symposiarchus trivirgatus	spectacled monarch		C	3	0	
animals	birds	Podicipedidae	Tachybaptus novaehollandiae	Australasian grebe		C	3	0	
animals	birds	Anatidae	Tadorna radjah	radjah shelduck		R	17	0	Ma
animals	birds	Estrildidae	Taeniopygia bichenovii	double-barred finch		C	31	0	
animals	birds	Estrildidae	Taeniopygia guttata	zebra finch		C	19	0	
animals	birds	Halcyonidae	Tanysiptera sylvia	buff-breasted paradise-kingfisher		C	1	0	Ma
animals	birds	Laridae	Thalasseus bengalensis	lesser crested tern		C	3	0	Ma, Mi (CAMBA)
animals	birds	Laridae	Thalasseus bergii	crested tern		C	27	0	Ma
animals	birds	Threskiornithidae	Threskiornis molucca	Australian white ibis		C	335	0	Ma
animals	birds	Threskiornithidae	Threskiornis spinicollis	straw-necked ibis		C	10	0	Ma
animals	birds	Halcyonidae	Todiramphus chloris	collared kingfisher		C	7	0	
animals	birds	Halcyonidae	Todiramphus macleayii	forest kingfisher		C	4	0	Ma
animals	birds	Halcyonidae	Todiramphus pyrrhopygius	red-backed kingfisher		C	8	0	
animals	birds	Halcyonidae	Todiramphus sanctus	sacred kingfisher		C	12	0	Ma
animals	birds	Rallidae	Tribonyx ventralis	black-tailed native-hen		C	3	0	
animals	birds	Psittacidae	Trichoglossus chlorolepidotus	scaly-breasted lorikeet		C	10	0	
animals	birds	Psittacidae	Trichoglossus haematodus moluccа	rainbow lorikeet		C	13	0	
animals	birds	Scolopacidae	Tringa brevipes	grey-tailed tattler		C	21	0	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Scolopacidae	Tringa incana	wandering tattler		C	2	0	Ma, Mi (Bonn, CAMBA, JAMBA)
animals	birds	Scolopacidae	Tringa nebularia	common greenshank		C	61	0	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Scolopacidae	Tringa stagnatilis	marsh sandpiper		C	96	0	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Turnicidae	Turnix pyrrhothorax	red-chested button-quail		C	3	0	
animals	birds	Turnicidae	Turnix velox	little button-quail		C	2	0	
animals	birds	Tytonidae	Tyto javanica	eastern barn owl		C	6	0	
animals	birds	Tytonidae	Tyto longimembris	eastern grass owl		C	1	0	
animals	birds	Charadriidae	Vanellus miles	masked lapwing		C	6	0	
animals	birds	Charadriidae	Vanellus miles miles	masked lapwing (northern subspecies)		C	2	0	
animals	birds	Charadriidae	Vanellus miles novaehollandiae	masked lapwing (southern subspecies)		C	1	0	
animals	birds	Charadriidae	Vanellus tricolor	banded lapwing		C	7	0	
animals	birds	Scolopacidae	Xenus cinereus	terek sandpiper		C	2	0	Ma, Mi (Bonn, CAMBA, JAMBA, ROKAMBA)
animals	birds	Timaliidae	Zosterops lateralis	silvereye		C	1	0	Ma
animals	bony fish	Terapontidae	Amniataba percoides	barred grunter			2	0	
animals	bony fish	Anguillidae	Anguilla reinhardtii	longfin eel			1	0	

animals	bony fish	Ariidae	Arius graeffei	blue catfish				1	0
animals	bony fish	Hemiramphidae	Arrhamphus sclerolepis	snubnose garfish				1	0
animals	bony fish	Gobiidae	Glossogobius giuris	tank goby				2	0
animals	bony fish	Terapontidae	Hephaestus fuliginosus	sooty grunter				1	0
animals	bony fish	Eleotridae	Hypseleotris compressa	empire gudgeon				2	0
animals	bony fish	Eleotridae	Hypseleotris galii	firetail gudgeon				1	0
animals	bony fish	Centropomidae	Lates calcarifer	barramundi				1	0
animals	bony fish	Terapontidae	Leiopotherapon unicolor	spangled perch				1	1
animals	bony fish	Melanotaeniidae	Melanotaenia splendida splendida	eastern rainbowfish				1	0
animals	bony fish	Clupeidae	Nematalosa erebi	bony bream				1	0
animals	bony fish	Plotosidae	Neosilurus ater	black catfish				1	1
animals	bony fish	Plotosidae	Neosilurus hyrtlii	Hyrtl's catfish				6	5
animals	bony fish	Plotosidae	Porochilus rendahli	Rendahl's catfish				1	0
animals	bony fish	Terapontidae	Scortum hillii	leathery grunter				1	0
animals	bony fish	Belonidae	Strongylura krefftii	freshwater longtom				1	0
animals	mammals	Potoroidae	Aepyprymnus rufescens	rufous bettong		C		12	0
animals	mammals	Dasyuridae	Antechinus flavipes	yellow-footed antechinus		C		1	0
animals	mammals	Bovidae	Bos taurus	European cattle	Y			50	0
animals	mammals	Canidae	Canis familiaris	dog	Y			4	0
animals	mammals	Canidae	Canis lupus dingo	dingo				11	0
animals	mammals	Molossidae	Chaerephon jobensis	northern freetail bat		C		2	0
animals	mammals	Vespertilionidae	Chalinolobus gouldii	Gould's wattled bat		C		1	0
animals	mammals	Vespertilionidae	Chalinolobus nigrogriseus	hoary wattled bat		C		4	2
animals	mammals	Vespertilionidae	Chalinolobus picatus	little pied bat		R		1	1
animals	mammals	Dasyuridae	Dasyurus hallucatus	northern quoll		C	E	1	0
animals	mammals	Dugongidae	Dugong dugon	dugong		V		1	0
animals	mammals	Equidae	Equus caballus	horse	Y			1	0
animals	mammals	Felidae	Felis catus	cat	Y			6	0
animals	mammals	Muridae	Hydromys chrysogaster	water rat		C		1	0
animals	mammals	Macropodidae	Lagorchestes conspicillatus	spectacled hare-wallaby		C		8	0
animals	mammals	Vombatidae	Lasiorhinus krefftii	northern hairy-nosed wombat		E	E	23	0
animals	mammals	Muridae	Leggadina forresti	Forrest's mouse		C		2	1
animals	mammals	Leporidae	Lepus capensis	brown hare	Y			2	0
animals	mammals	Macropodidae	Macropus agilis	agile wallaby		C		22	0
animals	mammals	Macropodidae	Macropus dorsalis	black-striped wallaby		C		2	0
animals	mammals	Macropodidae	Macropus giganteus	eastern grey kangaroo		C		97	0

