Start Page

PEMBROKE

Olive Downs Coking Coal Project

Draft Environmental Impact Statement

Appendix C

Aquatic Ecology Assessment

DPM ENVIROSCIENCES

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

August 2018

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

August 2018

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DISTRIBUTION

Olive Downs Coking Coal Project – Aquatic Ecology Assessment
20 August 2018

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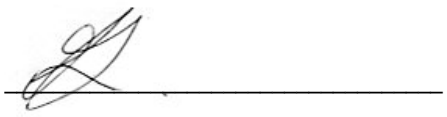
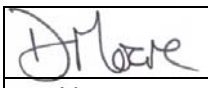


Melody Stoneham
Principal Ecologist, Gaia Environmental Consulting

Technical Review: Date:

	20 August 2018
David Moore Principal Ecologist, DPM Enviroscienses Pty Ltd	

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EXECUTIVE SUMMARY

DPM Enviros ciences Pty Ltd was engaged by Pembroke Olive Downs Pty Ltd to undertake aquatic ecological surveys and to prepare an impact assessment for the proposed Olive Downs Project (herein referred to as the Project). The Project is a proposed coal mine and associated infrastructure within the Bowen Basin, located approximately 40 kilometres (km) south-east of Moranbah, Queensland (Qld).

In a regional context, the Project is located within the headwaters of the Isaac River catchment of the greater Fitzroy Basin. The Isaac River transects the Project area, receiving runoff, via North Creek, Cherwell Creek, Ripstone Creek and a network of smaller, unnamed tributaries.

In a local context, the Project area is located within the Bowen Basin mining area where, in parallel with agricultural activities, open cut (and underground) coal mining is a key land use. As a result, the majority of the Study area comprises agricultural grasslands with tracts of remnant vegetation.

The scope of this assessment was to describe the aquatic values, identify any conservation significant species under the Qld *Nature Conservation Act 1992* (NC Act), *Fisheries Management Act 1994* and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), identify the presence of stygofauna, identify and describe any Matters of State and National Environmental Significance; and identify proposed impact avoidance and mitigation measures to protect the natural values, including consideration of biodiversity offset requirements.

The findings discussed in this report are based on a desktop assessment of readily available information on the aquatic characteristics in a study area covering the Project (i.e. the Study area), supplemented by aquatic surveys in the late wet season (June and July 2017) and follow-up early wet season surveys (December 2016, October and November 2017).

Aquatic ecology surveys were undertaken in accordance with the Australian River Assessment System (AusRivAS) protocols for Queensland streams. In addition, the Queensland *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* was applied and a desktop review was undertaken to assist in determining the likelihood and significance of stygofauna habitat potentially occurring within the Study area. This was supplemented with low-intensity sampling or assessment of nine representative bores (i.e. a pilot survey) within the Study area.

The waterways of the Study area are generally ephemeral, expected to experience flow only after sustained or intense rainfall and runoff in the catchment. Stream flows are expected to be highly variable, with most channels drying during winter to early spring when rainfall and runoff is historically low.

Instream (aquatic) habitat assessment scores ranged from poor to good for the riverine survey sites within the Study area, with most sites scoring fair. Bottom substrate / available cover was mostly rated poor at each site, owing to the dominance of fine sediments (silt / clay and sand) and general lack of the larger pebble, cobble and boulder substrates at each site.

There are no wetlands of International or National Importance identified within the Study area. A total of 60 palustrine wetlands are mapped as occurring within the Study area. This includes 11 wetlands of High Ecological Significance (HES) and 49 wetlands of General Ecological Significance (GES). An additional 16 wetlands of GES were identified across the Study area as part of the terrestrial flora surveys.

The HES wetlands include a paleochannel lake, ox-bow lakes and flood channel wetlands on the Isaac River floodplain, as well as vegetated swamps in depressions on and beyond the floodplain. The GES wetlands include riverine wetlands of the Isaac River, as well as numerous floodplain and non-floodplain palustrine wetlands. Eight lacustrine wetlands (mainly dams) are mapped as occurring within the Study area.

Aquatic macroinvertebrate communities showed variability amongst seasons, reflecting the ephemeral and seasonal nature of the waterways and wetlands sampled. Biotic indices, including

taxonomic composition, PET taxa, pollution-tolerant taxa, SIGNAL2 and AusRivAS OE50 scores, were generally within or favourably above the 20-80th percentile of the relevant guidelines.

No conservation significant aquatic flora or fauna species listed under the NC Act and / or EPBC Act were recorded within the Study area. In addition, no Matters of National Environmental Significance relevant to aquatic ecology were identified.

The Project would remove aquatic habitat in the Project area, comprising ephemeral watercourses and drainage lines, as well as ephemeral and semi-permanent wetlands (including artificial dams). Matters of State Environmental Significance (MSES) relevant to this assessment are limited to Wetlands and Watercourses (i.e. HES Wetlands). The Project would remove or modify seven HES Wetlands mapped within the Project area, totalling approximately 61 ha. Although waterways within the Study area were identified as being able to provide for fish passage, it was concluded that the Project was unlikely to result in a significant impact on fish passage.

It is considered that the generally poor groundwater quality (indicated by EC levels up to 26,800 µs/cm) within the regolith material in the Study area indicates an environment that is largely unsuitable for stygofauna, however stygofauna could potentially occur in the unconsolidated sediments (alluvium) associated with the Isaac River. Despite this, no stygofauna were encountered during sampling. Although the Project may have local impacts on a portion of the stygofauna community (if they were to occur), these impacts are likely to be insignificant when placed in the context of the wider extent of similar habitat.

Indirect impacts that have been considered in this assessment include potential impacts associated with changes in water quality, hydrological changes, impacts to groundwater dependant ecosystems and potential cumulative impacts. It is concluded that the Project is unlikely to have a significant impact on aquatic ecology as a result of these potential indirect impacts.

To mitigate unavoidable adverse impacts on aquatic ecology associated with the Project, Pembroke has committed to a number of mitigation and management measures, including:

- vegetation clearance procedures that specify when and how riparian vegetation would be cleared with the view of minimising impacts on aquatic values;
- consideration of the *Accepted Development Requirements for Operational Work that is Constructing or Raising Waterway Barrier Works*;
- design of the Isaac River crossings in consultation with the Department of Agriculture and Fisheries; and
- implementation of a Water Management Plan, Erosion and Sediment Control Plan and a Receiving Environment Monitoring Plan.

To address the residual significant adverse impacts on MSES (HES wetlands), an offset strategy has been developed by Pembroke in accordance with relevant State offset requirements.

Pembroke proposes a staged environmental offset in consideration of the staged land clearing (i.e. staged clearing of HES wetlands) described above. The offset for each stage of clearance would be provided before clearing the relevant stage. The result of implementing the offset strategy would be an increase in the area of HES wetlands being conserved and managed for conservation in the medium to long term.

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Acronyms

Acronym	Description
ACA	Aquatic Conservation Assessment (associated with AquaBAMM)
AHD	Australian Height Datum
AquaBAMM	Aquatic Biodiversity Assessment Mapping Methodology
AusRivAS	Australian River Assessment System
BoT	Back on Track
CE	Critically Endangered (threatened fauna species status)
CHPP	Coal Handling and Preparation Plant
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAF	Queensland Department of Agriculture and Fisheries
DAFF	The former Queensland Department of Agriculture, Fisheries and Forestry
DEE	Commonwealth Department of the Environment and Energy
DEHP	Queensland Department of Environment and Science
DERM	The former Queensland Department of Environment and Resource Management
DES	Queensland Department of Environment and Science
DNRM	The Queensland Department of Natural Resources and Mines
DotE	The former Commonwealth Department of the Environment
DSEWPC	The former Australian Government Department of Sustainability, Environment, Water, Population and Communities
DSITI	The former Queensland Department of Science, Information Technology and Innovation
DSITIA	The former Queensland Department of Science, Information Technology, Innovation and the Arts
DSDIP	The former Queensland Department of State Development, Infrastructure and Planning
E	Endangered (threatened species status)
EA	Environmental Authority
EC	Electrical Conductivity
EH	Essential Habitat
EIS	Environmental Impact Statement
EO Act	Queensland *Environmental Offsets Act* 2014
EO Regulation	Queensland Environmental Offsets Regulation 2014
EP Act	Queensland *Environmental Protection Act 1994*
EP Regulation	Queensland Environmental Protection Regulation 2008
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
ERE	Endangered Regional Ecosystem
EVNT	Endangered, Vulnerable or Near Threatened (threatened fauna species)
GBR	Great Barrier Reef
GDA	Geocentric Datum of Australia
GDE	Groundwater Dependent Ecosystem
GES	General Ecological Significance
HES	High Ecological Significance
HRA	High Risk Area
LC	Least Concern species listed under the NC Act
LGA	Local Government Area
MLA	Mining Lease Area
MNES	Matters of National Environmental Significance
MSES	Matters of State Environmental Significance

Mtpa	Million tonnes per annum
NC Act	Queensland *Nature Conservation Act 1992*
NC Regulation	Nature Conservation (Wildlife) Regulation 2006
NRM	Natural Resource Management
NT	Near Threatened (species status)
PCI	Pulverised Coal Injection
RE	Regional Ecosystem
ROM	Run of Mine
SIGNAL2	Stream Invertebrate Grade Number – Average Level Version 2
SLC	Special Least Concern
SPMLA	Specific Purpose Mining Lease Application
SPP	State Planning Policy
V	Vulnerable (threatened species status)
VM Act	Queensland *Vegetation Management Act 1999*
WoNS	Weeds of National Significance
WPA	Wetland Protection Area

Definitions

Term	Description
Aquatic fauna	An aquatic animal is either a vertebrate or invertebrate that lives in water for most or all of its life. It does not include amphibians or waterbirds (which are considered terrestrial fauna).
Aquatic flora	Plants that have adapted to living in aquatic environments (saltwater or freshwater). They are also referred to as hydrophytes or macrophytes. These plants require special adaptations for living submerged in water, or at the water's surface.
Biosecurity matter	A living thing, other than a human or part of a human; or a pathogenic agent that can cause disease in a living thing, other than a human, or a pathogenic agent that can cause disease in a human, by the transmission of a pathogenic agent from an animal to a human; or a disease; or a contaminant.
Groundwater Dependent Ecosystem	Groundwater-Dependent Ecosystems (or GDEs) are ecosystems that rely upon groundwater for their continued existence. They may be 100% dependent on groundwater, such as aquifer GDEs, or may access groundwater intermittently to supplement their water requirements, such as riparian tree species in arid and semi-arid areas.
Restricted matter	Listed in Schedule 2 of the Queensland *Biosecurity Act 2014*, and refers to biosecurity matter that are currently found in Queensland and that are known to have a significant impact on human health, social amenity, the economy or the environment.
Stygofauna	Stygofauna are aquatic fauna that live part or all of their lives in groundwater systems such as aquifers or underground caves. Stygofauna are found in aquifers and caves, inhabiting the water filled pore spaces, voids, cracks and fissures (DES 2018h)
Waterway	Waterways include riverine systems, watercourses, waterways or drainage lines identified in Queensland Wetlands Map 2009, *Fisheries Act 1994*, Queensland Waterways for Waterway Barrier Works, DNRM Watercourse identification map (*Water Act 2000*).
Wetland	Wetlands include marine, estuarine, riverine, lacustrine and palustrine waterbodies and wetland REs in Qld identified in Queensland Wetlands Map 2009, Wetlands of International Importance (EPBC Act), Wetlands of National Importance (EPBC Act) and GES, HES and WPA wetlands identified in the Map of Referrable Wetlands.

1 INTRODUCTION

Pembroke Olive Downs Pty Ltd (Pembroke) proposes to develop the Olive Downs Project (the Project), a metallurgical coal mine and associated infrastructure within the Bowen Basin, located approximately 40 kilometres south east of Moranbah, Queensland (Figure 1). The Project provides an opportunity to develop an open cut metallurgical coal resource within the Bowen Basin mining precinct that can deliver up to 20 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal.

The Project comprises the Olive Downs South and Willunga mining domains and associated linear infrastructure corridors, including a rail spur connecting to the Norwich Park Branch Railway, a water pipeline connecting to the Eungella pipeline network, an electricity transmission line (ETL) and access roads (Figure 2). The coal resource would be mined by conventional open cut mining methods, with product coal to be transported by rail to the Dalrymple Bay Coal Terminal. Up to 20 Mtpa of ROM coal would be extracted over the anticipated Project operational life of approximately 79 years.

1.1 Purpose

The Coordinator-General has declared the Olive Downs Project to be a 'coordinated project for which an EIS is required' under section 26(1)(a) of the *State Development and Public Works Organisation Act 1971* (SDPWO Act). This declaration initiates the statutory environmental impact assessment procedure of Part 4 of the Act, which requires a proponent to prepare an EIS for the project. Further, several referrals have been made under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) regarding the four different components of the Project. The Commonwealth Minister for the Environment and Energy (DEE) has determined the following controlling provisions apply for each proposed action under the EPBC Act:

1. Olive Downs Project Mine Site and Access Road (EPBC 2017/7867)
    a) listed threatened species and communities (sections 18 and 18A);
    b) listed migratory species (sections 20 and 20A); and
    c) a water resource, in relation to coal seam gas development and large coal mining development (sections 24D and 24E).
2. Olive Downs Project Water Pipeline (EPBC 2017/7868)
    i. listed threatened species and communities (sections 18 and 18A).
3. Olive Downs Project Electricity Transmission Line (EPBC 2017/7869)
    i. listed threatened species and communities (sections 18 and 18A).
4. Olive Downs Project Rail Spur (EPBC 2017/7870)
    i. listed threatened species and communities (sections 18 and 18A).

The EIS process has been accredited under the Bilateral Agreement for the assessment of the Project under the EPBC Act, hence the EIS must state the controlling provisions for the project and describe the particular aspects of the environment that led to the controlled action decision.

In December 2017, Pembroke lodged an application to vary the Action to incorporate the latest Project layout designs for the Olive Downs Project Mine Site and Access Road (EPBC 2017/7867) and the Olive Downs Project Water Pipeline (EPBC 2017/7868). These variations were accepted by the DEE on 17 April 2018.

The purpose of the Aquatic Ecology Assessment is to describe the aquatic values of the Project area as relevant to current Commonwealth and State legislation, assess the impacts of the proposed actions on these values and present strategies to avoid, minimise or mitigate impacts to significant aquatic values. This document is a supporting document to the EIS.

1.2 Scope of work

The scope of work for this aquatic ecology assessment includes the following tasks:

- conduct a desktop review of available literature and previous studies in the vicinity of the Study area, and conduct database searches for conservation significant aquatic species;
- undertake aquatic ecology surveys throughout the Study area using appropriate methodology to:
  - describe aquatic habitats and their value and importance, including features such as substrate, stream type, water quality condition, and surrounding land uses;
  - describe aquatic flora and fauna (including mammals, fish, reptiles and aquatic invertebrates) present, or likely to be present at any time of the year;
  - identify and describe any listed threatened aquatic species, and any introduced aquatic species, that are present or likely to be present in the Study area and identify their habitat resources;
  - consider relevant State and Commonwealth guidelines associated with threatened species likely to occur in the Study area;
  - identify and describe wetlands present, and their value and importance;
  - identify and describe groundwater-dependent ecosystems; and
- prepare an aquatic ecology assessment report that identifies the methods and results of the desktop and field studies, assesses the potential impacts of the Project, and present mitigation measures and any offset requirements.

1.3 Terms of Reference

Sections of the Terms of Reference (ToR) (June 2017) addressed by this report and the accompanying Terrestrial Flora Assessment and Terrestrial Fauna Assessment (DPM Enviroscences 2018a and 2018b) are shown in Table 1.

Table 1 Location of information addressing ToR within the ecological reports

Terms of Reference	Section in this report
Matters of National Environmental Significance – listed threatened species and communities	
11.16 For each proposed action the EIS must: *(a) describe the relevant listed threatened species and ecological communities (including EPBC Act listing status, distribution, life history and habitat);*	Sections 4.4 and 5.6
(b) provide details of the scope, methodology, timing and effort of surveys for each proposed action (including areas outside of each proposed action area which may be impacted by each proposed action); and include details of: *(i) the application of best practice survey guidelines* *(ii) how studies or surveys are consistent with (or a justification for divergence from) published Australian Government guidelines and policy statements;*	Sections 4.4 and 4.5
(c) describe and assess the impacts to listed threatened species and ecological communities identified below and any others that are found to be or may potentially be present in areas that may be impacted by each proposed action in accordance with the Matters of National Environmental	Sections 5.6, 5.11 and 5.12

Terms of Reference	Section in this report
Significance, Significant impact guidelines 1.1, Environment Protection and Biodiversity Conservation Act 1999;	
(d) identify which aspect of each proposed action is of relevance to each listed threatened species or ecological community or if the threat of impact relates to consequential actions; and	Sections 5.11 and 6.8
(e) where relevant, have regard to any approved conservation advice.	Sections 5.11 and 6.8
11.17 Where relevant, the EIS must demonstrate that each proposed action will not be inconsistent with:	
(a) Australia's obligations under: *(i) the Biodiversity Convention;* *(ii) the Convention on Conservation of Nature in the South Pacific (Apia Convention);* *(iii) the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); and*	Terrestrial fauna are addressed in the Terrestrial Fauna Assessment (DPM Enviroscienses 2018b)
(b) a recovery plan or threat abatement plan.	
11.18 The EIS must address impacts on the following listed threatened species for each proposed action:	
(a) Red Goshawk (Erythrotriorchis radiatus) – vulnerable; *(b) Australian Painted Snipe (Rostratula australis) – endangered;* *(c) Curlew Sandpiper (Calidris ferruginea) – critically endangered;* *(d) Squatter Pigeon (southern) (Geophaps scripta scripta) – vulnerable;* *(e) Painted Honeyeater (Grantiella picta) – vulnerable;* *(f) Star Finch (eastern) (Neochmia ruficauda ruficauda) – endangered;* *(g) Black-throated Finch (southern) (Poephila cincta cincta) – endangered;* *(h) Northern Quoll (Dasyurus hallucatus) – endangered;* *(i) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) (Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)) – vulnerable;* *(j) Greater Glider (Petauroides volans) – vulnerable;* *(k) Grey-headed Flying-fox (Pteropus poliocephalus) – vulnerable;* *(l) Ghost Bat (Macroderma gigas) – vulnerable;* *(m) Corben's Long-eared Bat (Nyctophilus corbeni) – vulnerable;* *(n) Southern Snapping Turtle (Elseya albagula) – critically endangered;* *(o) Fitzroy River Turtle (Rheodytes leukops) – vulnerable;* *(p) Yakka Skink (Egernia rugosa) – vulnerable;*	Sections 5.7, 5.11 and 6.8

Terms of Reference	Section in this report
(q) Allan's Lerista (Lerista allanae) – endangered; *(r) Ornamental Snake (Denisonia maculata) – vulnerable;* *(s) Dunmall's Snake (Furina dunmalli) – vulnerable;*	
(t) Cycas ophiolitica – endangered; *(u) King Blue-grass (Dichanthium queenslandicum) – endangered;* *(v) Bluegrass (Dichanthium setosum) – vulnerable;* *(w) Black Ironbox (Eucalyptus raveretiana) – vulnerable; and* *(x) Quassia (Samadera bidwillii) – vulnerable.*	Flora are addressed in the Terrestrial Flora Assessment (DPM Enviros ciences 2018a)
11.19 The EIS must address impacts on the following listed threatened ecological communities for each proposed action: *(a) Brigalow (Acacia harpophylla dominant and co-dominant) – endangered;* *(b) Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin – endangered; and* *(c) Semi-evergreen Vine Thickets of the Brigalow Belt (North and South) and Nandewar Bioregions – endangered.*	Flora are addressed in the Terrestrial Flora Assessment (DPM Enviros ciences 2018a)
11.20 For the proposed mine site and access road (EPBC 2017/7867) the EIS must: *(a) describe the listed migratory species identified below (including distribution, life history and habitat);*	Migratory fauna are addressed in the Terrestrial Fauna Assessment (DPM Enviros ciences 2018b)
(b) provide details of the scope, methodology, timing and effort of surveys for the proposed action (including areas outside of the proposed action area which may be impacted by the proposed action); and include details of: *(i) the application of best practice survey guidelines;* *(ii) how studies or surveys are consistent with (or a justification for divergence from) published Australian Government guidelines and policy statements;*	
(c) describe and assess the impacts to the listed migratory species identified below and any others that are found to be or may potentially be present in areas that may be impacted by the proposed action in accordance with the Matters of National Environmental Significance, Significant impact guidelines 1.1, Environment Protection and Biodiversity Conservation Act 1999; and	
(d) identify which aspect of the proposed action is of relevance to each species or if the threat of impact relates to consequential actions.	
11.21 Where relevant, demonstrate that the proposed action will not be inconsistent with:	Migratory fauna are addressed in the

Terms of Reference	Section in this report
(a) Australia's obligations under: *(i) the Bonn Convention;* *(ii) CAMBA;* *(iii) JAMBA; and* *(iv) an international agreement approved under subsection 209(4) of the EPBC Act.*	Terrestrial Fauna Assessment (DPM Enviroscienses 2018b)
11.22 The EIS must address impacts on the following migratory species: *(a) Glossy Ibis (Plegadis falcinellus);* *(b) Caspian Tern (Hydroprogne caspia) ;* *(c) Fork-tailed Swift (Apus pacificus);* *(d) Oriental Cuckoo (Cuculus optatus);* *(e) White-throated Needletail (Hirundapus caudacutus);* *(f) Black-faced Monarch (Monarcha melanopsis);* *(g) Yellow Wagtail (Motacilla flava);* *(h) Satin Flycatcher (Myiagra cyanoleuca);* *(i) Curlew Sandpiper (Calidris ferruginea);* *(j) Latham's Snipe (Gallinago hardwickii);* *(k) Osprey (Pandion haliaetus); and* *(l) Common Greenshank (Tringa nebularia).*	
Offsets *11.27 The EIS must describe the residual impacts of each proposed action for each relevant matter protected by the EPBC Act, after all proposed avoidance and mitigation measures are taken into account.*	Sections 6.8 and 8.2
11.28 The EIS must identify whether the residual impacts are significant with reference to the Matters of National Environmental Significance, Significant impact guidelines 1.1, Environment Protection and Biodiversity Conservation Act 1999.	Sections 6.8 and 8.2
11.29 If those residual impacts are significant the EIS must propose offsets for relevant matters protected by the EPBC Act consistent with the Environment Protection and Biodiversity Conservation Act 1999, Environmental Offsets Policy.	Sections 6.8 and 8.2
Information requirements—flora and fauna *11.46 Describe the likely impacts on the biodiversity and natural environmental values of affected areas arising from the construction, operation and eventual decommissioning of the project (where known) in accordance with EHP's EIS information guidelines relevant to terrestrial and aquatic ecology.*	Section 6
11.47 Take into account any proposed avoidance and/or mitigation measures. The assessment should include, but not be limited to, the following key elements:	Sections 7.1 and 7.2
(a) matters of state environmental significance and national environmental significance	Sections 5.11, 5.12, 6.8 and 6.9

Terms of Reference	Section in this report
(b) terrestrial and aquatic ecosystems (including groundwater-dependent ecosystems) and their interaction	Sections 5.8 and 6.5
(c) biological diversity including listed flora and fauna species and regional ecosystems	Sections 5.6, 6.8 and 6.9
(d) the existing integrity of ecological processes, including habitats of threatened, near-threatened or special least-concern species	Section 5
(e) the integrity of landscapes and places, including wilderness and similar natural places	Sections 5.1, 5.2, 5.3, 5.11 and 5.12
(f) actions of the project that require an authority under the Nature Conservation Act 1992, and/or would be assessable development for the purposes of the Vegetation Management Act 1999 (VMA) and the Fisheries Act 1994*	Flora are addressed in the Terrestrial Flora Assessment (DPM Enviroscienes 2018a)
(g) impacts on native fauna due to wastes at the site, particularly those related to any form of toxicants in supernatant water of any tailings storage facility.	Section 6.4
11.48 Propose practical measures for protecting or enhancing natural values, and assess how the nominated quantitative indicators and standards may be achieved for nature conservation management. In particular, address measures to protect or preserve any threatened or near-threatened species.	Sections 7.1, 7.2
11.49 Assess the need for buffer zones and the retention, rehabilitation or planting of movement corridors, and propose measures that would avoid the need for waterway barriers, or propose measures to mitigate the impacts of their construction and operation.	Section 7.1
11.50 The measures proposed for the progressive rehabilitation of disturbed areas should include rehabilitation success criteria in relation to natural values that would be used to measure progress and adjust practices if necessary to ensure success over time.	The Project rehabilitation strategy is detailed within Section 4 of the main text of the EIS.
11.51 Describe how the achievement of the rehabilitation objectives would be monitored and audited, and how corrective actions would be managed.	
11.52 Proposals for the rehabilitation of disturbed areas should incorporate, where appropriate, provision of nest hollows, watering points and ground litter.	
Offsets *11.53 The EIS should identify whether the project will result in a significant residual impact on matters of State environmental significance (MSES) with reference to the Queensland Environmental Offsets Policy, Significant Residual Impact Guideline 2014.*	Section 8
11.54 For staged offsets, the full extent of potential impacts on prescribed environmental matters from the entire proposal needs to be taken into account as part of the significant residual impact test.	Section 8

Terms of Reference	Section in this report
11.55 The proposed offsets should be in line with the requirements set out in the Queensland Environmental Offsets Policy (Version 1.2) 2016.	Section 8

Notes:
**This is not withstanding that the Vegetation Management Act 1999 does not apply to mining projects. Refer also to www.nrm.qld.gov.au/vegetation/idex.html*

2 PROJECT DESCRIPTION

The main activities associated with the development of the Project would include:

- up to 20 Mtpa of ROM coal production for an operational mine life of approximately 79 years (commencing approximately in 2020 or upon grant of all required approvals), including mining operations using conventional mining equipment (e.g. excavators, dozers, front end loaders and trucks) and strip mining, associated with:
  - development of the Olive Downs South domain open cut pits and out-of-pit waste rock emplacements within Mining Lease Application (MLA) 1, MLA 2 (within Mineral Development Licenses [MDL] 3012 and MDL 3013), Specific Purpose Mining Lease Application (SPMLA) 1 and SPMLA 2; and
  - development of the Willunga domain open cut pits and out-of-pit waste rock emplacements within MLA 3 (within MDL 3014).
- exploration activities;
- progressive development of soil stockpiles, laydown areas and borrow areas (e.g. for road base and ballast material);
- use of local quarries to source road base and ballast material (e.g. in the case where material is unavailable from sources within MLA 1, MLA 2 and MLA 3);
- drilling and blasting of competent waste rock material;
- progressive placement of waste rock in emplacements adjacent to and nearby the open pit extents;
- progressive backfilling of the mine voids with waste rock behind the advancing open cut mining operations;
- construction of an access road from Annandale Road to the Olive Downs South domain infrastructure area including a crossing of the Isaac River, and a second access road from the Fitzroy Developmental Road to the Willunga infrastructure facilities;
- progressive development of new haul roads and internal roads, including an Isaac River road crossing to provide access between the Olive Downs South and Willunga domains;
- installation and operation of on-site ROM coal handling and crushing facilities at the Willunga domain;
- transfer of crushed ROM coal from the Willunga domain to the CHPP at the Olive Downs South domain, via either haul road or conveyor with an Isaac River crossing;
- storage and disposal of CHPP rejects (coarse and fine rejects) during the initial years (until in-pit containment facilities become available) in initial rejects storage facilities including tailings cells;
- disposal of CHPP rejects (coarse and fine rejects) on-site within appropriate in-pit containment facilities, including mine voids behind the advancing open cut mining operations, and where circumstances allow, disposal in other out-of-pit containment facilities;
- progressive development of sediment dams and water storage dams (including the North Eastern Water Dam, North Western Water Dam, Central Water Dam, mine affected water dams, raw water dams, etc.) and installation of pumps, pipelines and other water management equipment and structures (including up-catchment diversions and levees);
- wastewater and sewage treatment by package sewage treatment plants;
- advance dewatering of Olive Downs South and Willunga domain open cut pits and construction and use of a groundwater supply borefield subject to the prevalence of suitable hydrogeological conditions;
- installation of a raw water supply pipeline from the existing Eungella pipeline network;

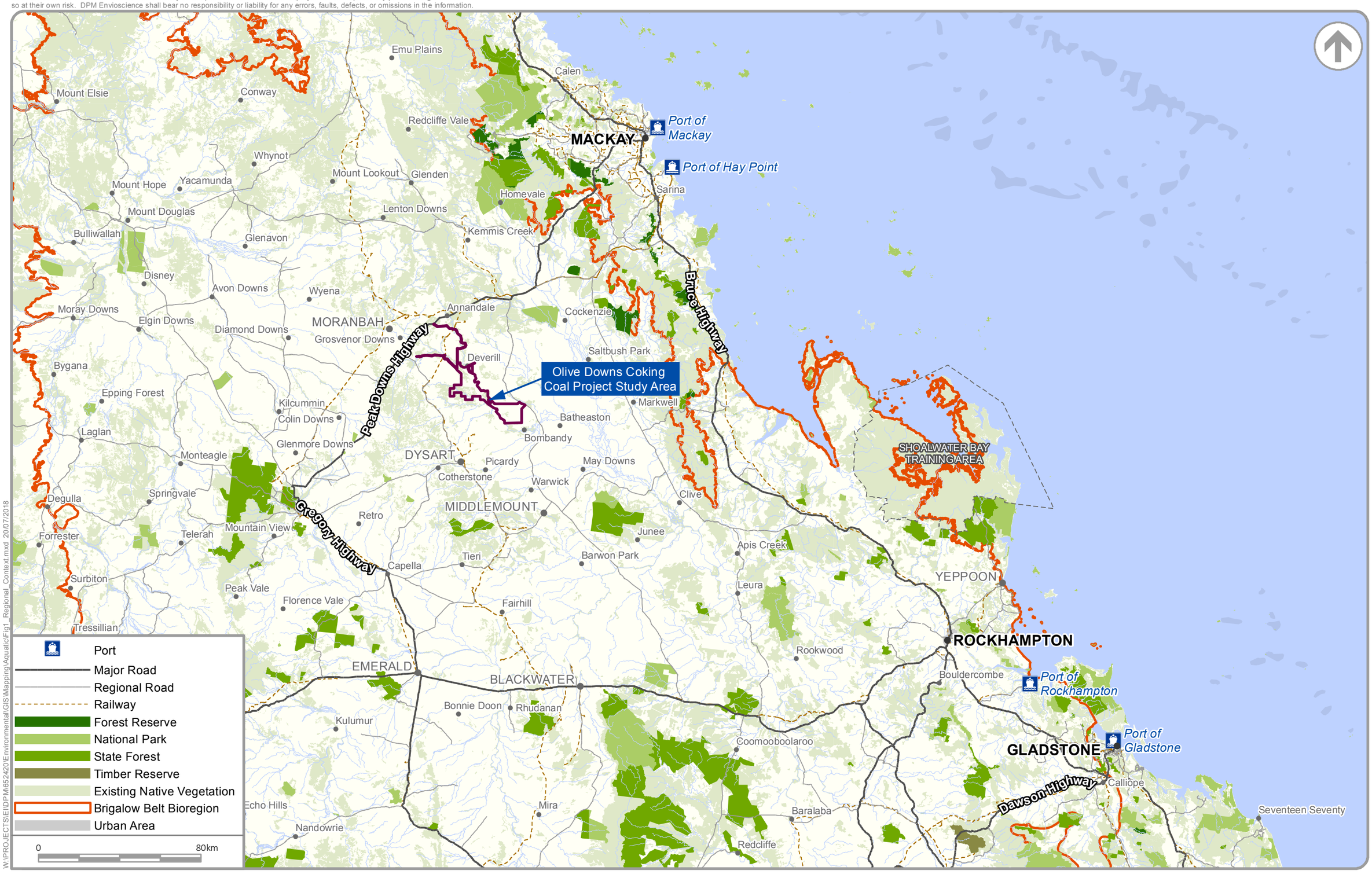
- discharge of excess water off-site in accordance with relevant principles and conditions of the Final Model Water Conditions for Coal Mines in the Fitzroy Basin;
- electricity supply from the existing regional power network, via construction of a 66 kilovolt (kV) ETL and switching/substation;
- construction of a new rail loop and rail spur from the Norwich Park Branch Railway, and rail-loadout facility including product coal stockpiles at the Olive Downs South domain for rail transport of coking and PCI coal products and by-products (i.e. thermal coal) for the export market via the DBCT (subject to availability of rail and port allocation); and
- other associated minor infrastructure, plant, equipment and activities.

2.1 Study area

The Study area covers all components of the proposed Project, including (Figure 4):

- Olive Downs Project Mine Site and Access Road (EPBC 2017/7867);
- Olive Downs Project Water Pipeline (EPBC 2017/7868);
- Olive Downs Project Electricity Transmission Line (EPBC 2017/7869); and
- Olive Downs Project Rail Spur (EPBC 2017/7870).

The overall Study area for the Project covers approximately 27,000 ha of land including the full extent of the Project MDLs, MLAs and SPMLAs. The Study area extends between 75 and 175 m either side of the proposed infrastructure corridors.



