Waratah Coal

China First Project - Aquatic Ecology

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14 December 2010

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Document History and Status

Revision	Date Issued	Reviewed By	Approved By	Date Approved	Revision Type
Draft	9 October 2010	Peter Wulf	Frank Ganendran	9 October 2010	Draft
Rev 2	14 December 2010	Sam Maynard	Frank Genendran	8 November	Final

Distribution of Copies

Version	Date Issued	Quantity	Electronic	Issued To
Draft	9 October 2010	1	MS Word	Client
Final	14 December 2010	1	MS Word	Client

Printed:	14 December 2010
Last Saved:	14 December 2010 04:08 PM
File Name:	Waratah Coal - Aquatic Ecology - Final 8 November 2010.docx
Author:	Peter Wulf
Project Manager:	Frank Ganendran
Client:	Waratah Coal
Document Title:	China First Project - Aquatic Ecology
Document Version:	Final
Project Number:	B09216.10

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Executive Summary

E3 Consulting Pty Ltd (E3) was commissioned by Waratah Coal Pty Ltd (Waratah Coal) to undertake the assessment of aquatic (freshwater) flora, fauna and ecology for the Galilee Coal Project – Northern Export Facility Project (China First Project). This technical report assesses the existing aquatic ecology and identifies any potential impacts resulting from the China First Project (CFP).

The project includes a:

- Coal mine located near Alpha in the Galilee Basin, Central Queensland;
- Rail alignment between the mine and a coal terminal located at the Abbot Point State Development Area (APSDA); and
- Coal terminal incorporated within both the APSDA and the Port of Abbot Point.

To better describe the aquatic ecology, the CFP study area was separated into the three main components of the project, this being the mine, rail alignment and coal terminal. The entire CFP falls within the Burdekin Catchment. For reporting purposes the Burdekin has been divided into five sub catchments based on the major rivers and their tributaries within the study area, these being the Belyando, Suttor, Bowen, Bogie (Lower Catchments) and Don (coal terminal area) heading downstream.

Desktop investigations suggested that *Apus pacificus* (EPBC Act - Migratory and Marine), *Crocodylus porosus* (EPBC Act and NC Act - Vulnerable), *Ephippiorhynchus asiaticus* (NC Act - Near Threatened), *Eucalyptus raveretiana* (EPBC Act and NC Act Vulnerable), *Haliaeetus leucogaster* (EPBC Act - Migratory and Marine), *Hirundapus caudacutus* (EPBC Act - Migratory and Marine), *Nettapus coromandelianus* (NC Act - Near Threatened) and *Tadorna radja* ((NC Act - Near Threatened) occur within the Bowen catchment and Lower Catchments. Of these, *Eucalyptus raveretiana* was observed at several of the sites.

A number of important wetland related regional ecosystems and wetlands were identified within the CFP footprint. These occur on the mine area, within the rail alignment footprint and at the APSDA. There are also numerous wetlands considered of *high ecological significance* and wetlands listed as Great Barrier Reef Wetland Protection Areas and Wetland Management Areas which have 100m and 500m buffer zones around the wetland itself.

A total of 34 species of macro invertebrates, eight species of macro crustacea and 28 species of fish were observed across the project area. This fishes observed during the study included three catadromous species, one facultative amphidromous fish species dependent on migratory linkages to the ocean and seven fishery associated species. Species richness was highest within the Bowen River Catchment of the CFP. A number of turtles and other aquatic related vertebrate species were also observed during field work.

The development has the potential to impact on aquatic ecosystems through:

- The diversion of an ephemeral stream from the open cut areas of the mine site;

- Clearing of semi-contiguous and contiguous riparian vegetation from the CFP construction footprint;
- Creation of breeding habitats for biting insects;
- Direct physical impacts to referable wetlands and wetland associated vegetation;
- Disturbance of indirect impacts on the EPBC Act and NC Act protected *Eucalyptus raveretiana* and rainforest vegetation community allied to endangered RE11.3.11
- Disturbance to any stream channel hosted aquatic refugia;
- Earthworks disturbance in and adjacent to perennial waterholes and associated riverine wetland RE vegetation that provide aquatic refugia;
- Extraction of groundwater within the mine that may impact on recharge of wetlands in the area;
- Obstruction of flow and aquatic fauna passage;
- Reduction of floodplain flow paths supplying downstream wetland habitats including referable palustrine systems;
- Reduction or removal of aquatic habitat connectivity for upstream movement of aquatic fauna from downstream refugia;
- Removal of aquatic habitat connectivity for migratory fauna; and
- Stormwater and associated water entering waterways as runoff, causing changes to physical and chemical water quality;

Proposed management measures include designing bridge structures to minimise the clearing of riparian vegetation and the development of an Erosion and Sediment Control Plan (ESCP) to reduce potential impacts resulting from stormwater runoff throughout construction and operation of the various components of the CFP. Further, prior to final design and construction, an assessment of important perennial waterholes that may act as refugia during dry seasons will be undertaken and based on that assessment, the alignment of the rail line will be reassessed so as the Project does not impact these locations.

If properly managed, the impacts to aquatic ecosystems resulting from the works are expected to be minimal.

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1 Introduction

1.1 Project Overview

Waratah Coal Pty Ltd (Waratah Coal) proposes to establish a coal mine, railway and coal terminal to export high volatile, low sulphur, steaming coal to international markets. The Co-ordinator General declared the Galilee Coal Project – Northern Export Facility (the China First Project) to be a significant project requiring the preparation of an Environmental Impact Statement (EIS).

The project includes the following components:

- A mine located near Alpha in the Galilee Basin, Central Queensland;
- A rail network between the mine and Abbot Point State Development Area (APSDA) and Port of Abbot Point; and
- A coal terminal that is incorporated within both the APSDA and Port of Abbot Point.

The project study area is shown in Figure 1-1 and a full description of the project is provided in the Project Description section of the EIS.

1.2 Terms of Reference and Scope of Study

This technical report addresses *Section 3.3.4 (*Freshwater aquatic flora and fauna*)* of the Terms of Reference (August 2009, ToR) for the Galilee Coal Project. The ToR pertaining to aquatic flora and fauna requirements are listed in Table 1-1. For ease of reference, the respective sections of this report that address each of the ToR requirements are also provided.

This report describes the existing aquatic flora and fauna and the relevant habitats across the project area. This report identifies the potential for the China First Project (CFP) to impact on existing aquatic flora and fauna in areas directly within or adjacent to the infrastructure footprint. The scope of the study included:

- A literature review and desktop assessment of publicly available databases, research publications and grey literature relevant to aquatic flora and fauna in the study area; and
- Undertake field investigations of the aquatic flora and fauna and associated habitat within the project area.

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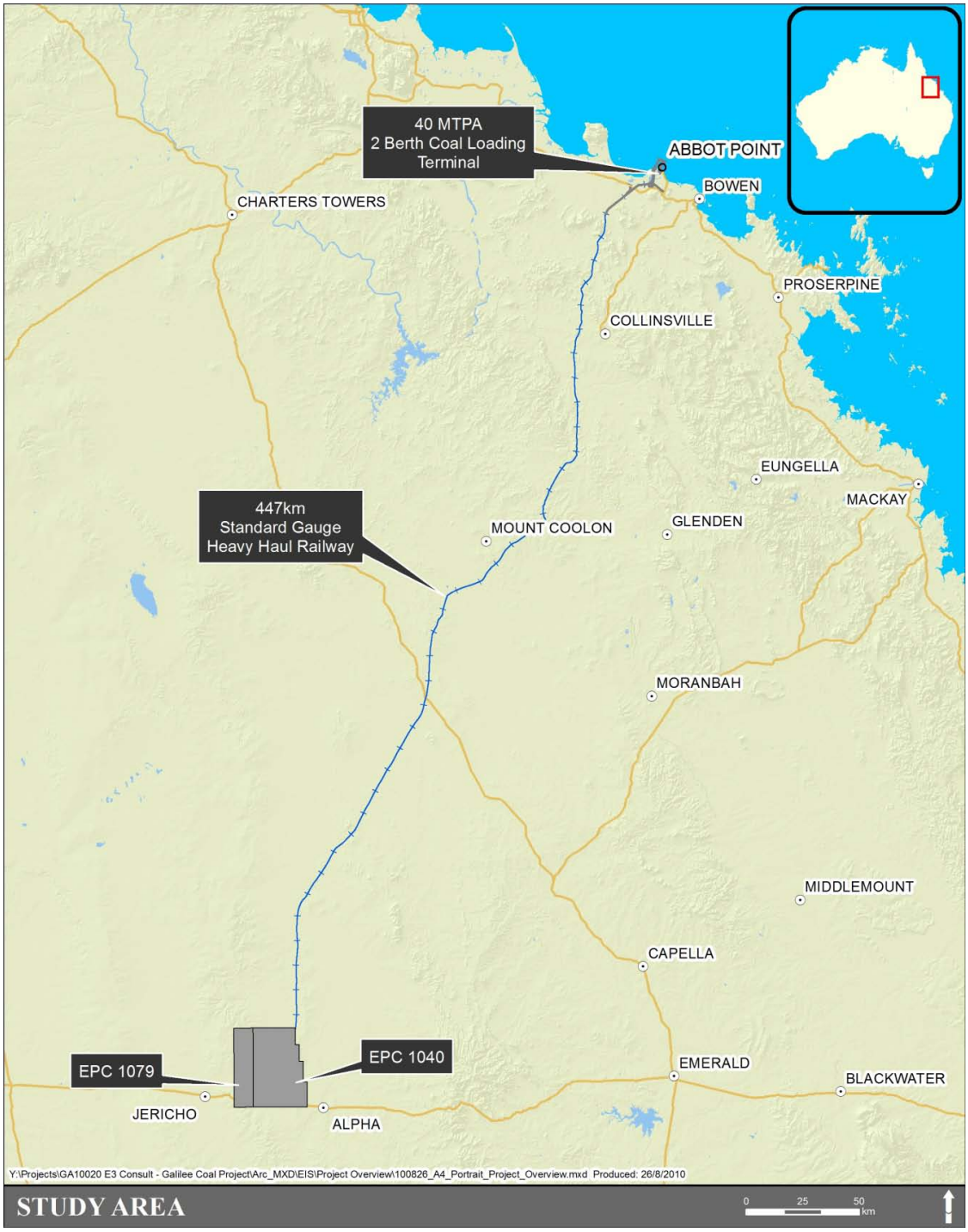

Figure 1-1: Study Area

Table 1-1: Terms of Reference

Freshwater Aquatic Flora and Fauna	Section
The aquatic flora and fauna occurring in the areas affected by the project should be described, noting the patterns and distribution in the waterways, with reference to EPBC Act and state listed fauna and flora. 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 should be provided. The discussion of the fauna and flora present or likely to be present in the area should include: • fish species, mammals, reptiles, amphibians and aquatic invertebrates occurring in the waterways within the project area, including any feral and exotic fauna species • aquatic (waterway) macrophytes including native and exotic/weed species • wetlands listed by the Commonwealth or State agencies as areas of national, state or regional significance, and their values and importance • reference should be made to Ramsar wetlands of international importance in terms of proximity to proposal and likelihood of impacts • a description of terrestrial species that are ecologically associated with wetlands or waterways and are likely to be affected by the project • aquatic substrate and stream type	Sections 3, 4 and 5
Order or Family taxonomic rank of the presence and nature of stygofauna occurring in groundwater likely to be affected by the project. Sampling and survey methods should follow the best practice guideline which is currently published by the Western Australian Environmental Protection Authority – *Guidance for the Assessment of Environmental Factors* No. 54 (December 2003) and No. 54a (August 2007). For project areas outside of the mine site, the assessment should be limited to areas where an appropriate risk assessment has determined that the project will have a material impact upon the groundwater resource.	Section 3.7
Wetlands should be mapped, described and analysed in a similar manner to that of regional ecosystems.	Sections 3, 4 and 5

Freshwater Aquatic Flora and Fauna	Section
This section should discuss all foreseen direct and indirect effects on aquatic flora and fauna, including strategies for protecting rare or threatened species and any obligations, legislation or policies imposed by the state and federal governments. The discussion should include: • measures to minimise wildlife injury and mortality during construction, operation and decommissioning • details of the methodologies that would be used to avoid injuries to native fauna as a result of the project's construction and operational works, and if accidental injuries should occur the methodologies to assess and handle injuries • details of measures to be used to maintain fish passage in waterways and wetlands that will be affected • methods for minimising the introduction of feral species, and other exotic fauna • review of control measures to prevent increases in local populations and spread of biting insect species of pest and health significance associated with construction activities and disposal of construction wastes • identification of necessary permits/authorities required by the project • description of the potential for and mitigation measures to prevent the introduction, transfer or facilitation of exotic, non-Indigenous and noxious plants and water borne insect pests • in any groundwater aquifers found to contain stygofauna, describe the potential impacts on stygofauna of any changes in the quality and quantity of the groundwater, and describe any mitigation measures that may be applied.	Sections 3, 4, 5, 6 and 7

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2 Methods of Assessment

2.1 Introduction

A combination of desktop assessments and field investigations were used to document and describe the existing aquatic flora and fauna of the CFP study area. The desktop assessments included database searches and reviews of previously prepared technical reports and relevant literature (research publications and grey literature). As the project area is relatively poorly documented in terms of its aquatic biota, it was necessary to collect new field survey data at most aquatic ecosystem sites potentially affected by the Project. Less survey effort was expended in areas where recent studies have compiled current information on aquatic biota and ecosystems present within the study area. Most of the recent studies have been carried out at the Port of Abbot Point.

2.2 Desktop Assessments

Desktop assessments were conducted prior to the commencement of the field survey to document the existing environment of the CFP study area and to identify any listed species of flora and fauna or other matters of Commonwealth or Queensland significance that may be associated with aquatic ecosystems of the project area. Some of these assessments were conducted generically for both terrestrial and aquatic ecosystems as part of the broader EIS being compiled for the project as this provide information on the vegetation in and around streams. Assessment outputs were then interpreted specifically in relation to the ToR for aquatic species and habitat types or those associated with or dependent upon aquatic ecosystems including riparian and wetland communities. Searches were undertaken of the mine, a 10km buffer around the rail alignment and coal terminal.

The assessments undertook searches of the following databases and literature sources:

- Department of the Environment, Water, Heritage and the Arts (DEWHA) Protected Matters Search Tool to identify species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) that are predicted to occur within the study area;
- Commonwealth Government's Environment Reporting Tool (ERT) Database to obtain additional information on aquatic species of threatened status and invasive species of national significance associated with aquatic ecosystems predicted to occur within the study area;
- DEWHA's on-line Australian Wetland Database for Wetlands that are listed RAMSAR sites or listed in the Directory of Important Wetlands In Australia (DIWA);
- Queensland Department of Environment and Resource Management (DERM) *Wildlife Online* database to identify aquatic flora and fauna species including threatened species listed under the *Nature Conservation Act 1992* (NC Act) that have been historically recorded in the study area;
- DERM Regional Ecosystem (RE) and Essential Habitat Mapping (Version 5.0, 2005) protected under the *Vegetation Management Act 1999* (VM Act) to determine the type and extent of remnant riparian and wetland vegetation as well as such areas recognised as essential habitat within the study area;

- DERM's on-line Moratorium mapping facility to determine if any areas within the study area contained regrowth riparian and/or wetland vegetation protected under the *Vegetation Management (Regrowth Clearing Moratorium) Act 2009*;
- DERM Queensland Wetland Program Wetland Mapping and Classification base mapping (1:100,000);
- DERM *Wetland Info "*Wetland Summary Information" (including listed plant and animal species) for river Basins (Burdekin and Don);
- DERM *Wetland Info "*'Legislation and Planning Maps" specifically for referable wetlands identified on the map as Great Barrier Reef (GBR) Wetland Protection Areas (WPA) and Wetland Management Areas (WMA);
- Department of Employment, Economic Development and Innovation (DEEDI) Declared Fish Habitat area plans;
- Alluvium Consulting. 2007. *Burdekin Dry Tropics NRM Region Fish Passage Study*, Report to Burdekin Dry Tropics NRM;
- Australian Centre for Tropical Freshwater Research (1999) "*Environmental Study of a Proposed Dam at Mt. Douglas on the Belyando River*", ACTFR unpublished Report 99/28 prepared for the Queensland Department of Natural Resources;
- Burrows, D., Davis, A., and Knott, M., (2009) "*Survey of the Freshwater Fishes of the Belyando Suttor System, Burdekin Catchment, Queensland*" Australian Centre for Tropical Freshwater Research, James Cook University, Townsville, unpublished Report 09/08 prepared for the North Queensland Dry Tropics NRM Board
- Carter, J. and Tait, J. 2008. "*Freshwater Fishes of the Burdekin Dry Tropics NRM Region*", Burdekin Dry Tropics and Alluvium Consulting, Townsville;
- Consortium of National Centre for Tropical Wetland Research and Centre for Riverine Landscapes web based *Freshwater Fish Atlas of Northern Australia outputs for Burdekin and Don River Basins*; and
- North Queensland Bulk Ports (2009) *Terrestrial and Aquatic Ecological Assessment, Report for Proposed Abbot Point Multi Cargo Facility*. Unpublished report prepared for North Queensland Bulk Ports Corporation Limited.

A review was undertaken of the *Temporary Planning Policy: Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments*. The review assessed the existence of any wetlands mapped as being of *high ecological significance* occurring in close proximity to both the mine and rail alignment. The assessment interpreted the terrestrial vegetation mapping for wetland associated RE's to identify wetlands that may be impacted by the project.

2.3 Field Surveys

Field surveys and sampling were conducted to identify aquatic species and communities within the project area, fill information gaps in areas poorly served by available survey data and to verify the likelihood of the occurrence of EPBC Act and NC Act listed species identified via desktop searches as having the potential to occur within the CFP footprint. Verification was based on direct observation of flora, fauna, REs present or suitable habitat.

The primary aquatic ecological survey was conducted during the post wet season (May 2010) which provided optimum timing in terms on vehicular access, fauna activity, flora inflorescence and persistence of seasonal stream and water bodies.

To better describe aquatic ecology, the study area was broken down into the three main components of the project, being the mine, rail alignment and coal terminal. There are five main catchments based on the major rivers and their tributaries within the CFP study area, these being the Belyando, Suttor, Bowen, Lower Catchments and Don heading downstream. The whole study area falls within the Burdekin Catchment. For ease of reading, the rail alignment is split with sites being described within each of the main catchments.

2.3.1 Selection of Sites

Most of the project area is remote, poorly served by road networks, under freehold or leasehold land tenure and includes floodplain and hilly dissected terrain inaccessible even by 4wd vehicle. Previous water quality sampling was conducted by helicopter with samples taken from all larger creek and river drainages intercepting the CFP footprint. The aquatic flora and fauna survey was dependent upon vehicle based mobilisation of survey equipment and this restricted the selection of survey sites to areas accessible by the available road and track network and subject to landholder permission. The location of the 14 aquatic sampling sites relative to the CFP are highlighted in Figure 2-1 and Figure 2-2.

Where survey sites could not be located within the 10km buffer for the rail alignment, they were chosen as near as possible within the same drainage system on the basis of access, availability of water bodies and representation of the potentially impacted sites.

2.3.2 Aquatic Habitat

The aquatic habitat at 14 sites was assessed using the Australian River Assessment System (AusRivAS) rapid assessment technique developed under the National River Health Program by the Commonwealth Government in 1994. This technique broadly defines stream morphology; available aquatic habitats, vegetation and observed land use impacts. Stream morphology provides information such as: flow characteristics, bed morphology, bed substrate, bed width and any seasonal variations

Description of survey site habitats included aquatic physical and biotic features and adjoining riparian vegetation communities were derived from wetland associated RE mapping, application of State of the Rivers (Anderson 1993a and 1993b) reporting pro-forma protocols and additional qualitative description of observed habitat features. This information was stored on a Trimble Data Logger. Qualitative habitat descriptions were structured by a consistent set of descriptors across all sites including geomorphic setting, riparian vegetation structure and dominant overstorey, emergent and submergent plant species, available aquatic habitats, substrate type, hydrological regime, weeds and other disturbance factors and observed water clarity.

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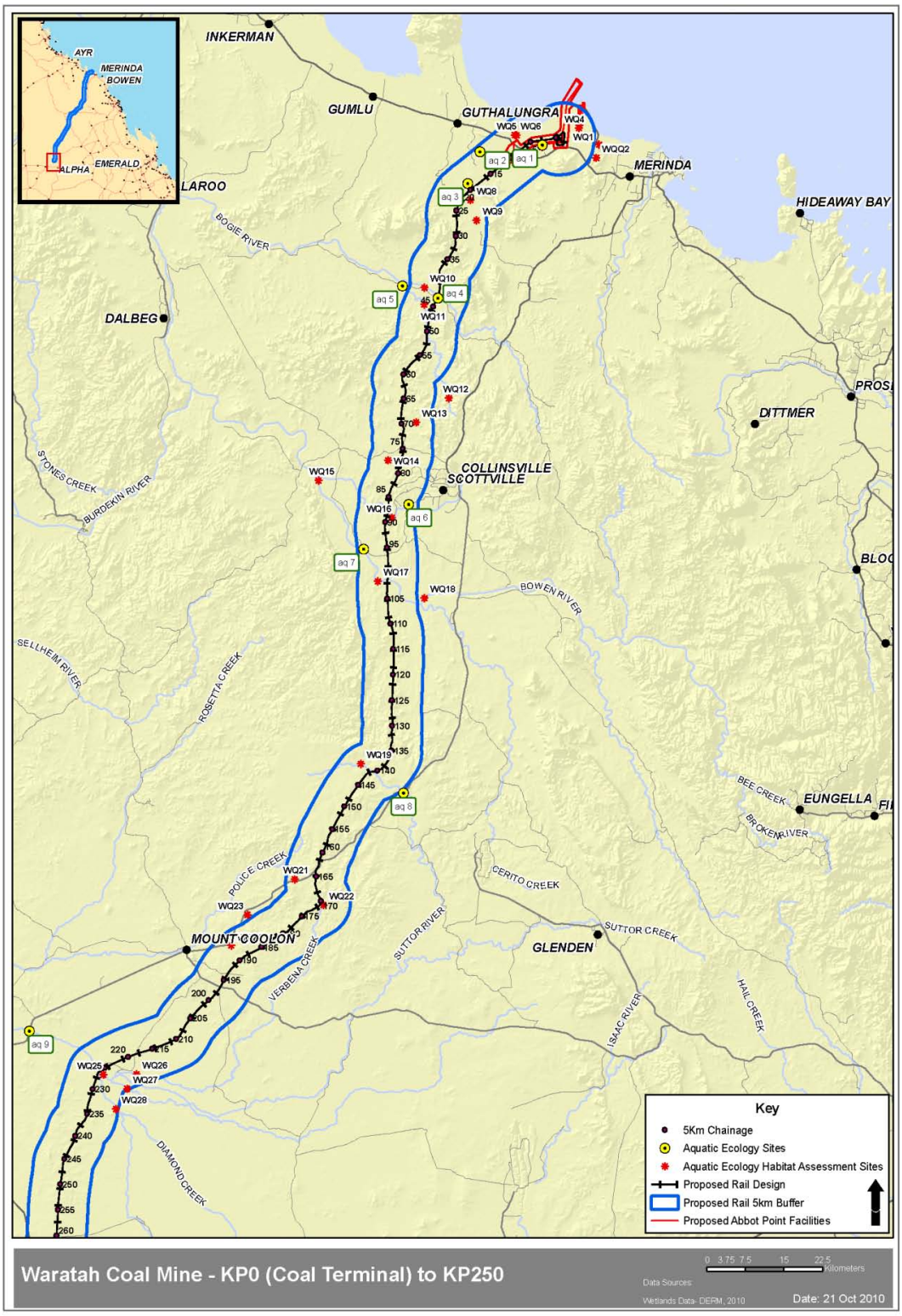

Figure 2-1: Aquatic Ecology Sampling Sites – Port and Northern Section

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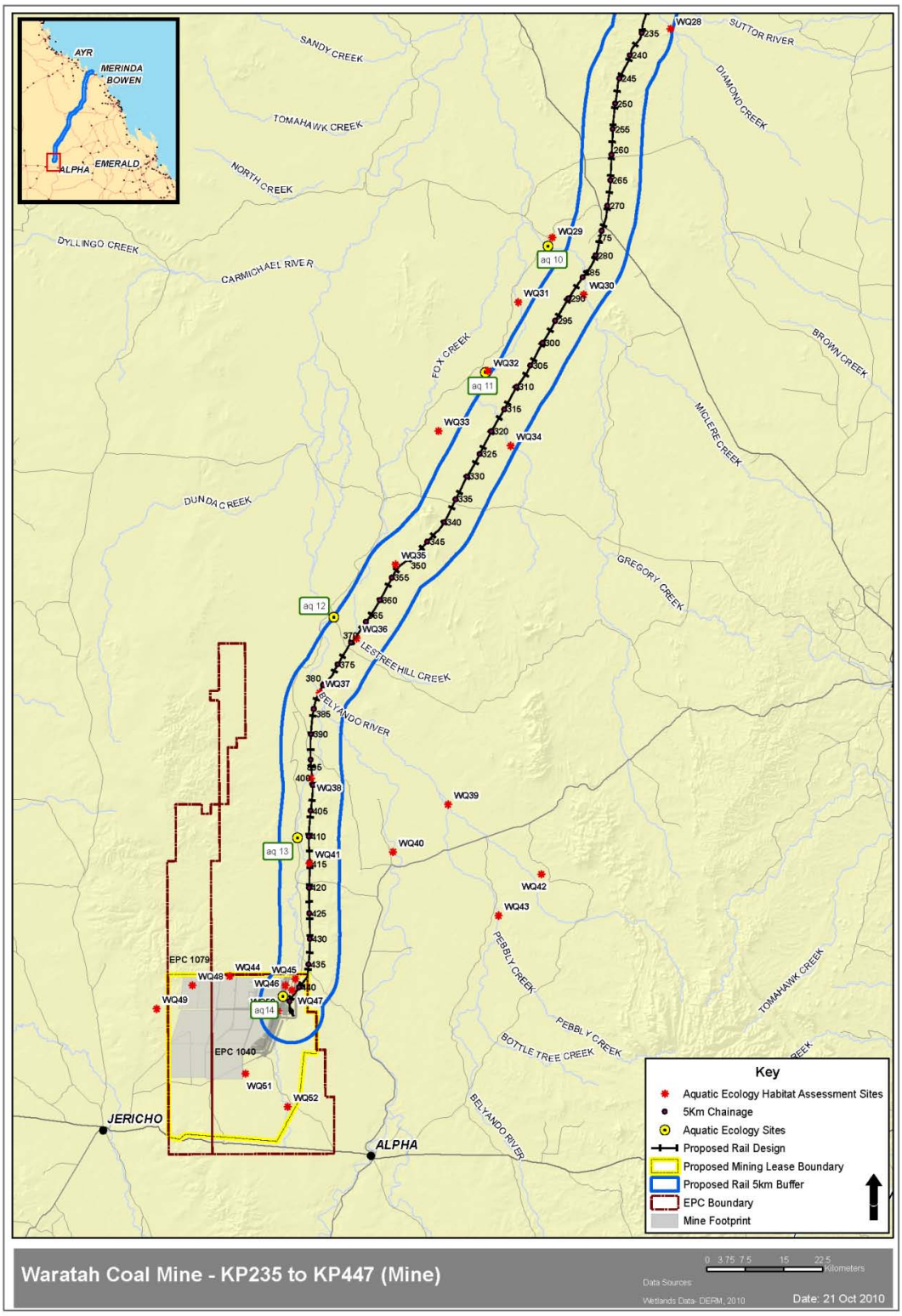

Figure 2-2: Aquatic Ecology Sampling Site – Mine and Southern Section

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Aquatic Habitat Types

Aquatic ecosystems within the study area can be divided into four broad habitat types; estuarine, lacustrine, palustrine and riverine.

Estuarine habitats occur where freshwater from riverine habitats mixes with oceanic waters to produce a brackish environment. Estuarine habitats within the study area include saltwater wetlands (including mudflats and samphire wetlands) and adjacent tidal creeks. These habitats are located in the Abbot Point region and are generally associated with the Caley Valley Wetland.

Lacustrine habitats are open water bodies such as lakes and artificial dams. These habitats are generally deep and still or slow-flowing and are often utilised by fauna species during the dry season as a refuge when other water sources have dried up.

Palustrine habitats are primarily off-stream habitats such as wetlands, gilgais and billabongs that generally support a high abundance of emergent vegetation. Palustrine habitats are inundated during the wet season and gradually dry out as rainfall declines and water levels in the main river channel subside (depending on specific site conditions these habitats may or may not completely dry out). Due to their shallow depth and still water conditions, palustrine habitats can support a high diversity of in-stream habitat in form of detritus, fallen branches and logs.

Riverine habitats include all aquatic habitat types that occur within a channel (i.e. rivers and creeks) and may be periodically or permanently inundated by flowing water. This is the predominant habitat type within the study area.

Where relevant these areas have been identified through regional mapping tools and referred to during site assessment.

2.3.3 Water Quality

Water quality samples were not taken as part of this work. The water quality of the project area was assessed and is described in the Surface Water Quality Technical Report. A total of 54 sites had physical and chemical properties analysed for both wet and dry seasons including two sites located within a quarry at Abbot Point. Samples were taken in close proximity to a number of the aquatic sampling sites. However, as a result of needing to use a motor vehicle to access sites from public roads, exact replication was not possible as many of the aquatic sites were only accessible by air through the use of a helicopter.

2.3.4 Aquatic Flora

Aquatic macrophytes observed at each sites including emergent, submergent and floating forms were described as part of site habitat descriptions. The relative abundance, growth habit and preferred habitat of observed macrophytes were recorded. Plants were identified to species levels by reference to field guides (Sainty and Jacobs 2003, Stephens and Dowling 2003, Cowie, *et al* 2000), photographed and checked against lists of listed species known or predicted to occur in the project area.

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2.3.5 Aquatic Macro Invertebrate Communities

The streambeds consist primarily of gravel, leaf litter, macropyhtes, sand and stones (alphabetical only). Samples of invertebrates were taken from all habitats including riffles, runs and pool using a 250μm dip net. Three replicate samples were taken by placing the net immediately below a sampled area and allowing the water flow to transport the sample into the net. Fist-sized stones (Phi Scale –7) were sampled by lifting the stone from the substrate, taking care not to include any accumulation of organic material underneath the stone and placing it in the net; a spray bottle was then used to remove the invertebrates from the stone. Kick samples were taken off the surface of sandy substrates by placing the net downstream of the sampler and disturbing a 10 x 10 cm^2 section of the substrate, and then moving the net through the disturbed substrate to collect the disturbed invertebrates. Leaf litter was collected by placing the net immediately downstream of the leaf litter pack, and picking up a 10 x 10 cm^2 section of leaf litter and placing it into the net. All invertebrate samples (n = 36) were preserved in 70% ethanol and returned to the laboratory for processing. Macro invertebrates were screened through a 2mm, 1mm, 300μm and 180μm sieve and sorted based on the location within each sieve. Macro invertebrates were counted and identified under a stereo dissecting microscope. All taxa were identified using published keys (eg Williams, 1980) and reference collections obtained from the University of Queensland library and those held by staff at E3. Where the number of individuals of a family in a sample/sieve equalled greater than 50, the count was stopped for that particular family.

Stream Invertebrate Grade Number – Average Level (SIGNAL) scores were also calculated for all of the sites sampled using the order – class – phylum methodology outlined in Chessman (2003). SIGNAL scores provide an indication of waterway health with higher scores generally associated with healthier waterway ecosystems. The calculated SIGNAL scores were then compared to Gooderum and Tsyrlin (2002) to identify the relative health of the sampled stream. Signal scores were split into the following categories:

- Greater than 6 - Healthy habitat
- Between 5 and 6 - mild pollution
- Between 4 and 6 - moderate pollution
- Less than 4 - severe pollution

2.3.6 Fish and Macro Crustacea Communities

Fish and macro crustacea sampling was conducted using a site applicable subset of standardised quantitative and qualitative sampling methods listed in Table 2-2. Macro crustacea were identified using Jones and Morgan (1994).

These methods included:

- **Gill Netting** - Gill netting provides catch per unit effort (CPUE) measures and samples a wide range of fish species and sizes including some species and larger individuals that avoid electrofisher capture. The gill net set used consisted of two identical panel nets and three small meshed gill nets. Dimensions of the nets used are listed in Table 2-1. The use of gill nets was subject to availability at each site of larger and deeper water bodies and not all sites were suitable for gill netting and the full set of gill nets could not be employed at all gill netted sites. Gill nets were set

over the pre to post dusk period from approximately 1630h until 2030h each evening with nets monitored for entanglement of non-target species and cleared of catch from approximately 1830h onwards. In some instances, large catches extended the set period due to the time taken to clear nets (as late as 0130). On all occasions, the total actual set time was recorded and used to scale the effort employed for each catch;

- **Fyke Netting –** Fyke nets are essentially a hoop framed funnel trap which has barrier net wing extensions either side of the funnel entrance to guide fish into the trap. Two fyke nets, one large (1.2m diameter, 6mm mesh, with two in-line funnels entrances and 4m × 1.5m wings of the same mesh size) and one small (0.5m diameter, 4mm mesh, with two in-line funnels entrances and 4m × 1.5m wings of the same mesh size) were set overnight at stream sites with sufficiently sized water bodies that ensured the fyke nets could be expanded to full length and the fyke net funnels were more than half immersed in the water. The small fyke net was only employed at sites where the large one could not be. Sites AQ5, AQ11, AQ13 and AQ14 were not surveyed overnight by the fyke net (Plate 2-1);
- **Electrofishing** – backpack electrofishing is a method of sampling fish and larger crustaceans from shallow, wadable waters that is highly effective in small clear freshwater streams. The instrument used for this study was a Smith-Root Model LR-24 backpack mounted electrofisher. Due to the medium conductivities typical of streams in the CFP area, relatively low voltage of 320 V was sufficient for the instrument to operate effectively. The electrofishing method entailed wading upstream through the sampling site, and applying the anode in or near all safely accessible aquatic habitats. Sampling was conducted as a single pass at each site for a minimum of 10 minutes, restarting that 10 minute count each time a new species was collected. Sampling time duration ranged from 20 to 60 minutes between sites subject to the diversity of species present and the rate at which they were encountered. The instrument records electrical current "on-time" and this figure was recorded for each site sampled as a quantitative measure of sampling "effort". Due to logistical difficulties getting the electrofisher delivered to site, electrofishing was not conducted at sampling sites AQ1 – AQ4. Electrofishing was conducted at all other sites though effectiveness at each site was influences by water clarity and the availability of shallow wadable reaches (Plate 2-2);
- **Baited Box Traps** - Collapsible baited box traps (bait fish traps) were used at all sites other than those not surveyed overnight (AQ5, AQ11, AQ 13 and AQ14). Box traps were baited with fish oil flavoured cat biscuits and set across the range of aquatic habitats available at a site and left in overnight. These traps were effective in collecting small fishes and crustaceans (Plate 2-3);
- **Drag Seine Netting** – Drag seine netting is a method that is suitable for sampling fish in medium to large creeks and rivers. Seining is carried out in the shallows (water level up to chest height) on gentle sloping banks relatively free of submerged structures that might otherwise entangle and damage the net. Seining was done by pulling the seine net (10m x 2m; 6mm mesh) perpendicular to the bank until fully stretched, then dragging the net in a stretched arc towards the bank, corralling fish into the central cod-end of the net. Five replicate hauls were done where the extent of accessible habitat permitted. Water shallowness, steep bank profile, water current and bottom snags and rock obstacles prevented drag seining at all but two sites; and
- **Visual Observation/Spotlighting** – At sites where water clarity was good, some fish species could be observed and readily identified by qualified fish biologists on the survey team. The use of visual

observation is highly qualitative but can contribute additional species records that are not caught in other devices. At one site (AQ1), two less abundant species were recorded only by visual observation. Night time hand held spotlighting was also conducted at sites with good water clarity. Spotlighting effort was quantified by time but effectiveness may not have been consistent due to variable water clarity, edge cover and stream side accessibility.

Fish and macro crustacea samples obtained by each method were identified to species level and counted in the field and released where possible. Where species identification was not possible, representative specimens were preserved and shipped to Brisbane for formal identification by the Queensland Museum. Up to 20 randomly selected specimens of each species from each sampling device were measured for length frequency data in the following manner: Fish fork length to the nearest mm; prawn post-orbital carapace length, to the nearest 0.1mm; and crab carapace width to the nearest 0.1mm. Once twenty individuals had been measured, they were only counted for overall catch data.

Table 2-1: Dimensions of Gill Nets used for Fish Sampling

Net Type	Quantity	Mesh Size (mm stretched)	Length (m)	Depth	Area (m^2)
Panel	2	5m each of 75mm, 100mm and 125mm	15	2m	30
	1	50	10	2	20
Fine monofilament	1	35	10	2	20
	1	25	10	2	20

A list of the methods of assessment used at each site is contained within Table 2-2. Invertebrate sampling was undertaken at all sites except AQ5 and AQ14 due to a lack of aquatic habitat.