animals	mammals	Macropodidae	Macropus parryi	whiptail wallaby		C	3	0
animals	mammals	Macropodidae	Macropus robustus	common wallaroo		C	11	0
animals	mammals	Macropodidae	Macropus rufogriseus	red-necked wallaby		C	1	0
animals	mammals	Macropodidae	Macropus rufus	red kangaroo		C	51	0
animals	mammals	Muridae	Melomys burtoni	grassland melomys		C	2	0
animals	mammals	Vespertilionidae	Miniopterus schreibersii oceanensis	eastern bent-wing bat		C	1	0
animals	mammals	Molossidae	Mormopterus beccarii	Beccari's freetail bat		C	9	1
animals	mammals	Molossidae	Mormopterus planiceps	southern freetail bat		C	1	0
animals	mammals	Muridae	Mus musculus	house mouse	Y		18	0
animals	mammals	Vespertilionidae	Nyctophilus bifax	northern long-eared bat		C	2	0
animals	mammals	Vespertilionidae	Nyctophilus geoffroyi	lesser long-eared bat		C	5	5
animals	mammals	Ornithorhynchidae	Ornithorhynchus anatinus	platypus		C	1	0
animals	mammals	Leporidae	Oryctolagus cuniculus	rabbit	Y		56	0
animals	mammals	Pseudocheiridae	Petauroides volans	greater glider		C	2	0
animals	mammals	Petauridae	Petaurus breviceps	sugar glider		C	3	0
animals	mammals	Macropodidae	Petrogale assimilis	allied rock-wallaby		C	12	9
animals	mammals	Macropodidae	Petrogale herberti	Herbert's rock-wallaby		C	14	7
animals	mammals	Macropodidae	Petrogale inornata	unadorned rock-wallaby		C	22	16
animals	mammals	Phascolarctidae	Phascolarctos cinereus	koala		C	7	0
animals	mammals	Dasyuridae	Planigale ingrami	long-tailed planigale		C	14	0
animals	mammals	Dasyuridae	Planigale maculata	common planigale		C	4	1
animals	mammals	Dasyuridae	Planigale tenuirostris	narrow-nosed planigale		C	2	2
animals	mammals	Muridae	Pseudomys delicatulus	delicate mouse		C	49	0
animals	mammals	Muridae	Pseudomys desertor	desert mouse		C	3	0
animals	mammals	Muridae	Pseudomys gracilicaudatus	eastern chestnut mouse		C	1	1
animals	mammals	Muridae	Pseudomys patrius	eastern pebble-mound mouse		C	4	0
animals	mammals	Pteropodidae	Pteropus alecto	black flying-fox		C	2	1
animals	mammals	Pteropodidae	Pteropus scapulatus	little red flying-fox		C	3	0
animals	mammals	Muridae	Rattus sordidus	canefield rat		C	2	0
animals	mammals	Muridae	Rattus tunneyi	pale field-rat		C	13	0
animals	mammals	Rhinolophidae	Rhinolophus megaphyllus	eastern horseshoe-bat		C	2	0
animals	mammals	Emballonuridae	Saccolaimus flaviventris	yellow-bellied sheathtail bat		C	1	0
animals	mammals	Vespertilionidae	Scotorepens balstoni	inland broad-nosed bat		C	1	0
animals	mammals	Vespertilionidae	Scotorepens greyii	little broad-nosed bat		C	2	2
animals	mammals	Vespertilionidae	Scotorepens sanborni	northern broad-nosed bat		C	1	1
animals	mammals	Dasyuridae	Sminthopsis macroura	stripe-faced dunnart		C	6	0

animals	mammals	Suidae	Sus scrofa	pig	Y			9	0	
animals	mammals	Tachyglossidae	Tachyglossus aculeatus	short-beaked echidna		C		22	0	
animals	mammals	Molossidae	Tadarida australis	white-striped freetail bat		C		2	0	
animals	mammals	Phalangeridae	Trichosurus vulpecula	common brushtail possum		C		4	0	
animals	mammals	Vespertilionidae	Vespadelus vulturnus	little forest bat		C		3	0	
animals	mammals	Macropodidae	Wallabia bicolor	swamp wallaby		C		4	0	
animals	reptiles	Elapidae	Acanthophis antarcticus	common death adder		R		3	0	
animals	reptiles	Agamidae	Amphibolurus burnsi			C		2	0	
animals	reptiles	Agamidae	Amphibolurus gilberti	Gilbert's dragon		C		1	0	
animals	reptiles	Agamidae	Amphibolurus nobbi			C		5	2	
animals	reptiles	Scincidae	Anomalopus brevicollis			R		1	0	
animals	reptiles	Boidae	Antaresia maculosa			C		4	0	
animals	reptiles	Boidae	Aspidites melanocephalus	black-headed python		C		2	0	
animals	reptiles	Colubridae	Boiga irregularis	brown tree snake		C		1	0	
animals	reptiles	Scincidae	Carlia foliorum			C		4	0	
animals	reptiles	Scincidae	Carlia jarnoldae			C		4	0	
animals	reptiles	Scincidae	Carlia munda			C		12	1	
animals	reptiles	Scincidae	Carlia mundivensis			C		1	0	
animals	reptiles	Scincidae	Carlia pectoralis			C		5	0	
animals	reptiles	Scincidae	Carlia schmeltzii			C		1	0	
animals	reptiles	Chelidae	Chelodina canni	Cann's longneck turtle		C		2	0	
animals	reptiles	Chelidae	Chelodina longicollis	eastern snake-necked turtle		C		2	0	
animals	reptiles	Cheloniidae	Chelonia mydas	green turtle		V	V	2	0	Ma, Mi (Bonn)
animals	reptiles	Agamidae	Chlamydosaurus kingii	frilled lizard		C		2	0	
animals	reptiles	Crocodylidae	Crocodylus porosus	estuarine crocodile		V		1	0	Ma, Mi (Bonn)
animals	reptiles	Scincidae	Cryptoblepharus metallicus	metallic snake-eyed skink		C		2	1	
animals	reptiles	Scincidae	Cryptoblepharus pannosus	ragged snake-eyed skink		C		52	2	
animals	reptiles	Scincidae	Cryptoblepharus plagiocephalus sensu lato			C		10	0	
animals	reptiles	Scincidae	Cryptoblepharus virgatus sensu lato			C		12	0	
animals	reptiles	Agamidae	Ctenophorus nuchalis	central netted dragon		C		6	0	
animals	reptiles	Scincidae	Ctenotus allotropis			C		5	0	
animals	reptiles	Scincidae	Ctenotus capricorni			R		1	0	
animals	reptiles	Scincidae	Ctenotus hebetior			C		1	0	
animals	reptiles	Scincidae	Ctenotus leonhardii			C		3	0	
animals	reptiles	Scincidae	Ctenotus pantherinus			C		7	1	
animals	reptiles	Scincidae	Ctenotus robustus			C		55	0	

