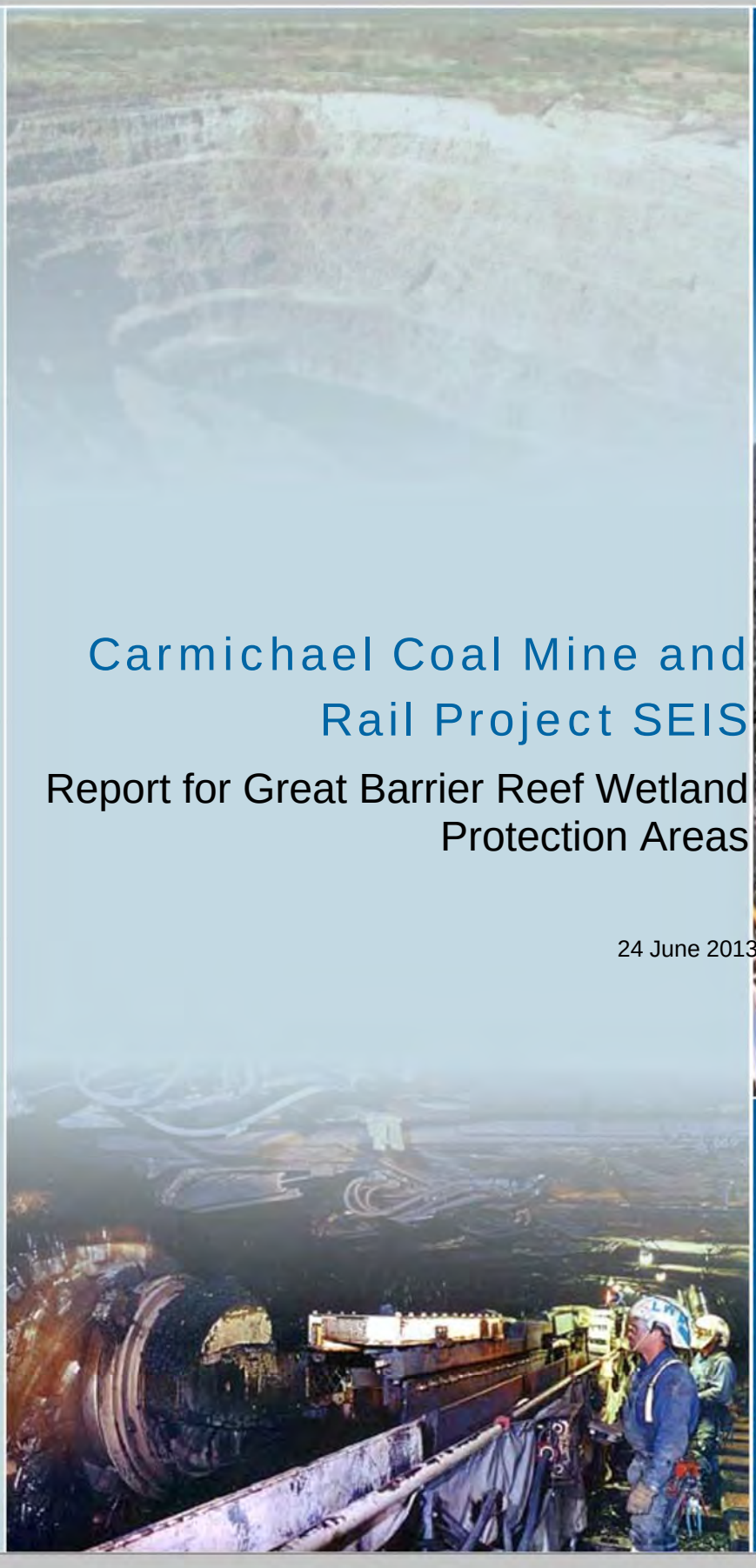
Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project SEIS

Report for Great Barrier Reef Wetland Protection Areas

24 June 2013



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The Report may only be used and relied on by Adani for the purpose of informing environmental assessments and planning approvals for the proposed Carmichael Coal Mine and Rail Project (Purpose) and may not be used by, or relied on by any person other than Adani.

The services undertaken by GHD in connection with preparing the Report were limited to those specifically detailed in Section 1.3 of the Report and did not include GHD undertaking testing at some parts of the site.

The Report is based on conditions encountered and information reviewed, including assumptions made by GHD, at the time of preparing the Report. Assumptions made by GHD are contained through the Report and that the information provided to GHD is accurate.

To the maximum extent permitted by law GHD expressly disclaims responsibility for or liability arising from:

- *any error in, or omission in connection with assumptions, or*
- *reliance on the Report by a third party, or use of this Report other than for the Purpose.*

Executive summary

Three areas within the Carmichael Coal Mine Project area, referred to as Study Area, are mapped as Great Barrier Reef (GBR) Wetland Protection Areas (WPA) under the State Planning Policy 4/11: Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments.

This report provides a description of the three GBR WPAs within the Study Area in terms of the Queensland Wetland Definition and Delineation Guidelines wetland criteria, hydrology, biota (flora and fauna) and soils. The wetlands were described using desktop information and field surveys conducted in May 2013.

No water was present at the three GBR WPAs during the 2011 survey or the recent survey (2013). The arid regions of Queensland commonly contain wetlands that naturally dry up entirely. These wetlands are often dry for years and may only be wet for a short period (i.e. ephemerally). This makes their identification difficult. The local 10 year Average Recurrence Interval (ARI) flood model indicates a 10 percent chance of flooding to the north of the Carmichael River every year, with 0.08 – 1.00 m of water inundating each GBR WPAs. One of the GBR WPAs covers a mapped first order tributary of the Carmichael River, which may suggest that this GBR WPA will frequently be inundated. The 100 year ARI flood event modelling suggests that the GBR WPAs are inundated with 1 – 2 m of water during these events. The inundation of the GBR WPAs during 10 and 100 year ARI storm events suggest that they may be wetlands.

During the 2013 survey the soils from two of the GBR WPAs were identified as clay and being light grey in colour. Soils from the other GBR WPA were identified as sandy clay and being tan to light brown in colour. The colour and the alluvium nature of the soil in the GBR WPAs suggest that they are wetlands. Alluvial deposits are a common element in this type of wetland, where the substrate is deep and cracking grey clays are common with minor relief of gilgai hollows.

Flora species listed as wetland indicator species were dominant at all GBR WPAs. Five wetland indicator flora species were observed at two GBR WPAs and three wetland flora indicator species were identified at the third GBR WPA.

According to the semi-arid swamps wetland management profile (Jaensch and Young, 2010) species predicted to occur in this type of wetland including spike-rushes (*Eleocharis* spp.) and sedges (*Cyperus* spp.). This suggests that more than one species of Eleocharis and Cyperus occur in this type of wetland and may include additional species to those on the wetland indicator species list. *Eleocharis pallens and Cyperus betchei* were identified at two of the GBR WPAs and *C. betchei* at the third GBR WPA. These species may also be indicators of the presence of a wetland.

The 2013 survey found snail shells, crab shells and burrows at the GBR WPAs. The snails, crabs and burrows could not be conclusively identified, however, they are indicative of the presence of freshwater fauna that utilise wetland habitat. Freshwater crayfish and crabs can be expected to occur in semi-arid swamps that are connected to rivers (Jaensch and Young, 2010). Recent nesting activity was also observed at one of the GBR WPAs in the form of numerous nests.

The GBR WPAs within the Study Area are wetlands and they fit the Queensland wetland classified of a semi-arid grass, sedge and herb swamp. Semi-arid swamps are mostly situated in alluvial plains and typically subject to temporary inundation. They may be inundated annually or less regularly; some may be inundated once every three years at most.

Table of contents

Table index

Figure index

Plate index

1. Introduction

1.1 Project overview

Adani Mining Pty Ltd (Adani, the Proponent), commenced an Environmental Impact Statement (EIS) process for the Carmichael Coal Mine and Rail Project (the Project) in 2010. On 26 November 2010, the Queensland (Qld) Office of the Coordinator General declared the Project a 'significant project' and the Project was referred to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (referral No. 2010/5736). The Project was assessed to be a controlled action on the 6 January 2011 under section 75 and section 87 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The controlling provisions for the Project include:

- World Heritage properties (sections 12 & 15A)
- National Heritage places (sections 15B & 15C)
- Wetlands (Ramsar) (sections 16 & 17B)
- Listed threatened species and communities (sections 18 & 18A)
- Listed migratory species (sections 20 & 20A)
- The Great Barrier Reef Marine Park (GBRMP) (sections 24B & 24C)
- Protection of water resources (sections 24D & 24E)

The Qld Government's EIS process has been accredited for the assessment under Part 8 of the EPBC Act (1999) in accordance with the bilateral agreement between the Commonwealth of Australia and the State of Queensland.

The Proponent prepared an EIS in accordance with the Terms of Reference (ToR) issued by the Qld Coordinator-General in May 2011 (Qld Government, 2011). The EIS process is managed under section 26(1) (a) of the *State Development and Public Works Act 1971* (SDPWO Act), which is administered by the Qld Government's Department of State Development, Infrastructure and Planning (DSDIP).

The EIS, submitted in December 2012, assessed the environmental, social and economic impacts associated with developing a 60 million tonne (product) per annum (Mtpa) thermal coal mine in the northern Galilee Basin, approximately 160 kilometres (km) north-west of Clermont, Central Queensland, Australia. Coal from the Project will be transported by rail to the existing Goonyella and Newlands rail systems, operated by Aurizon Operations Limited (Aurizon). The coal will be exported via the Port of Hay Point and the Point of Abbot Point over the 60 year (90 years in the EIS) mine life.