Plate 2-1: Fyke Net

Plate 2-2: Electrofishing at AQ13

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Plate 2-3: Bait Trap

Table 2-2: Suite of Fish and Macro crustacea sampling methods utilised at each site

Sampling Method	AQ1	AQ2	AQ3	AQ4	AQ5	AQ6	AQ7	AQ8	AQ9	AQ10	AQ11	AQ12	AQ13	AQ14
Electrofishing	x	x	x	x		x	x	x	x	x	x	x	x	
Panel Gill Nets						x	x		x	x		x		
Fine Monofilament Gill Nets	x					x	x	x	x	x		x		
Large Fyke Net	x			x		x	x	x	x	x		x		
Small Fyke Net		x	x											
Baited Box Traps	x	x	x	x		x	x	x	x	x		x		
Seine Netting	x										x			
Visual Observations	x	x	x	x	x	x	x			x	x	x		
Spotlighting			x	x		x	x			x		x		

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2.3.7 Turtle Communities

During the field based aquatic surveys, the available in-stream habitat including edge, bank, macrophyte beds and riparian habitat at each site was thoroughly inspected for the presence of turtles, their nests or pathways. Opportunistic sampling was undertaken and a number of individuals were caught, identified and measured. Turtles were identified through keys prepared by Cann (1998).

2.3.8 Artesian Spring Communities – Stygofauna

Stygofauna sampling was undertaken at 12 sites over the mine area during groundwater sampling. These samples were for the assessment of any Stygofauna that may exist within the subterranean aquifers. The samples were collected following best practice guidelines published by the Western Australian Environmental Protection Authority – *Guidance for the Assessment of Environmental Factors No. 54* (December 2003) and *No. 54a* (August 2007).

2.3.9 Other Aquatic Vertebrates

During the aquatic surveys, the available in-stream habitat including edge, bank, macrophyte beds and riparian habitat at each site was thoroughly inspected for the presence of other vertebrate fauna. Opportunistic sampling was undertaken and data collected. No dedicated trapping effort was undertaken at any of the sites for amphibians and/or avian fauna utilising these habitats.

2.3.10 Rapid Aquatic Ecology Habitat Assessment Sites

Visual observations of aquatic ecological habitats were undertaken as part of the water quality sampling using the AusRivas methodology to assess these habitats at waterway crossings across the CFP footprint. Characteristics noted on site including stream morphology, dominant substrate type, flow regimes, vegetation structure and stream cover. A total of 52 sites were observed during the field works (sites WQ1 to WQ52).

3 Mine

The mine site is located within the Belyando Catchment, a sub-catchment of the Burdekin River. The Belyando Catchment encompasses an area of approximately 73,000km^2 and is the largest sub-catchment of the Burdekin River Basin, comprising almost 60% of the total area. Some of the major tributaries of the Belyando River include Mistake, Sandy and Native Companion Creeks.

The Belyando Catchment within the mine area is described with reference to the topography, land use, location of the sites sampled, aquatic habitat, protected species, wetlands, remnant vegetation, aquatic flora (algae and macrophytes), macro invertebrates, macro crustacean and fish, turtles and other vertebrate communities observed within the catchment.

3.1 Catchment Description

3.1.1 Topography

The Belyando Catchment is predominately low relief floodplain with wide braided channels and alluvial plains. The Belyando River flows in a northerly direction and joins the Suttor River in its lower reaches. It is bounded by the Great Dividing Range in the west of Denham and Drummond Ranges to the east. General topography within the Belyando catchment differs from other sub-catchments in the Burdekin Basin, lacking high mountain conditions with a drier, typically semi-arid landscape (ANRA 2002).

The section of the catchment covering the mine is predominantly gently undulating plains with strongly undulating to hilly land in the north-east corner of the Exploration Permit Coal (EPC) 1040. Surface geology at the mine is dominated by unconsolidated Cainozoic sediments including sands, silts and clay, with thickness of up to 90m in the eastern and central sections. Soils at the mine are structureless and are mostly well drained permeable soils. The soils have low fertility and land use is limited to grazing and native pastures. Grazing lands are susceptible to surface soil degradation such as hard setting and crusting even when grazing intensity is low (see Geology, Soils, and Landforms Technical Report).

3.1.2 Land Use

The Belyando catchment is predominantly agricultural land with cattle grazing on natural vegetation. Cropping and/or horticulture are not undertaken within the EPC. The vegetation within the mine open cut footprint is generally characterised as being in a degraded condition having been cleared and blade ploughed for grazing land.

3.2 Aquatic Habitat

The streams within the catchment are generally small with widths of less than 5m except at major river systems and flood plain channels. These larger streams also have larger riparian areas which are up to 20m wide and sparsely populated with mature eucalypts. The riparian areas at all sites sampled were in good condition with few obvious signs of anthropogenic impact outside of clearing for agriculture.

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AQ14 was dry at the time of sampling and therefore, no aquatic habitat remained. It is anticipated that AQ14 would have the same diversity of AQ13 (See Section 4.3.8).

The site surveyed is a 6m wide sand bed dominated stream channel. Riparian overstorey vegetation is dominated by woodland consisting of isolated *Eucalyptus camaldulensis* with an ecotone comprised of *Callitris intratropica.* The channel is occluded with sand beds with a few emergent macrophyte species recorded on clayey channel margins. Dense stands of riparian grasses including *Heteropogon contortus* and *Themeda australis* were observed on the channel levees. No weeds were recorded and no significant erosion of channel banks was observed.

Habitat features present indicate that the seasonal aquatic habitats including shallow riffles, runs and pools, sand beds, undercut banks, root masses, leaf litter piles, clay banks and large woody debris. The substrate was dominated by coarse sand, though the channel margins were clayey. The hydrological regime of the site is highly seasonal. For example, only 40 days prior to the sampling, the stream had good flow. A detailed description of the sites including photos is shown in Appendix A.

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Plate 3-1: AQ14 - Malcolm Creek

3.2.1 Rapid Aquatic Habitat Assessment

Rapid habitat assessments were carried out at nine sites (WQ44 – WQ52) within the proposed mining lease boundary during the water quality monitoring program. The assessments identified riparian areas in the

catchment as generally consisting of a layer of mature Eucalypts including ironbark and other eucalypts species, one or two trees thick directly on the banks of the streams surrounded by a layer of saplings and shrubs before the landscape opens up into grazing paddocks. The majority of sites had highly disturbed vegetation and accordingly, trees less that 10m and grass were the dominant vegetation.

Aquatic habitat at the sites generally had low complexity and was predominantly pooled water with a sandy substrate. An assessment for each site has been provided in Appendix B.

3.3 Wetlands

Regional ecosystems (REs) were defined by Sattler and Williams (1999) as vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil. They have been mapped by Neldner *et al* (2005). AQ14 is not mapped as having any Wetland RE due to its small size. On the basis of site data, it has community affinities with RE10.3.13 (Fringing Wetland) which include *Melaleuca fluviatilis* and/or *M. leucadendra* and/or *Eucalyptus camaldulensis* open-woodland and woodland that occurs mostly as narrow bands along channels and on levees with sandy to clayey soils along larger watercourses. There are RE10.3.13 wetland areas within the mine site that are classified as GBR WMA and WPA which are also surrounded by a 100m WMA and WPA trigger areas. Under the VM Act, the site is listed as being of "Least Concern" and has a Biodiversity status listed as "Of Concern". However, as the site is extremely seasonal, it would not be classed as a wetland RE by Qld Wetland Inventory methods. Local wetland mapping is shown in Figure 3-1 and Figure 3-2.

3.4 Remnant Vegetation

AQ14 has a narrow corridor of remnant riparian vegetation surrounded by an extensively cleared landscape. There is some remnant vegetation although this has been subject to clearing in the past. The riparian zone would be no more than 5m wide. Regional ecosystem mapping is shown in Figure 3-3 and is discussed with respect to terrestrial environments within the Terrestrial Flora and Fauna Technical Reports.

3.5 Aquatic Flora

The site had no aquatic habitat at the time of sampling, although it is anticipated that at time when inundated, it would have similar flora to that contained in other upland streams such as AQ13 (see Section 4.4.6).

3.6 Aquatic Macro Invertebrate Communities

The site had no aquatic habitat at the time of sampling, although it is anticipated that at the time when inundated, it would have similar macro invertebrate communities as that observed at other upland streams such as AQ13 (see Section 4.4.7).

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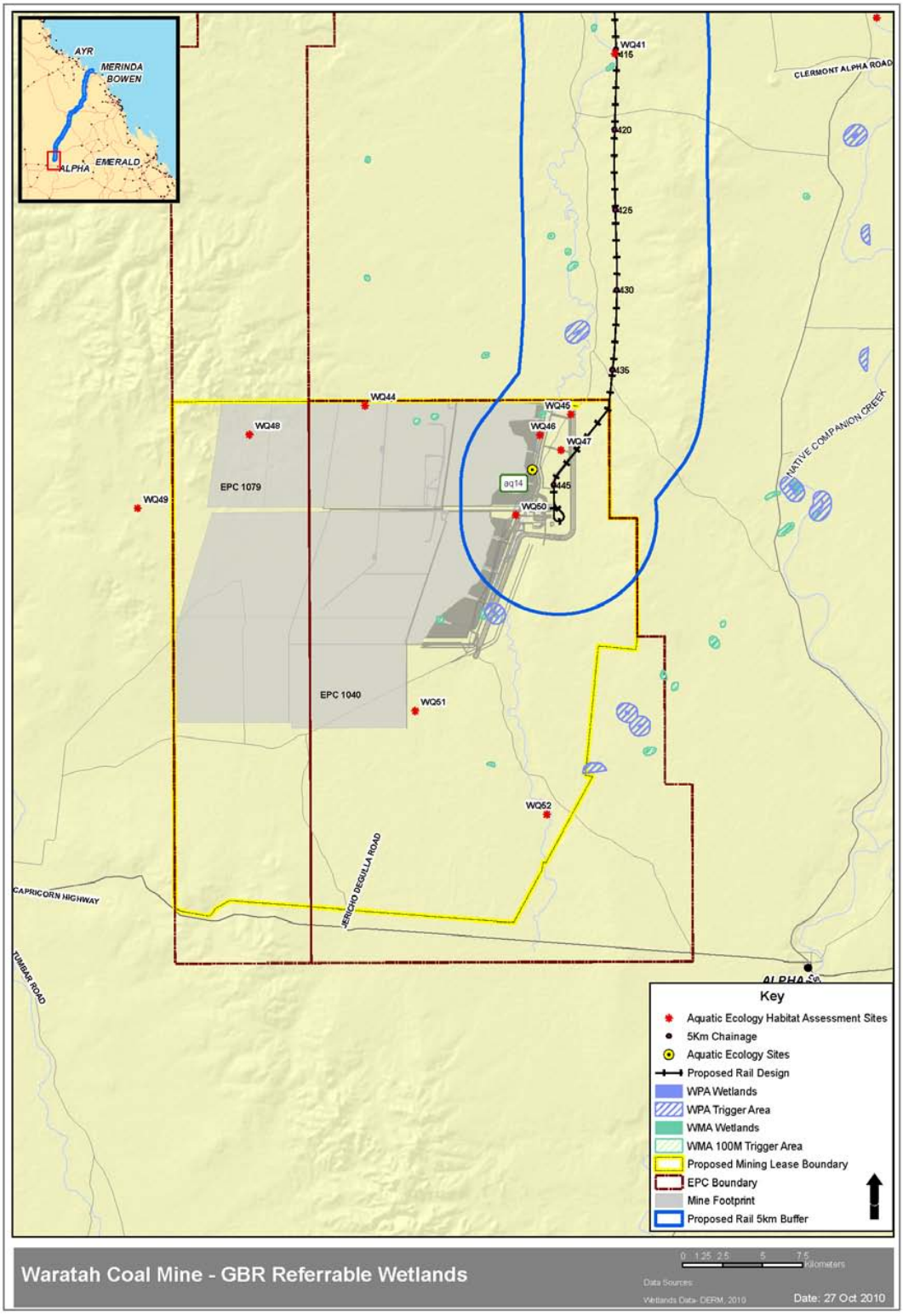

Figure 3-1: GBR Referrable Wetlands: Mine

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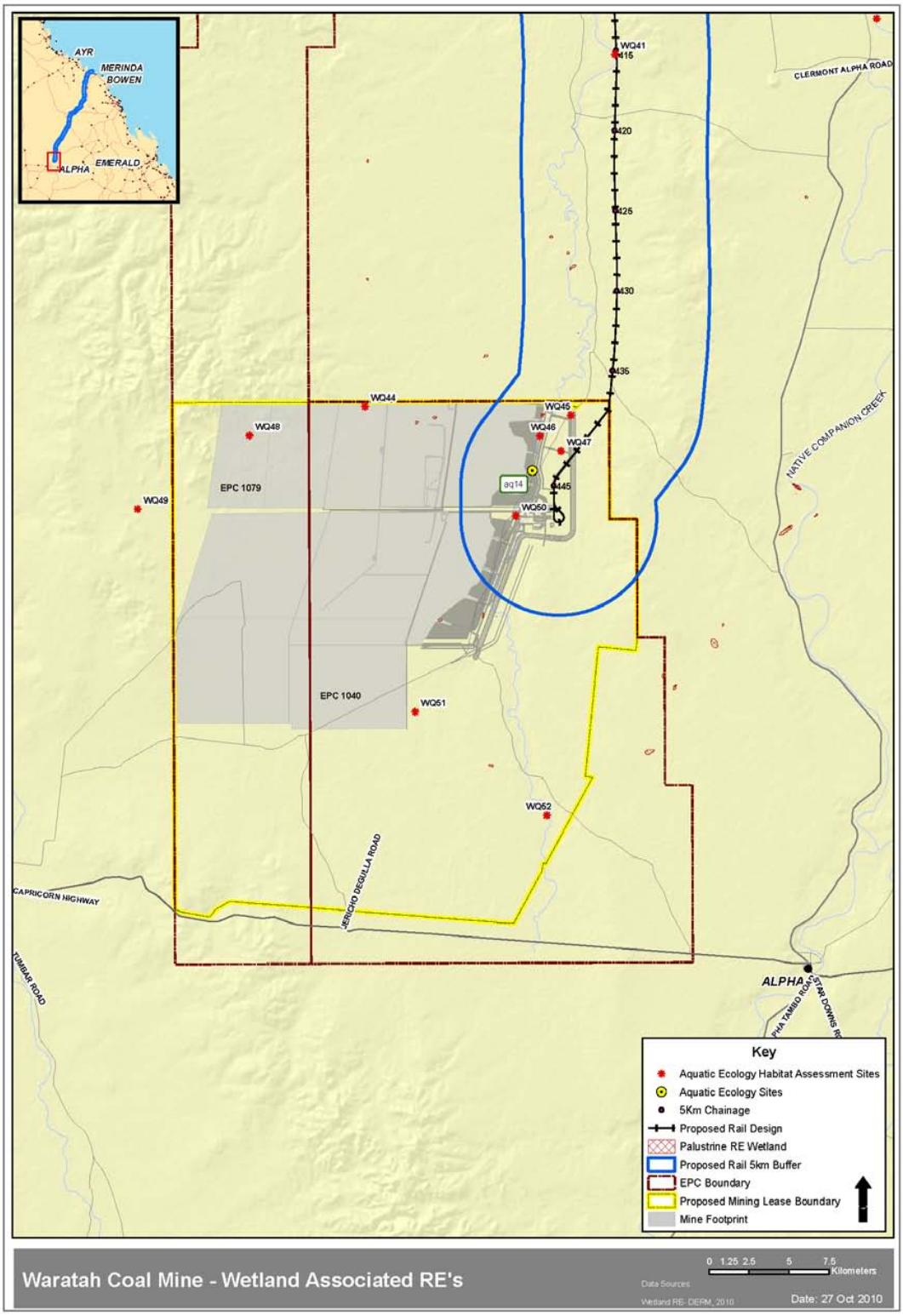

Figure 3-2: Wetland Associated RE: Mine

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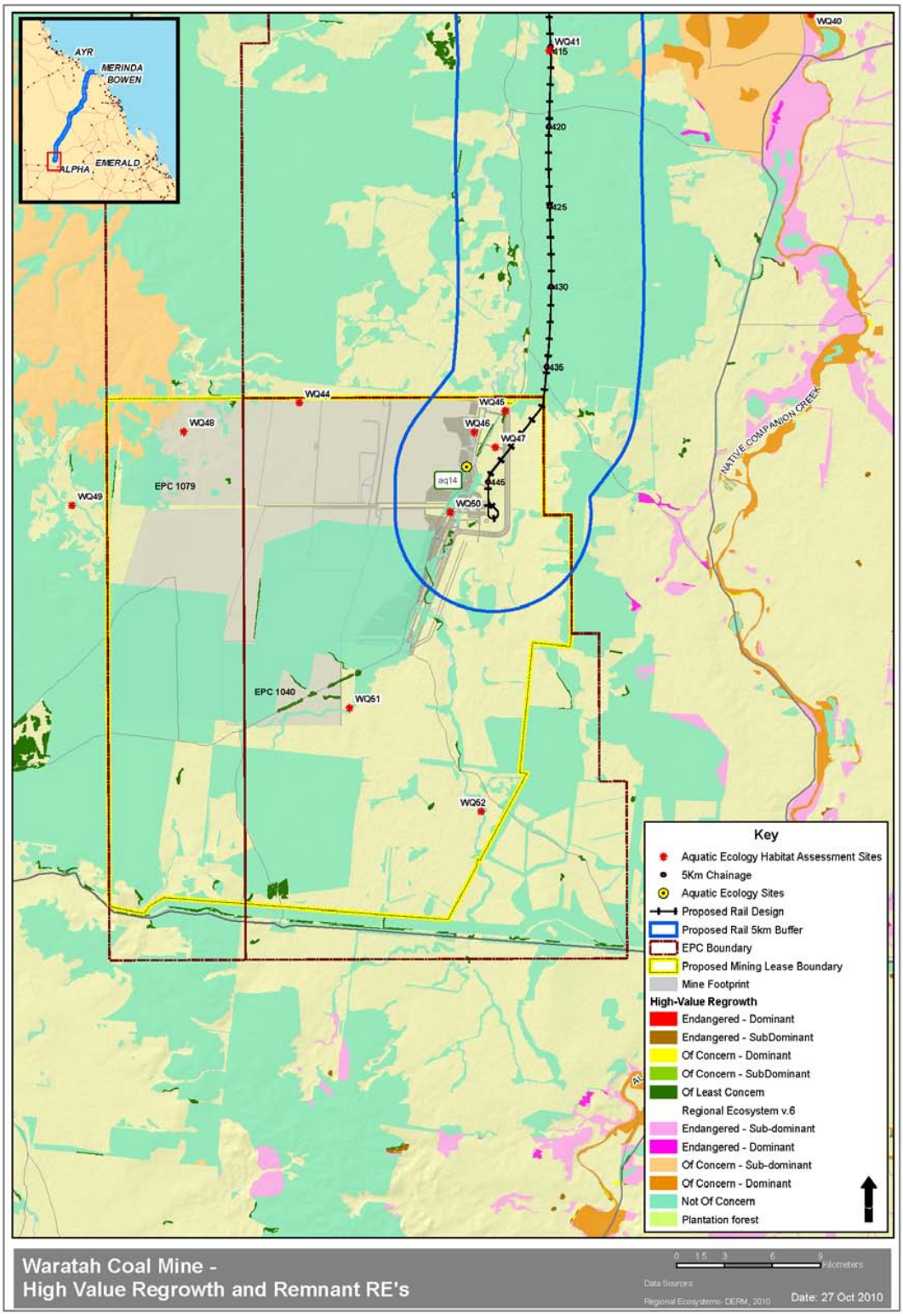

Figure 3-3: High Value Regrowth and Remnant RE

3.7 Macro Crustacea Communities

The site had no aquatic habitat at the time of sampling, although it is anticipated that at the time when inundated, it would have similar fish communities as that observed at other upland streams such as AQ13 (see Section 4.4.8).

3.8 Fish Communities

The site had no aquatic habitat at the time of sampling, although it is anticipated that at the time when inundated, it would have similar fish communities as that observed at other upland streams such as AQ13 (see Section 4.4.9).

3.9 Turtle Communities

No turtles were observed at the site.

3.10 Artesian Spring Communities – Stygofauna

No Stygofauna were observed in any of the twelve samples. Few of the groundwater environments in eastern Australia have been sampled for Stygofauna. It is likely that Stygofauna would be found within the Great Artesian Basin west of the project, although the CFP will not impact on these artesian waters.

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4 Rail Alignment

This section provides an overview of aquatic habitats within the Belyando, Suttor, Bowen and Lower Catchments which are traversed by the rail alignment. AQ14 which falls within the mine area is part of the Belyando catchment. The Don Catchment includes the section KP00 to KP20 of the rail alignment and the coal terminal and includes AQ1 and AQ2. Aquatic habitats for the Don catchment are described in Section 5.

The sample sites are split as follows:

- Lower Catchments – Sites AQ3, AQ4 and AQ5 (approximately KP20 to KP50);
- Bowen Catchment – Sites AQ6 and AQ7 (approximately KP50 to KP130);
- Suttor Catchment – Sites AQ8 and AQ9 (approximately KP130 to KP250); and
- Belyando Catchment – Sites AQ10, AQ11, AQ12 and AQ13 (AQ14 is also within the Belyando Catchment) (approximately KP250 to KP447).

Each catchment is described with reference to the topography, land use, location of the sites sampled, aquatic habitat, protected species, wetlands, remnant vegetation, aquatic flora (algae and macrophytes), macro invertebrates, macro crustacean, fish, turtles and other vertebrate communities observed within each catchment. A detailed description of the site including photos is shown in Appendix A.

Wetlands and REs are discussed with respect to each specific catchment. Importantly, the rail alignment intersects a number of important areas which include riparian vegetation that is protected under the EPBC Act, NC Act and VM Act. No listed fauna species were observed within the aquatic ecosystems intersected by the rail alignment.

A total of 33 macro invertebrate groups, seven macro crustacea and 24 fish species were observed across the rail alignment sites. For ease of reading, a list of all macro invertebrate, macro crustacea and fish species caught/observed within the rail alignment area are provided in Table 4-1, Table 4-2 and Table 4-3 respectively. An “x” indicates that the animal was observed during sampling. Macro invertebrates, macro crustacea and fish observed within each specific catchment are highlighted within the relevant section.

Table 4-1: Distribution of Macro Invertebrate Families across the Rail Alignment

Family	Species	Common Name	AQ3	AQ4	AQ6	AQ7	AQ8	AQ9	AQ10	AQ11	AQ12	AQ13
-	*Tricoptera*	Caddisfly larvae	x	x	x	x		x	x	x	x	x
-	*Ephemeroptera*	Mayfly nymphs	x	x	x	x	x	x	x	x	x	x
-	*Isopoda*	Sow bugs or isopods		x								
-	*Plecoptera*	Stonefly nymphs				x					x	x
Chironomidae	*Diptera*	Gnats or Midges	x	x	x	x	x	x	x	x	x	x
Corbiculidae	*Class: Bivalvia*	Orb-shell mussel								x	x	x
Culicidae	*Diptera*	Mosquiotes				x						
Dytiscidae	*Coleoptera*	Diving beetles	x	x	x	x	x		x		x	x
Gerridae	*Hemiptera*	Water striders or pond skaters	x		x	x						
Gyrinidae	*Coleoptera*	Whirligig larvae			x		x		x			
Haliplidae	*Coleoptera*	Crawling water beetles				x						
Helminthidae	*Coleoptera*	Riifle or Marl beetles	x		x	x	x	x	x	x	x	x
Helminthidae	*Coleoptera*	Helminthid larvae	x	x	x	x	x	x	x	x	x	x
Hydrometridae	*Hemiptera*	Water measurer						x		x		
Hydrophilidae	*Coleoptera*	Water scavenger beetles	x		x	x						x
Hygrobiidae	*Coleoptera*	Screech beetles	x		x		x		x	x	x	x
Lymnaeidae	*Class: Gastropoda*	Pond snails		x	x	x	x	x		x		
Nepidae	*Hemiptera*	Water scorpion		x								
Notonectidae	*Hemiptera*	Water boatman or backswimmers										x
Palaemonidae, Atyidae	*Decapoda*	Shrimp		x	x	x				x	x	x
Physidae	*Class: Gastropoda*	Bladder or tadpole snails			x			x		x		
Pisauridae	*Araneae*	Fisher spiders		x			x		x	x		
Planorbidae	*Class: Gastropoda*	Ramshorn snails	x		x	x						
Pleidae	*Hemiptera*	Pigmy backswimmer			x					x	x	x
Simuliidae	*Diptera*	Sand or Black flies			x	x	x	x			x	x
Simuliidae	*Diptera*	Sand or black fly pupa				x		x				
Sphaeriidae	*Class: Bivalvia*	Pea-shell mussel				x					x	
Sub Order: Anisoptera	*Odonata*	Dragonfly nymphs	x	x		x	x					x
Sub order: Cladocera	*Diplostraca*	Water fleas		x	x	x	x		x	x	x	x
Sub Order: Hydracarina	*Acarina*	Water mites		x				x	x	x		

Family	Species	Common Name	AQ3	AQ4	AQ6	AQ7	AQ8	AQ9	AQ10	AQ11	AQ12	AQ13
Sub Order: Zygoptera	*Odonata*	Damselfly nymphs				x						
Tipulidae	*Diptera*	Crane flies or daddy-long-legs				x						
Veliidae	*Hemiptera*	Water crickets					x					x
Total Number Species Recorded/Site			11	13	17	21	13	11	11	15	14	17

Table 4-2: Distribution of Macro Crustacea Species across the Rail Alignment

Family	Species	Common Name	AQ3	AQ4	AQ6	AQ7	AQ8	AQ9	AQ10	AQ11	AQ12	AQ13
Atyidae	*Caridina sp.*	Shrimp	x	x	x	x	x	x		x	x	
	Australatya striolata	Riffle Shrimp	x									
Palaemonidae	*Macrobrachium australiense*	Australian River Prawn	x	x	x	x	x	x	x	x	x	x
	Macrobrachium tolmerum	East Australian River Prawn	x									
Parastacidea	*Cherax drepressus*	Orange Fingered Yabby					x					
	Cherax quadricarinatus (T)	Redclaw			x			x	x		x	
Parathelphusidae	*Austrothelphusa transversa*	Freshwater Crab					x	x				x
Total Number Species Recorded / Site			4	2	3	2	4	4	2	2	3	2

Species type key: (T) Translocated to Basin or site

Table 4-3: Distribution of Fish Species across the Rail Alignment

Family	Species	Common Name	AQ3	AQ4	AQ5	AQ6	AQ7	AQ8	AQ9	AQ10	AQ11	AQ12	AQ13
Ambassidae	*Ambassis agassizii*	Agassiz's Glassfish	x	x		x	x			x	x	x	x
Anguillidae	*Anguilla reinhardtii* (M) (F)	Long-finned Eel	x	x		x	x						
Arridae	*Neoarius graeffei* (F)	Lesser salmon Catfish					x						
Atherinidae	*Craterocephalus stercusmuscarum*	Flyspecked Hardyhead				x							
Centropomidae	*Lates calcarifer* (M)(F)	Barramundi					x						
Cichlidae	*Oreochromis mossambica* (E)	Tilapia				x			x		x	x	
Clupeidae	*Nematalosa erebi*	Bony Bream				x	x		x	x	x	x	
Eleotrididae	*Mogurnda adspersa*	Southern Purple-Spotted Gudgeon		x		x	x	x	x		x	x	x
	Hypseleotris compressa	Empire Gudgeon	x										
	Hypseleotris klunzingeri	Western Carp Gudgeon	x			x					x		
Eleotrididae	*Oxyeleotris lineolata* (F) (T @ sites> AQ7)	Sleepy Cod				x	x	x	x	x	x	x	x
Gobiidae	*Redigobius bikolanus* (M)	Speckled Goby					x						
Megalopidae	*Megalops cyprinoides* (M)	Tarpon					x						
Melanotaeniidae	*Melanotaenia splendida splendida*	Eastern Rainbowfish	x	x	x	x	x	x	x	x	x	x	x
Percichthyidae	*Macquaria ambigua* (T)(F)	Yellow Belly										x	
Plotosidae	*Neosilurus hyrtlii*	Hyrtl's Tandan				x	x	x	x	x	x	x	x
	Neosilurus ater (F)	Black Catfish				x	x		x	x		x	
	Porochilus rendahli	Rendahl's Catfish							x	x			
Pseudomugilidae	*Pseudomugil gertrudae*	Pacific Blue-eye				x	x						
Terapontidae	*Leiopotherapon unicolor*	Spangled Perch	x	x	x	x	x	x	x	x	x	x	x
	Hephaestus fuliginosus (F)	Sooty Grunter					x						
	Scortum parviceps (R)	Smallhead Grunter						x	x	x	x	x	
	Amniataba percoides	Barred Grunter				x	x						
Toxotidae	*Toxotes chatareus* (F)	Seven spot Archerfish					x						
Total Number Species Recorded/Site			6	5	2	14	17	6	10	9	10	11	6

Species type key: (E) Exotic, (F) Important to Traditional /commercial/recreational fisheries, (M) Migratory species with amphidromous, catadromous or marine vagrant life history, (R) Restricted Burdekin River Basin Endemic, (T) Translocated to Basin or site

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4.1 Lowland Catchments

The lowland catchments include three sites, these being all on the northern side of the Clarke Range. The streams sampled were the Elliot River (AQ3), Bogie River (AQ4) and Sandy Creek (AQ5). A suite of sampling was undertaken at both AQ3 and AQ4. There was insufficient aquatic habitat present at AQ5 to carry out a full suite of sampling.

4.1.1 Topography

Elevations in this area range from around 100m Australian Height Datum (AHD) to over 1,000m AHD; however the rail alignment reaches maximum elevations of about 200m. The topography includes the granite hills of Mt Abbot (1056m), Mt Aberdeen (910m), Mount MacKenzie (514m), Pine Hill (624m), and Highlanders Bonnet (487m). The geology of the Clarke Range is comprised of granite, rhyolite, diorite and other igneous rocks ranging in origin from Carboniferous to Early Permian age (354 to 270 million years). The foothills of the range are generally low undulations before rising to very rugged and broken country.

The major structural faults and shears that occur in close proximity to and/or intersect the rail alignment include those in the Bulgonunna Volcanics region where the north-west trending fault sets dominate including the Glenore Shear zone. Further to the south-east of the rail alignment, the Millaroo Fault Zone extends through the Lizzie Creek Volcanics. It is highly unlike that fossil will be found in this area. There are numerous other faults and structures exploited by dykes that mirror the north-west trend of these zones. The combination of localised steep topography and greater prevalence of fault and fracture systems indicates a higher potential for landslip in these areas adjacent to the rail alignment. The presence of dykes indicates the potential for bars of hard ground requiring rock breaking or explosives in areas otherwise amenable to normal excavation/construction equipment.

4.1.2 Land Use

Almost 100% of the land within the lower catchments is used for grazing land (production from relatively natural environments). Mount Aberdeen National Park is located approximately 5km east of the rail alignment near KP35 to KP45. The Aberdeen Nature Refuge is set on two parcels of land. Both of these conservation areas are considered to be well outside the project study area. The Mount Pleasant Nature Refuge is present and conjoins to the southern extent of the Mt Aberdeen Nature Refuge, extending from KP45 to KP55. There are also multiple parcels of land predominantly classified as State Forest; none of which are considered to encroach upon the rail alignment. A detailed description of land uses in the region can be found in the Land Use and Planning Technical Chapter.

4.1.3 Aquatic Habitat

AQ3 and AQ4 are sand bed dominated broad river channel incised within broad shallow valleys in an undulating low hills landscape. In contrast, AQ5 is a sand to cobble bedded creek channel within a narrow valley in an undulating low hills landscape. The majority of the substrate is coarse granite derived sands. Active flow channels incised through sand beds and surface flow was lacking in some sand bed reaches,

typical of seasonal variations and reduction in flow post wet season, although the Bogie River has a braided, coalesce at bed rock exposure locations to form riffles and runs.

Alluvial terraces and benches are present across the Lower Catchment area. Where the canopy is undisturbed, ground cover is sparse and is dominated by leaf litter. Cattle have open access to streams and use the streams for water external to the troughs set up by the land owners. Stream flow at AQ3 is seasonal with only widely separated scour pools likely to be perennial in wetter than average years.

The riparian vegetation consists of open forest dominated by tall *Melaleuca fluviatilis* and *M. leucadendra* overstorey with co-dominant emergent *Eucalyptus raveretiana* (protected under the EPBC Act and NC Act) and co-dominant *Casuarina cunninghamiana*. Scattered *Corymbia tessellaris* and *Melaleuca dealbata* are also present on the channel margins. The channel margin mid storey includes *Lopostemon grandiflorus, Melaleuca bracteata*, *M. viminalis* and *Pandanus spiralis*. At AQ4 and AQ5, *Melaleuca viminalis* formed a near contiguous riparian vegetation corridor that extended across the river channel in areas of bed rock exposure. Other isolated canopy species present include *Nauclea orientalis* and *Pleiogynium timorense.*

Away from the channel margins, a semi evergreen vine thicket and semi-deciduous notophyll rainforest community are present on alluvial terraces. Species include *Alphitonia excelsa, Canarium australianum, Castanospermum australe, Diospyros humilis, Dysoxylum oppositifolium, Exocarpos latifolius, Ficus opposita, F. racemosa, Macaranga involucrate, Mallotus philippensis, Melia azedarach, Nauclea orientalis, Planchonia careya, Pleiogynium timorense, Sterculia quadrifida* and *Terminalia seriocarpa.* Exotic *Mangifera indica* and *Tamarindus indica* (E) are scattered through the canopy. Isolated vine towers of *Cryptostegia grandiflora* are also present, while small understorey patches of *Lantana camara* were present at AQ5. The alluvial terraces at AQ3 and AQ4 are dominated by stands of *Hyptis suaveolens*. Cattle and pig disturbance of riparian zone was apparent but does not appear to major. A *Sus scrofa* (wild pig) was observed at AQ4 while undertaking sampling.

The aquatic habitats present at the three sites include broad sand bedded stream channel with shallow flowing surface water runs, riffles and pools (~0.4m max, most <0.2m) formed against bank scours though some deeper pools backwater pools (~1.5m max) that are likely to be perennial aquatic refugia. The majority of substrate is coarse granite derived sands, though solid bed rock exposures are also present in some reaches. Natural features of the stream include bed rock exposures and associated cobble bedded riffle zones, root masses, undercut banks, snags, large woody debris, litter piles and isolated submerged macrophyte beds in off channel backwaters. Flow exposed to bed rock formed extremely shallow riffles and runs. Water clarity was good to high though algal and bacterial surface scums were present at AQ5. At AQ3, a bed rock exposed reach 1km downstream of the site is apparently semi-perennial (*pers comm.* Landholder), and aquatic biota recorded at this site would indicate the presence of perennial aquatic refugia within the river system that would have high ecological values.

Rapid Aquatic Habitat Assessment

Rapid habitat assessments were carried out at four sites (WQ8 – WQ11) within the Lowland Catchments during the water quality monitoring program. These were generally small, shallow streams (<10m in width) with sandy soils and sediments and sparse riparian areas dominated by wetland species such as

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Melaleucas. No sites were flooded during the sampling events; however all showed signs of recent flooding. All three sites displayed low to medium vegetation complexity and contained running water with some riffles. The substrates were sandy with some pebbles and gravel.

Plate 4-1: AQ3 - A tributary of the Elliot River

4.1.4 Protected Species

Desktop investigations suggested that *Apus pacificus* (EPBC Act - Migratory and Marine), *Crocodylus porosus* (EPBC Act and NC Act - Vulnerable), *Ephippiorhynchus asiaticus* (NC Act - Near Threatened), *Eucalyptus raveretiana* (EPBC Act and NC Act Vulnerable), *Haliaeetus leucogaster* (EPBC Act - Migratory and Marine), *Hirundapus caudacutus* (EPBC Act - Migratory and Marine), *Nettapus coromandelianus* (NC Act - Near Threatened) and *Tadorna radja* ((NC Act - Near Threatened) occur within the Lower Catchments.

Site surveys identified extensive stands of the vulnerable species *Eucalyptus raveretiana* at AQ3 and AQ4. If this species is found within the rail footprint measures should be put in place to minimise or avoid impacts during construction and operations.

4.1.5 Wetland

AQ3 was observed to have RE11.3.25 (Riverine wetland - *Eucalyptus tereticornis* or *E. Camuldalensis* woodland fringing drainage lines). At AQ3 and upstream of the site where the rail alignment crosses the Elliot River, is a GBR WMA, which is also surrounded by a 100m WMA trigger area. Under the VM Act, the site is listed as being of **"**Least Concern" and has a Biodiversity status listed as "Of Concern".