animals	reptiles	Scincidae	Ctenotus strauchii			C		15	0
animals	reptiles	Scincidae	Ctenotus taeniolatus	copper-tailed skink		C		11	0
animals	reptiles	Pygopodidae	Delma tincta			C		3	1
animals	reptiles	Elapidae	Demansia psammophis	yellow-faced whip snake		C		7	0
animals	reptiles	Elapidae	Demansia torquata	collared whip snake		C		1	0
animals	reptiles	Elapidae	Demansia vestigiata	black whip snake		C		5	0
animals	reptiles	Colubridae	Dendrelaphis punctulata	common tree snake		C		1	0
animals	reptiles	Elapidae	Denisonia maculata	ornamental snake		V	V	3	0
animals	reptiles	Gekkonidae	Diplodactylus conspicillatus	fat-tailed diplodactylus		C		12	0
animals	reptiles	Gekkonidae	Diplodactylus vittatus	wood gecko		C		3	0
animals	reptiles	Agamidae	Diporiphora australis			C		7	0
animals	reptiles	Scincidae	Egernia rugosa	yakka skink		V	V	1	0
animals	reptiles	Scincidae	Egernia striolata	tree skink		C		1	0
animals	reptiles	Chelidae	Elseya irwini	Irwin's turtle		C		2	0
animals	reptiles	Chelidae	Emydura macquarii krefftii	Krefft's river turtle		C		1	0
animals	reptiles	Scincidae	Eremiascincus fasciolatus	narrow-banded sand swimmer		C		2	0
animals	reptiles	Scincidae	Eremiascincus richardsonii	broad-banded sand swimmer		C		1	0
animals	reptiles	Elapidae	Furina diadema	red-naped snake		C		5	0
animals	reptiles	Elapidae	Furina ornata	orange-naped snake		C		2	0
animals	reptiles	Gekkonidae	Gehyra catenata			C		51	0
animals	reptiles	Gekkonidae	Gehyra dubia			C		8	0
animals	reptiles	Gekkonidae	Gehyra variegata	tree dtella		C		4	0
animals	reptiles	Scincidae	Glaphyromorphus punctulatus			C		3	2
animals	reptiles	Gekkonidae	Hemidactylus frenatus	house gecko	Y			1	0
animals	reptiles	Gekkonidae	Heteronotia binoei	Bynoe's gecko		C		63	0
animals	reptiles	Elapidae	Hoplocephalus bitorquatus	pale-headed snake		C		4	0
animals	reptiles	Scincidae	Lerista fragilis			C		22	0
animals	reptiles	Scincidae	Lerista punctatovittata			C		17	2
animals	reptiles	Scincidae	Lerista timida			C		1	0
animals	reptiles	Pygopodidae	Lialis burtonis	Burton's legless lizard		C		4	0
animals	reptiles	Gekkonidae	Lucasium steindachneri	Steindachner's gecko		C		11	0
animals	reptiles	Scincidae	Menetia greyii			C		22	0
animals	reptiles	Scincidae	Menetia timlowi			C		3	1
animals	reptiles	Boidae	Morelia spilota	carpet python		C		2	0
animals	reptiles	Scincidae	Morethia boulengeri			C		35	0
animals	reptiles	Scincidae	Morethia taeniopleura	fire-tailed skink		C		6	1