Project components are as follows:

- The Project (Mine): a greenfield coal mine over EPC 1690 and the eastern portion of EPC 1080, which includes both open cut and underground mining, on mine infrastructure and associated mine processing facilities (the Mine) and the Mine (offsite) infrastructure including a workers accommodation village and associated facilities, a permanent airport site, an industrial area and water supply infrastructure

- The Project (Rail): a greenfield rail line connecting to mine to the existing Goonyella and Newlands rail systems to provide for the export of coal via the Port of Hay Point (Dudgeon Point expansion) and the Port of Abbot Point, respectively including:
  - Rail (west): a 120 km dual gauge portion running west from the Mine site east to Diamond Creek
  - Rail (east): a 69 km narrow gauge portion running east from Diamond Creek connecting to the Goonyella rail system south of Moranbah.
  - Quarries: The use of five local quarries to extract quarry materials for construction and operational purposes

1.2 Purpose of this report

Adani has prepared an Environmental Impact Statement (EIS) for the proposed Project, which included assessments of the terrestrial and aquatic, flora and fauna communities on and adjacent to the proposed Project (GHD, 2012a; 2012b; 2012c).

Three areas within the Study Area are mapped as Great Barrier Reef (GBR) Wetland Protection Areas (WPA) under the State Planning Policy 4/11: Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments. Initial surveys of the mapped GBR WPAs undertaken as part of the Project (Mine) EIS indicated that no standing water or associated aquatic vegetation was present at the time of the surveys (GHD, 2012c).

This report provides the findings of an assessment of the characteristics of the mapped GBR WPAs against the Queensland Wetland definition criteria (DERM, 2010) to determine whether they are wetlands.

1.3 Scope of works

In order to assess the nature of the mapped GBR WPA, Adani commissioned GHD to assess the area against the Queensland Wetland definition criteria (DERM, 2010) to determine whether the sites were wetlands. The scope of works for this assessment included:

- A description of the GBR WPAs including a collection of multiple lines of evidence for the hydrology, biota (flora and fauna) and soils wetland definition criteria outlined in the Queensland Wetland Definition and Delineation Guidelines (DERM, 2010)
- Determination of the GBR WPAs status as a wetland
- Delineation of the wetland boundaries.

Information from the following Project (Mine) EIS and associated technical reports was used to support the assessment:

- Mine Terrestrial Ecology Report which assesses the terrestrial flora and fauna ecological values of the Mine Study Area (GHD, 2012a).
- Mine Soils Assessment Report which assesses the soil characteristics of EPC 1690 (GHD, 2012b).
- Aquatic Ecology Report which assesses the aquatic flora and fauna ecological values of the Mine Study Area (GHD, 2012c).

- Mine Hydrology Report which assesses the surface water flow and flooding of the Mine Study Area (GHD, 2012d).

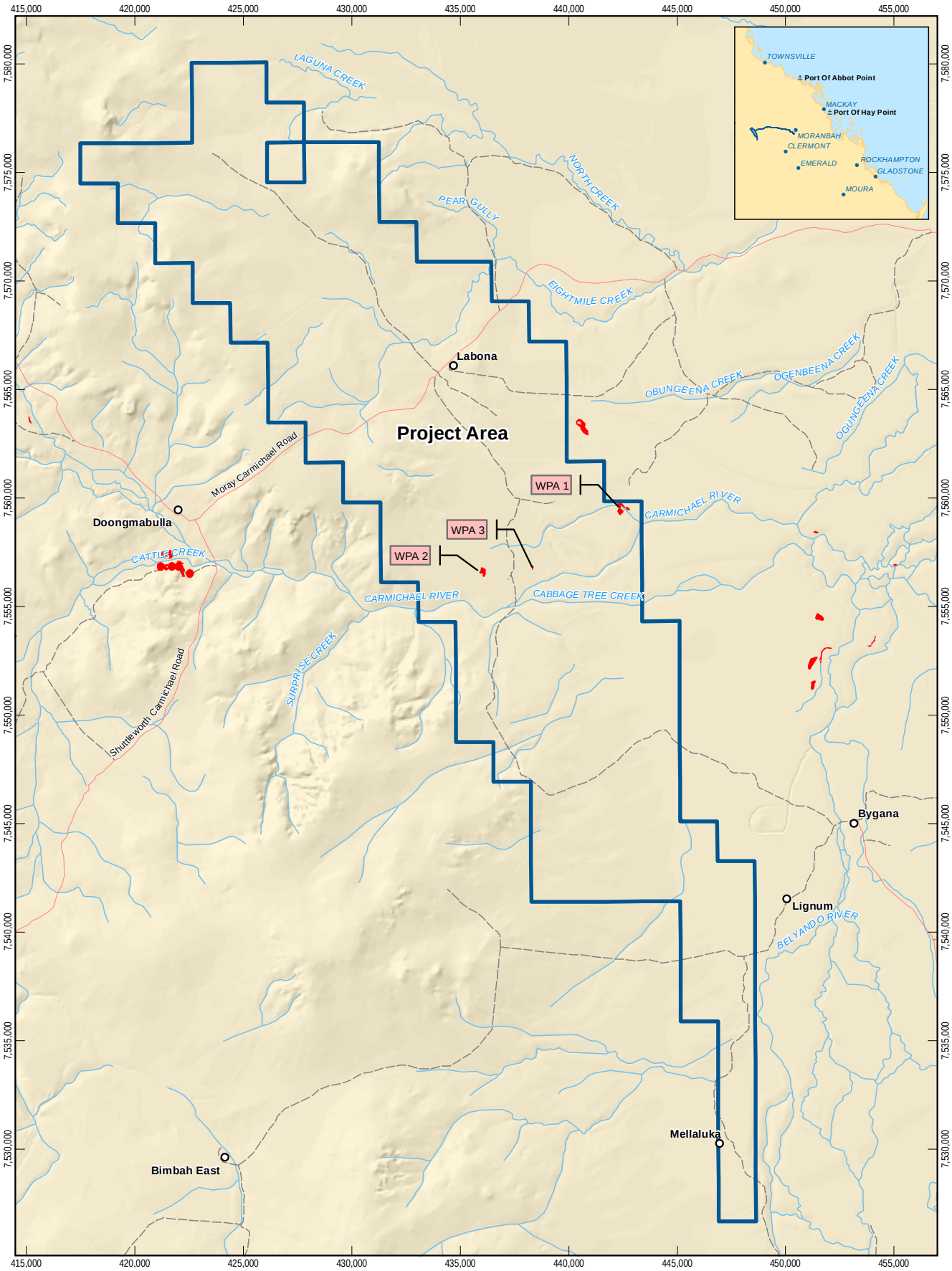
1.4 Study area

The Study Area as shown in Figure 1 is comprised of the three areas mapped as Great Barrier Reef (GBR) Wetland Protection Areas (WPA) under the State Planning Policy 4/11: Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments within the proposed Carmichael Coal Mine Project Area. The Project Area is bound by Exploration Permit Coal (EPC) areas 1690 and 1080 and offsite infrastructure areas.

1.5 Limitations

Field surveys of the three GBR WPAs located within Study Area were conducted on 3 May 2013 to support the assessment of the mapped GBR WPAs against the Queensland Wetland definition criteria outlined in the Queensland Wetland Definition and Delineation Guidelines (DERM, 2010).

A determination of whether the GBR WPAs are of high ecological significance was outside the current scope of work. The Aquatic Biodiversity Assessment Mapping Methodology (AquaBAMM) (Clayton et al, 2006) is used to identify the conservation values for wetlands. The AquaBAMM uses a range of criteria, indicators and measures in combination with peer review to categorise the riverine and non-riverine freshwater wetlands. The criteria are allocated an AquaScore for each wetland, which are then mathematically combined to give an overall AquaScore, this overall AquaScore of high and very high conservation value is then used to determine a wetland as high ecological significance.



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Project Area
- Great Barrier Reef Wetland Protection Area

1:250,000 (at A4)

0 1 2 3 4 5

Kilometres

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

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Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project
Great Barrier Reef Wetland Protection Areas Report

Job Number 41-26422
Revision C
Date 24-06-2013

Great Barrier Reef Wetland Protection Areas

Figure 1

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Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: DNRM: GBR Wetland Protection Areas (2009)© Copyright Commonwealth of Australia - Geoscience Australia: Road, Homestead, Watercourse (2007); DME: EPC1690 (2010), EPC1080 (2011). Created by: MS

2. Relevant legislation

2.1 Introduction

Several Commonwealth and State water policies aim to protect wetland systems of high ecological value, such as wetlands listed as GBR WPAs. A description of the key regulatory instruments, of relevance to WPAs, is provided below.

2.2 *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Commonwealth's principal piece of environmental protection legislation. It provides a national framework for the protection of the Australian environment and its unique biodiversity. Specifically, the EPBC Act aims to protect the environment by reducing significant impacts to matters of national environmental significance (matters of NES).

The Project was referred to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) on 18 November 2010 (EPBC 2010/5736). It was declared a 'controlled action' requiring assessment and approval under the EPBC Act on 6 January 2011. The controlling provisions for the Project that are relevant to the three GBR WPAs include:

- Listed threatened species and communities (sections 18 & 18a)
- Listed migratory species (section 20 & 20A).

2.3 *Queensland Nature Conservation Act 1992* and Nature Conservation (Wildlife) Regulation 2006

The *Nature Conservation Act 1992* (NC Act) provides for the conservation of nature through protection of all native plants and animals in Queensland. Protection is provided under the NC Act through conservation of land as protected areas and wildlife protection outside of protected areas. Actions impacting on protected native flora and fauna are regulated under the NC Act. Permits for disturbance to native flora and fauna can be administered under the NC Act.

The Queensland Nature Conservation (Wildlife) Regulation 2006 lists flora and fauna species considered to be extinct, endangered, and vulnerable, near threatened or special least concern in Queensland. NC Act listed flora and fauna species includes species which are considered wetlands indicator species and may be present within the GBR WPAs.

2.4 *Queensland Sustainable Planning Act 2009*

The *Sustainable Planning Act 2009* (SP Act) provides a number of statutory planning tools that address environmental objectives including regional plans, local government planning schemes and development assessment processes, including the State Planning Policy 4/11: Protecting Wetlands of High Ecological Significance in the Great Barrier Reef Catchments (discussed below Section 2.5).