Both AQ4 and AQ5 exhibit RE11.3.25b (Riverine wetland or fringing riverine wetland) which is a variation of RE11.3.25 containing *Melaleuca fluviatilis* and/or *M. Leucadendra* and *Nauclea orientalis* forming an open forest. Riverine Wetland RE11.3.25b at AQ4 and AQ5 are GBR WMAs, these being surrounded by a 100m WMA trigger area. Under the VM Act, the two sites are listed as being of "Least Concern" and have a Biodiversity status listed as "Of Concern". Local wetland mapping is shown in Figure 4-1 and Figure 4-2.

4.1.6 Remnant Vegetation

There is a diversity of remnant vegetation within the Lower Catchments, the majority being "Of Concern" subdominant RE.

At AQ3, RE11.3.25 (Riverine Wetland) is 184m wide and forms a contiguous remnant ecotonal woodland extends from both high banks beyond the break in slope to the stream channel. Where the rail alignment crosses the Elliot River, RE11.3.25 is 150m wide although the ecotonal woodland has been cleared on the eastern side of the river channel. Beyond the western bank, contiguous remnant vegetation extends beyond the high banks of both the main and adjoining tributary channel and includes a sub-dominant "Of Concern" RE. Importantly, the rainforest community present at AQ3 on the alluvial benches and terraces adjoining the stream channel in combination with *Eucalyptus raveretiana* emergents is closely aligned with an endangered RE11.3.11 (Semi-evergreen vine thicket on alluvial plains) rather than the mapped RE11.3.25.

At both AQ4 and AQ5, RE11.3.25b (Riverine Wetland) is present. The riparian vegetation is up to 220m and 85m wide at AQ4 and AQ5 respectively and beyond the ecotone boundary of the northern bank. Past this, the land has been historically cleared and is now open regrowth woodland. Beyond the southern banks, the contiguous remnant ecotonal woodland including a sub-dominant "Of Concern" RE extends beyond the high bank of the creek channel. RE mapping is shown in Figure 4-3.

4.1.7 Aquatic Flora

Aquatic macrophytes were very sparse due to the active nature of the channel bed sands. Two submerged species were recorded from an off channel backwater, these being *Hydrilla verticillata* and *Ottelia alismoides*. Sunlit shallow runs at the sample sites also contained some filamentous algae (*Spirogyra sp*) growth on sand beds although these were also rare.

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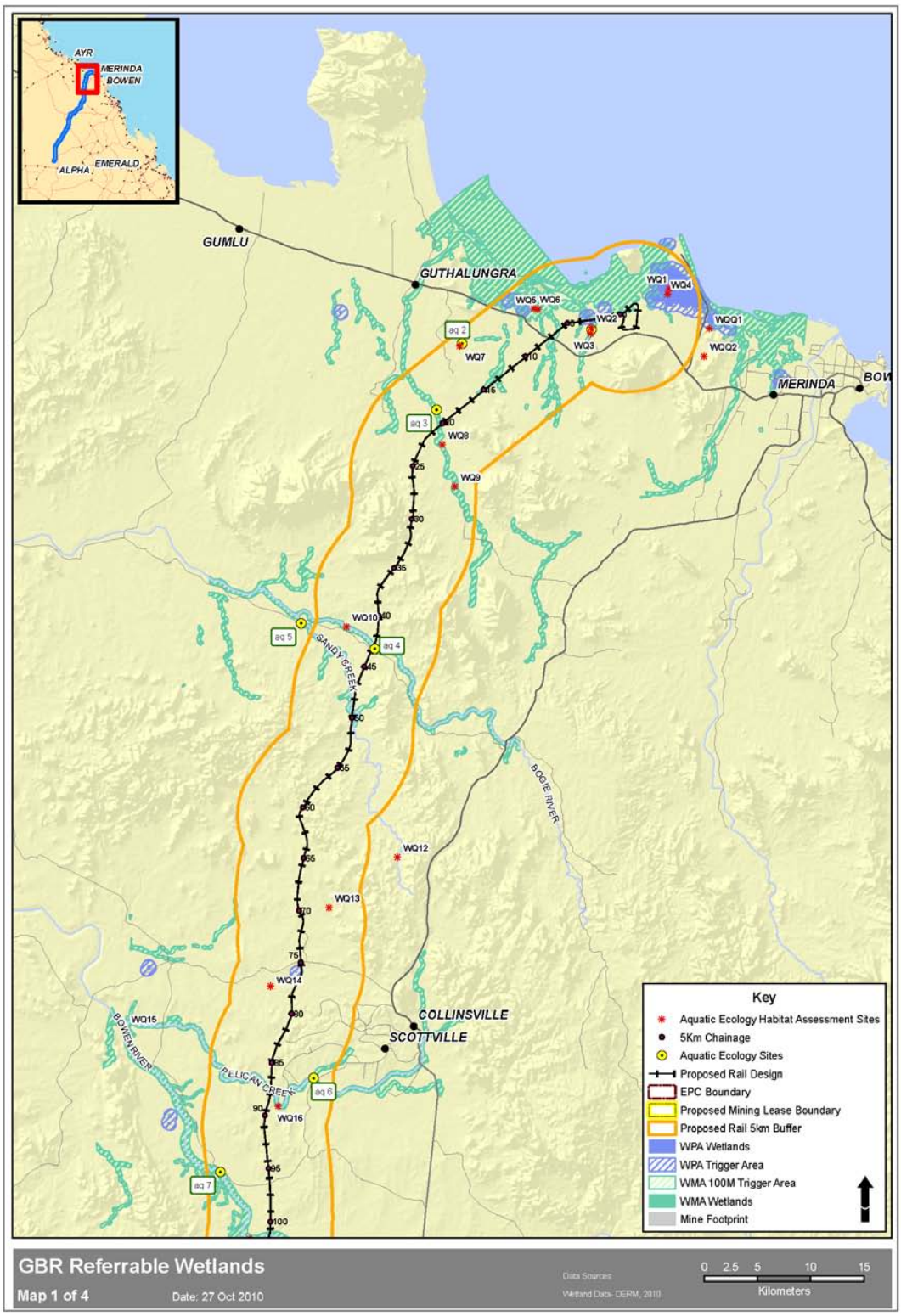

Figure 4-1: GBR Referrable Wetlands: KP00 to KP95

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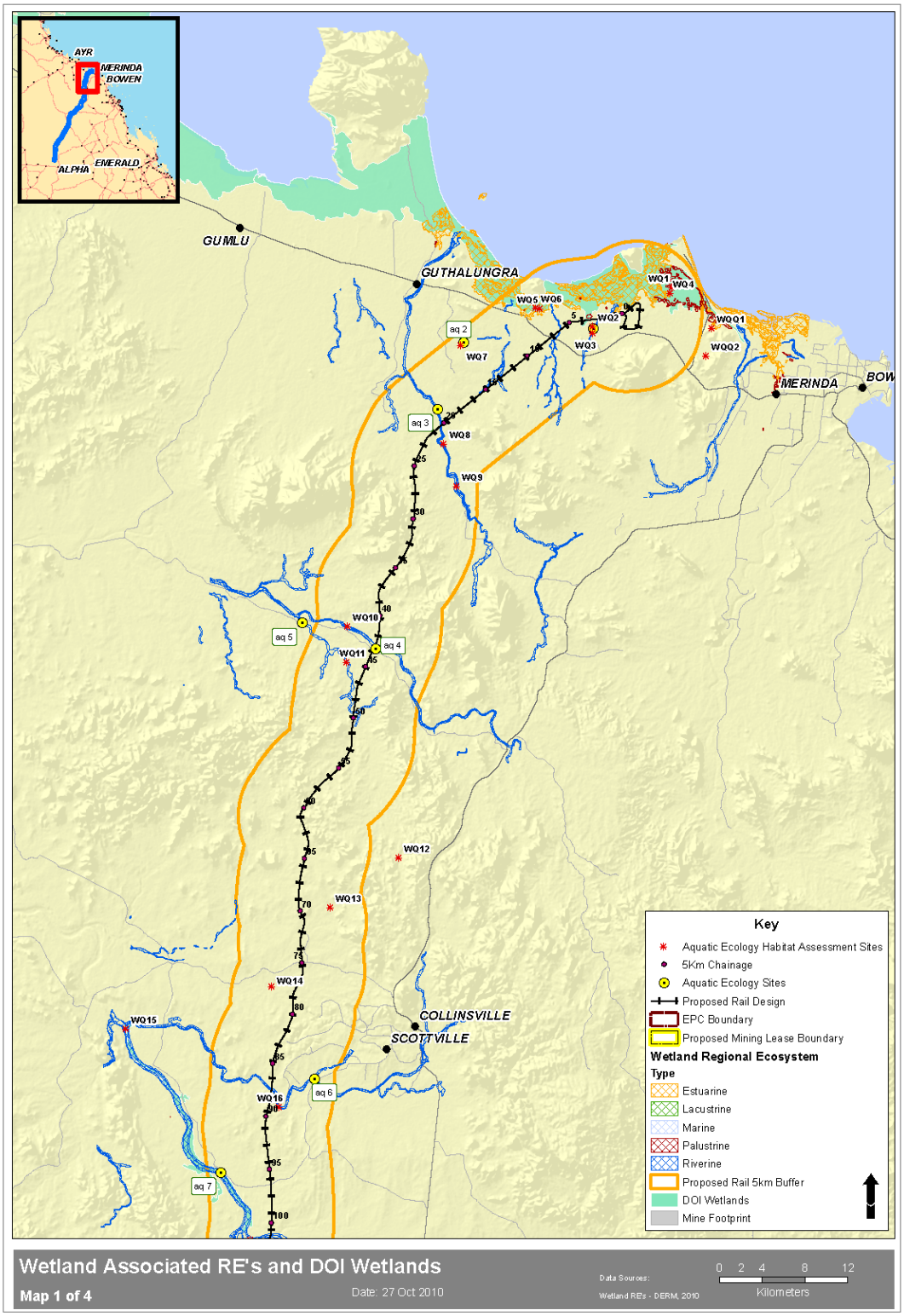

Figure 4-2: Wetland Associated RE: KP00 to KP95

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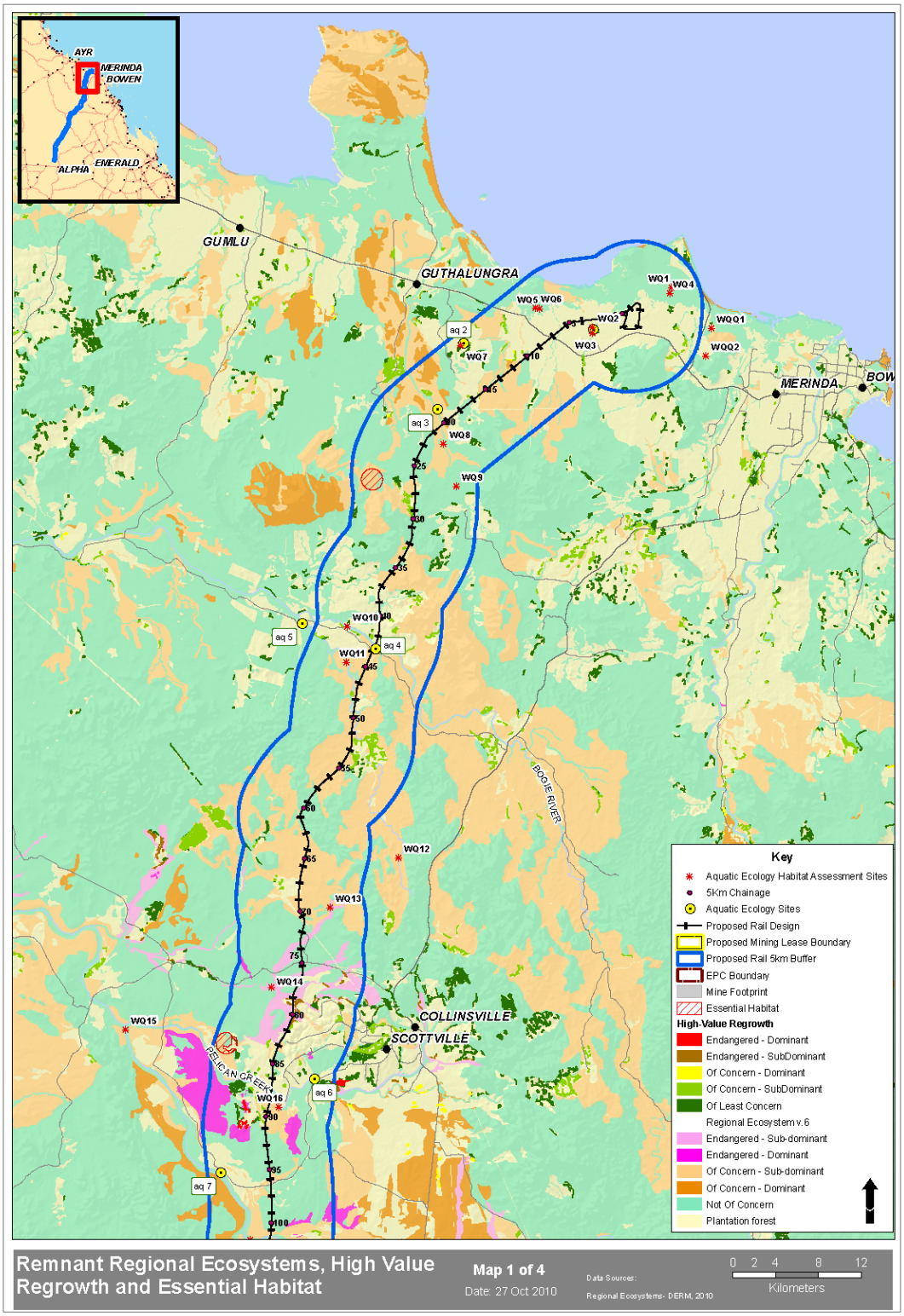

Figure 4-3: High Value Regrowth and Remnant RE: KP00 to KP95

4.1.8 Aquatic Macro Invertebrate Communities

A total of 20 families of aquatic macro invertebrates were captured across the two sites sampled within the Lower Catchment area of the CFP (11 families at AQ3 and 15 families at AQ4) (Table 4-4). There were high abundances of Chironomidae and Ephemeroptera at both sites. These high abundances, particularly of Ephemeroptera are likely to be as a result of the clean flowing water of the streams, particularly as they are filtered by sand.

Table 4-4: Distribution of Macro Invertebrates Species across the Lowland Streams Sampling Sites

Family	Order	Common Name	AQ3	AQ4
Palaemonidae, Atyidae	Decapoda	Shrimp	0	8
Chironomidae	Diptera	Gnats or Midges	210+	151+
Sub Order: Anisoptera	Odonata	Dragonfly nymphs	1	2
Pisauridae	Araneae	Fisher spiders	0	2
-	Tricoptera	Caddisfly larvae	3	18
-	Ephemeroptera	Mayfly nymphs	79	92+
Helminthidae	Coleoptera	Riifle or Marl beetles	1	0
Lymnaeidae	Class: Gastropoda	Pond snails	0	1
Planorbidae	Class: Gastropoda	Ramshorn snails	2	0
Sub Order: Hydracarina	Acarina	Water mites	0	1
Hydrophilidae	Coleoptera	Water scavenger beetles	1	0
Hygrobiidae	Coleoptera	Screech beetles	3	0
Dytiscidae	Coleoptera	Diving beetles	2	14
Helminthidae	Coleoptera	Helminthid larvae	6	41
Gerridae	Hemiptera	Water striders or pond skaters	2	0
Nepidae	Hemiptera	Water scorpion	0	1
Bufo marinus	-	Cane Toad larvae	0	6
-	Isopoda	Sow bugs or isopods	0	3
Sub order: Cladocera	Diplostraca	Water fleas	0	1
Palaemonidae, Atyidae	Decapoda	Shrimp	0	8

SIGNAL calculations carried out for AQ3 and AQ4 gave scores of 5.3 and 4.4 respectively. This indicates mild pollution at AQ3 and moderate pollution at AQ4. These scores likely reflect the surrounding land uses at each of the sites with AQ3 being surrounded by relatively continuous stands of remnant woodland while land uses around AQ4 are predominantly agricultural outside of the immediate riparian area.

4.1.9 Macro Crustacea Communities

The macro crustacea fauna observed included four species (AQ3 – two species and AQ4 only two species). The diversity at AQ3 included a freshwater prawn species dependent on access to estuarine habitats and surprisingly, a shrimp species associated with flowing habitats. The low diversity at AQ4 may be as a result of the high flows that have occurred in recent months that resulted in many of the species being flushed out of the system. The diversity of macro crustacea observed within the Lower Catchments is listed in Table 4-5.

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Table 4-5: Distribution of Macro Crustacea Species across the Lower Catchment Sampling Sites

Family	Species	Common Name	AQ3	AQ4	AQ5
Atyidae	*Caridina sp.*	Shrimp	x	x	
	Australatya striolata	Riffle Shrimp	x		
Palaemonidae	*Macrobrachium australiense*	Australian River Prawn	x	x	
	Macrobrachium tolmerum	East Australian River Prawn	x		
Total Number Species Recorded / Site			4	2	0

Species type key: (T) Translocated to Basin or site

4.1.10 Fish Communities

The Lower Catchments recorded the low species richness in their fish community (seven species) (AQ3 – six species; AQ4 – five species and AQ5 – two species). The species comprised a ubiquitous seasonal stream species and one fishery associated catadromous fish species (*Anguilla reinhardtii*) dependent on migratory linkages to the ocean. No exotic, translocated, restricted or rare species were recorded. Only visual observation was used to record fish species at AQ5 and only two ubiquitous seasonal stream species were recorded. At least as many fish species as recorded at AQ4 would be expected to occur at AQ5 given its proximity and possibly more given the availability of deeper more complex habitat types.

The most abundance species observed at AQ3 was *Hypseleotris compressa*, 44 in bait traps and 111 in the fyke net (minimum length 29mm; maximum length 59mm, mean length 46mm). No individuals of this species were observed at AQ4. The most abundance species observed at AQ4 were *Melanotaenia splendida* and *Ambassis agrammus*; however only 20 individuals and eight individuals respectively were observed at AQ3. A total of 166 *Melanotaenia splendida splendida* individuals were caught, 13 in bait traps and 153 in the fyke net (minimum length 26mm; maximum length 70mm, mean length 41mm), while a total of 157 *Ambassis agrammus* individuals were caught, 139 in bait traps and only 18 in the fyke net (minimum length 24mm; maximum length 44mm, mean length 31mm). There also was significant *Anguilla reinhardtii* at AQ3 and only one larger individual at AQ4. There was a few smaller and two larger individuals, but overall, there was a large number of about 100mm, which would suggest they were all from the same cohort. Other abundance species included *Leiopotherapon unicolor*.

Anguilla reinhardtii was observed to be the longest fish species caught at both sites (313mm and 492mm at AQ3 and AQ4 respectively). All other fishes were less than 100mm. The diversity of fishes observed within the Lower Catchments is listed in Table 4-6.

Table 4-6: Distribution of Fish Species across the Lower Catchment Sampling Sites

Family	Species	Common Name	AQ3	AQ4	AQ5
Ambassidae	*Ambassis agassizii*	Agassiz's Glassfish	x	x	
Anguillidae	*Anguilla reinhardtii* (M) (F)	Long-finned Eel	x	x	
Eleotrididae	*Mogurnda adspersa*	Southern Purple-Spotted Gudgeon		x	
	Hypseleotris compressa	Empire Gudgeon	x		
	Hypseleotris klunzingeri	Western Carp Gudgeon	x		
Melanotaeniidae	*Melanotaenia splendida splendida*	Eastern Rainbowfish	x	x	x
Terapontidae	*Leiopotherapon unicolor*	Seven spot Archerfish	x	x	x
Total Number Species Recorded / Site			6	5	2

Species type key: (F) Important to Traditional /commercial/recreational fisheries, (M) Migratory species with amphidromous, catadromous or marine vagrant life history,

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4.1.11 Turtle Communities

A juvenile *Elseya latisternum* was observed during spotlighting at AQ3 (Plate 4-2).

Plate 4-2: *Elseya latisternum*

4.1.12 Other Vertebrates Communities

A number of other vertebrate species were observed within or around the sites. Evening spotlighting recorded two native frog species *Limnodynastes ornatus* and *Litoria rubella*. *Litoria* spp. tadpoles were observed to be common at the sites. Numerous *Bufo marinus* were also observed, as well as many dead specimens, which had been predated upon in a manner indicative of both *Hydromys chysogaster* and avian fauna. A feral *Pavo cristatus* population was observed to inhabit riparian forest at AQ3.

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4.2 Bowen River

The Bowen River Catchment includes two sites, these being Pelican Creek (AQ6) and the Bowen River (AQ7). Both streams are on the southern side of the Clarke Range and northern side of the Leichhardt Range.

4.2.1 Topography

Topography varies over the catchment and is characterised by low relief floodplains with minor undulating slopes. The Bowen River is cut into the Lizzie Creek Volcanics including basalts, andesites, tuffs and minor acid volcanics and further to the south the Blackwater and Back Creeks Group comprising sedimentary rocks including sandstones, siltstones, shales and coal. Dominant soils in the river valley include dark clays at depth with sandy loam overlying these clays.

4.2.2 Land use

The dominant land use within both catchments is agriculture (grazing) in relatively natural environments such as semi cleared paddocks. In the Bowen Catchment, an operating coal mine is located adjacent to the rail alignment (near Collinsville). A detailed description of land uses in the region can be found in the Land Use and Planning Technical Chapter.

Plate 4-3: AQ7 - Bowen River

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4.2.3 Aquatic Habitat

The two sites within the Bowen River catchment were distinctly different.

AQ7 was formed on a substrate that varies from clayey loam margins, to coarse sands and outcropping bed rock within a narrower base flow channel. The narrow base flow has vegetated margins within a shallow broad valley in an undulating low hills landscape. The flow regime is semi-perennial, and larger pools are perennial and important drought refugia. Importantly, comments suggested that some reach sections are groundwater fed (*pers comm*., landholder) which would indicate that the pools sampled are perennial and this would provide important aquatic refugia. The flood plain of the stream was dry, but when flowing, it would form a broad (~200m) stream with open sand, gravel to cobble bedded anastomosing distributary and flood runner channels.

In contrast, the Bowen Rover site lies within a broad (~300m) river channel incised into the alluvial plain to volcanic bedrock substrate. The channel base contains coarse sand bars, outcropping bedrock, clayey channel margins, loamy channel benches..The northern bank bench cliff is approximately 15m high to the alluvial levee. The substrate varies through the site reach from coarse sands, though gravel and cobble to solid bed rock exposures and associated cobble bedded riffle zones are present in some reaches. Deeper pools within this reach of the Bowen River are important aquatic refugia for obligate freshwater biota. There are a number of important matters that need to be considered when assessing the Bowen River, including:

- The *Directory Of Important Wetlands in Australia* (DIWA) site QLD198 Birralee-Pelican Creek Aggregation is located 3km downstream of the rail crossing; and
- The area has a history of camping and other recreational uses along the whole of the river; and

The riparian zones and channel margins are dominated by an open riparian forest of *Melaleuca fluviatilis* and *M. leucadendra* overstorey with co-dominant emergent *Corymbia tessellaris*, *C. clarksoniana*, *Eucalyptus raveretiana* and *E. tereticornis*. Other native channel margin species include *Lopostemon grandiflorus* and *Melaleuca viminalis* while other overstorey species present on loam benches include*, Casuarina cunninghamiana*, *Ficus opposita*, *F. racemosa*, *Melaleuca bracteata* and *Nauclea orientalis.* The mid storey is dominated by younger stands of canopy species. The semi-contiguous riparian vegetation at AQ7 provides a regional faunal corridor and provides important nesting and feeding resources for surrounding terrestrial fauna including acting as a drought refuge (Blackman *et al* 1999).

The weediness of the riparian vegetation at AQ6 is indicative of high levels of past disturbance. The mid storey strata includes a co-dominant weed community including *Cascabella thevetia*, *Parkinsonia aculeate*, *Ricinus communis* and *Ziziphus mauritiana*. Vine towers of *Cryptostegia grandiflora* are also conspicuous. Ground cover is also dominated by exotic species including *Alternanthera pungens* and *Panicum maximum*. The riparian vegetation although weedy includes a rare species, retains vigorous recruitment of native species and provides contiguous complex habitat valuable to fauna as feeding and nesting resources and as a movement corridor. Current cattle disturbance of riparian zone apparent but not major.

The ground cover at AQ7 is composed almost entirely of lawn of native Couch *Cynodon dactylon*. No weeds were observed at AQ7 although *Grewia asiatica, Parkinsonia aculeate* and *Salanum torvum* have previously been reported (Blackman *et al* 1999). There are no fences or barriers blocking cattle access at both AQ6 and AQ7 but disturbance appears minor.

The aquatic habitat at AQ6 included shallow runs (~0.6m), small scour and large channel hosted pools (~1.8m depth max), rocky riffles, emergent macrophyte stands, submerged macrophyte beds, root masses, undercut banks, leaf litter piles and large woody debris. Sunlit reaches have sparse emergent macrophyte communities and a well developed and diverse submerged macrophyte community. The water clarity was medium though opaque with a bluish tinge likely due to suspended colloids.

In contrast, there was a diverse range of aquatic habitats present at AQ7 including rapids, races, runs and broad (~60m wide ~4m+ deep) pools, root masses, undercut banks, rock cobble, boulders, large woody debris and back water pools isolated from the main channel containing sparse charophyte *Chara* sp. algae beds. The water clarity was excellent.

Rapid Aquatic Habitat Assessment

Rapid habitat assessments were carried out at seven sites (WQ12 – WQ18) within the Bowen River Catchment during the water quality monitoring program. Riparian vegetation density was varied across the sites. Most sites had larger tree species, although WQ13, WQ14 and WQ18 had very limited large trees, and relatively undisturbed vegetation along the banks. WQ18 also had several trees within the stream itself. WQ14 was heavily cleared with grasses the only dominant vegetation. Most sites had limited to moderate shading depending on stream width.

All sites contained running water with some pooling and low complexity aquatic habitat. The substrate at all of the sites was course consisting predominantly of sands and pebbles.

4.2.4 Protected Species

Desktop investigations suggested that *Apus pacificus* (EPBC Act - Migratory and Marine), *Crocodylus porosus* (EPBC Act and NC Act - Vulnerable), *Ephippiorhynchus asiaticus* (NC Act - Near Threatened), *Eucalyptus raveretiana* (EPBC Act and NC Act Vulnerable), *Haliaeetus leucogaster* (EPBC Act - Migratory and Marine), *Hirundapus caudacutus* (EPBC Act - Migratory and Marine), *Nettapus coromandelianus* (NC Act - Near Threatened) and *Tadorna radja* ((NC Act - Near Threatened) occur within the Bowen Catchment and Lower Catchments.

At AQ7, there were extensive stands of *Eucalyptus raveretiana*. If similar stands are located within the construction footprint measures should be put in place to avoid or minimise potential impacts.

4.2.5 Wetland

Both AQ6 and AQ7 exhibit RE11.3.25b (Riverine wetland or fringing riverine wetland). The dominant species making up this RE include *Melaleuca fluviatilis* and/or *M. Leucadendra* and *Nauclea orientalis* forming an open forest. Riverine Wetland RE11.3.25b at AQ6 and AQ7 are GBR WMAs, these being

surrounded by a 100m WMA trigger buffer area. Under the VM Act, the two sites are listed as being of "Least Concern" and have a Biodiversity status listed as "Of Concern". Local wetland mapping is shown in Figure 4-1 and Figure 4-2.

4.2.6 Remnant Vegetation

At both AQ6 and AQ7, RE11.3.25b (Riverine Wetland) is present. AQ6 and AQ7 respectively, the riparian vegetation is up to 100m and 440m wide and beyond the ecotone boundary of the northern bank. Past this, the land has been historically cleared and is now open regrowth woodland. Beyond the southern banks, contiguous remnant ecotonal woodland including a sub-dominant "Of Concern" RE extends beyond the high bank of the creek channel. At the rail crossing of Bowen River, RE11.3.25b is 350m wide. An existing utilities corridor has been cleared through riparian and ecotonal woodland 230m downstream of the rail alignment centreline. RE mapping is shown in Figure 4-3.

4.2.7 Aquatic Flora

The two sites had significantly different diversities of aquatic plants. At AQ6, the fringing emergent macrophytes include *Baumea articulata*, *Cyprus difformis, C. exaltus*, *C. involucratus* (exotic) *and Typa domingensis*. The submerged macrophyte community included extensive beds of *Aponogeton queenslandicus*, *Blyxa aubertii*, *Hydrilla verticillata, Najas tennifolia, Ottelia alismoides, Potamogeton crispius, P. pectinatus* and submerged and emergent beds of *Myriophyllum verucosum.*

No aquatic plants were observed at AQ7 other than the Charophyte algae *Chara* sp. During a dry season low flow period, Blackman *et al* (1999) indicated that the macrophyte community included *Maidenia rubra*, *Myriophyllum verrucosum, Nitella sp., Nymphaea violacea, Nymphoides indica*, *Ottelia ovalifolia, Potomogeton crispus, P. javanicus, P. tricarinatus,* and *Vallisneria caulescens*. It is likely that macrophytes that existed at the site were removed during extremely high flood flows experienced during Cyclone Olga in March 2010.

4.2.8 Aquatic Macro Invertebrate Communities

A total of 26 families of aquatic macro invertebrates were captured across the two sites within the Bowen Catchment area of the CFP (19 families at AQ6 and 22 families at AQ7), this being the most diverse catchment with respect to macro invertebrates (Table 4-7). There were high abundances of Chironomidae and Helminthidae at both sites and Ephemeroptera at AQ7. These high abundances, particularly of Ephemeroptera and Simuliidae are likely to be a result of the clean, flowing water of the Bowen River.

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Table 4-7: Distribution of Macro Invertebrates Species across the Bowen Catchment Sampling Sites

Family	Order	Common Name	AQ6	AQ7
Palaemonidae, Atyidae	Decapoda	Shrimp	10	29
Chironomidae	Diptera	Gnats or Midges	170+	161+
Sub Order: Anisoptera	Odonata	Dragonfly nymphs	1	24
-	Tricoptera	Caddisfly larvae	1	22
-	Ephemeroptera	Mayfly nymphs	112+	90+
Simuliidae	Diptera	Sand or Black flies	2	150+
Helminthidae	Coleoptera	Riifle or Marl beetles	11	2
Lymnaeidae	Class: Gastropoda	Pond snails	35	72+
Planorbidae	Class: Gastropoda	Ramshorn snails	46	2
Culicidae	Diptera	Mosquiotes	0	14
Hydrophilidae	Coleoptera	Water scavenger beetles	26	2
Hygrobiidae	Coleoptera	Screech beetles	4	0
Dytiscidae	Coleoptera	Diving beetles	3	2
Helminthidae	Coleoptera	Helminthid larvae	150+	121+
Gerridae	Hemiptera	Water striders or pond skaters	1	7
Sub order: Cladocera	Diplostraca	Water fleas	3	6
Physidae	Class: Gastropoda	Bladder or tadpole snails	54	0
Pleidae	Hemiptera	Pigmy backswimmer	2	0
Gyrinidae	Coleoptera	Whirligig larvae	1	0
Tipulidae	Diptera	Crane flies or daddy-long-legs	0	1
Sub Order: Zygoptera	Odonata	Damselfly nymphs	0	53
Sphaeriidae	Class: Bivalvia	Pea-shell mussel	0	1
Haliplidae	Coleoptera	Crawling water beetles	0	3
-	Plecoptera	Stonefly nymphs	0	9
Simuliidae	Diptera	Sand or black fly pupa	0	13
Palaemonidae, Atyidae	Decapoda	Shrimp	10	29

SIGNAL calculations carried out for AQ6 and AQ7 gave scores of 3.7 and 4.1 respectively. This indicates severe pollution levels at AQ6 and moderate pollution at AQ7. The low scores are likely a reflection of the agricultural land uses surrounding these streams.

4.2.9 Macro Crustacea Communities

The macro crustacea fauna was relatively depauperate (three species) and included the translocated *Cherax quadricarinatus* also a species of interest to recreational fisheries. This may be as a result of the high flows, particularly in the Bowen River. The diversity of macro crustacea observed within the Bowen Catchment is listed in Table 4-8.

Table 4-8: Distribution of Macro Crustacea Species across the Bowen Catchment Sampling Sites

Family	Species	Common Name	AQ6	AQ7
Atyidae	*Caridina sp.*	Shrimp	x	x
Palaemonidae	*Macrobrachium australiense*	Australian River Prawn	x	x
Parastacidea	*Cherax quadricarinatus* (T)	Redclaw	x	
Total Number Species Recorded / Site			3	2

Species type key: (T) Translocated to Basin or site

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4.2.10 Fish Communities

The Bowen River was the largest habitat sampled and recorded the most diverse fish community (17 species) of all sites including three catadromous, one facultative amphidromous fish species (*Redigobius bikolanus*) dependent on migratory linkages to the ocean and seven fishery associated species including *Lates calcarifer*. Pelican Creek recorded the second most diverse fish community (14 species) of all sites sampled including one fishery associated catadromous fish species (*Anguilla reinhardtii*) dependent on migratory linkages to the ocean and two other recreational fishery associated species. *Oreochromis mossambicai*, an exotic species was common at the site. No translocated, restricted or rare species were recorded.

The most abundance species observed at AQ6 was *Ambassis agrammus*; however not one individual was observed at AQ7. A total of 1646 individuals were caught, 332 in bait traps and 1314 in the Fyke Net (minimum length 17mm; maximum length 53mm, mean length 28mm). The most abundance species observed at AQ7 was *Amniataba percoides*; however in contrast to the huge abundances of *Ambassis agrammus* at AQ6, only 29 individuals were observed of this species at AQ7, 21 individuals were caught in the 13mm gill net caught and 8 during electrofishing (minimum length 22mm; maximum length 93mm, mean length 82mm). Other abundance species included (by abundance) *Melanotaenia splendid* and *Leiopotherapon unicolor*.

Five *Anguilla reinhardtii* was observed to be the longest fish species caught at both sites (600mm and 700mm at AQ6 and AQ7 respectively). Of other fish species, numerous *Neosilurus hyrtlii* exceeded 250mm (minimum length 84mm; maximum length 265mm; mean length approximately 145mm) at AQ6 and *Neosilurus ater* exceeded 400mm (minimum length 159mm; maximum length 445mm; mean length approximately 375mm) at AQ7. An individual *Lates calcarifer* was observed at AQ7 (366mm). The diversity of fishes observed within the Bowen Catchment is listed in Table 4-9.

Plate 4-4: *Ambassis agrammus*

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Table 4-9: Distribution of Fish Species across the Bowen Catchment Sampling Sites

Family	Species	Common Name	AQ6	AQ7
Ambassidae	*Ambassis agassizii*	Agassiz's Glassfish	X	X
Anguillidae	*Anguilla reinhardtii* (M) (F)	Long-finned Eel	X	X
Arridae	*Neoarius graeffei* (F)	Lesser salmon Catfish		X
Atherinidae	*Craterocephalus stercusmuscarum*	Flyspecked Hardyhead	X	
Centropomidae	*Lates calcarifer* (M)(F)	Barramundi		X
Cichlidae	*Oreochromis mossambica* (E)	Tilapia	X	
Clupeidae	*Nematalosa erebi*	Bony Bream	X	X
Eleotrididae	*Mogurnda adspersa*	Southern Purple-Spotted Gudgeon	X	X
	Hypseleotris klunzingeri	Western Carp Gudgeon	X	
Eleotrididae	*Oxyeleotris lineolata* (F) (T @ sites> AQ7)	Sleepy Cod	X	X
Gobiidae	*Redigobius bikolanus* (M)	Speckled Goby		X
Megalopidae	*Megalops cyprinoides* (M)	Tarpon		X
Melanotaeniidae	*Melanotaenia splendida splendida*	Eastern Rainbowfish	X	X
Plotosidae	*Neosilurus hyrtlii*	Hyrtl's Tandan	X	X
	Neosilurus ater (F)	Black Catfish	X	X
Pseudomugilidae	*Pseudomugil gertrudae*	Pacific Blue-eye	X	X
Terapontidae	*Leiopotherapon unicolor*	Spangled Perch	X	X
	Hephaestus fuliginosus (F)	Sooty Grunter		X
	Amniataba percoides	Barred Grunter	X	X
Toxotidae	*Toxotes chatareus* (F)	Seven spot Archerfish		X
Total Number Species Recorded / Site			14	17

Species type key: (E) Exotic, (F) Important to Traditional /commercial/recreational fisheries, (M) Migratory species with amphidromous, catadromous or marine vagrant life history, (R) Restricted Burdekin River Basin Endemic, (T) Translocated to Basin or site

4.2.11 Turtle Communities

A large *Elseya latisternum* was captured in the multi panel gill net and *Enydura krefftii* was recorded by electrofishing at AQ7 (Bowen River).

4.2.12 Other Vertebrate Communities

Blackman *et al* (1999) identified 40 species of aquatic ecosystem dependent vertebrates including two amphibians, one reptile, and 37 riparian or wetland dependent bird species in the Bowen River catchment. This list includes seven species listed under either the EPBC Act and/or NC Act. None of these species were observed during sampling. However, *Litoria spp*. tadpoles were observed to be common at AQ6.