animals	reptiles	Gekkonidae	Nephrurus asper	spiny knob-tailed gecko	C		6	0
animals	reptiles	Gekkonidae	Oedura castelnaui	northern velvet gecko	C		1	0
animals	reptiles	Gekkonidae	Oedura marmorata	marbled velvet gecko	C		2	0
animals	reptiles	Gekkonidae	Oedura monilis		C		7	0
animals	reptiles	Gekkonidae	Oedura rhombifer	zig-zag gecko	C		3	0
animals	reptiles	Elapidae	Oxyuranus scutellatus	coastal taipan	C		1	0
animals	reptiles	Pygopodidae	Paradelma orientalis	brigalow scaly-foot	V	V	5	0
animals	reptiles	Agamidae	Pogona barbata	bearded dragon	C		18	0
animals	reptiles	Scincidae	Proablepharus tenuis		C		3	1
animals	reptiles	Elapidae	Pseudechis australis	king brown snake	C		1	0
animals	reptiles	Elapidae	Pseudonaja guttata	speckled brown snake	C		1	1
animals	reptiles	Elapidae	Pseudonaja nuchalis	western brown snake	C		1	0
animals	reptiles	Elapidae	Pseudonaja textilis	eastern brown snake	C		1	0
animals	reptiles	Pygopodidae	Pygopus nigriceps	hooded scaly-foot	C		2	0
animals	reptiles	Pygopodidae	Pygopus schraderi		C		11	0
animals	reptiles	Typhlopidae	Ramphotyphlops grypus		C		1	0
animals	reptiles	Typhlopidae	Ramphotyphlops ligatus		C		4	0
animals	reptiles	Typhlopidae	Ramphotyphlops unguirostris		C		1	0
animals	reptiles	Elapidae	Rhinoplocephalus boschmai	Carpentaria whip snake	C		1	0
animals	reptiles	Elapidae	Rhinoplocephalus nigrostriatus	black-striped snake	C		3	0
animals	reptiles	Gekkonidae	Rhynchoedura ornata	beaked gecko	C		2	0
animals	reptiles	Elapidae	Simoselaps australis	coral snake	C		6	0
animals	reptiles	Gekkonidae	Strophurus williamsi	soft-spined gecko	C		10	0
animals	reptiles	Elapidae	Suta suta	myall snake	C		3	0
animals	reptiles	Scincidae	Tiliqua scincoides	eastern blue-tongued lizard	C		2	0
animals	reptiles	Colubridae	Tropidonophis mairii	freshwater snake	C		11	0
animals	reptiles	Agamidae	Tympanocryptis lineata	lined earless dragon	C		3	2
animals	reptiles	Varanidae	Varanus gouldii	sand monitor	C		1	0
animals	reptiles	Varanidae	Varanus mertensi	Mertens' water monitor	C		2	1
animals	reptiles	Varanidae	Varanus panoptes	yellow-spotted monitor	C		1	0
animals	reptiles	Varanidae	Varanus storri	Storr's monitor	C		1	0
animals	reptiles	Varanidae	Varanus tristis	black-tailed monitor	C		19	0
animals	reptiles	Elapidae	Vermicella annulata	bandy-bandy	C		2	0

Queensland Museum Search Results – Crustaceans

Order	Family	Genus	Species	Locality Name	Field Collection Date
Arguloida	Argulidae	*Argulus*	*sp.*	Emerald	21-Aug-1978
Decapoda	Albuneidae	*Albunea*	*sp..*	Bowen	
Decapoda	Alpheidae	*Alpheus*	*sp..*	Doughty Ck., Bowen	21-Mar-1987
Decapoda	Atyidae	*Caridina*	*longirostris*	Elliott R, Guthulungra	25-Jun-1997
Decapoda	Atyidae	*Caridina*	*nilotica*	Burdekin R.	16-Nov-1983
Decapoda	Belliidae	*Zalasius*	*dromiaeformis*	Bowen	
Decapoda	Calappidae	*Calappa*	*hepatica*	Bowen	
Decapoda	Dorippidae	*Dorippe*	*dorsipes*	Port Deninson, Bowen.	
Decapoda	Dromiidae	*Dromidiopsis*	*edwardsi*	Bowen	
Decapoda	Dromiidae	*Dromidiopsis*	*excavata*	Bowen	
Decapoda	Grapsidae	*Metopograpsus*	*sp.*	Dalrymple Pt., Bowen	22-Mar-1987
Decapoda	Grapsidae	*Metopograpsus*	*messor*	Dalrymple Pt., Bowen	22-Mar-1987
Decapoda	Grapsidae	*Plagusia*	*depressa*	Shrimp Bank, NE of Bowen	15-Jul-1972
Decapoda	Grapsidae	*Pseudograpsus*	*elongatus*	Dalrymple Pt., Port Denison	21-Mar-1987
Decapoda	Leucosiidae	*Arcania*	*novemspinosa*	Bowen	Feb-1934
Decapoda	Leucosiidae	*Leucosia*	*sp.*	Bowen	
Decapoda	Leucosiidae	*Leucosia*	*leslii*	Bowen	Feb-1934
Decapoda	Leucosiidae	*Urnalana*	*whitei*	Bowen	
Decapoda	Majidae	*Achaeus*	*brevirostris*	Bowen	

Order	Family	Genus	Species	Locality Name	Field Collection Date
Decapoda	Majidae	*Hyastenus*	*diacanthus*	Bowen	
Decapoda	Mictyridae	*Mictyris*	*longicarpus*	Doughty Ck., Bowen	21-Mar-1987
Decapoda	Ocypodidae	*Macrophthalmus*	*sp.*	Dalrymple Pt., Bowen	22-Mar-1987
Decapoda	Ocypodidae	*Uca*	*sp.*	Doughty Ck., Bowen	21-Mar-1987
Decapoda	Oziidae	*Epixanthus*	*frontalis*	Dalrymple Point, Bowen	21-Mar-1987
Decapoda	Oziidae	*Epixanthus*	*frontalis*	Dalrymple Pt., Bowen	21-Mar-1987
Decapoda	Oziidae	*Myomenippe*	*fornasinii*	Bowen	Dec-1982
Decapoda	Palaemonidae	*Macrobrachium*	*auratum*	Elliott R, Guthulungra	2-Jun-1997
Decapoda	Palaemonidae	*Macrobrachium*	*auratum*	Elliott R, Guthulungra	2-Jun-1997
Decapoda	Palaemonidae	*Macrobrachium*	*auratum*	Elliott R, Guthulungra	25-Jun-1997
Decapoda	Palaemonidae	*Macrobrachium*	*australiense*	Isaac R	30-Oct-1974
Decapoda	Palaemonidae	*Macrobrachium*	*australiense*	Peak Downs	1-Nov-1974
Decapoda	Palaemonidae	*Macrobrachium*	*australiense*	Peak Downs, rainwater dam	1-Nov-1974
Decapoda	Palaemonidae	*Macrobrachium*	*australiense*	Peak Downs, No. 2 settlement tailings dam	1-Nov-1974
Decapoda	Palaemonidae	*Macrobrachium*	*australiense*	Eureka Ck, nr Goonyella mine	2-Nov-1974
Decapoda	Palaemonidae	*Macrobrachium*	*australiense*	Eureka Ck, Isaac R junction	2-Nov-1974
Decapoda	Palaemonidae	*Macrobrachium*	*australiense*	Grosvenor Ck, junction with Isaac R	Sep-1977
Decapoda	Palaemonidae	*Macrobrachium*	*australiense*	Isaac R	Sep-1977