2.5 State Planning Policy 4/11: Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments

The State Planning Policy 4/11 (Wetlands SPP) seeks to ensure that development is planned, designed, constructed and operated so as to not cause harm to the hydrology of wetlands that protect matters of national and state environmental significance including the outstanding universal values of the GBR.

The Wetlands SPP took effect on 25 November 2011. Department of Environment and Heritage Protection (DEHP) has produced a map of referrable wetlands, indicating where the Wetlands SPP applies. Wetlands considered being of High Ecological Significance (HES) in GBR catchments have been mapped as WPAs.

The AquaBAMM (Clayton *et al*., 2006) was used to identify the conservation values (including HES) for wetlands. The mapping uses a range of criteria, indicators and measures in combination with peer review to categorise the riverine and non-riverine freshwater wetlands.

The three GBR WPAs in the Study Area have been mapped as WPAs under the Wetlands SPP. These core protection areas have a 500 metre (m) assessable development trigger area (measured from the wetland boundary) around them.

2.6 Strategy for Conservation and Management of Queensland's Wetlands

The Strategy for Conservation and Management of Queensland's Wetlands 1999 provides the overarching Queensland policy position on wetlands. The Strategy sets out:

- the Queensland Government's intent for conservation and management of wetlands
- a definition of wetlands
- a statement on the values and functions of wetlands
- the Queensland Government's objectives for wetlands
- initiatives to achieve these objectives.

The strategy defines wetlands as: "areas of permanent or periodic/intermittent inundation, whether natural or artificial, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 metres."

A suite of tools have been developed through the Queensland Wetlands Program to support the implementation of wetland strategies, policies and legislation, including the Queensland Wetland Definition and Delineation Guidelines (DERM, 2010).

3. Methodology

3.1 Wetland criteria and indicators

The GBR WPAs are mapped using AquaBAMM (Clayton *et al*., 2006) which identifies relative wetland conservation values within a catchment. The mapping uses a range of criteria, indicators and measures in combination with peer review to categorise the riverine and non-riverine freshwater wetlands in the catchment. The criteria used to determine wetland conservation value includes:

a. the health and biodiversity of the wetland's ecosystems

b. the wetland's natural state and biological integrity

c. the presence of distinct or unique features, plants or animals and their habitats, including threatened wildlife, near-threatened wildlife and rare wildlife under the NC Act

d. the wetland's natural hydrological cycle

e. the natural interaction of the wetland with other ecosystems, including other wetlands.

When a wetland is ephemeral a number indicators may be used to indicate that a wetland exists. In most of these cases, wetland soils may be used, as well as the remains of wetland plants and animals, traces of plants or seeds within the soil. The shells, bones or scales of wetland animals (such as mussels, snails, crabs, crayfish, turtles and fish) may remain indicating presence of seasonal aquatic habitat. Some species may be underground waiting for the water's return and traces of obligate animal burrows may also be evident.

Three GBR WPAs are mapped within the Study Area (Figure 1). The GBR WPAs were mapped north of the Carmichael River up to 2 km from the waterway and as 'seasonal palustrine/swamps of the floodplain with native macrophyte communities (Regional Ecosystem (RE) 11.3.27)'. Initial surveys undertaken by GHD in 2011 indicated that no standing water or associated aquatic vegetation was present. The RE mapping discussed is from the official DERM version 6.1 RE mapping layer. RE units are as defined in the Regional Ecosystem Description Database (Queensland Herbarium, 2013).

The Queensland Wetland Definition and Delineation Guidelines wetland criteria, hydrology, biota (flora and fauna) and soils were described using desktop assessments and field surveys. The criteria factors and their indicators are outlined in Table 1.

The wetland definition is satisfied if sufficient information is provided to demonstrate inundation as well as one (or more) of three additional criteria as described in Table 1. The wetland definition is applied using a multiple-lines-of-evidence approach in which more conclusive indicators can be used on their own to reliably determine a criterion has been met, whilst less conclusive indicators are used with other information to determine if a criterion has been met.

Table 1 Criteria and indicators for identifying a wetland

Factor	Criterion	Indicators
Hydrology	Areas of permanent or periodic/intermittent inundation, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 m	• Direct observation: water saturation/inundation • Indirect observations: micro relief, algal mats, aerial roots, floodmarks, iron staining • Presence of wetland soils, vegetation dominated by wetland indicator plants, observation of inundation on imagery, hydrological monitoring
Biota	Supports plants and animals, at least periodically, that are adapted to or dependent on living in wet conditions for at least part of their life cycle	• Flora - Predominance of wetland indicator plants • Fauna - Species recorded at lifecycle stage known to be dependent on wet conditions • Species known to be dependent on wetlands for all stages of their lifecycle
Soils	The substratum is predominately undrained soils that are saturated, flooded or ponded long enough to develop anaerobic conditions in the upper layer (hydric soils)	• Indicators in parts 1 and 2 of wetlands soil key (Bryant et al., 2008)
Modified from DERM, 2010		

Hydrology

While direct evidence of saturation may be used as an indicator for hydrology, this is often difficult to obtain due to the temporal and spatial variability in wetland hydrology and because a site often needs to be evaluated at one point in time. Therefore, in the absence of hydrological information the dominance of wetland plant or soil indicators, in conjunction with other hydrological indicators, provide enough evidence that the hydrological criteria have been met.

Biota – flora and fauna

While the criterion in the definition includes land that supports wetland plants, to be conclusive it is considered that the vegetation has to be dominated by such plants, as this indicates that inundation with water is the dominant factor determining the types of plant (and animal) communities associated with the site.

The Queensland Wetland Indicator Species List (http://wetlandinfo.ehp.qld.gov.au/wetlands/ecology/) contains an extensive suite of wetland species, both flora and fauna, that have been selected by a justification process and, therefore, can be used as one line of evidence when testing a feature for wetland status. However, a foot note is included to the Wetland Indicator Species List that states that the list is indicative and may not be all inclusive of all wetland indicator species.

Soils

The field guide to soil indicators includes a key to help identify and delineate Queensland wetland soils and provides a user friendly system for applying soil indicators to assist wetland identification across Queensland.

3.2 Desktop assessment

A desktop assessment of the Study Area against each WPA criterion was conducted. The desktop assessment included review of existing maps, aerial imagery and previous studies relevant to the site. Table 2 identifies the specific purpose and desktop methodology for each criterion.

Table 2 Desktop assessment methodologies used for each WPA criterion

Criteria	Purpose	Methodology
Hydrology	Provide an understanding of flooding and how it affects the WPAs	• Review of existing documentation and flooding maps prepared for Project (Mine) EIS (GHD, 2012d) • Review of publically available desktop sources including satellite and aerial imagery
Biota	Provide background to aquatic flora and fauna in the vicinity of the GBR WPAs and inform the aquatic habitat values of the GBR WPAs	• Information relating to the aquatic ecological values of the adjacent area was obtained from the Project (Mine) EIS (GHD, 2012a and 2012c) • Species identified from desktop sources were cross checked against wetland indicator flora and fauna species
Soils	Provide understanding of types of soils in the WPAs against wetland soil types	• Review of existing documentation and soils maps prepared for the Project (Mine) EIS (GHD, 2012b).

Previous aquatic ecology survey sites were selected to provide information representative of the aquatic ecosystems and habitats within the Study Area. Six aquatic ecology survey sites were in close vicinity to the GBR WPAs (Table 3). At each previous survey site habitat, fauna and flora assessments were undertaken (GHD, 2012c).

Terrestrial fauna surveys were undertaken in the vicinity of GBR WPA 2 and 3, with a number of rapid fauna assessments and comprehensive fauna surveys also being undertaken. No surveys sites were in the vicinity of the GBR WPA 1. The fauna surveyed included amphibians and water birds. During the August – November 2011 survey the GBR WPAs were visited and flora and fauna was assessed (GHD, 2012a).

Table 3 Aquatic ecology survey sites from the EIS and GBR WPA in their vicinity

Site No.	Waterbody Type	Watercourse	Habitat Assessment			GBR WPA
			Nov 2010	May 2011	Nov 2011	
5	Riverine	Carmichael River (upstream)	✓	✓		3
6	Riverine	Carmichael River (central)	✓	✓		3
15	Palustrine	Swamp Tank (dam)	✓	✓		2
19	Palustrine	Mapped Wetland			✓	1

Site No.	Waterbody Type	Watercourse	Habitat Assessment			GBR WPA
			Nov 2010	May 2011	Nov 2011	
22	Riverine	Carmichael River			✓	1
25	Riverine	Carmichael River			✓	2

3.3 Field surveys

Queensland Wetland Definition and Delineation Guidelines suggest the best approach when undertaking and investigating wetland determination is to collect multiple lines of evidence for all of the above mentioned wetland criteria. With this in mind, GHD carried out the following aquatic survey methods to characterise, define and delineate the three GBR WPAs within the Study Area (Table 4).

On 3 May 2013, field surveys of the three GBR WPAs located within Study Area were conducted. Field surveys included an assessment of the GBR WPAs against the Queensland Wetland criteria and a delineation of the GBR WPA boundaries. A soil sample to germinate potential aquatic seed bank was also collected at each GBR WPA to confirm the presence of wetland flora species if none were observed in the field. The observed presence of wetland indicator flora species in the field meant that it was not necessary to germinate the seed bank of the sample collected.

Table 4 Field assessment methodologies used for each WPA criterion

Criteria	Methodology
Hydrology	Direct field observations of hydrology features including water saturation/inundation, micro relief, algal mats, aerial roots, floodmarks, iron staining, presence of closed depressions, wetland drainage patterns, mud cracks, surface staining, algal flakes and salt crusts.
Biota	A rapid quaternary vegetation survey was conducted at the three GBR WPAs. A soil sample to germinate potential aquatic seed bank was also collected. Rapid habitat assessment and rapid fauna survey were undertaken at the three GBR WPAs. See Sections 3.3.1 and 3.3.2. Incidental searches were undertaken to examine evidence of eggs, nests, burrows, shells and skeleton remains. Active searches were also undertaken for less mobile aquatic species that may burrow and aestivate until water returns.
Soils	The presence or absence of the following indicators was recorded: • accumulation of organic (decomposed plant) materials • presence of sulfidic material • Gleyed soil matrix colours.