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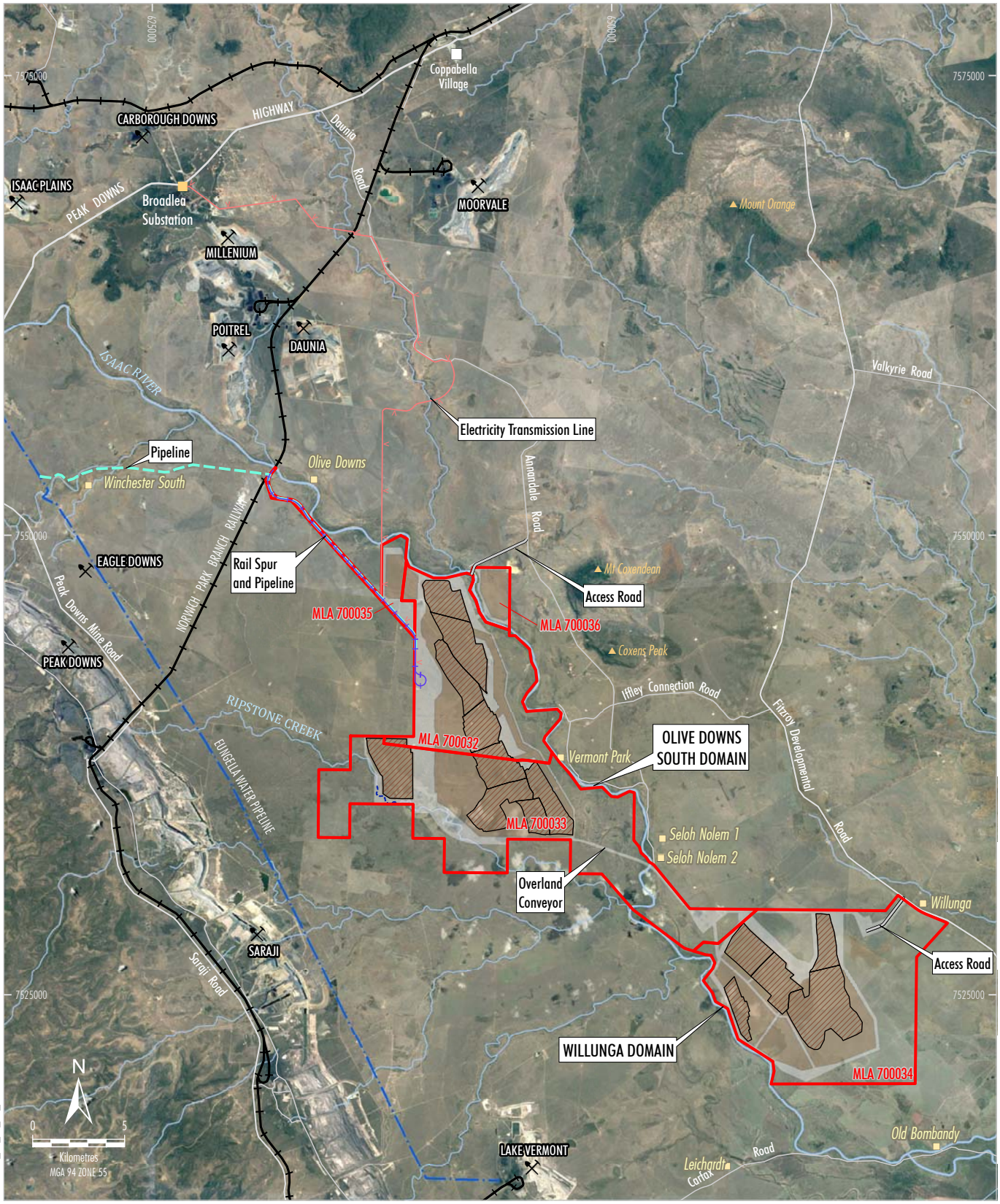
DPM ENVIROSCIENCES

REGIONAL CONTEXT

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 1



PRN-16-02_EIS_AQ_Eco_201A

LEGEND

- Mining Lease Application Boundary
- Approved/Operating Coal Mine
- Dwelling
- Eungella Pipeline Network
- Railway
- Proposed Access Road
- Proposed Electricity Transmission Line
- Proposed Rail
- Proposed Water Pipeline
- Proposed Creek Diversion
- Open Cut Pit Extent
- Out-of-Pit and In-Pit Waste Rock Emplacement
- Infrastructure Area

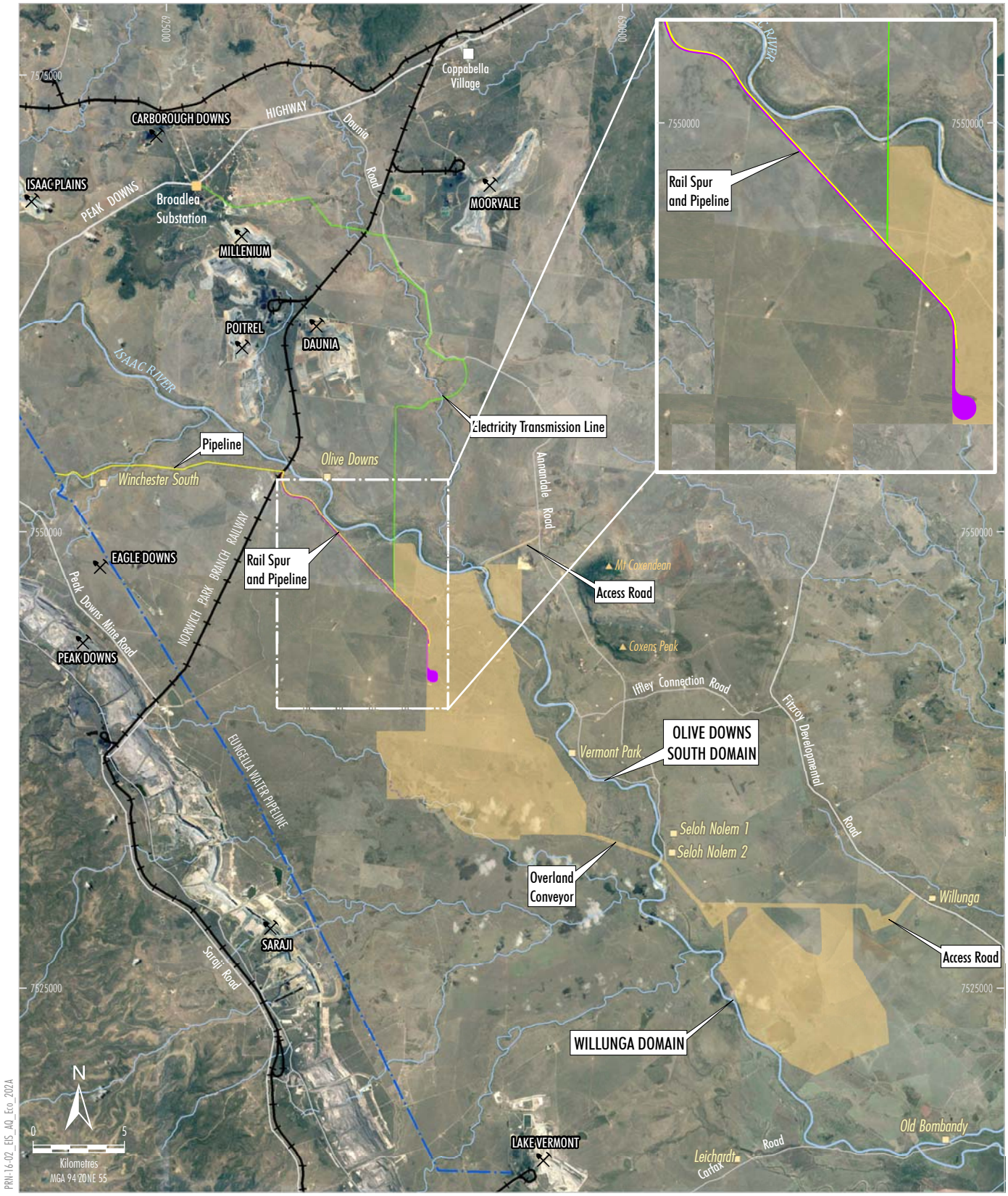
Source: Geoscience Australia - Topographical Data 250K (2006)
Department of Natural Resources and Mines (2016)
Orthophotography: Google Image (2016)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Project General Arrangement

Figure 2



LEGEND

- Approved/Operating Coal Mine
- Dwelling
- Eungella Pipeline Network
- Railway
- Proposed Creek Diversion
- Olive Downs Project Mine Site and Access Road (EPBC 2017/7867)
- Olive Downs Project Water Pipeline (EPBC 2017/7868)
- Olive Downs Project Rail Spur (EPBC 2017/7870)
- Olive Downs Project Electricity Transmission Line (EPBC 2017/7869)

Source: Pembroke (2018); Department of Natural Resources and Mines (2018); Orthophotography; Google Image (2016)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

EPBC Act Assessment Areas

Figure 3

DPM Enviroscience does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. DPM Envioscience shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

Aerial Imagery:

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DPM ENVIROSCIENCES

STUDY AREA

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 4

3 EXISTING ENVIRONMENT

3.1 Regional setting

The Study area is located centrally within the Isaac Regional Council Local Government Area (Isaac LGA). It is approximately 40 km south-east of Moranbah and within the Brigalow Belt Bioregion. The Project spans across two biodiversity sub-regions, with the northern extents (including the ETL, rail spur and water pipeline) falling within the Northern Bowen Basin subregion and the mine site in the Isaac – Comet Downs subregion. The context of the Study area on a regional scale is shown in Figure 1.

3.2 Climate

The climate of the Study area is sub-tropical with December through to February typically the warmest months, with mean maximum daily temperatures around mid-30°C (Figure 5). The mean maximum daily temperature at the Moranbah monitoring station was 33.8 degrees Celsius (°C), recorded during the summer season. The mean minimum daily temperature at the monitoring station is 9.9°C, recorded during winter.

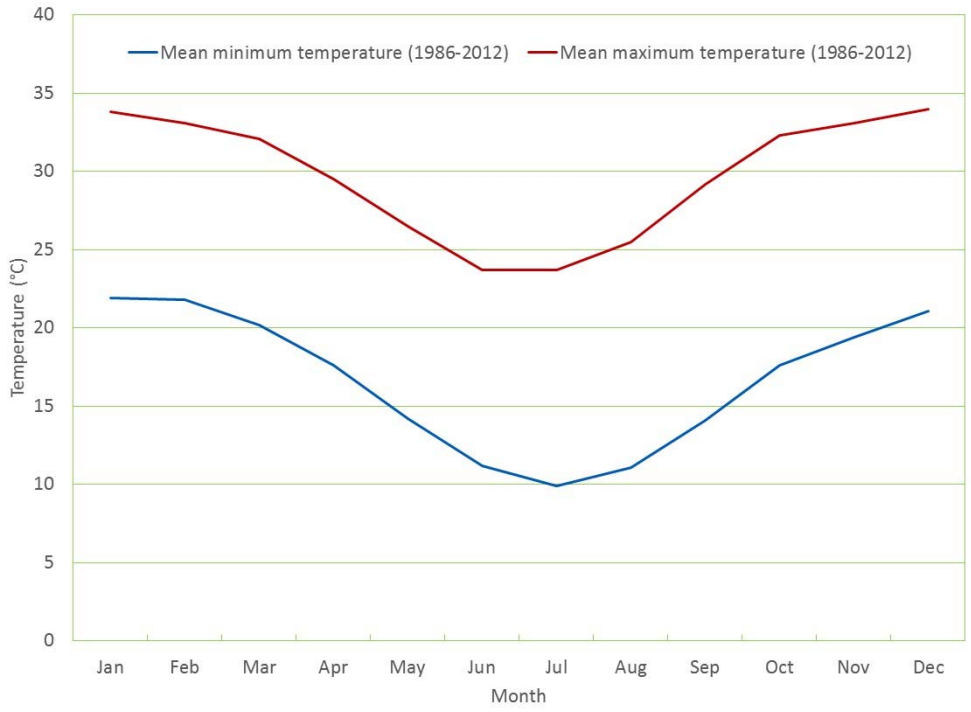


Figure 5 Temperature statistics for Moranbah Water Treatment Plant (BoM station 034038)

The annual average rainfall is 614 millimetres (mm), with the wettest period occurring during the warmer months from December to February when, on average, 50% of the annual rainfall occurs (Figure 6).

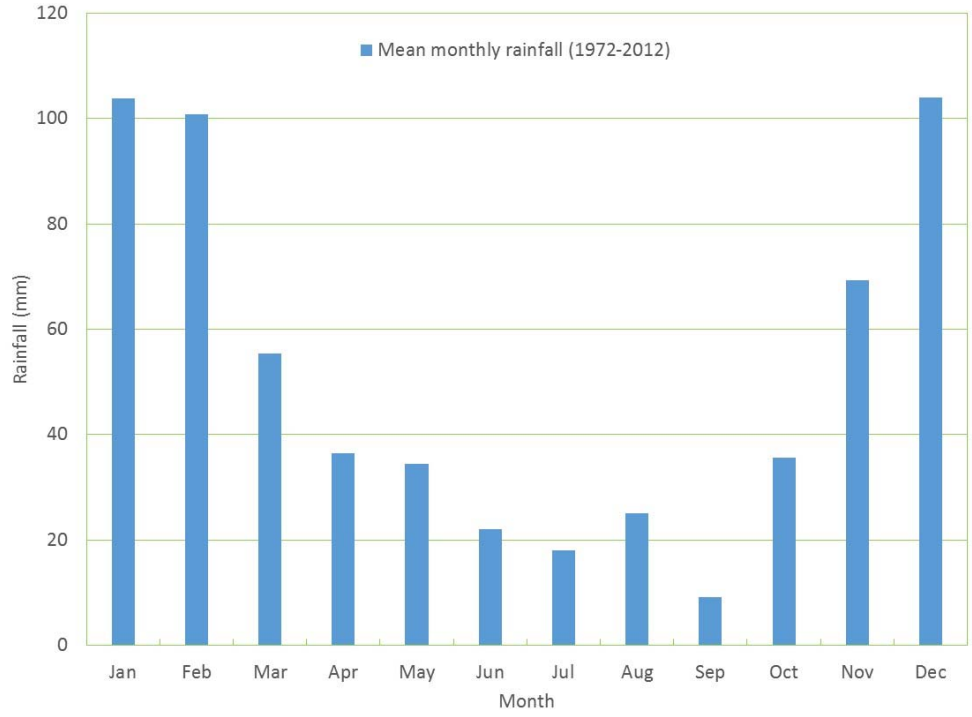


Figure 6 Rainfall statistics for Moranbah Water Treatment Plant (BoM station 034038)

On the north-eastern boundary of the Study area, the Deverill rainfall and stream gauging station 130410A (DNRM 2017a) has measured similar patterns in rainfall. That is: November through to March are typically the wetter months of the year (Figure 7), with rainfall across the Study area expected to be greatest in mid-summer, and lowest in mid-winter, as inferred from 21 years of data. More recent data (2016-2017) has indicated variable but typically higher than average rainfall, particularly over autumn and early spring.

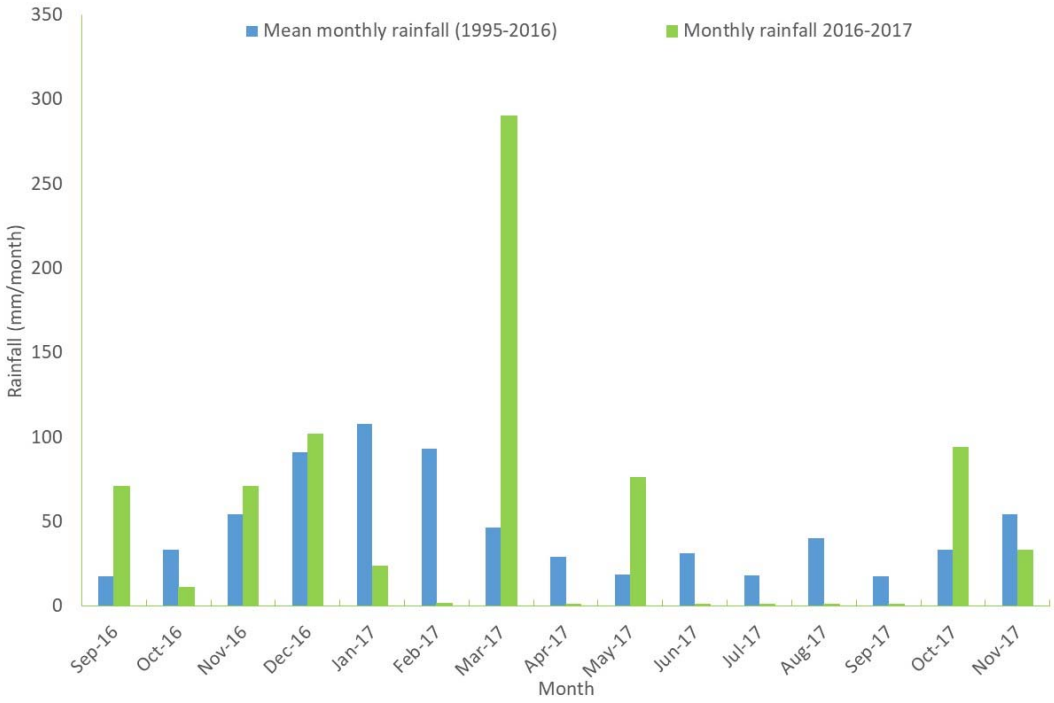


Figure 7 Historical and recent rainfall at Deverill rainfall and stream gauging station 130410A (DNRM 2017a)

3.3 Topography

The surrounding land is gently undulating to flat and low-lying (i.e. 200 m AHD or less). The overall elevation of the Project area ranges from 150 mAHD in the low-lying south-east of the Willunga domain to 200 mAHD in the higher areas to the west and north-west of the Project area. Immediately adjacent to the east of the Study area is a small isolated hill known as Mt Coxendean (470 m AHD), Coxen's Peak (415 m AHD) and Iffley Mount (310 m AHD).

3.4 Hydrology

The Study area is located within the headwaters of the Isaac River catchment of the greater Fitzroy Basin (Hatch 2018a). The Isaac River is the main watercourse which bisects the Study area and flows in a north-west to south-east direction, passing the township of Moranbah. The existing Isaac Plains, Millennium, Poitrel and Daunia mines are immediately upstream of the Study area. The Isaac River flows to the north-east of the Olive Downs South domain and then further downstream to the south of the Willunga domain before continuing in a south-easterly direction.

The Connors River flows into the Isaac River approximately 85 km downstream of the Study area (Hatch 2018a), with the Isaac River finally converging with the Mackenzie River a further approximate 50 km downstream (Figure 1). Ultimately, the Mackenzie River joins the Fitzroy River, which flows initially north and then east towards the east coast of Queensland and discharges into the Coral Sea southeast of Rockhampton near Port Alma (Hatch 2018a).

At a regional scale, the greater Isaac-Connors sub-catchment area (at the confluence with the Mackenzie River) is approximately 22,364 square kilometres (km²) of the total Fitzroy River catchment of 142,665 km², or if represented as a percentage, it accounts for 15% of the overall Fitzroy River catchment area (Hatch 2018a).

DNRM has confirmed (via a letter dated 5 February 2018) that the only tributaries of the Isaac River in the vicinity of the Study area which have been determined to meet the definition of a 'watercourse' under the *Water Act 2000* include (from upstream to downstream) (Figure 4):

- North Creek;
- Ripstone Creek;
- Boomerang Creek (including One Mile Creek); and
- Phillips Creek.

The document titled *Environmental Protection (Water) Policy 2009: Isaac River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Isaac River Sub-basin (including Connors River)* (DEHP 2011) and accompanying map identify Environmental Values (EVs) relevant to the Study area. This includes EVs for the 'Isaac and lower Connors River main channel' and for the 'Isaac western upland tributaries'. These EVs comprise:

- aquatic ecosystems;
- irrigation;
- farm supply;
- stock water;
- aquaculture (only for the 'Isaac River and lower Connors River main channel');
- human consumer;
- primary, secondary and visual recreation;
- drinking water;
- industrial use; and
- cultural and spiritual values.

Historical flow and river height monitoring data (1968-2016) for the Isaac River at Deverill (DNRM monitoring station 130410A), located on the north-eastern boundary of the Study area, provides an indication of the local flow regime (Figure 8). Surveyed cross-section data for this gauging station in September 2014 (DNRM 2017a) indicates approximately 1 m of sediment built up above the original gauge height. Consequently, it is deduced that surface flow in the Isaac River at Deverill is more likely to occur in the wetter months from November to April, reducing to shallow subsurface flows from about May to October in an average year (Figure 8).

Figure 8 Flow volume and river height for the Isaac River at Deverill (DNRM station 130410A, located on the north-eastern edge of the Study area)

3.5 Land Zones and soils

The following land zones occur in the Study area:

- Land Zone 3 – Recent Quaternary alluvial systems, including closed depressions, paleo-estuarine deposits currently under freshwater influence, inland lakes and associated wave built lunettes. Excludes colluvial deposits such as talus slopes and pediments. Includes a diverse range of soils, predominantly Vertosols and Sodosols; also with Dermosols, Kurosols, Chromosols, Kandosols, Tenosols, Rudosols and Hydrosols; and Organosols in high rainfall areas.
- Land Zone 4 – Tertiary-early Quaternary clay deposits, usually forming level to gently undulating plains not related to recent Quaternary alluvial systems. Excludes clay plains formed in-situ on bedrock. Mainly Vertosols with gilgai microrelief, but includes thin sandy or loamy surfaced Sodosols and Chromosols with the same paleo-clay subsoil deposits.
- Land Zone 5 – Tertiary-early Quaternary extensive, uniform near level or gently undulating plains with sandy or loamy soils. Includes dissected remnants of these surfaces. Also includes plains with sandy or loamy soils of uncertain origin, and plateau remnants with moderate to deep soils usually overlying duricrust. Excludes recent Quaternary alluvial systems (Land Zone 3), exposed duricrust (Land Zone 7), and soils derived from underlying bedrock (Land Zones 8 to 12). Soils are usually Tenosols and Kandosols, also minor deep sandy surfaced Sodosols and Chromosols. There may be a duricrust at depth.
- Land Zone 9 (present in areas with higher relief) – Fine grained sedimentary rocks, generally with little or no deformation and usually forming undulating landscapes. Siltstones, mudstones, shales, calcareous sediments, and labile sandstones are typical rock types, although minor interbedded volcanics may occur. Includes a diverse range of fine textured soils of moderate to high fertility, predominantly Vertosols, Sodosols, and Chromosols.

3.6 Land use

The Study area is located within the Bowen Basin where open cut coal mining is a key land use, and a number of existing and approved coal mines, including Moorvale, Daunia, Poitrel, Millennium, Eagle Downs, Peak Downs, Saraji, Lake Vermont surround the Study area. Coal and petroleum (e.g. coal seam gas) mining exploration activities have been conducted within the Study area and surrounds for decades, and continues.

Land within the Study area is used predominately for cattle grazing, with small areas showing some evidence of opportunistic cropping. The land has been largely cleared through past agricultural practices; however some tracts of remnant vegetation exist, particularly along the riparian corridor of the Isaac River.

The properties associated with the Study area are owned by Pembroke (i.e. Iffley and Deverill), other mining companies (i.e. Wynette) and private landholders (i.e. Vermont Park, Willunga, Seloh Nolem, Old Bombandy and Winchester South). Surrounding land to the west of the Study area is owned predominantly by other mining companies.

The Study area is overlapping with existing petroleum tenements in the region, including those for the approved Bowen Gas Project.

4 METHODS

4.1 Taxonomic nomenclature

Scientific names of fauna used in this report follow the CSIRO List of Australian Vertebrates (Clayton et al. 2006). Scientific names of flora used in this report follow the Australian Plant Census (CHAH 2014).

4.2 Determination of significance level

EVNT species are defined as those taxa listed in the EPBC Act or NC Act as Critically Endangered (CE), Endangered (E), Vulnerable (V) or Near Threatened (NT). Priority species are those listed as such in the Back on Track Actions for Biodiversity for the Fitzroy NRM Region (DERM 2010) or in the Expert Panel Reports of the Aquatic Conservation Assessments (ACA) for riverine and non-riverine wetlands of the Fitzroy section of the Great Barrier Reef (GBR) catchment (Inglis and Howell 2009; Rollason and Howell 2012). All other native fauna species are Special Least Concern (SLC) or Least Concern (LC) under the NC Act.

4.3 EVNT species likelihood of occurrence

EVNT species identified from the desktop assessment (and subsequent field surveys) were assigned a likelihood of occurrence based on the criteria identified in Table 2. Targeted searches were undertaken in the field for species identified as either being likely to occur, or having potential to occur within the Study area, based on the desktop sources. The methodology was applied again after surveys to determine the likelihood of occurrence once site based information became available.

Table 2 Criteria adopted for the likelihood of EVNT species, identified from the desktop assessment, occurring within the Study area

Likelihood of occurrence	Criteria
Unlikely	▪ species or species habitat may occur, is likely to occur or is known to occur from the broader search area (based on database searches); but ▪ preferred habitat has not been identified within the Study area; and ▪ there are no confirmed species records within 10 km of the Study area. ▪ preferred habitat occurs within the Study area, but there are no confirmed species records within 50 km of the Study area.
Potential	▪ species or species habitat may occur, is likely to occur or is known to occur from the broader search area (based on database searches); and ▪ preferred habitat occurs within the Study area; and ▪ there are no confirmed species records within 10 km of the Study area; however, there are confirmed species records within 50 km of the Study area; OR ▪ species indicated as likely during desktop assessment, but field surveys revealed no evidence of occurrence in the Study area.
Likely	▪ preferred habitat occurs within the Study area; and ▪ confirmed species records within 10 km of the Study area; however ▪ species not yet confirmed as occurring within the Study area.
Known	▪ confirmed species records within the Study area (generally as a result of subsequent field survey).

4.4 Desktop assessment

4.4.1 Surface aquatic ecosystems

Desktop searches were undertaken in September 2016, May 2017 and December 2017 with revised searches undertaken in March and July 2018. This included a review of the following:

- Department of the Environment and Energy (DEE) EPBC Act Protected Matters Search Tool, to identify aquatic MNES within approximately 10 km of the Study area (DEE 2018a).
- Department of Environment and Heritage Protection (DEHP) mapping of Matters of State Environmental Significance Version 4.1 (DEHP 2014a), to identify aquatic matters of state interest under the State Planning Policy (SPP).
- Department of Environment and Science (DES) Queensland Wetland Data Version 4 series – Queensland Wetlands Map 2015 (DES 2018a), to determine the classification, extent and significance of lacustrine, palustrine and riverine systems within the Study area.
- DES (2018b) Wetland*Info* Wetland Summary Information (including species listings) for the Fitzroy Basin, incorporating data from the DES Wildlife Online database, Queensland Museum and Queensland Herbarium.
- Queensland Waterways for Waterway Barrier Works mapping (DAF 2016).
- Queensland Groundwater Dependent Ecosystems (GDE) and Potential GDE Aquifer Mapping (DES 2017).
- The Fitzroy Natural Resource Management Region Back-on-Track Actions for Biodiversity (DERM 2010).
- Aquatic Conservation Assessments (ACAs) for the riverine (Inglis and Howell 2009) and non-riverine (Rollason and Howell 2012) wetlands of the Great Barrier Reef catchment.
- Published ecological information on EVNT and SLC aquatic flora and fauna species.
- Previous studies from Red Hill Mine (approximately 50 km north-west) (URS 2013), Lake Vermont (approximately 12 km east) (AARC 2016a and 2016b), Eagle Downs Mine (approximately 15 km east) (Hansen Bailey 2009) and Saraji Mine approximately (6 km east) (SKM 2011a and 2011b).
- Relevant survey guidelines, including the Australian River Assessment System (AusRivAS) protocols for Queensland streams (DNRM 2001).

4.4.2 Stygofauna

DPM Enviroscience applied the Queensland *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (DSITIA 2015). This included a desktop review to assess the likely presence and composition of subterranean aquatic faunal communities in the Project area and the likely degree of impact on subterranean aquatic fauna from proposed activities. The desktop review involved:

- assessing the suitability of local habitat for subterranean aquatic fauna based on local geological and hydrological conditions; and
- determining the presence and composition of subterranean aquatic fauna in the region and project locality based on previous studies.

The desktop review results are provided in Section 5.10. A pilot survey was carried out to sample the local presence of subterranean aquatic fauna as described in Section 4.6.

An assessment of the likely degree of impact on any subterranean aquatic fauna, including direct (e.g. drawdown of groundwater) and indirect impacts (e.g. impacts on groundwater quality), is provided in Section 6.6 in consideration of the desktop review and pilot survey results.

4.5 Field survey of surface aquatic ecosystems

4.5.1 Survey timing and site selection

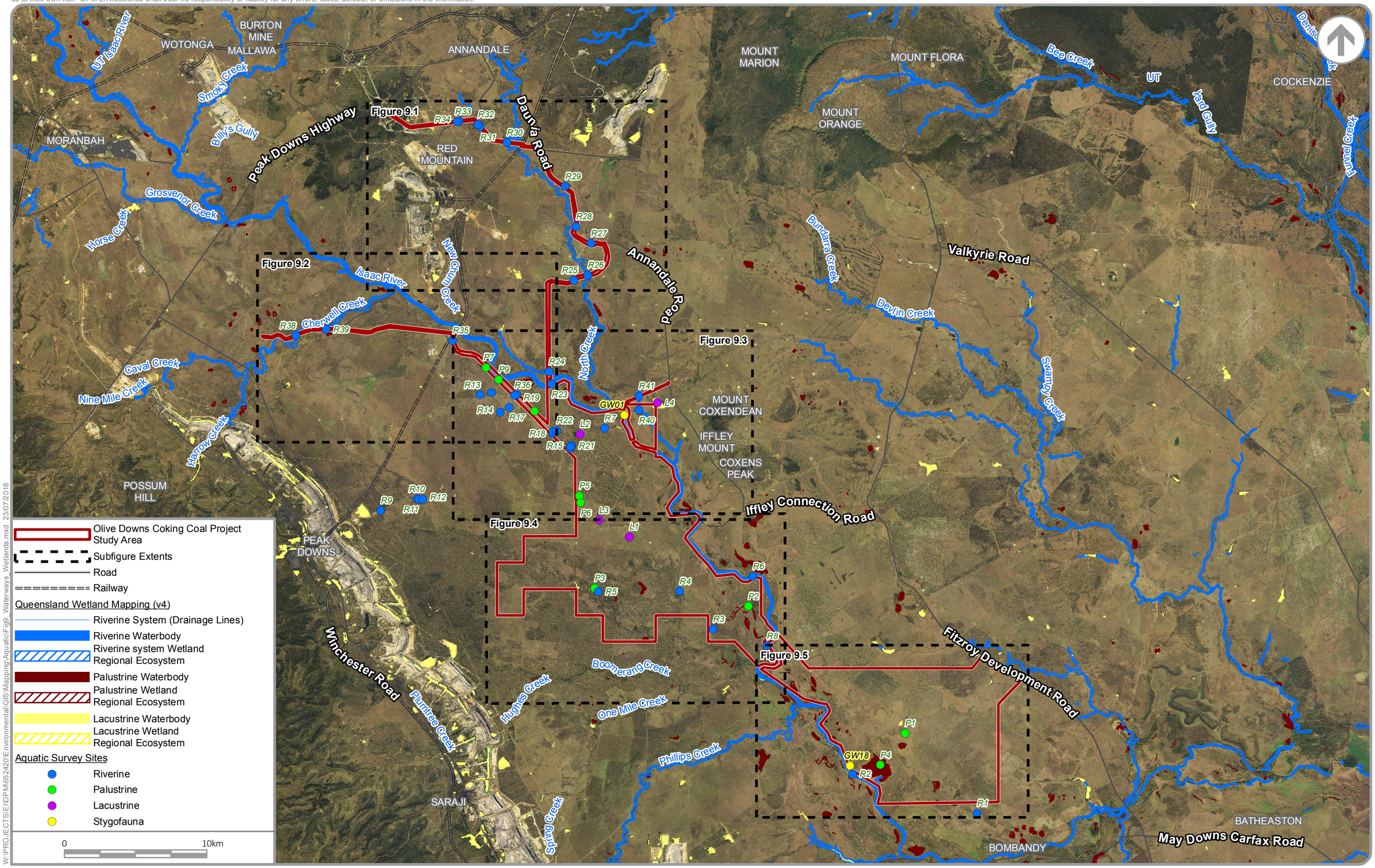
Early wet season surveys were undertaken across the Study area by DPM Enviros ciences over the period 12-19 December 2016 and again during 2-9 October 2017 and 14-20 November 2017, aligning with the AusRivAS 'early wet' sampling season (October to December). Follow-up surveys were undertaken in 22-28 June and 4-11 July 2017 in line with the AusRivAS 'late wet' sampling season (May to July). No rain was recorded during the 'late wet' survey period, although surface water was prevalent across the Study area as a result of significant rainfall and runoff associated with Cyclone Debbie in late March 2017. The Isaac River was in flow at the time of the late wet surveys, although had reduced to scattered deep pools connected only by very shallow, trickling runs. Numerous wetlands and gilgais across the Study area remained full of water.

Desktop investigations, including review of available aerial imagery and review of the Queensland Wetlands Mapping 2015 (DES 2018a), were used to identify representative stream reaches and wetlands for in-field assessment. Detailed aquatic survey was attempted at 54 locations (Figure 9), comprising:

- 41 riverine system drainage lines:
  - 16 stream order 1 sites;
  - 14 stream order 2 sites;
  - three stream order 3 sites (including R3 and R5 – Ripstone Creek);
  - three stream order 4 sites (R26, R28 and R30 – North Creek);
  - one stream order 5 site (R38 – Cherwell Creek);
  - four stream order 6 sites (R2, R6, R8 and R23 – Isaac River);
- nine palustrine wetlands:
  - one non-floodplain vegetated swamp in a depression (P1), representing a wetland of High Ecological Significance (HES wetland);
  - one paleochannel wetland (P2), representing a HES wetland;
  - six modified swamps / dams (P3, P5, P6-9), representing wetlands of General Ecological Significance;
  - one modified swamp (P4); and
- four dams mapped as lacustrine wetlands (L1-L4).

All sites were not able to be surveyed during all surveys due to seasonal variation. Four sites could not be surveyed in December 2016 due to land access constraints. This included riverine sites R4 and R7, and lacustrine wetland sites L1 and L2. A further three sites were dry (R1, R5 and P1). In June / July 2017, land access was not available for site R1 and a number of sites were dry due to seasonally low rainfall (R7, R10-12, R14-18, R20-21, R25-26, R29, R31-34 and L1 and P6). In October and November 2017 many sites were dry and were unable to be surveyed (R9-22, R25-26, R30-34, R36-41 and P6-9).

The sampling sites and survey effort are identified in Table 3.