Order	Family	Genus	Species	Locality Name	Field Collection Date
Decapoda	Palaemonidae	*Macrobrachium*	*australiense*	Isaac R	Sep-1977
Decapoda	Palaemonidae	*Macrobrachium*	*australiense*	Isaac R	Sep-1977
Decapoda	Palaemonidae	*Macrobrachium*	*australiense*	Isaac R	Sep-1977
Decapoda	Palaemonidae	*Macrobrachium*	*australiense*	Burdekin R	16-Nov-1983
Decapoda	Palaemonidae	*Macrobrachium*	*australiense*	Burdekin R	16-Nov-1983
Decapoda	Palaemonidae	*Macrobrachium*	*australiense*	Burdekin R	16-Nov-1983
Decapoda	Palaemonidae	*Macrobrachium*	*australiense*	Belyando R, Mt Douglas	28-May-1987
Decapoda	Palaemonidae	*Periclimenes*	*brevicarpalis*	Bowen	
Decapoda	Parastacidae	*Cherax*	*depressus*	Belyando R., Mt Douglas, Burdekin R. system	28-May-1987
Decapoda	Parastacidae	*Cherax*	*depressus*	Abbot Ck, Mt Abbot, 2 km SE of summit	8-Dec-1996
Decapoda	Parastacidae	*Cherax*	*depressus*	Abbot Ck, Mt Abbot, 1 km SE of summit	08-Dec-1996 – 09-Dec-1996
Decapoda	Parathelphusidae	*Austrothelphusa*	*sp.*	Moranbah	21-May-2004
Decapoda	Parathelphusidae	*Austrothelphusa*	*transversa*	Farm Pond on Floodway, Goonyella	1-Nov-1974
Decapoda	Parathelphusidae	*Austrothelphusa*	*transversa*	Blair Athol coal mine near Clermont	15-Feb-2001
Decapoda	Parthenopidae	*Cryptopodia*	*queenslandi*	Bowen	
Decapoda	Parthenopidae	*Parthenope*	*nodosa*	Bowen	Feb-1934
Decapoda	Pilumnidae	*Pilumnus*	*sp.*	Bowen	

Order	Family	Genus	Species	Locality Name	Field Collection Date
Decapoda	Porcellanidae	*Petrolisthes*	*teres*	Doughty Ck, Bowen	21-Mar-1987
Decapoda	Porcellanidae	*Petrolisthes*	*teres*	Cape Edgecombe, Bowen	22-Mar-1987
Decapoda	Porcellanidae	*Petrolisthes*	*teres*	Dalrymple Pt, Bowen	22-Mar-1987
Decapoda	Portunidae	*Charybdis*	*sp.*	Dalrymple Pt., Bowen	21-Mar-1987
Decapoda	Portunidae	*Portunus*	*sanguinolentus*	Bowen	
Decapoda	Portunidae	*Scylla*	*serrata*	Bowen	1982
Decapoda	Portunidae	*Thalamita*	*sp.*	Doughty Ck., Bowen	21-Mar-1987
Decapoda	Xanthidae	*Actaea*	*carcharias*	Bowen	Feb-1934
Decapoda	Xanthidae	*Actaea*	*catalai*	Bowen	
Decapoda	Xanthidae	*Actaea*	*catalai*	Bowen	
Decapoda	Xanthidae	*Leptodius*	*sp.*	Cape Edgecumbe, Bowen	22-Mar-1987
Decapoda	Xanthidae	*Leptodius*	*australis*	Doughty Ck., Bowen	21-Mar-1987
Decapoda	Xanthidae	*Leptodius*	*australis*	Dalrymple Pt., Bowen	22-Mar-1987
Decapoda	Xanthidae	*Leptodius*	*australis*	Dalrymple Pt., Bowen	22-Mar-1987
Decapoda	Xanthidae	*Leptodius*	*exaratus*	Doughty Ck., Port Denison	21-Mar-1987
Decapoda	Xanthidae	*Leptodius*	*exaratus*	Dalrymple Point, Bowen	21-Mar-1987
Decapoda	Xanthidae	*Leptodius*	*exaratus*	Dalrymple Pt., Bowen	22-Mar-1987
Decapoda	Xanthidae	*Pilodius*	*pilumnoides*	Bowen	
Isopoda	Cymothoidae	*Codonophilus*	*imbricatus*	Bowen	
Isopoda	Sphaeromatidae	*Cerceis*	*sp.*	Bowen, near rest area S of	22-Dec-1992

Order	Family	Genus	Species	Locality Name	Field Collection Date
				township	
Rhizocephala	Sacculinidae	*Sacculina*	*carcina*	Bowen	
Stomatopoda	Eurysquillidae	*Manningia*	*notialis*	Bowen	Feb-1934
Stomatopoda	Gonodactylidae	*Gonodactylus*	*graphurus*	Under rocks, outside Bowen	
Stomatopoda	Squillidae	*Oratosquillina*	*inornata*	Bowen	
Thoracica	Balanidae	*Balanus*	*tintinnabulum*	Bald Hills, Bowen	

Queensland Museum Search Results - Fish

Family	Genus	Species	Locality Name	Field Collection Date
Anguillidae	*Anguilla*	*reinhardtii*	Don River upper, Bowen	
Ambassidae	*Ambassis*	*agassizii*	Belyando R, trib Burdekin R at Mt Douglas	25-Nov-1976
Ambassidae	*Ambassis*	*agassizii*	Belyando R, trib Burdekin R at Mt Douglas	28-May-1987
Ambassidae	*Ambassis*	*agassizii*	Bowen R, trib Burdekin R, 22 km SW Collinsville	28-May-1987
Ambassidae	*Ambassis*	*agassizii*	Bowen, in lagoon	15-May-1978
Ambassidae	*Ambassis*	*agassizii*	Cape River, trib Burdekin R on Taemus Stn	23-Nov-1976
Ambassidae	*Ambassis*	*agassizii*	Don River, on Mt Danger Rd	24-Mar-1998
Ambassidae	*Ambassis*	*agassizii*	Eureka Creek, trib Isaac River at Goonyella mine	11-Nov-1974
Ambassidae	*Ambassis*	*agassizii*	Eureka Creek, trib Isaac River at Goonyella mine	11-Nov-1975
Ambassidae	*Ambassis*	*agassizii*	Goonyella road water dam, Isaac R system	1-Nov-1974
Ambassidae	*Ambassis*	*agassizii*	Goonyella, Isaac River, Fitzroy R system	1-Nov-1974
Ambassidae	*Ambassis*	*agassizii*	Isaac River	
Ambassidae	*Ambassis*	*agassizii*	Isaac River billabong	11-Nov-1974
Ambassidae	*Ambassis*	*agassizii*	Isaac River on Hwy SE of Morambah Stn	3-June-1987
Ambassidae	*Ambassis*	*agassizii*	Peak Downs rainwater dam, Isaac R system	1-Nov-1974
Ambassidae	*Ambassis*	*agassizii*	Theresa Ck, Fitzroy R syst, btn Capella & Emerald	3-June-1987
Ambassidae	*Ambassis*	*agassizii*	Theresa Ck, trib Nogoa R, Fitzroy system	27-Feb-1995
Anguillidae	*Anguilla*	*reinhardtii*	Don River, Bowen	