3.3.1 Rapid habitat assessment

Rapid habitat assessments were undertaken at each GBR WPA to determine the availability of habitat and resources for wetland indicator species. These determined the availability of resources (feeding, drinking, nesting, sheltering and breeding) for local terrestrial and aquatic fauna, by identifying the type and structural complexity of vegetation at canopy, shrub and ground level, the relative abundance of hollow-bearing trees, woody debris, logs, the type of soil and the proximity to water.

3.3.2 Rapid fauna surveys

At each of the GBR WPA a rapid fauna survey was undertaken. This included:

- Standardised survey for reptiles and frogs (i.e. a 20 minute 'active search' of potential microhabitats, looking beneath rocks, logs, leaf litter, woody debris and adjacent to waterbodies)
- Incidental searches for wildlife and wildlife traces recording all wildlife or wildlife traces (i.e. scats, tracks, feathers, bones, diggings, nests, burrows, eggs, shells and skeleton remains).

Species identified during field assessment were cross checked against the wetland indicator flora and fauna species list.

GHD undertook ground-truthing of the wetland/s boundary in the field. The wetland boundary was determined by walking a single line representative of the landward wetland extent relative to the survey site. The boundary was located on the ground using a combination of the extent of wetland indicators including hydrology, biota, and soils. A hand held global positioning system (GPS) was used to track the identified wetland boundary.

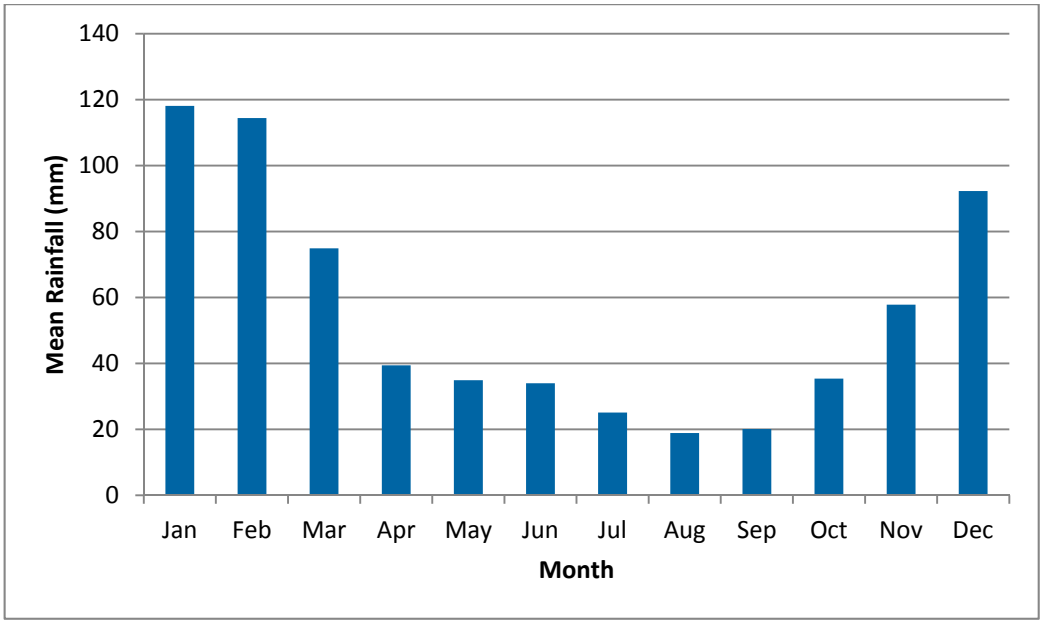
3.4 Weather condition

All weather data was sourced from the nearest Australian Bureau of Meteorology (BoM) weather station – Clermont Sirus Street (Station ID035019), located approximately 150 km south-east of the Project Area (BoM, 2013).

In the three months leading up to the November 2011 (i.e. August – October 2011), 95.6 mm of rain was recorded in Clermont. No rainfall was recorded during the 2011 field survey period. In the three months leading up to the May 2013 survey (i.e. February – April 2013), 144.7 mm of rain was recorded in Clermont. No rainfall was recorded during this field survey period.

Mean rainfall in Clermont shows the wet season from November to March and the dry season from April to October (Figure 2). The survey at the GBR WPAs in 2011 was during or after the dry season and the survey in May 2013 was after the wet season. The timing of the 2013 survey, after the wet season, is predicted to provide a better opportunity to observe wetland flora and fauna if present.

Figure **2** Mean rainfall (mm) for years 1870 to 2013 in Clermont



Source: BoM, 2013

4. Results

4.1 Hydrology

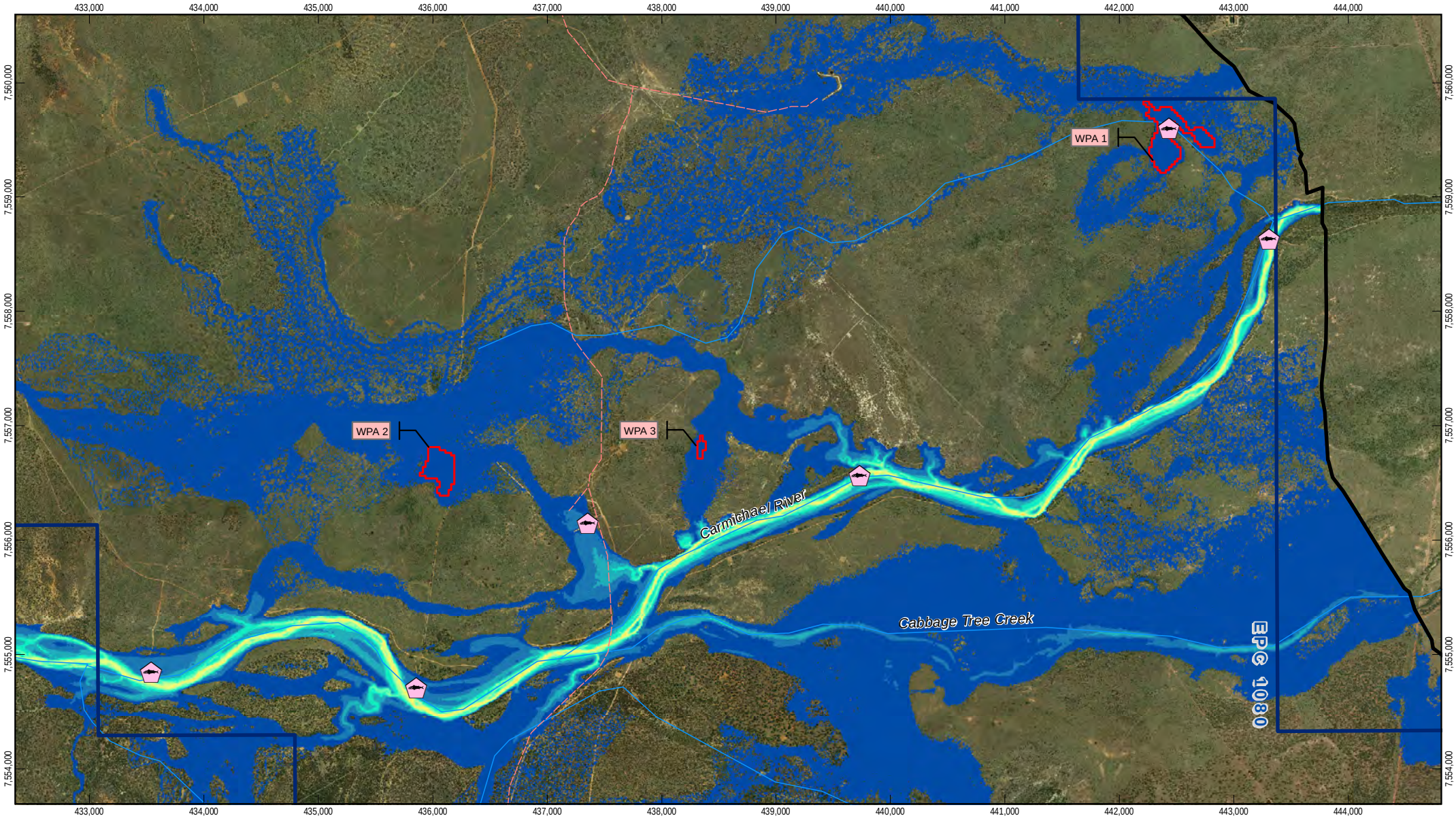
No water was present at the three GBR WPAs during the 2011 survey or the recent survey (May 2013). Hydrologic modelling of the Carmichael River regional catchment was undertaken for the Project EIS (GHD, 2012d) to provide input to the baseline flooding model of the Carmichael River corridor. The 10 year, 50 year, 100 year and 1,000 year ARI design floods were determined. The ARI is the “average” number of years between successive flood events of the same or greater magnitude. The ARI can also indicate the probability of a particular flood event being equalled or exceeded in any one year period.

During the 10 year ARI storm event, the flood flow path follows an existing route that ultimately discharges into Cabbage Tree Creek to the south-east of the Carmichael River, with the flows largely contained within the river channel with some localised overbank flooding at the major inflow gullies.

The local 10 year ARI flood model indicates a 10 percent chance of flooding to the north of the Carmichael River every year, with 0.08 – 1.00 m of water inundating all three GBR WPAs (Figure 3). GBR WPA 1 also covers a mapped first order tributary of the Carmichael River, which may suggest that this GBR WPA will frequently be inundated.

During a major 100 year ARI storm event, wide-spread flooding is evident to the north of the Carmichael River. Flood water depths overbank of the Carmichael River range between 0.3 – 1.7 m. The flood extents along the defined runoff paths typically increase by 7 – 20 m either side and up to 60 m either side in the larger flat inundated area to the east during a 100 year ARI compared to a lower 10 year ARI flood event (Figure 4). Flood modelling suggests that the GBR WPAs are inundated with 1 – 2 m of water during a 100 year ARI flood event.