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4.3 Suttor

Two sites were sampled within the Suttor Catchment, these being AQ8 (Upper Suttor River) and AQ9 (Suttor River at the Bowen Development Road). Due to access constraints, AQ9 is not within the buffer areas of the alignment but the author considers that it provides an accurate representation of the aquatic habitats, flora and fauna of the Suttor Catchment within the rail alignment.

4.3.1 Topography

Topography varies over the catchment and is characterised by low relief floodplains with minor undulating slopes across the Suttor River floodplain. Dominant soils in the river valley include dark clays at depth with sandy loam overlying these clays. In the Suttor Catchment, the alignment crosses sedimentary rocks of the Suttor Formation and alluvium of the Suttor River derived from these rock types. Dominant soils on the hilly land are shallow, gritty leached sands or sandy loams. The soils of the sloping plains consist of loamy duplex soils to loamy yellow, red and grey earths and cracking clays on the lower areas.

4.3.2 Land use

The dominant land use within the catchments is agriculture (grazing) in relatively natural environments such as semi cleared paddocks. A detailed description of land uses in the region can be found in the Land Use and Planning Technical Report.

Plate 4-5: AQ8 - Upper Suttor River

Plate 4-6: AQ9 - Lower Suttor River

4.3.3 Aquatic Habitat

The two sites were distinct in that one was an upper catchment section of the stream, while AQ9 was in the lower areas of the catchment in the stream's floodplain with a diversity of aquatic habitats present set by variable hydrological settings within individual channels (i.e. active flowing versus backwaters). Much of the broader regional landscape has been cleared; therefore the semi-contiguous riparian vegetation and complex understorey vegetation of the Suttor River would provide a regional faunal corridor for small vertebrates and important nesting and feeding (particularly nectar) resources for surrounding terrestrial fauna particularly woodland birds and would act as a drought refuge.

AQ8 was a small "v" shaped channel cut into clay subsoil to volcanic basement rock in a gently undulating landscape. The active steam channel is ~5m wide, incised a further ~2m and has adjoining benches of clayey loam. Finer alluvial overbank deposits adjoin the high stream bank. The substrate varied from outcropping bed rock to clayey intermixed gravel beds to clay. The hydrological regime was assessed as seasonal with none of the observed aquatic habitats expected to persist through the dry season. The water clarity was poor with high turbidity associated with clay colloid levels. The aquatic habitats present at the time of the sampling included shallow seasonal riffles and runs, pools to ~1.8m depth, undercut banks, large woody debris, leaf litter piles, gravel beds, clay banks and outcropping bed rock.

In contrast, AQ9 was located within a broad alluvial plain on an actively flowing channel and was one of four variably separated braided, anastamosing channels which include flood runner and back water systems. The substrate varied from outcropping bed rock to clayey intermixed gravel beds to clay with

gravel in some higher flow areas. Flow is seasonal though several larger holes would be expected to persist through the dry season. The water clarity was poor with high turbidity associated with clay colloid levels.

The vegetation at AQ8 consisted of channel margins and benches which are dominated by an open riparian forest of *Melaleuca fluviatilis* and *M. leucadendra* saplings also occurred on and within the active channel margins though there were no mature specimens observed. Scattered stands of *Lomandra longifolia* occur on the channel margin with denser stands on the channel benches. *Eleocharis* sp*, Fimbristylis* sp and *Gahnia* sp also occur amongst a dense cover of *Pseudoraphis spinescens* and other riparian grass species growing from the water's edge to the outer bench margins. An open woodland of *Corymbia tessellaris*, occurs on alluvial soils adjoining the high bank. No weed species were observed at the site. Cattle access the steam channel via the highly erodible duplex soils of the high bank and clayey soils of the lower channel that has caused significant gully erosion in reaches adjoining the site. There was also a small ford upstream from the sampling site; however an inspection suggested that it had not been used in many years.

Riparian overstorey consisted of an open woodland co-dominated by *Eucalyptus camaldulensis* and *E. coolabah* with scattered *Melaleuca bracteata* on channel margins. Back levee lagoons retain water levels elevated relative to the main channel and have a different overstorey community which includes *Excoecaria parvifolia* and *Lysiphyllum gilvum*. Ground cover is variable composed of aquatic grasses such as *Lomandra longifolia, Pseudoraphis spinescens,* sedges (*Cyprus difformis, Eleocharis* sp and *Fimbristylis* sp) and flowering species *Alternanthera* sp, *Commelina cyanea* and *Persicaria attenuata.* Weeds were not conspicuous although scattered plants included *Xanthium pungens.* Bank levee and channel margins showed exposed roots and bank erosion which could be as a result of prior cattle access and recent flood spate.

Aquatic habitats present at the time of sampling include shallow riffles and deeper runs, pools to ~2m depth, including larger waterholes (15 x 20m at AQ9) within the stream channel, undercut banks, abundant large woody debris, leaf litter piles, gravel beds, clay banks and emergent macrophyte margins. Backwater channels hosting isolated pools contained a greater density of emergent macrophytes.

Rapid Aquatic Habitat Assessment

Rapid habitat assessments were carried out at ten sites (WQ19 – WQ28) within the Suttor River Catchment during the water quality monitoring program. Riparian vegetation density varied across the sites. The majority of sites had large tree species and relatively undisturbed vegetation with fairly regular vegetation along both banks; however sites WQ21, WQ22, WQ26 and WQ28 had highly disturbed riparian vegetation communities. All sites except for WQ22 had extensive coverage of trees, shrubs and grasses. Site W22 was heavily cleared with grasses the only dominant vegetation. Most sites had limited to slight shading.

All streams sampled contained flowing water during the wet season with WQ25, WQ26 and WQ28 (Suttor River, Verbena and Logan Creeks respectively) all flooding at the time of sampling. The streams on the Suttor catchment were predominantly remnant channels that were flat or two staged (stepped) banked streams. Most streams sampled had flowing and pooled water although two streams (WQ23 and WQ24) had significant flowing water (rapids and riffles >65%) and all the streams had extensive runs. The majority

of the streams had no in stream aquatic plant growth except for site WQ22 that had some submerged aquatic plants.

Silt was the dominant particle in the southern area of the catchment while sand was the dominant sediment in the upper reaches of the catchment. The majority of streams were partly to very restricted at base flow with this either being a non-vegetated side channel bars in the upper reaches and vegetated mid channel bars in the lower reaches.

4.3.4 Protected Species

None predicted or observed species are likely at the sites.

4.3.5 Wetland

There are a wide variety of wetland REs within the Suttor catchment that may be impacted by the CFP. These include RE11.3.25 (Riverine wetland) and RE11.3.37 (Freshwater wetlands) or one of its subsets.

Numerous palustrine wetlands mapped as RE11.3.27b (Freshwater wetland with naturalised species including *Egeria densa* flooded by overland flow) and RE11.3.27f (Freshwater wetland with naturalised species including *Egeria densa* less prone to flooding) occur within the area. RE11.3.25, RE11.3.27b and RE11.3.27f are classified as GBR WMA and WPA which are also surrounded by a 100m WMA and WPA trigger areas. Under the VM Act, the area is listed as being of "Least Concern" and has a Biodiversity status listed as both "Of Concern" and "Not of Concern at Present". Local wetland mapping is shown in Figure 4-4 and Figure 4-5.

4.3.6 Remnant Vegetation

RE11.3.25 forms a contiguous remnant ecotonal woodland including a dominant "Of Concern" RE that extends from the both high banks onto the adjoining alluvial plain around AQ8. At AQ9, seven separate channel associated occurrences of RE11.3.37 are crossed by the rail alignment across a ~2.5km wide flood plain of the Suttor River. Contiguous remnant ecotonal woodland on alluvial plains of a "Not of Concern" RE occurs between the crossing channels. Ecotonal woodland comprised of a sub-dominant "Of Concern" RE that extends onto the adjoining alluvial plain for a limited distance either side of the western and eastern channels of the Suttor River. There are a number of "Endangered" terrestrial REs within the alignment which are discussed in the Terrestrial Flora and Fauna Technical Report. Remnant vegetation within the Suttor Catchment is mapped in Figure 4-6.

4.3.7 Aquatic Flora

No submerged macrophytes were present at either site due to the high turbidity of the water. Emergent, fringing and aquatic grass species included *Eleocharis* sp*, Fimbristylis* sp, *Gahnia* sp, *Lomandra longifolia* and *Pseudoraphis spinescens.* Sedges included *Cyprus difformis, Eleocharis* sp and *Fimbristylis* sp. Flowering species included *Commelina cyanea* and *Persicaria attenuate*.

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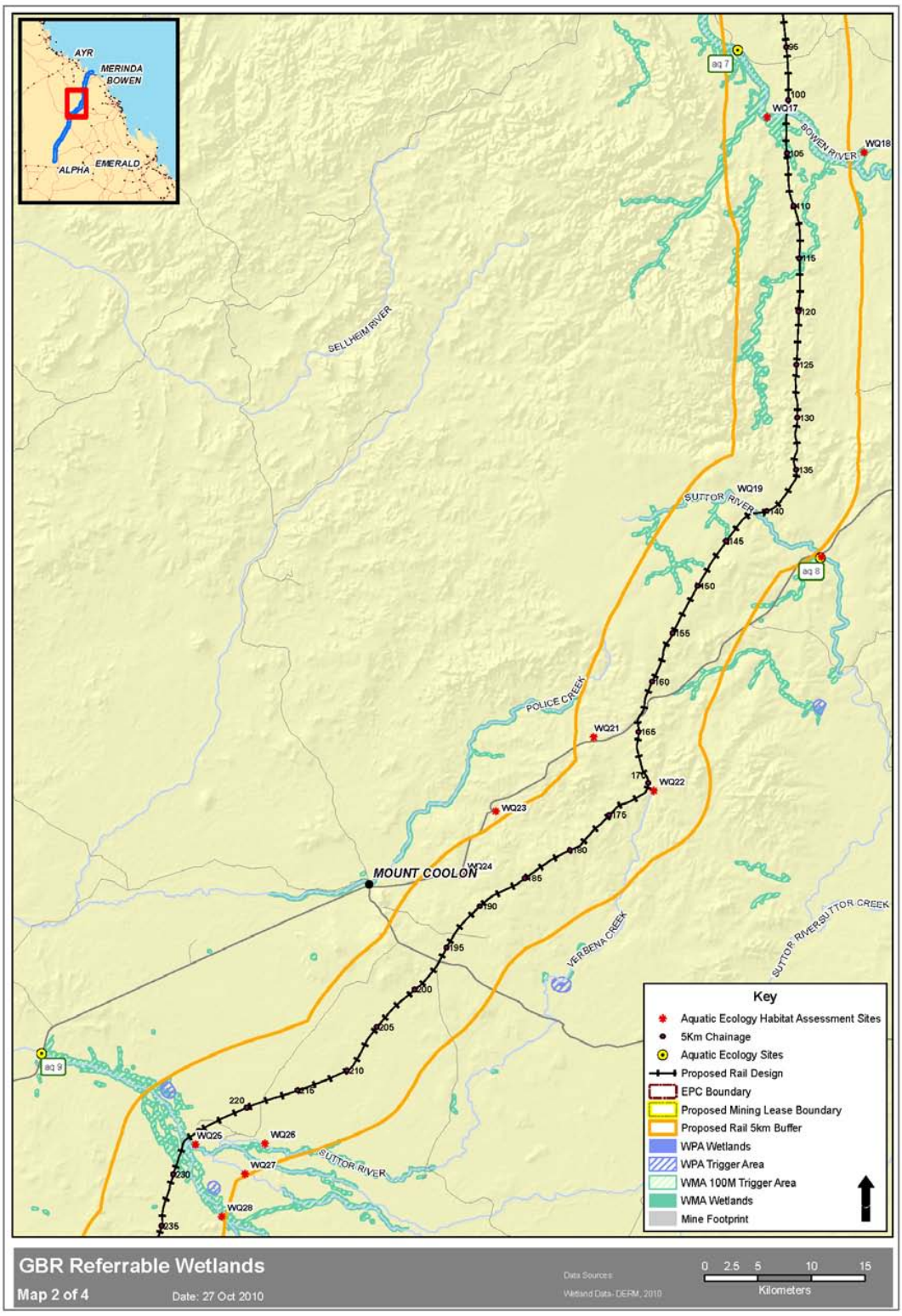

Figure 4-4: GBR Referrable Wetlands: KP95 to KP230

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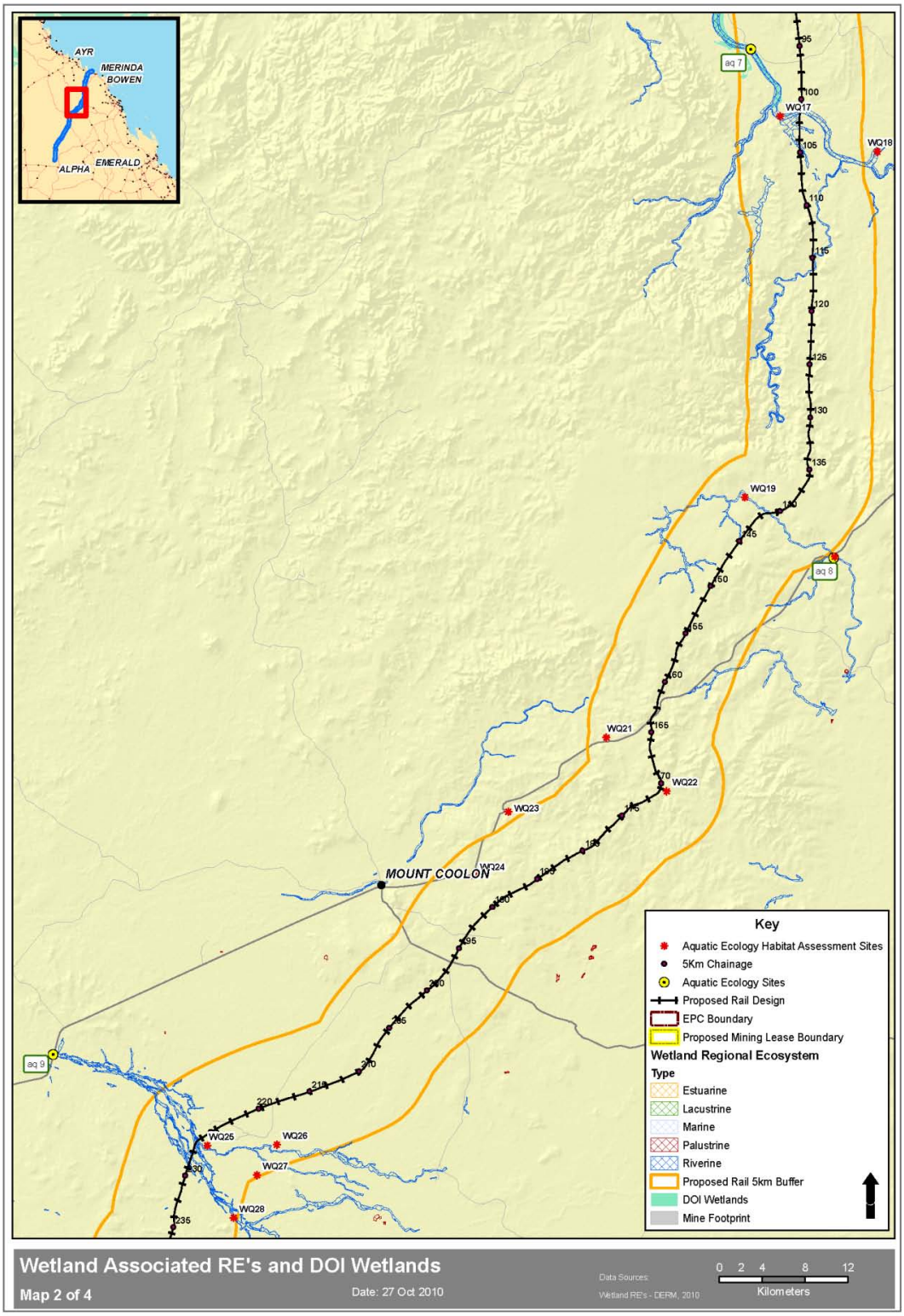

Figure 4-5: Wetland Associated RE: KP95 to KP230

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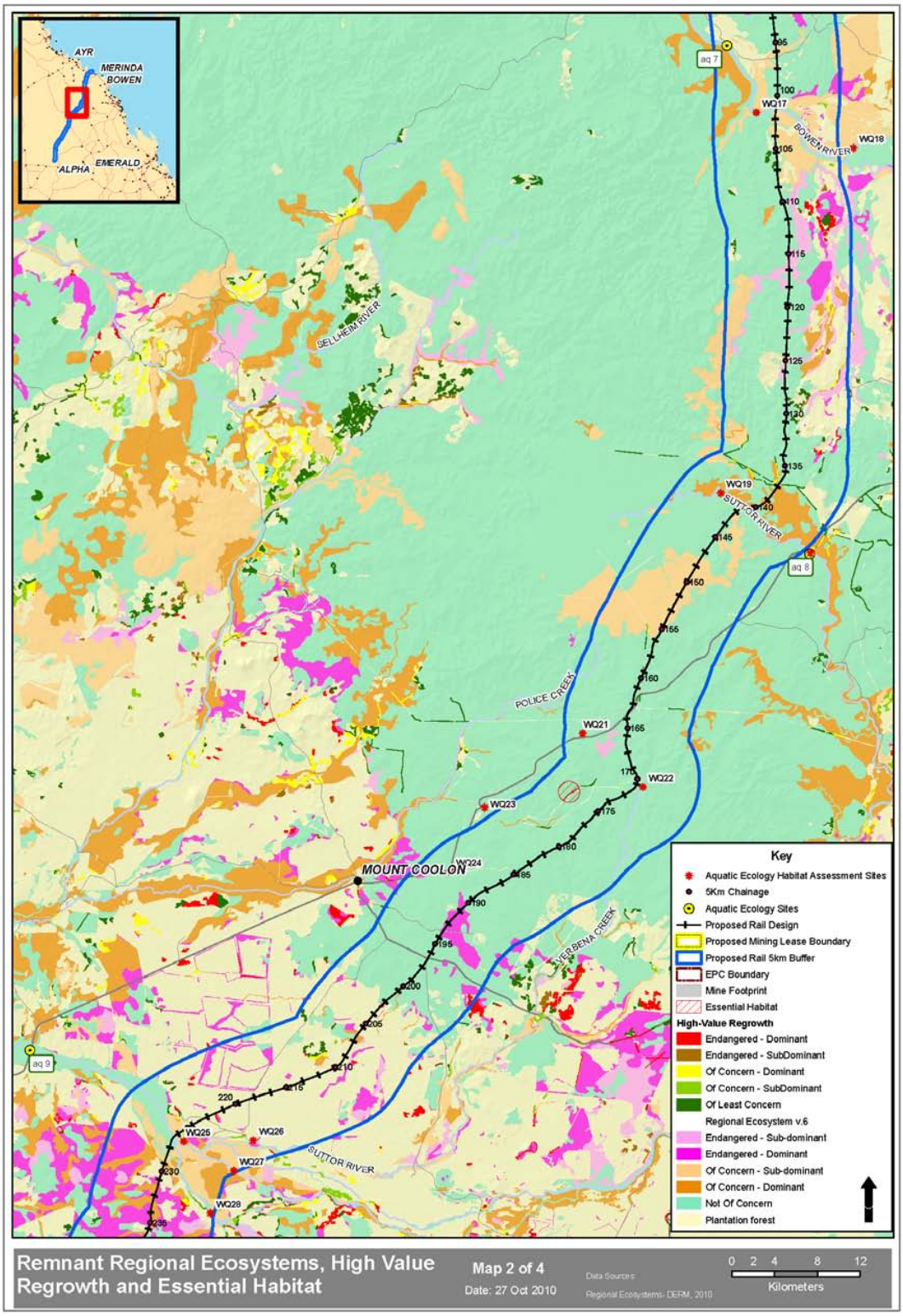

Figure 4-6: High Value Regrowth and Remnant RE: KP95 to KP230

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4.3.8 Aquatic Macro Invertebrate Communities

A total of 18 families of macro invertebrates were captured across the two sites within the Suttor Catchment area of the CFP (13 families at AQ8 and 11 families at AQ9) (Table 4-10). There was an abundances of Chironomidae at AQ8, while there was significantly higher numbers of Simuliidae and Helminthid Larvae at AQ9.

Table 4-10: Distribution of Macro Invertebrates Species across the Suttor Catchment Sampling Sites

Family	Order	Common Name	AQ8	AQ9
Chironomidae	Diptera	Gnats or Midges	96+	80+
Sub Order: Anisoptera	Odonata	Dragonfly nymphs	1	0
Pisauridae	Araneae	Fisher spiders	3	0
-	Tricoptera	Caddisfly larvae	0	5
-	Ephemeroptera	Mayfly nymphs	14	21
Simuliidae	Diptera	Sand or Black flies	4	161+
Helminthidae	Coleoptera	Riifle or Marl beetles	15	5
Lymnaeidae	Class: Gastropoda	Pond snails	1	2
Sub Order: Hydracarina	Acarina	Water mites	0	1
Hygrobiidae	Coleoptera	Screech beetles	4	0
Dytiscidae	Coleoptera	Diving beetles	1	0
Helminthidae	Coleoptera	Helminthid larvae	3	200+
Sub order: Cladocera	Diplostraca	Water fleas	9	0
Physidae	Class: Gastropoda	Bladder or tadpole snails	0	1
Gyrinidae	Coleoptera	Whirligig larvae	1	0
Simuliidae	Diptera	Sand or black fly pupa	0	17
Veliidae	Hemiptera	Water crickets	1	0
Hydrometridae	Hemiptera	Water measurer	0	1

SIGNAL calculations carried out for AQ8 and AQ9 gave scores of 3.9 and 4.6 respectively. This indicates severe pollution levels at AQ8 and moderate pollution levels at AQ9. These scores likely reflect the surrounding land uses which are predominantly areas cleared for grazing and other agricultural purposes.

4.3.9 Macro Crustacea Communities

The macro crustacea fauna was diverse recording four species at the two sites (Table 4-11). These species were distributed across a diverse range of taxa including a shrimp, prawn, crayfish and crab. *Cherax depressus* is recognised to be undergoing range reductions with the Upper Burdekin River Basin due to competition with the translocated native species *Cherax quadricarinatus* (Burrows *et al*, 1999). The observance of these species highlights the sites upper catchment extra-limital location and its potential value as a species refugia.

Table 4-11: Distribution of Macro Crustacea Species across the Suttor Catchment Sampling Sites

Family	Species	Common Name	AQ8	AQ9
Atyidae	*Caridina sp.*	Shrimp	x	x
Palaemonidae	*Macrobrachium australiense*	Australian River Prawn	x	x
Parastacidea	*Cherax drepressus*	Orange Fingered Yabby	x	
	Cherax quadricarinatus (T)	Redclaw		x
Parathelphusidae	*Austrothelphusa transversa*	Freshwater Crab	x	x
Total Number Species Recorded / Site			4	4

Species type key: (T) Translocated to Basin or site

4.3.10 Fish Communities

Considering the small size and seasonality of AQ8, the site had a relatively diverse fish fauna (6 species). AQ9 had a relatively diverse fish (10 species). Only one exotic species, *Oreochromis mossambicai* was common at AQ9 (36 individuals) but was not observed at AQ8. *Ocyeleotris lineolata* recorded at the site are translocated to the Upper Burdekin River Basin (Burrows *et al*, 1999). Two species of recreational fishery interest and one species (*Scortum parviceps*) with a restricted distribution endemic to the Burdekin River Basin were also observed. *Morgurnda adspersa* is also recognised to be undergoing range reductions with the Upper Burdekin River Basin due to competition with translocated *O. lineolata*. The records for these species highlight the sites upper catchment extra-limital location and its potential value as a species refugia.

The most abundance species observed was *Neosilurus hyrtlii* at both AQ8 and A9 with over 85 and 384 individuals caught respectively in the various sampling devices (AQ8 minimum length 74mm, maximum length 96mm; AQ9 minimum length 58mm, maximum length 147mm). Other species included (by abundance) *Melanotaenia splendid splendida*, *Leiopotherapon unicolour*, *Neosilurus ater* and *Oxyeleotris lineolata*.

Oxyeleotris lineolata was observed to be the longest fish species caught at AQ8 (only one individual 166mm). *Leiopotherapon unicolour* was the second longest species at AQ8 and the longest species at AQ9 (minimum length 35mm; maximum length 205mm; mean length approximately 111mm). Fish species found at AQ8 and AQ9 are listed in Table 4-12.

Table 4-12: Distribution of Fish Species across the Suttor Catchment Sampling Sites

Family	Species	Common Name	AQ8	AQ9
Cichlidae	*Oreochromis mossambica* (E)	Tilapia		x
Clupeidae	*Nematalosa erebi*	Bony Bream		x
Eleotrididae	*Mogurnda adspersa*	Southern Purple-Spotted Gudgeon	x	x
Eleotrididae	*Oxyeleotris lineolata* (F)	Sleepy Cod	x	x
Melanotaeniidae	*Melanotaenia splendida splendida*	Eastern Rainbowfish	x	x
Plotosidae	*Neosilurus hyrtlii*	Hyrtl's Tandan	x	x
	Neosilurus ater (F)	Black Catfish		x
	Porochilus rendahli	Rendahl's Catfish		x
Terapontidae	*Leiopotherapon unicolor*	Spangled Perch	x	x
	Scortum parviceps (R)	Smallhead Grunter	x	x
Total Number Species Recorded / Site			6	10

Species type key: (E) Exotic, (F) Important to Traditional /commercial/recreational fisheries, (R) Restricted Burdekin River Basin Endemic, (T) Translocated to Basin or site

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4.3.11 Turtle Communities

A *Enydura krefftii* individual was recorded at AQ9 (Plate 4-7).

Plate 4-7: *Enydura krefftii* - Lower Suttor River

4.3.12 Other Vertebrate Communities

Cyclorana alboguttata and *Litoria inermis* were observed at both sites.

4.4 Belyando

Four sites were sampled within the Belyando Catchment, these being AQ10 (Mistake Creek), AQ11 (Middle Creek), AQ12 (Belyando Creek) and AQ13 (Sandy Creek). AQ14 also lies within this catchment.

Mistake Creek consisted of a broader set of anastamosing channels. Middle Creek is interlinked with Lascelles and Fox Creeks drainage system and is crossed numerous times by the rail alignment. Belyando Creek is within the upper reaches of the Belyando River and consists of permanent water holes. Sandy Creek is made up on broader set of anastamosing channels.

Plate 4-8: AQ11 – Middle Creek

4.4.1 Topography

The Belyando Catchment is predominately low relief floodplain with wide braided channels and alluvial plains (Roth *et al*., 2002). The Belyando River flows in a northerly direction and joins the Suttor River in its lower reaches. It is bounded by the Great Dividing Range in the west of Denham and Drummond Ranges to the east. General topography within the Belyando catchment differs from other sub-catchments in the Burdekin Basin, lacking high mountain conditions with a drier, typically semi-arid landscape (ANRA 2002).

Surface geology at the catchment is dominated by unconsolidated Cainozoic sediments including sands, silts and clay, with thickness of up to 90m in the eastern and central sections. Soils have low fertility and land use is limited to grazing and native pastures. Grazing lands are susceptible to surface soil degradation

such as hard setting and crusting even when grazing intensity is low (see generally Geology, Soils, and Landforms Technical Report).

Plate 4-9: AQ12 - Belyando Creek - Upstream

4.4.2 Land use

The Belyando Catchment is predominantly agricultural land with cattle grazing on natural vegetation. Cropping and/or horticulture are not undertaken within the area. The vegetation within the catchment and rail footprint itself is generally characterised as being in a degraded condition having been cleared and blade ploughed for grazing land.

4.4.3 Aquatic Habitat

The four sites had quite distinct aquatic habitats. AQ10 is located within a broad alluvial plain on the main channel of one of four variably separated braided anastamosing channels which include flood runner and back water systems. The substrate was predominantly pebble to gravel beds with clay channel margins. The site is a floodplain with the diversity of aquatic habitats present set by variable hydrological settings within individual channels with several of the larger holes that persisted through most dry seasons (*pers comm.* Land Holders). The water clarity was medium with bottom visible to~0.5m.

Middle Creek (AQ11) is located within a broad alluvial plain in the main channel of one of many widely separated braided anastamosing channels. The substrate was predominantly pebble to gravel beds with clay channel margins. Flow is highly seasonal though several of the larger holes and an adjoining excavated dam site would be expected to be perennial. The water was very turbid.

Belyando Creek (AQ12) is a 70m wide river channel incised in an alluvial plain to bedrock. The channel sides are steep though benches of alluvium occur within the channel and overbank alluvial deposits adjoin the high bank. The aquatic habitats present during the field survey included shallow flowing riffles and runs, pools to ~3m depth, including a large channel waterhole (20m wide x 400m long), undercut banks, root masses, rocky outcrop and crevices, abundant large woody debris, leaf litter piles, gravel and sand beds and clay banks. The water clarity was medium (~1m sechi depth). The substrate varied within the reach from clay in depositional areas to sand beds and bed rock. A small seasonal base flow was present at the time of sampling and the main waterhole is perennial in all but exceptionally dry years (*pers comm.* Land Holder).

Sandy Creek links directly with Lagoon Creek (AQ14) located on the mine. The aquatic habitats were very similar to that site, although at AQ13 Sandy Creek was a 100m wide sand bed dominated stream channel with braided flow channels within an alluvial plain. More elevated benches of alluvium occurred in some of the reaches. While the site has highly seasonal flows, the Sandy Creek channel adjoining the rail alignment at KP416 appears to hold a semi-perennial waterhole which is likely to be an important aquatic refugia within such a seasonal system.

The riparian vegetation at the sites was fairly consistent across the catchment. Each site had an open woodland comprised of *Eucalyptus coolabah* with semi contiguous band of *Melaleuca bracteata* on channel margins although AQ12 and AQ13 had increased abundance of *Eucalyptus camaldulensis* and *Melaleuca leucadendra* on the channel margins. At AQ12, the higher levee had a different overstorey community which includes *Atalaya hemigaluca*, *Excoecaria parvifolia, Lysiphyllum gilvum* and scattered *Acacia harpophylla*. Ground cover along most shaded edges was sparse though dense stands of grasses occur on high levees but included some dense stands of *Lomandra longifolia. Cynodon dactylon* also occurred in sparse sunlit patches on alluvium near the water's edge. In most sites, there were no emergent macrophytes; however at AQ12, *Alternanthera* sp and *Cyprus difformis* were observed and beds of filamentous algae were present in rocky shallows. In sunlit water margins, there was a range of emergent macrophyte species. At most sites, there were very few if any weeds observed, although *Xanthium pungens* were recorded at AQ12. Cattle access varied from riparian fencing totally limiting access to areas where cattle access to the streams had generated significant bank erosion and most channel marginal tree roots were exposed by severe erosion. Some areas of the banks at Belyando Creek exhibited severe bank erosion from past tordon (herbicide) poisoning of levee vegetation.

All sites had some form of aquatic habitat, although the available habitat varied greatly. At all sites except for AQ13, there were large long channel hosted waterholes with some being as large as ~3m depth x 20m wide x 400m long with undercut banks. AQ13 had limited available aquatic habitat, with these being shallow pools within sand beds, undercut banks, root masses, leaf litter piles, clay banks and large woody debris that were likely to dry within a month (Plate 2-2). Most sites had abundant large woody debris, leaf litter piles, gravel beds, clay banks and emergent macrophyte margins.

Much of the broader regional landscape has been cleared across the catchment although there are semi-contiguous riparian vegetation across the four streams that provide a regional faunal corridor and important nesting and feeding (particularly nectar) resources for surrounding terrestrial fauna and would act as a drought refuge. The perennial waterholes would also act as aquatic refugia.

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Rapid Aquatic Habitat Assessment

Rapid habitat assessments were carried out at 15 sites (WQ29 – WQ43) within the Belyando River Catchment during the water quality monitoring program. The assessments identified riparian areas in the catchment as generally consisting of a layer of mature Eucalypts including ironbark and other eucalypts species, one or two trees thick directly on the banks of the streams surrounded by a layer of saplings and shrubs before the landscape opens up into grazing paddocks. The majority of sites had highly disturbed vegetation and accordingly, trees less that 10m and grass were the dominant vegetation.

The streams in the lower reaches of the Belyando catchment were predominantly remnant channels that were flat, low or moderate banked streams. The streams ranged from 3m to 60m wide although most streams had an observed flood plain that extended up to 25m either side of the centre of the stream. Most streams sampled had flowing and pooled water although two streams (WQ35 and WQ38) had significant flowing water (glides >65%) and over half the streams had extensive runs. All streams except for those with high flows also had large pools that covered extensive areas. The majority of the streams had no in stream aquatic plant growth except for site WQ31 that had significant emergent aquatic plants.

Silt was the dominant particle observed at the majority of sites. The majority of streams had partly or very restricted flows due to non-vegetated mid channel bars. Only WQ34 had unobstructed base flows.

4.4.4 Wetland

There are a wide variety of wetland REs within the Belyando Catchment that are found within the CFP rail alignment. These include

- RE10.3.13 - Fringing wetland containing *Melaleuca fluviatilis* and/or *M. leucadendra* and/or *Eucalyptus camaldulensis* open-woodland and woodland occurs mostly as narrow bands along channels and on levees with sandy to clayey soils along larger watercourses;
- RE11.3.3c - Palustrine wetland made up if *Eucalyptus coolabah* woodland to open-woodland (to scattered trees) with a sedge or grass understorey in back swamps and old channels;
- RE11.5.3b - Palustrine wetlands including *Eucalyptus populnea* on closed depressions;
- RE11.3.25 - Riverine wetland made up of *Eucalyptus camaldulensis* or *E. tereticornis* woodland fringing drainage lines);
- RE11.3.27 - Freshwater Wetlands;
- RE 11.3. 27b and RE11.3.27f - Palustrine wetland containing *Eucalyptus coolabah* and/or *E. tereticornis* open woodland to woodland fringing swamps); and
- RE11.3.37 - Riverine wetland (*Eucalyptus coolabah* fringing woodland on alluvial plains).

In addition to the riverine wetland crossed by the rail alignment, another eleven wetlands lie within a 5km of the alignment including:

- RE10.3.13 on both sides of Sandy Creek (AQ13) and 250m to the west of the rail alignment at KP416;
- RE11.3.3c at KP375 (2.7km to the north west);

- RE11.3.25 occur at KP357 (4.5 km north west), KP 370 (250m to the north), KP379 (800m to the north west); KP381 (350m to the south east);
- RE11.3.27f occur within a 5km corridor adjoining the proposed rail alignment between KP290 and KP292, at KP351 (150m to the east); and
- RE11.5.3b lies 4.5km to the south east at KP341.

All these wetlands are classified as GBR WMA and WPA which are also surrounded by either a 100m and 500m WMA and WPA trigger areas. AQ12 and the immediately preceding creek crossings are not mapped as wetland REs and are not referable wetlands.

Under the VM Act, the area is listed as being of "Least Concern" and has a Biodiversity status listed as both "Of Concern" and "Not of Concern at Present". Local wetland mapping is shown in Figure 4-7, Figure 4-8, Figure 4-9 and Figure 4-10.