Olive Downs Coking Coal Project Study Area
Subfigure Extents
Road
Railway

Queensland Wetland Mapping (v4)
Riverine System (Drainage Lines)
Riverine Waterbody
Riverine system Wetland Regional Ecosystem
Palustrine Waterbody
Palustrine Wetland Regional Ecosystem
Lacustrine Waterbody
Lacustrine Wetland Regional Ecosystem

Aquatic Survey Sites
Riverine
Palustrine
Lacustrine
Stygofauna

0 10km

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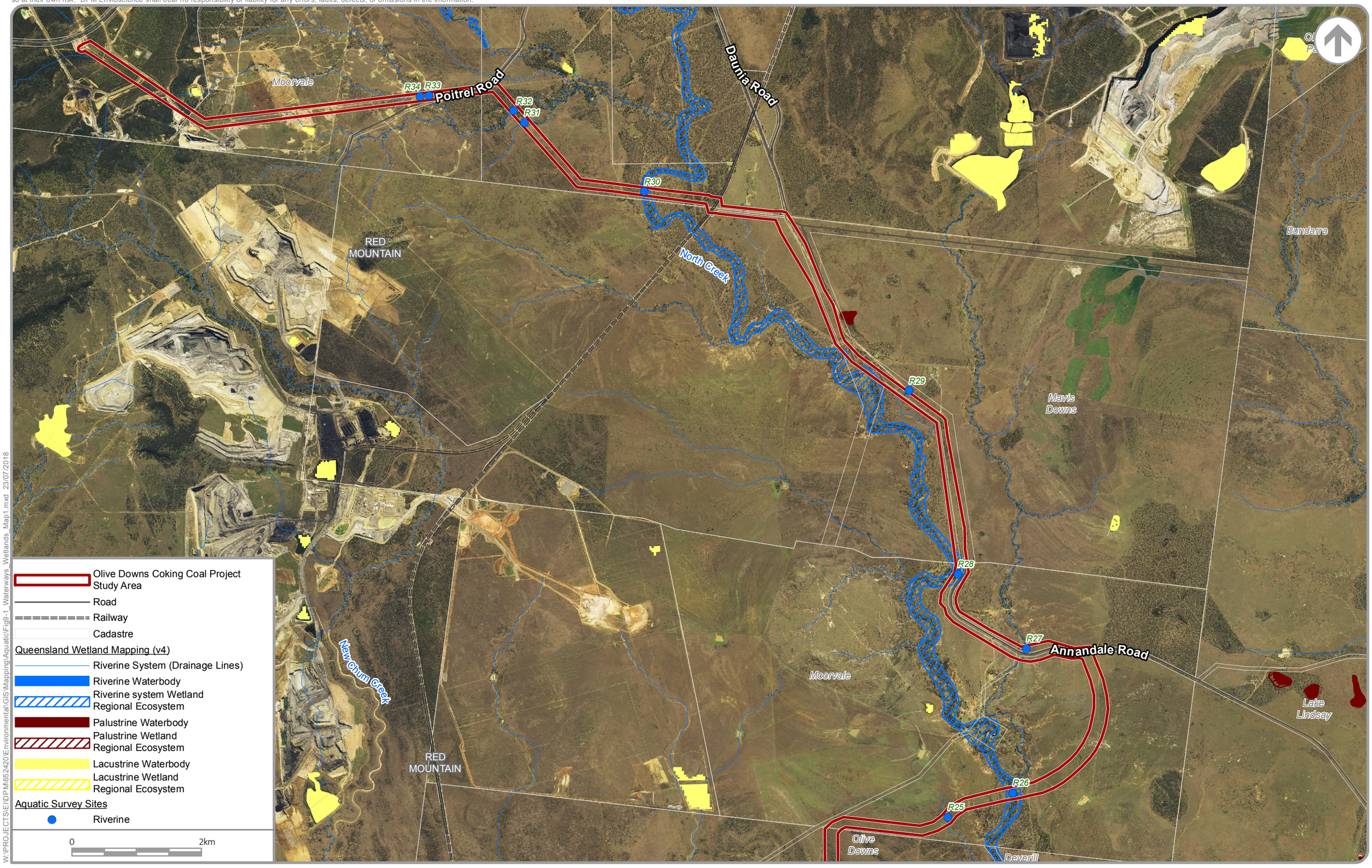
DPM ENVIROSCIENCES

WATERWAYS AND WETLANDS OF THE STUDY AREA

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 9



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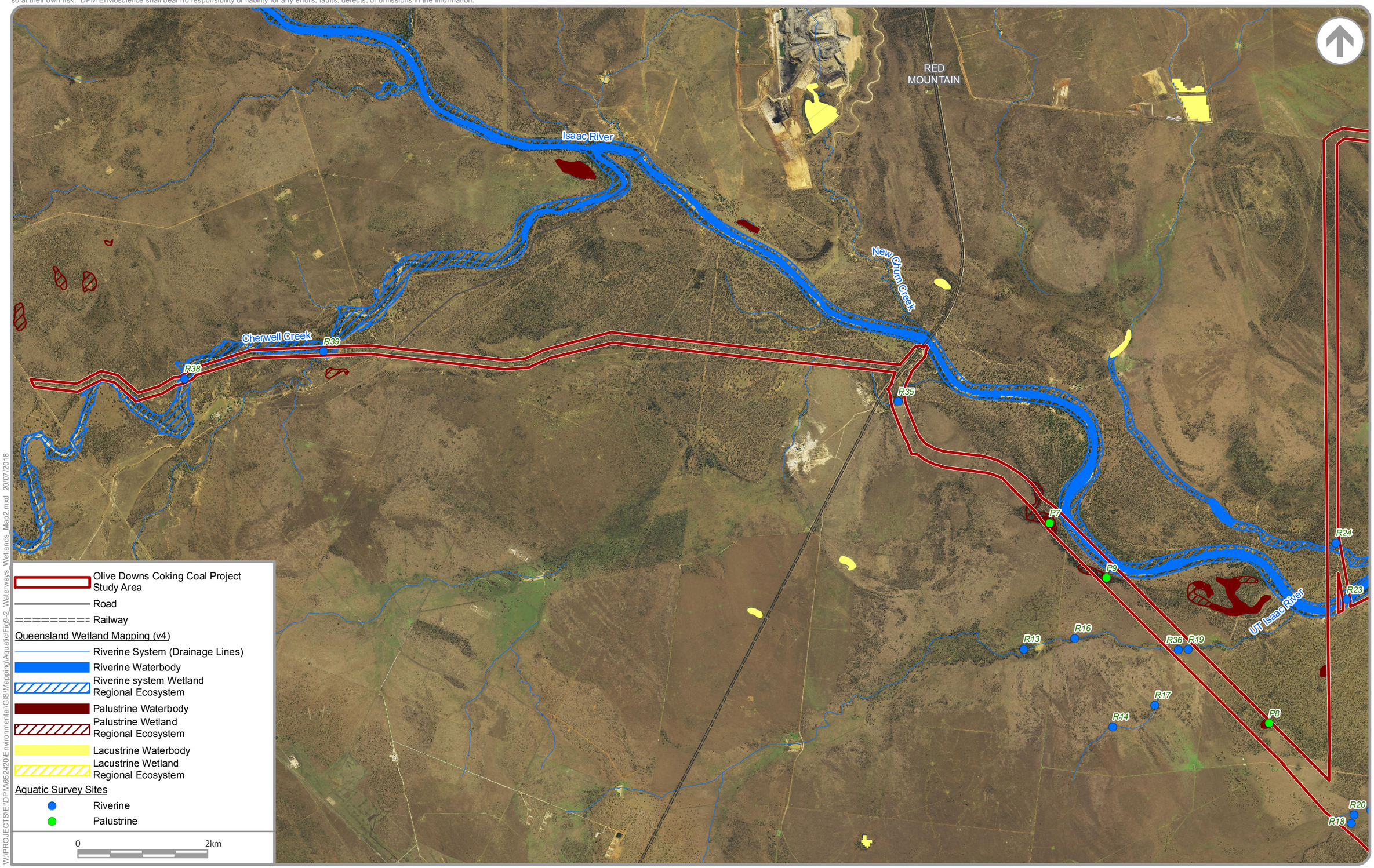
DPM ENVIROSCIENCES

WATERWAYS AND WETLANDS OF THE STUDY AREA – MAP 1

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 9.1



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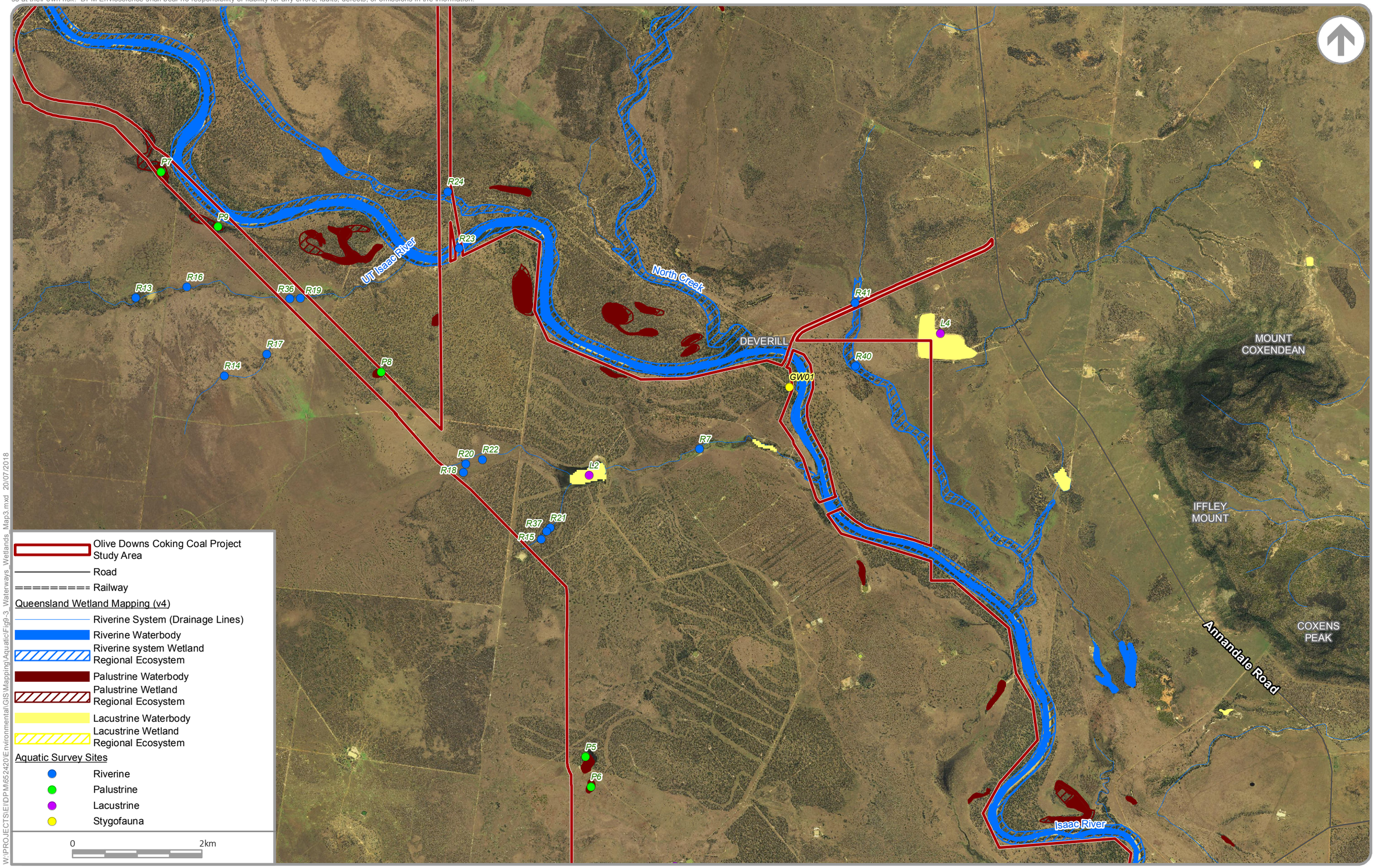
DPM ENVIROSCIENCES

WATERWAYS AND WETLANDS OF THE STUDY AREA – MAP 2

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 9.2



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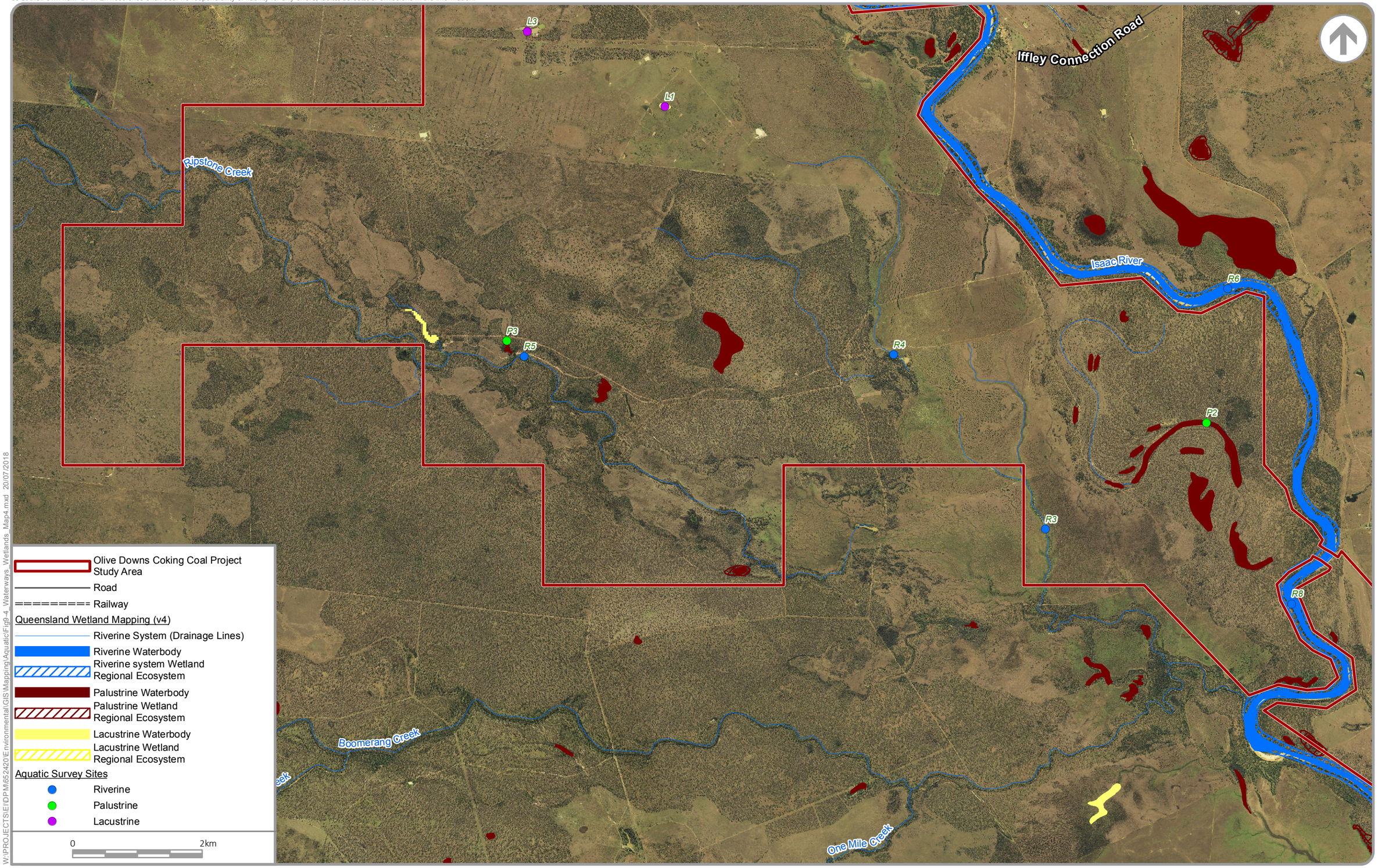
DPM ENVIROSCIENCES

WATERWAYS AND WETLANDS OF THE STUDY AREA – MAP 3

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 9.3



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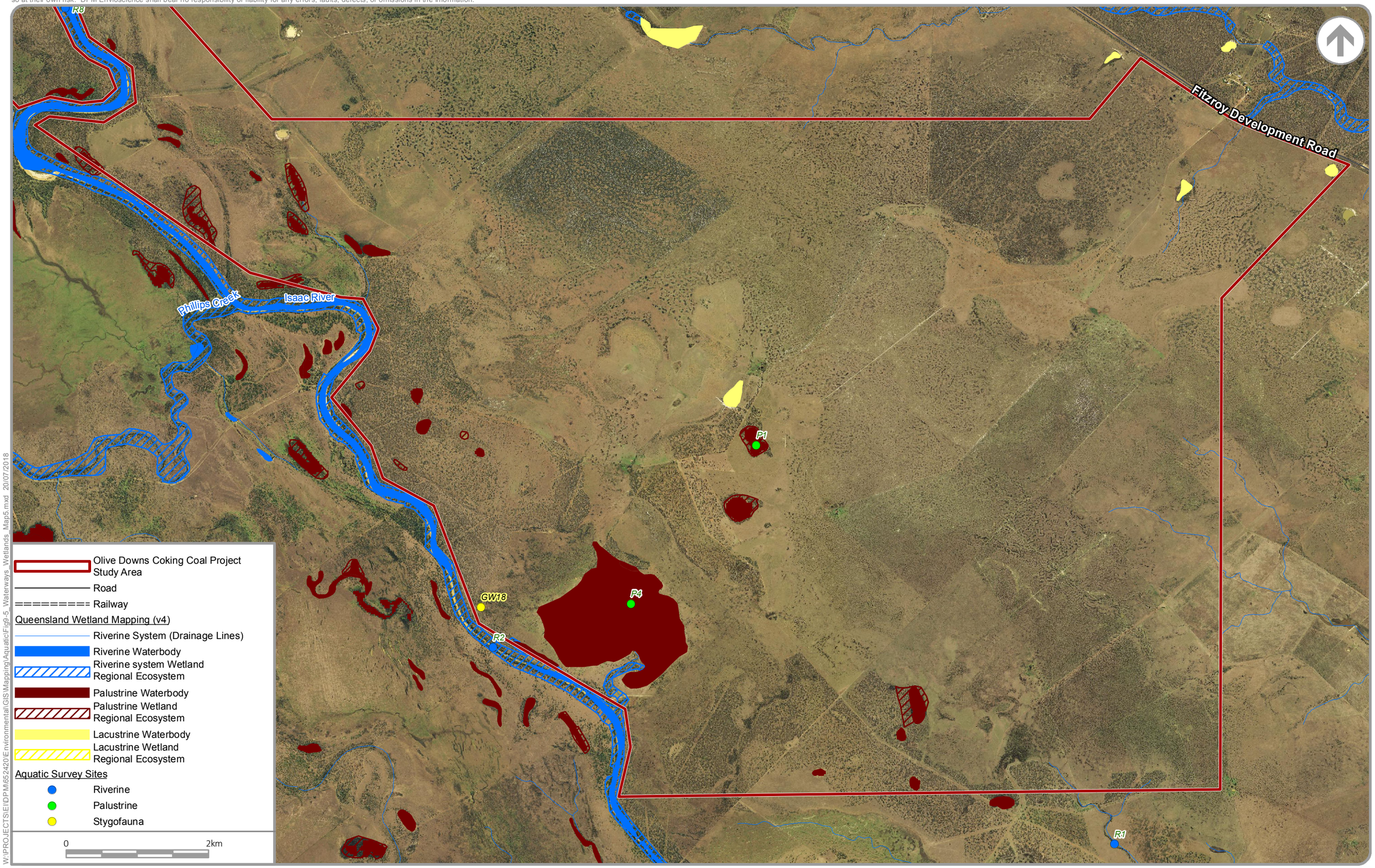
DPM ENVIROSCIENCES

WATERWAYS AND WETLANDS OF THE STUDY AREA – MAP 4

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 9.4



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DPM ENVIROSCIENCES

WATERWAYS AND WETLANDS OF THE STUDY AREA – MAP 5

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 9.5

Table 3 Assessment sites survey effort across the Study area

Site	Site ID	Date / Season	Stream order (Strahler)	Lat. (GDA 1994)	Long. (GDA 1994)	Fish survey effort			Turtle survey effort			Aquatic macro-invert. sampling		Physico-chem. water quality	Habitat assess. and aquatic plant survey
						Electro-fishing	Fyke nets	Box traps	Cathedral traps	Fyke nets	Snorkelling	Bed habitat	Edge habitat		
Riverine sites															
Unnamed tributary of the Isaac River	R1	12/12/16 Pre-wet	2	-22.4235	148.6042	Dry									✓
Isaac River	R2	14/12/16 Pre-wet	6	-22.3986	148.5257	Not safe to access due to steep banks, deep water and unconsolidated silt substrates. Replaced by site R8.							✓	✓	✓
Unnamed tributary of Ripstone Ck	R3	18/12/16 Pre-wet	3	-22.3074	148.4374	✓	✓	✓		✓		✓	✓	✓	✓
Unnamed tributary of Ripstone Ck	R3	08/07/17 Post-wet	3	-22.3074	148.4374	✓	✓	✓		✓		✓	✓	✓	✓
Unmapped riverine wetland	R4	19/12/16 Pre-wet	1	-22.2836	148.4171	✓	✓	✓	✓	✓		Encountered site access issues (Isaac River flow). Survey effort not completed.			
Unmapped riverine wetland	R4	07/07/17 Post-wet	1	-22.2836	148.4171	✓	✓	✓	✓	✓		✓	✓	✓	✓
Ripstone Creek	R5A	18/12/16 Pre-wet	3	-22.2845	148.3676	Dry									✓
Ripstone Creek	R5B	06/07/17 Post-wet	3	-22.2833	148.3651	✓	✓	✓		✓		✓	✓	✓	✓
Isaac River	R6	14/12/16 Pre-wet	6	-22.2740	148.4622	✓	Too much flow for deployment of nets					✓	✓	✓	✓
Isaac River	R6	09/07/17 Post-wet	6	-22.2740	148.4622	✓	✓	✓	✓	✓		✓	✓	✓	✓

Site	Site ID	Date / Season	Stream order (Strahler)	Lat. (GDA 1994)	Long. (GDA 1994)	Fish survey effort			Turtle survey effort			Aquatic macro-invert. sampling		Physico-chem. water quality	Habitat assess. and aquatic plant survey
						Electro-fishing	Fyke nets	Box traps	Cathedral traps	Fyke nets	Snorkelling	Bed habitat	Edge habitat		
Unnamed tributary of the Isaac River	R7	04/07/17 Post-wet	2	-22.1801	148.3689	Dry									✓
Isaac River (Additional site)	R8	17/12/16 Pre-wet	6	-22.3181	148.4719	✓	✓	✓	✓	✓		✓	✓	✓	✓
Isaac River (Additional site)	R8	10/07/17 Post-wet	6	-22.3181	148.4719	✓	✓	✓	✓	✓		✓	✓	✓	✓
Unnamed tributary of Ripstone Creek	R9	3/10/17 Pre-wet	1	-22.2322	148.2276	Dry									✓
Unnamed tributary of Ripstone Creek	R9	23/06/17 Post-wet	1	-22.2322	148.2276									✓	✓
Unnamed tributary of Ripstone Creek	R10	3/10/17 Pre-wet	2	-22.2249	148.2504	Dry									✓
Unnamed tributary of Ripstone Creek	R10	23/06/17 Post-wet	2	-22.2249	148.2504	Dry									✓
Unnamed tributary of Ripstone Creek	R11	3/10/17 Pre-wet	2	-22.2250	148.2516	Dry									✓
Unnamed tributary of Ripstone Creek	R11	23/06/17 Post-wet	2	-22.2250	148.2516	Dry									✓
Unnamed tributary of Ripstone Creek	R12	3/10/17 Pre-wet	2	-22.2251	148.2542	Dry									✓
Unnamed tributary of Ripstone Creek	R12	23/06/17 Post-wet	2	-22.2251	148.2542	Dry									✓
Unnamed tributary of the Isaac River	R13	4/10/17 Pre-wet	2	-22.1592	148.2905	Dry									✓

Site	Site ID	Date / Season	Stream order (Strahler)	Lat. (GDA 1994)	Long. (GDA 1994)	Fish survey effort			Turtle survey effort			Aquatic macro-invert. sampling		Physico-chem. water quality	Habitat assess. and aquatic plant survey
						Electro-fishing	Fyke nets	Box traps	Cathedral traps	Fyke nets	Snorkelling	Bed habitat	Edge habitat		
Unnamed tributary of the Isaac River	R13	22/06/17 Post-wet	2	-22.1592	148.2905	✓	✓	✓		✓		✓	✓	✓	✓
Unnamed tributary of the Isaac River	R14	5/10/17 Pre-wet	1	-22.1700	148.3029	Dry									✓
Unnamed tributary of the Isaac River	R14	23/06/17 Post-wet	1	-22.1700	148.3029	Dry									✓
Unnamed tributary of the Isaac River	R15	5/10/17 Pre-wet	1	-22.1927	148.3469	Dry									✓
Unnamed tributary of the Isaac River	R15	25/06/17 Post-wet	1	-22.1927	148.3469	Dry									✓
Unnamed tributary of the Isaac River	R16	4/10/17 Pre-wet	2	-22.1577	148.2976	Dry									✓
Unnamed tributary of the Isaac River	R16	23/06/17 Post-wet	2	-22.1577	148.2976	Dry									✓
Unnamed tributary of the Isaac River	R17	5/10/17 Pre-wet	1	-22.1670	148.3087	Dry									✓
Unnamed tributary of the Isaac River	R17	23/07/17 Post-wet	1	-22.1670	148.3087	Dry									✓
Unnamed tributary of the Isaac River	R18	4/10/17 Pre-wet	1	-22.1834	148.3361	Dry									✓
Unnamed tributary of the Isaac River	R18	24/07/17 Post-wet	1	-22.1834	148.3361	Dry									✓
Unnamed tributary of the Isaac River	R19	4/10/17 Pre-wet	2	-22.1592	148.3134	Dry									✓

Site	Site ID	Date / Season	Stream order (Strahler)	Lat. (GDA 1994)	Long. (GDA 1994)	Fish survey effort			Turtle survey effort			Aquatic macro-invert. sampling		Physico-chem. water quality	Habitat assess. and aquatic plant survey
						Electro-fishing	Fyke nets	Box traps	Cathedral traps	Fyke nets	Snorkelling	Bed habitat	Edge habitat		
Unnamed tributary of the Isaac River	R19	24/07/17 Post-wet	2	-22.1592	148.3134									✓	✓
Unnamed tributary of the Isaac River	R20	4/10/17 Pre-wet	1	-22.1823	148.3364	Dry									✓
Unnamed tributary of the Isaac River	R20	24/07/17 Post-wet	1	-22.1823	148.3364	Dry									✓
Unnamed tributary of the Isaac River	R21	5/10/17 Pre-wet	1	-22.1911	148.3482	Dry									✓
Unnamed tributary of the Isaac River	R21	25/06/17 Post-wet	1	-22.1911	148.3482	Dry									✓
Unnamed tributary of the Isaac River	R22	4/10/17 Pre-wet	1	-22.1816	148.3387	Dry									✓
Unnamed tributary of the Isaac River	R22	24/06/17 Post-wet	1	-22.1816	148.3387	Dry									✓
Isaac River	R23	6/10/17 Pre-wet	6	-22.1523	148.3355	✓						✓	✓	✓	✓
Isaac River	R23	25/06/17 Post-wet	6	-22.1523	148.3355	✓	✓	✓		✓		✓	✓	✓	✓
Unnamed tributary of the Isaac River	R24	6/10/17 Pre-wet	2	-22.1444	148.3339									✓	✓
Unnamed tributary of the Isaac River	R24	26/06/17 Post-wet	2	-22.1444	148.3339									✓	✓
Unnamed tributary of North Creek	R25	8/10/17 Pre-wet	1	-22.0867	148.3494										✓

Site	Site ID	Date / Season	Stream order (Strahler)	Lat. (GDA 1994)	Long. (GDA 1994)	Fish survey effort			Turtle survey effort			Aquatic macro-invert. sampling		Physico-chem. water quality	Habitat assess. and aquatic plant survey
						Electro-fishing	Fyke nets	Box traps	Cathedral traps	Fyke nets	Snorkelling	Bed habitat	Edge habitat		
Unnamed tributary of North Creek	R25	27/06/17 Post-wet	1	-22.0867	148.3494	Dry									✓
North Creek	R26	8/10/17 Pre-wet	4	-22.0833	148.3584	Dry									✓
North Creek	R26	27/06/17 Post-wet	4	-22.0833	148.3584	Dry									✓
Unnamed tributary of North Creek	R27	3/10/17 Pre-wet	2	-22.0632	148.3603									✓	✓
Unnamed tributary of North Creek	R27	27/06/17 Post-wet	2	-22.0632	148.3603									✓	✓
North Creek	R28	3/10/17 Pre-wet	4	-22.0528	148.3508	✓	✓	✓	✓	✓		✓	✓	✓	✓
North Creek	R28	27/06/17 Post-wet	4	-22.0528	148.3508	✓	✓	✓	✓	✓		✓	✓	✓	✓
Unnamed tributary of North Creek	R29	3/10/17 Pre-wet	1	-22.0273	148.3440									✓	✓
Unnamed tributary of North Creek	R29	28/06/17 Post-wet	1	-22.0273	148.3440	Dry									✓
North Creek	R30	8/10/17 Pre-wet	4	-21.9995	148.3074	✓						✓	✓	✓	✓
North Creek	R30	27/06/17 Post-wet	4	-21.9995	148.3074	✓	✓	✓		✓		✓	✓	✓	✓
Unnamed tributary of North Creek	R31	8/10/17 Pre-wet	1	-21.9899	148.2904	Dry									✓

Site	Site ID	Date / Season	Stream order (Strahler)	Lat. (GDA 1994)	Long. (GDA 1994)	Fish survey effort			Turtle survey effort			Aquatic macro-invert. sampling		Physico-chem. water quality	Habitat assess. and aquatic plant survey
						Electro-fishing	Fyke nets	Box traps	Cathedral traps	Fyke nets	Snorkelling	Bed habitat	Edge habitat		
Unnamed tributary of North Creek	R31	28/06/17 Post-wet	1	-21.9899	148.2904	Dry									✓
Unnamed tributary of North Creek	R32	8/10/17 Pre-wet	3	-21.9882	148.2889	Dry									✓
Unnamed tributary of North Creek	R32	28/06/17 Post-wet	3	-21.9882	148.2889	Dry									✓
Unnamed tributary of North Creek	R33	8/10/17 Pre-wet	2	-21.9861	148.2771	Dry									✓
Unnamed tributary of North Creek	R33	28/06/17 Post-wet	2	-21.9861	148.2771	Dry									✓
Unnamed tributary of North Creek	R34	8/10/17 Pre-wet	1	-21.9863	148.2759	Dry									✓
Unnamed tributary of North Creek	R34	28/06/17 Post-wet	1	-21.9863	148.2759	Dry									✓
Unnamed tributary of Isaac River	R35	5/10/17 Pre-wet	2	-22.1250	148.2731									✓	✓
Unnamed tributary of Isaac River	R36	5/10/17 Pre-wet	2	-22.1592	148.3118	Dry									✓
JB Gully	R38	14/11/17 Pre-wet	5	-22.1216	148.1738	Dry									✓
JB Gully	R39	15/11/17 Pre-wet	2	-22.1178	148.1931	Dry									✓
Unnamed tributary of Isaac River	R40	18/11/17 Pre-wet	1	-22.1686	148.3905	Dry									✓

Site	Site ID	Date / Season	Stream order (Strahler)	Lat. (GDA 1994)	Long. (GDA 1994)	Fish survey effort			Turtle survey effort			Aquatic macro-invert. sampling		Physico-chem. water quality	Habitat assess. and aquatic plant survey
						Electro-fishing	Fyke nets	Box traps	Cathedral traps	Fyke nets	Snorkelling	Bed habitat	Edge habitat		
Unnamed tributary of Isaac River	R41	18/11/17 Pre-wet	1	-22.1599	148.3905	Dry									✓
Wetland sites															
Palustrine wetland (HES)	P1	12/12/16 Pre-wet	NA	-22.3727	148.5587	Dry									✓
Palustrine wetland (HES)	P1	11/07/17 Post-wet	NA	-22.3727	148.5587	✓	✓	✓		✓		✓		✓	✓
Palustrine wetland (HES)	P2	18/12/16 Pre-wet	NA	-22.2942	148.4541	✓	✓	✓	✓	✓		✓		✓	✓
Palustrine wetland (HES)	P2	08/07/17 Post-wet	NA	-22.2942	148.4541	✓	✓	✓		✓		✓		✓	✓
Palustrine wetland (GES)	P3	19/12/16 Pre-wet	NA	-22.2821	148.3627	✓	✓	✓	✓	✓		✓		✓	✓
Palustrine wetland (GES)	P3	05/07/17 Post-wet	NA	-22.2821	148.3627	✓	✓	✓		✓		✓		✓	✓
Large unmapped palustrine wetland	P4	9/10/17 Pre-wet	NA	-22.3931	148.5431	✓	✓	✓	✓	✓		✓		✓	✓
Large unmapped palustrine wetland	P4	10/07/17 Post-wet	NA	-22.3931	148.5431	✓	✓	✓		✓		✓		✓	✓
Palustrine wetland (GES)	P5	6/10/17 Pre-wet	NA	-22.2230	148.3531	✓	✓	✓		✓		✓		✓	✓
Palustrine wetland (GES)	P5	24/06/17 Post-wet	NA	-22.2230	148.3531	✓	✓	✓		✓		✓		✓	✓

Site	Site ID	Date / Season	Stream order (Strahler)	Lat. (GDA 1994)	Long. (GDA 1994)	Fish survey effort			Turtle survey effort			Aquatic macro-invert. sampling		Physico-chem. water quality	Habitat assess. and aquatic plant survey
						Electro-fishing	Fyke nets	Box traps	Cathedral traps	Fyke nets	Snorkelling	Bed habitat	Edge habitat		
Palustrine wetland (GES)	P6	6/10/17 Pre-wet	NA	-22.2272	148.3538	Dry									✓
Palustrine wetland (GES)	P6	25/06/17 Post-wet	NA	-22.2272	148.3538	Dry									✓
Palustrine wetland (GES)	P7	4/10/17 Pre-wet	NA	-22.1417	148.2941	Dry									✓
Palustrine wetland (GES)	P7	22/06/17 Post-wet	NA	-22.1417	148.2941	✓						✓		✓	✓
Palustrine wetland (GES)	P8	4/10/14 Pre-wet	NA	-22.1695	148.3246	Dry									✓
Palustrine wetland (GES)	P8	24/06/17 Post-wet	NA	-22.1695	148.3246									✓	✓
Palustrine wetland (GES)	P9	5/10/17 Pre-wet	NA	-22.1494	148.3017	Dry									✓
Lacustrine wetland / dam	L1	05/07/17 Post-wet	NA	-22.1797	148.3778	Dry									✓
Lacustrine wetland / dam	L2	6/10/17 Pre-wet	NA	-22.1837	148.3534	✓	✓	✓		✓		✓		✓	✓
Lacustrine wetland / dam	L2	04/07/17 Post-wet	NA	-22.1837	148.3534	✓	✓	✓	✓	✓		✓		✓	✓
Lacustrine wetland / dam	L3	5/10/17 Pre-wet	NA	-22.2383	148.3655									✓	✓
Lacustrine wetland / dam	L3	25/06/17 Post-wet	NA	-22.2383	148.3655									✓	✓

Site	Site ID	Date / Season	Stream order (Strahler)	Lat. (GDA 1994)	Long. (GDA 1994)	Fish survey effort			Turtle survey effort			Aquatic macro-invert. sampling		Physico-chem. water quality	Habitat assess. and aquatic plant survey
						Electro-fishing	Fyke nets	Box traps	Cathedral traps	Fyke nets	Snorkelling	Bed habitat	Edge habitat		
Lacustrine wetland / dam	L4	18/11/17 Pre-wet	NA	-22.1641	148.4024	✓	✓	✓		✓		✓		✓	✓

4.5.2 Aquatic habitats

Aquatic habitats were described in accordance with AusRivAS protocols for Queensland streams (DNRM 2001). This established a general description of the environment of each site and its immediate surrounds. The classifications are based on flow level, depth, velocity, width, canopy cover, substrate types, habitat attributes, local catchment erosion, sediment deposits, water colour, algae, water odour, substrate odour, presence of large woody debris, riparian zone width and cover, and general signs of disturbance.

Variable flow, caused by natural events such as rainfall, runoff and drought / flood cycles can influence the aquatic ecosystems of an area. This should be taken into consideration for future studies which may utilise results contained in this report.

Habitat assessment scores (out of 135) were made for each site based on the nine AusRivAS categories (Table 4). Aquatic habitat at each site was classified as Poor, Fair, Good or Excellent based on the overall scores.

A detailed description of the aquatic habitat encountered at each site is included in the site profiles in Appendix B.

Table 4 Aquatic habitat assessment variables and categories

Habitat variable	Poor	Fair	Good	Excellent
Bottom substrate / available cover	0 – 5	6 – 10	11 – 15	16 – 20
Embeddedness	0 – 5	6 – 10	11 – 15	16 – 20
Velocity / depth category	0 – 5	6 – 10	11 – 15	16 – 20
Channel alteration	0 – 3	4 – 7	8 – 11	12 – 15
Bottom scouring and deposition	0 – 3	4 – 7	8 – 11	12 – 15
Pool / riffle, run / bend ratio	0 – 3	4 – 7	8 – 11	12 – 15
Bank stability	0 – 2	3 – 5	6 – 8	9 – 10
Bank vegetative stability	0 – 2	3 – 5	6 – 8	9 – 10
Streamside cover	0 – 2	3 – 5	6 – 8	9 – 10
Total	**0 – 38**	**39 – 74**	**75 – 110**	**111 – 135**

4.5.3 Physico-chemical water quality

In-situ physico-chemical water quality parameters were measured at each wetted survey site visited by DPM Enviroscienses using a YSI Professional Plus multi-parameter water quality meter and Hach Turbidimeter 2100Q, each calibrated both prior to and following sampling. Water quality parameters measured included:

- temperature (°C);
- pH;
- electrical conductivity (EC; µS/cm);
- turbidity (NTU); and
- dissolved oxygen (mg/L and % saturation).

For the purposes of this assessment, the measure of salinity is based on the following electrical conductivity (EC) ranges (DAFF 2012):

- Fresh – water with electrical conductivity (EC) <800 µS/cm;
- Marginal – 800 to 1,600 µS/cm;
- Brackish – 1,600 to 4,800 µS/cm;
- Slightly saline – 4,800 to 10,000 µS/cm;
- Moderately saline – 10,000 to 20,000 µS/cm; and
- Saline – >20,000 µS/cm.

4.5.4 Fish

Fish were surveyed at most wetted sites (R3-6, R8, R13, R23, R28, R30, P3-5, L2 and L4) using a combination of backpack electrofishing, dip-netting and overnight deployment of baited fyke nets and baited box traps. Fish were surveyed at sites P1, P2 and P7, but no fish were recorded.

Fish survey effort employed at most fished sites (except the sites indicated below) included:

- backpack electrofishing using a Smith-Root LR-24 electrofisher for up to 1200 seconds power-on time (100Hz frequency; 20% duty cycle; 150-500v, to suit conductivity);
- dip-netting in combination with backpack electrofishing, using an Environet manoeuvred through the water column;
- fyke netting – with 2 x fyke nets, dual wing, 4 m wing lengths, 0.6 m drop, 3 mm mesh, baited with beef heart, banana, apple, spinach and rinsed sardines – deployed overnight to capture mobile fish (and turtles); and
- box traps – with 5 x traps, 22 cm x 22 cm x 40 cm, 2 mm mesh, 50 mm opening, baited with dry cat food.