The inundation of the GBR WPAs during 10 and 100 year ARI storm events suggest that they may be wetlands.



1:45,000 (at A4)

0 0.5 1

Kilometres

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

N

LEGEND

- Great Barrier Reef Wetland Protection Area
- EIS Habitat Assessment Site
- Watercourse
- Track
- 2D Model Extent
- Project Area

Depth (m)

- 0.08 - 1.0
- 1.0 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- 4.0 - 5.0
- 5.0 - 6.0
- 6.0 - 7.0
- 7.0 - 8.0
- 8.0 - 9.0
- 9.0 - 10.0
- 10.0 - 10.44

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Carmichael Coal Mine and Rail Project
Great Barrier Reef Wetland Protection Areas Report

10 Year ARI Flood Event and GBR Wetland Protection Areas

Job Number 41-26422
Revision B
Date 24-06-2013

Figure 3

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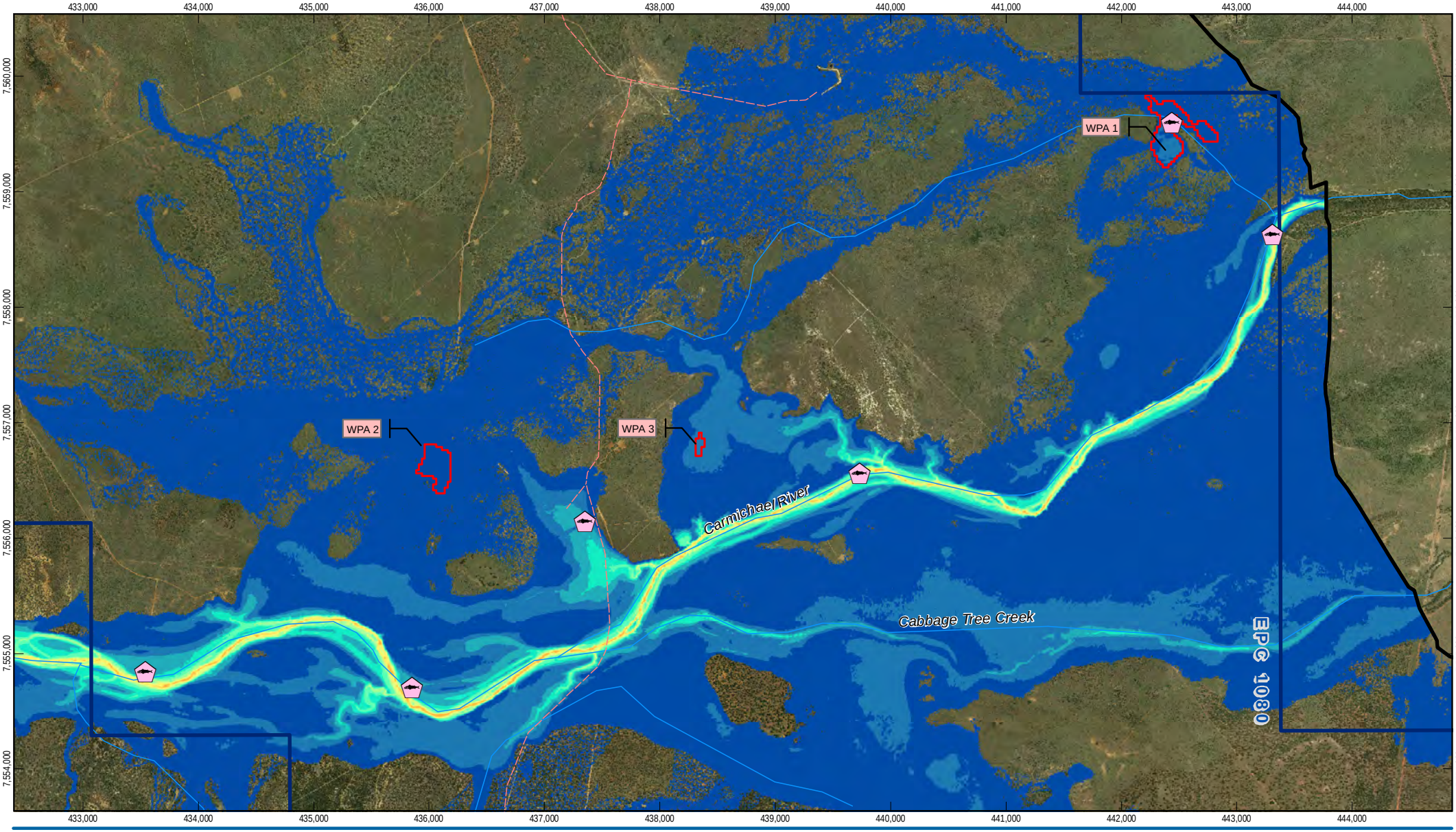
Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: DME: EPC1690 (2010)/EPC1080 (2011); © Commonwealth of Australia (Geoscience Australia): Watercourse, Tracks (2007); GHD: Assessment Sites (2011), Modelling (2012); DNRM: WPA (2010); Adani/AAM: Aerial Photo (2012). Created by: MS



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0 0.5 1

Kilometres

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

N

LEGEND

- Great Barrier Reef Wetland Protection Area
- EIS Habitat Assessment Site
- Watercourse
- Track
- 2D Model Extent
- Project Area

Depth (m)

- 0.08 - 1.0
- 1.0 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- 4.0 - 5.0
- 5.0 - 6.0
- 6.0 - 7.0
- 7.0 - 8.0
- 8.0 - 9.0
- 9.0 - 10.0
- 10.0 - 10.44

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Great Barrier Reef Wetland Protection Areas Report

100 Year ARI Flood Event and GBR Wetland Protection Areas

Job Number 41-26422
Revision B
Date 24-06-2013

Figure 4

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Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: DME: EPC1690 (2010)/EPC1080 (2011); © Commonwealth of Australia (Geoscience Australia): Watercourse, Tracks (2007); GHD: Assessment Sites (2011), Modelling (2012); DNRM: WPA (2010); Adani/AAM: Aerial Photo (2012). Created by: MS

4.2 Biota (flora and fauna)

4.2.1 Project Area

Six aquatic ecology survey sites within the Project Area (Table 3) were selected to provide background information on the wetland flora and fauna species in the vicinity of the GBR WPAs. Wetland indicator species that were predicted and observed during studies undertaken as part of the Project (Mine) EIS (GHD, 2012a and 2012c) are summarised below and listed in Appendix A.

The Carmichael River (5th order stream) to the south of the GBR WPAs maintains aquatic habitat throughout the year, even if in isolated pools. The river provides small amounts of submerged macrophytes, trailing bank vegetation and overhanging vegetation. It also provides suitable habitat for turtles, fish and crustaceans.

During the previous flora surveys in the vicinity of Carmichael River for the Project (Mine) EIS, 19 wetland indicator flora species and one species (*Eriocaulon carsonii* subsp. *orientale*) listed as endangered under the NC Act were identified (GHD, 2012a).

Eleven fish species were recorded within the Project Area during the Project (Mine) EIS field surveys. All of the fish recorded are common freshwater species previously recorded in the upper Burdekin Catchment.

A number of turtles were predicted to occur within the Project Area. Of these all are wetland indicator species. The turtle species predicted to occur inhabit a variety of habitats ranging from ephemeral waterholes and pools to structurally complex rivers and creeks. Field assessments undertaken for the Project (Mine) EIS did not observe any turtles. The presence of the habitat features used by the turtles predicted to occur were identified and therefore, freshwater turtles are considered likely to occur within the Project Area.

Eleven species of frog were observed during Project (Mine) EIS field surveys. Of these, three are listed as wetland indicator species. The wetland indicator species are burrowing frogs which are not considered aquatic in the adult life stage. For the early life stages (egg and tadpole) of these species, however, the aquatic environment is essential. Therefore, these species are only an indicator for possible wetland conditions in the egg and tadpole stages, and during breeding events.

In the arid inland areas with ephemeral wetlands burrowing frogs can be found. These frogs bury themselves in the moist underground, subdue body metabolism and enter a state of dormancy referred to as aestivation for months or years of drought. They can then activate themselves within 24 hours of a rain or flood event, rise to the surface and mate with the tadpole metamorphosing into a frog in about 14 to 20 days in most species. Breeding occurs as long as the wet event lasts.

During previous 2011 field surveys, 23 wetland indicator bird species and one wetland indicator mammal species (*Hydromys chrysogaster* – water rat), were identified within the Project Area. A number of the wetland bird species are of conservation significance, namely:

- One bird (*Ardea alba* – great egret) listed as migratory (Mig) and marine (Ma) under the EPBC Act as well as CAMBA[1] and JAMBA[2].
- Two birds (*Nycticorax xaledonicus* – nankeen night heron and *Pelecanus conspicillatus* – Australian pelican) listed as marine under the EPBC Act
- Two birds (*Nettapus coromandelianus* – cotton pygmy goose and *Ephippiorhynchus asiaticus* – black-necked stork) listed as Near Threatened (NT) under the NC Act.

The flora and fauna observed during the 2011 and 2013 surveys of the GBR WPAs is provided in the following sections.

4.2.2 Great Barrier Reef Wetland Protection Area 1

Previous survey

The area surrounding the GBR WPA 1 was observed to be predominantly cleared, and dominated by grasses and some woody regrowth during the 2011 survey. No standing water or associated aquatic vegetation was present at the time of the 2011 survey (Plate 1). Evidence of recent water was noted with many of the surrounding trees exhibiting a watermark at approximately 0.5 m from the ground level. Recent waterbird nesting activity was observed in the form of numerous nests (no longer being used). It was concluded that GBR WPA 1 is likely to provide seasonal habitat for aquatic species including waterbirds during the wet season or after significant rainfall.

Field assessment

During the 2013 survey the GBR WPA 1 was described to be dominated by sedges and rushes with fringing coolabah woodland (Plate 2). Recent nesting activity was observed in the form of numerous nests. The GBR WPA 1 had been subject to fire, predicted to be approximately 6 months ago based on vegetation regrowth.