Waratah Coal

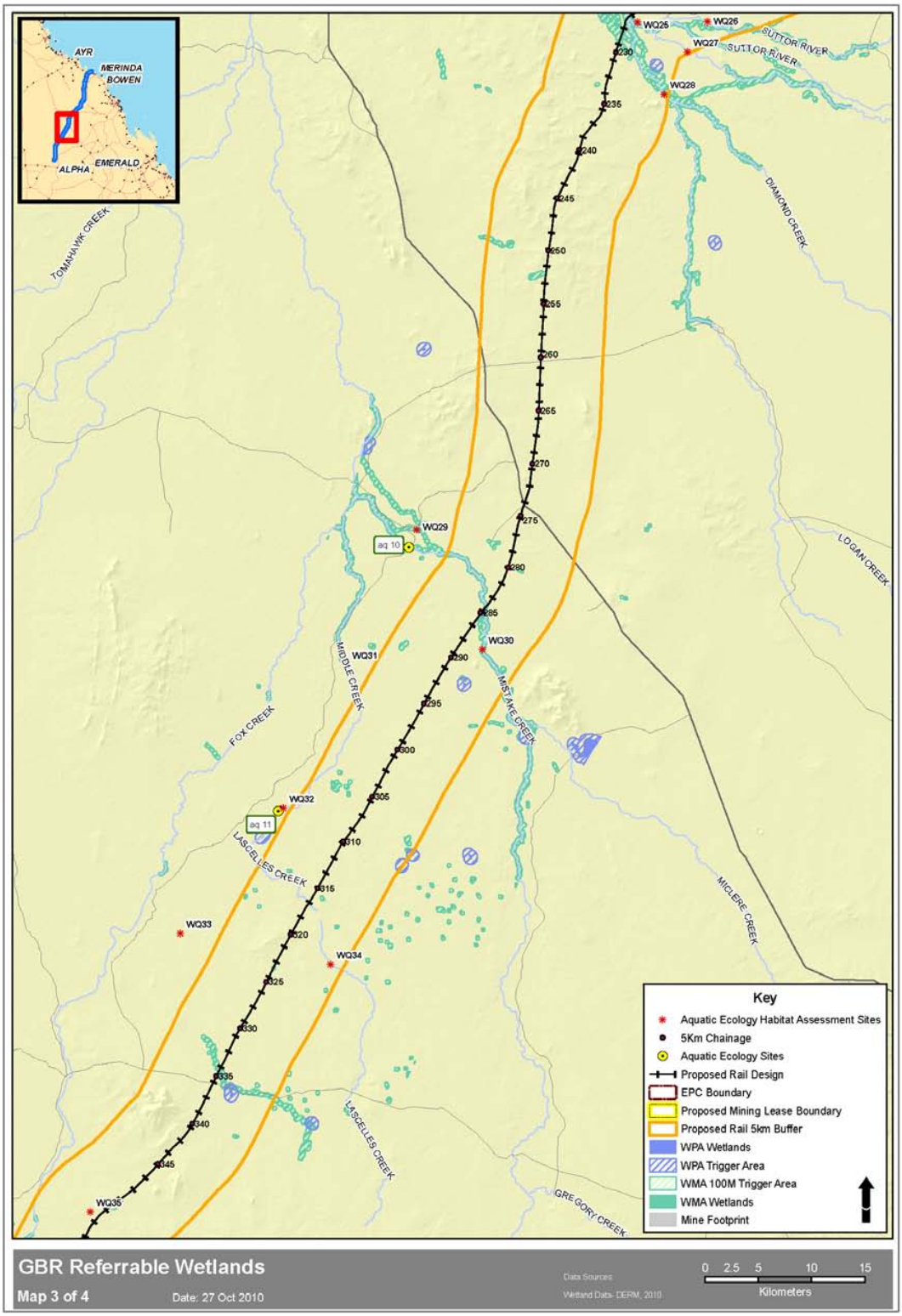

Figure 4-7: GBR Referrable Wetlands: KP230 to KP350

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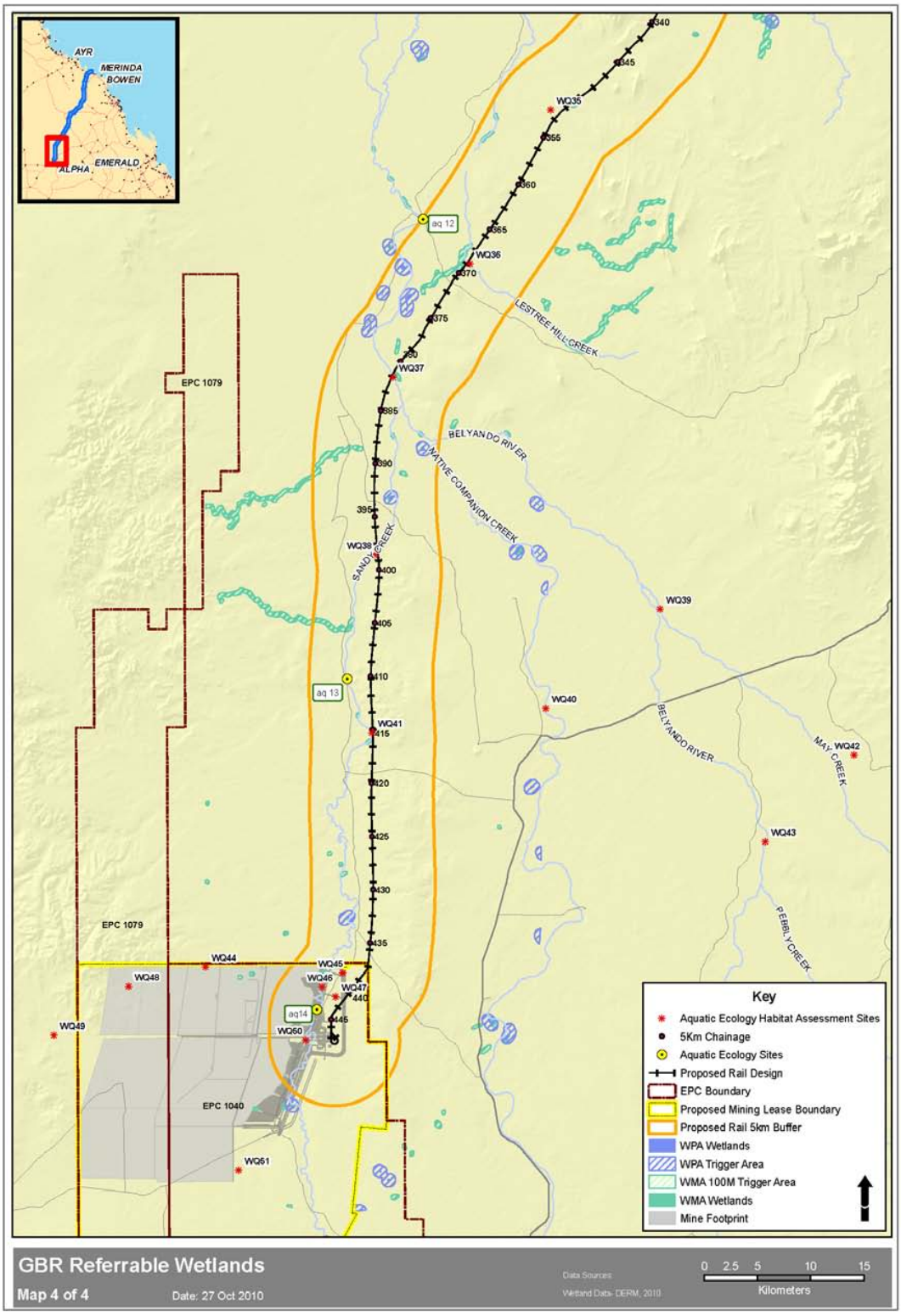

Figure 4-8: GBR Referrable Wetlands: KP350 to KP447

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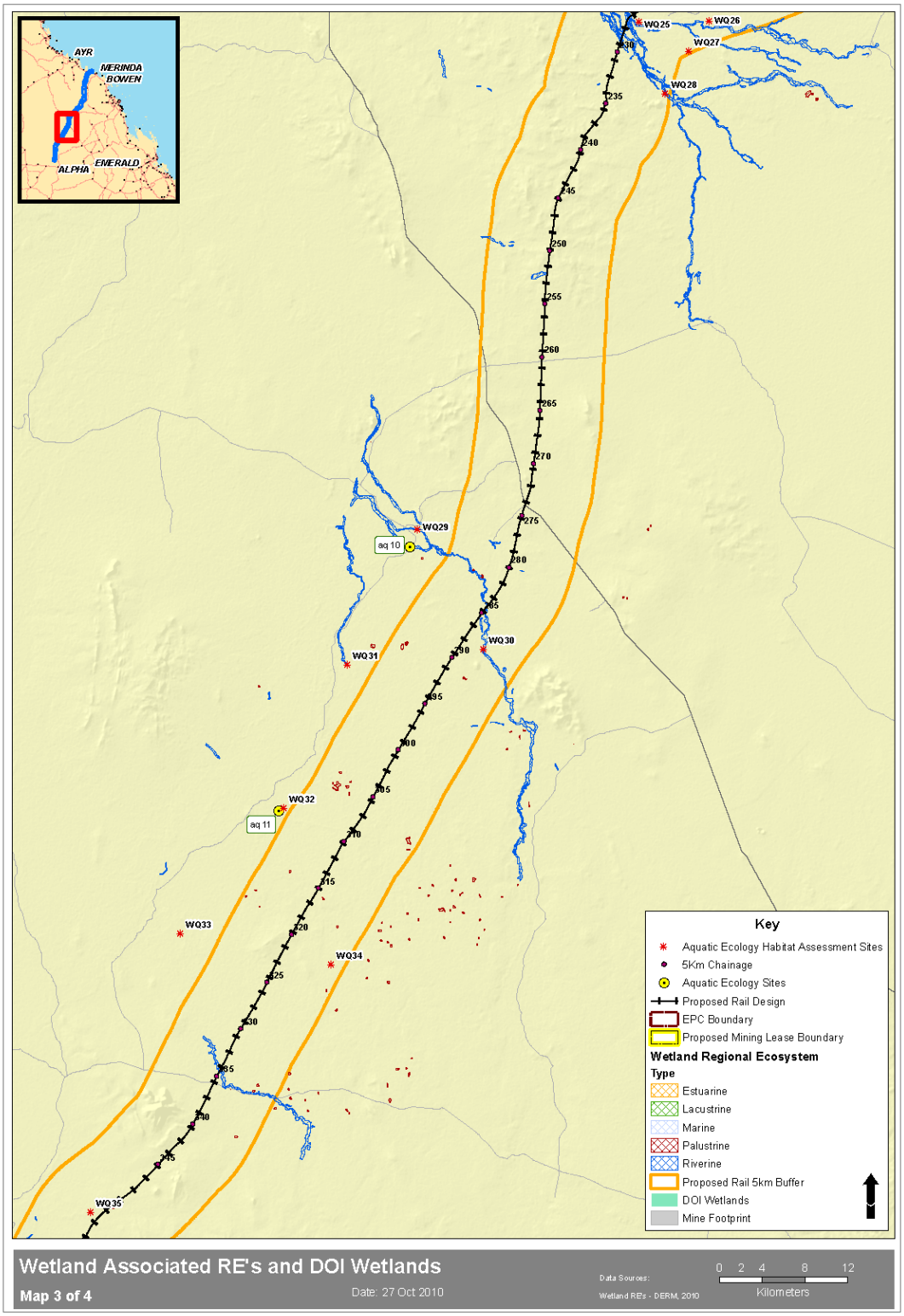

Figure 4-9: Wetland Associated RE: KP230 to KP350

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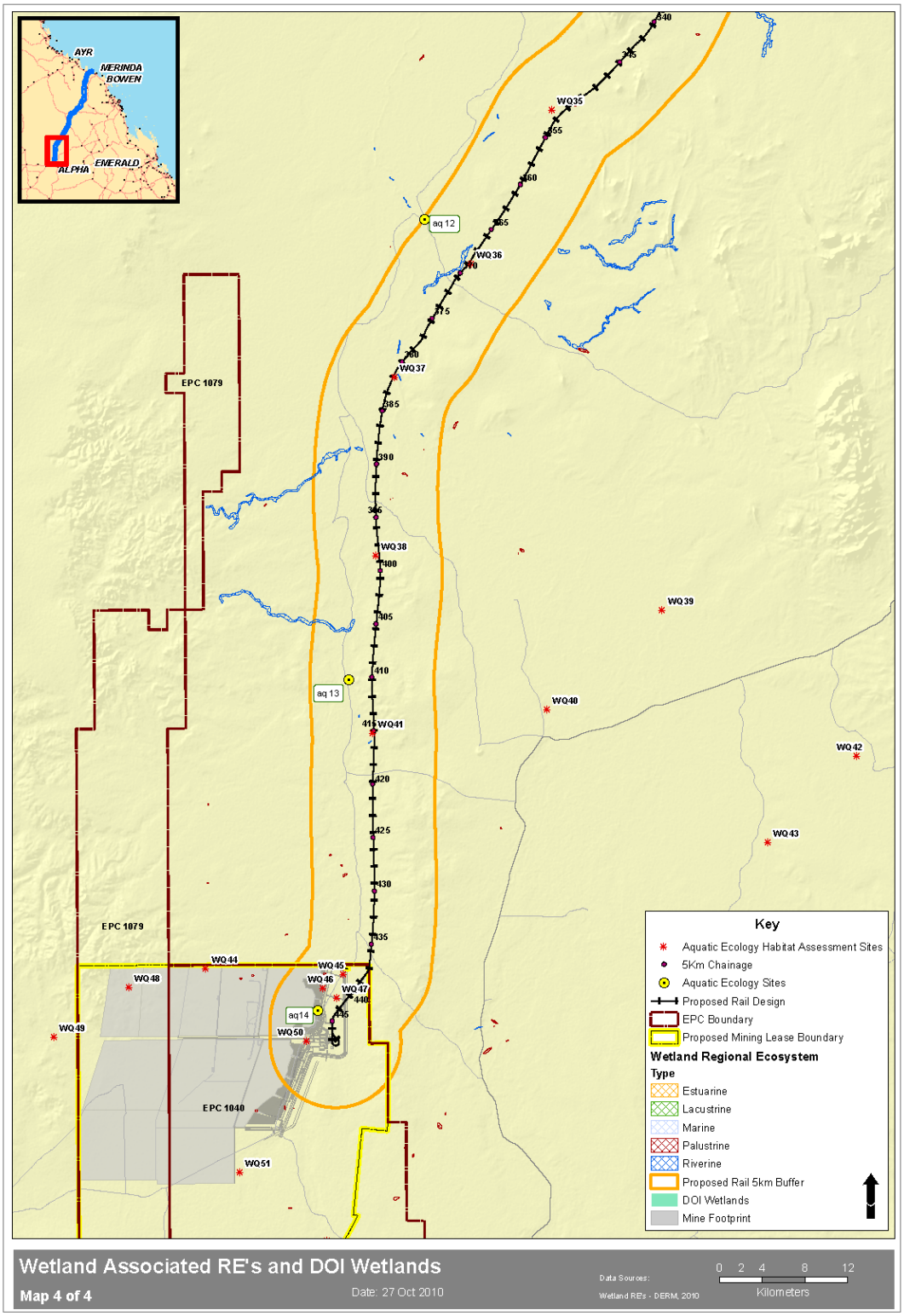

Figure 4-10: Wetland Associated RE: KP350 to KP447

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4.4.5 Remnant Vegetation

The predominant riparian remnant vegetation is RE11.3.25. Where the rail alignment crosses the streams located within the Belyando Catchment, the riparian remnant vegetation can be up to 390m wide. For example, at Mistake Creek, the riparian zone is approximately 110m wide though in between that there are at least two other channels that are 20-30m apart. A 300m riparian corridor exists between KP316 and KP317 (Lascelles Creek). At the rail crossing of the Belyando River, three separate riparian corridors interpreted as remnant RE11.3.25 are crossed between KP380 and KP382 with widths of 60m, 55m and 390m respectively. A 100m wide riparian corridor of riparian vegetation on Lestree Hill Creek also interpreted as RE11.3.25 is crossed at approximately KP367. Beyond the high bank of the crossing sites, the vegetation has been cleared. Where the rail intersects with Sandy Creek, channel wetland associated riparian vegetation is approximately 280m wide east to west. The alignment skirts the eastern boundary of the wetland associated RE which is cleared further to the east. RE mapping for the Belyando catchment is shown in Figure 4-11 and Figure 4-12.

Importantly, these high bank contiguous remnant ecotonal woodland including dominant and sub-dominant “Endangered” and “Of Concern” RE adjoining the high bank which changes to “Not of Concern” RE further onto the adjoining alluvial plain provide habitat for both terrestrial and aquatic related species.

4.4.6 Aquatic Flora

No submerged macrophytes were observed throughout the catchment areas although water clarity and bottom substrates would indicate the presence of submerged macropyhtes within the system. Fringing emergent macrophytes were composed of aquatic grasses *Pseudoraphis spinescens* and sedges *Cyprus difformis, C. exaltatus, C. polystachyos* and *Limnophila fragrans*. Flowering species included *Alternanthera* sp, *Commelina cyanea, Persicaria attenuata* and *Sesbania cannabinna.*

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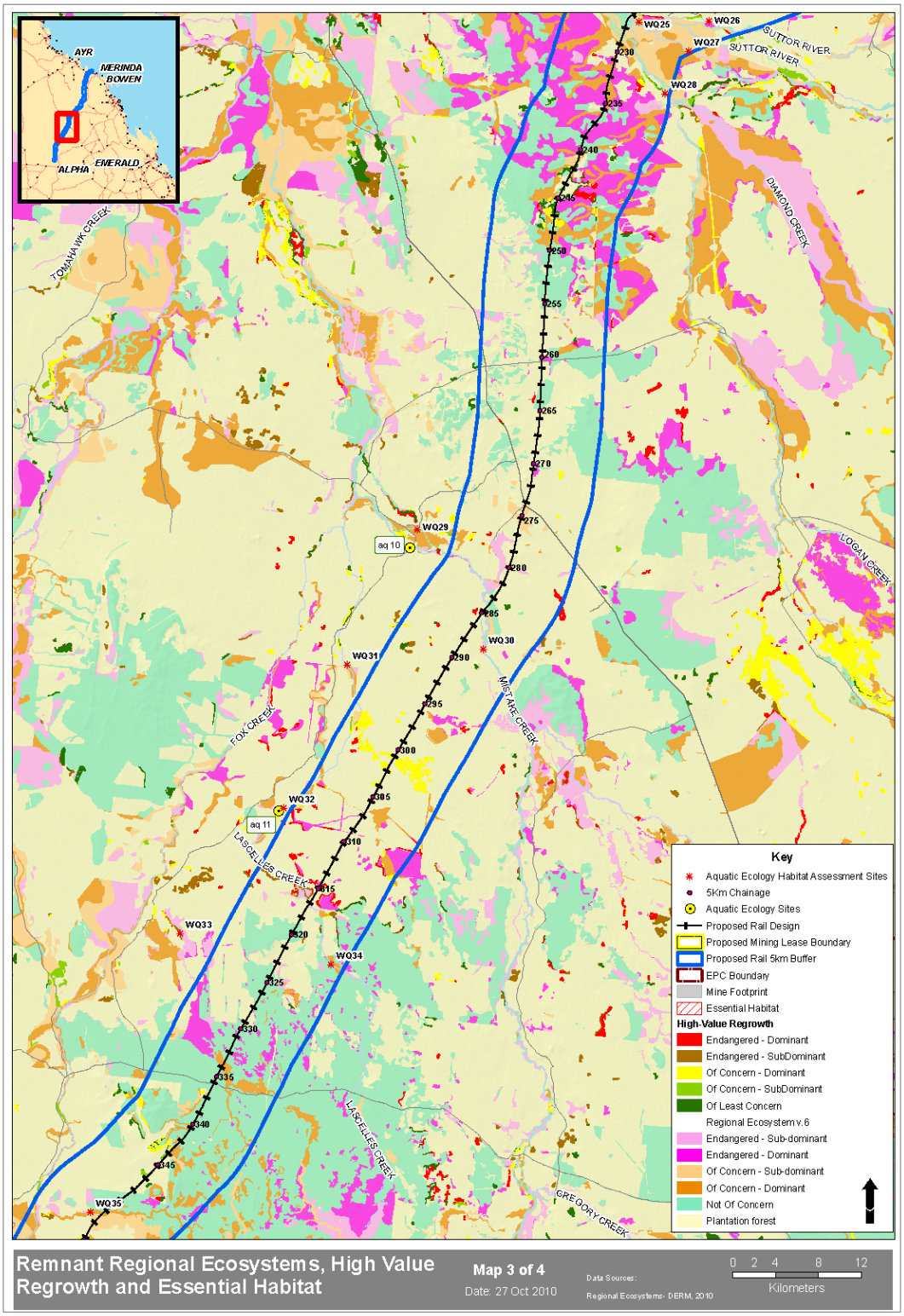

Figure 4-11: High Value Regrowth and Remnant RE: KP230 to KP350

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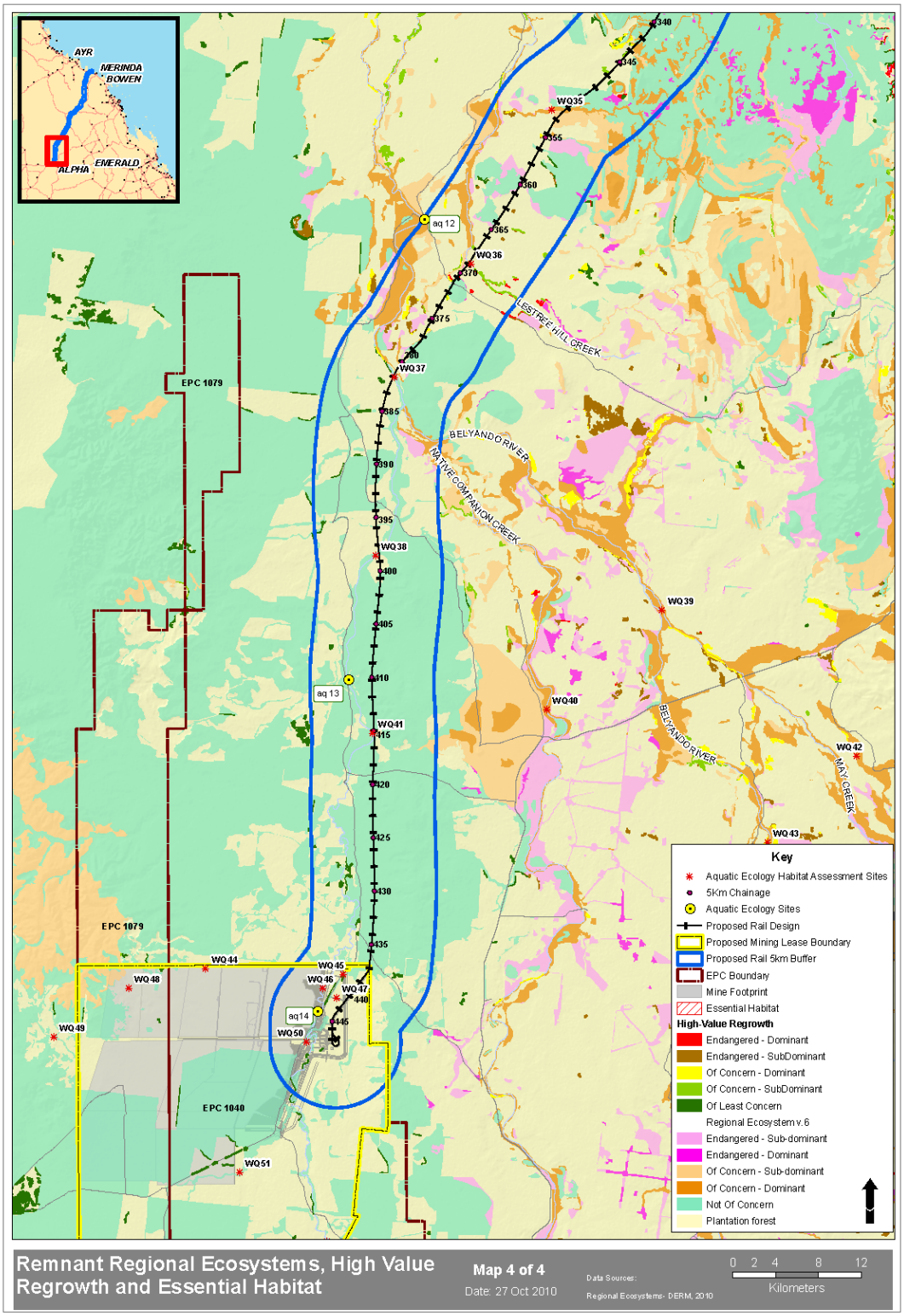

Figure 4-12: High Value Regrowth and Remnant RE: KP350 to KP447

4.4.7 Aquatic Macro Invertebrate Communities

A total of 25 families of macro invertebrates were captured across the four sites within the Belyando Catchment (11 families at AQ10, 15 families at AQ11, 14 families at AQ12 and 17 families at AQ13) (Table 4-13). The highest diversity of macro invertebrates was observed at AQ13 which is likely to be as a result of the limited available habitat and therefore, animals moving into the last remaining pools. There were high abundances of Chironomidae at all sites, while Ephemeroptera where in relatively high abundances at AQ10, AQ11 and AQ12. Helminthid larvae were in high abundances at AQ12 and likewise, Notonectidae where in high abundances at AQ13 likely as a result of the restricted available habitat.

Table 4-13: Distribution of Macro Invertebrates Species across the Belyando Sampling Sites

Family	Order	Common Name	AQ10	AQ11	AQ12	AQ13
Palaemonidae, Atyidae	Decapoda	Shrimp	0	1	2	1
Chironomidae	Diptera	Gnats or Midges	121+	167+	165+	148+
Sub Order: Anisoptera	Odonata	Dragonfly nymphs	0	0	0	1
Pisauridae	Araneae	Fisher spiders	1	2	0	0
-	Tricoptera	Caddisfly larvae	59+	15	3	16
-	Ephemeroptera	Mayfly nymphs	42	69+	76+	10
Simuliidae	Diptera	Sand or Black flies	0	0	3	1
Helminthidae	Coleoptera	Rifle or Marl beetles	3	3	16	23
Lymnaeidae	Class: Gastropoda	Pond snails	0	1	0	0
Sub Order: Hydracarina	Acarina	Water mites	1	9	0	0
Hydrophilidae	Coleoptera	Water scavenger beetles	0	0	0	3
Hygrobiidae	Coleoptera	Screech beetles	3	3	1	10
Dytiscidae	Coleoptera	Diving beetles	1	0	9	53+
Dixidae	Diptera	Midges	0	0	0	0
Helminthidae	Coleoptera	Helminthid larvae	2	1	191+	35
Sub order: Cladocera	Diplostraca	Water fleas	1	9	1	4
Physidae	Class: Gastropoda	Bladder or tadpole snails	0	1	0	0
Pleidae	Hemiptera	Pigmy backswimmer	0	1	1	1
Gyrinidae	Coleoptera	Whirligig larvae	1	0	0	0
Sphaeriidae	Class: Bivalvia	Pea-shell mussel	0	0	1	0
-	Plecoptera	Stonefly nymphs	0	0	1	2
Veliidae	Hemiptera	Water crickets	0	0	0	4
Hydrometridae	Hemiptera	Water measurer	0	1	0	0
Corbiculidae	Class: Bivalvia	Orb-shell mussel	0	1	3	1
Notonectidae	Hemiptera	Water boatman or backswimmers	0	0	0	100+

SIGNAL calculations carried out for AQ10, AQ11, AQ12 and AQ13 gave scores of 5.6, 4.6, 5.1 and 4.5 respectively. This indicates mild to moderate pollution of the waterways within the catchment. The generally higher scores for these streams compared to those in the lower catchments is likely due to the lower intensity of grazing and agriculture that occurs in these areas. While much of the land in this catchment has been cleared there remains a relatively high level of vegetation and open woodlands that would have the effect of "polishing" runoff before it enters creek systems.

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4.4.8 Macro Crustacea Communities

Four species of macro crustacea were observed across the catchment (Table 4-14). These included *Macrobrachium australiense* which was observed at all sites and *Cherax quadricarinatus* which are translocated to the upper Burdekin River Basin (Burrows *et al* 1999).

Table 4-14: Distribution of Macro Crustacea Species across the Belyando Catchment Sampling Sites

Family	Species	Common Name	AQ10	AQ11	AQ12	AQ13
Atyidae	*Caridina sp.*	Shrimp		x	x	
Palaemonidae	*Macrobrachium australiense*	Australian River Prawn	x	x	x	x
Parastacidea	*Cherax quadricarinatus* (T)	Redclaw	x		x	
Parathelphusidae	*Austrothelphusa transversa*	Freshwater Crab				x
Total Number Species Recorded/Site			2	2	3	2

Species type key: (T) Translocated to Basin or site

4.4.9 Fish Communities

Considering the larger sized habitats present at least three of the sites, the catchment had good fish diversity (13 species). There was medium diversity at AQ10, AQ 11 and AQ 12 which is likely attributable to the high seasonality of habitats present. AQ12 recorded the fourth highest fish diversity with eleven species recorded including three recreational fishery associated species, two of which are translocated, *Macquaria ambigua* and *Ocyeleotris lineolata* (Burrows *et al* 1999). *Scortum parviceps*, a species with restricted distribution endemic to the Burdekin River Basin was also recorded. One exotic species, *Oreochromis mossambicai* was recorded and was common at AQ11 but were either not observed (AQ10 and AQ13) or were in extremely low abundances (AQ12). Only a subset of sampling methods were undertaken at AQ11 (i.e. electrofishing, seine netting and macro invertebrates only) as overnight sampling could not be carried out due to access restrictions. Considering the limited sampling methods used at AQ11, the site had relatively high fish diversity (ten species).

The most abundance species observed was *Neosilurus hyrtlii* at both AQ10 and AQ12 with over 528 and 437 individuals caught respectively in the various sampling devices (AQ10 minimum length 77mm, maximum length 241mm; AQ12 minimum length 74mm, maximum length 147mm). Other abundance species included (by abundance) *Melanotaenia splendid*, *Leiopotherapon unicolor* and *Oxyeleotris lineolata*.

Macquaria ambigua was observed to be the longest fish species caught at all sites, although it was only observed at AQ12 from all surveys. *Macquaria ambigua* had a maximum fork length of 443mm (minimum length 223mm; mean length approximately 300mm). The diversity of fishes observed within the Belyando Catchment is listed in Table 4-15.

4.4.10 Turtle Communities

No turtles were observed within the Belyando catchment.

4.5 Other Aquatic Vertebrates

Cyclorana alboguttata, *Litoria inermis* and the exotic *Bufo marinus* were all observed in the catchment.

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Table 4-15: Distribution of Fish Species across the Belyando Catchment Sampling Sites

Family	Species	Common Name	AQ10	AQ11	AQ12	AQ13
Ambassidae	*Ambassis agassizii*	Agassiz's Glassfish	X	X	X	X
Cichlidae	*Oreochromis mossambica* (E)	Tilapia		X	X	
Clupeidae	*Nematalosa erebi*	Bony Bream	X	X	X	
Eleotrididae	*Mogurnda adspersa*	Southern Purple-Spotted Gudgeon		X	X	X
	Hypseleotris klunzingeri	Western Carp Gudgeon		X		
Eleotrididae	*Oxyeleotris lineolata* (F)	Sleepy Cod	X	X	X	X
Melanotaeniidae	*Melanotaenia splendida splendida*	Eastern Rainbowfish	X	X	X	X
Percichthyidae	*Macquaria ambigua* (T)(F)	Yellow Belly			X	
Plotosidae	*Neosilurus hyrtlii*	Hyrtl's Tandan	X	X	X	X
	Neosilurus ater (F)	Black Catfish	X		X	
	Porochilus rendahli	Rendahl's Catfish	X			
Terapontidae	*Leiopotherapon unicolor*	Spangled Perch	X	X	X	X
	Scortum parviceps (R)	Smallhead Grunter	X	X	X	
Total Number Species Recorded/Site			9	10	11	6

Species type key: (E) Exotic, (F) Important to Traditional /commercial/recreational fisheries, ((R) Restricted Burdekin River Basin Endemic, (T) Translocated to Basin or site

Plate 4-10: *Neosilurus hyrtlii*

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5 Coal Terminal

The coal terminal is located adjacent to existing infrastructure at the Port of Abbot Point, approximately 20km north-west of Bowen. This area is characterised by low lying coastal floodplains and wetlands with some elevated areas including Mt Luce.

Abbot Point falls within the Don River Catchment; however the dominant hydrological feature of the coal terminal area is the Abbot Point - Caley Valley Wetlands, which are situated to the south west of the existing coal terminal at Abbot Point. The wetland is currently bunded off from tidal exchange and is fed by a series of small creeks, including Armstrong and Sandy Creek. The total catchment draining into the wetland is approximately 400km^2. The wetland retreats on a seasonal basis to a small lake (Lake Caley) and can become completely dry during drought; however when inundated, it can cover an area of 5,000 ha.

5.1 Topography

The location of the coal terminal straddles the 5m AHD contour with approximately 25ha of the 38ha area located below the 5m AHD contour and 13ha above the 5m AHD contour. Approximately 2.4km of the 5.8km coal conveyor alignment crosses the coastal mudflats below 5m AHD.

The topography of Abbot Point consists of coastal mud flats lying at elevations below 5m AHD and abrupt granitic hills such as Mount Luce located to the west of the coal conveyor alignment and Mount Roundback located to the south east of the coal terminal and conveyor rising to 728m AHD. The coastal plain is dominated by intrusive/extrusive rock types and recent alluvial and erosional geology with a low potential for fossils. This includes the predominantly Palaeozoic granitoid terrain from which the Tenosols and sandy soils are derived and the Quaternary mudflats and alluvial valley floors from which the cracking clays are derived. Quaternary coastal sand dunes and talus outwash surround the granitoid intrusives along the coast.

5.2 Land Use

The land use within the footprint of the coal terminal and broader APSDA include intensive uses associated with the current Port of Abbot Point cover the north eastern corner of the APSDA and grazing lands.

5.3 Previous Studies of Coal Terminal Area

North Queensland Bulk Ports (NQBP) intend expanding their operations at the Port of Abbot Point through an infrastructure expansion program which will expand capacity to 110Mtpa (X110 Project) and also the development of a Multi Cargo Facility (MCF). As part of the MCF EIS, NQBP engaged GHD to undertaken terrestrial (including aquatic) studies over the footprint for the MCF and associated infrastructure. The land-based aspects of the MCF include a haul road, and laydown areas. GHD on behalf of NQBP (2010) undertook aquatic surveys at 16 sites within the footprint that will also be used by the CFP. The sites are shown on Figure 5-1 as NQBP Sites.

Field results indicated that NQBP (2010) observed five species of macro crustacea and eight species of fish. The macro crustacea included *Scylla serrata* (although these were observed in estuarine habitats), a number of of *Uca* spp. (estuarine) and *Grapsidae* spp. which are classified as coastal dunes and shoreline dwellers. NQBP (2010) did not indicate that they observed any freshwater macro crustacea.

With respect to fish species, NQBP (2010) observed eight species of fish. *Leiopotherapon unicolor* were the most abundant species followed by *Lutjanus russelli* and *Terapon jarbau*. Other species include *Mugil cephalus*, *Scatophagus argus* and *Selenotoca multifasciata*, although all of these are classified as migratory species with amphidromous, catadromous or marine vagrant life history. In the freshwater environs, NQBP (2010) caught *Lates calcarifer* (catadromous) and *Ambassis agassizii*.

5.4 Aquatic Habitat

Two sites were sampled in the Don Catchment. AQ1 was located on Splitters Creek between KP2 and KP3. At the sampling site, the stream splits with the base flow heading down the southern arm of the stream. The northern arm is an overflow channel during high flow events. AQ2 was located on a tributary of Saltwater Creek on tributary stream between KP13 and KP14. Locations of the sites are shown on Figure 5-1.

Splitters Creek is a coarse sand bedded coastal flood plain distributary stream. The riparian vegetation is dominated by open forest medium height *Melaleuca leucadendra* overstorey with isolated sub- dominant *Corymbia tessellaris* occur on back levees. Other tree species present forming the open forest community include *Canarium australianum, Casuarina cunninghamiana, Ficus racemosa, Lysiphyllum hookeri Melaleuca viminalis, Nauclea orientalis, Sterculia quadrifida, Tamarindus indica* (E) and *Terminalia sericarpa.* Groundcover is dominated by exotic legumes and pasture species particularly *Panicum maximum.* The surrounding area is cleared to top of stream levee and cattle have open access to banks and beds, with numerous track and pads observed during sampling.

The tributary of Saltwater Creek (AQ2) was an incised narrow (~4m) stream channel within the undulating coastal plain. Riparian overstorey vegetation was not distinct from the surrounding vegetation and comprised of open woodland species including overstorey of *Corymbia clarksoniana, C. dallachiana*, *Eucalyptus crebra*, *E. platyphylla,* and a midstorey of *Acacia* spp*, Atalaya hemiglauca, Carissa ovata* and *Planchonia careya.* While weeds were present, they were not dominant although both *Cryptostegia grandiflora* and *Leucaena leucocephala* were observed.

The aquatic habitats present included riffles, pools (AQ1 ~1.8m max, most <0.5m; AQ2~1 m max), fringing emergent and submergent macrophyte beds (AQ2), root masses, undercut banks, snags, sand beds and litter piles. At AQ1, the water was clear at the time of sampling. The substrate ranged from clay banks to silt to sand channel bed. Stream flow is seasonal with only the deepest pools likely to be perennial in wetter than average years. AQ1 was sampled during the two surface water quality sampling events (WQ2). At AQ2, there was low flow although the landowner indicated that the stream was fed from groundwater and parts of the stream retain perennial pools. Depending on the specific location at the site, there were sparse to dense stands of fringing emergent macrophytes and submergent macrophytes beds (Section 5.6). There was significant floating algal scum in more open canopy reaches which is indicative of nutrient

availability. The water clarity was good and like AQ1, AQ2 was sampled during the two surface water quality sampling events (WQ7). Cattle had open access to both steams.

Rapid Aquatic Habitat Assessment

Rapid habitat assessments were carried out at 15 sites (WQ1 – WQ7) within the Don River Catchment and Caley Valley Wetlands during the water quality monitoring program. Sites WQ1, WQ4, WQ5 and WQ6 were within wetlands associated with the Caley Valley system at Abbot Point. These areas vary between brackish wetland in the wet season and samphire dominated forbland in the dry season therefore do not offer habitat for freshwater species. The other sites in the catchment were generally small, shallow streams (<10m in width) with sandy soils and sediments and sparse riparian areas dominated by wetland species such as *Melaleucas*.