Fish survey was not attempted at site R2 on the Isaac River in the 2016 early wet survey due to safety concerns with access associated with steep banks, deep water and unconsolidated silt substrates at the time of assessment. Backpack electrofishing was conducted at site R6 and R23 on the Isaac River in the 2016 early wet survey; however, no nets were deployed at this location as flow velocities and water level fluctuations were not suitable for these techniques at the time of assessment. No fish survey was undertaken in December 2016 at sites R1, R5 or P1 or at sites R7, R10-12, R14-18, R20-21, R25-26, R29, R31-34 and L1 and P6 in June / July 2017 as these sites were dry at the time of assessment. In October and November 2017 many sites were dry and were unable to be surveyed (R9-22, R25-26, R30-34, R36-41 and P6-9).

Captured fish were identified, with native species released at the point of capture. Pest fish were euthanized as per DPM Enviros ciences' General Fisheries Permit and Animal Ethics Committee Approval.

4.5.5 Turtles

The Survey Guidelines for Australia's Threatened Reptiles (DSEWPC 2011) suggests that the the Fitzroy River turtle (*Rheodytes leukops*) can be readily observed in riffle zones by diving with a face mask and snorkel, or collected by seine netting, and also that the partly carnivorous diet of this species indicates it might be attracted to meat baits in traps. Survey guidelines for the southern snapping turtle (*Elseya albagula*) are not identified in DSEWPC 2011, due to the subsequent listing of this species as Critically Endangered (from common / Least Concern) in November 2014. However, DPM Enviros ciences has successfully captured this species using baited cathedral traps on other projects in the Fitzroy River Basin (including for the proposed Arrow Bowen Pipeline; unpublished).

The Terrestrial Vertebrate Fauna Survey Guidelines for Queensland (DSITIA 2014) suggest that freshwater turtle surveys should employ one or more of the following capture techniques:

- visual survey;
- snorkelling;
- spotlighting;
- trapping; and
- seine netting.

Freshwater turtles were surveyed at most wetted sites (R3-6, R8, R13, R23, R28, R30, P1-5, P9, L2 and L4) by overnight deployment of baited fyke nets and baited cathedral traps, as well as observations of the bank and water surface for sunning and breaching turtles.

Water clarity was too poor to enable snorkelling surveys at any sites. Water depths were insufficient for deployment of cathedral traps at site R3 in either the early wet 2016 or late wet 2017 surveys. Turtle trapping was not attempted at site R2 on the Isaac River in the early wet 2016 survey due to safety concerns with access associated with steep and slippery banks (from recently deposited silts), deep water and unconsolidated silt substrates at the time of assessment. No traps were deployed at site R6 on the Isaac River in the early wet 2016 survey as flow velocities and water level fluctuations were not suited to the deployment of nets at the time of assessment. No turtle survey was undertaken in the early wet 2016 survey at sites R1, R5 or P1 or at sites R7, R10-12, R14-18, R20-21, R25-26, R29, R31-34 and L1, or at P6 in the late wet 2017 survey as these sites were dry at the time of assessment. In October and November 2017 many sites were dry and were unable to be surveyed (R9-22, R25-26, R30-34, R36-41 and P6-9).

4.5.6 Mammals

Habitat suitability for platypus (*Ornithorhynchus anatinus*) was assessed at each wetted site. However, the seasonal nature of most riverine and palustrine waterbodies of the Study area are not conducive to sustaining a population of platypus. At those sites considered suitable and accessible, targeted searches for burrows along river banks were conducted. Targeted searches for platypus were conducted at site R4 (upstream of a dam) which provided habitat suitable for platypus breeding (including relative permanence of water, and bank substrates dominated by silt / clay, as opposed to apedal sediments such as sand). The potential for platypus occurring in lacustrine wetlands (lakes and farm dams) of the Study area was also assessed as part of the 2017 late wet and early wet aquatic surveys, but all sites were considered unsuitable for the species.

4.5.7 Freshwater macroinvertebrates

Freshwater macroinvertebrate samples were collected from suitable habitat at sites R2-6, R8, R13, R23, R28, R30, P1-5, P7, L2 and L4 (Figure 9) to gain an improved understanding of the health, trophic interactions and aquatic values of each site. Samples were collected by an AusRivAS accredited ecologist following AusRivAS protocols for Queensland streams (DNRM 2001). AusRivAS protocols specify a standardised, qualitative, rapid bioassessment method that aims to consistently sample a wide diversity of macroinvertebrates within a defined timeframe. The bed and edge habitats were sampled separately at each site in accordance with AusRivAS protocols. At wetland sites, a composite sample was collected incorporating all macro habitat conditions available (i.e. woody debris, macrophytes, bed and edge).

A standard sized dip net with 250 µm mesh was used to sample macroinvertebrates. Following collection, the samples were transferred to plastic sorting trays, where the contents were sorted and live-picked for 30 minutes. Picked specimens were placed into specimen jars with 70% ethanol.

Samples were identified by AusRivAS accredited taxonomists Dr Terry Walker and Chris Pietsch to AusRivAS taxonomic level in the laboratory under stereomicroscope. AusRivAS taxonomic identification is primarily to Family level, with the exception of lower Phyla such as Porifera, Nematoda and Nemertea, Oligochaetes (freshwater worms), Acarina (mites), and microcrustacea such as Ostracoda, Copepoda and Cladocera. Chironomids (midges) are identified to sub-family taxonomic level.

Data analysis

The macroinvertebrate data was used to calculate a number of community descriptors as described in the following sections.

Taxonomic richness

Taxonomic richness was calculated from the number of taxa present in each sample, providing an indication of community diversity at the site, with richness typically increasing with ecological condition.

PET

The Plecoptera, Ephemeroptera and Trichoptera (PET) richness was calculated from the number of taxa belonging to the three PET orders. These three orders are widely accepted as being most sensitive to environmental change, such as habitat degradation and pollution (DEHP 2009). A low PET richness score suggests that a site may be impacted by degradation or pollution, due to the absence of these pollution-sensitive taxa. Conversely, a high PET richness suggests a system free from degradation or pollution.

Pollution-tolerant taxa

The percentage of pollution-tolerant taxa was calculated based on the SIGNAL2 indices. Tolerant taxa are classified as those with a SIGNAL2 score of 3 or less (Marshall et al. 2001). Macroinvertebrate families in this group are expected to be able to tolerate changes to their environment, including habitat degradation and some pollution. An absence of more sensitive taxa suggests environmental conditions may be too harsh for sensitive taxa (those with SIGNAL2 scores above 3) to tolerate.

SIGNAL2

SIGNAL2 (Stream Invertebrate Grade Number – Average Level Version 2) indices were calculated, with each taxon allocated a score from 1 to 10 based on Chessman (2003). Taxa with a low score are most tolerant of a range of environmental conditions, and those with a high score are more sensitive to pollution. The presence / absence data of each taxon were used to calculate the SIGNAL2 average for the site, in accordance with the protocols described by Chessman (2003).

AusRivAS

The macroinvertebrate and predictor variables (habitat) data were analysed using the AusRivAS macroinvertebrate predictive modelling program, version 3.2.0 (Ransom and Blackman 2003). The predictive models are typically based on semi-permanent to permanent reference streams. Although the models provide another useful macroinvertebrate community descriptor, the results are applied to ephemeral waterways with caution.

The AusRivAS models utilised, based on location, date and habitats sampled, are identified in Table 5 and Table 6, along with the input variables applied.

4.5.8 Aquatic flora

Aquatic plants were surveyed at each site. All aquatic plants were identified to species using available literature and taxonomic keys where needed. The abundance of each species was estimated using the AusRivAS categories: extensive (>75% cover), moderate (50-75%), some (10-50%) or little (1-10%).

Table 5 AusRivAS 'early wet' habitat predictor model variables for QLD Regional Coastal draining sites, and the values applied

Code	Description	Site and input value						
		R2	R3	R6	R8	R23	R28	R30
Edge habitat								
ALTITUDE	Height above sea level (mAHD)	163	166	171	167	185	203	222
LONGITUDE	Longitude of site – decimal degrees to four decimal places	148.5257	148.4374	148.4627	148.4716	148.3354	148.3508	148.3071
MDMR	Mean dry season monthly rainfall (mm)	24.1	24.1	24.1	24.1	24.1	24.1	24.1
MINTEMP	Mean daily minimum temperature (°C)	16.7	16.7	16.7	16.7	16.7	16.7	16.7
RAWD	Ratio of mean wet season to mean dry season rainfall	3.25	3.25	3.25	3.25	3.25	3.25	3.25
WETR	Range in wet season monthly rainfall means (mm)	67.5	67.5	67.5	67.5	67.5	67.5	67.5
Pool / Bed habitat								
COBBLE	Percent cobble (64-256 mm diameter sediments) in habitat	-	0	0	0	0	0	0
MDMR	Mean dry season monthly rainfall (mm)	-	24.1	24.1	24.1	24.1	24.1	24.1
PROCESSZONE	Process zone category (2 = erosional; 1 = transport; 0 = depositional)	-	2	1	1	1	1	1
RAINRANGE	Annual range in mean monthly rainfall	-	95	95	95	95	95	95
RANGETEMP	Mean daily temperature range (°C)	-	13.0	13.0	13.0	13.0	13.0	13.0

Notes:
Meteorology data derived from Bureau of Meteorology station 034038 – Moranbah Water Treatment Plant – 1972-2012.

Table 6 AusRivAS 'late wet' habitat predictor model variables for QLD Regional Coastal draining sites, and the values applied

Code	Description	Site and input value								
		R3	R4	R5	R6	R8	R13	R23	R28	R30
Edge habitat										
ALTITUDE	Height above sea level (mAHD)	166	170	183	174	167	167	185	203	222
BEDSLOPE	Slope of bed (m/m)	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
LONGITUDE	Longitude of site – decimal degrees to four decimal places	148.4374	148.4164	148.3651	148.4627	148.4716	148.2905	148.3354	148.3508	148.3071
MDMR	Mean dry season monthly rainfall (mm)	24.1	24.1	24.1	24.1	24.1	24.1	24.1	24.1	24.1
RAINRANGE	Annual range in mean monthly rainfall (mm)	95	95	95	95	95	95	95	95	95
RAWD	Ratio of mean wet season to mean dry season rainfall	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25
WETPERCENT	Percentage rainfall in wet season (%)	76	76	76	76	76	76	76	76	76
Pool / Bed habitat										
COBBLE	Percent cobble (64-256 mm diameter sediments) in habitat (%)	0	0	0	0	0	0	0	0	0
DFS	Distance from source (km)	45	4.5	34	170	176	8.5	142	54.5	43.5
MDMR	Mean dry season monthly rainfall (mm)	24.1	24.1	24.1	24.1	24.1	24.1	24.1	24.1	24.1
MINTEMP	Mean daily minimum temperature (°C)	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7
RAINFALL	Mean annual rainfall (mm)	614	614	614	614	614	614	614	614	614

Notes:

Meteorology data derived from Bureau of Meteorology station 034038 – Moranbah Water Treatment Plant – 1972-2012.

4.5.9 Overall aquatic values

An aquatic values rating of Low, Moderate or High was assigned to each site based on the summation of all available information from the desktop and field assessments (Table 7). When assessing each site the overall aquatic value criteria that fit the situation best is applied. The criteria in Table 7 are listed from most to least important.

Table 7 Adopted criteria for assigning aquatic values ratings

Aquatic Values / Sensitivity	Criteria
Low	▪ Ephemeral waterbody
	▪ No EVNT, platypus or Priority species habitat
	▪ In-stream habitat highly modified / disturbed
	▪ Poor to Fair habitat bioassessment score (0 – 74)
Moderate	▪ Ephemeral or semi-permanent waterbody
	▪ Wetland of General Ecological Significance
	▪ Priority species or platypus habitat present
	▪ Known presence of Priority species
	▪ Some good quality in-stream habitat
	▪ Good habitat bioassessment score (75 – 110)
	▪ Dry season refuge for common (Least Concern) species
High	▪ Semi-permanent or permanent waterbody
	▪ Wetland of High Ecological Significance
	▪ EVNT species habitat present
	▪ Known presence of platypus breeding place
	▪ Near natural / excellent in-stream habitat
	▪ Excellent habitat bioassessment score (111 – 135)

4.6 Field survey of stygofauna

A pilot survey was carried out to sample the local presence of subterranean aquatic fauna in consideration of the *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (DSITIA 2015).

4.6.1 Bore locations

Hydro Simulations installed 17 groundwater monitoring bores in nine locations across the Study area from November 2016 to March 2017, comprising eight paired bores (one shallow and one deep) and a single shallow bore.

Hydro Simulations recorded the characteristics of the groundwater (SWL, ph and EC) for each of the bores installed. The data for the nine shallow bores (9-43 m deep) is presented in Table 8. The data for the deeper bores is not included as the screen depths were greater than 100 m and unsuitable for sampling.

Of the nine shallow bores, only two were suitable for stygofauna sampling (GW01-S and GW18-S) (Figure 9), as four bores were dry and two hypersaline (>20,000 µS/cm). 4T (2012) report that stygofauna have not been recorded in Queensland within groundwater with EC greater than 20,000 µS/cm.

The two bores (GW01-S and GW18-S) were sampled. It is noted that Hydro Simulations incorporated slot widths of 1.5 mm into the screened interval of these bores so that they are also suitable for stygofauna sampling.

The *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (DSITIA 2015) requires that bores sampled for the presence of stygofauna be at least six months old. Consequently, the stygofauna sampling was delayed until October 2017 to meet this guideline requirement.

A total of 132 additional bores were identified within 10 km of the Project MLAs by the Project bore census conducted by ENRS and subsequently assessed for their potential to be suitable stygofauna sampling bores. Of the 132 additional bores:

- 111 bores are potentially suitable, but not accessible due to landholder access constraints;
- 18 bores not able to be sampled due to lack of access to the water in the bore (capped bores); and
- three bores are located around the Willunga Domain (capped with taps) but with no data on water quality or slot width in the screened interval.

Table 8 Location and characteristics of groundwater bores assessed for stygofauna in October 2017

Bore ID	Stratigraphy and surficial geology	Lithology (at screen)	Bore completion date	Casing diameter (mm)	Bore depth (mBGL)^	SWL (mBGL)	Screen interval (mBGL)	pH*	EC* (µS/cm)	Suitable for sampling
GW01-S	**Quaternary alluvium and lacustrine deposits**	**(Tertiary) Extremely weathered sand and highly weathered clay**	**28/02/2017**	**50**	**20.65**	**11.92**	**13-19**	**6.42**	**385**	**Yes - pH only slightly lower than ideal range**
GW02-S	Quaternary alluvium and lacustrine deposits	(Tertiary) Highly weathered sandstone and gravel	21/02/2017	50	19.32	15.37	7-19	6.89	26800	No - too saline
GW04	Quaternary alluvium and lacustrine deposits	(Tertiary) Extremely weathered loose sand	1/03/2017	50	18 or 41	15.37	6-15	7.49	1350	Dry at the time of the bore census Sep/Oct 2017
GW06-S	Late Tertiary-Quaternary colluvial and residual deposits	(Tertiary) Highly weathered sand and clay	19/02/2017	50	11.01		4-10			Dry at the time of the bore census Sep/Oct 2017
GW08-S	Quaternary alluvium and lacustrine deposits	(Tertiary) Extremely weathered clay, extremely weathered loose sand, and extremely weathered stiff clay	28/02/2017	50	13		6-12			Dry at the time of the bore census Sep/Oct 2017

Bore ID	Stratigraphy and surficial geology	Lithology (at screen)	Bore completion date	Casing diameter (mm)	Bore depth (mBGL)^	SWL (mBGL)	Screen interval (mBGL)	pH*	EC* (µS/cm)	Suitable for sampling
GW12-S	Late Tertiary-Quaternary colluvial and residual deposits	Highly weathered clay and highly weathered sandstone	-	50	42.5	18.19	30-42	6.79	24800	No - too saline
GW16-S	Late Tertiary-Quaternary colluvial and residual deposits	-	-	50	27.73	-	-	-	-	Dry at the time of the bore census Sep/Oct 2017
GW18-S	**Quaternary alluvium and lacustrine deposits**	**fine grained sand and weathered clay**	**21/11/2016**	**50**	**15**	**12.79**	**9-15**	**6.84**	**2934**	**Yes - EC only slightly higher than ideal range**
GW21-S	Paleocene-Oligocene sedimentary rock	-	3/11/2016	150	9	-	-	-	-	No - no water intercepted during construction

4.6.2 Field sampling

The equipment used to sample stygofauna conforms with the DSITIA (2014) guidelines. Three sizes of phreatobiological nets were carried in the field for stygofauna sampling, with diameters of 40 mm, 90 mm and 130 mm. Nets are constructed of 50 µm monomesh and are weighted at the bottom. The net tapers to a removable collection chamber at the base, allowing ease of collection for replicate samples following each haul. Nets were lowered to the bottom of the bore, bounced five to ten times to dislodge resting animals, then retrieved. The collection chamber was rinsed into a 50 µm mesh sieve at the top of each haul. Once five hauls were completed, the entire sieve contents were transferred to a labelled sample jar and preserved in 100% analytical reagent (AR) grade ethanol (to allow for future DNA analysis if required).

Nets were washed thoroughly three times in deionised water between sampling locations.

4.6.3 Sample processing

Field samples were sorted in the laboratory under stereomicroscope. Each sample container was drained of ethanol and washed into a channelled counting tray to create a thin layer of sediment spread across the bottom of the tray. Any aquatic animals were to be picked under stereomicroscope. Samples yielding aquatic animals would then be in labelled, polyethylene containers filled with 100% AR grade ethanol and sent to a specialist to undertake identifications to genus / morphospecies taxonomic level. As no stygofauna were detected during the processing stage, no taxonomic identifications were required.

4.6.4 Personnel

Field sampling was conducted by David Moore (BAS Eco & Env Sci), an Aquatic Ecologist with 14 years of experience on both surface water and groundwater projects across Australia, including stygofauna sampling. Laboratory processing was undertaken by Chris Pietsch, an Aquatic Ecologist with 12 years of experience with aquatic assessments across Australia, including processing of aquatic invertebrate samples. As no stygofauna were detected during the processing stage, no taxonomic identifications were required.

5 AQUATIC ECOLOGY CHARACTERISTICS OF THE STUDY AREA

5.1 Waterways

The Queensland Wetlands Map 2015 (DES 2018a) identifies riverine systems, watercourses, waterways or drainage lines (here referred to collectively as waterways) for the Study area. There are 37 waterways mapped for the Study area, including:

- 23 waterways of (Strahler) stream order 1;
- eight waterways of stream order 2;
- three waterways of stream order 3 (including Ripstone Creek);
- one waterway of stream order 4 (North Creek);
- one waterways of stream order 5 (Cherwell Creek); and
- one waterway of stream order 6 (the Isaac River).

The aquatic survey assessed a diversity of waterways, each with varying flow permanence (duration that flow exists in the channel) and predictability (reliability of flow) deduced by field observations. The majority of waterways are expected to be ephemeral, only flowing after largely unpredictable rainfall and runoff, ceasing to flow within days, supporting aquatic life whose life cycles are adapted to these conditions.

Surface flow within Ripstone Creek is likely to be largely ephemeral, especially where sand is the dominant substrate (such as site R5 – Appendix B). However, intermittent pools are expected to persist on Ripstone Creek and its tributaries at locations with less permeable clay substrates, such as site R3, where the composition of aquatic macrophytes suggested that standing water may persist for months, sufficient for some macroscopic plants and animals to complete the aquatic stages of their life cycles.

The Isaac River is a seasonal waterway, alternatively wet and dry most years according to season. Surface flows in the Isaac River typically persist for about half of the year, enough for some macroscopic plants and animals to complete the aquatic stages of their life cycles, as well as allowing for the passage of aquatic fauna upstream and downstream of the Study area.

The DNRM (2017b) Watercourse Identification Map (Figure 10) identifies the Isaac River and Ripstone Creek as waterways that exhibit the characteristics of a watercourse as defined by the *Water Act 2000*, as well as a number of smaller waterways corresponding with the Queensland Wetland Map 2015 (DSITI 2017) (Figure 10). These smaller waterways are drainage features that facilitate overland flow. The DNRM (2017b) Watercourse Identification Map is generally consistent with observations made by DPM Enviros ciences across the Study area in December 2016 and June / July 2017. Exceptions to this include the paleochannel lake on Vermont Park, (site P2 on Figure 9), which doesn't appears to connect with the Isaac River, except during times of flood.

The Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM) (Clayton et al. 2006), was developed to assess conservation values of wetlands and waterways in Queensland. It is a comprehensive method that uses available data (including data resulting from expert opinion), to identify relative non-social, non-economic conservation / ecological values within a specified Study area. The criteria, in AquaBAMM, are: naturalness (aquatic); naturalness (catchment); diversity and richness; threatened species and ecosystems; priority species and ecosystems; special features; connectivity and representativeness. The Aquatic Conservation Assessment (ACA) for the riverine (v1.1 October 2009) and non-riverine (v1.3 April 2011) wetlands of the Great Barrier Reef catchment (produced by DERM) is a product of applying this method. The ACA data for the Study area identifies most of the waterways and wetlands in the Study area to be of medium conservation value with a number of wetlands considered to be of high or very high conservation value. This data is shown in Figure 11.

5.1.1 Waterways for fish passage

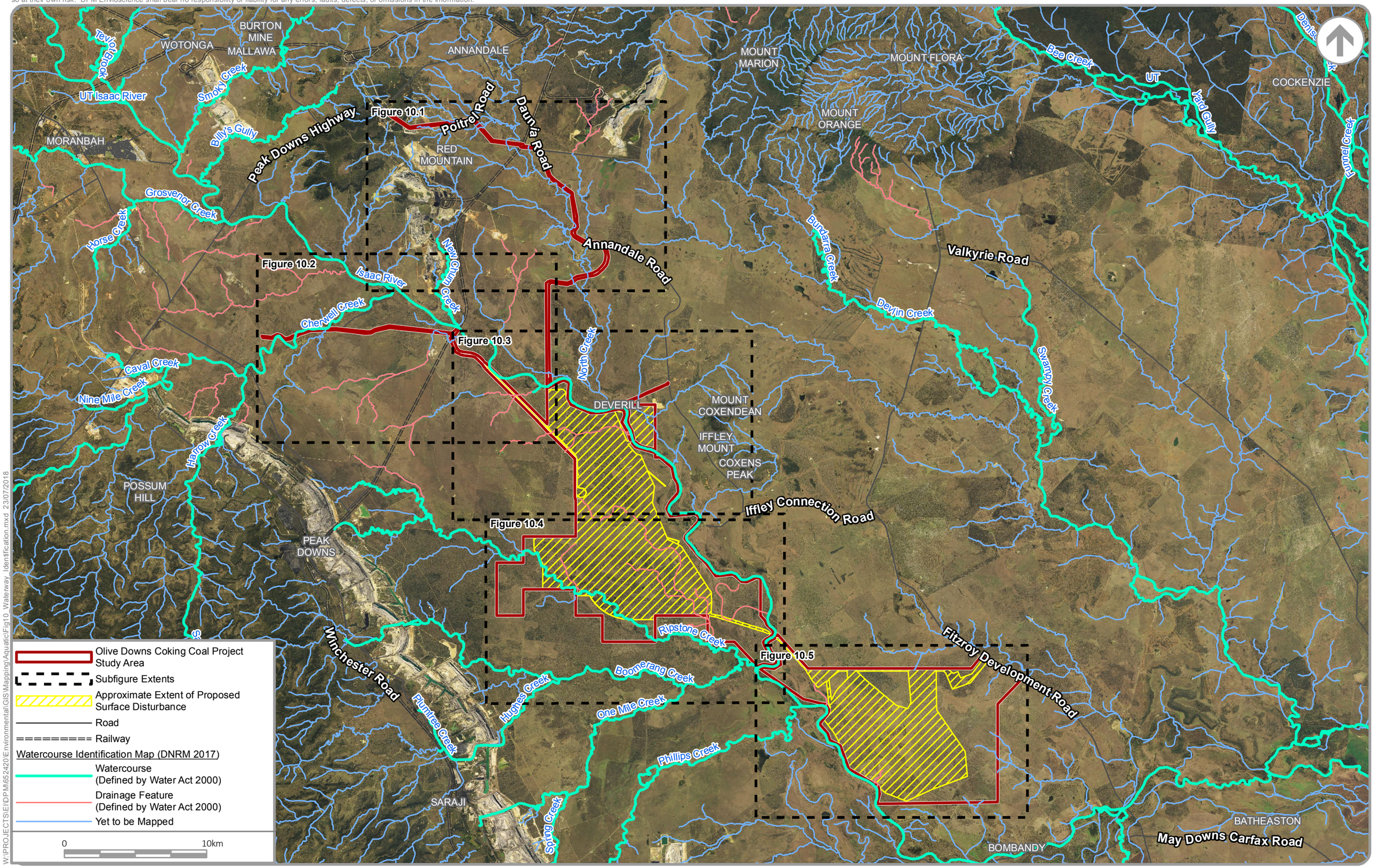
Waterways, as defined by the *Fisheries Act 1994*, include rivers, creeks, streams, watercourses or inlets of the sea. The upstream limits of waterways are identified by Peterken et al. (2009) as including features relevant to fisheries resources, such as the following physical and hydrological attributes:

- defined bed and banks – the bed and banks need to be continuous rather than isolated and broken sections of a depression;
- an extended, if non-permanent, period of flow – flow must continue for a reasonable period after rain ceases and have some reliability commensurate with rainfall; and
- flow adequacy – the flow needs to be sufficient to sustain basic ecological processes and to maintain biodiversity within the feature.

The DAFF (2013) Queensland Waterways for Waterway Barrier Works mapping (Figure 12) indicates the level of 'risk' associated with undertaking waterway barrier works within Qld waterways. Waterways with higher stream orders, steeper slopes, higher flow rates, greater number of fish present and fish with stronger swimming abilities obtain a higher level of risk (DAF 2013).

In consideration of these factors, the Isaac River is mapped as being at major risk of adverse impact from waterway barrier works on fish movement (DAF 2013). Ripstone Creek is indicated as being of high risk of adverse impact, and other mapped waterways within the Study area are indicated as being of low to moderate risk of adverse impact from waterway barrier works on fish movement (DAF 2013) (Figure 12).

The type of waterway barrier being proposed (e.g. culverts, bed-level crossings) within these waterways determines the assessment requirements for the development. The potential impacts on fish passage are discussed in Section 6.3.1, along with mitigation measures considered sufficient to avoid significant impacts on MSES.



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DPM ENVIROSCIENCES

WATERCOURSE IDENTIFICATION MAP

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 10

DPM Enviroscience does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. DPM Envioscience shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

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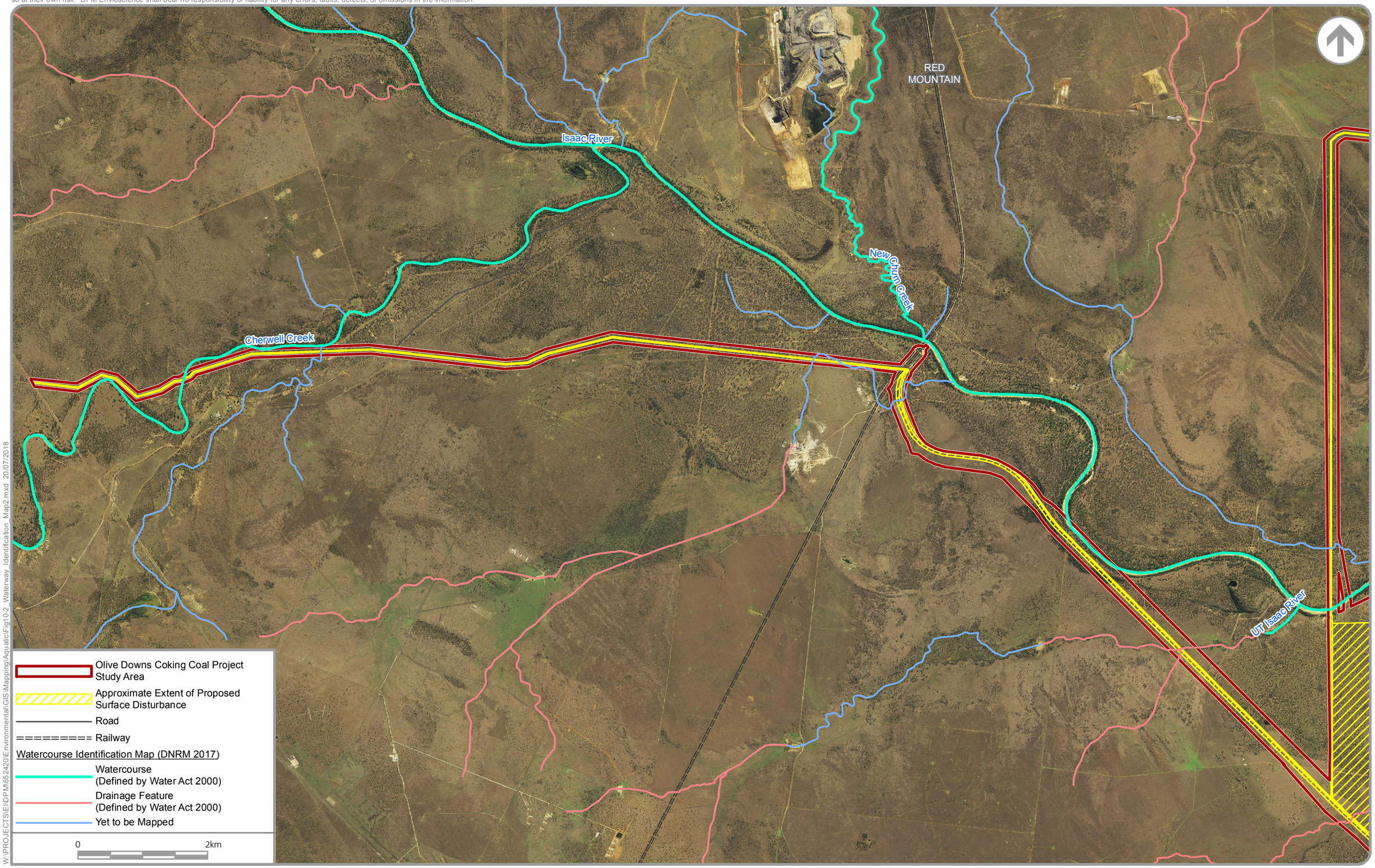
DPM ENVIROSCIENCES

WATERCOURSE IDENTIFICATION – MAP 1

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 10.1



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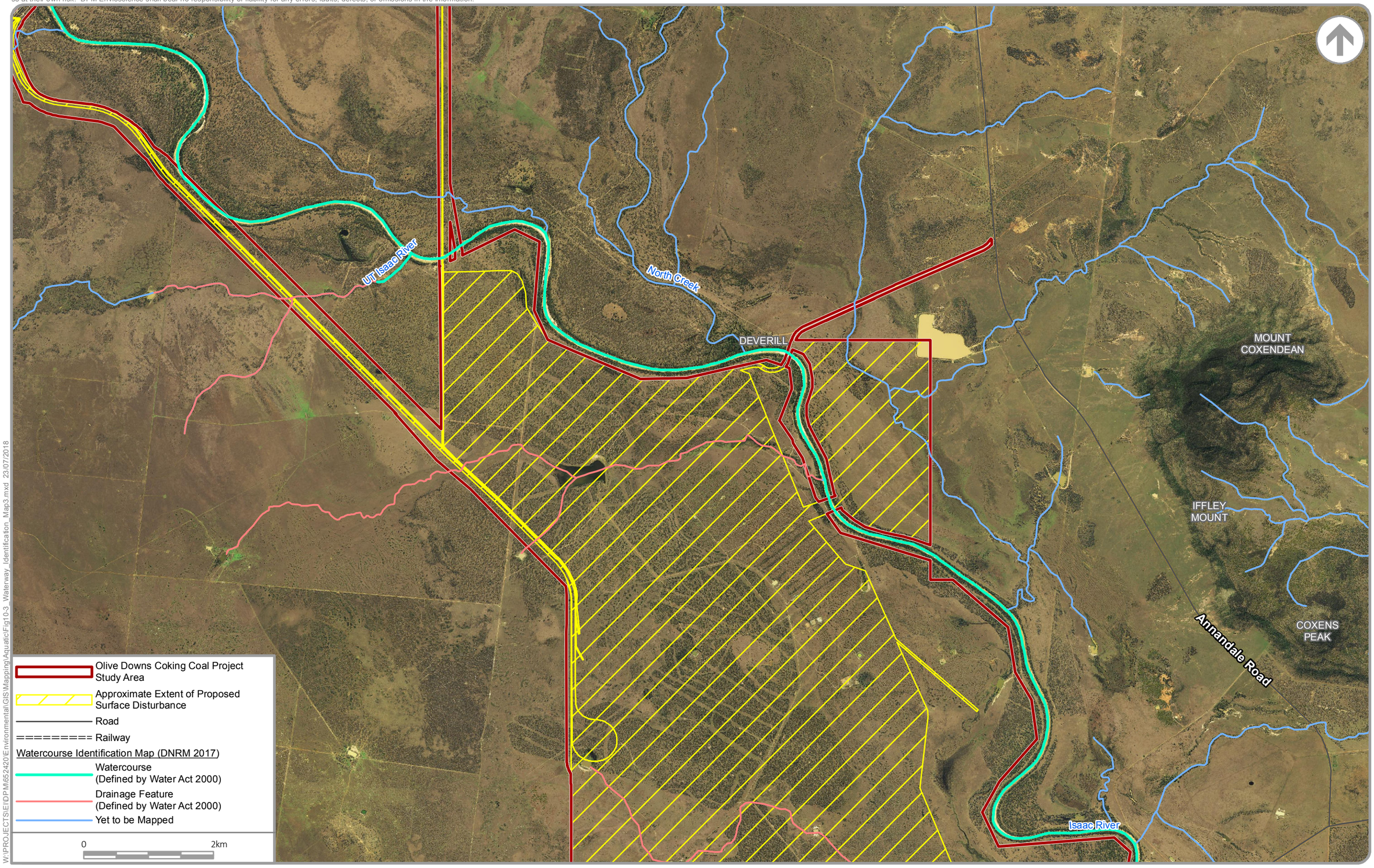
DPM ENVIROSCIENCES