[1] CAMBA refers to the agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment

[2] JAMBA refers to the agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment.

Plate 1 Great Barrier Reef Wetland Protection Area 1 (November 2011)

Plate 2 Great Barrier Reef Wetland Protection Area 1 (May 2013)

** Note that the photos were taken from different areas of GBR WPA 1 between November 2011 and May 2013. Consequently, the aspects of Plate 1 and Plate 2 are showing alternative views of the GBR WPA.*

Of the flora species identified during the 2013 field surveys five species are wetland indicator flora species (Table 5). *Eucalyptus coolabah*, *Eleocharis pallens and Cyperus betchei* were the dominant flora species within GBR WPA 1. *Eucalyptus coolabah* is listed as a wetland indicator species. *Eleocharis pallens and Cyperus betchei* which were identified at GBR WPA 1 are not included as a wetland indicator species. *Eleocharis pallens* is described as growing in seasonally wet situations such as floodways, usually on clayey soils and *C. betchei* is also described as growing in seasonally wet situations, such as stream banks and roadside drains (plantNet http://plantnet.rbgsyd.nsw.gov.au/floraonline.htm).

According to the semi-arid swamps wetland management profile (Jaensch and Young, 2010) species predicted to occur in this type of wetland including spike-rushes (*Eleocharis* spp.) and sedges (*Cyperus* spp.). This suggests that more than one species of *Eleocharis* and *Cyperus* may occur in this type of wetland and may include additional species to those on the wetland indicator species list.

The GBR WPAs are mapped as RE 11.3.27. Based on the observed flora species present the major vegetation community of 11.3.27f applies. 11.3.27f is described as a palustrine wetland with *Eucalyptus coolabah* and/or *E. tereticornis* open-woodland to woodland fringing swamps. Ground layer and treeless areas range from open water with or without aquatic and emergent macrophytes such as *Potamogeton crispus*, *Myriophyllum verrucosum*, *Chara* spp., *Eleocharis* spp., *Nitella* spp, *Cyperus difformis* and *Hydrilla verticillata*. This RE occurs on closed depressions on floodplains associated with old drainage courses that are intermittently flooded.

Table 5 Flora species identified at GBR WPA 1 in 2013

Flora species	Wetland indicator species
Aeschynomene indica	Yes
Crinum flaccidum	Yes
Cynodon dactylon	Yes
Echinochloa colona	Yes
Eucalyptus coolabah	Yes
Cyperus betchei	No *
Eleocharis pallens	No *
Abutilon fraseri	No
Alternanthera nana	No
Aristida calycina	No
Arundinella nepalensis	No
Carissa ovata	No
Cenchrus ciliaris	No
Chrysopogon fallax	No
Cucumis melo	No
Eragrostis elongata	No
Eragrostis sororia	No
Fimbristylis dichotoma	No
Gomphrena celosioides	No
Grevillea parallela.	No
Grevillea striata	No

** species may also indicate the presence of a wetland*

The rapid fauna survey found snail shells, crab shells (Plate 3) and burrows (Plate 4) within the GBR WPA 1. The snails, crabs and burrows could not be conclusively identified as live specimens were not observed. However, these observations indicate the presence of freshwater fauna that utilise wetland habitat. In the absence of an operculum, the corneous or calcareous anatomical lid (trapdoor like) structure, the taxonomy of the snail shells collected could not be refined, however, morphologically resemble the freshwater taxa *Physa* or *Physastra* (Williams, 1980). Based on morphology the samples are not considered to be land snails. The morphology of the burrows observed was consistent with that of a freshwater crayfish burrow.

Plate 3 Freshwater crab claw

Plate 4 Burrows

4.2.3 Great Barrier Reef Wetland Protection Area 2

Previous survey

During the 2011 survey, GBR WPA 2 displayed little evidence of water retention. The area appeared to be a depression in the landscape where, during wetter periods, the substrate retained moisture. No macrophytes or emergent grass species were present. The area displayed heavy cattle and pig disturbance. The aquatic ecology values of this area were considered to be low for aquatic flora and fauna (Plate 5).

Plate 5 Great Barrier Reef Wetland Protection Area 2 (August 2011)

Field assessment

During the 2013 survey, GBR WPA 2 was dominated by sedges and rushes with fringing coolabah woodland (Plate 6 and Plate 7). The GBR WPA 2 had been subject to fire, predicted to be approximately 12 months ago based on vegetation regrowth. Of the flora species identified during the 2013 field surveys five species are wetland indicator flora species (Table 6). *Eucalyptus coolabah* and *Eleocharis pallens* were the dominant flora species within GBR WPA 2. *Eucalyptus coolabah* is listed as a wetland indicator species. *Eleocharis pallens and Cyperus betchei* which were identified at GBR WPA 1 and 2 are not included as a wetland indicator species.

Similarly to GBR WPA 1, the presence of *E pallens* and *C betchei* in combination with other wetland indicators provide evidence that GBR WPA 2 is a wetland. GBR WPA 2 is mapped as RE 11.3.27 and based on the observed flora species present (Table 6), the major vegetation community of 11.3.27f applies to this GBR WPA.

Plate 6 Great Barrier Reef Wetland Protection Area 2 (May 2013)

** Note that Plate 5 and Plate 6 are taken from the same aspect; however, the image in Plate 6 was taken from a greater distance, and the central subject in Plate 5 is to the far left in Plate 6.*

Plate 7 Great Barrier Reef Wetland Protection Area 2 (May 2013)

Table 6 Flora species identified at GBR WPA 2 in 2013

Flora species	Wetland indicator species
Aeschynomene indica	Yes
Crinum sp.	Yes
Cynodon dactylon	Yes
Echinochloa colona	Yes
Eucalyptus coolabah	Yes
Cyperus betchei	No *
Eleocharis pallens	No *
Abutilon fraseri	No
Acacia harpophylla	No
Acacia salicina	No
Alternanthera nana	No
Arundinella nepalensis	No
Bothriochloa bladhii	No
Capillipedium spicigerum	No
Centipeda minima	No
Chrysopogon fallax	No
Cucumis melo	No
Cymbidium canaliculatum	No
Dactyloctenium radulans	No
Eragrostis parviflora	No
Eragrostis tenellula	No
Eucalyptus brownii	No
Grevillea striata	No
Lysiana subfalcata	No
Lysiphyllum carronii	No
Oxalis perennans	No
Stemodia glabella	No
Tephrosia supina	No
Urochloa mosambicensis	No

* species may also indicate the presence of a wetland

The rapid fauna survey found snail shells, crab shells and burrows (Plate 8) within the GBR WPA 2. The snails, crabs and burrows could not be conclusively identified, however, they are indicative of the presence of freshwater fauna (snails, crabs and crayfish) that utilise wetland habitat.

Plate 8 Snail shells and burrow

4.2.4 Great Barrier Reef Wetland Protection Area 3

Previous survey

The GBR WPA 3 displayed little evidence of water retention when surveyed in November 2011. Ground-truthing of the vegetation found that the area was comprised on non-remnant vegetation and did not appear to provide ecological values for aquatic flora and fauna (Plate 9).

Field assessment

During the 2013 field survey, the GBR WPA 3 was dominated by sedges and rushes with fringing coolabah woodland (Plate 10 and Plate 11). The GBR WPA 3 had been subject to fire, predicted to be approximately 12 months ago based on vegetation regrowth.

Plate 9 Great Barrier Reef Wetland Protection Area 3 (November 2011)

Plate 10 Great Barrier Reef Wetland Protection Area 3 (May 2013)

** Note that Plate 9 and Plate 10 taken from the same aspect (inside the WPA facing outwards in the same direction); however, the image in Plate 10 was taken from a greater distance, and the central subject in Plate 9 is to the far left in Plate 10.*

Plate 11 Great Barrier Reef Wetland Protection Area 3 (May 2013)

Of the flora species identified during field surveys three species are wetland indicator flora species (Table 7). *Eucalyptus brownii* and *Cyperus betchei* were the dominant flora species within GBR WPA 3. These dominant species are not listed as a wetland indicator species. *Cyperus betchei* which were identified at all GBR WPAs is not included as a wetland indicator species.

Similarly to GBR WPA 1 and GBR WPA 2, the presence of *C betchei* in combination with other wetland indicators provides evidence that GBR WPA 3 is a wetland. GBR WPA 3 is also mapped as RE 11.3.27 and based on the observed flora species present (Table 7), the major vegetation community of 11.3.27f applies to this GBR WPA.

Table 7 Flora species identified at GBR WPA 3 in 2013

Flora species	Wetland indicator species
Aeschynomene indica	Yes
Echinochloa colona	Yes
Marsilea mutica	Yes
Cyperus betchei	No *
Acacia cambagei	No
Acacia harpophylla	No
Alectryon oleifolius	No
Alternanthera nana	No
Arundinella nepalensis	No
Astrebla pectinata	No
Bothriochloa bladhii	No
Brachyscome dentata	No
Cenchrus ciliaris	No
Chrysopogon fallax	No
Cymbopogon bombycinus	No
Eucalyptus brownii	No
Eulalia aurea	No
Gomphrena celosioides	No
Opuntia tomentosa	No
Oxalis perennans	No
Parthenium hysterophorus	No
Sporobolus mitchellii	No

* species may also indicate the presence of a wetland

The rapid fauna survey found burrows (Plate 12) within the GBR WPA 3. The burrows could not be conclusively identified, however, they are indicative of the presence of freshwater crayfish that utilise wetland habitat.