The freshwater sites were shallow and/or steeped banked streams with remnant channels ranging from 2m to 12m wide. All streams had significant flowing water (including rapids and riffles) and sites WQ2 and WQ3 had extensive runs with little to no aquatic plant growth. WQ7 had extensive pools and/or backwaters with a high abundance of in stream aquatic plant growth, both floating and submerged.

Sand was the dominant particle in the freshwater streams the majority of which were moderately restricted at base flow with mid channel non-vegetated bars.

5.5 Mapped Wetland Associated RE and Status

Both sites are listed as being RE11.3.25 (Riverine wetland). The dominant species of this RE include *Eucalyptus camaldulensis* or *E. tereticornis*. Wetland within the rail loop at the coal terminal (between KP0 and KP1) is mapped as RE11.1.2a (Estuarine wetland - e.g. mangroves). Samphire forbland on Quaternary estuarine deposits are also observed within this area. Under the VM Act, the site is listed as being of “Least Concern” and has a Biodiversity status listed as “Of Concern”.RE11.3.25 (Riverine Wetland) at AQ1 is a GBR WMA which is also surrounded by a 100m WMA trigger area as is estuarine wetland RE11.1.2a within the rail loop. There are two RE11.3.31a (Palustrine wetlands - e.g. vegetated swamp) within the area, one 900m north of the rail alignment centre line between KP1 and KP2 and 170m north of the centre line at KP3. Both of these are GBR WPAs which are also surrounded by a 500m WPA trigger area. Under the VM Act, the two sites are listed as being of “Least Concern” and have a Biodiversity status listed as “Of Concern”.

Within the rail alignment, the downstream extension of the riverine wetland RE mapped at AQ1 extends into the mapped boundary of a *Directory Of Important Wetlands in Australia* (DIWA) site QLD001 Abbot Point – Caley Valley Wetland Aggregation. The Caley Valley Wetland has been highly altered as a result of land practices of the past. Without tidal flushing, the wetland becomes progressively hypersaline which can have significant impacts on the local flora and fauna, including water birds that use this habitat as a feeding and nesting area (NQBP, 2010). During water quality surveys, large areas of salt encrusted pans were observed as a result of drying. While not listed as a RAMSAR wetland, the Abbot Point – Caley Valley Wetland Aggregation is listed as wetland of National Significance. This designation does not provide

specific protection under Commonwealth legislation however gives an indication of the high ecological values of the area. Wetland mapping is shown in Figure 5-1 and Figure 5-2.

At AQ1 and AQ2, the surrounding landscape above the banks has been cleared (except for isolated remnant trees) for improved pasture. Downstream extension of mapped riverine wetland includes potentially perennial waterholes. At the rail alignment crossing of Saltwater Creek, the main and tributary stream channels retain broad band of riparian vegetation mapped as RE11.3.25 and the intervening levee and coastal plain areas also retain contiguous remnant vegetation including a sub-dominant "Of Concern"

Plate 5-1: AQ1 – Splitters Creek

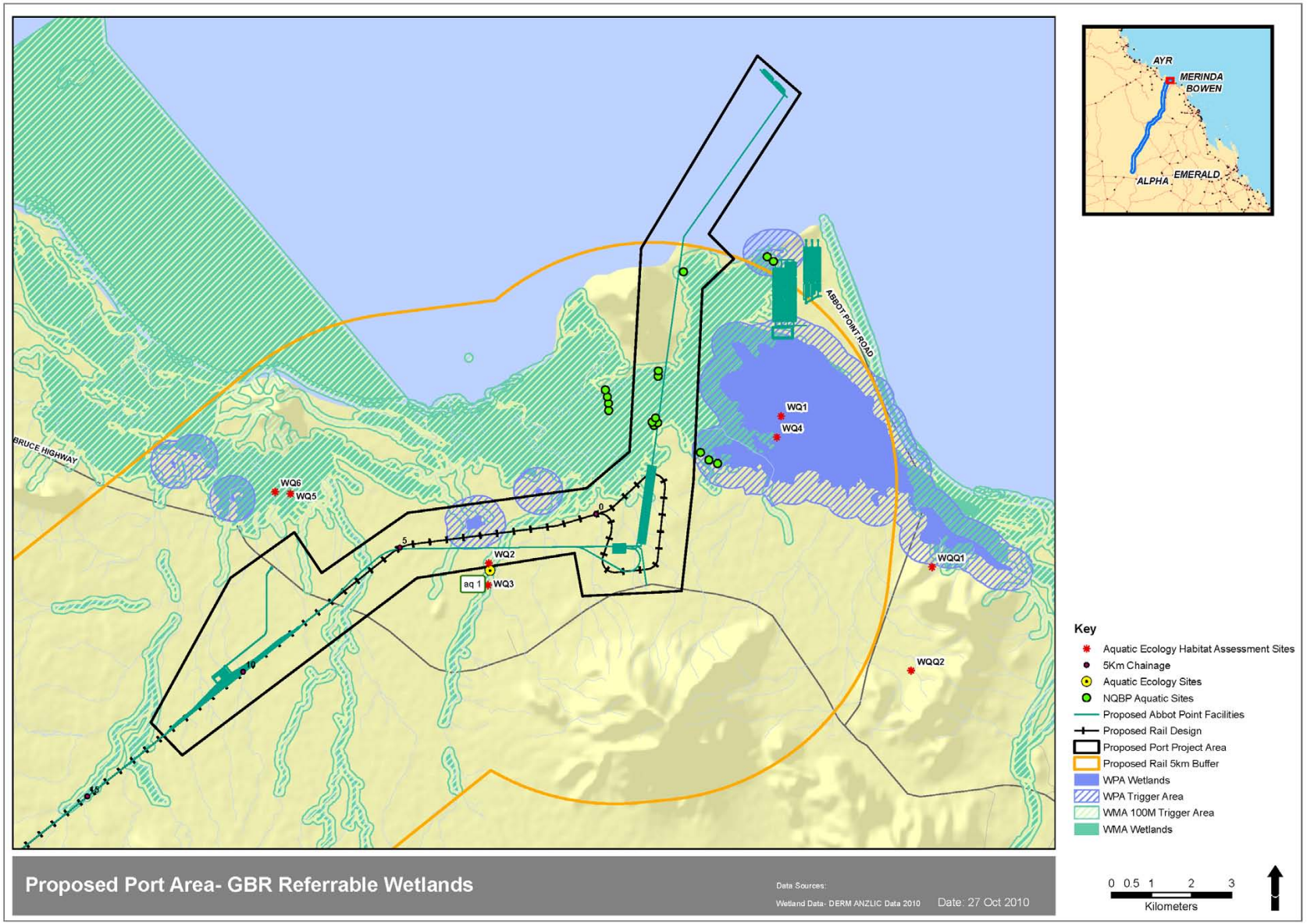

Figure 5-1: GBR Referrable Wetlands: Coal Terminal

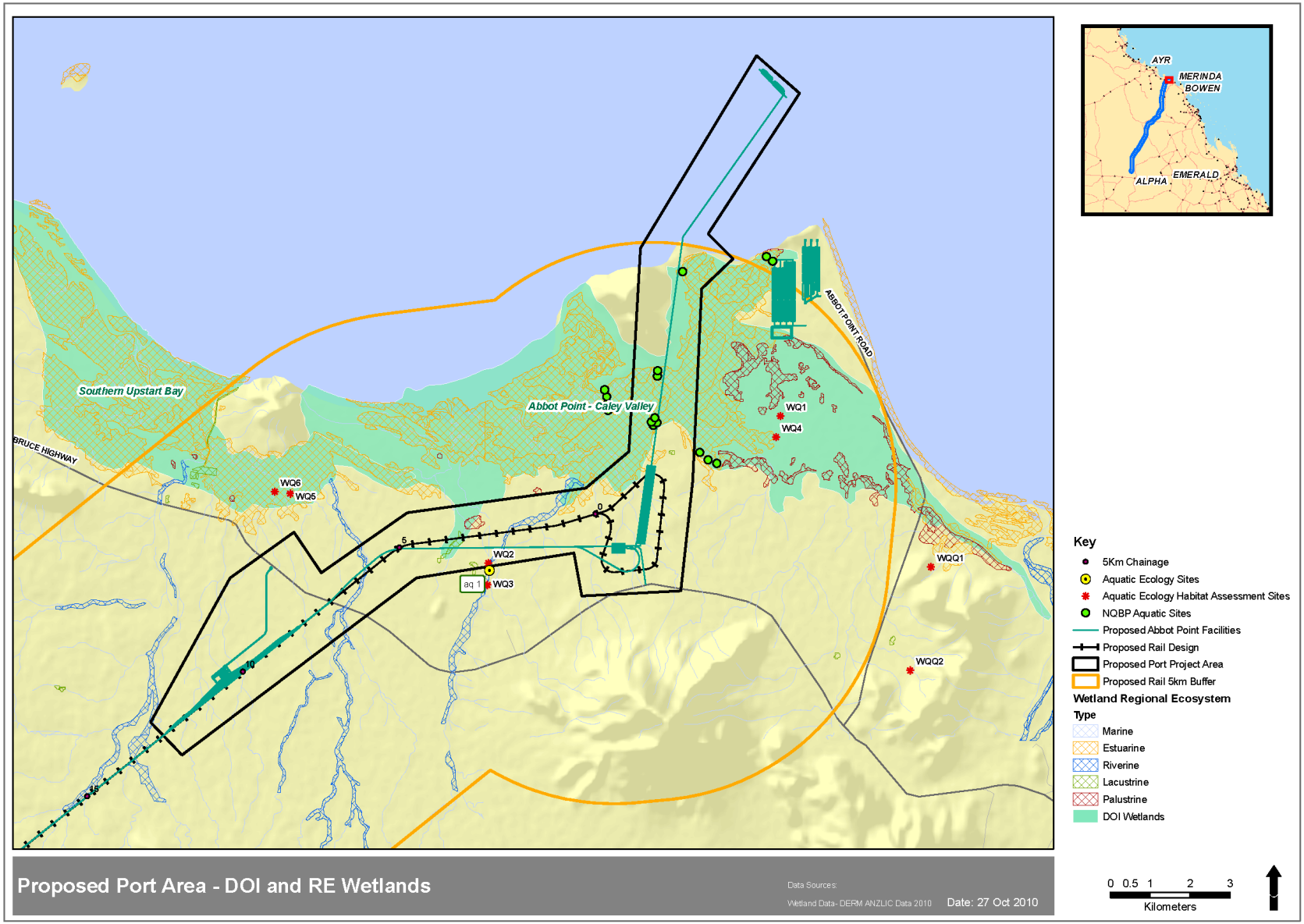

Figure 5-2: Wetland Associated RE: Coal Terminal

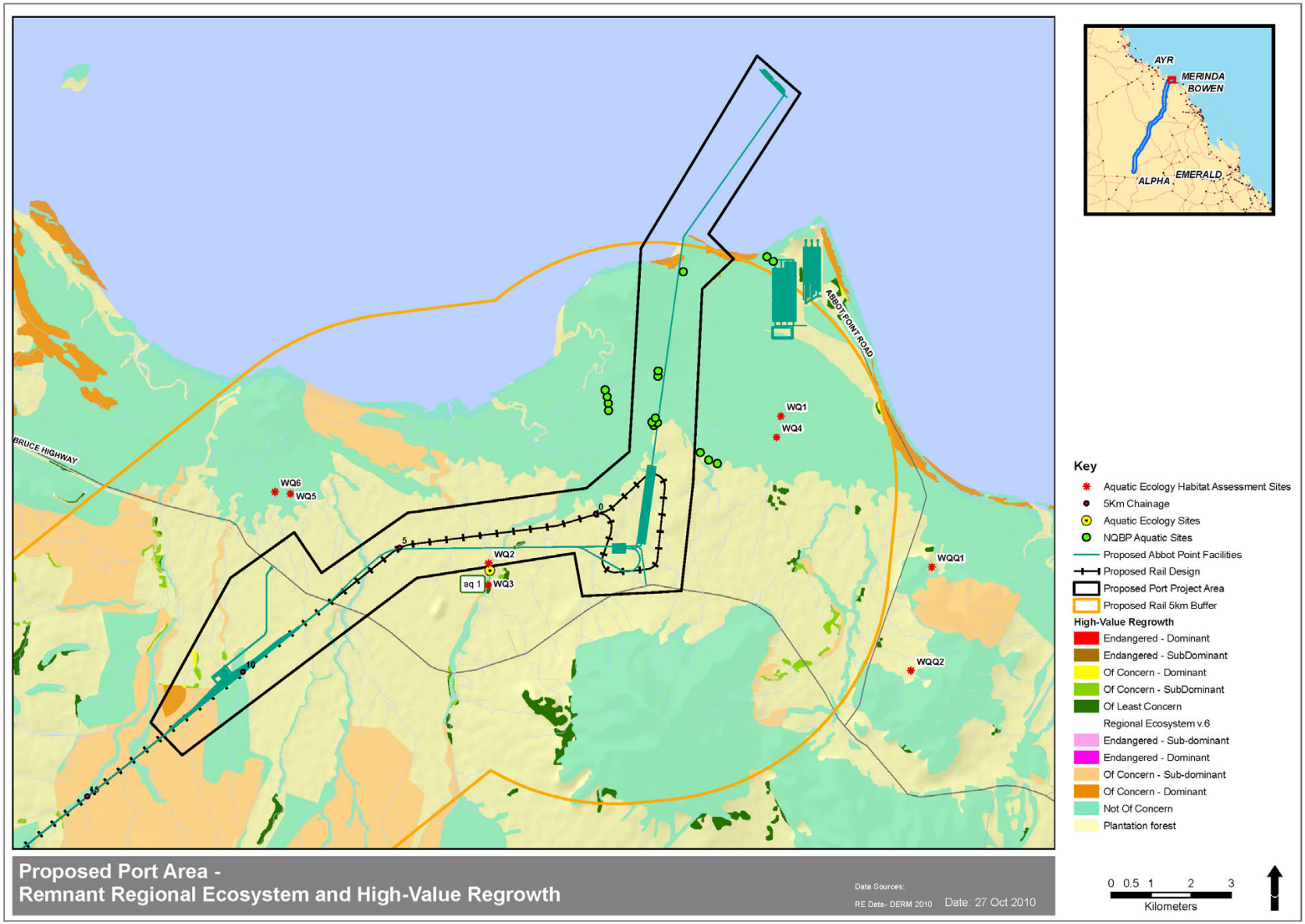

Figure 5-3: High Value Regrowth and Remnant RE: Coal Terminal

5.6 Aquatic Flora

Aquatic flora differed greatly across the two sites. At AQ1, no macrophytes were observed, although in sunlit shallows, large areas of *Spirogyra* spp was growing abundantly. Importantly, while not surveyed during this sampling event, the authors have observed a relatively diverse suite of macrophytes are associated with wetland associated RE11.1.2a and RE11.3.31a downstream of the site in previous studies.

At AQ2, there are well developed emergent macrophyte community occurs on emerged sandy/silty substrate. The macrophytes include *Cyprus difformis*, *C. exaltus*, *Fimbristylis denudata* and *Juncus usitatus*. Several species extend into shallows including tall stands of *Typha domingenis* and low dense stands of *Eleocharis geniculata*. Isolated plants and dense beds of *Aponogeton queenslandicus* occur in the stream channel within pools and slow run (**Error! Reference source not found.** and **Error! Reference source not found.**).

Plate 5-2: ***Aponogeton queenslandicus***

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5.7 Aquatic Macro Invertebrate Communities

A total of 17 families of macro invertebrates were captured across the two sites within the coal terminal area of the CFP (13 families at AQ1 and 11 families at AQ2) (Table 5-1). There were greater abundances of Chironomidae and Ephemeroptera at AQ1 in comparison to other macro invertebrate species and greater abundances of Chironomidae, Helminthid larvae and Ephemeroptera at AQ2.

Table 5-1: Distribution of Macro Invertebrates Species across the Coal Terminal Sampling Sites

Family	Order	Common Name	AQ1	AQ2
Palaemonidae, Atyidae	Decapoda	Shrimp	7	0
Chironomidae	Diptera	Gnats or Midges	58	50
Sub Order: Anisoptera	Odonata	Dragonfly nymphs	3	2
Pisauridae	Araneae	Fisher spiders	1	1
	Tricoptera	Caddisfly larvae	3	13
	Ephemeroptera	Mayfly nymphs	28	22
Simuliidae	Diptera	Sand or Black flies	1	0
Helminthidae	Coleoptera	Riifle or Marl beetles	1	8
Lymnaeidae	Class: Gastropoda	Pond snails	3	0
Planorbidae	Class: Gastropoda	Ramshorn snails	1	0
Culicidae	Diptera	Mosquiotes	5	0
Sub Order: Hydracarina	Acarina	Water mites	2	0
Hydrophilidae	Coleoptera	Water scavenger beetles	3	1
Hygrobiidae	Coleoptera	Screech beetles	0	1
Dytiscidae	Coleoptera	Diving beetles	0	1
Dixidae	Diptera	Midges	0	2
Helminthidae	Coleoptera	Helminthid larvae	0	33

SIGNAL calculations carried out for AQ1 and AQ2 gave scores of 4.5 and 5.5 respectively. This indicates moderate to mild pollution in these waterways. These scores are likely a result of surrounding land uses which are predominantly agricultural with some low density urbanisation throughout the catchment area. These sites also border the Caley Valley Wetlands, which are protected through Commonwealth and State legislation, resulting in less clearing in these areas allowing better waterway health.

5.8 Macro crustacea Communities

A total of four species of macro crustacea were captured across the two sites within the coal terminal area of the CFP (four species at AQ1 and two species at AQ2) (Table 5-2). These observations suggest that the streams, particularly AQ1, are relatively diverse (four species) as the streams includes a crab and freshwater prawn species.

Table 5-2: Distribution of Macro Crustacea Species across the Coal Terminal Sampling Sites

Family	Species	Common Name	AQ1	AQ2
Atyidae	*Caridina sp.*	Shrimp	x	x
Palaemonidae	*Macrobrachium australiense*	Australian River Prawn	x	x
	Macrobrachium tolmerum	East Australian River Prawn	x	
Sesarmidae	*Sesarma sp.*	Mangrove Crab	x	
Total Number Species Recorded / Site			4	2

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5.9 Fish Communities

A total of 13 species of fish were captured across the two sites within the coal terminal area of the CFP including six catadromous species dependent on migratory linkages to marine ecosystems and three fishery associated species (12 species at AQ1 and six species at AQ2) (Table 5-3). One exotic species, *Gambusia holbrooki* was recorded at AQ2. No translocated, restricted or rare species were recorded.

The most abundance species observed was *Melanotaenia splendida splendida* (over 200 individuals at AQ1 (minimum length 17mm; maximum length 67mm; mean length 33mm); 157 individual at AQ2 (minimum length 37mm; maximum length 82mm; mean length 53mm). Other abundance species included (by abundance) *Leiopotherapon unicolor*, *Hypseleotris compressa* and *Ambassis agassizii*.

Lates calcarifer was observed to be the longest fish species caught at both sites, with a maximum length of 157mm although only one individual was caught. With respect to abundance, *Leiopotherapon unicolor* was observed to have a maximum length of 140mm with numerous individuals measuring over 120mm. Other larger species included *Megalops cyprinoides* and *Mugil cephalus.* The observed species are listed in Table 5-3.

Table 5-3: Distribution of Fish Species across the Coal Terminal Sampling Sites

Family	Species	Common Name	AQ1	AQ2
Ambassidae	*Ambassis agassizii*	Agassiz's Glassfish	x	x
Anguillidae	*Anguilla reinhardtii* (M) (F)	Long-finned Eel	x	x
Atherinidae	*Craterocephalus stercusmuscarum*	Flyspecked Hardyhead		
Centropomidae	*Lates calcarifer* (M)(F)	Barramundi	x	
Cichlidae	*Oreochromis mossambica* (E)	Tilapia		
Clupeidae	*Nematalosa erebi*	Bony Bream	x	
Eleotrididae	*Hypseleotris compressa*	Empire Gudgeon	x	x
	Hypseleotris klunzingeri	Western Carp Gudgeon	x	
Megalopidae	*Megalops cyprinoides* (M)	Tarpon	x	
Melanotaeniidae	*Melanotaenia splendida splendida*	Eastern Rainbowfish	x	x
Mugilidae	*Mugil cephalus* (M)(F)	Sea Mullet	x	
Poeciliidae	*Gambusia holbrooki* (E)	Mosquito Fish		x
Scatophagidae	*Scatophagus argus* (M)	Spotted Scat	x	
Terapontidae	*Leiopotherapon unicolor*	Spangled Perch	x	x
	Terapon jarbua (M)	Crescent Perch	x	x
Total Number Species Recorded / Site			12	6

Species type key: (E) Exotic, (F) Important to Traditional /commercial/recreational fisheries, (M) Migratory species with amphidromous, catadromous or marine vagrant life history

5.10 Turtle Communities

NQBP (2010) observed two species of freshwater turtles during their surveys including an adult *Chelodina rankini* which was observed within the coastal scrub. No turtles were observed at either site.

5.11 Other Aquatic Vertebrates

A number of other vertebrate species were observed at the two sites including:

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- *Limnodynastes ornaatus* and both alive and dead *Bufo marinus*;
- A juvenile *Anas superciliosa* - the wetlands adjacent to AQ1 are heavily utilised by waterbirds and waterfowl; and
- *Hydromys chysogaster*.

It is likely as a result of visual observations that *Sus scrofa* inhabit the area and utilise the streams as a water source.

Plate 5-3: *Limnodynastes ornatus*

6 Potential Impacts

The CFP will involve the construction and operation of a mine, a 447km rail alignment including a number of waterway crossings and the development of a coal terminal at Abbot Point. The development has the potential to impact on aquatic ecosystems through:

- The diversion of an ephemeral stream from the open cut areas of the mine site;
- Clearing of semi-contiguous and contiguous riparian vegetation from the CFP construction footprint;
- Creation of breeding habitats for biting insects;
- Direct physical impacts to referable wetlands and wetland associated vegetation;
- Disturbance of indirect impacts on the EPBC Act and NC Act protected *Eucalyptus raveretiana* and rainforest vegetation community allied to endangered RE11.3.11
- Disturbance to any stream channel hosted aquatic refugia;
- Earthworks disturbance in and adjacent to perennial waterholes and associated riverine wetland RE vegetation that provide aquatic refugia;
- Extraction of groundwater within the mine that may impact on recharge of wetlands in the area;
- Obstruction of flow and aquatic fauna passage;
- Reduction of floodplain flow paths supplying downstream wetland habitats including referable palustrine systems;
- Reduction or removal of aquatic habitat connectivity for upstream movement of aquatic fauna from downstream refugia;
- Removal of aquatic habitat connectivity for migratory fauna; and
- Stormwater and associated water entering waterways as runoff, causing changes to physical and chemical water quality;

Specific environmental impacts associated with the individual components of the CFP are discussed below.

6.1 Mine Site

Construction and ongoing operation of the mine has the potential to impact on streams in the region. The activities with the highest risk of causing impacts to aquatic ecosystems include:

- The clearing of vegetation and topsoils from work sites and stockpiling of overburden on site resulting in sediment movement though overland flow;
- The storage of chemicals on site (e.g. hydrocarbons, detergents, degreasers, etc) during construction and operations and the movement of these to streams;
- The storage, seepage and overtopping of potentially contaminated water such as tailings water or pit process water in dams and Basins at the mine site;
- The construction and operation of underground mines which may result in subsidence impacting drainage in the immediate area; and
- The construction of two diversions to divert Tallarenha Creek from the open cut mine areas.

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6.1.1 Clearing and stockpiles

The clearing of vegetation and construction of mine infrastructure (open cut areas, dams, supporting infrastructure, etc) has the potential to increase sediment deposition in streams offsite and therefore reduce the quality and availability of aquatic ecosystems. Overburden dumps have the highest potential to impact surrounding streams in the event of large storm events prior to full rehabilitation. Potential impacts include:

- Siltation of watercourses and aquatic habitat;
- Irregular and unstable land forms due to gully, channel and bank erosion;
- Adverse ecological effects from de-silting streams;
- Reduced ecology and aesthetic value of streams and riparian vegetation;
- Increased turbidity in the streams;
- Clogged drainage infrastructure and increased localised flooding;
- Silting and bank damage to trench works and drainage structures; and
- Increased downtime during construction after storm events while these areas are rehabilitated.

6.1.2 Chemical and water storage

Inappropriately stored and handled chemicals and other hazardous substances have the potential to impact aquatic ecosystems in and around the mine site during construction and operations. Chemical spills or low-level exposure of the aquatic environment to chemicals (e.g. run-off from machinery, including potential vehicle accidents) would most likely involve hydrocarbon products such as fuels and lubricants. Fuels and chemicals will be stored, transported, handled and used in accordance with relevant legislation, regulations, standards and guidelines. As such, the risk of spillage would be low.

6.1.3 Underground mines

The construction and ongoing operations of the underground mines have the potential to cause subsidence directly above the mining areas. Potential impacts would include changed drainage due to ground depressions which may have an effect on the existing hydraulics of surface waters near the mine and thus the aquatic ecosystems. The streams located over the underground mines include unnamed tributaries of Tallarenha Creek.

6.1.4 Diversions

The diversion of Tallarenha Creek would impact on drainage in the region with higher flows caused by the diversion potentially impacting on hydrology and increasing flooding risk of the creeks downstream of the diversions thus reducing the quality and availability of aquatic ecosystems. Potential impacts to hydrology are addressed in the flooding technical report; however increased flows have the potential to have a number of downstream impacts including:

- Erosion and sedimentation within the diverted creeks if opened before vegetation is established and stabilised;

- Increase in water velocity in the diverted creek, with the potential for scour erosion if not managed correctly; and
- Increased upstream and downstream flood levels due to increased flow rates. Existing and planned infrastructure such as roads and rail will need to undergo design reviews to ensure they will not be affected by flooding.

6.2 Rail Alignment

During construction and operation of the rail alignment, there are a number of mechanisms that have the potential to impact on aquatic ecosystems including:

- Impacts on vegetation and banks during bridge construction through their removal, causing sediment movement;
- Disturbance and stockpiling of soils causing increased turbidity or suspended solids within the water column;
- Piling and culvert works for stream crossings;
- Use of potentially contaminated/low quality water for dust suppression and other site activities; and
- Storage of oil, fuel and chemicals on site.

6.2.1 Clearing and disturbance of soils

Construction activities are expected to be relatively invasive, involving extensive excavations including removal of large areas of vegetation in order to create works areas near streams to construct culverts and bridges for crossings. This has the potential to increase sediment loads within the stream as well as nutrients and toxicants associated with the suspended sediment and reduce the quality and availability of aquatic ecosystems. The stockpiling of topsoils near streams also has the potential to increase sediment loads in streams if not managed properly.

Excavation activities may also result in the disturbance and exposure of Acid Sulfate Soils (ASS) in the Don Catchment within the coal terminal area which can then impact on aquatic ecosystem; however further testing needs to be undertaken to determine their presence and extent. Potential impacts from ASS disturbance include:

- Damage or death of aquatic fauna and flora;
- The release of iron, aluminium and other metals into surface water, which reduces water quality;
- Damage to infrastructure which is subject to corrosion from acidic water; and
- Slumping of structures built on material containing ASS, as this soil type generally has a low-bearing capacity.

6.2.2 Piling

Construction will involve the driving of concrete piles and placement of culverts within the riparian zone and potentially the watercourse itself. These works will result in direct disturbance to the streams,

especially for crossings requiring piling or the placement of structures in the stream itself. Potential impacts include the re-suspension of bottom sediments into the water column increasing turbidity and any toxicants present in the sediment.

Noise, light and vibrations associated with works on or near waterway crossings also have the potential to impact on aquatic species by disturbing fish behaviour or impairing hearing, sight and other identification mechanisms. This could disrupt normal behaviour such as breeding or predator / prey interactions.

6.2.3 Release of potentially contaminated water

Construction of the railway will require substantial quantities of water for dust suppression (not quantifiable at present), landscaping, and surface stabilisation or compaction purposes. Due to the remoteness of large section of the rail alignment, town water supplies may not be available or practical for use. Supply for construction purposes is likely to be sought from non-potable sources such as existing streams, private dams or quarry sites (i.e. the quarry at Abbot Point). Water from non-potable sources may have poor water quality, and if run-off from the construction site occurs at a high velocity, it may contribute to lowering water quality in the catchment and therefore reduce the quality and availability of aquatic ecosystems.

6.2.4 Spills

Chemical spills or low-level exposure of the aquatic environment to chemicals (e.g. run-off from machinery, including potential vehicle accidents) would most likely involve hydrocarbon products such as fuels and lubricants. Fuels and chemicals will be stored, transported, handled and used in accordance with relevant legislation, regulations, standards and guidelines. As such, the risk of spillage would be low.

6.2.5 Operational phase impacts

There is little available information specifically addressing the effect of operational rail lines on water quality, however impacts to aquatic ecosystems may occur if site runoff is not managed correctly. It is likely that a number of potential contaminants could be released from trains, including oils and lubricants, which could disperse into downstream environments and reduce the quality and availability of aquatic ecosystems. Such releases could either occur as a result of a single major incident or multiple small releases from the day to day operations of rail infrastructure.

Major incidents releasing contaminants into streams have the greatest potential to impact on aquatic fauna if spill response efforts are not carried out in a timely manner. However, the effects of multiple small releases over extended periods are difficult to quantify and will be highly dependent on the nature of the chemical released.

6.3 Coal Terminal

The components of the coal terminal with the most potential to impact on aquatic ecosystems include construction of the coal stockyards and conveyor transporting the coal to the wharf and ongoing operation of the stockyards and conveyor. The activities with the most potential to impact streams include:

- Piling works associated with the conveyor through the Caley Valley wetlands;
- Clearing of vegetation, excavations and stockpiling of materials, including potential ASS, associated with construction of the coal stockyards;
- Use of potentially contaminated/low quality water for dust suppression and other site activities; and
- Storage of oil, fuel and chemicals on site.

6.3.1 Piling

Construction of the supporting structures for the coal conveyor will likely require piling within the Caley Valley Wetland. Impacts to aquatic ecosystems resulting from these works would be dependent on the methodology employed (i.e. vibrocoring would result in reduced impacts compared to a hammer piling) but will likely include:

- Disturbance of ASS which may result in the impacts if not managed appropriately;
- Re-suspension of sediment from the wetland into the water column. These sediments have the potential to contain high levels of metals such as arsenic; and
- Impacts resulting from leaching of any materials used in the construction of the supporting structures.

Potential impacts resulting from the storage clearing, the use of potentially contaminated water on site and storage of chemicals on site are similar to those described for the mine and rail components.

7 Management Measures

The mitigation measures applicable to the potential impacts on aquatic ecosystems are described in Table 7-1.

Table 7-1: Aquatic Ecosystem Management Measures

Potential Impact	Management measure	Component	Timing	Responsibility
Direct impacts on Wetland Vegetation	Avoid disturbing broad diverse riparian vegetation assemblages, high value habitat nodes and corridors in highly fragmented landscapes to remove linkages across semi contiguous and contiguous corridors through variation in alignment or changes in design of structures.	Mine, rail and coal terminal	Pre Construction	Design Engineers
Direct disturbance due to proximity to faunal habitat	Commit to avoid important habitats by 500m through design.	Mine, rail and coal terminal	Pre Construction	Design Engineers
Loss of connectivity terrestrial – riparian ecotonal vegetation corridors	Design alignment crossing to be elevated to minimise dissection of contiguous ecotonal vegetation corridors and high value habitat nodes and corridors in highly fragmented landscapes.	Rail	Pre Construction	Design Engineers
	Incorporate wildlife underpasses into design of bridges and culverts crossing waterways.			
	Revegetate understorey and mid storey vegetation in clearing corridors across drainage lines following construction.			
Geomorphic impacts that cause the loss of aquatic refugia	Engineer bridge foundation works so as they do not affect stream bed loads, bedrock chokepoints, channel avulsion due to modification/constriction of high flows, leveeing floodplain flows, altering floodplain flow paths, sediment run in at bridge cutting sites, potential impacts on groundwater aquifers/ discharge points.	Mine, rail and coal terminal	Pre Construction	Design Engineers
Loss of connectivity hydrological between aquatic habitats due physical structures, altered flow hydrology, geomorphic impacts	Commitment to best practice maintenance of fish passage via appropriate structures (Cotterell, 1998).	Mine, rail and coal terminal	Pre Construction	Design Engineers
Erosion and sediment control impacting aquatic ecosystems	Develop of an Erosion and Sediment Control Plans (ESCPs) for the mine, rail and coal terminal works detailing control measures to be implemented, construction details, dimensions, materials used, expected outcomes and staging of erosion and sediment control once construction is complete. The ESCP will be signed off by the appropriate authority prior to the commencement of works.	Mine, rail and coal terminal	Pre Construction	Construction Contractor
	Sediment control structures will be regularly checked, repaired, replaced or cleaned out. They shall be maintained so that they will always have 70% of their capacity available.	Mine, rail and coal terminal	Pre Construction	Construction Contractor

Potential Impact	Management measure	Component	Timing	Responsibility
	Ensure all sediment from work sites remains outside of drainage lines, streams and existing stormwater treatment devices. No material should be stockpiled within known drainage lines. Any material transported from work areas into these places should be cleaned as soon as practicable.	Mine, rail and coal terminal	Pre Construction	Construction Contractor
	All stockpiled material is to be kept inside bunded/sediment fenced areas with delineated access points.	Mine, rail and coal terminal	Construction	Construction contractor
	Temporary sediment control fences will be installed around any stockpiles in place for more than one week.	Mine, rail and coal terminal	Construction	Construction contractor
Material transport	Limit vehicle access during construction to access tracks and designated construction areas.	Mine, rail and coal terminal	Construction	Construction contractor
	Sediment on vehicle should be prevented from being carried out from the site onto local roads. A vehicle shakedown area at the entrance to work sites will ensure sediment is removed before accessing off-site road networks.	Mine, rail and coal terminal	Construction	Construction contractor
	Any material spilled from trucks must be recovered from road surfaces and placed in designated fill areas, stockpiles or disposal areas.	Mine, rail and coal terminal	Construction	Construction contractor
	Wash down of plant and equipment shall be undertaken only where there are appropriate handling facilities. If on-site wash down is unavoidable, a bunded, impervious receptacle will be used.	Mine, rail and coal terminal	Construction	Construction contractor
Safe and effective fuel, oil and chemical storage and handling	Ensure safe and effective fuel, oil and chemical storage and handling on site.	Mine, rail and coal terminal	Construction	Construction contractor
	Ensure all oils, fuels and chemicals for use at the site are located within roofed, bunded areas with a storage capacity exceeding the capacity of the storage vessel by 100%.	Mine, rail and coal terminal	Construction and operation	Construction contractor
	All refuelling facilities and the storage and handling of oil and chemicals will comply with the relevant Australian Standards.	Mine, rail and coal terminal	Construction	Construction contractor
	Machinery is not to be left unattended while it is being refuelled.	Mine, rail and coal terminal	Construction and operation	Construction contractor
	Fuel facilities should have back pressure automatic shut-off nozzles.	Mine, rail and coal terminal	Construction and operation	Construction contractor
Spill control	Appropriate spill control materials including booms and absorbent materials will be maintained on site and at refuelling facilities for use in the event that a substance is spilled into the surrounding waters. In the event of a spill to the environment, the following actions will be undertaken:	Mine, rail and coal terminal	Construction and operation	Construction contractor

Potential Impact	Management measure	Component	Timing	Responsibility
	• Fuel/oil clean up kits including absorbent materials are to be kept on site at all times; • Any spills to be contained, and cleaned up immediately; and • No flushing of spills into streams or drainage channels.			
Acid Sulphate Soils (ASS)	An ASS Management Plan will be developed prior to the commencement of construction which will include the results of detailed site investigations and put in place management measures to reduce the potential for ASS to impacts on aquatic ecosystems.	Mine, rail and coal terminal	Construction and operation	Construction contractor
Dams	A dam failure impact assessment should be carried out for any proposed dams. Any dams that are likely to be referrable under the *Water Act 2000* should be noted and emergency response procedures developed.	Mine, rail and coal terminal	Construction	Construction contractor
Stormwater	Develop storm water management plans for each component of the construction. These should consider the use of storm water tanks and re-use of grey water.	Mine	Pre Construction	Waratah Coal
Construction Timing	Where possible stream crossing works for the rail alignment will be carried out during the dry season (April – October) when many of the streams are unlikely to contain flowing water and there is less risk from tropical storms.	Mine, rail and coal terminal	Pre Construction	Waratah Coal
Works within streams	Where works are to be carried out within the streams themselves (i.e. piling for creek crossings and the coal conveyor) sediment sampling will be carried out to identify potential contaminants.	Rail	Construction	Construction contractor
	Where possible vibrocorers will be used in preference to hammer pile drivers to reduce re-suspension of bottom sediments.	Rail and coal terminal	Pre Construction	Waratah Coal
	Limit lighting to that which is required for operations and employing lighting with directional guards to minimise effect on non target areas.	Rail and coal terminal	Construction	Construction contractor
	Maintain all plant and equipment and fit noise reducers where possible.	Rail and coal terminal	Construction	Construction contractor

7.1 Monitoring Program

An aquatic ecosystem monitoring program will be put in place for construction works through the Construction Environmental Management Plans (EMP). The monitoring program will incorporate the following:

- Impact monitoring criteria will be included in the EMP. Criteria will be developed for each of the catchments addressed in this report (Don, Lower Catchment, Bowen, Suttor and Belyando);
- Monitoring will include visual inspections of construction areas and surrounding waters for evidence of spills; and
- Physical and chemical water quality monitoring will be carried out up and down stream of work sites for the mine, railway and coal terminal;

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8 Conclusion

Baseline aquatic ecology investigations were undertaken at 14 sites encompassing the three main components of the project, this being the mine, rail alignment and coal terminal. There are five main catchments based on the major rivers and their tributaries within the rail alignment, these being the Belyando, Suttor, Bowen, Lower Catchments and Don (coal terminal area) heading downstream. The whole CFP falls within the Burdekin Catchment.