WATERCOURSE IDENTIFICATION – MAP 2

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 10.2



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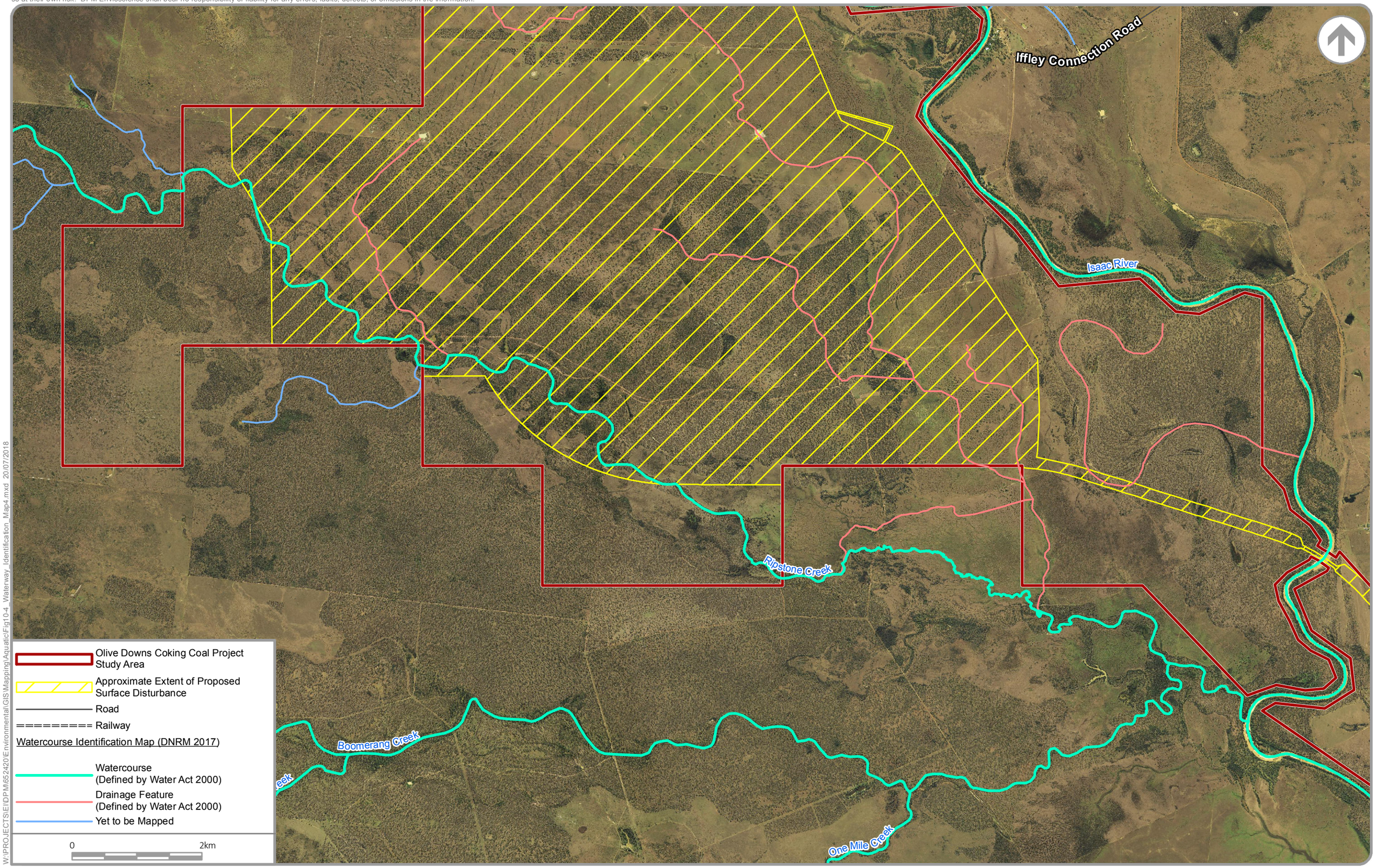
DPM ENVIROSCIENCES

WATERCOURSE IDENTIFICATION – MAP 3

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 10.3



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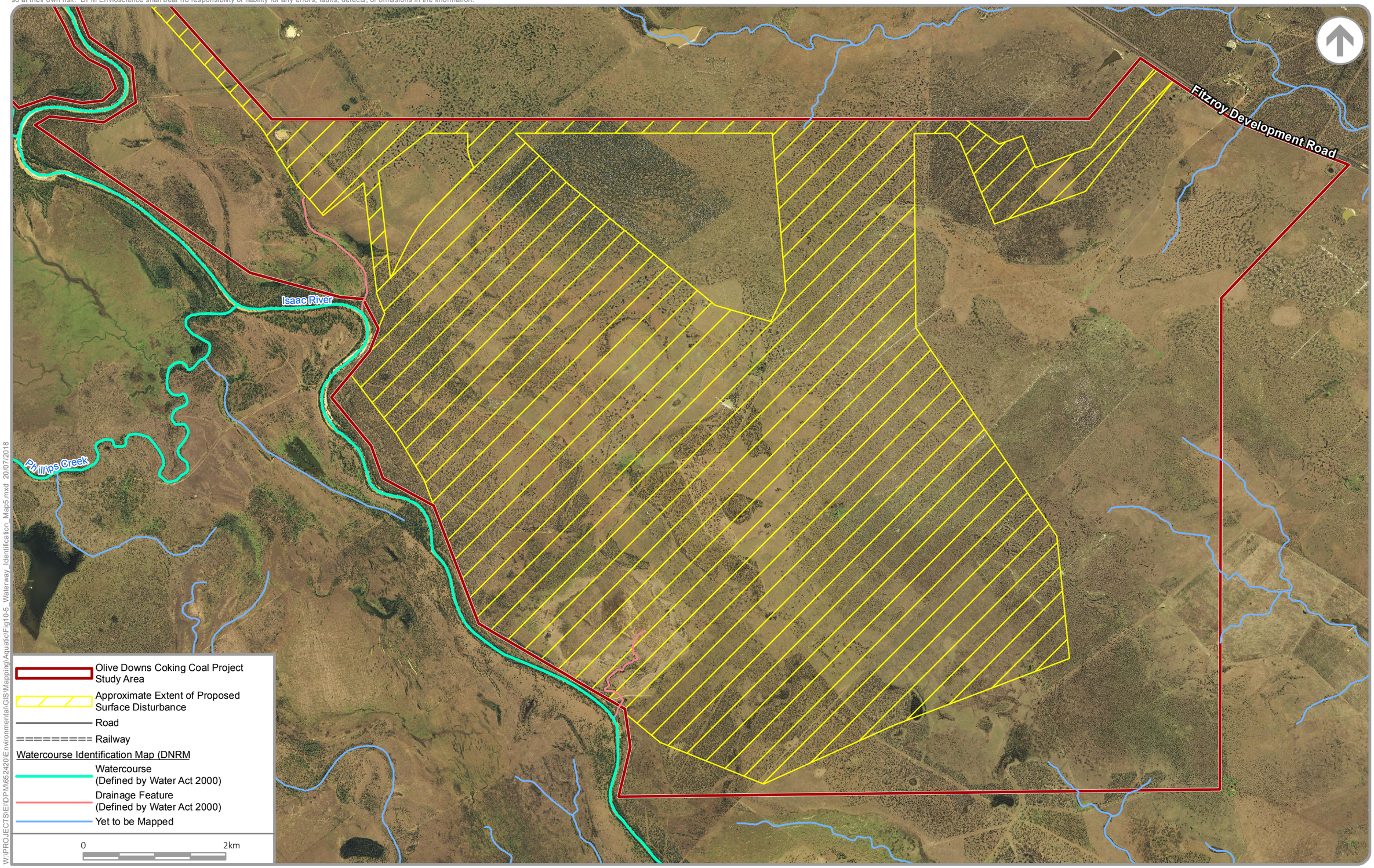
DPM ENVIROSCIENCES

WATERCOURSE IDENTIFICATION – MAP 4

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 10.4



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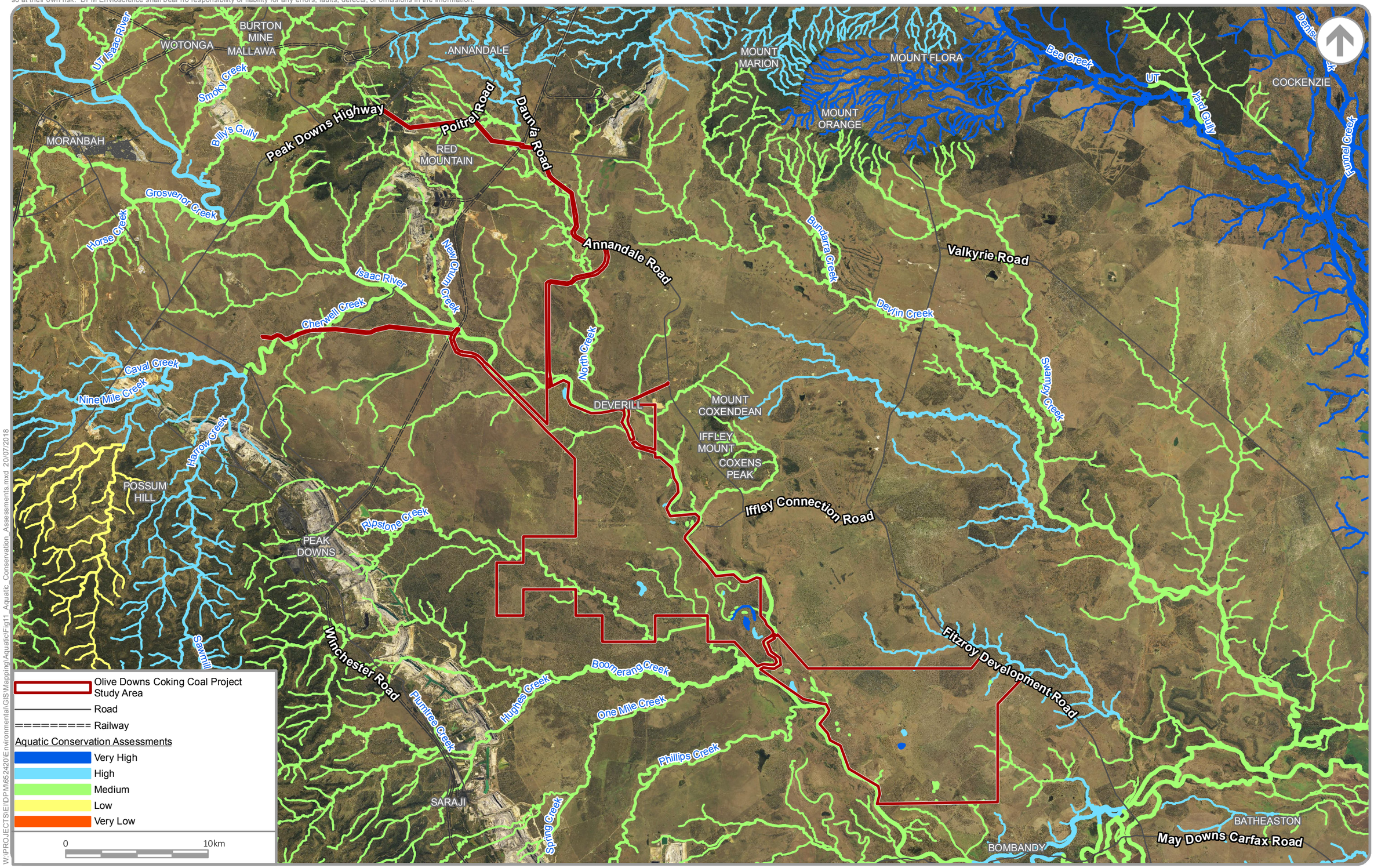
DPM ENVIROSCIENCES

WATERCOURSE IDENTIFICATION – MAP 5

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 10.5



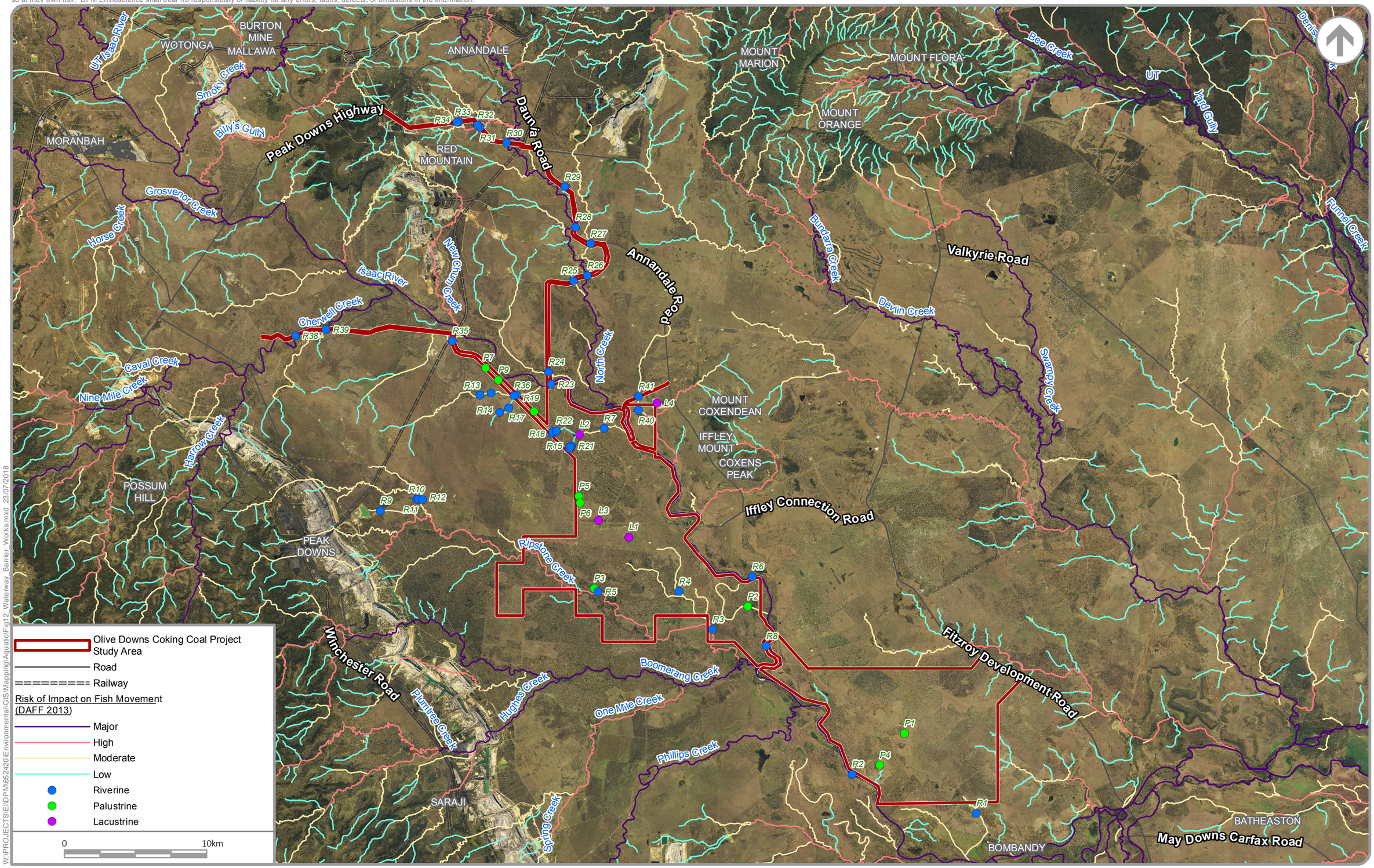
W:\PROJECTS\IE\DPM\652420\Environmental\GIS\Mapping\AquaticFig11 Aquatic Conservation Assessments.mxd 20/07/2018

DPM ENVIROSCIENCES

AQUATIC CONSERVATION ASSESSMENT

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 11



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DPM ENVIROSCIENCES

WATERWAYS FOR WATERWAY BARRIER WORKS

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 12

5.2 Aquatic habitat

5.2.1 Waterways

The waterways of the Study area are ephemeral and expected to experience flow only after sustained or intense rainfall and runoff in the catchment. Stream flows are expected to be highly variable, with most channels drying during winter to early spring when rainfall and runoff is historically low. During these times, aquatic fauna are likely to concentrate in senescing pools. As a consequence, physical attributes, water quality, and the composition of aquatic flora and fauna communities are expected to be highly variable over time.

5.2.2 Instream habitat

Instream (aquatic) habitat assessment scores ranged from poor to good for the riverine survey sites within the Study area (Table 9), with most sites scoring fair. Bottom substrate / available cover was mostly rated poor at each site, owing to the dominance of fine sediments (silt / clay and sand) and general lack of the larger pebble, cobble and boulder substrates at each site. However, each site exhibited at least some detritus, sticks, branches and logs, providing some instream habitat and refugia for aquatic fauna. Embeddedness rated poor at most sites, as did the velocity / depth category due to lack of flow, and increased to fair at sites on the Isaac River.

5.2.3 Bank stability / erosion

Bank vegetative stability ranged from fair to excellent at each riverine site, indicating that at least 50% of the stream banks were covered by vegetation at the time of assessment. Local catchment erosion (although typically only little) was recorded at most sites, evident from sediment deposits and bare ground within the riparian zone. Banks were moderately stable at each site, with only small, infrequent areas of erosion mostly healed over at each site. There remains some potential for erosion in extreme flooding at each site.

5.2.4 Adjacent land use

Land use across the Study area comprises cattle grazing of low to moderate intensity (estimated by grass cover and height). Riparian zone widths ranged from 5 m at site R1 (a second order tributary of the Isaac River) to approximately 50 m (single bank measurements) on the Isaac River itself. Trees commonly encountered in riparian zones across the Study area included forest red gum (*Eucalyptus tereticornis*), river red gum (*E. camaldulensis*), coolabah (*E. coolabah*), brush box (*Lophostemon confertus*), poplar box (*E. populnea*), carbeen (*Corymbia tessellaris*), weeping tea-tree (*Melaleuca fluviatilis*), river she-oak (*Casuarina cunninghammiana*), belah (*C. cristata*), sally wattle (*Acacia salicina*) and white bauhinia (*Lysiphyllum hookeri*). The shrub layer and groundcover was variable across the site (Appendix B).

Table 9 Aquatic habitat assessment scores for riverine survey sites across the Study area

Habitat variable	R1	R2	R3	R3	R4	R5	R5	R6	R6	R7	R8	R8	R9	R9	R10	R10
	Early	Early	Early	Late	Late	Early	Late	Early	Late	Late	Early	Late	Early	Late	Early	Late
Bottom substrate / available cover	P (4)	F (8)	F (6)	F (6)	G (15)	P (4)	F (10)	F (8)	F (8)	P (0)	F (8)	F (8)	P (3)	P (3)	P (1)	P (1)
Embeddedness	P (5)	P (5)	P (5)	P (5)	P (2)	P (5)	P (5)	P (5)	P (3)	P (0)	P (3)	P (2)	P (1)	P (1)	P (3)	P (3)
Velocity / depth category	P (0)	F (6)	P (3)	P (3)	F (8)	P (0)	F (8)	F (8)	F (8)	P (0)	F (6)	F (8)	P (0)	P (2)	P (0)	P (0)
Channel alteration	G (8)	P (3)	G (11)	G (11)	G (14)	F (4)	F (6)	P (3)	P (3)	G (8)	P (3)	P (0)	F (5)	F (5)	F (4)	F (4)
Bottom scouring and deposition	F (7)	P (1)	G (11)	G (11)	G (12)	P (1)	F (7)	P (1)	P (1)	F (6)	P (1)	P (0)	F (5)	F (5)	P (2)	P (2)
Pool / riffle, run / bend ratio	P (3)	F (6)	F (4)	F (4)	F (4)	F (5)	F (5)	F (6)	F (6)	P (0)	F (6)	F (6)	P (1)	P (1)	P (1)	P (1)
Bank stability	G (7)	G (7)	G (8)	G (8)	E (9)	G (8)	F (5)	G (7)	G (7)	G (6)	G (7)	G (7)	G (6)	G (6)	G (7)	G (7)
Bank vegetative stability	G (8)	E (9)	E (9)	E (9)	E (9)	E (9)	E (9)	E (9)	E (10)	E (9)	E (9)	E (10)	G (6)	G (6)	E (10)	E (10)
Streamside cover	E (9)	E (10)	F (4)	F (4)	E (10)	E (10)	E (1)0	E (10)	E (10)	E (9)	E (10)	E (10)	F (4)	F (4)	F (4)	F (4)
Total (out of 135)	**51**	**55**	**61**	**61**	**83**	**46**	**65**	**57**	**56**	**38**	**53**	**51**	31	**33**	32	**32**
Rating	**Fair**	**Fair**	**Fair**	**Fair**	**Good**	**Fair**	**Fair**	**Fair**	**Fair**	**Poor**	**Fair**	**Fair**	Poor	**Poor**	Poor	**Poor**

Habitat variable	R11	R11	R12	R12	R13	R13	R14	R14	R15	R15	R16	R16	R17	R17	R18	R18
	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late
Bottom substrate / available cover	P (1)	P (1)	G (11)	G (11)	P (1)	P (5)	P (1)	P (1)	P (3)	P (3)	P (5)	P (5)	P (2)	P (2)	P (0)	P (0)
Embeddedness	P (3)	P (3)	F (8)	F (8)	F (10)	F (10)	P (1)	P (1)	P (2)	P (2)	P (5)	P (5)	P (2)	P (2)	P (0)	P (0)
Velocity / depth category	P (0)	P (0)	P (0)	P (0)	P (1)	F (6)	P (0)	P (0)	P (0)	P (3)	P (0)	P (0)	P (0)	P (0)	P (0)	P (0)
Channel alteration	F (4)	F (4)	F (7)	F (7)	G (12)	E (12)	G (10)	G (10)	P (0)	P (0)	G (10)	G (10)	G (10)	G (10)	P (1)	P (1)
Bottom scouring and deposition	P (2)	P (2)	F (7)	F (7)	G (12)	E (12)	G (10)	G (10)	G (10)	G (10)	G (10)	G (10)	G (10)	G (10)	G (10)	G (10)
Pool / riffle, run / bend ratio	P (2)	P (2)	P (3)	P (3)	F (5)	F (5)	P (1)	P (1)	P (1)	P (1)	P (2)	P (2)	P (2)	P (2)	P (0)	P (0)
Bank stability	G (7)	G (7)	F (4)	F (4)	F (7)	G (7)	P (1)	P (1)	E (10)	E (10)	G (7)	G (7)	G (8)	G (8)	E (10)	E (10)
Bank vegetative stability	E (10)	E (10)	E (10)	E (10)	F (7)	G (7)	E (9)	E (9)	E (9)	E (9)	E (10)	E (10)	E (10)	E (10)	E (10)	E (10)
Streamside cover	F (4)	F (4)	F (4)	F (4)	E (9)	E (9)	F (4)	F (4)	E (10)	E (10)	F (4)	F (4)	F (4)	F (4)	F (4)	F (4)
Total (out of 135)	33	**33**	54	**54**	64	**73**	**37**	**37**	**45**	**48**	**53**	**53**	**48**	**48**	**35**	**35**
Rating	Poor	**Poor**	Fair	**Fair**	Fair	**Fair**	**Poor**	**Poor**	**Fair**	**Fair**	**Fair**	**Fair**	**Fair**	**Fair**	**Poor**	**Poor**

Table 9 (Continued) Aquatic habitat assessment scores for riverine survey sites across the Study area

Habitat variable	R19	R19	R20	R20	R21	R21	R22	R22	R23	R23	R24	R24	R25	R25	R26	R26
	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late
Bottom substrate / available cover	P (4)	P (4)	P (0)	P (0)	P (0)	P (0)	P (0)	P (0)	P (1)	P (1)	F (6)	F (6)	P (0)	P (0)	P (0)	P (0)
Embeddedness	P (2)	P (2)	P (0)	P (0)	P (0)	P (0)	P (0)	P (0)	P (1)	P (1)	P (2)	P (2)	P (0)	P (0)	P (0)	P (0)
Velocity / depth category	P (0)	P (1)	P (0)	P (0)	P (0)	P (0)	P (0)	P (0)	P (4)	P (4)	P (1)	P (2)	P (0)	P (0)	P (0)	P (0)
Channel alteration	G (8)	G (8)	P (1)	P (1)	P (0)	P (0)	G (10)	G (10)	P (1)	P (1)	F (4)	F (4)	P (0)	P (0)	P (0)	P (0)
Bottom scouring and deposition	G (8)	G (8)	G (10)	G (10)	E (12)	E (12)	G (10)	G (10)	P (1)	P (1)	F (4)	F (4)	P (0)	P (0)	P (0)	P (0)
Pool / riffle, run / bend ratio	P (2)	P (2)	P (0)	P (0)	P (0)	P (0)	P (0)	P (0)	P (2)	P (2)	F (4)	F (4)	P (1)	P (1)	P (0)	P (0)
Bank stability	G (7)	G (7)	E (10)	E (10)	E (10)	E (10)	E (10)	E (10)	G (8)	G (8)	F (3)	F (3)	G (6)	G (6)	G (6)	G (6)
Bank vegetative stability	G (8)	G (8)	E (10)	E (10)	E (10)	E (10)	E (10)	E (10)	E (10)	E (10)	E (9)	E (9)	E (9)	E (9)	E (10)	E (10)
Streamside cover	F (4)	F (4)	F (4)	F (4)	E (10)	E (10)	F (4)	F (4)	E (10)	E (10)	E (9)	E (9)	E (9)	E (9)	E (10)	E (10)
Total (out of 135)	**44**	**44**	**35**	**35**	**42**	**42**	**44**	**44**	**38**	**38**	**43**	**43**	**25**	**25**	**26**	**26**
Rating	**Fair**	**Fair**	**Poor**	**Poor**	**Fair**	**Fair**	**Fair**	**Fair**	**Poor**	**Poor**	**Fair**	**Fair**	**Poor**	**Poor**	**Poor**	**Poor**

Habitat variable	R27	R27	R28	R28	R29	R29	R30	R30	R31	R31	R32	R32	R33	R33	R34	R34
	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late
Bottom substrate / available cover	F (6)	F (6)	G (15)	G (15)	P (1)	P (2)	F (8)	F (8)	F (6)	F (6)	P (1)	P (1)	P (3)	P (3)	P (3)	P (3)
Embeddedness	P (1)	P (1)	P (2)	P (2)	F (10)	F (10)	P (0)	P (0)	P (2)	P (2)	P (1)	P (1)	F (7)	F (7)	F (6)	F (6)
Velocity / depth category	F (6)	F (6)	F (10)	F (10)	P (1)	P (0)	F (6)	F (6)	P (0)	P (0)	P (0)	P (0)	P (0)	P (0)	P (0)	P (0)
Channel alteration	P (2)	P (2)	F (4)	F (6)	G (8)	G (8)	P (0)	P (0)	F (4)	F (4)	P (1)	P (1)	P (1)	P (1)	P (2)	P (2)
Bottom scouring and deposition	P (2)	P (2)	F (6)	F (6)	E (12)	E (12)	P (0)	P (0)	F (4)	F (4)	P (0)	P (0)	P (1)	P (1)	P (1)	P (1)
Pool / riffle, run / bend ratio	F (4)	F (4)	G (8)	G (8)	P (0)	P (0)	P (3)	P (3)	F (4)	F (4)	P (2)	P (2)	P (1)	P (1)	P (1)	P (1)
Bank stability	P (2)	F (4)	G (8)	G (8)	G (8)	G (8)	F (4)	F (4)	P (2)	P (2)	G (8)	G (8)	G (8)	G (8)	G (7)	G (7)
Bank vegetative stability	E (10)	E (10)	E (10)	E (10)	G (8)	G (8)	E (9)	E (9)	E (10)	E (10)	E (10)	E (10)	E (10)	E (10)	E (10)	E (10)
Streamside cover	E (10)	E (10)	E (10)	E (10)	F (3)	F (3)	E (10)	E (10)	F (4)	F (4)	E (10)	E (10)	F (4)	F (4)	F (4)	F (4)
Total (out of 135)	**43**	**45**	**73**	**75**	**51**	**51**	**40**	**40**	**36**	**36**	**33**	**33**	**35**	**35**	**34**	**34**
Rating	**Fair**	**Fair**	**Good**	**Good**	**Fair**	**Fair**	**Fair**	**Fair**	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**

Table 9 (Continued) Aquatic habitat assessment scores for riverine survey sites across the Study area

Habitat variable	R35	R36	R38	R39	R40	R41
	Early	Early	Early	Early	Early	Early
Bottom substrate / available cover	F (7)	P (4)	P (3)	F (6)	P (2)	P (1)
Embeddedness	F (7)	P (2)	P (3)	P (5)	P (3)	F (8)
Velocity / depth category	P (1)	P (0)	P (0)	P (0)	P (1)	P (0)
Channel alteration	F (5)	F (7)	P (2)	F (5)	G (10)	G (12)
Bottom scouring and deposition	F (5)	F (7)	P (2)	F (5)	F (6)	E (12)
Pool / riffle, run / bend ratio	F (5)	F (4)	F (4)	F (4)	F (5)	F (5)
Bank stability	G (6)	G (7)	G (7)	G (6)	G (7)	G (9)
Bank vegetative stability	E (10)	G (8)	G (8)	E (9)	F (4)	E (9)
Streamside cover	E (9)	E (9)	E (9)	E (9)	E (9)	F (4)
Total (out of 135)	55	48	38	49	47	60
Rating	Fair	Fair	Poor	Fair	Fair	Fair

5.2.5 Aquatic values

Aquatic values for each site are presented in the site profiles in Appendix B. Ratings for aquatic values were determined for each site based on the criteria in Section 4.5.9 and are presented in Table 10. Four palustrine wetland sites and three lacustrine wetland sites were rated as having high aquatic values, owing to their HES wetland status. All other palustrine wetland sites were noted to have moderate values. The four sites on the Isaac River were rated as having moderate aquatic values, due to seasonal flows, the presence of Priority aquatic flora, and the importance of the Isaac River as a regional conduit for fish passage. The sites on North Creek, a fourth order waterway, were also noted as having moderate values for the same reasons. Sites R3, R4, R13 and R29 was also rated as having moderate aquatic values, due to semi-permanence of wetted habitat and the presence of Priority flora species. Most ephemeral riverine sites with a stream order 1-2 were rated as having low aquatic values.

Table 10 Aquatic values ratings for the Study area

Site	Waterway	Stream order	Key aquatic values / criteria	Aquatic values rating
R1	Unnamed tributary of the Isaac River	2	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ No priority flora species detected	Low
R2	Isaac River	6	▪ Seasonal waterway ▪ Poor quality instream habitat ▪ No EVNT species or platypus habitat detected ▪ Priority flora species detected ▪ Regional conduit for fish passage	Moderate
R3	Unnamed tributary of Ripstone Creek	3	▪ Ephemeral stream with semi-permanent pools ▪ Poor quality instream habitat ▪ No EVNT species or platypus habitat detected ▪ Extensive stands of Priority flora species detected	Moderate
R4	Unmapped riverine wetland	1	▪ Ephemeral stream with semi-permanent pools ▪ Moderate quality instream habitat ▪ No EVNT species ▪ Potential platypus habitat detected ▪ Priority flora species detected	Moderate
R5	Ripstone Creek	3	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT, platypus or Priority species habitat detected ▪ Local conduit for fish passage	Low-Moderate
R6	Isaac River	6	▪ Seasonal waterway ▪ Poor quality instream habitat ▪ No EVNT species or platypus habitat detected ▪ Priority flora species detected ▪ Regional conduit for fish passage	Moderate
R7	Unnamed tributary of the Isaac River	2	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT, platypus or Priority species habitat detected	Low

Site	Waterway	Stream order	Key aquatic values / criteria	Aquatic values rating
R8	Isaac River	6	▪ Seasonal waterway ▪ Poor quality instream habitat ▪ No EVNT species or platypus habitat detected ▪ Priority flora species detected ▪ Regional conduit for fish passage	Moderate
R9	Unnamed tributary of Ripstone Creek	1	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ No Priority species detected	Low
R10	Unnamed tributary of Ripstone Creek	2	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ No Priority species detected	Low
R11	Unnamed tributary of Ripstone Creek	2	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ No Priority species detected	Low
R12	Unnamed tributary of Ripstone Creek	2	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ No Priority species detected	Low
R13	Unnamed tributary at Winchester Downs	2	▪ Ephemeral stream with semi-permanent pools ▪ Modified stream (dammed) ▪ Moderate quality instream habitat ▪ No EVNT or SLC species ▪ A number of Priority flora species detected	Moderate
R14	Unnamed tributary of Isaac River	1	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ No Priority species detected	Low
R15	Unnamed tributary of Isaac River	1	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ No Priority species detected	Low
R16	Unnamed tributary of Isaac River	2	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ No Priority species detected	Low
R17	Unnamed tributary of Isaac River	1	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ No Priority species detected	Low
R18	Unnamed tributary of Isaac River	1	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ No Priority species detected	Low
R19	Unnamed tributary of Isaac River	2	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ No Priority species detected	Low

Site	Waterway	Stream order	Key aquatic values / criteria	Aquatic values rating
R20	Unnamed tributary of Isaac River	1	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ No Priority species detected	Low
R21	Unnamed tributary of Isaac River	1	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ No Priority species detected	Low
R22	Unnamed tributary of Isaac River	1	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ No Priority species detected	Low
R23	Isaac River	6	▪ Seasonal waterway ▪ Poor quality instream habitat ▪ No EVNT species or platypus habitat detected ▪ Priority flora species detected ▪ Regional conduit for fish passage	Moderate
R24	Unnamed tributary of Isaac River	2	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ No Priority species detected	Low
R25	Unnamed tributary of North Creek	1	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ No Priority species detected	Low
R26	North Creek	4	▪ Ephemeral waterway ▪ Poor quality instream habitat ▪ No EVNT species or platypus habitat detected ▪ Priority flora species detected ▪ Local Conduit for fish passage	Moderate
R27	Unnamed tributary of North Creek	2	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ Only common Priority flora species detected	Low
R28	North Creek	4	▪ Ephemeral stream with semi-permanent pools ▪ Moderate quality instream habitat ▪ No EVNT or SLC species ▪ Priority flora species detected ▪ Local Conduit for fish passage	Moderate
R29	Unnamed tributary of North Creek	1	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ Only common Priority species detected	Low
R30	North Creek	4	▪ Ephemeral stream with semi-permanent pools ▪ Moderate quality instream habitat ▪ No EVNT or SLC species ▪ Priority flora species detected ▪ Local Conduit for fish passage	Moderate

Site	Waterway	Stream order	Key aquatic values / criteria	Aquatic values rating
R31	Unnamed tributary of North Creek	1	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ No priority species detected	Low
R32	Unnamed tributary of North Creek	3	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ Only common Priority flora species detected	Low
R33	Unnamed tributary of North Creek	2	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ No Priority flora species detected	Low
R34	Unnamed tributary of North Creek	1	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ Only common Priority flora species detected	Low
R35	Unnamed tributary of North Creek	2	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ Only common Priority flora species detected	Low
R36	Unnamed tributary of the Isaac River	2	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ No Priority flora species detected	Low
R37	Unnamed tributary of the Isaac River	1	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ Only common Priority flora species detected	Low
R38	Cherwell Creek	5	▪ Ephemeral stream with semi-permanent pools ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ Priority flora species detected ▪ Local conduit for fish passage	Moderate
R39	Unnamed tributary of Cherwell Creek	2	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ No Priority flora species detected	Low
R40	Unnamed tributary of the Isaac River	1	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ Only common Priority flora species detected	Low
R41	Unnamed tributary of the Isaac River	1	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT or SLC species ▪ Only common Priority flora species detected	Low
P1	Palustrine wetland (HES)	-	▪ Ephemeral wetland ▪ No EVNT or SLC species ▪ Priority flora species detected ▪ Moderate habitat value ▪ Mapped as wetland of HES	High

Site	Waterway	Stream order	Key aquatic values / criteria	Aquatic values rating
P2	Palustrine wetland (HES)	-	▪ Ephemeral wetland ▪ No EVNT or SLC species detected ▪ Priority flora species detected ▪ Good quality habitat ▪ Mapped as wetland of HES	High
P3	Palustrine wetland (GES)	-	▪ Modified (dammed) wetland ▪ Semi-permanent ▪ No EVNT or SLC species detected ▪ Priority flora species detected ▪ Good quality habitat ▪ Mapped as wetland of GES	High
P4	Palustrine wetland	-	▪ Ephemeral wetland ▪ No EVNT or SLC species detected ▪ Priority flora species detected ▪ Moderate quality habitat	Moderate
P5	Palustrine wetland (GES)	-	▪ Modified (dammed) wetland ▪ Semi-permanent ▪ No EVNT or SLC species detected ▪ Priority flora species detected ▪ Good quality habitat ▪ Mapped as wetland of GES	High
P6	Palustrine wetland (GES)	-	▪ Ephemeral wetland ▪ No EVNT or SLC species detected ▪ No priority flora detected ▪ Poor quality habitat ▪ Mapped as wetland of GES	Moderate
P7	Palustrine wetland (GES)	-	▪ Ephemeral wetland ▪ No EVNT or SLC species detected ▪ Priority flora detected ▪ Poor quality habitat ▪ Mapped as wetland of GES	Moderate
P8	Palustrine wetland (GES)	-	▪ Ephemeral wetland ▪ No EVNT or SLC species detected ▪ Priority flora species detected ▪ Moderate quality habitat ▪ Mapped as wetland of GES	Moderate
P9	Palustrine wetland (GES)	-	▪ Ephemeral wetland ▪ No EVNT or SLC species detected ▪ Priority flora species detected ▪ Moderate quality habitat ▪ Mapped as wetland of GES	Moderate
L1	Mapped lacustrine wetland, Iffley	-	▪ Palustrine wetland, mapped as lacustrine ▪ Ephemeral wetland ▪ Poor quality habitat ▪ No EVNT or SLC detected ▪ Priority flora species detected	Moderate
L2	Lacustrine wetland, Iffley	-	▪ Modified (dammed) wetland ▪ Semi-permanent ▪ Good quality habitat ▪ No EVNT or SLC species detected ▪ Priority flora species detected	High

Site	Waterway	Stream order	Key aquatic values / criteria	Aquatic values rating
L3	Lacustrine wetland, Iffley	-	▪ Modified (dammed) wetland ▪ Semi-permanent ▪ Good quality habitat ▪ No EVNT or SLC species detected ▪ Priority flora species detected	High
L4	Lacustrine wetland, Deverill	-	▪ Modified (dammed) wetland ▪ Semi-permanent ▪ Good quality habitat ▪ No EVNT or SLC species detected ▪ Priority flora species detected	High

5.3 Wetlands

5.3.1 Wetlands of International Importance

There are no wetlands of International Importance identified within the Study area or broader search area in the EPBC Act Protected Matters Report (DEE 2018a). Wetlands of International Importance nearest to the Study area include those of the Shoalwater and Corio Bays Area, approximately 150 km to the east.