Plate 12 Burrow

4.3 Soils

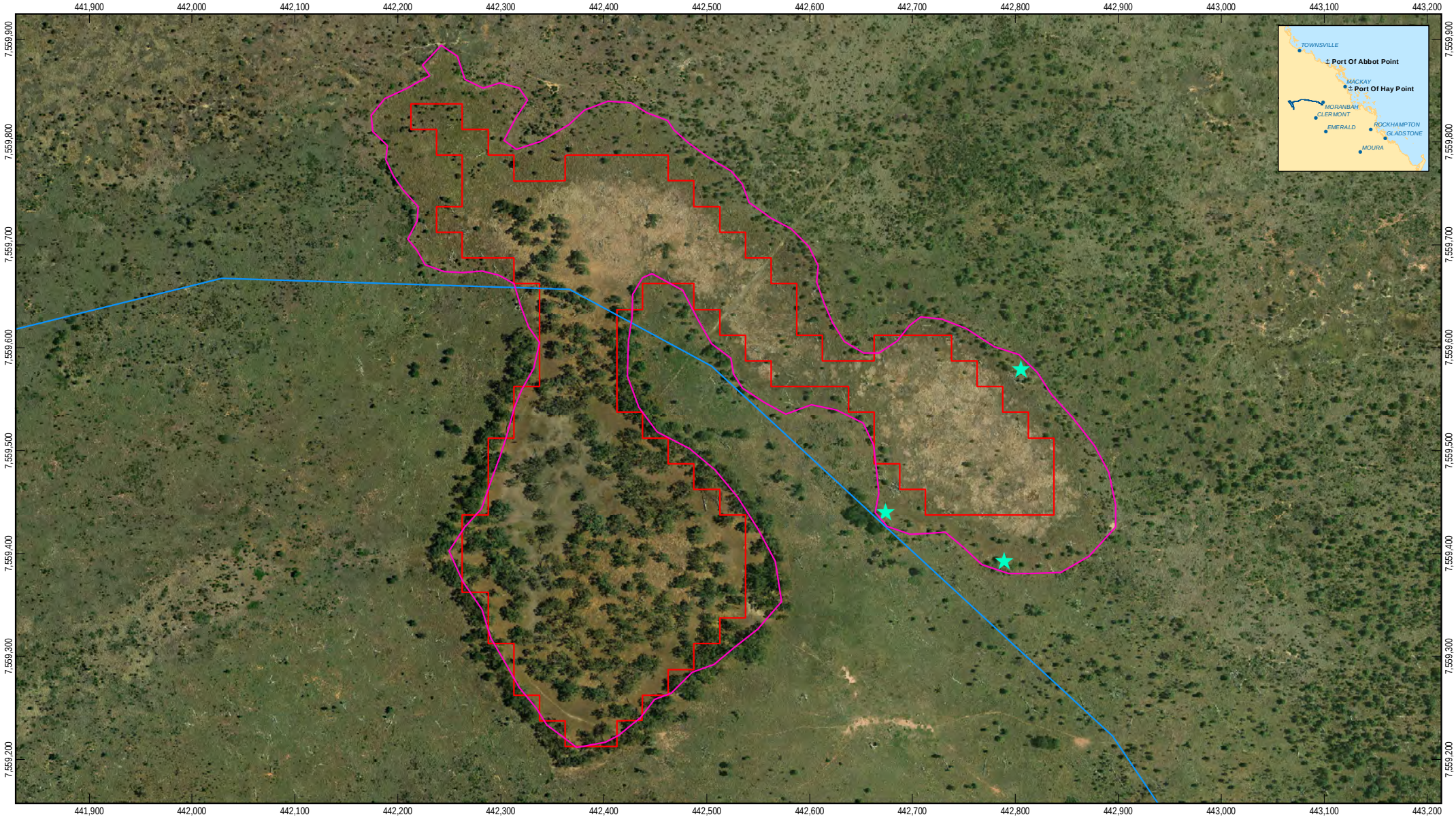
A soil survey of the EPC 1690 was undertaken for the Project EIS (GHD, 2012b). The GBR WPA 1 area was not covered by the soil survey undertaken for the Project (Mine) EIS. However, as described in Section 4.1, GBR WPA 1 covers a mapped tributary of the Carmichael River. Therefore, it is suggested that the soils would also be alluvium and associated with the Carmichael River. The soils associated with GBR WPA 2 were mapped in the Project (Mine) EIS (GHD, 2012b) as CR3, CR4 and Eb2. CR3 and CR4 being described as recent alluvium (soil deposited by running water) associated with the Carmichael River, occurring on a small backplain. Eb2 was described as very deep cracking clay with moderate to strong gilgai or melon holes (small, ephemeral lake formed from a depression in the soil surface) on broad alluvial flats, generally low-lying with imperfect drainage. Soils associated with GBR WPA 3 are mapped as CR3.

Soil colour is an important soil property used in the classification of soils. It is of particular importance in the characterisation of wetland soils due to the unique colours that can form under reducing conditions (Bryant, 2008). Reducing conditions occur when soils are temporally flooded and remain water saturated for days, weeks or months. Prolonged periods of saturation can convert iron to its reduced, soluble colourless form, resulting in greyish colours in coarse textured soils. Grey or low chroma colours have been reported in the literature as being useful for the identification of wetland soils (Bryant, 2008).

During the 2013 survey, the soils from GBR WPA 1 and 3 were identified as clay and being light grey in colour. Soils from GBR WPA 2 were identified as sandy clay and being tan to light brown in colour. The colour and the alluvium nature of the soil observed from all three GBR WPAs suggest that they are wetlands.

4.4 Great Barrier Reef Wetland Protection Area boundaries

The boundary of the GBR WPAs was determined based on aerial imagery and ground-truthing in the field using wetland flora indicator species. The AquaBAMM boundary of the GBR WPAs was refined and digitised based on aerial imagery (Moray_Downs_10cm_Mosaic). The digitised boundary of GBR WPA 1 was closely aligned with the AquaBAMM mapped boundary (Figure 5) and only limited ground-truthing was completed for this GBR WPA. The digitised boundary of GBR WPA 2 using aerial imagery was slightly smaller than the mapped boundary using the AquaBAMM (Figure 6), however, the digitised boundary of GBR WPA 3 using aerial imagery was larger than the mapped boundary using AquaBAMM (Figure7). Field verification of the wetland boundaries was confirmed by mapping the landward edge during site surveys.



Paper Size A4

0 50 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Digitised WPA 1 Boundary
- Great Barrier Reef Wetland Protection Area
- Watercourse (Minor)
- Field Survey Points

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Great Barrier Reef Wetland Protection Areas Report

Job Number 41-26422
Revision B
Date 24-06-2013

Great Barrier Reef
Wetland Protection Area 1 boundary

Figure 5

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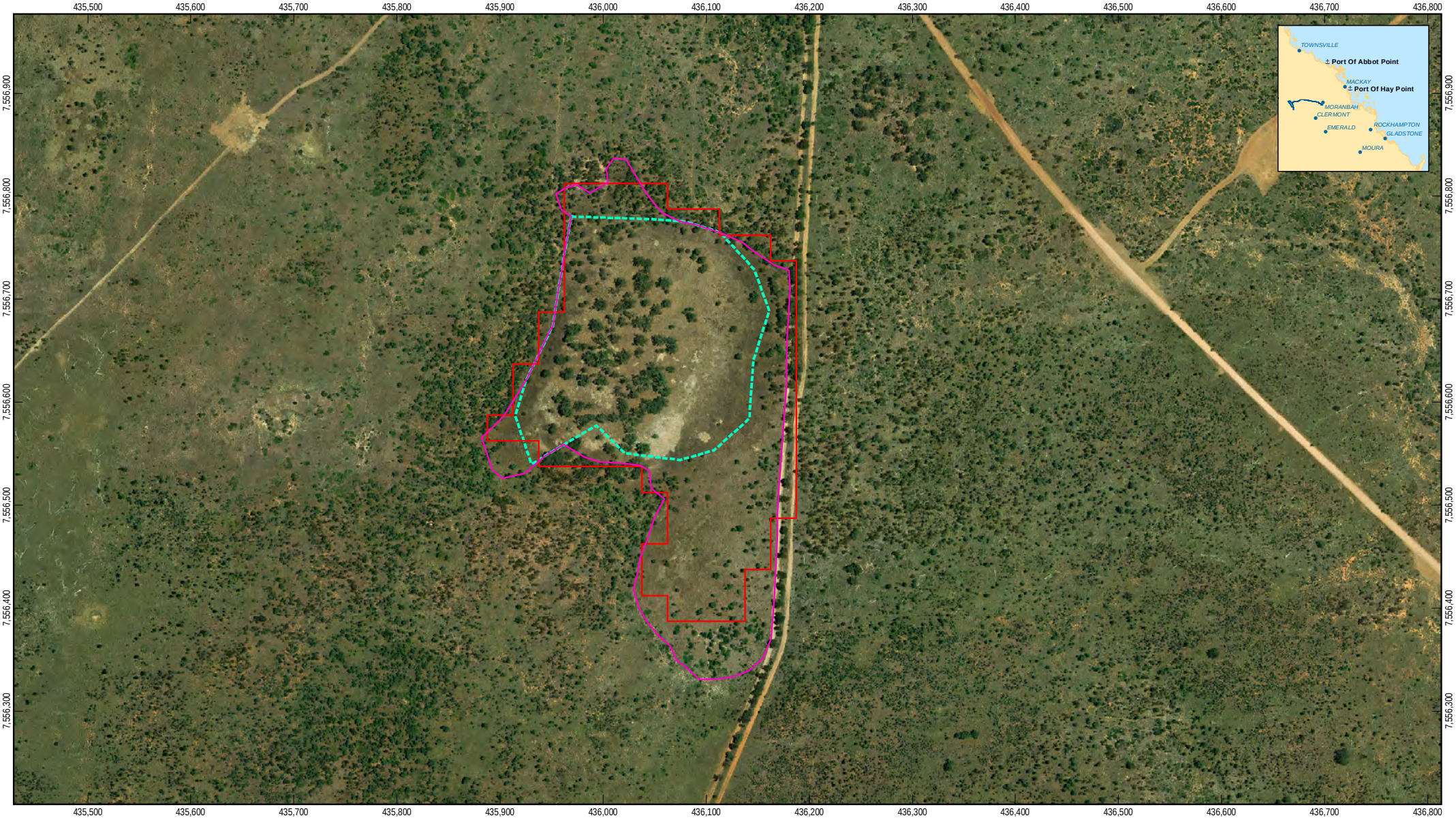