Desktop investigations also suggested that *Apus pacificus* (EPBC Act - Migratory and Marine), *Crocodylus porosus* (EPBC Act and NC Act - Vulnerable), *Ephippiorhynchus asiaticus* (NC Act - Near Threatened), *Eucalyptus raveretiana* (EPBC Act and NC Act Vulnerable), *Haliaeetus leucogaster* (EPBC Act - Migratory and Marine), *Hirundapus caudacutus* (EPBC Act - Migratory and Marine), *Nettapus coromandelianus* (NC Act - Near Threatened) and *Tadorna radja* ((NC Act - Near Threatened) occur within the Bowen Catchment and Lower Catchments. Of these, *Eucalyptus raveretiana* was observed at numerous locations.

There are numerous important wetland related regional ecosystems and wetlands within the CFP footprint. These occur on the mine area, within the rail alignment footprint and at the coal terminal. There are also numerous wetlands considered of *high ecological significance* and that are listed as Great Barrier Reef Wetland Protection Areas and Wetland Management Areas which have 100m and 500m buffer zones around the wetland itself.

A total of 34 species of macro invertebrates, eight species of macro crustacea and 28 species of fish were observed across the project area. This fishes observed during the study included three catadromous, one facultative amphidromous fish species dependent on migratory linkages to the ocean and seven fishery associated species. Species richness was highest within the Bowen River Catchment of the CFP. A number of turtles and other aquatic related vertebrate species were also observed during field work that should be considered when constructing the project.

Construction works that have the most potential to impact on aquatic ecosystems include:

- Clearing of semi-contiguous and contiguous riparian vegetation faunal corridors;
- Construction and runoff from vehicle and rail crossing at all streams crossing;
- Creation of breeding habitats for biting insects;
- Direct physical impacts to referable wetlands and wetland associated vegetation;
- Disturbance of indirect impacts on the EPBC Act and NC Act protected *Eucalyptus raveretiana* and rainforest vegetation community allied to endangered RE11.3.11
- Disturbance to any stream channel hosted aquatic refugia;
- Earthworks disturbance in and adjacent to perennial waterholes and associated riverine wetland RE vegetation that provide aquatic refugia;
- Extraction of groundwater within the mine that may impact on recharge of wetlands in the area;
- Leakage and seepage of tailings waters entering subterranean waters that filter into streams, causing changes to physical and chemical water quality;
- Obstruction of flow and aquatic fauna passage;

- Reduction of floodplain flow paths supplying downstream wetland habitats including referable palustrine system;
- Reduction or removal of aquatic habitat connectivity for upstream movement of aquatic fauna from downstream refugia;
- Removal of aquatic habitat connectivity for migratory fauna;
- Stormwater and associated water entering streams as runoff into streams, causing changes to physical and chemical water quality; and
- Tailing dams overflow entering streams into streams, causing changes to physical and chemical water quality.

Management measures including the variations of design including bridge structures and the to development of an ESCP to reduce potential impacts resulting from the works and also an assessment prior to construction of important perennial waterholes that may act as refugia during dry seasons and based on that assessment, move the rail alignment so as the project does not impact these locations.

If properly managed the impacts to surface water resulting from the works are expected to be minimal.

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9 Recommendations

It is recommended that the following actions be carried out be Waratah Coal:

- The design of road and rail crossings will be planned to avoid streams and important aquatic and associated habitat;
- The selection the final alignment will avoid the dissection of broader expression of riparian vegetation communities;
- Maintain floodplain flow paths that supply downstream wetland habitat;
- Where possible avoid impacts on *Eucalyptus raveretiana* communities through placement of the rail alignment. Where impacts are unavoidable manage works appropriately to minimise the extent of clearing and ensure disturbance does not exceed footprint areas;
- Design the final alignment so as to not impact on wetlands with *high ecological significance* or those listed as GBR WPA and WMA and maintain a 500m buffer zones around the wetlands;
- Undertake dry season field works to identify perennial water holes/aquatic refugia within the crossed seasonal drainage lines so as to allow the design engineers to avoid the potential for aquatic ecological impact on these locations;
- Developing ASS management and ESCPs prior to the commencement of construction;
- Develop storm water management plans for each component of the construction. These will consider the use of storm water tanks and re-use of grey water;
- Carry out aquatic sampling where works are to be carried out within the streams themselves (i.e. piling for creek crossings and the coal conveyor) to identify potential contaminants; and
- Develop a construction EMP incorporating monitoring requirements for aquatic ecosystems.

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Queensland Department of Environment and Resource Management "Wildlife Online database to identify aquatic flora and fauna species including threatened species listed under the Queensland *Nature Conservation Act 1992* (NC Act)"

Queensland Department of Environment and Resource Management "Regional Ecosystem (RE) and Essential Habitat Mapping (Version 5.0, 2005)

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Abbreviations and Glossary of Terms

Abbreviations

Abbreviation	Meaning
ASS	acid sulfate soil
Abbot Point X110	the Abbot Point Coal Terminal Expansion X110 project
ACTFR	Australian Centre for Tropical Freshwater Research
AHD	Australian Height Datum
ANRA	Australian Natural Resources Atlas
APSDA	Abbot Point State Development Area
AusRivas	Australian River Assessment System
CEMP	Construction environmental management plan
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Cth	Commonwealth
DEEDI	Queensland Government Department of Employment, Economic Development and Innovation
DERM	Queensland Government Department of Environment and Resource Management
DEWHA	Australian Government Department of the Environment, Water, Heritage and the Arts
DIWA	Directory of Important Wetlands In Australia
DPI	former Department of Primary Industries (Qld)
E	Exotic
EIS	Environmental Impact Statement
EMP	Environmental management plan
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Cth)
ERT	Environment Reporting Tool
EPC	Exploration permit coal
ESCP	Erosion and sediment control plan
FHA	fish habitat area
Fisheries Act	*Fisheries Act 1994*
GBR	Great Barrier Reef
GQAL	good quality agricultural land
JCU	James Cook University
km^2	square kilometre
KP	kilometre point

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Abbreviation	Meaning
mAHD	metres above Australian Height Datum
MCF	Multi Cargo Facility
mm	millimetre
MNES	matters of national environmental significance
NC Act	*Nature Conservation Act 1992*
NQBP	North Queensland Bulk Ports Corporation Limited
NRM	Natural Resource Management
pers. comm.	personal communication
Qld	Queensland
QPI&F	Queensland Primary Industries and Fisheries (see DPIF)
RE	regional ecosystem
REDD	regional ecosystem description database
SDPWO Act	State Development and Public Works Organisation Act 1971 (QLD)
sp.	species (singular)
spp.	species (plural)
SPOCAS	Suspension peroxide oxidation combined acidity and sulphur analysis for acid sulfate soils using peroxide oxidisable sulphur (Spos) to determine sulphur percent
spp.	species (plural)
µm	micron
VM Act	*Vegetation Management Act 1999*
WMA	Wetland Management Areas
WPA	Wetland Protection Areas

Glossary of Terms

Abbreviation	Meaning
Acid sulfate soils	Naturally occurring soils, sediments or organic substrates (e.g. peat) that are formed under waterlogged conditions. These soils contain iron sulfide minerals (predominantly as the mineral pyrite) or their oxidation products. In an undisturbed state below the water table, acid sulfate soils are benign. However if the soils are drained, excavated or exposed to air by a lowering of the water table, the sulfides will react with oxygen to form sulfuric acid.
Alluvial	Pertaining to, contained in, or composed of, alluvium; relating to the deposits made by flowing water; washed away from one place and deposited in another; as alluvial soil, mud, accumulations, or deposits.
Alluvial terrace	Former floodplain which either no longer floods or rarely floods due to deepening or

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Abbreviation	Meaning
	enlargement of the stream channel.
Alluvium	Sediment deposited from the transport by channelled stream flow or over-bank stream flow.
Aquatic ecosystems	The abiotic and biotic component, habitats and ecological processes contained within rivers and their riparian zones and reservoirs, lakes, wetlands and their fringing vegetation.
Aquatic macrophytes	Plants which grow in or near water. In lakes macrophytes provide cover for fish and substrate for aquatic invertebrates, produce oxygen, and act as food for some fish and wildlife. A decline in a macrophyte population may indicate water quality problems.
Aquifer	A water-saturated geologic unit that is capable of transmitting significant or usable quantities of groundwater under ordinary hydraulic gradients.
Aquitard	A water-saturated sediment or rock whose permeability is so low it cannot transmit any useful amount of water. An aquitard allows some measure of leakage between the aquifer interval it separates.
Artesian	A condition which applies to aquifers which are confined by layers of low permeability, and where the hydraulic head in the aquifer is higher than the overlying ground surface. Wells penetrating such aquifers may result in groundwater flowing at the surface without pumping.
Basin	A topographic depression containing, or capable of containing, sediment.
Bedrock	The solid rock that underlies unconsolidated surficial sediments.
Benthic	Relating to the bottom (bed) of any water body.
Buffer	Area of vegetation providing protection from disturbance.
Catadromous	Living in fresh water but migrating to marine waters to breed.
Catchment	The term used to describe the area which is drained by a river. It is sometimes called the river basin or watershed. The catchment is the most significant factor determining the amount or likelihood of flooding.
Channel	An eroded depression in the soil or bedrock surface within which alluvial deposits accumulate (i.e. gravel, sands, silt, clay).
Coal Terminal	A new coal terminal that is incorporated within the APSDA and existing infrastructure at the Port of Abbot Point, 22km north/west of Bowen
Dam	A land-based structure or void that will contain, divert or control flowable substances. For the purposes of this study, a pond is also referred to as a dam.
Datalogger	An electronic device that records data over time or in relation to location either with a built in instrument or sensor or via external instruments and sensors.
Dominant	One or more species, by means of their number, coverage, or size that exerts considerable influence upon or control of the conditions of existence of associated species.

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Abbreviation	Meaning
Ecology	The scientific study of the distribution and abundance of life and the interactions between organisms and their environment. The environment of an organism includes physical properties, which can be described as the sum of local abiotic factors such as insolation (sunlight), climate, and geology and biotic factors, which are other organisms that share its habitat.
Ecological Community	An assemblage of species occupying a particular area
Ecosystem	A natural unit consisting of all plants, animals and micro-organisms (biotic factors) in an area functioning together with all of the non-living physical (abiotic) factors of the environment.
EIS Study Area	The EIS Study Area (or the Study Area) refers to the region encompassing the Mine Catchment, Abbot Point Catchment and Broader Service Area and represents the region in which the project is located and expected to have the greatest direct impact.
Electrofishing	The use of electricity to stun fish. Electrofishing is a common scientific survey method used to sample fish populations to determine abundance, density, and species composition. When performed correctly, electrofishing results in no permanent harm to fish, which return to their natural state in as little as 2 minutes after being stunned.
Emergent species	A species that emerges above the canopy or overstorey.
Endangered	Designated as 'Endangered' under the EPBC Act, NC Act and / or VM Act. Refer to definitions of 'EPBC Act conservation status', 'NC Act conservation status' and 'VM Act conservation status' for meaning of Endangered under each Act
Endemic	A species restricted to a particular place or region.
Environmental Impact Assessment (EIA)	The process used to assess the environmental impact of a proposed development.
Environmental Impact Statement (EIS)	The information document prepared by the proponent when undertaking an environmental impact assessment. It is prepared in accordance with terms of reference prepared or approved by government. EIS is the term used by the *Environment Protection and Biodiversity Conservation Act 1999* and the *Environmental Protection Act 1994*, and it is defined in Part 4 of the *State Development and Public Works Organisation Act 1971*.
Environmental Management Plan	A document developed by proponents during a project's planning and design. An Environmental management plan (EMP) provides life-of-project control strategies in accordance with agreed performance criteria for specified acceptable levels of environmental harm. It may continue through the whole life of a project (e.g. preconstruction, construction, operation and decommissioning).
EPBC Act conservation status	Under the EPBC Act, listed threatened species and ecological communities are assigned a conservation status of 'extinct in the wild', 'Critically Endangered', 'Endangered' or 'Vulnerable'. Definitions of these terms under the EPBC Act areas follows: Extinct in the wild

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Abbreviation	Meaning
	• it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range or • it has not been recorded in its known and / or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form. Critically Endangered • it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria. Endangered • it is not Critically Endangered and • it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria. Vulnerable • it is not Critically Endangered or Endangered and • it is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Ephemeral	A stream, creek, river or waterbody that carries or contains water only during or immediately after irregular rainfall or flow events. These waterbodies have limited baseflow component with no groundwater discharge during the no flow period.
Epifauna	Benthic invertebrates that attach themselves to rocky reefs or to the seafloor. They include hydroids, sea-pens, small bryozoans and sponges.
Erosion	The process by which material, such as rock or soil, is worn away or removed by wind or water.
Estuarine	Pertaining to aquatic habitats where freshwater from streams or rivers mixes with sea water, resulting in a gradation of brackish waters with varying degrees of salinity. The estuarine environment consists of deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partially obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land.
Exotic	An introduced species.
Fauna	Animal life.
Floodplain	An area of land periodically inundated by floodwater.
Flora	Plant life.
Fluvial	Material deposited by moving water (i.e. rivers and streams).
Fluvial deposits	Particles of minerals or rocks which are transported and deposited by moving water (i.e. a river).

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Abbreviation	Meaning
Fresh water	Water that is not salty, especially when considered as a natural resource.
Galilee Coal	Waratah Coal China First Project
Good quality agricultural land	Land which is capable of sustainable use for agriculture, with a reasonable level of inputs, and without causing degradation of land or other natural resources. As defined in State Planning Policy 1/92: Development and the Conservation of Agricultural Land.
Groundwater	All the water contained in the pores/voids within unconsolidated sediments or consolidated rocks (i.e. bedrock).
Habitat	An area or areas permanently, periodically or occasionally occupied by a species, population or ecological community, including any and all biotic and abiotic features of the area or areas occupied
Half graben	A topographic depression that forms as a result of movement on a fault plane.
Impermeable layer	A layer of material (such as clay) in an aquifer through which water does not pass.
Instream flow needs	The amount of water required in a river to sustain a healthy aquatic ecosystem, and/or meet human needs such as recreation, navigation, waste assimilation or aesthetics.
Lagoon	A body of water enclosed by a barrier, such as a water storage pond.
Landscape	Natural and manmade features of the urban, rural or natural environment, such as vegetation, topography and land use elements.
Least Concern	Designated as 'Least Concern' under the VM Act. Refer to definition of 'VM Act status' for meaning of 'Least Concern' under the Act.
Likelihood	Used as a general description of probability or frequency. Can be expressed qualitatively or quantitatively (AS/NZS ISO 3100:2009 Risk management – Principles and guidelines).
Loam	A medium, textured soil of approximate composition 10 – 25 per cent clay, 25 - 50 per cent silt and <50 per cent sand.
Macroinvertebrates	The taxonomic group of freshwater invertebrates, which are visible without magnification.
Matters of national environmental significance	Matters of national environmental significance, as defined under the *Environment Protection and Biodiversity Conservation Act 1999*.
Micro-habitat	A small localized habitat within a larger ecosystem.
Migratory species	Species listed as 'Migratory' under the EPBC Act
Mine footprint	Area to be cleared for mining activities.
Mitigation	Actions that can be taken to reduce the affect of actions/works.
NC Act conservation status	Under the NC Act, protected species are assigned a conservation status of 'Extinct in the wild', 'Endangered', 'Vulnerable', 'Near Threatened', or 'Least Concern'. Definitions of these terms under the NC Act are as follows:

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Abbreviation	Meaning
	Extinct in the wild there have been thorough searches conducted for the wildlife and it has not been seen in the wild over a period that is appropriate for the life cycle or form of the wildlife. Endangered there have not been thorough searches conducted for the wildlife and the wildlife has not been seen in the wild over a period that is appropriate for the life cycle or form of the wildlife or the habitat or distribution of the wildlife has been reduced to an extent that the wildlife may be in danger of extinction or the population size of the wildlife has declined, or is likely to decline, to an extent that the wildlife may be in danger of extinction or the survival of the wildlife in the wild is unlikely if a threatening process continues. Vulnerable its population is decreasing because of threatening processes or its population has been seriously depleted and its protection is not secured or its population, while abundant, is at risk because of threatening processes or its population is low or localised or depends on limited habitat that is at risk because of threatening processes. Near Threatened the population size or distribution of the wildlife is small and may become smaller or the population size of the wildlife has declined, or is likely to decline, at a rate higher than the usual rate for population changes for the wildlife or the survival of the wildlife in the wild is affected to an extent that the wildlife is in danger of becoming vulnerable. Least Concern the wildlife is common or abundant and is likely to survive in the wild. Native wildlife may be prescribed as Least Concern wildlife even if: the wildlife is the subject of a threatening process or the population size or distribution of the wildlife has declined or there is insufficient information about the wildlife to conclude whether the wildlife is common or abundant or likely to survive in the wild.
Near Threatened	Designated as 'Near Threatened' under the NC Act. Refer to definition of 'NC Act conservation status' for meaning of Near threatened under the NC Act.
Non-remnant vegetation	Vegetation that is not mapped as remnant vegetation by DERM and / or which fails to meet DERM's criteria for 'remnant vegetation' (see definition of 'remnant vegetation', below). This includes regrowth, heavily thinned or logged vegetation and significantly

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Abbreviation	Meaning
	disturbed vegetation that fails to meet the structural and / or floristic characteristics of remnant vegetation. It also includes urban and cropping land. Non-remnant vegetation may retain significant biodiversity values (Neldner *et al.* 2005).
Predators	An ecological functional feeding group of macroinvertebrates. Predators are animals that require live prey.
Rail corridor	The 'corridor' of land in which the China First Project's rail line will intersect.
Ramsar	The Ramsar Convention (The Convention on Wetlands of International Importance, especially as Waterfowl Habitat) is an international treaty for the conservation and sustainable utilisation of wetlands.
Refugia	A geographical location that maintains habitat when other areas not longer are accessible, places where negative impacts are lower than elsewhere
Regional Ecosystem	A vegetation community, within a bioregion, that is consistently associated with a particular combination of geology, landform and soil. REs may be classified under schedules 1–3 of the *Vegetation Management Regulation 2000* as either Endangered, Of Concern or Least Concern. Refer to 'VM Act conservation status' for meaning of Endangered, Of Concern or Least Concern under the VC Act.
Regionally Significant	Refer to taxa not listed as Threatened or Near Threatened species under the EPBC Act and / or NC Act, but have been listed as non-threatened priority taxa for the Desert Uplands bioregion.
Regrowth	A native vegetation community that has regrown after clearing, in which native species that would have naturally occurred within this vegetation community dominate but have not reached the height and canopy cover necessary to be regarded as remnant as defined in the Queensland *Vegetation Management Act 1999*.
Remnant vegetation	Remnant woody vegetation is defined as vegetation where the dominant canopy has >70% of the height and >50% of the cover relative to the undisturbed heightand cover of that stratum and is dominated by species characteristic of the vegetation's undisturbed canopy (Neldner *et al.* 2005).
Riparian	Any land which adjoins or directly influences or is influenced by a body of water.
Runoff	The portion of precipitation (rain and snow) that ultimately reaches streams.
Sampling sites	Specific locations within the study area where data is collected.
Seepage	1. The slow movement of water into or out of a body of surface or subsurface water. 2. The loss of water by infiltration into the soil from a canal, ditch, lateral, watercourse, reservoir, storage facility, or other body of water, or from a field.
Sensitivity	The relative susceptibility to adverse impacts to environments.
Shade lines	Long narrow strips of native trees retained within pasture areas to provide shelter from prevailing winds and shade for livestock.
Stygofauna	Any fauna that live within groundwater systems, such as caves and aquifers, or more specifically small, aquatic groundwater invertebrates, though terrestrial air-breathing

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Abbreviation	Meaning
	subterranean animals are also sometimes included.
Surface water	Water above the surface of the land, including lakes, rivers, streams, ponds, floodwater, and runoff.
Terms of Reference	As defined by Part 4 of the *State Development and Public Works Organisation Act 1971*.
Threatened	A term used for: flora and fauna species which have been designated as Extinct in the wild, Endangered or Vulnerable under the NC Act; flora and fauna species which have been designated as Extinct in the wild, Endangered or Vulnerable under the EPBC Act; Ecological Communities designated as Critically Endangered, Endangered or Vulnerable under the EPBC Act; and / or REs designated as Endangered or Of Concern under the VM Act.
Topsoil	A part of the soil profile, typically the A1 horizon, containing material which is usually darker, more fertile and better structured than the underlying layers.
Turbidity	The cloudiness or haziness of a fluid caused by individual particles (suspended solids) that are generally invisible to the naked eye, similar to smoke in air. The measurement of turbidity is a key test of water quality.
VM Act conservation status	Under the VM Act, REs may be classified as either 'Endangered', 'Of Concern' or 'Least Concern'. Definitions of these terms under the VM Act are provided below. Endangered less than 10% of pre-clearing extent of remnant vegetation (see following definition) exists in the bioregion, or 10 to 30 % of pre-clearing extent remains and the remnant vegetation is less than 10 000 hectares. In addition, for biodiversity planning purposes DERM also classifies a regional ecosystem as Endangered if: less than 10% of its pre-clearing extent remains unaffected by severe degradation and / or biodiversity loss or 10-30% of its pre-clearing extent remains unaffected by severe degradation and / or biodiversity loss and the remnant vegetation is less than 10,000 hectares; or it is a rare regional ecosystem subject to a threatening process. Of Concern 10 to 30% of pre-clearing extent of remnant vegetation exists in the bioregion, or more than 30% of pre-clearing extent remains and the remnant vegetation is less than 10 000 hectares. In addition, for biodiversity planning purposes DERM also classifies a regional ecosystem as Of Concern if: 10-30% of its pre-clearing extent remains unaffected by moderate degradation and / or

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Abbreviation	Meaning
	biodiversity loss. Least Concern more than 30% of pre-clearing extent of remnant vegetation exists in the bioregion, and it is greater than 10, 000 hectares. In addition, for biodiversity planning purposes DERM also classifies a regional ecosystem as Least Concern if the degradation criteria listed above for Endangered or Of Concern regional ecosystems are not met.
Vulnerable	Designated as 'Vulnerable' under the EPBC Act and / or NC Act. Refer to definitions of 'EPBC Act conservation status' and 'NC Act conservation status' for meaning of 'Vulnerable' under these Acts.
Weeds	Plant species that invade native ecosystems and can adversely affect the survival of indigenous flora and fauna.
Wetland	The land area alongside fresh and salt waters, that is flooded all or part of the time.

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Appendix A – Site Descriptions

AQ1 – Splitters Creek

View Upstream

View Downstream

View of Right Bank

View of Left Bank

Channel Habitat

Morphology	
Pattern	Meandering Braided Channels
Flow Regime	Perennial
Channel Width	20m
Wetted Width	3m
Water Level	Medium
Bank Slope	Sloping

Habitat (%)		**Substrate (%)**	
Riffle	10	Bedrock	-
Run	40	Boulder	-
Pool	50	Pebbles	-
Backwater	-	Gravel	25
Overall Complexity	Low	Sand	75
		Silt/Clay	-

Flora and Fauna

Vegetation

Riparian Width	Right Bank = 15m: Left Bank = 5m
Dominant Type	RE11.3.25 and RE11.3.31a *Melaleuca leucadendra*

Fauna

Macro Invertebrates (13), Macro Crustacea (4), Fish (12), *Limnodynastes ornaatus Anas supercillosa*

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	10
Macrophyte	15
Detritus	15

AQ2 – Saltwater Creek

View Upstream

View Downstream

View of Right Bank

View of Left Bank

Channel Habitat

Morphology	
Pattern	Meandering
Flow Regime	Perennial – Groundwater Feed
Channel Width	8m
Wetted Width	3m
Water Level	Medium
Bank Slope	V Shaped

Habitat (%)		**Substrate (%)**	
Riffle	15	Bedrock	-
Run	30	Boulder	-
Pool	55	Pebbles	-
Backwater	-	Gravel	25
Overall Complexity	Medium	Sand	50
		Silt/Clay	25

Flora and Fauna

Vegetation

Riparian Width	Right Bank = 5m: Left Bank = 5m
Dominant Type	RE11.3.25 *Corymbia clarksoniana, C. Dallachiana,E. crebra* and *E. platyphylla*

Fauna

Macro Invertebrates (11), Macro Crustacea (2), Fish (6), *Gambusia holbrooki* (E)

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	15
Macrophyte	50
Detritus	15

AQ3 – Elliott River

View Upstream

View Downstream

View of Right Bank

View of Left Bank

Channel Habitat

Morphology	
Pattern	Open - Straight
Flow Regime	Ephemeral
Channel Width	20m
Wetted Width	1m
Water Level	Low
Bank Slope	Sloping

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	10	Pebbles	-
Backwater	-	Gravel	-
Overall Complexity	Low	Sand	90
		Silt/Clay	10

Flora and Fauna

Vegetation

Riparian Width	Right Bank = 60m: Left Bank = 90m
Dominant Type	RE11.3.25 and RE11.3.25b *Casuarina cunninghamiana, Corymbia tessellaris, Eucalyptus raveretiana, Melaleuca dealbata and M. leucadendra*

Fauna

Macro Invertebrates (11), Macro Crustacea (4), Fish (6), *Limnodynastes ornaatus, Litoria rubella Elseya latisternum, Pavo cristatus*

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	5
Macrophyte	5
Detritus	5

AQ4 – Bogie River

View Upstream

View Downstream

View of Right Bank

View of Left Bank

Channel Habitat

Morphology	
Pattern	Braided - Straight
Flow Regime	Perennial
Channel Width	200m
Wetted Width	6m
Water Level	Low
Bank Slope	Sloping

Habitat (%)		**Substrate (%)**	
Riffle	15	Bedrock	25
Run	40	Boulder	-
Pool	40	Pebbles	10
Backwater	-	Gravel	-
Overall Complexity	Medium	Sand	65
		Silt/Clay	-

Flora and Fauna

Vegetation

Riparian Width	Right Bank = 80m: Left Bank = 30m
Dominant Type	RE11.3.25b *Eucalyptus raveretiana*, *Lopostemon grandiflorus, Melaleuca fluviatilis, M. leucadendra,* and *M. viminalis*

Fauna

Macro Invertebrates (15), Macro Crustacea (2), Fish (5), *Litoria rubella, Bufo marinus, Hydromys chysogaster*

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	5
Macrophyte	5
Detritus	5

AQ5 – Sandy Creek

View Upstream

View Downstream

View of Right Bank

View of Left Bank

Channel Habitat

Morphology	
Pattern	Braided - Straight
Flow Regime	Perennial
Channel Width	30m
Wetted Width	3m
Water Level	Low
Bank Slope	Sloping

Habitat (%)		**Substrate (%)**	
Riffle	15	Bedrock	50
Run	40	Boulder	-
Pool	40	Pebbles	35
Backwater	-	Gravel	10
Overall Complexity	Medium	Sand	5
		Silt/Clay	-

Flora and Fauna

Vegetation

Riparian Width	Right Bank = 30m: Left Bank = 45m
Dominant Type	RE11.3.25 and RE11.3.25b *Casuarina cunninghamian, Eucalyptus raveretiana*, *Lopostemon grandiflorus, Melaleuca fluviatilis* and *M. viminalis*

Fauna

Macro Invertebrates (N/A), Macro Crustacea (N/A), Fish (2)

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	5
Macrophyte	5
Detritus	5

AQ6 – Pelican Creek

View Upstream

View Downstream

View of Right Bank

View of Left Bank

Channel Habitat

Morphology	
Pattern	Meandering - Anastomosing distributary and flood channels
Flow Regime	Semi Perennial – Groundwater Feed
Channel Width	200m
Wetted Width	6m
Water Level	Low
Bank Slope	Sloping

Habitat (%)		**Substrate (%)**	
Riffle	10	Bedrock	10
Run	5	Boulder	-
Pool	85	Pebbles	35
Backwater	-	Gravel	30
Overall Complexity	High	Sand	25
		Silt/Clay	-

Flora and Fauna

Vegetation

Riparian Width	Right Bank = 30m: Left Bank = 45m
Dominant Type	RE11.3.25b *Casuarina cunninghamian, Eucalyptus raveretiana, Lopostemon grandiflorus, Melaleuca fluviatilis, M. viminalis* and *Nauclea orientalis*

Fauna

Macro Invertebrates (18), Macro Crustacea (3), Fish (14)

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	25
Macrophyte	25
Detritus	5

AQ7 – Bowen River

View Upstream

View Downstream

View of Right Bank

View of Left Bank

Channel Habitat

Morphology	
Pattern	Broad
Flow Regime	Perennial
Channel Width	300m
Wetted Width	75m
Water Level	Medium
Bank Slope	Sloping

Habitat (%)		**Substrate (%)**	
Riffle	20	Bedrock	20
Run	15	Boulder	-
Pool	75	Pebbles	5
Backwater	-	Gravel	5
Overall Complexity	High	Sand	50
		Silt/Clay	25

Flora and Fauna

Vegetation

Riparian Width	Right Bank = 30m: Left Bank = 250m
Dominant Type	RE11.3.25b *Casuarina cunninghamian, Corymbia clarksoniana,. C. Tessellaris, Eucalyptus raveretiana*, *Ficus opposite*, *F. racemosa Lopostemon grandiflorus, Melaleuca fluviatilis, M. viminalis* and *Nauclea orientalis*

Fauna

Macro Invertebrates (22), Macro Crustacea (2), Fish (17), *Elsaya latisternum*, *Enydura krefftii*

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	10
Macrophyte	-
Detritus	30

AQ8 – Upper Suttor River

View Upstream

View Downstream

View of Right Bank

View of Left Bank

Channel Habitat

Morphology	
Pattern	Meandering
Flow Regime	Ephemeral
Channel Width	100m
Wetted Width	5m
Water Level	Low
Bank Slope	V Shaped

Habitat (%)		**Substrate (%)**	
Riffle	20	Bedrock	30
Run	15	Boulder	-
Pool	75	Pebbles	-
Backwater	-	Gravel	-
Overall Complexity	Low	Sand	10
		Silt/Clay	60

Flora and Fauna

Vegetation

Riparian Width	Right Bank = 20m: Left Bank = 20m
Dominant Type	RE11.3.25 *Lomandra longifolia, Melaleuca fluviatilis* and *M. leucadendra*

Fauna

Macro Invertebrates (13), Macro Crustacea (4), Fish (6) *Cyclorana alboguttata*

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	25

AQ9 – Lower Suttor River

View Upstream

View Downstream

View of Right Bank

View of Left Bank

Channel Habitat

Morphology	
Pattern	Meandering, anastamosing channels
Flow Regime	Perennial
Channel Width	2000m
Wetted Width	6m
Water Level	Low
Bank Slope	Flat, mild slope

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	15	Boulder	-
Pool	85	Pebbles	-
Backwater	-	Gravel	-
Overall Complexity	Medium	Sand	10
		Silt/Clay	90

Flora and Fauna

Vegetation

Riparian Width	Right Bank = 40m: Left Bank = 40m
Dominant Type	RE11.3.37, RE11.3.37b. RE11.3.37f *E. coolabah E. tereticornis* and *Melaleuca bracteata*

Fauna

Macro Invertebrates (11), Macro Crustacea (4), Fish (10), *Cyclorana alboguttata, Litoria inermis, Enydure krefftii*

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	25
Aquatic Grasses	35

AQ10 – Mistake Creek

View Upstream

View Downstream

View of Right Bank

View of Left Bank

Channel Habitat

Morphology	
Pattern	Broad, anastamosing channels
Flow Regime	Semi Perennial
Channel Width	110m
Wetted Width	5m
Water Level	Low
Bank Slope	Flat U

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	5	Boulder	-
Pool	90	Pebbles	-
Backwater	-	Gravel	-
Overall Complexity	Medium	Sand	10
		Silt/Clay	90

Flora and Fauna

Vegetation

Riparian Width	Right Bank = 35m: Left Bank = 10m
Dominant Type	RE11.3.25, RE11.3.37f *Acacia harpophylla,coolabah,h E. tereticornis, Excoecaria parvifolia* and *Melaleuca bracteata*

Fauna

Macro Invertebrates (11), Macro Crustacea (2), Fish (9)

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	10
Macrophyte	-
Detritus	10
Aquatic Grasses	-

AQ11 – Middle Creek

View Upstream

View Downstream

View of Right Bank

View of Left Bank

Channel Habitat

Morphology	
Pattern	Meandering
Flow Regime	Semi Perennial
Channel Width	230m
Wetted Width	15m
Water Level	Low
Bank Slope	Flat, mild slope

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	100	Pebbles	5
Backwater	-	Gravel	10
Overall Complexity	Low	Sand	-
		Silt/Clay	85

Flora and Fauna

Vegetation

Riparian Width	Right Bank = 5m: Left Bank = 15m
Dominant Type	RE11.3.25, RE11.3.27, RE11.3.37f, RE11.5.3b *Acacia harpophyll and Excoecaria parvifolia*

Fauna

Macro Invertebrates (15), Macro Crustacea (2), Fish (10), *Oreochromis mossambica* (E)

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	10
Macrophyte	-
Detritus	10
Aquatic Grasses	10

AQ12 – Belyando Creek

View Upstream

View Downstream

View of Right Bank

View of Left Bank

Channel Habitat

Morphology	
Pattern	Meandering
Flow Regime	Perennial
Channel Width	70m
Wetted Width	15m
Water Level	Low
Bank Slope	V Shaped

Habitat (%)		**Substrate (%)**	
Riffle	3	Bedrock	10
Run	7	Boulder	-
Pool	90	Pebbles	-
Backwater	-	Gravel	10
Overall Complexity	Medium	Sand	15
		Silt/Clay	65

Flora and Fauna

Vegetation

Riparian Width	Right Bank = 40m: Left Bank = 60m
Dominant Type	RE11.3.25, RE11.3.37f, RE11.5.3b *E. coolabah, Excoecaria parvifolia, Melaleuca bracteata* and *M. leucadendra*

Fauna

Macro Invertebrates (14), Macro Crustacea (3), Fish (11), *Oreochromis mossambica* (E)

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	5
Macrophyte	10
Detritus	10
Aquatic Grasses	-

AQ13 – Sandy Creek

View Upstream

View Downstream

View of Right Bank

View of Left Bank

Channel Habitat

Morphology	
Pattern	Braided flow channels
Flow Regime	Ephemeral
Channel Width	100m
Wetted Width	3m
Water Level	Very Low
Bank Slope	Flat

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	100	Pebbles	-
Backwater	-	Gravel	5
Overall Complexity	Low	Sand	95
		Silt/Clay	-

Flora and Fauna

Vegetation

Riparian Width	Right Bank = 60m: Left Bank = 35m
Dominant Type	RE10.3.13 *Melaleuca bracteata*

Fauna

Macro Invertebrates (18), Macro Crustacea (2), Fish (6)

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	10
Aquatic Grasses	-

AQ14 – Lagoon Creek

View Upstream

View Downstream

View of Right Bank

View of Left Bank

Channel Habitat

Morphology	
Pattern	Braided flow channels
Flow Regime	Ephemeral
Channel Width	12m
Wetted Width	-
Water Level	Nil
Bank Slope	Flat

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	-	Pebbles	-
Backwater	-	Gravel	-
Overall Complexity	-	Sand	100
		Silt/Clay	-

Flora and Fauna

Vegetation

Riparian Width	Right Bank = 5m: Left Bank = 5m
Dominant Type	RE10.3.13 *Callitris intratropica,Melaleuca fluviatilis and M. eucadendra*

Fauna

Macro Invertebrates (0), Macro Crustacea (0), Fish (0)

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-
Aquatic Grasses	-

Waratah Coal

Appendix B – Aquatic Ecology Habitat Assessment Sites

AH1 – Caley Valley Wetland

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Open Floodplain
Flow Regime	Still
Channel Width (m)	2000
Wetted Width (m)	1000
Water Level	Medium
Bank Shape	Flat

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	-	Pebbles	-
Backwater/Wetland	100	Gravel	-
Overall Complexity	Low	Sand	-
		Silt/Clay	100