5.3.2 Wetlands of National Importance

One nationally important wetland, Lake Elphinstone, is recorded by Wetland*Info* for the Isaac River sub-basin (DES 2018b). Lake Elphinstone is located approximately 70 km north of the Study area. Although the Study area is hydraulically linked to Lake Elphinstone, the lake is located upstream of the Study area and is unlikely to be of significance to this Project.

5.3.3 Wetlands of High Ecological Significance

DEHP has determined the ecological significance of wetlands within the GBR catchments using their AquaBAMM (Rollason and Howell 2012). The method identifies relative wetland conservation values within a catchment, and includes consideration of environmental values for wetlands in s.81A of the *EP Regulation*, including:

- the health and biodiversity of the wetland's ecosystems;
- the wetland's natural state and biological integrity;
- the presence of distinct or unique features, plants or animals and their habitats, including EVNT and rare wildlife under the NC Act;
- the wetland's natural hydrological cycle; and
- the natural interaction of the wetlands with other ecosystems, including other wetlands.

Referable wetlands are areas shown as wetlands on the Map of Referable Wetlands, a document approved by the Chief Executive of, and published by, DEHP (s.12 EP Regulation). The map of referable wetlands identifies:

- High Ecological Significance (HES) wetlands;
- Wetland Protection Areas (WPAs), comprising HES wetlands and their trigger area buffers; and
- General Ecological Significance (GES) wetlands.

A total of 60 palustrine wetlands have been mapped within the Study area. This includes 11 HES wetlands and their WPA buffers, and 49 GES wetlands (Figure 13). A further 16 previously unmapped GES wetlands have also been identified during the field surveys. The HES wetlands include a paleochannel lake (Plate 1), ox-bow lakes and flood channel wetlands on the Isaac River floodplain, as well as modified vegetated swamps (Plate 2) and largely un-modified vegetated swamps (Plate 3 and Plate 4) in depressions on and beyond the floodplain. The GES wetlands include riverine wetlands of the Isaac River (Plate 5), as well as a number of floodplain and non-floodplain palustrine wetlands (Plate 6).

WPAs, including HES wetlands, are a MSES identified in the *EO Regulation* (Section 5.10). Wetlands of GES are not considered a MSES.

Plate 1 HES wetland on Vermont Park (sampling site P2), being a paleochannel lake, December 2016

Plate 2 GES wetland on Iffley, with vegetated swamp remnants behind a lacustrine waterbody as a result of damming the depression to facilitate direct stock watering, December 2016

Plate 3 HES wetland on Old Bombandy, being a largely unmodified vegetated swamp in a depression beyond the Isaac River floodplain, December 2016

Plate 4 HES wetland central to Vermont Park (terrestrial flora / fauna site Q51), being a largely unmodified vegetated swamp in a depression beyond the Isaac River floodplain, November 2016

Plate 5 GES wetland on Old Bombandy, being the Isaac River main channel and strip of riparian vegetation comprising RE 11.3.25, December 2016

Plate 6 GES palustrine wetland (sampling site P3) on Vermont Park, December 2016

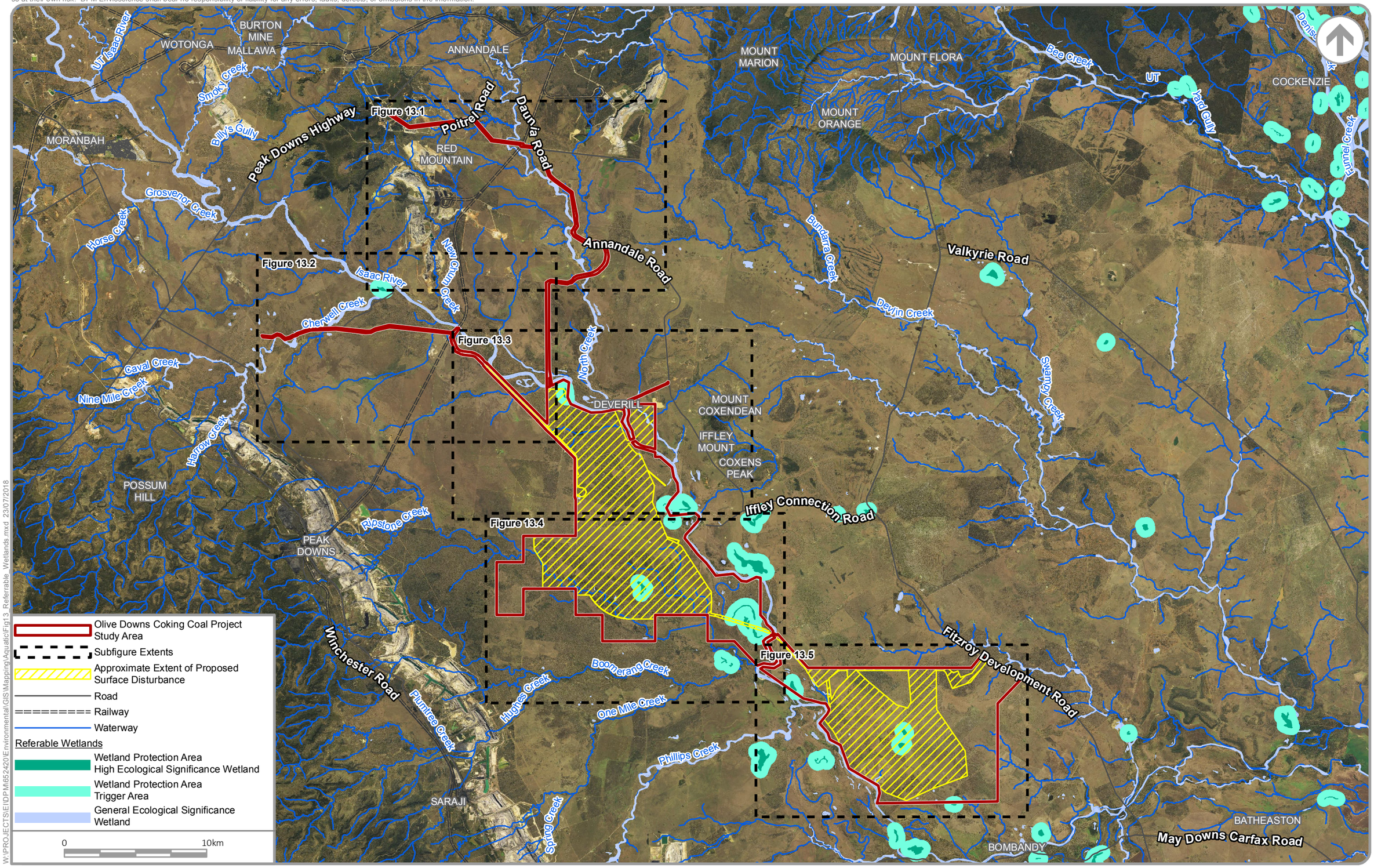
5.3.4 Other mapped wetlands

The Queensland Wetlands Mapping 2015 (DES 2018a) identifies marine, estuarine, riverine, lacustrine and palustrine waterbodies and wetland REs in Queensland. Within the Study area, this mapping includes (Figure 9):

- riverine wetland waterbodies, comprising the Isaac River main channel (Plate 5);
- 60 palustrine wetland waterbodies, including 11 HES and 49 GES wetlands (Section 5.3.3);
- seven mapped lacustrine wetland waterbodies;
- riverine system REs, represented by RE 11.3.25 along the Isaac River riparian corridor and a number of tributaries; and
- 16 remnant RE 1-50% wetland (mosaic units), comprising REs 11.3.27b (4), 11.3.27c (1), 11.3.27i (3), 11.3.27f (6) and 11.5.17 (2) within the Study area (in the MLA).

The lacustrine wetlands of the Study area include dams of approximately 2 ha, 3 ha and 5 ha on Willunga, a 5 ha dam on Vermont Park, 1 ha, 2 ha and 12 ha dams on Iffley, part of a 30 ha dam on Deverill, as well as a number of smaller dams (<1 ha) that are too small to appear in the Queensland Wetlands Mapping (Figure 13). These lacustrine wetlands provide a water source for an array of aquatic and terrestrial fauna, domestic livestock, as well as foraging and breeding habitat for waterbirds, wader birds, frogs, reptiles, water rats and other mammals. Thirty-six species of birds (primarily waterfowl and wader birds) were detected utilising one of the larger dams within the Study area (Plate 7) during the terrestrial fauna surveys in November 2016 (DPM Enviroscences 2018a). Although modified, this lacustrine wetland provides an important ecological role in the landscape, supporting a diversity of flora and fauna, including EVNT and migratory bird species (DPM Enviroscences 2018a and 2018b).

Plate 7 Lacustrine wetland (site L2) on Iffley, December 2016



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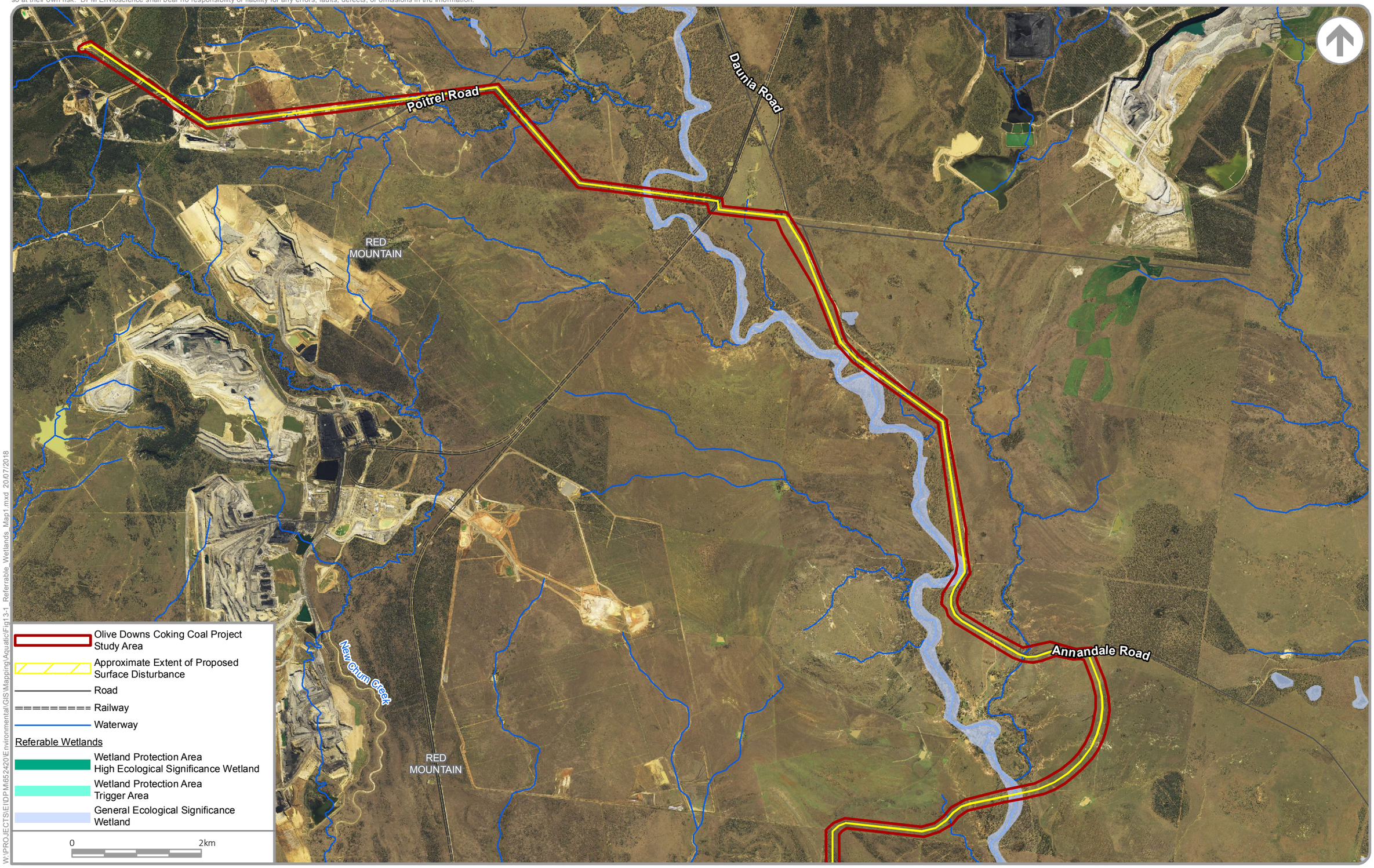
DPM ENVIROSCIENCES

REFERABLE WETLANDS

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 13



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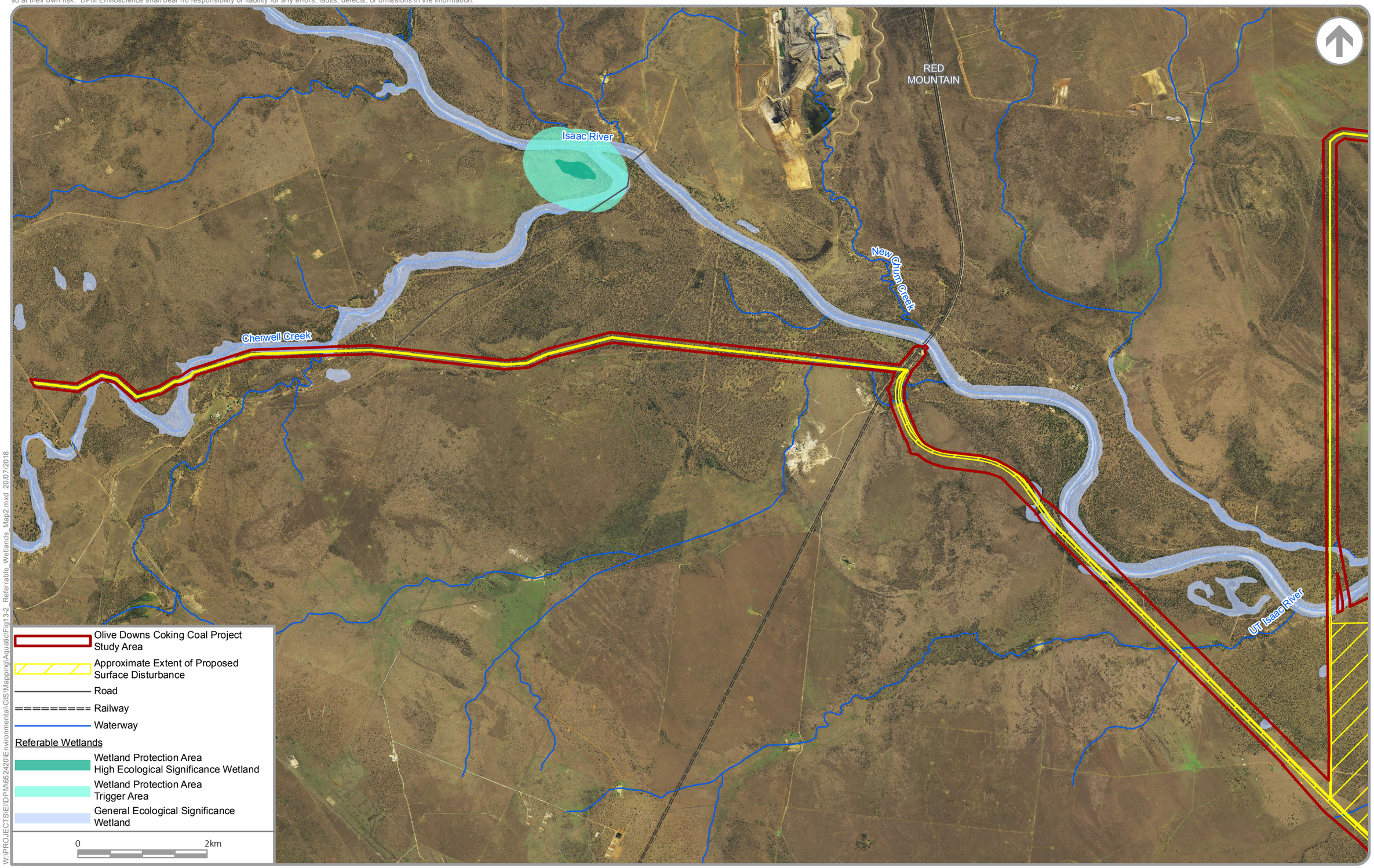
DPM ENVIROSCIENCES

REFERABLE WETLANDS – MAP 1

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 13.1



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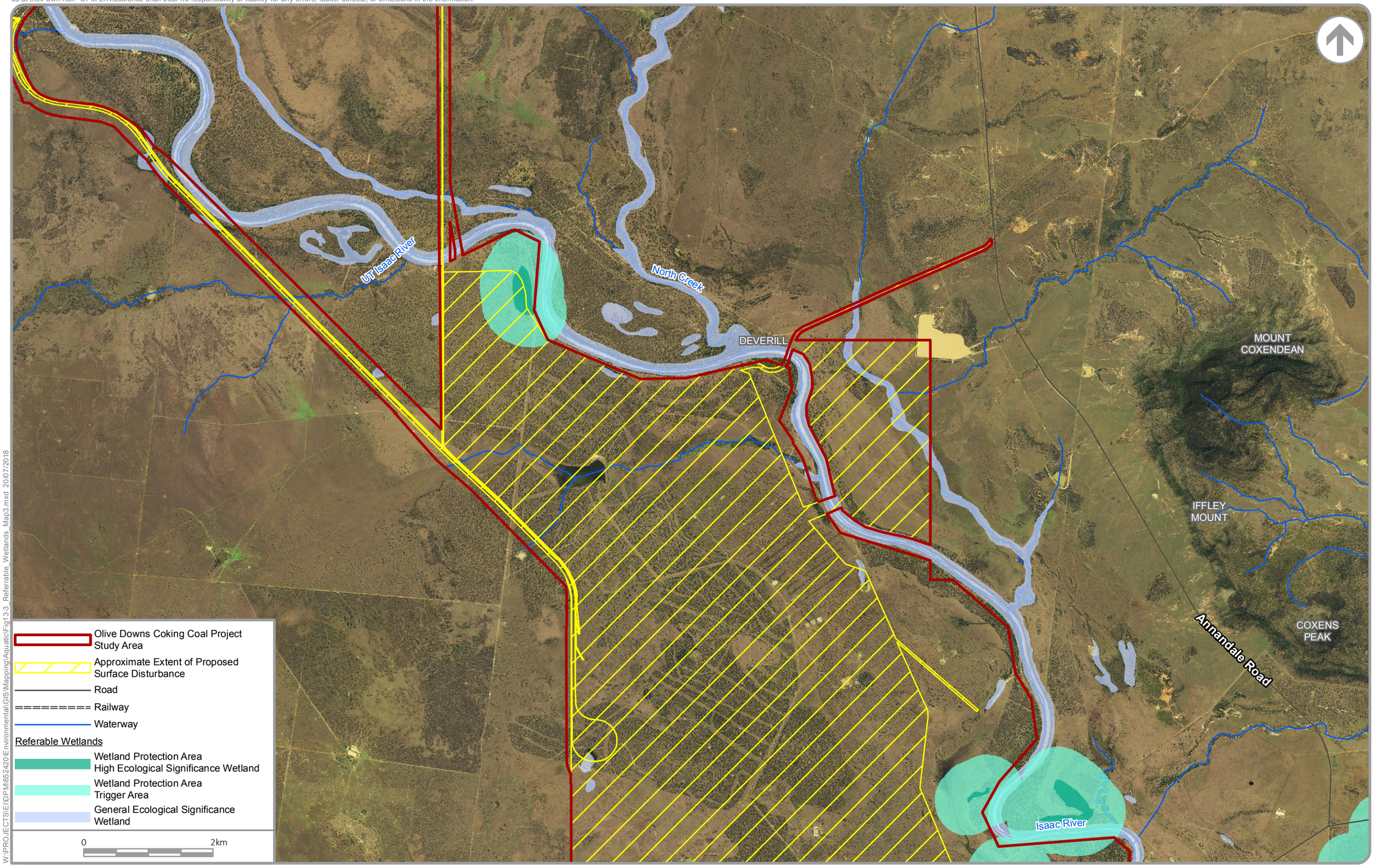
DPM ENVIROSCIENCES

REFERABLE WETLANDS – MAP 2

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 13.2

DPM Enviroscience does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. DPM Envioscience shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



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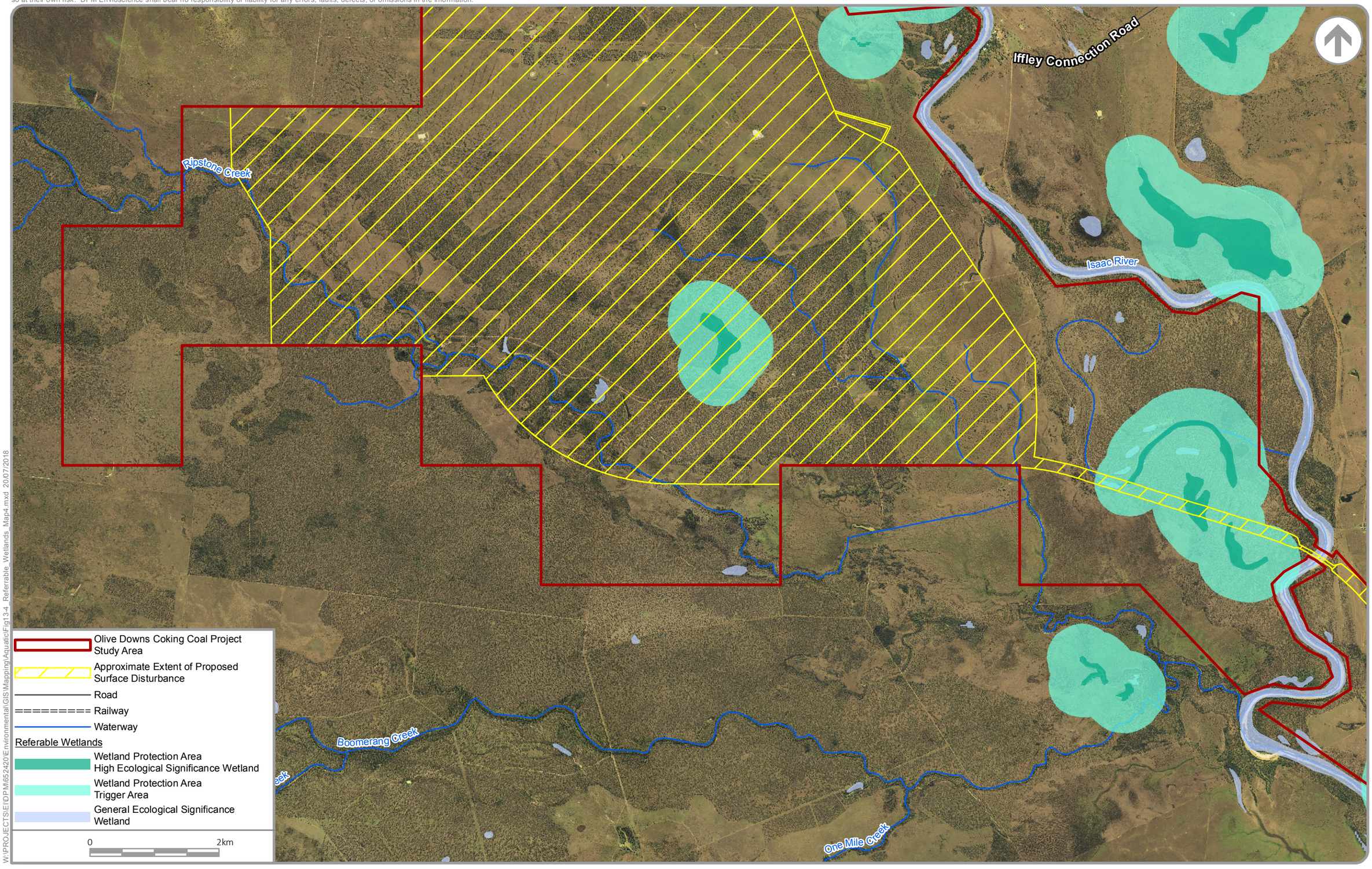
DPM ENVIROSCIENCES

REFERABLE WETLANDS – MAP 3

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 13.3



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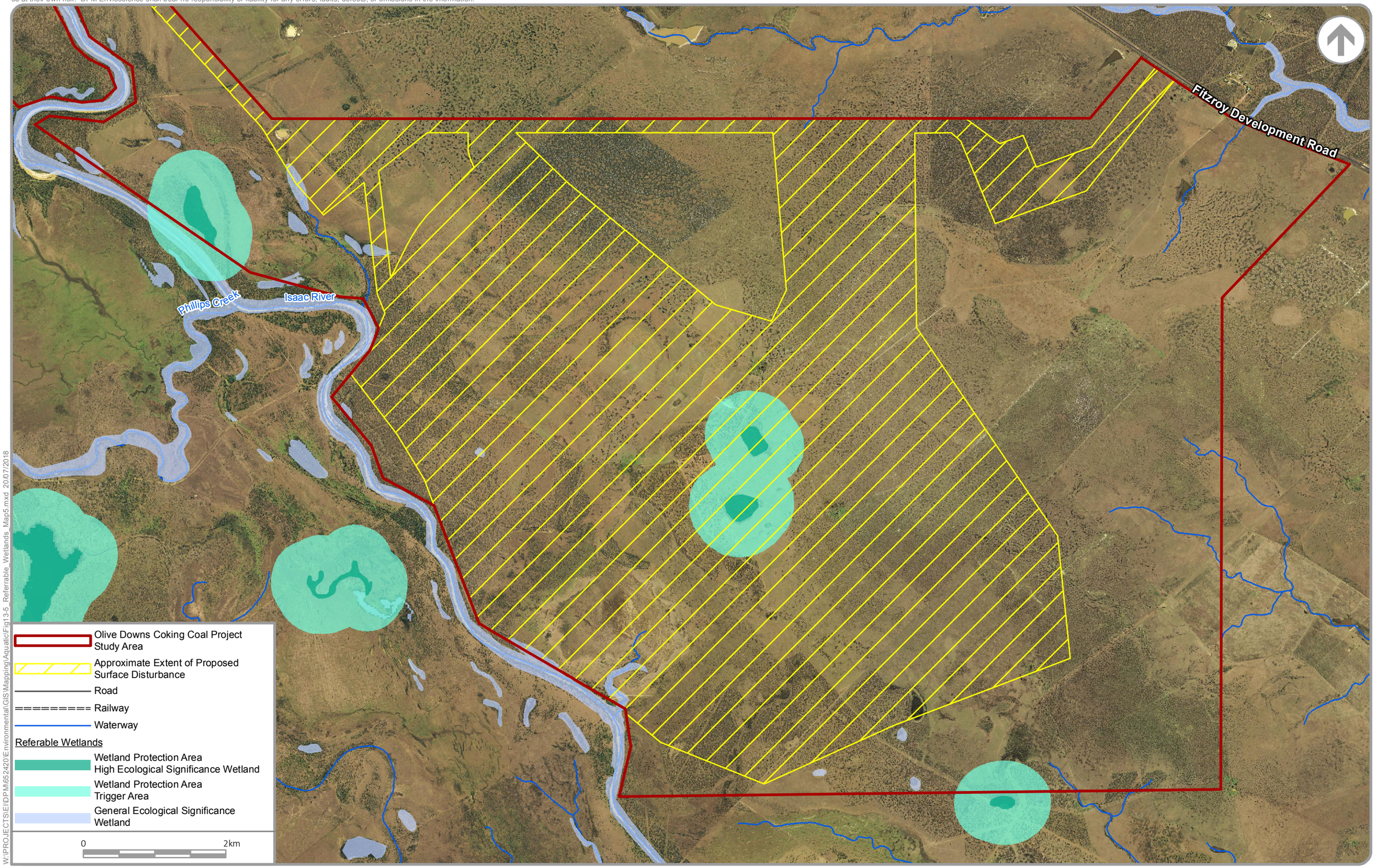
DPM ENVIROSCIENCES

REFERABLE WETLANDS – MAP 4

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 13.4



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DPM ENVIROSCIENCES

REFERABLE WETLANDS – MAP 5

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 13.5

5.4 Aquatic flora

A total of 23 species of aquatic plants were detected from the Study area during the initial early wet surveys, an additional 22 species were detected during the late wet surveys and another 3 species were detected during follow up surveys in October – November 2017 (Appendix C). More diverse aquatic communities may occur through recruitment over the wetter months of the year.

All aquatic flora species detected are considered Least Concern under the NC Act. Seven Priority aquatic flora species were detected:

- tall flatsedge (*Cyperus exaltatus*) – sites R2, R3, R4, R5, R6, R7, R8, R9, R13, R15, R23, R24, R25, R26, R27, R28, R29, R30, R32, R33, R34, R35, R38, R40, R41, P1, P2, P3, P4, P5, P6, P7, P8, P9, L1, L2, L3 and L4);
- water chestnut (*Eleocharis dulcis*) – sites P3 and P7;
- native hyacinth (*Monochoria cyanea*) – sites R3, R4, R15, P3, P5, P6 and L1;
- red milfoil (*Myriophyllum verrucosum*) – sites R13, P4, L2 and L4;
- water nymph (*Najas tenuifolia*) – sites P1, P2, P3, P7, L2 and L3;
- giant waterlily (*Nymphaea gigantea*) – site P3; and
- broad-leaved Cumbungi (*Typha orientalis*) – site L4.

The majority of aquatic flora species encountered are common emergent species such as aquatic (or semi-aquatic) grasses, sedges and rushes. The greatest diversity of aquatic flora was recorded from the palustrine wetlands that had retained water between the early and late wet sampling periods.

The lack of both diversity and abundance of aquatic plants at some sites is likely indicative of harsh physical conditions, cattle grazing and trampling, or a combination of these factors.