Paper Size A4

0 50 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Digitised WPA 2 Boundary
- Great Barrier Reef Wetland Protection Area
- Field Survey Boundary

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Great Barrier Reef Wetland Protection Areas Report

Job Number 41-26422
Revision B
Date 24-06-2013

Great Barrier Reef Wetland Protection Area 2 boundary

Figure 6

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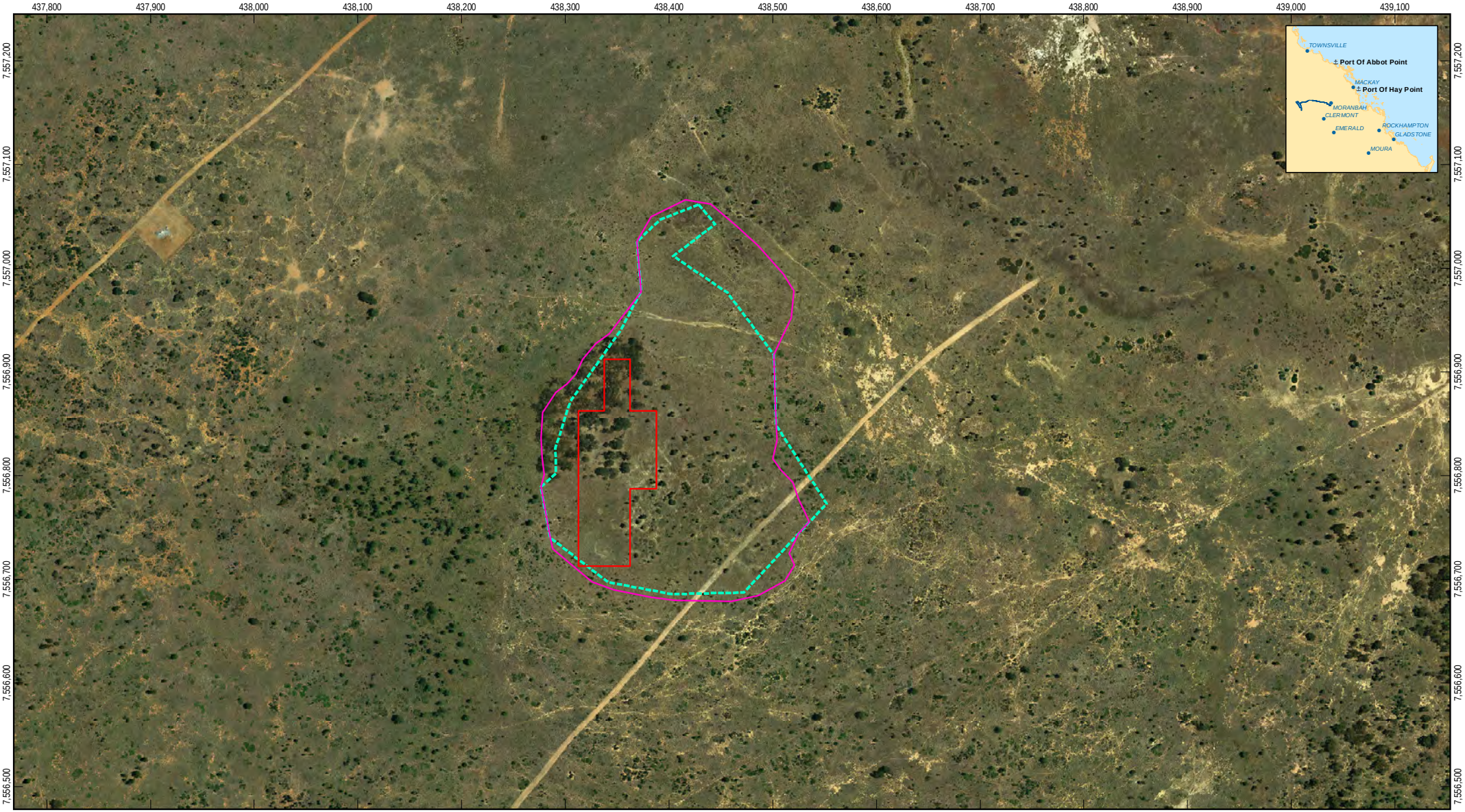

Paper Size A4

0 50 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Digitised WPA 3 Boundary
- Great Barrier Reef Wetland Protection Area
- Field Survey Boundary

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Carmichael Coal Mine and Rail Project
Great Barrier Reef Wetland Protection Areas Report

Job Number	41-26422
Revision	B
Date	24-06-2013

Great Barrier Reef Wetland Protection Area 3 boundary

Figure 7

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5. Discussion and conclusion

The three GBR WPAs within the Study Area were described in terms of the Queensland Wetland Definition and Delineation Guidelines wetland criteria, hydrology, biota (flora and fauna) and soils. To confirm presence of a wetland, multiple lines of evidence were collected at each of the mapped GBR WPAs during field surveys. The multiple lines of evidence were also informed by previous studies of the Study Area and desktop work.

The GBR WPAs surveyed all supported multiple lines of evidence that verify them as being wetlands. The hydrological flood modelling suggests that the GBR WPAs are inundated with 0.08 – 1.00 m of water during a 10 year ARI flood event and 1 – 2 m of water during a 100 year ARI flood event. The inundation of the GBR WPAs during 10 and 100 year ARI flood events suggest that they may be wetlands. Observations of soil colour (light grey and tan) and the alluvium nature also indicate that the GBR WPAs are wetlands.

Flora species listed as wetland indicator species were dominant at all mapped GBR WPAs within the Project Area. These occurred in conjunction with evidence of aquatic fauna species (snails, crabs and crayfish) which was detected in the form of shells, burrows and nests. Freshwater crayfish and crabs can be expected to occur in semi-arid swamps that are connected to rivers. Evidence of freshwater crayfish and crabs, including shells and burrows, were observed in the GBR WPAs.

A number of wetland indicator bird species and one wetland indicator mammal species have been identified within the Study Area, including

- One bird (*Ardea alba* – great egret) listed as migratory (Mig) and marine (Ma) under the EPBC Act as well as CAMBA and JAMBA.
- Two birds (*Nycticorax xaledonicus* – nankeen night heron and *Pelecanus conspicillatus* – Australian pelican) listed as marine under the EPBC Act
- Two birds (*Nettapus coromandelianus* – cotton pygmy goose and *Ephippiorhynchus asiaticus* – black-necked stork) listed as Near Threatened (NT) under the NC Act.

When inundated, the GBR WPAs will provide habitat for these wetland bird species. In addition, habitat required for Australian painted snipe (*Rostratula australis*) (vulnerable under EPBC Act and NC Act) may be available within the GBR WPAs when inundated. The Australian painted snipe is one of the few listed threatened species known to use semi-arid swamps, it typically inhabits swamps that offer a mix of medium to dense low shelter as well as open muddy or marshy shallows for feeding.

On this basis it is concluded that the mapped GBR WPAs within the Study Area are wetlands and fit the Queensland classification of semi-arid grass, sedge and herb swamps. Semi-arid grass, sedge and herb swamps are mostly situated in alluvial plains and typically subject to temporary inundation and, depending on water source, climate factors, substrate and their position in the landscape, might be inundated annually or less regularly (some may be inundated once every three years at most). Alluvial deposits are a common element in this type of wetland and where the substrate is deep, cracking grey clays are common with minor relief of gilgai hollows (Jaensch and Young, 2010).

6. References

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Appendices

Appendix A – Wetland Indicator Species

Wetland indicator species

Wetland indicator species that were predicted and observed during the Project (Mine) EIS (GHD, 2012a and GHD 2012d) within the Project Area are listed below.

Fish

- *Ambassis agassiziii* – Agassiz's glassfish
- *Nematalosa erebi* – bony bream
- *Mogurnda adspersa* – purple-spotted gudgeon
- *Hypseleotris klunzingeri* – western carp gudgeon
- *Hypseleotris sp*. – Midgley's carp gudgeon
- *Melanotaenia splendida splendida* – eastern rainbowfish
- *Neosilurus hyrtlii* – Hyrtl's tandan
- *Leiopotherapon unicolor* – spangles perch
- *Amniataba percoides* – barred grunter
- *Craterocephalus stercusmuscarum* – flyspecked hardyhead
- *Oxyeleotris lineolata* – sleepy cod.

Turtles

- *Chelodina canni* – Cann's snake-neck turtle
- *Chelodina longicollis* – snake necked turtle
- *Elseya irwini* – Irwins turtle
- *Wollumbinia latisternum* – saw-shelled turtle
- *Emydura macquarii krefftii* – Krefft's turtle.

Amphibians

- *Cyclorana novaehollandiae* – new Holland frog
- *Limnodynastes tasmaniensis* – spotted grass frog
- *Platyplectrum ornatum* – ornate burrowing frog.

Birds

- *Anas gracillis* – grey teal
- *Anas platyrhynchos* – mallard
- *Anas supercilliosa* – pacific black duck
- *Aythya australis* – hardhead
- *Anhinga novaehollandiae* – Australasian darter
- *Ardea alba* – great egret (Mig, Ma, CAMBA, JAMBA)
- *Ardea intermedia* – intermediate egret

- *Ardea pacifica* – white-necked heron
- *Egretta novaehollandiae* – white faced heron
- *Ixobrychus flavicollis* – black bittern
- *Cygnus atratus* – black swan
- *Nettapus coromandelianus* – cotton pygmy goose (NT)
- *Nycticorax xaledonicus* – nankeen night heron (Ma)
- *Elseyornis melanops* – black-fronted dotterel
- *Ephippiorhynchus asiaticus* – black-necked stork (NT)
- *Irediparra gallinacean* – comb-crested jacana
- *Pelecanus conspicillatus* – Australian pelican (Ma)
- *Microcarbo melanoleucos* – little pied cormorant
- *Phalacrocorax carbo* – black cormorant
- *Phalacrocorax sulcirostris* – little black cormorant
- *Phalacrocorax varius* – pied cormorant
- *Tachybaptus novaehollandiae* – Australasian grebe
- *Platalea regia* – royal spoonbill

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