Vegetation

Riparian Width	Right -0m	Left -0m
Dominant Type	Grasses	

Cover %	
Periphyton	10
Moss	-
Filamentous Algae	10
Macrophyte	25
Detritus	-

Water Quality – Wet Season	
Temperature	28.8^{O}C
pH	6.51
Conductivity	0.00394
DO (% saturation)	83
Turbidity	0.1

AH2 – Splitters Creek

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Meandering Braided Channels
Flow Regime	Perennial
Channel Width (m)	20m
Wetted Width (m)	3m
Water Level	Medium
Bank Shape	Sloping

Habitat (%)		**Substrate (%)**	
Riffle	10	Bedrock	-
Run	40	Boulder	-
Pool	50	Pebbles	-
Backwater/Wetland	-	Gravel	25
Overall Complexity	Low	Sand	75
		Silt/Clay	-

Vegetation

Riparian Width	Right -15m	Left -5m
Dominant Type	*Eucalpytus camaldulenis, E. tereticornis, Melaleacu leucadendra*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	10
Macrophyte	15
Detritus	15

Water Quality – Wet Season	
Temperature	21.9^{O}C
pH	7.9
Conductivity	0.693
DO (% saturation)	82
Turbidity	2.9

AH3 – Upper Splitters Creek


View Upstream - Dry


View Downstream - Dry


View Upstream - Wet


View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Meandering Braided Channels
Flow Regime	Ephemeral
Channel Width (m)	26m
Wetted Width (m)	7m
Water Level	Medium
Bank Shape	Stepped/Undercut

Habitat (%)		**Substrate (%)**	
Riffle	25	Bedrock	-
Run	65	Boulder	-
Pool	10	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	100
		Silt/Clay	-

Vegetation

Riparian Width	Right – 2m	Left -2m
Dominant Type	*Eucalpytus camaldulenis, E. tereticornis, Melaleacu leucadendra*, Grasses	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	10
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	22.0^{O}C
pH	739
Conductivity	0.678
DO (% saturation)	86
Turbidity	4.8

AH4 – Caley Valley Wetland

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Open Floodplain
Flow Regime	Still
Channel Width (m)	2000
Wetted Width (m)	2000
Water Level	Medium
Bank Shape	Flat

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	-	Pebbles	-
Backwater/Wetland	100	Gravel	-
Overall Complexity	Low	Sand	-
		Silt/Clay	100

Vegetation

Riparian Width	Right -0m	Left -0m
Dominant Type	Grasses	

Cover %	
Periphyton	10
Moss	-
Filamentous Algae	10
Macrophyte	25
Detritus	-

Water Quality – Wet Season	
Temperature	25.4^{O}C
pH	6.2
Conductivity	2.156
DO (% saturation)	83
Turbidity	377

AH5 – Caley Valley Wetland

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Open Floodplain
Flow Regime	Still
Channel Width (m)	1000
Wetted Width (m)	500
Water Level	Medium
Bank Shape	Flat

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	-	Pebbles	-
Backwater/Wetland	100	Gravel	-
Overall Complexity	Low	Sand	-
		Silt/Clay	100

Vegetation

Riparian Width	Right -0m	Left -0m
Dominant Type	Grasses	

Cover %	
Periphyton	5
Moss	-
Filamentous Algae	25
Macrophyte	10
Detritus	-

Water Quality – Wet Season	
Temperature	28.6^{O}C
pH	7.22
Conductivity	0.02423
DO (% saturation)	113
Turbidity	40.1

AH6 – Caley Valley Wetland

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Open Floodplain
Flow Regime	Still
Channel Width (m)	1000
Wetted Width (m)	500
Water Level	Medium
Bank Shape	Flat

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	-	Pebbles	-
Backwater/Wetland	100	Gravel	-
Overall Complexity	Low	Sand	-
		Silt/Clay	100

Vegetation

Riparian Width	Right -0m	Left -0m
Dominant Type	Grasses	

Cover %	
Periphyton	15
Moss	-
Filamentous Algae	10
Macrophyte	10
Detritus	-

Water Quality – Wet Season	
Temperature	24.2^{O}C
pH	7.32
Conductivity	0.01624
DO (% saturation)	82
Turbidity	7.1

AH7 – Saltwater Creek (Tributary)

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Meandering
Flow Regime	Perennial – Groundwater Feed
Channel Width (m)	8m
Wetted Width (m)	3m
Water Level	Medium
Bank Shape	V Shaped

Habitat (%)		**Substrate (%)**	
Riffle	15	Bedrock	-
Run	30	Boulder	-
Pool	55	Pebbles	-
Backwater/Wetland	-	Gravel	25
Overall Complexity	Medium	Sand	50
		Silt/Clay	25

Vegetation

Riparian Width	Right – 5m	Left -5m
Dominant Type	*Corymbia clarksoniana C. Dallachiana,Eucalpytus camaldulenis, E. crebra, E. platyphylla, E. tereticornis, Melaleacu leucadendra*	

Cover %	
Periphyton	
Moss	-
Filamentous Algae	15
Macrophyte	50
Detritus	15

Water Quality – Wet Season	
Temperature	23.2^{O}C
pH	7.4
Conductivity	1.549
DO (% saturation)	51
Turbidity	1

AH8 – Elliot River

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Meandering
Flow Regime	Ephemeral
Channel Width (m)	45m
Wetted Width (m)	12m
Water Level	Medium
Bank Shape	Sloping

Habitat (%)		**Substrate (%)**	
Riffle		Bedrock	-
Run	-	Boulder	-
Pool	Medium	Pebbles	-
Backwater/Wetland		Gravel	10
Overall Complexity		Sand	90
		Silt/Clay	-

Vegetation

Riparian Width	Right – 25m	Left -25m
Dominant Type	*Corymbia clarksoniana C. Dallachiana,Eucalpytus camaldulenis, E. crebra, E. platyphylla, E. tereticornis*	

Cover %	
Periphyton	
Moss	-
Filamentous Algae	10
Macrophyte	-
Detritus	5

Water Quality – Wet Season	
Temperature	29.5^{O}C
pH	7.89
Conductivity	1.36
DO (% saturation)	88
Turbidity	.05

AH9 – Upper Elliot River


View Upstream - Dry


View Downstream - Dry


View Upstream - Wet


View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Meandering
Flow Regime	Ephemeral
Channel Width (m)	50m
Wetted Width (m)	9m
Water Level	Low
Bank Shape	Sloping

Habitat (%)		**Substrate (%)**	
Riffle	30	Bedrock	5
Run	55	Boulder	-
Pool	15	Pebbles	15
Backwater/Wetland	-	Gravel	10
Overall Complexity	Medium	Sand	75
		Silt/Clay	-

Vegetation

Riparian Width	Right – 30m	Left – 35m
Dominant Type	*Casuarina cunninghamian, Eucalyptus raveretiana, Lopostemon grandiflorus, Melaleuca fluviatilis, M. viminalis*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	5
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	29.2^{O}C
pH	7.55
Conductivity	1.0007
DO (% saturation)	93
Turbidity	0.7

AH10 – Bogie River

Not Sampled

View Upstream - Dry

Not Sampled

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Meandering
Flow Regime	Ephemeral
Channel Width (m)	80
Wetted Width (m)	130
Water Level	Low
Bank Shape	Sloping

Habitat (%)		**Substrate (%)**	
Riffle	15	Bedrock	-
Run	80	Boulder	-
Pool	5	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	100
		Silt/Clay	-

Vegetation

Riparian Width	Right – 40m	Left -75m
Dominant Type	*Eucalyptus raveretiana, Lopostemon grandiflorus, Melaleuca fluviatilis, M. leucadendra, M. viminalis*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	5
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	23.0^{O}C
pH	7.8
Conductivity	0.905
DO (% saturation)	91
Turbidity	8.1

AH11 – Sandy Creek

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Meandering
Flow Regime	Ephemeral
Channel Width (m)	5
Wetted Width (m)	30
Water Level	Low
Bank Shape	Sloping

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	75	Boulder	-
Pool	25	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	100
		Silt/Clay	-

Vegetation

Riparian Width	Right – 35m	Left -90m
Dominant Type	*Eucalyptus raveretiana, Lopostemon grandiflorus, Melaleuca fluviatilis, M. leucadendra, M. viminalis*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	22.9^{O}C
pH	7.7
Conductivity	0.81
DO (% saturation)	76
Turbidity	1.4

AH12 – Pine Creek

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Meandering
Flow Regime	Ephemeral
Channel Width (m)	4
Wetted Width (m)	15
Water Level	Low
Bank Shape	Stepped

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	55	Boulder	-
Pool	45	Pebbles	-
Backwater/Wetland	-	Gravel	20
Overall Complexity	Low	Sand	80
		Silt/Clay	-

Vegetation

Riparian Width	Right – 10m	Left -25m
Dominant Type	*Lopostemon grandiflorus, Melaleuca fluviatilis, M. leucadendra*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	5
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	29.8^{O}C
pH	7.6
Conductivity	1.149
DO (% saturation)	128
Turbidity	11.2

AH13 – Pine Creek


View Upstream - Dry


View Downstream - Dry


View Upstream - Wet


View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Meandering
Flow Regime	Ephemeral
Channel Width (m)	2
Wetted Width (m)	7
Water Level	Low
Bank Shape	Stepped

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	10	Boulder	15
Pool	90	Pebbles	5
Backwater/Wetland	-	Gravel	5
Overall Complexity	Low	Sand	75
		Silt/Clay	-

Vegetation

Riparian Width	Right – 2m	Left -7m
Dominant Type	*Lopostemon grandiflorus, Melaleuca fluviatilis, M. leucadendra*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	29.8^{O}C
pH	7.6
Conductivity	1.289
DO (% saturation)	59
Turbidity	11.2

AH14 – Pelican Creek

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Meandering/Falls
Flow Regime	Perenial
Channel Width (m)	10
Wetted Width (m)	22
Water Level	Low
Bank Shape	Sloping

Habitat (%)		**Substrate (%)**	
Riffle	10	Bedrock	30
Run	10	Boulder	25
Pool	80	Pebbles	10
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	35
		Silt/Clay	-

Vegetation

Riparian Width	Right – 2m	Left -7m
Dominant Type	*Eucalpytus camaldulenis, E. crebra, E. platyphylla, E. tereticornis, Lopostemon grandiflorus, Melaleuca fluviatilis, M. leucadendra,* Grasses	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	10
Macrophyte	-
Detritus	20

Water Quality – Wet Season	
Temperature	29.8^{O}C
pH	7.28
Conductivity	0.00278
DO (% saturation)	90
Turbidity	11.2

AH15 – Confluence Bowen River - Pelican Creek

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Open Channel
Flow Regime	Perennial
Channel Width (m)	60
Wetted Width (m)	300
Water Level	High
Bank Shape	Sloping

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	60
Run	100	Boulder	5
Pool	-	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	35
		Silt/Clay	-

Vegetation

Riparian Width	Right – 60m	Left -250m
Dominant Type	*Casuarina cunninghamian, Corymbia clarksoniana, C. tessellaris, Eucalyptus raveretiana, Ficus opposite, F. racemesa, Lopostemon grandiflorus, Melaleuca fluviatilis, M. viminalis, Nauclea orientalis*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	31.7^{O}C
pH	7.37
Conductivity	0.00317
DO (% saturation)	80
Turbidity	4.5

AH16 – Two Mile Creek

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Open Channel
Flow Regime	Perennial
Channel Width (m)	18
Wetted Width (m)	60
Water Level	Medium
Bank Shape	Left – Stepped / Right - Sloping

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	60
Run	75	Boulder	5
Pool	25	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	35
		Silt/Clay	-

Vegetation

Riparian Width	Right – 30m	Left -60m
Dominant Type	*Casuarina cunninghamian, Lopostemon grandiflorus, Melaleuca fluviatilis, M. viminalis, Nauclea orientalis*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	15
Macrophyte	5
Detritus	-

Water Quality – Wet Season	
Temperature	32.7^{O}C
pH	7.48
Conductivity	1.222
DO (% saturation)	80
Turbidity	4.3

AH17 – Bowen River

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Open Channel
Flow Regime	Perennial
Channel Width (m)	23
Wetted Width (m)	65
Water Level	Medium
Bank Shape	Left – Stepped / Right - Sloping

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	70	Boulder	-
Pool	30	Pebbles	30
Backwater/Wetland	-	Gravel	10
Overall Complexity	Medium	Sand	60
		Silt/Clay	-

Vegetation

Riparian Width	Right – 45m	Left -70m
Dominant Type	*Casuarina cunninghamian, Corymbia clarksoniana, C. tessellaris, Eucalyptus raveretiana, Ficus opposite, F. racemesa, Lopostemon grandiflorus, Melaleuca fluviatilis, M. viminalis, Nauclea orientalis*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	30.8^{O}C
pH	6.99
Conductivity	0.508
DO (% saturation)	58
Turbidity	5.68

AH18 – Upper Bowen River

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Open Channel
Flow Regime	Perennial
Channel Width (m)	31
Wetted Width (m)	73
Water Level	Medium
Bank Shape	Left – Steep / Right - Sloping

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	100	Boulder	-
Pool	-	Pebbles	35
Backwater/Wetland	-	Gravel	5
Overall Complexity	Medium	Sand	60
		Silt/Clay	-

Vegetation

Riparian Width	Right – 55m	Left -40m
Dominant Type	*Casuarina cunninghamian, Corymbia clarksoniana, C. tessellaris, Eucalyptus raveretiana, Ficus opposite, F. racemesa, Lopostemon grandiflorus, Melaleuca fluviatilis, M. viminalis, Nauclea orientalis*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	30.6^{O}C
pH	6.38
Conductivity	0.302
DO (% saturation)	62
Turbidity	3.8

AH19 – Upper Suttor River

Not Sampled

View Upstream - Dry

Not Sampled

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Meandering
Flow Regime	Ephemeral
Channel Width (m)	8
Wetted Width (m)	40
Water Level	Medium
Bank Shape	Moderately Sloping/Stepped

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	100	Boulder	-
Pool	-	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Medium	Sand	80
		Silt/Clay	20

Vegetation

Riparian Width	Right – 15m	Left -20m
Dominant Type	*Eucalyptus camaldulenis, Lomandra longifolia, Melaleuca fluviatilis, M. leucadendra*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	10

Water Quality – Wet Season	
Temperature	30.8^{O}C
pH	5.33
Conductivity	0.473
DO (% saturation)	50
Turbidity	10

AH20 – Upper Suttor River

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Meandering
Flow Regime	Ephemeral
Channel Width (m)	9
Wetted Width (m)	28
Water Level	Medium
Bank Shape	Moderately Sloping/Stepped

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	45
Run	100	Boulder	-
Pool	-	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	45
		Silt/Clay	10

Vegetation

Riparian Width	Right – 10m	Left -15m
Dominant Type	*Eucalyptus camaldulenis, Lomandra longifolia, Melaleuca fluviatilis, M. leucadendra*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	10

Water Quality – Wet Season	
Temperature	29.9^{O}C
pH	6.8
Conductivity	0.2133
DO (% saturation)	74
Turbidity	302

AH21 – Deception Creek

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Meandering
Flow Regime	Ephemeral
Channel Width (m)	16
Wetted Width (m)	5
Water Level	Medium
Bank Shape	Moderately Sloping/Stepped

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	100	Boulder	-
Pool	-	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	100
		Silt/Clay	-

Vegetation

Riparian Width	Right – 5m	Left -10m
Dominant Type	*Eucalyptus camaldulenis, Lomandra longifolia, Melaleuca fluviatilis, M. leucadendra*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	10

Water Quality – Wet Season	
Temperature	30.7^{O}C
pH	7.7
Conductivity	0.2133
DO (% saturation)	74
Turbidity	302

AH22 – Verbena Creek

Not Sampled

View Upstream - Dry

Not Sampled

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Remnant Channel – Small Tributary
Flow Regime	Ephemeral
Channel Width (m)	8
Wetted Width (m)	4
Water Level	Low
Bank Shape	Moderately Sloping

Habitat (%)		**Substrate (%)**	
Riffle	35	Bedrock	-
Run	65	Boulder	-
Pool	-	Pebbles	15
Backwater/Wetland	-	Gravel	10
Overall Complexity	Low	Sand	75
		Silt/Clay	-

Vegetation

Riparian Width	Right – 1m	Left -1m
Dominant Type	*Eucalyptus camaldulenis, Melaleuca fluviatilis,* Grasses	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	32.7^{O}C
pH	8.06
Conductivity	0.1468
DO (% saturation)	101
Turbidity	1.3

AH23 – Bulgonunna Creek

Not Sampled

Not Sampled

View Upstream - Wet

View Downstream - Wet

View Upstream - Dry

View Downstream - Dry

Channel Habitat – Wet Season

Morphology	
Pattern	Remnant Channel – Small Tributary
Flow Regime	Ephemeral
Channel Width (m)	8
Wetted Width (m)	4
Water Level	Low
Bank Shape	Moderately Sloping

Habitat (%)		**Substrate (%)**	
Riffle	35	Bedrock	-
Run	65	Boulder	-
Pool	-	Pebbles	15
Backwater/Wetland	-	Gravel	10
Overall Complexity	Low	Sand	75
		Silt/Clay	-

Vegetation

Riparian Width	Right – 1m	Left -1m
Dominant Type	*Eucalyptus camaldulenis, Lomandra longifolia, Melaleuca fluviatilis, M. leucadendra*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	32.7^{O}C
pH	8.06
Conductivity	0.1468
DO (% saturation)	101
Turbidity	1.3

AH24 – Manaman Creek

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Remnant Channel - Meandering
Flow Regime	Ephemeral
Channel Width (m)	19
Wetted Width (m)	4
Water Level	Medium
Bank Shape	Minimal Slope/Bedrock

Habitat (%)		**Substrate (%)**	
Riffle	45	Bedrock	45
Run	50	Boulder	5
Pool	5	Pebbles	-
Backwater/Wetland	-	Gravel	25
Overall Complexity	Medium	Sand	25
		Silt/Clay	-

Vegetation

Riparian Width	Right – 12m	Left -15m
Dominant Type	*Eucalyptus camaldulenis, Lomandra longifolia, Melaleuca leucadendra*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	29.6^{O}C
pH	7.51
Conductivity	0.265
DO (% saturation)	63
Turbidity	24.6

AH25 – Lower Suttor River

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Flood Plain – Meandering when not in flood
Flow Regime	Predominantly ephemeral – minor pools
Channel Width (m)	8
Wetted Width (m)	2000
Water Level	High
Bank Shape	Flat/Open Channel

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	100	Boulder	-
Pool	-	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	100
		Silt/Clay	-

Vegetation

Riparian Width	Right – 40m	Left -32m
Dominant Type	*Eucalyptus camaldulenis, E. coolabah, E. tereticornis, Melaleuca bracteata*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	23.6^{O}C
pH	6.8
Conductivity	0.19
DO (% saturation)	50
Turbidity	380

AH26 – Verbena Creek

Not Sampled

Not Sampled

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Flood Plain – Meandering when not in flood
Flow Regime	Predominantly ephemeral – minor pools
Channel Width (m)	8
Wetted Width (m)	1500
Water Level	High
Bank Shape	Flat/Open Channel

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	100	Boulder	-
Pool	-	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	100
		Silt/Clay	-

Vegetation

Riparian Width	Right – 15m	Left -45m
Dominant Type	*Eucalyptus camaldulenis, E. coolabah, E. tereticornis, Melaleuca bracteata*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	23.3^{O}C
pH	6.4
Conductivity	0.118
DO (% saturation)	50
Turbidity	250

AH27 – Lower Suttor River

Not Sampled

View Upstream - Dry

Not Sampled

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Flood Plain
Flow Regime	Predominantly ephemeral except when in flood
Channel Width (m)	35
Wetted Width (m)	400
Water Level	High
Bank Shape	Flat/Open Channel

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	100	Boulder	-
Pool	-	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	100
		Silt/Clay	-

Vegetation

Riparian Width	Right –40m	Left -85m
Dominant Type	*Eucalyptus camaldulenis, E. coolabah, E. tereticornis, Melaleuca bracteata*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	22.3^{O}C
pH	6.3
Conductivity	0.092
DO (% saturation)	63
Turbidity	473

AH28 – Logan Creek


View Upstream - Dry


View Downstream - Dry


View Upstream - Wet


View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Flood Plain– storage area
Flow Regime	Perennial
Channel Width (m)	800
Wetted Width (m)	300
Water Level	High
Bank Shape	Flat/Open Channel

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	100	Boulder	-
Pool	-	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	100
		Silt/Clay	-

Vegetation

Riparian Width	Right –10m	Left -25m
Dominant Type	*Eucalyptus camaldulenis, E. coolabah, E. tereticornis, Melaleuca bracteata*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	23.0^{O}C
pH	6.3
Conductivity	0.202
DO (% saturation)	53
Turbidity	588

AH29 – Mistake Creek


View Upstream - Dry


View Downstream - Dry


View Upstream - Wet


View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Flooded Meandering
Flow Regime	Ephemeral
Channel Width (m)	29
Wetted Width (m)	12
Water Level	High
Bank Shape	Flat/Open Channel

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	100	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	40
		Silt/Clay	60

Vegetation

Riparian Width	Right –10m	Left -25m
Dominant Type	*Eucalyptus camaldulenis, E. coolabah, E. tereticornis, Melaleuca bracteata*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	21.0^{O}C
pH	6.9
Conductivity	0.21
DO (% saturation)	41
Turbidity	103

AH30 – Mistake Creek

Not Sampled

View Upstream - Dry

Not Sampled

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Flooded Meandering
Flow Regime	Ephemeral
Channel Width (m)	50
Wetted Width (m)	23
Water Level	High
Bank Shape	Flat/Open Channel

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	100	Boulder	-
Pool	-	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	10
		Silt/Clay	90

Vegetation

Riparian Width	Right –30m	Left -45m
Dominant Type	*Acacia harpophylla,Eucalyptus camaldulenis, E. coolabah, E. tereticornis, Excoecaria parvifolia, Melaleuca bracteata*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	24.1^{O}C
pH	6.8
Conductivity	0.21
DO (% saturation)	42
Turbidity	85

AH31 – Middle Creek


View Upstream - Dry


View Downstream - Dry


View Upstream - Wet


View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Flooded Meandering
Flow Regime	Ephemeral
Channel Width (m)	19
Wetted Width (m)	11
Water Level	Medium
Bank Shape	Sloping

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	100	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Medium	Sand	15
		Silt/Clay	85

Vegetation

Riparian Width	Right –30m	Left -15m
Dominant Type	*Acacia harpophylla,Eucalyptus camaldulenis, E. coolabah, E. tereticornis, Excoecaria parvifolia, Melaleuca bracteata*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	10

Water Quality – Wet Season	
Temperature	21.0^{O}C
pH	6.4
Conductivity	0.189
DO (% saturation)	41
Turbidity	114

AH32 – Upper Middle Creek

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Flooded Meandering
Flow Regime	Ephemeral
Channel Width (m)	5
Wetted Width (m)	300
Water Level	High
Bank Shape	Low Sloping

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	30	Boulder	-
Pool	70	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	20
		Silt/Clay	80

Vegetation

Riparian Width	Right –10m	Left -10m
Dominant Type	*Acacia harpophylla,Eucalyptus camaldulenis, E. coolabah, E. tereticornis, Excoecaria parvifolia, Melaleuca bracteata*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	10

Water Quality – Wet Season	
Temperature	22.7^{O}C
pH	6.9
Conductivity	0.0932
DO (% saturation)	40
Turbidity	103

AH33 – Sixteen Mile Creek


View Upstream - Dry


View Downstream - Dry


View Upstream - Wet


View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Flooded Meandering
Flow Regime	Ephemeral
Channel Width (m)	22
Wetted Width (m)	7
Water Level	Medium
Bank Shape	Sloping

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	95	Boulder	-
Pool	5	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	90
		Silt/Clay	10

Vegetation

Riparian Width	Right –2m	Left -5m
Dominant Type	*Acacia harpophylla,Eucalyptus camaldulenis, E. coolabah, E. tereticornis, Excoecaria parvifolia, Melaleuca bracteata*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	22.7^{O}C
pH	6.9
Conductivity	0.0159
DO (% saturation)	74
Turbidity	114

AH34 – Lascelles Creek

Not Sampled

Not Sampled

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Flooded Meandering
Flow Regime	Ephemeral
Channel Width (m)	10
Wetted Width (m)	7
Water Level	High
Bank Shape	Low Sloping

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	100	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	60
		Silt/Clay	40

Vegetation

Riparian Width	Right –5m	Left -2m
Dominant Type	*Acacia harpophylla,Eucalyptus camaldulenis, E. coolabah, E. tereticornis, Excoecaria parvifolia*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	22.0^{O}C
pH	6.6
Conductivity	0.126
DO (% saturation)	51
Turbidity	144

AH35 – Sandy Creek


View Upstream - Dry


View Downstream - Dry


View Upstream - Wet


View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Flooded Meandering
Flow Regime	Ephemeral
Channel Width (m)	17
Wetted Width (m)	7
Water Level	Medium
Bank Shape	Low Sloping

Habitat (%)		**Substrate (%)**	
Riffle	15	Bedrock	-
Run	85	Boulder	-
Pool	-	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Medium	Sand	95
		Silt/Clay	5

Vegetation

Riparian Width	Right –5m	Left -40m
Dominant Type	*Acacia harpophylla,Eucalyptus camaldulenis, E. coolabah, E. tereticornis, Excoecaria parvifolia, Melaleuca bracteata*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	10

Water Quality – Wet Season	
Temperature	21.2^{O}C
pH	6.6
Conductivity	0.175
DO (% saturation)	80
Turbidity	96

AH36 – Lestree Hill Creek


View Upstream - Dry


View Downstream - Dry


View Upstream - Wet


View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Flooded Meandering
Flow Regime	Ephemeral
Channel Width (m)	6
Wetted Width (m)	23
Water Level	Medium
Bank Shape	Low Sloping

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	100	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Medium	Sand	85
		Silt/Clay	15

Vegetation

Riparian Width	Right –65m	Left -30m
Dominant Type	*Acacia harpophylla,Eucalyptus camaldulenis, E. coolabah, E. tereticornis, Excoecaria parvifolia, Melaleuca bracteata*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	24.4^{O}C
pH	6.8
Conductivity	0.121
DO (% saturation)	40
Turbidity	121

AH37 – Belyando River


View Upstream - Dry


View Downstream - Dry


View Upstream - Wet


View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Flooded Meandering
Flow Regime	Ephemeral
Channel Width (m)	50
Wetted Width (m)	35
Water Level	High
Bank Shape	Low Sloping

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	100-	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Medium	Sand	45
		Silt/Clay	55

Vegetation

Riparian Width	Right –70m	Left -80m
Dominant Type	*Acacia harpophylla,Eucalyptus camaldulenis, E. coolabah, E. tereticornis, Excoecaria parvifolia, Melaleuca bracteata*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	24.9^{O}C
pH	6.7
Conductivity	0.1688
DO (% saturation)	52
Turbidity	370

AH38 – Sandy Creek

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Flooded Channel
Flow Regime	Ephemeral
Channel Width (m)	20
Wetted Width (m)	13
Water Level	High
Bank Shape	Low Sloping

Habitat (%)		**Substrate (%)**	
Riffle	30	Bedrock	-
Run	70	Boulder	-
Pool	-	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	100
		Silt/Clay	-

Vegetation

Riparian Width	Right –65m	Left -50m
Dominant Type	*Acacia harpophylla,Eucalyptus camaldulenis, E. coolabah, E. tereticornis, Excoecaria parvifolia, Melaleuca bracteata*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	25.0^{O}C
pH	6.7
Conductivity	0.524
DO (% saturation)	75
Turbidity	220

AH39 – Belyando River


View Upstream - Dry


View Downstream - Dry


View Upstream - Wet


View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Flooded Channel
Flow Regime	Ephemeral – Some aquatic refugia
Channel Width (m)	9
Wetted Width (m)	3
Water Level	Low
Bank Shape	Moderate Slope

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	100	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Medium	Sand	-
		Silt/Clay	100

Vegetation

Riparian Width	Right –25m	Left -40m
Dominant Type	*Eucalyptus camaldulenis, E. coolabah, E. tereticornis, Excoecaria parvifolia, Melaleuca bracteata, M. leucadendra*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	23.6^{O}C
pH	6.8
Conductivity	0.36
DO (% saturation)	39
Turbidity	115

AH40 – Native Companion Creek


View Upstream - Dry


View Downstream - Dry


View Upstream - Wet


View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Remnant Channel
Flow Regime	Ephemeral
Channel Width (m)	18
Wetted Width (m)	5
Water Level	Medium
Bank Shape	Moderate/Steep Slope

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	100	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	100
		Silt/Clay	-

Vegetation

Riparian Width	Right –30m	Left -30m
Dominant Type	*Eucalyptus camaldulenis, E. coolabah, E. tereticornis, Excoecaria parvifolia, Melaleuca bracteata M. leucadendra*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	20.8^{O}C
pH	6.8
Conductivity	0.334
DO (% saturation)	80
Turbidity	75

AH41 – Tributary of Sandy Creek


View Upstream - Dry


View Downstream - Dry


View Upstream - Wet


View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Remnant Channel
Flow Regime	Ephemeral
Channel Width (m)	15
Wetted Width (m)	10
Water Level	Medium
Bank Shape	Low Slope

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	100	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	-
		Silt/Clay	100

Vegetation

Riparian Width	Right –60m	Left -45m
Dominant Type	*Eucalyptus camaldulenis, E. coolabah, Excoecaria parvifolia, Melaleuca bracteata, M. leucadendra*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	23.2^{O}C
pH	6.8
Conductivity	0.215
DO (% saturation)	48
Turbidity	83

AH42 – May Creek

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Remnant Channel
Flow Regime	Ephemeral
Channel Width (m)	13
Wetted Width (m)	4
Water Level	Low
Bank Shape	Moderate Slope

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	100	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	20
		Silt/Clay	80

Vegetation

Riparian Width	Right –10m	Left -25m
Dominant Type	*Eucalyptus camaldulenis, E. coolabah, Excoecaria parvifolia, Melaleuca bracteata, M. leucadendra*	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	23.2^{O}C
pH	6.8
Conductivity	0.215
DO (% saturation)	48
Turbidity	83

AH43 – Pebbly Creek


View Upstream - Dry


View Downstream - Dry


View Upstream - Wet


View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Remnant Channel
Flow Regime	Ephemeral
Channel Width (m)	16
Wetted Width (m)	3
Water Level	Low
Bank Shape	Moderate Slope

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	100	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	-
		Silt/Clay	100

Vegetation

Riparian Width	Right –2m	Left -5m
Dominant Type	*Eucalyptus camaldulenis, E. coolabah, Excoecaria parvifolia, Melaleuca bracteata, M. leucadendra,* Grasses	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	24.0^{O}C
pH	6.8
Conductivity	0.36
DO (% saturation)	50
Turbidity	300

AH44 – Spring Creek

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Remnant Channel
Flow Regime	Ephemeral
Channel Width (m)	40
Wetted Width (m)	12
Water Level	Low
Bank Shape	Steep Slope

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	25	Boulder	-
Pool	75	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	100
		Silt/Clay	-

Vegetation

Riparian Width	Right –2m	Left -2m
Dominant Type	*Eucalyptus camaldulenis, Excoecaria parvifolia, Melaleuca leucadendra,* Grasses	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	28.4^{O}C
pH	6.7
Conductivity	0.247
DO (% saturation)	76
Turbidity	110

AH45 – Malcolm Creek


View Upstream - Dry


View Downstream - Dry


View Upstream - Wet


View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Remnant Wetland
Flow Regime	Perennial – Aquatic Refugia
Channel Width (m)	29
Wetted Width (m)	20
Water Level	High
Bank Shape	Low Slope

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	-	Pebbles	-
Backwater/Wetland	100	Gravel	-
Overall Complexity	Medium	Sand	-
		Silt/Clay	100

Vegetation

Riparian Width	Right –40m	Left -65m
Dominant Type	*Eucalyptus camaldulenis, E. coolabah, Excoecaria parvifolia, Melaleuca bracteata, M. leucadendra,* Grasses	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	15
Macrophyte	40
Detritus	-

Water Quality – Wet Season	
Temperature	27.7^{O}C
pH	5.9
Conductivity	0.162
DO (% saturation)	42
Turbidity	25

AH46 – Tributary of Malcolm Creek

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Remnant Channel
Flow Regime	Ephemeral
Channel Width (m)	14
Wetted Width (m)	4
Water Level	Low
Bank Shape	Low Slope

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	100	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	100
		Silt/Clay	-

Vegetation

Riparian Width	Right –2m	Left -5m
Dominant Type	*Eucalyptus camaldulenis, Excoecaria parvifolia, Melaleuca leucadendra,* Grasses	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	25.2^{O}C
pH	6.2
Conductivity	0.228
DO (% saturation)	45
Turbidity	162

AH47 – Saltbush Creek


View Upstream - Dry


View Downstream - Dry


View Upstream - Wet


View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Remnant Channel
Flow Regime	Ephemeral
Channel Width (m)	16
Wetted Width (m)	12
Water Level	High
Bank Shape	Low Slope

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	100	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	50
		Silt/Clay	50

Vegetation

Riparian Width	Right –5m	Left -5m
Dominant Type	*Eucalyptus camaldulenis, Excoecaria parvifolia, Melaleuca leucadendra,* Grasses	

Cover %	
Periphyton	20
Moss	-
Filamentous Algae	15
Macrophyte	15
Detritus	-

Water Quality – Wet Season	
Temperature	25.0^{O}C
pH	6.3
Conductivity	0.152
DO (% saturation)	35
Turbidity	1.7

AH48 – Tributary of Spring Creek


View Upstream - Dry


View Downstream - Dry


View Upstream - Wet


View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Remnant Channel
Flow Regime	Ephemeral
Channel Width (m)	12
Wetted Width (m)	2
Water Level	Low
Bank Shape	Low Slope

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	50	Boulder	-
Pool	50	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	100
		Silt/Clay	-

Vegetation

Riparian Width	Right –3m	Left -4m
Dominant Type	*Callitris intratropica,Eucalyptus camaldulenis, Melaleuca fluviatilis, M. leucadendra,* Grasses	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	28.9^{O}C
pH	6.8
Conductivity	0.212
DO (% saturation)	55
Turbidity	16

AH49 – Pebbly Creek


View Upstream - Dry


View Downstream - Dry


View Upstream - Wet


View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Remnant Channel
Flow Regime	Ephemeral
Channel Width (m)	8
Wetted Width (m)	2
Water Level	Low
Bank Shape	Low Slope

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	100	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	-
		Silt/Clay	100

Vegetation

Riparian Width	Right –1m	Left -1m
Dominant Type	*Callitris intratropica,Eucalyptus camaldulenis, Melaleuca fluviatilis, M. leucadendra,* Grasses	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	25.2^{O}C
pH	6.4
Conductivity	0.1316
DO (% saturation)	43
Turbidity	270

AH50 – Malcolm Creek

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Remnant Channel
Flow Regime	Ephemeral
Channel Width (m)	16
Wetted Width (m)	2
Water Level	Low
Bank Shape	Low Slope

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	100	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	100
		Silt/Clay	-

Vegetation

Riparian Width	Right –4m	Left -6m
Dominant Type	*Callitris intratropica,Eucalyptus camaldulenis, Melaleuca fluviatilis, M. leucadendra,* Grasses	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	15
Detritus	-

Water Quality – Wet Season	
Temperature	24.4^{O}C
pH	6.6
Conductivity	0.289
DO (% saturation)	57
Turbidity	19

AH51 – Beta Creek


View Upstream - Dry


View Downstream - Dry


View Upstream - Wet


View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Remnant Channel
Flow Regime	Ephemeral
Channel Width (m)	16
Wetted Width (m)	4
Water Level	Low
Bank Shape	Low Slope

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	100	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	50
		Silt/Clay	50

Vegetation

Riparian Width	Right –15m	Left -25m
Dominant Type	*Callitris intratropica,Eucalyptus camaldulenis, Melaleuca fluviatilis, M. leucadendra,* Grasses	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	25.2^{O}C
pH	7.2
Conductivity	0.247
DO (% saturation)	65
Turbidity	247

AH52 – Tallarenha Creek

View Upstream - Dry

View Downstream - Dry

View Upstream - Wet

View Downstream - Wet

Channel Habitat – Wet Season

Morphology	
Pattern	Remnant Channel
Flow Regime	Ephemeral
Channel Width (m)	10
Wetted Width (m)	0.5
Water Level	Very Low
Bank Shape	Step and Low Slope

Habitat (%)		**Substrate (%)**	
Riffle	-	Bedrock	-
Run	-	Boulder	-
Pool	100	Pebbles	-
Backwater/Wetland	-	Gravel	-
Overall Complexity	Low	Sand	100
		Silt/Clay	-

Vegetation

Riparian Width	Right –10m	Left -15m
Dominant Type	*Callitris intratropica,Eucalyptus camaldulenis, Melaleuca fluviatilis, M. leucadendra,* Grasses	

Cover %	
Periphyton	-
Moss	-
Filamentous Algae	-
Macrophyte	-
Detritus	-

Water Quality – Wet Season	
Temperature	25.4^{O}C
pH	6.2
Conductivity	0.482
DO (% saturation)	60
Turbidity	377