Table 11 EVNT and Priority aquatic flora recorded from the Fitzroy Basin and search area

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2018a	DERM 2010	DES 2018b
EVNT species													
Eriocaulon carsonii (including subsp. *orientale*)	salt pipewort / button grass	E	E	H/H		Restricted to saturated soil adjacent to flowing mound springs (Sainty and Jacobs 2003).	**Unlikely**. Current known distribution (ALA 2018) is not in proximity to the Study area. Mound springs not known to occur within the Study area. Preferred habitat is not present within the Study area.	**Unlikely**. Not found during field surveys.				✓	✓
Maundia triglochinoides	-		V			Grows in coastal freshwater swamps and streams (Sainty and Jacobs 2003), in waters up to 0.5 m deep, or shallow waters that may dry up seasonally.	**Unlikely**. Current distribution (ALA 2018) is not in proximity to the Study area. Preferred habitat is not present within the Study area.	**Unlikely**. Not found during field surveys.					✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2018a	DERM 2010	DES 2018b
Myriophyllum artesium	-		E	H/H	R & T	Wetlands and creek lines associated with springs emanating from the Great Artesian Basin and associated basins (DES 2018c).	**Unlikely**. Current known distribution (ALA 2018) is not in proximity to the Study area. Spring fed wetlands and creeks not known to occur within the Study area. Preferred habitat is not present within the Study area.	**Unlikely**. Not found during field surveys.		✓		✓	✓
Phaius australis	lesser swamp-orchid	E	E	C/C	R & T	Grows in sandy areas where soils are almost always damp, but not flooded for lengthy periods; occurring in southern Queensland and northern NSW (DES 2018d).	**Unlikely**. Current known distribution (ALA 2018) is not in proximity to the Study area. Preferred habitat is not present within the Study area.	**Unlikely**. Not found during field surveys.		✓	✓	✓	✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2018a	DERM 2010	DES 2018b
Thelypteris confluens	swamp fern		V		R & T	Found in permanently swampy areas and mound springs (DEHP 2018d). Occurs in the Queensland pastoral districts on Leichhardt, Moreton and Wide Bay (DES 2018e).	**Unlikely**. Current known distribution (ALA 2018) is not in proximity to the Study area. Preferred habitat is not present within the Study area.	**Unlikely**. Not found during field surveys.		✓			✓
Priority species													
Baumea articulata	jointed twigrush		L		P	Grows in standing water <1 m deep. Inhabits coastal lagoons, deeper swamps and slow-moving streams. Scattered occurrence in inland wetlands (Fielder et al. 2011).	**Unlikely**. Preferred habitat does not occur within the Study area.	**Unlikely**. Not found during field surveys.		✓			✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2018a	DERM 2010	DES 2018b
Baumea rubiginosa	soft twigrush		L		P	Grows in damp environments such as ephemeral swamps, lagoons and creek banks (Sainty and Jacobs 2003).	**Potential**. The species habitat is known to occur in the broader search area and there are records within 50 km of the Study area.	**Unlikely**. Not found during field surveys.		✓			✓
Cyperus exaltatus	tall flatsedge		L		P	Forms extensive stands along inland rivers and creeks, in areas which are often flooded. Grows in swamps and wetland margins (Sainty and Jacobs 2003).	**Likely**. The species habitat is known to occur in the broader search area and there are records within 10 km of the Study area.	**Known**. Found during field survey. Widespread across Study area.		✓			✓
Eleocharis blakeana	-		L	H/M	R	Occurs on plains and low undulating country on poorly drained, clayey soils; commonly in ephemeral wet habitats in gilgai country and in small depressions along drainage lines in open	**Potential**. The species habitat is known to occur in the broader search area and there are records within 50 km of the Study area.	**Unlikely**. Not found during field surveys.	✓			✓	✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2018a	DERM 2010	DES 2018b
						forest and woodland communities (Halford 1996; and Wilson 2006, cited in DES 2018f).							
Eleocharis dulcis	water chestnut		L		P	Grows in shallow lagoons and floodplains, on heavy soils (Sainty and Jacobs 2003).	**Likely**. The species habitat is known to occur in the broader search area and there are records within 10 km of the Study area.	**Known**. Recorded in the Study area at site P3 and P7.		✓			✓
Eleocharis sphacelata	tall spikerush		L		P	Grows in stationary or slow-moving water bodies of the coast and inland; occurring in shallow water up to 2m depth (Sainty and Jacobs 2003).	**Potential**. The species habitat is known to occur in the broader search area and there are records within 50 km of the Study area.	**Unlikely**. Not found during field surveys.		✓			✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2018a	DERM 2010	DES 2018b
Gahnia sieberiana	sword grass		L		P	Swamps and wet heaths (Melzer and Plumb 2011).	**Potential**. The species habitat is known to occur in the broader search area and there are records within 50 km of the Study area.	**Unlikely**. Not found during field surveys.		✓			✓
Leersia hexandra	swamp rice grass		L		P	Edges of billabongs, in swamps and constructed wetlands. Forms dense stands, often excluding other plant species (Sainty and Jacobs 2003).	**Potential**. The species habitat is known to occur in the broader search area and there are records within 50 km of the Study area.	**Unlikely**. Not found during field surveys.		✓			✓
Monochoria cyanea	monochoria		L		P	Generally rooted in the mud; preferring stationary or slow-flowing nutrient-rich water, but will survive for short periods on drying mud (Sainty and Jacobs 2003).	**Likely**. The species habitat is known to occur in the broader search area and there are records within 10 km of the Study area.	**Known**. Recorded in the Study area at site R3, R4, R15, P3, P5, P6 and L1.		✓			✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2018a	DERM 2010	DES 2018b
Myriophyllum simulans	-		L		P	Grows in still water, or more frequently, fully emergent on mud (Harden 2002).	**Potential**. The species habitat is known to occur in the broader search area and there are records within 50 km of the Study area.	**Unlikely**. Not found during field surveys.	✓				✓
Myriophyllum verrucosum	water milfoil		L		P	Various habitats, from deep water to exposed mud (Harden 2002).	**Likely**. The species habitat is known to occur in the broader search area and there are records within 10 km of the Study area.	**Known**. Recorded in the Study area at site R13, P4 and L2.	✓				✓
Najas tenuifolia	water nymph		L		P	Fresh water less than 3 m deep, widespread; submerged aquatic species (Fielder et al. 2011).	**Likely**. The species habitat is known to occur in the broader search area and there are records within 10 km of the Study area.	**Known**. Recorded in the Study area at site P1, P2, P3, P7 and L2.	✓	✓			✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2018a	DERM 2010	DES 2018b
Nelumbo nucifera	pink waterlily		L		P	Deep lagoons and deep slow-moving streams (Fielder et al. 2011).	**Unlikely**. Preferred habitat does not occur within Study area.	**Unlikely**. Not found during field surveys.	✓	✓			✓
Nymphaea gigantea	giant waterlily		L		P	Permanent deep water with muddy substrates (Sainty and Jacobs 2003).	**Likely**. The species habitat is known to occur in the broader search area and there are records within 10 km of the Study area.	**Known**. Recorded in the Study area at site P3.	✓	✓			✓
Nymphoides exiliflora	-		L		P	Saturated soils or clear shallow (to 5cm) fresh water; low heath/ s edge swamps on sandy soils (Stanley and Ross 1983).	**Unlikely**. Preferred habitat does not occur within Study area.	**Unlikely**. Not found during field surveys.	✓	✓			
Nymphoides indica	water snowflake		L		P	Stationary and slow-moving water bodies (Sainty and Jacobs 2003).	**Potential**. The species habitat is known to occur in the broader search area and there are records within 50 km of the Study area.	**Unlikely**. Not found during field surveys.	✓	✓			✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2018a	DERM 2010	DES 2018b
Ottelia alismoides	-		L		P	Margins of lakes, ponds and backwaters; usually submerged, but may be partly emergent in shallow water (Sainty and Jacobs 2003).	**Potential**. The species habitat is known to occur in the broader search area and there are records within 50 km of the Study area.	**Unlikely**. Not found during field surveys.	✓	✓			✓
Paspalum distichum	water couch		L		P	Damp areas and margins of waterbodies, creeks, streams, channels and drains on the coast and inland (Sainty and Jacobs 2003).	**Potential**. The species habitat is known to occur in the broader search area and there are records within 50 km of the Study area.	**Unlikely**. Not found during field surveys.	✓	✓			✓
Phragmites australis	common reed		L		P	Stationary or slow-moving waterbodies, margins of creeks, streams, channels and drains, swamps, areas with high water or that are seasonally inundated; tolerant of slightly brackish water (Sainty	**Potential**. The species habitat is known to occur in the broader search area and there are records within 50 km of the Study area.	**Unlikely**. Not found during field surveys.	✓	✓			✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2018a	DERM 2010	DES 2018b
						and Jacobs 2003). May grow in deep and permanent waters, or shallow, seasonally inundated lowlands, or where there is a permanently high watertable not far below the surface (Romanowski 1998).							
Schoenoplectus mucronatus	schoenoplectus		L		P	Creek and river banks, periodically inundated floodplains and in billabongs. Banks of stationary or slow-moving waterbodies and floodplains (Sainty and Jacobs 2003).	**Potential**. The species habitat is known to occur in the broader search area and there are records within 50 km of the Study area.	**Unlikely**. Not found during field surveys.		✓			✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2018a	DERM 2010	DES 2018b
Typha orientalis	broad-leaved cumbungi		L		P	Stationary or slow-moving waterbodies, margins of creeks and rivers of the inland and coast; fresh or brackish water up to 2 m deep (Sainty and Jacobs 2003).	**Likely**. The species habitat is known to occur in the broader search area and there are records within 10 km of the Study area.	**Known**. Located in the Study area at site L4.	✓	✓			✓
Vallisneria nana	ribbonweed		L		P	Still to fast-flowing waters of streams, lakes, ponds and irrigation channels (Stephens and Dowling 2002).	**Potential**. The species habitat is known to occur in the broader search area and there are records within 50 km of the Study area.	**Unlikely**. Not found during field surveys.	✓	✓			✓

Notes:

E = Endangered, V = Vulnerable, L = Least Concern, C = Critical Priority, H = High Priority, M = Medium Priority, P = Priority, R&T = Rare and Threatened.

1. EPBC Act = status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
2. NC Act = status under the Queensland *Nature Conservation Act 1992*.
3. Back on Track = status under the DERM (2010) Fitzroy Natural Resource Management Region – Back on Track Actions for Biodiversity.
4. ACA = status under the Aquatic Conservation Assessments using AquaBAMM for riverine and non-riverine wetlands of the Great Barrier Reef catchments (Inglis and Howell 2009; Rollason and Howell 2012).

* *Aponogeton queenslandicus* is listed as Rare in the ACA for the riverine wetlands of the Great Barrier Reef catchment: Fitzroy region. However, as of May 2010, this species is a Least Concern species under the NC Act.

References:

- Inglis and Howell 2009, Aquatic Conservation Assessments using AquaBAMM for the riverine wetlands of the Great Barrier Reef catchment: Fitzroy region.
- Rollason and Howell 2012, Aquatic Conservation Assessments using AquaBAMM for the non-riverine wetlands of the Great Barrier Reef catchment: Fitzroy region
- Commonwealth Department of the Environment and Energy (DEE) 2018a, EPBC Act Protected Matters Report – created 24/04/2018.
- Queensland Department of Environment and Resource Management (DERM) 2010, Fitzroy Natural Resource Management Region – Back on Track Actions for Biodiversity.
- Queensland Department of Environment and Science (DES) 2018b, Wetland*Info* – Fitzroy Basin – Wetland Summary Information.

5.5 Aquatic Fauna

5.5.1 Fishes

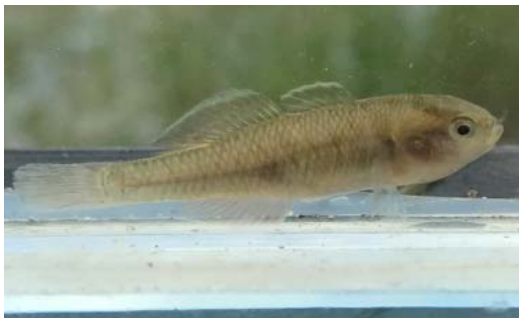
Eleven species were recorded from 640 fishes captured by DPM Enviros ciences from the Study area during the early wet surveys in December 2016 and an additional six species were recorded from an additional 5,745 fishes during the late wet surveys in June / July 2017 (Appendix C). No new species were recorded in further surveys during October to November 2017. A specimen of each species was photographed on site (Plate 8). Each species has previously been recorded from the Fitzroy basin (DES 2018b; Catchment Solutions 2015). All specimens appeared healthy, with no signs of stress or disease. Pest fish were euthanised in accordance with DPM Enviros ciences' Animal Ethics Committee approval and General Fisheries Permit.

The greatest species richness was recorded at site R8 on the Isaac River, with 10 species recorded from 181 fishes captured in the early wet surveys in 2016 (Appendix C). In the late wet surveys (2017) the greatest species richness (11) was recorded at P3 (a lacustrine wetland connected to Ripstone Creek near R5), R5 (Ripstone Creek) and R6 (Isaac River), with the highest number of fish (1,283) at P4. No fish were captured from site P2, being a paleochannel lake on Vermont Park (Figure 9). This was despite thorough fish survey at this site, implementing backpack electrofishing techniques, as well as overnight deployment of five baited box traps, two fyke nets and two cathedral traps. The results suggest that this waterbody may be subjected to complete wetting and drying cycles that limit the persistence of native fish that may find their way into this wetland during flood events.

Agassiz's glassfish (*Ambassis agassizii*)

Barred grunter (*Amniataba percoides*)

Fly-specked hardyhead (*Craterocephalus stercusmuscarum)*



Gudgeon (*Hypseleotris* sp.)

Spangled perch (*Leiopotherapon unicolor*)

Eastern rainbowfish (*Melanotaenia splendida splendida*)

Southern purple-spotted gudgeon (*Mogurnda adspersa*)

Bony bream (*Nematalosa erebi*)

Tilapia (*Oreochromus mossambicus*) – a pest species

Sleepy cod (*Oxyeleotris lineolata*)

Hyrtyl's tandan (*Neosilurus hyrtlii*)

Australian smelt (*Retropinna semoni*)

Golden perch (*Macquaria ambigua*)

Marbled eel (*Anguilla marmorata*)

Rendahl's catfish (*Tandanus rendahli*)

Plate 8 Fish captured from the Study area

5.5.2 Reptiles (turtles)

Three Least Concern turtle species were recorded from the Study area:

- eastern snake-necked turtle (*Chelodina longicollis*) – recorded at sites R4, R8, R23 and P1-3 and L4 (Plate 9);
- broad-shelled turtle (*Chelodina expansa*) – recorded at site P5; and
- Krefft's river turtle (*Emydura macquarii krefftii*) – recorded at sites R4, R6, R8, L2, P3, P4 and P5 (Plate 9).

No EVNT turtles were detected within the Study area, nor was suitable habitat for EVNT turtles encountered.

Eastern snake-necked turtle (*Chelodina longicollis*)

Krefft's river turtle (*Emydura macquarii krefftii*)

Plate 9 Turtles captured and identified from the Study area, December 2016

5.5.3 Platypus

The platypus (*Ornithorhynchus anatinus*) is listed as Special Least Concern (SLC) for cultural reasons under the NC Act. The Wetland*Info* database for the Fitzroy Basin (DEHP 2018b) identifies the platypus as having previously been recorded from the Fitzroy Basin. Although some riverine waterbodies (e.g. site R4, upstream of a dam) provided habitat suitable for platypus breeding (including relative permanence of water, and bank substrates dominated by silt / clay, as opposed to apedal sediments such as sand), the seasonal nature of most riverine and

palustrine waterbodies of the Study area are not conducive to sustaining a population of platypus. No platypus burrows were encountered during the surveys, despite targeted searches of accessible sites. The potential for platypus occurring in lacustrine wetlands (lakes and farm dams) of the Study area was assessed as part of the 2017 late wet aquatic surveys, and it was determined that the habitat was unsuitable.

5.5.4 Aquatic invertebrates

Aquatic macroinvertebrates and stream health

A total of 75 aquatic macroinvertebrate taxa representing 22 orders were retained within samples collected from riverine (bed and edge habitat) and wetland ecosystems within the Study area (including the MLA and proposed infrastructure corridors). Samples were collected over three sampling periods considering: early wet conditions in December 2016; late wet conditions in June-July 2017; and early wet conditions in October 2017. Raw macroinvertebrate data are presented in Tables C5, C6 and C7 in Appendix C.

Sampling effort over the three survey periods varied and was dependant on the availability of wetted habitat as well as land access constraints. In 2016 early wet sampling consisted of three riverine bed samples, four riverine edge samples and two palustrine wetland samples. Wetted habitat was more prevalent during the 2017 late wet sampling effort and most land access constraints had been lifted, allowing for representative wetlands and waterway reaches to be successfully sampled across the Study area. The 2017 late wet sampling consisted of nine riverine bed samples, nine riverine edge samples, six palustrine wetland samples and one lacustrine wetland sample. Sampling effort within the 2017 early wet aimed at sampling wetted sites previously inaccessible during the 2016 early wet. A total of three riverine edge samples, three riverine bed samples and three wetland samples were collected.

Taxonomic composition

The most taxa-rich order of aquatic macroinvertebrates collected within the Study area was Coleoptera (beetles) with 13 families identified. Hemiptera (true bugs) and Diptera (true flies) were also well represented with 12 and 11 families recorded respectively. Other commonly occuring taxa included: Ephemeroptera (mayflies); Trichoptera (caddis flies); Zygoptera (damselflies); Epiprocta (dragonflies); Acarina (mites), Decapoda (in this case freshwater crabs, yabbies, prawns and shrimp); Bivalvia (molluscs); Gastropoda (in this case limpets and snails); Cladocera (water fleas), Copepoda (copepods) and Ostracoda (seed shrimp).

Aquatic macroinvertebrate taxa richness ranged from seven to 27 taxa within samples collected from riverine bed habitat (Figure 14), from 16 to 33 taxa within samples collected from riverine edge habitat (Figure 15) and 18 to 36 taxa within composite wetland samples (Figure 16). Data is presented against the DEHP (2011) Water Quality Objectives for the ‘Upper Isaac River catchment waters’ derived for bed and edge habitats. The taxa richness guidelines apply to riverine systems only. No taxa richness guidelines are available for palustrine or lacustrine wetlands.

Taxa richness within riverine bed samples showed variability between sampling periods and amongst sites. All samples (three) collected within the 2016 late wet conditions from Ripstone Creek (R3) and the Isaac River (R6 and R8) contained a low number of taxa, falling below the DEHP (2011) 20:80 percentile guideline range. Conversely, seven of the nine samples collected within late wet conditions of 2017 exhibited moderate to high taxa richness being within or greater than the DEHP (2011) 20:80 percentile guideline range. This seasonal variability and higher taxa richness likely reflects an extended period of favourable aquatic conditions with surface waters prevalent across the Study area following Cyclone Debbie. Three samples collected in 2017 early wet conditions from the Isaac River (R23) and North Creek (R28 and R30) contained a moderate to high number of taxa.

Riverine edge samples exhibited consistent trends in taxa richness variability to those recorded within bed samples. Taxa richness was greater in the edge habitat of each riverine site than in the bed habitat, likely owing to the greater habitat complexity and food sources. Reduced taxa richness was recorded in both riverine bed and edge samples on at least one occasion at Ripstone Creek (R3), the Isaac River (R6 and R8) and North Creek (R28). While, this lower taxa richness may reflect seasonal variability as previously noted, it may also be a likely indication of unfavourable physio-chemical conditions and / or reduced habitat quality at these locations.

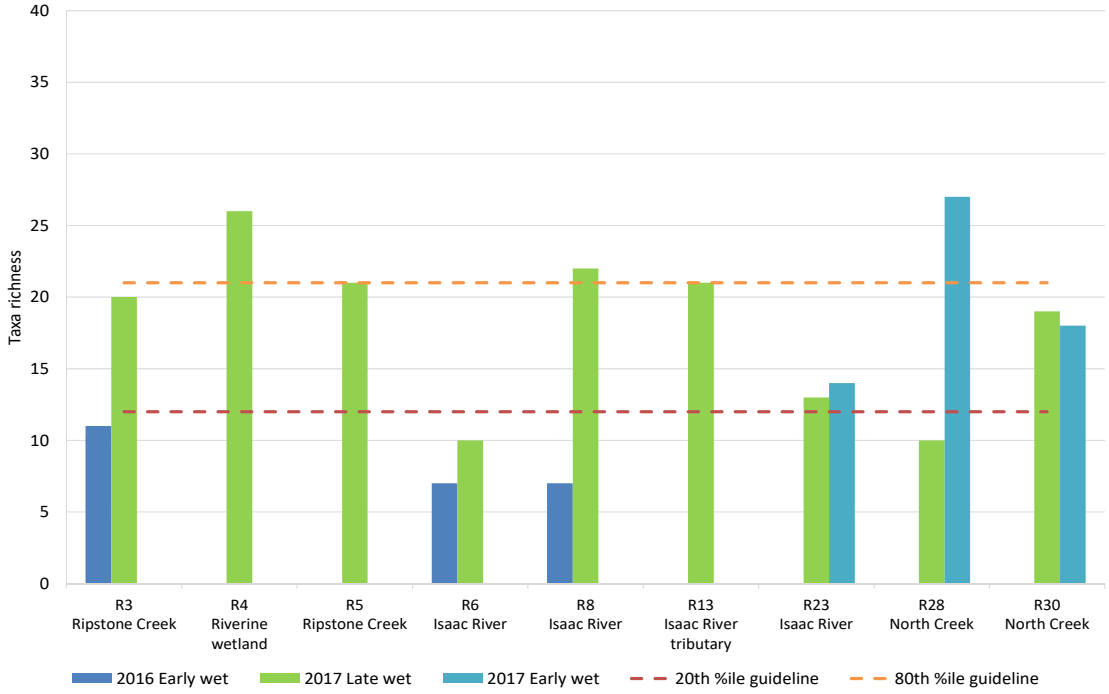


Figure 14 Aquatic macroinvertebrate taxa richness in riverine bed samples collected from the Study area

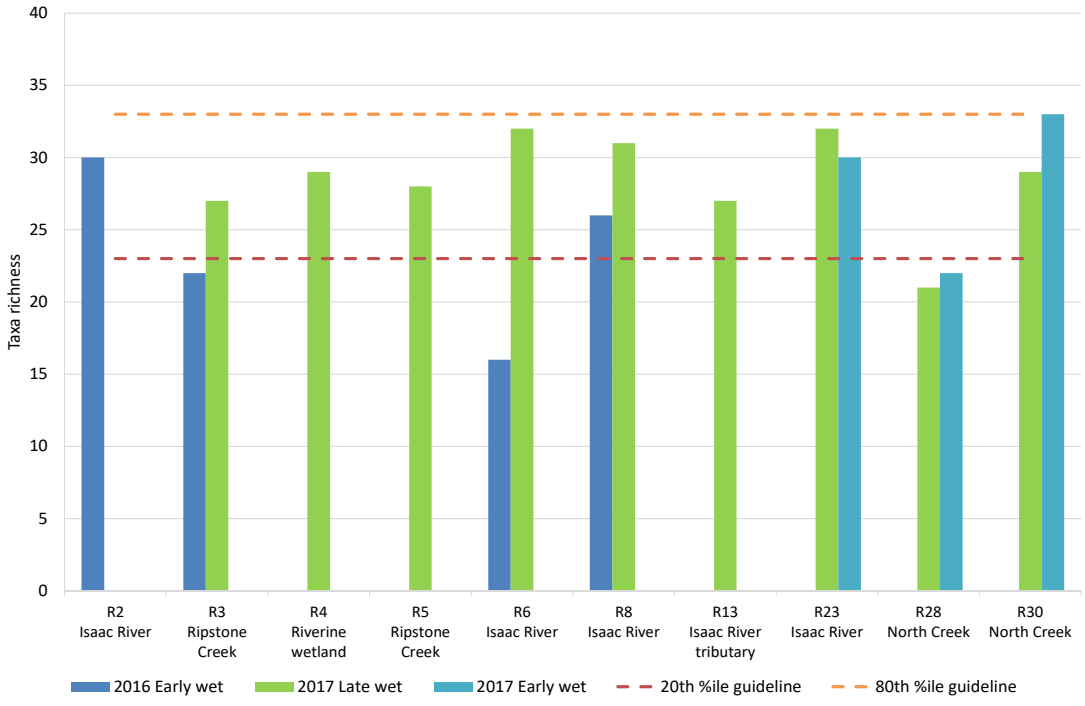


Figure 15 Aquatic macroinvertebrate taxa richness in riverine edge samples collected from the Study area

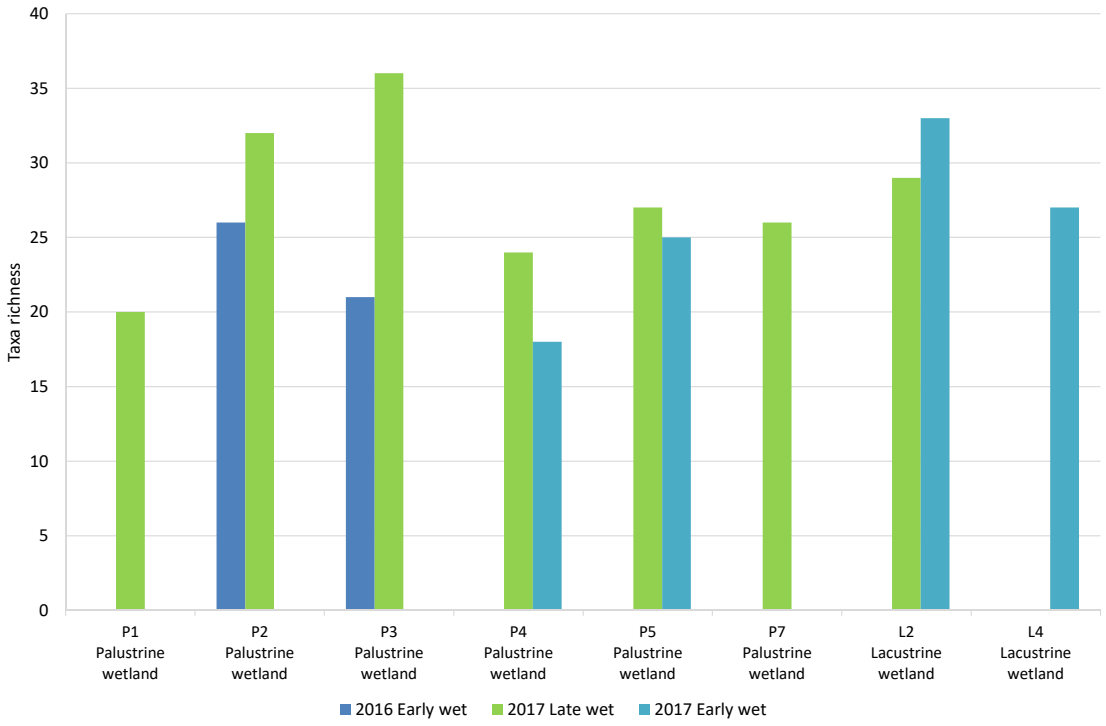


Figure 16 Aquatic macroinvertebrate taxa richness in wetland samples collected from the Study area

PET taxa

Six PET taxa were recorded within the Study area and included three Ephemeroptera (mayfly) families (Baetidae, Caenidae, and Leptophlebiidae) and three Trichoptera (caddisfly) families (Calamoceratidae, Ecnomidae, and Leptoceridae). No Plecoptera (stoneflies) families were recorded.

PET taxa richness ranged from 0 to 6 taxa within riverine bed samples (Figure 17), from 2 to 5 taxa within riverine edge samples (Figure 18), and from 1 to 4 taxa within composite wetland samples (Figure 19). Data is presented against the DEHP (2011) Water Quality Objectives for the 'Upper Isaac River catchment waters' derived for bed and edge habitats. The taxa richness guidelines apply to riverine systems only. No taxa richness guidelines are available for palustrine or lacustrine wetlands.

Typically, PET taxa richness was within the DEHP (2011) 20:80 percentile guideline range indicating an expected number of pollutant sensitive taxa. Consistent with overall taxa richness, a lower number of PET taxa were recorded in bed samples from Ripstone Creek (R3) and the Isaac River (R6) within 2016 early wet conditions. Additionally, low PET taxa richness was recorded at site R13 within 2017 late wet conditions.

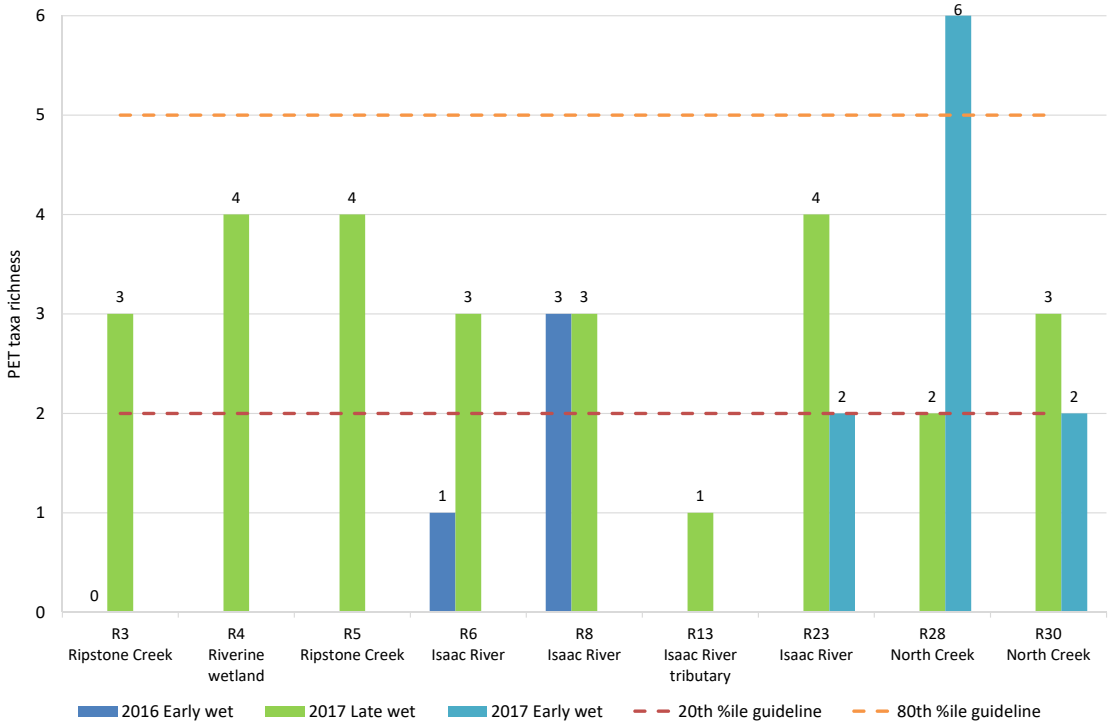


Figure 17 PET taxa richness in riverine bed samples collected from the Study area

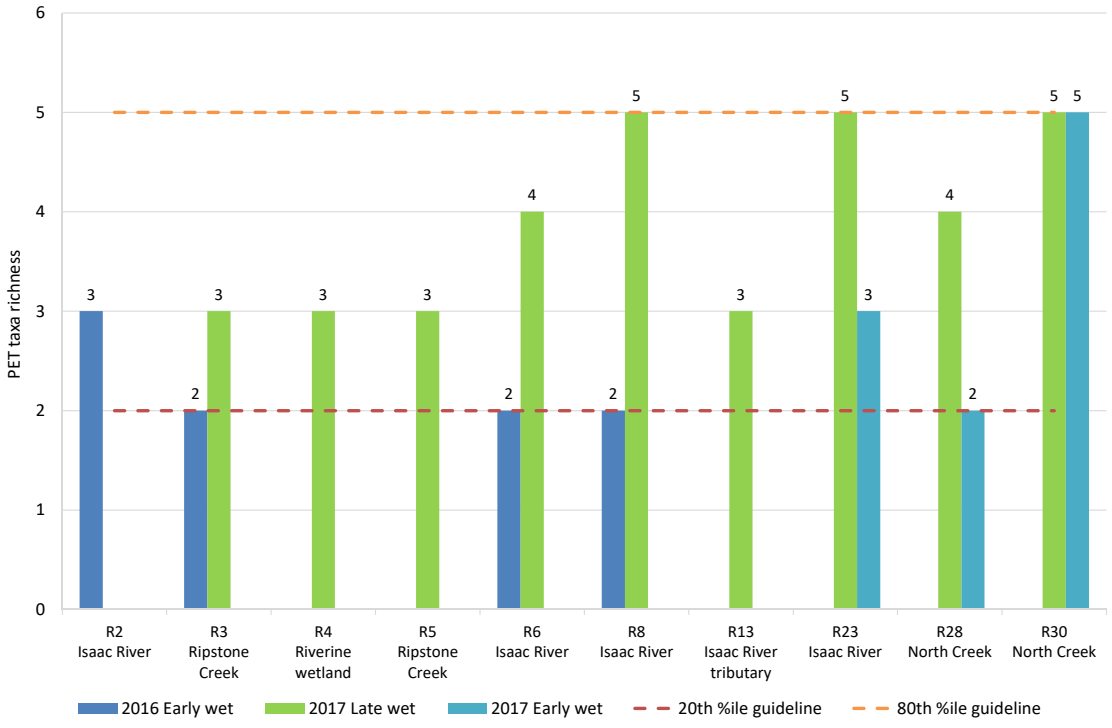


Figure 18 PET taxa richness in riverine edge samples collected from the Study area

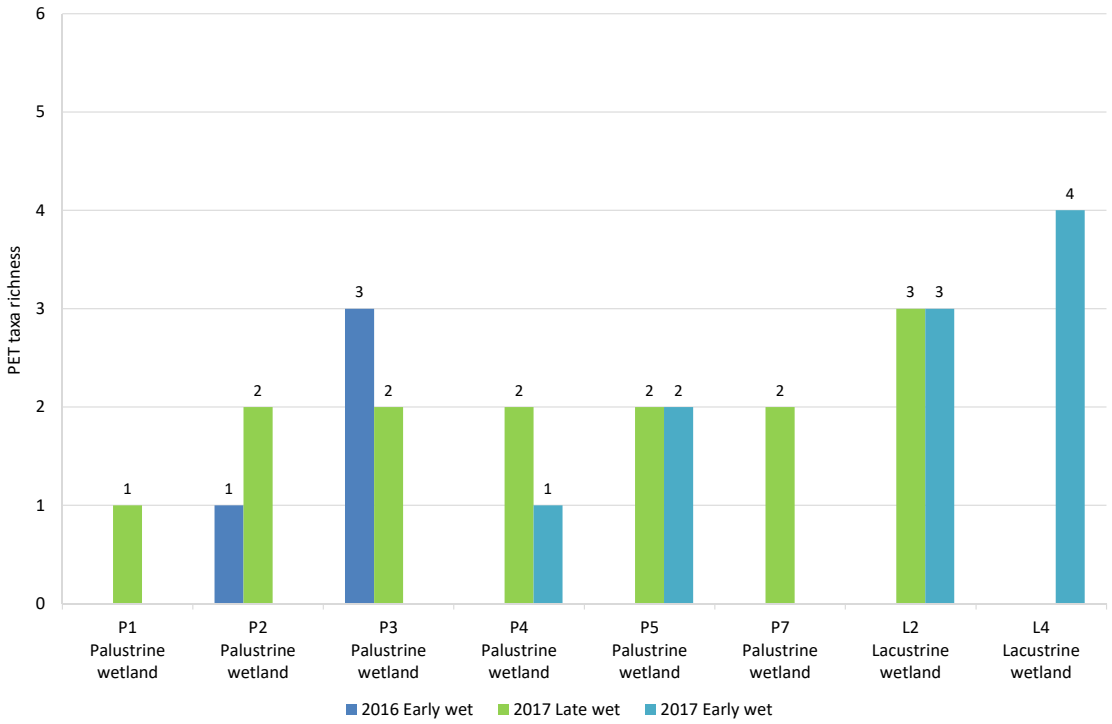


Figure 19 PET taxa richness in wetland samples collected from the Study area

Pollution-tolerant taxa

The percentage of pollutant tolerant taxa (SIGNAL 2 score of 1-3) ranged from 14.3% to 87.5% within riverine bed samples (Figure 230), from 46.1% to 60.7% within riverine edge samples (Figure 242) and from 46.1% to 75.0% within composite wetland samples (Figure 252). Data is presented against the DEHP (2011) Water Quality Objectives for the 'Upper Isaac River catchment waters' derived for bed and edge habitats. The taxa richness guidelines apply to riverine systems only. No taxa richness guidelines are available for palustrine or lacustrine wetlands.

Typically, the percentage of pollutant taxa within riverine bed and edge samples was within the DEHP (2011) 20:80 percentile guideline range. This indicates macroinvertebrate communities within the Study area generally comprised the expected amount of taxa more sensitive to pollutants. Three samples contained a notably higher composition of tolerant taxa, including: a bed sample from Ripstone Creek (R3) in early wet (2016) conditions; a bed sample from an unnamed tributary (R13) in late wet conditions (2017); and an edge sample from the Isaac River (R2) in early wet conditions (2016). An increase in the percentage of pollutant tolerant taxa at these locations may indicate unfavourable physical conditions and / or reduced habitat quality, and are likely to reflect a temporary state due to conditions encountered at the time of sampling (drying conditions at sites R3 and R13, and following a flushing flow event at R2).

Composite samples collected within wetlands typically contained a slightly higher percentage composition of pollutant tolerant taxa compared to those observed within riverine habitats. This may reflect slightly harsher conditions resulting from a greater range in diurnal oxygen (where dense macrophytes are present) or other physico-chemical stressors such as increased solar exposure / reducing habitat availability associated with drying (increased maximum temperature and diurnal variation), and nutrient input from avifauna.