Family	Genus	Species	Locality Name	Field Collection Date
Anguillidae	*Anguilla*	*reinhardtii*	Don River upper, Bowen	
Ariidae	*Arius*	*graeffei*	Nogoa River, Fitzroy River system, Emerald	
Atherinidae	*Craterocephalus*	*stercusmuscarum*	Cape River, trib Burdekin R on Taemus Stn	23-Nov-1976
Atherinidae	*Craterocephalus*	*stercusmuscarum*	Theresa Ck, Fitzroy R syst, btn Capella & Emerald	3-June-1987
Atherinidae	*Craterocephalus*	*stercusmuscarum*	Theresa Ck, trib Nogoa R, Fitzroy system	27-Feb-1995
Belonidae	*Strongylura*	*kreffti*	Bowen R, trib Burdekin R, 22 km SW Collinsville	28-May-1987
Belontiidae	*Trichogaster*	*trichopterus*	Burdekin River floodplain	10-Jan-1996
Clupeidae	*Nematalosa*	*erebi*	Belyando R, trib Burdekin R at Mt Douglas	25-Nov-1976
Clupeidae	*Nematalosa*	*erebi*	Belyando R, trib Burdekin R at Mt Douglas	28-May-1987
Clupeidae	*Nematalosa*	*erebi*	Bowen R, trib Burdekin R, 22 km SW Collinsville	28-May-1987
Clupeidae	*Nematalosa*	*erebi*	Cape River, trib Burdekin R on Taemus Stn	23-Nov-1976
Clupeidae	*Nematalosa*	*erebi*	Eureka Creek, Isaac River	11-Nov-1974
Clupeidae	*Nematalosa*	*erebi*	Goonyella, Isaac River, Fitzroy R system	1-Nov-1974
Clupeidae	*Nematalosa*	*erebi*	Isaac River billabong	11-Nov-1974
Clupeidae	*Nematalosa*	*erebi*	Isaac River on Hwy SE of Morambah Stn	3-June-1987
Eleotrididae	*Hypseleotris*	*compressus*	Isaac River	
Eleotrididae	*Hypseleotris*	*klunzingeri*	Theresa Ck, trib Nogoa R, Fitzroy system	27-Feb-1995
Eleotrididae	*Hypseleotris*	*sp 1 (midgley)*	Belyando R, trib Burdekin R at Mt Douglas	25-Nov-1976
Eleotrididae	*Hypseleotris*	*sp 1 (midgley)*	Burdekin River floodplain	10-Jan-1996

Family	Genus	Species	Locality Name	Field Collection Date
Anguillidae	*Anguilla*	*reinhardtii*	Don River upper, Bowen	
Eleotrididae	*Hypseleotris*	*sp 1 (midgley)*	Cape River, trib Burdekin R on Taemus Stn	23-Nov-1976
Eleotrididae	*Hypseleotris*	*sp 1 (midgley)*	Carbine Ck, trib Nogoa R, Fitzroy system	27-Feb-1995
Eleotrididae	*Hypseleotris*	*sp 1 (midgley)*	Eureka Creek, Isaac River	11-Nov-1974
Eleotrididae	*Hypseleotris*	*sp 1 (midgley)*	Eureka Creek, trib Isaac River at Goonyella mine	11-Nov-1975
Eleotrididae	*Hypseleotris*	*sp 1 (midgley)*	Goonyella, Isaac River, Fitzroy R system	1-Nov-1974
Eleotrididae	*Hypseleotris*	*sp 1 (midgley)*	Grosvener Ck, Isaac River	
Eleotrididae	*Hypseleotris*	*sp 1 (midgley)*	Isaac River billabong	30-Oct-1974
Eleotrididae	*Hypseleotris*	*sp 1 (midgley)*	Isaac River billabong	10-Oct-1974
Eleotrididae	*Hypseleotris*	*sp 1 (midgley)*	Theresa Ck, Fitzroy R syst, btn Capella & Emerald	3-June-1987
Eleotrididae	*Hypseleotris*	*sp 1 (midgley)*	Theresa Ck, trib Nogoa R, Fitzroy system	27-Feb-1995
Eleotrididae	*Mogurnda*	*adspersa*	Belyando R, trib Burdekin R at Mt Douglas	28-May-1987
Eleotrididae	*Oxyeleotris*	*lineolatus*	Bowen River, below Collinsville Weir	25-Mar-1999
Eleotrididae	*Philypnodon*	*grandiceps*	Belyando R, trib Burdekin R at Mt Douglas	25-Nov-1976
Eleotrididae	*Philypnodon*	*grandiceps*	Belyando R, trib Burdekin R at Mt Douglas	28-May-1987
Melanotaeniidae	*Melanotaenia*	*splendida splendida*	Belyando R, trib Burdekin R at Mt Douglas	25-Nov-1976
Melanotaeniidae	*Melanotaenia*	*splendida splendida*	Belyando R, trib Burdekin R at Mt Douglas	28-May-1987
Melanotaeniidae	*Melanotaenia*	*splendida splendida*	Bowen R, trib Burdekin R, 22 km SW Collinsville	28-May-1987
Melanotaeniidae	*Melanotaenia*	*splendida splendida*	Cape River, trib Burdekin R on Taemus Stn	23-Nov-1976

Family	Genus	Species	Locality Name	Field Collection Date
Anguillidae	*Anguilla*	*reinhardtii*	Don River upper, Bowen	
Melanotaeniidae	*Melanotaenia*	*splendida splendida*	Theresa Ck, Fitzroy R syst, btn Capella & Emerald	3-June-1987
Melanotaeniidae	*Melanotaenia*	*splendida splendida*	Theresa Ck, trib Nogoa R, Fitzroy system	27-Feb-1995
Melanotaeniidae	*Melanotaenia*	*splendida splendida*	Eureka Creek, Isaac River	11-Nov-1974
Melanotaeniidae	*Melanotaenia*	*splendida splendida*	Eureka Creek, trib Isaac River at Goonyella mine	11-Nov-1974
Melanotaeniidae	*Melanotaenia*	*splendida splendida*	Goonyella road water dam, Isaac R system	1-Nov-1974
Melanotaeniidae	*Melanotaenia*	*splendida splendida*	Goonyella, Isaac River, Fitzroy R system	1-Nov-1974
Melanotaeniidae	*Melanotaenia*	*splendida splendida*	Isaac River	11-Nov-1974
Melanotaeniidae	*Melanotaenia*	*splendida splendida*	Isaac River billabong	30-Oct-1974
Melanotaeniidae	*Melanotaenia*	*splendida splendida*	Isaac River on Hwy SE of Morambah Stn	3-June-1987
Melanotaeniidae	*Melanotaenia*	*splendida splendida*	Peak Downs mine settlement dam, Isaac R system	1-Jan-1974
Melanotaeniidae	*Melanotaenia*	*splendida splendida*	Peak Downs rainwater dam, Isaac R system	1-Nov-1974
Percichthyidae	*Macquaria*	*ambigua oriens*	Nogoa River, Fitzroy River system, Emerald	9-Aug-1954
Plotosidae	*Neosilurus*	*hyrtlii*	Isaac River on Hwy SE of Morambah Stn	3-June-1987
Plotosidae	*Neosilurus*	*hyrtlii*	Peak Downs mine settlement dam, Isaac R system	1-Nov-1974
Plotosidae	*Neosilurus*	*hyrtlii*	Theresa Ck, trib Nogoa R, Fitzroy system	27-Feb-1995
Plotosidae	*Neosilurus*	*hyrtlii*	Belyando R, trib Burdekin R at Mt Douglas	25-Nov-1976
Plotosidae	*Neosilurus*	*hyrtlii*	Belyando R, trib Burdekin R at Mt Douglas	28-May-1987

Family	Genus	Species	Locality Name	Field Collection Date
Anguillidae	*Anguilla*	*reinhardtii*	Don River upper, Bowen	
Plotosidae	*Neosilurus*	*hyrtlii*	Cape River, trib Burdekin R on Taemus Stn	23-Nov-1976
Plotosidae	*Neosilurus*	*mollespiculum*	Bowen River, Telegraph Hole	25-Mar-1998
Scorpaenidae	*Notesthes*	*robusta*	Bowen River, Burdekin R system	
Scorpaenidae	*Notesthes*	*robusta*	Nogoa River, Fitzroy River system, Emerald	
Teraponidae	*Amniataba*	*percoides*	Bowen R, trib Burdekin R, 22 km SW Collinsville	28-May-1987
Teraponidae	*Leiopotherapon*	*unicolor*	Lake Elphinstone	
Teraponidae	*Leiopotherapon*	*unicolor*	Belyando R, trib Burdekin R at Mt Douglas	28-May-1987
Teraponidae	*Leiopotherapon*	*unicolor*	Bowen R, trib Burdekin R, 22 km SW Collinsville	28-May-1987
Teraponidae	*Leiopotherapon*	*unicolor*	Isaac River on Hwy SE of Morambah Stn	3-June-1987
Teraponidae	*Leiopotherapon*	*unicolor*	Nogoa River, Fitzroy River system, Emerald	
Teraponidae	*Leiopotherapon*	*unicolor*	Peak Downs mine settlement dam, Isaac R system	1-Nov-1974
Teraponidae	*Scortum*	*hillii*	Sandy Ck/Theresa Ck junction, trib Nogoa R	27-Feb-1995
Teraponidae	*Scortum*	*parviceps*	Belyando R, trib Burdekin R at Mt Douglas	28-May-1987
Teraponidae	*Scortum*	*parviceps*	Burdekin Falls Dam	16-June-1995

Appendix B

Habitat Assessment Methodology

AUSRIVAS River Bioassessment Program Habitat Variables and Criteria Rankings

Habitat Variable	Excellent	Good	Fair	Poor
1. Bottom Substrate / Available cover	> 50% rubble, gravel, submerged logs, undercut banks, or other stable habitat.	30-50% rubble, gravel or other stable habitat.	10-30% rubble, gravel or other stable habitat. Habitat availability less than desirable.	<10% rubble, gravel or other stable habitat. Lack of habitat is obvious.
	20, 19, 18, 17, 16	15, 14, 13, 12, 11	10, 9, 8, 7, 6	5, 4, 3, 2, 1, 0
2. Embeddedness	Gravel, cobble and boulder particles are between 0 & 25% surrounded by fine sediment.	Gravel, cobble and boulder particles are between 25% & 50% surrounded by fine sediment.	Gravel, cobble and boulder particles are between 50% & 75% surrounded by fine sediment.	Gravel, cobble and boulder particles are between over 75% surrounded by fine sediment.
	20, 19, 18, 17, 16	15, 14, 13, 12, 11	10, 9, 8, 7, 6	5, 4, 3, 2, 1, 0
3. Velocity/Depth Category	Slow deep (<0.3m/s & >0.5 m); slow shallow; fast deep; fast shallow; habitats all present.	Only 3 of the four habitat categories present (missing riffles or runs receive lower score than missing pools).	Only two of the four habitat categories present (missing riffles or runs receive a lower score).	Dominated by one velocity/depth category (usually pool).
	20, 19, 18, 17, 16	15, 14, 13, 12, 11	10, 9, 8, 7, 6	5, 4, 3, 2, 1, 0
4. Channel Alteration	Little or no enlargement of island or point bars and/or no channelisation.	Some new increase in bar formation, mostly from coarse gravel; and/or some channelisation present.	Moderate deposition of new gravel, course sand, on old and new bars; pools partly filled with silt; and/or embankments on both banks.	Heavy deposits of fine materials; increased bar development; most pools filled with silt; and/or extensive channelisation.
	15, 14, 13, 12	11, 10, 9, 8	7, 6, 5, 4	3, 2, 1, 0
5. Bottom Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	5% - 30% affected. Scours at constrictions and where grades steepen, some deposition in pools.	30% - 50% affected. Deposits and scours at obstructions and bends. Some deposition in pools.	More than 50% of the bottom changing nearly year long. Pools almost absent due to deposition. Only large rocks in riffle exposed.
	15, 14, 13, 12	11, 10, 9, 8	7, 6, 5, 4	3, 2, 1, 0
6. Pool/Riffle, Run/Bend Ratio (Distance between riffles divided by stream width)	0 – 7. Variety of habitat. Deep riffles and pools.	7 – 15. Adequate depth in pools and riffles. Bends provide habitat	15 – 25. Occasional riffle or bend. Bottom contours provide some habitat.	? 25. Essentially a straight stream. Generally all flat water or shallow riffle. Poor habitat.
	15, 14, 13, 12	11, 10, 9, 8	7, 6, 5, 4	3, 2, 1, 0
7. Bank Stability	Stable. No evidence of erosion or bank failure. Side slopes generally <30%. Little potential for future problem.	Moderately stable. Infrequent small areas of erosion. Side slopes up to 40% on one bank. Slight potential in extreme floods.	Moderately unstable. Moderate frequency and size of erosional areas. Side slopes up to 60% on some banks. High erosion potential during extreme/high flows.	Unstable. Many eroded areas. Side slopes >60% are common. Exposed 'raw' areas frequent along straight sections and bends.
	10, 9	8, 7, 6	5, 4, 3	2, 1, 0

Habitat Variable	Excellent	Good	Fair	Poor
8. Bank Vegetative Stability	Over 80% of the streambank surfaces covered by vegetation or boulders and cobble.	50 - 79% of the streambank surfaces covered by vegetation, gravel or larger material.	25 - 49% of the streambank surfaces covered by vegetation, gravel or larger material.	<25% of the streambank surfaces covered by vegetation, gravel or larger material.
	10, 9	8, 7, 6	5, 4, 3	2, 1, 0
9. Streamside Cover	Dominant vegetation is of tree form.	Dominant vegetation is shrub form.	Dominant vegetation is grass, sedge, ferns.	Over 50% of streambank has no vegetation and dominant material is soil, rock, bridge materials, culverts, or mine tailings.
	10, 9	8, 7, 6	5, 4, 3	2, 1, 0

Appendix C

Water Quality Results

Surface Water Quality within the Study Area (mean ± standard error)

Site	Dissolved Oxygen (%)	TDS	pH	Temperature (°C)	Turbidity (NTU)	Conductivity (µs/cm)
Splitters Creek	86.14 ± 0.18	690.30 ± 17.42	7.837 ± 0.004	17.61 ± 0.03	0.31 ± 0.02	1535 ± 114
Elliot River	85.96 ± 0.73	425.70 ± 1.82	7.517 ± 0.010	21.38 ± 0.04	1.96 ± 0.20	786.1 ± 0.6
Bogie River	86.06 ± 0.30	293.30 ± 0.45	7.611 ± 0.005	25.00 ± 0.00	0.42 ± 0.07	546.2 ± 0.6
Artificial Dam/Wetland	95.09 ± 0.18	89.40 ± 0.34	7.952 ± 0.007	27.00 ± 0.00	5.57 ± 0.05	174.5 ± 0.3
Gilgais	31.65 ± 1.15	38.81 ± 1.25	5.065 ± 0.010	22.5 ± 0.00	29.7 ± 0.65	75.7 ± 0.1
Capsize Creek	130.01 ± 4.03	406.20 ± 0.13	8.218 ± 0.010	32.08 ± 0.02	30.88 ± 0.27	751.6 ± 2.5
King Creek	88.66 ± 2.63	573.40 ± 0.37	7.828 ± 0.007	25.00 ± 0.00	0.79 ± 0.04	1026.6 ± 0.8
Pelican Creek	110.77 ± 0.08	552.70 ± 0.45	8.144 ± 0.002	25.00 ± 0.00	0.78 ± 0.05	992.8 ± 0.6
Suttor River	87.8 ± 1.78	138.80 ± 0.33	6.938 ± 0.009	25.00 ± 0.00	160.26 ± 0.98	286.0 ± 0.0
Eaglefield Creek	54.97 ± 1.27	78.87 ± 0.07	6.276 ± 0.008	23.33 ± 0.02	154.79 ± 0.34	153.8 ± 0.1
Myra Creek	91.58 ± 0.18	82.62 ± 0.02	7.011 ± 0.012	24.42 ± 0.01	27.92 ± 0.21	147.4 ± 0.1
Mistake Creek	66.95 ± 0.89	87.00 ± 0.09	7.928 ± 0.005	27.20 ± 0.00	39.94 ± 0.11	163.6 ± 0.2
Sixteen Mile Creek	63.45 ± 3.95	135.20 ± 0.33	7.67 ± 0.017	26.64 ± 0.17	0.19 ± 0.51	255.7 ± 0.6
Star of Hope Creek	62.11 ± 0.67	140.80 ± 0.29	6.337 ± 0.003	25.87 ± 0.19	8.85 ± 0.11	257.4 ± 0.5
Star of Hope Dam/Wetland	10.89 ± 0.28	66.60 ± 0.04	5.352 ± 0.012	25.02 ±0.05	5.20 ± 0.28	114.8 ± 0.3
Belyando River	35.4 ± 0.26	117.50 ± 0.34	6.551 ± 0.016	25.91 ± 0.01	121.51 ± 1.36	210.0 ± 0.2
Native Companion Creek	88.79 ±0.04	148.50 ± 0.17	7.307 ± 0.013	22.44 ± 0.05	36.07 ± 0.21	275.8 ± 0.1

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