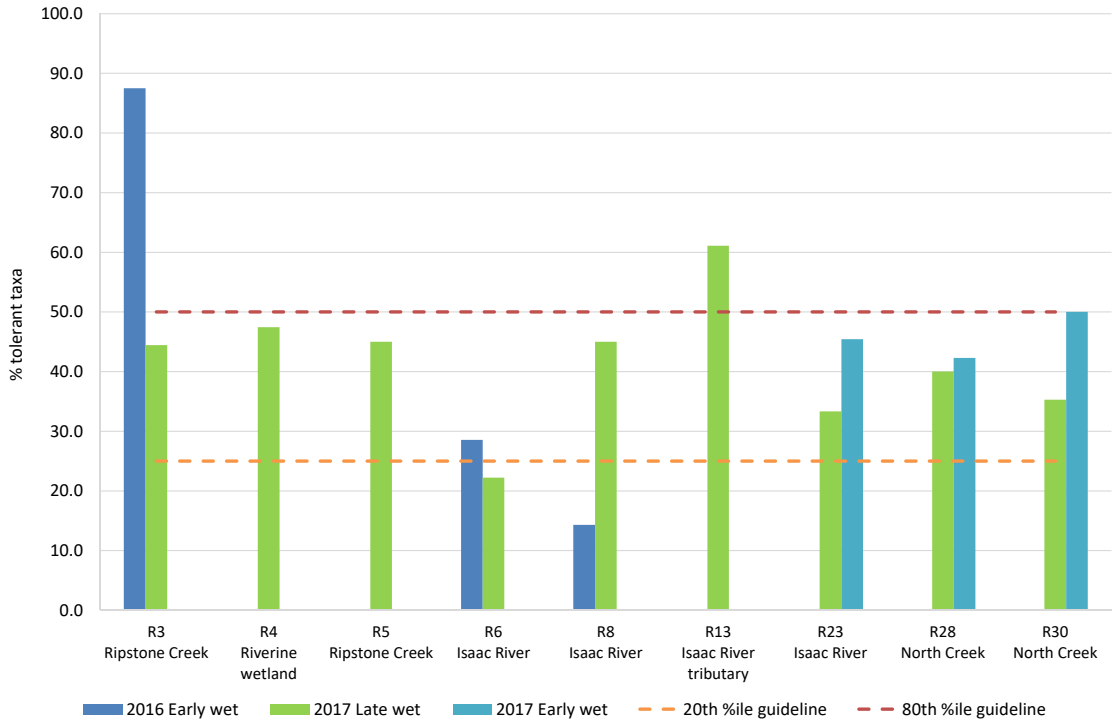


Figure 20 Percentage of tolerant taxa in riverine bed samples collected from the Study area

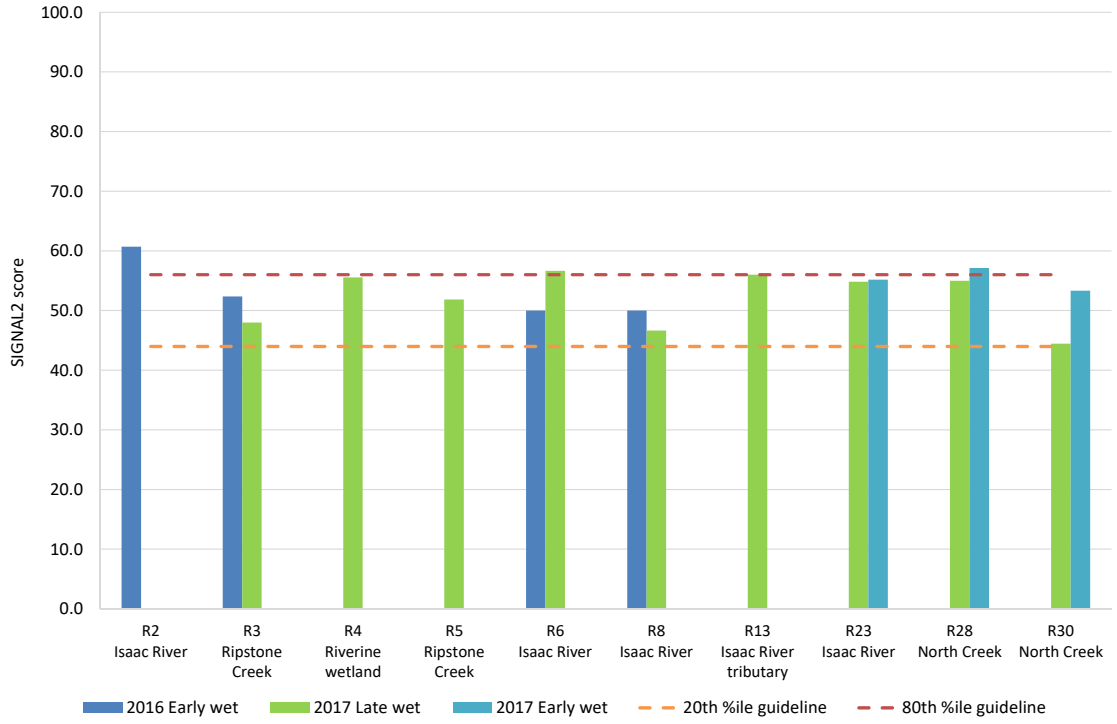


Figure 21 Percentage of tolerant taxa in riverine edge samples collected from the Study area

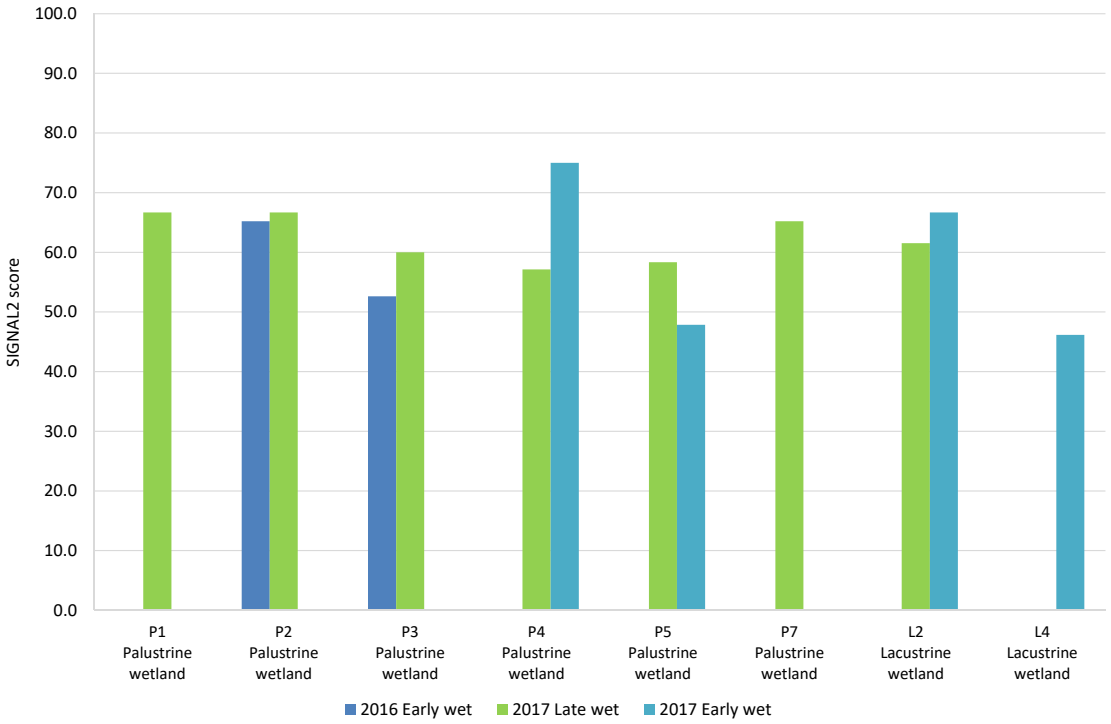


Figure 22 Percentage of tolerant taxa in wetlands samples collected from Study area

SIGNAL2 scores

Average SIGNAL 2 scores ranged from 2.63 to 4.43 for samples collected within riverine bed habitat (Figure 23), from 2.92 to 3.78 for samples collected within riverine edge habitat (Figure 24), and from 2.56 to 3.37 for composite samples collected within wetland systems (Figure 25). SIGNAL2 scores provide an average score for SIGNAL taxa present, varying from percentage pollutant taxa scores in that that consider the percentage of taxa with low SIGNAL scores. Results are presented against the DEHP (2011) Water Quality Objectives for the 'Upper Isaac River catchment waters'. The guidelines apply to riverine systems only. As such, no guidelines are presented for the palustrine and lacustrine wetland sites.

Typically, samples collected from riverine bed and edge habitats exhibited SIGNAL 2 scores within or greater than the DEHP (2011) 20:80 percentile guideline range, indicating an expected composition of pollutant tolerant and pollutant sensitive taxa. The three samples previously noted to contain a high percentage of pollutant tolerant taxa also received average SIGNAL 2 scores below 20th percentile guideline values, reiterating the reduction in pollutant sensitive taxa. Notably, riverine bed samples from the Isaac River sites R6 and R8 that contained a low number of taxa exhibited SIGNAL 2 scores greater than the 80th percentile guideline value, which is likely reflective of the harsh physical conditions (Chessman 2003).

SIGNAL 2 scores were typically lower at numerous wetland sites (P1, P2, P4, P7 and L2) compared to values determined for riverine bed and edge samples, indicating a greater composition of pollutant tolerant taxa in wetland systems opposed to riverine.

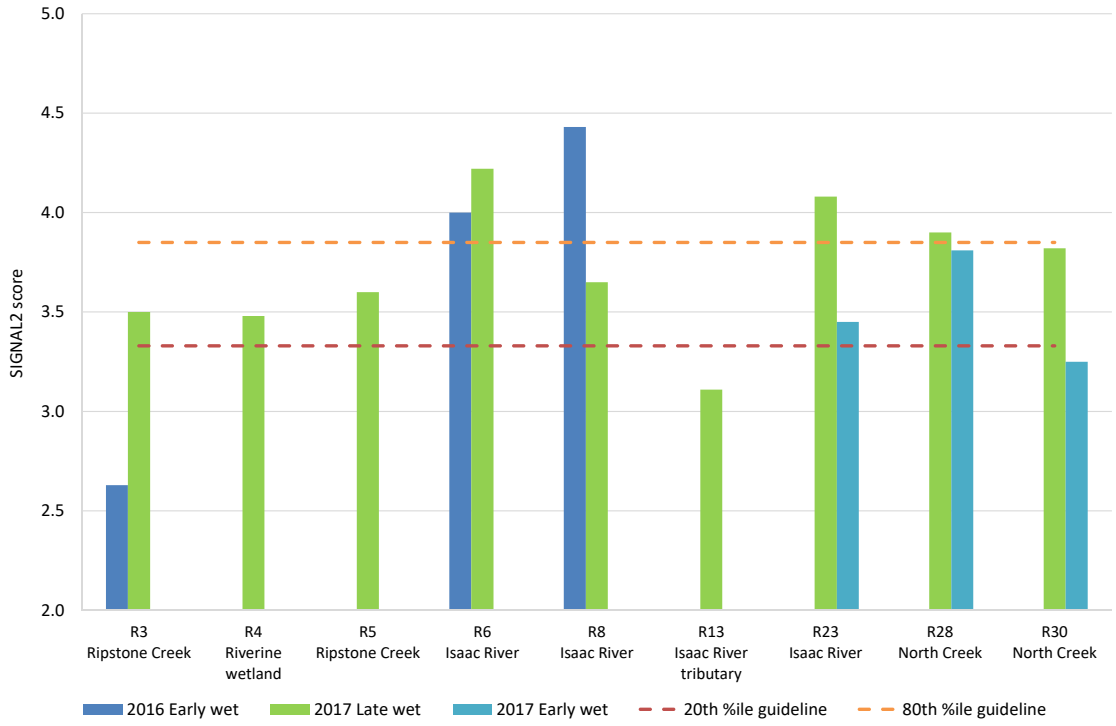


Figure 23 SIGNAL2 scores for riverine bed samples collected from the Study area

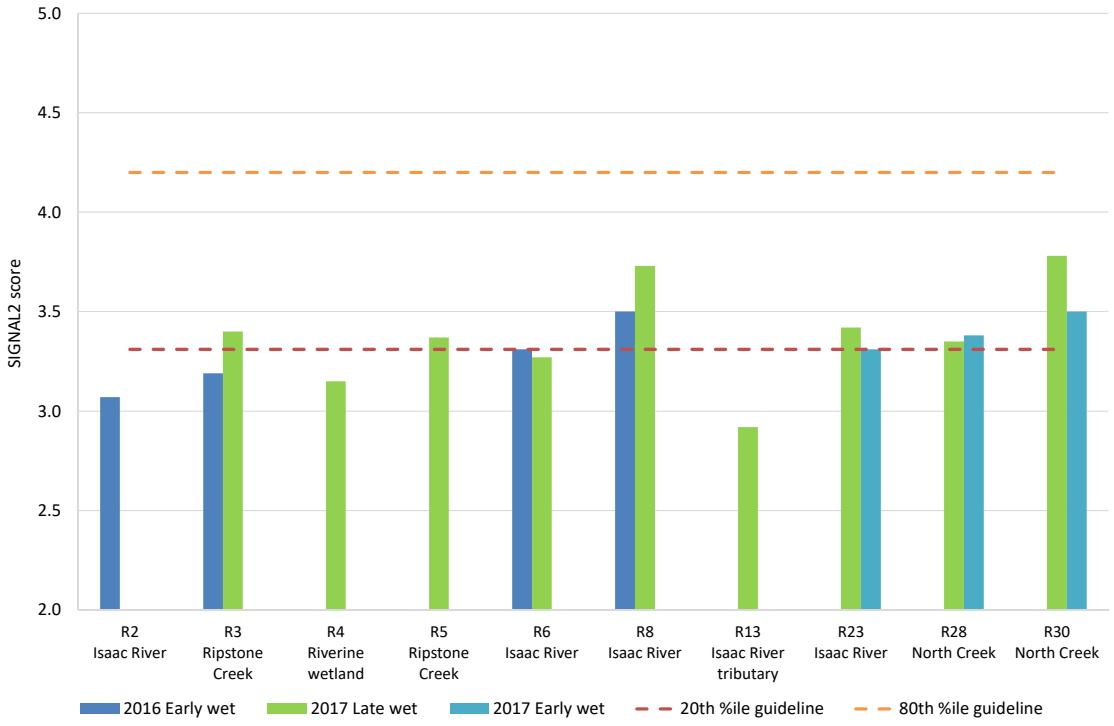


Figure 24 SIGNAL2 scores for riverine edge samples collected from the Study area

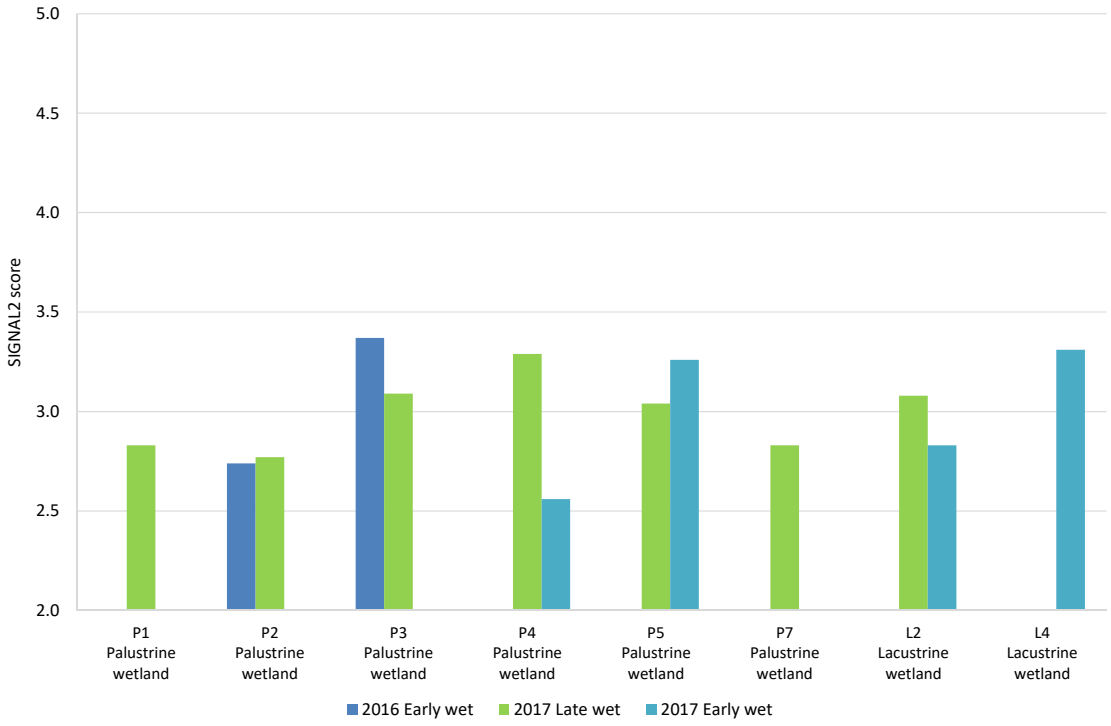


Figure 25 SIGNAL2 scores for wetland samples collected from the Study area

AusRivAS OE50

AusRivAS OE50 scores improved by at least one Band level from the 2016 early wet sampling round to the 2017 late wet sampling round for those sites sampled in both rounds. This is most likely attributed to the prevalence of wetted habitat in these largely ephemeral systems in the 2017 late wet sampling round, which followed significant rainfall associated with Cyclone Debbie approximately three months prior to sampling (Section 4.5.1).

Multiple sites consistently scored within Band A (similar to reference condition) and Band X (more biologically diverse than reference) for all samples collected within both bed and edge habitats, and include:

- North Creek at site R30;
- Isaac River at site R23 and R2 (a single edge sample collected from R2);
- Ripstone Creek at R5; and
- A riverine wetland at R4.

Other sites exhibited a seasonal change from Band B (slightly impaired) to either Band A or Band X, with an improvement in score commonly associated with late wet conditions, and include:

- Ripstone Creek at site R3;
- Isaac River at sites R6 and R8; and
- North Creek at site R28.

No sites were attributed with a score within Band B in more than one season and no sites received a score within Band C (severely impaired).

Caution is applied to the use of AusRivAS ratings in ephemeral systems. The fluctuating observed to expected (OE50) taxa scores are most likely a reflection of seasonality, as opposed to catchment impacts. The 2017 late wet samples that fell into Band X – more biologically diverse than reference – have an OE50 taxa score greater than the 90th percentile of reference sites used to create the AusRivAS model.

This may be attributed to a potential biodiversity hot-spot, mild organic enrichment, or prolonged flow in a normally intermittent stream. Stream flows in the Isaac River associated with Cyclone Debbie persisted for considerably longer duration than normal in the lead-up to sampling (Section 4.5.1). The Band X ratings are most likely a reflection of this extended flow.

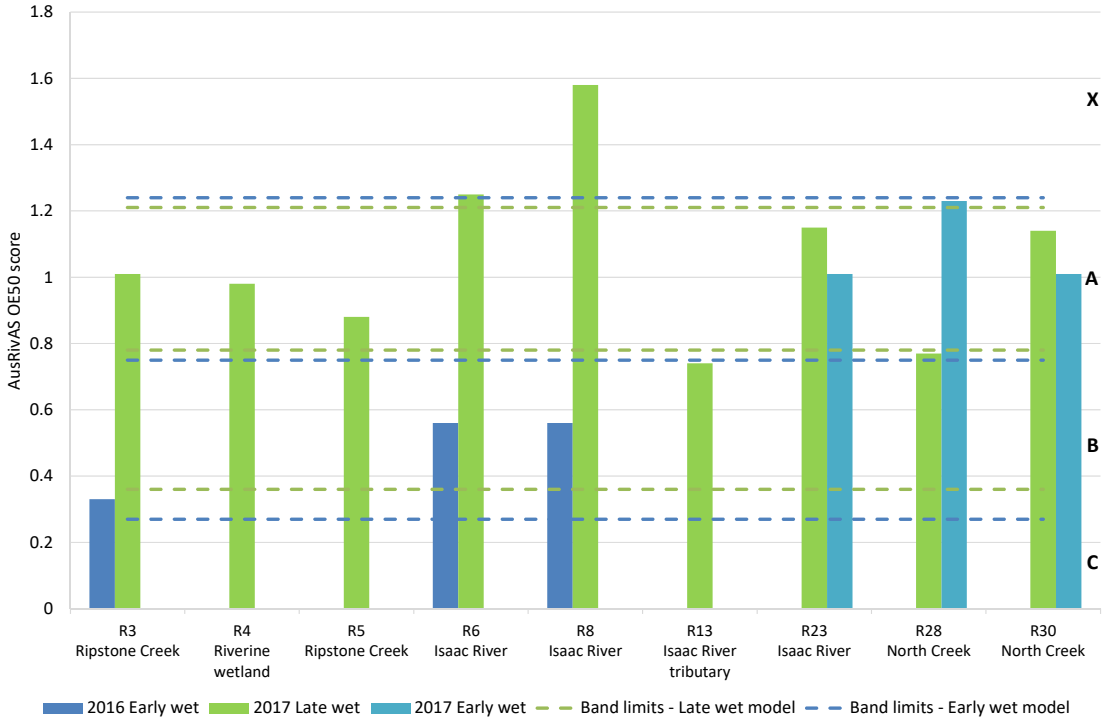


Figure 26 OE50 scores for riverine bed samples collected from the Study area

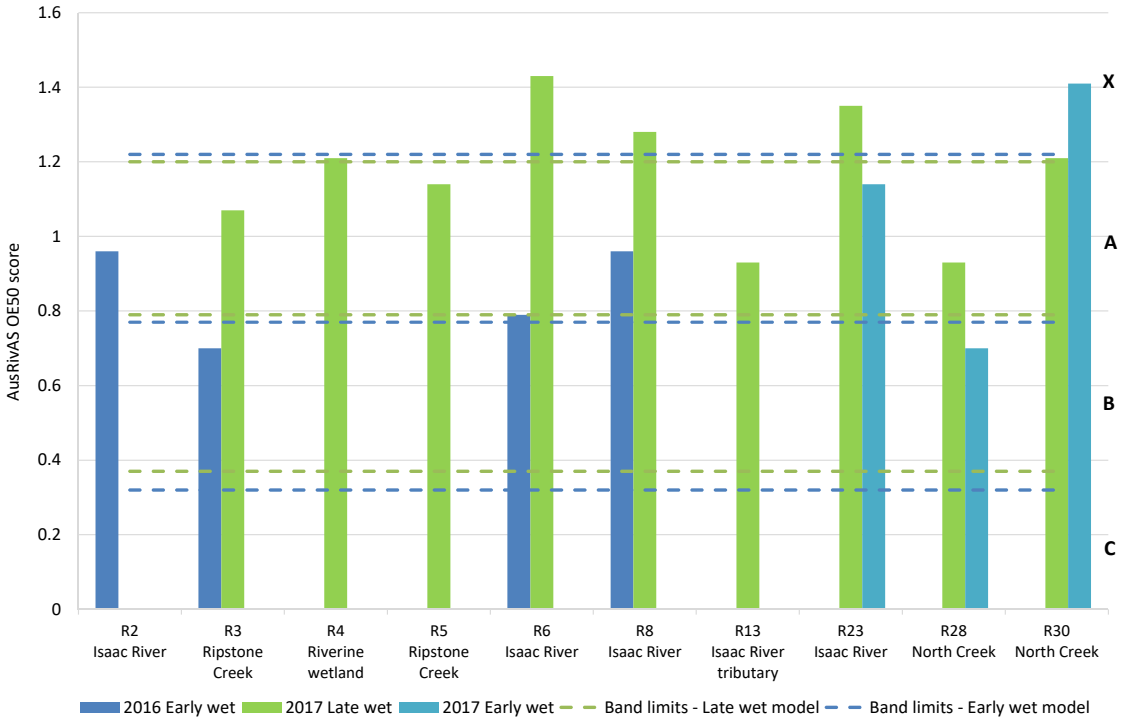


Figure 27 OE50 scores for riverine edge samples collected from the Study area

Summary of macroinvertebrate bio-indices

Riverine aquatic macroinvertebrate communities assessed within the Study area show variability amongst seasons particularly in the overall number of taxa present. This result is expected given the ephemeral nature of these watercourses, where the prevalence of wetted habitat would represent a key driver in macroinvertebrate community structure and ecosystem functioning.

Typically, the number of PET taxa, percentage of pollutant tolerant taxa and SIGNAL 2 scores fell within the DEHP (2011) 20:80 percentile guideline ranges derived for the Isaac River sub-basin. This result indicates that aquatic macroinvertebrate community assemblages comprised the expected number of pollutant tolerant and pollutant sensitive taxa. Consequently, these sites would be attributed with suitable quality physico-chemical conditions and habitat quality. This result was exemplified by many sites receiving an AusRivAS OE50 score within Band A (reference condition) or Band X (more biologically diverse than reference condition). However, several sites consistently displayed poor bio-indices scores indicating less than favourable conditions, and include:

- Ripstone Creek (R3) – which recorded low taxa richness, low PET taxa richness, low SIGNAL 2 score and a high percentage composition of pollution tolerant taxa from a sample collected during early wet conditions (2016). Low SIGNAL 2 scores combined with low taxa richness that may be attributed to urban, industrial or agricultural pollution (Chessman 2003).
- Isaac River sites R6 and R8 – which recorded low taxa richness in both bed and edge habitats in early wet conditions (2016) and late wet conditions (2017) in a bed sample (R6 only). Samples that were attributed with low taxa richness scores also received high SIGNAL 2 scores that likely indicates harsh physical conditions (Chessman 2003).
- An unnamed tributary of the Isaac River (site R13) – which recorded low PET taxa richness, a low SIGNAL 2 score and a high percentage of tolerant taxa during late wet conditions (2017), typically where bio-indices improved elsewhere across the Study area with a greater availability of surface water. This site was highly impacted by cattle that likely attributed to higher nutrient concentrations.

Macro-crustaceans

Five macro-crustacean families: Atyidae (freshwater shrimp), Gercarcinucidae (freshwater crabs), Palaemonidae (freshwater prawns), Parasticidae (freshwater crayfish) and Thamnocephalidae (fairy shrimp or *Branchinella sp*.), were encountered within the Study area. Individuals from the family Palaemonidae were identified as *Macrobrachium australiense*. Individuals from the family Gercarcinucidae were identified as inland freshwater crab (*Austrothelphusa transversa*). Individuals from the family Atyidae were identified as *Paratya australiense*. The family Parasticidae was represented by orange-fingered yabby (*Cherax depressus*). The fairy shrimp (*Branchinella* sp.) was identified to genus taxonomic level only. A list of species appears in Appendix C4.

5.7 Conservation Significant Species

5.7.1 Fishes

No fish species listed under the EPBC Act and / or NC Act were recorded during the surveys. The Wetland*Info* database identifies 53 fish species that have previously been recorded from the Fitzroy Basin (DES 2018b). Of these, three are listed as EVNT:

- Silver perch (*Bidyanus bidyanus*) – Critically Endangered (EPBC Act);
- Murray cod (*Maccullochella peelii*) – Vulnerable (EPBC Act); and
- Australian lungfish (*Neoceratodus forsteri*) – Vulnerable (EPBC Act).

Due to habitat requirements and distributional range, it is unlikely these EVNT species occur within waterbodies of the Study area as either resident or transient occurrences.

An additional EVNT fish species, the Vulnerable (EPBC Act and NC Act) honey blue-eye (*Pseudomugil mellis*), is identified in the ACA Expert Panel Report for non-riverine wetlands in the Fitzroy section of the GBR catchment (Rollason and Howell 2012). However, this species is not listed by Wetland*Info* as having been recorded from the Fitzroy Basin (DEHP 2018a) and is also unlikely to occur in the Study area.

The BoT Actions for Biodiversity for the Fitzroy NRM region (DERM 2010) report lists the ornate rainbowfish (*Rhadinocentrus ornatus*) as a Priority species (Table 12). An additional 11 Priority fish species are recorded by the ACA Expert Panel Reports for the Fitzroy section of the GBR catchment (Inglis and Howell 2009; Rollason and Howell 2012) (Table 12). During the late wet surveys (July 2017) one Priority species, golden perch (*Macquaria ambigua*), was recorded from the Isaac River (R8).

5.7.2 Reptiles

No reptile species listed under the EPBC Act and / or NC Act were recorded during the surveys.

The Wetland*Info* database identifies seven turtle species and the estuarine crocodile (*Crocodylus porosus*) as having previously been recorded from the Fitzroy Basin (DES 2018b). Of these, three are listed as EVNT:

- southern snapping turtle (*Elseya albagula*) – Critically Endangered (EPBC Act); Endangered (NC Act) (DES 2018g);
- Fitzroy River turtle (*Rheodytes leukops*) – Vulnerable (EPBC Act and NC Act); and
- estuarine crocodile (*Crocodylus porosus*) – Vulnerable (NC Act).

The southern snapping turtle and Fitzroy River turtle are also identified in the EPBC Act Protected Matters Report for the search area (DEE 2018a). There are no Priority aquatic reptile species identified in the Back on Track Actions for Biodiversity for the Fitzroy NRM region (DERM 2010) or ACA Expert Panel Reports for the Fitzroy section of the GBR catchment (Inglis and Howell 2009; Rollason and Howell 2012) that aren't also listed under the EPBC Act or NC Act (Table 13).

Due to habitat requirements and distributional range, it is unlikely that these EVNT turtle species occur within waterbodies of the Study area as either resident or transient occurrences.

5.7.3 Invertebrates

No aquatic invertebrates are identified in the EPBC Act Protected Matters Report, nor in the Back on Track Actions for Biodiversity for the Fitzroy NRM region (DERM 2010).

The Wetland*Info* database for the Fitzroy Basin (DEHP 2018a) identifies two macro-crustaceans and 20 wetland indicator insects as having previously been recorded from the Fitzroy Basin, none of which are listed in the EPBC Act or NC Act.

The ACA Expert Panel Report (riverine wetlands) for the Fitzroy sub-catchment of the GBR catchment (Rollason and Howell 2012) lists two Priority aquatic invertebrates: the spiny crayfish (*Euastacus monteithorum*) and the Eungella spiny crayfish (*E. eungella*). Due to their distributional range and high altitude requirements, it is unlikely these species occur in the Study area (Table 14).

Table 12 EVNT and Priority fish species recorded from the Fitzroy Basin and Study area

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell	DEE 2018a	DERM 2010	DES 2018b
EVNT species													
Bidyanus bidyanus	Silver perch	CE	LC			Faster-flowing water, including rapids and races, and more open sections of river, throughout the Murray-Darling Basin (MDB) (Clunie and Koehn 2001, cited in TSSC 2013).	**Unlikely**. Outside of natural area of distribution (ALA 2018). Distributional range is naturally in the MDB, although translocated to coastal streams in south-east Queensland (and other states). Preferred habitat does not occur within the Study area.	**Unlikely**. Not detected during field surveys.					✓
Maccullochella peelii	Murray cod	V	LC			Deep water with in-stream habitat such as boulders, logs, and overhanging vegetation (Allen et al. 2002). Found from fast-moving clear upland streams to slow-flowing, turbid lowland waters. Most individuals stay within 10 km reach of the river (Pusey	**Unlikely**. Outside of natural area of distribution (ALA 2018). Preferred habitat does not occur within Study area.	**Unlikely**. Not detected during field surveys.			✓		✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell	DEE 2018a	DERM 2010	DES 2018b
						et al. 2004; Allen et al. 2002).							
Neoceratodus forsteri	Australian lungfish	V	LC			Require shallow water and water plant cover for successful spawning. Inhabits mud, sand or gravel bottom. Prefers still or slow-flowing water, usually in deep pools (Pusey et al. 2004; Allen et al. 2002).	**Unlikely**. Only record in Fitzroy Basin is from the Dawson River between Cracow and Theodore in 1967 (ALA 2018).	**Unlikely**. Not detected during field surveys.					✓
Pseudomugil mellis	Honey blue-eye	V	V		R&T	Found in coastal lowland wallum, inhabiting flowing and still waterbodies. Generally found in areas with little or no flow, and where emergent and submerged aquatic plants are abundant (Pusey et al. 2004).	**Unlikely**. Outside of natural area of distribution (ALA 2018). Preferred habitat does not occur within the Study area.	**Unlikely**. Not detected during field surveys.		✓			

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell	DEE 2018a	DERM 2010	DES 2018b
Priority species													
Hephaestus fuliginosus	Sooty grunter		LC		✓	Found across a range of stream types from small tributaries to large lowland rivers, preferring flowing water of moderate depth, with juveniles most abundant in riffles and runs. Structural woody habitat, submerged root masses and bank undercuts are important habitat features (Pusey et al. 2004). Translocated populations in Fitzroy catchment are widely distributed (Pusey et al. 2004).	**Unlikely**. Natural distribution is outside of Study area, however species has been translocated into area encompassing the Study area. Preferred habitat does not occur within the Study area.	**Unlikely**. Not detected during field surveys.	✓	✓			✓
Kuhlia rupestris	Jungle perch		LC		✓	Patchily distributed in fast-flowing streams and rivers; however, also known to occur within floodplain lagoons. Usually occurs in	**Unlikely**. Outside of natural area of distribution (ALA 2018). Preferred habitat does not occur within the Study area.	**Unlikely**. Not detected during field surveys.	✓				

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell	DEE 2018a	DERM 2010	DES 2018b
						coastal rainforest drainages from the tip of the Cape York Peninsula south to Fraser Island (Allen et al. 2002).							
Lates calcarifer	Barramundi		LC		✓	Young live in freshwater upper reaches of rivers, favouring undercut banks, submerged logs and overhanging vegetation. Adults typically found in or near estuaries, often around mangroves in clear or turbid water (Allen et al. 2002).	**Unlikely**. Outside of natural area of distribution (ALA 2018). Preferred habitat does not occur within the Study area.	**Unlikely**. Not detected during field surveys.	✓	✓			✓
Macquaria ambigua	Golden perch		LC		✓	Predominantly found in lowland warmer, turbid, slow-flowing rivers, often in association with structural woody habitat and other cover. A wide-ranging species with a natural	**Likely**. The species habitat is known to occur in the broader search area and there are records within 10 km of the Study area.	**Known**. Recorded in the Study area at site R8 (Isaac River).	✓				✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell	DEE 2018a	DERM 2010	DES 2018b
						distribution throughout the Murray-Darling, Fitzroy, Lake Eyre and Bullaroo River basins (Pusey et al. 2004).							
Megalops cyprinoides	Oxeye herring/ tarpon		LC		✓	Juveniles and small adults occasionally occur within the freshwater reaches of coastal streams of Queensland; however, most commonly occurs in estuarine and marine waters (Allen et al. 2002).	**Unlikely**. Outside of normal area of distribution (ALA 2018). Preferred habitat does not occur within the Study area.	**Unlikely**. Not detected during field surveys.	✓	✓			✓
Mugil cephalus	Sea mullet		LC		✓	Found around the entire mainland coast of Australia, primarily occurring in brackish waters, although known to enter lower reaches of freshwater rivers (Allen et al. 2002).	**Unlikely**. Preferred habitat does not occur within the Study area.	**Unlikely**. Not detected during field surveys.	✓	✓			✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell	DEE 2018a	DERM 2010	DES 2018b
Ophiocara porocephala	Spangled gudgeon		LC		✓	Distributed in brackish estuaries and river mouths; however, also found in freshwater bodies at low elevations around the northern and eastern coasts of Australia (Allen et al. 2002).	**Unlikely**. Preferred habitat does not occur within the Study area.	**Unlikely**. Not detected during field surveys.	✓	✓			
Rhadinocentrus ornatus	Ornate rainbowfish		LC	H/ H	✓	Coastal lowland wallum and rainforest ecosystems; often in association with dense emergent and submerged vegetation / woody debris, leaf litter and undercut banks (Allen et al. 2002).	**Unlikely**. Preferred habitat does not occur within the Study area.	**Unlikely**. Not detected during field surveys.				✓	✓
Scleropages leichardti	Southern saratoga		LC		✓	Billabongs or large pools in slow-flowing streams, usually in fairly turbid conditions. Often associated with abundant large in-stream wood,	**Unlikely**. Preferred habitat does not occur within the Study area.	**Unlikely**. Not detected during field surveys.	✓	✓			✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell	DEE 2018a	DERM 2010	DES 2018b
						undercut banks and overhanging vegetation. Endemic to the Fitzroy River basin (Allen et al. 2002).							
Scortum hillii	Leathery grunter		LC		✓	Endemic to the Fitzroy River where it occurs in flowing freshwater streams and still pools. Most common in lower reaches of larger rivers and estuaries (Allen et al. 2002).	**Unlikely**. Preferred habitat does not occur within the Study area.	**Unlikely**. Not detected during field surveys.	✓	✓			✓
Strongylura krefftii	Freshwater longtom		LC		✓	Variety of habitats, including floodplain lagoons, main channels of rivers, sandy bed creeks and perennial escarpment streams (Pusey et al. 2004).	**Potential**. Natural distribution encompasses the Study area. Preferred habitat may occur within the Study area.	**Unlikely**. Not detected during field surveys.	✓	✓			✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell	DEE 2018a	DERM 2010	DES 2018b
Trachystoma petardi	Pinkeye mullet		LC		✓	Deep, gently flowing rivers; as well as estuaries and coastal seas on the east coast of Australia (Allen et al. 2002).	**Unlikely**. Preferred habitat does not occur within the Study area.	**Unlikely**. Not detected during field surveys.	✓	✓			✓

Notes:

E = Endangered, V = Vulnerable, LC = Least Concern, C = Critical priority, H = High Priority, M = Medium Priority, P = Priority, R&T = Rare and Threatened.

1. EPBC Act = status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
2. NC Act = status under the Queensland *Nature Conservation Act 1992*.
3. Back on Track = status under the DERM (2010) Fitzroy Natural Resource Management Region – Back on Track Actions for Biodiversity.
4. ACA = status under the Aquatic Conservation Assessments using AquaBAMM for riverine and non-riverine wetlands of the Great Barrier Reef catchments (Inglis and Howell 2009; Rollason and Howell 2012).

References:

- Inglis and Howell 2009, Aquatic Conservation Assessments using AquaBAMM for the riverine wetlands of the Great Barrier Reef catchment: Fitzroy region.
- Rollason and Howell 2012, Aquatic Conservation Assessments using AquaBAMM for the non-riverine wetlands of the Great Barrier Reef catchment: Fitzroy region
- Commonwealth Department of the Environment and Energy (DEE) 2018, EPBC Act Protected Matters Report – created 24/04/2018.
- Queensland Department of Environment and Resource Management (DERM) 2010, Fitzroy Natural Resource Management Region – Back on Track Actions for Biodiversity.
- Queensland Department of Environment and Science(DES) 2018b, Wetland*Info* – Fitzroy Basin – Wetland Summary Information.

Table 13 EVNT and Priority aquatic reptiles recorded from the Fitzroy Basin and search area

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2018a	DERM 2010	DES 2018b
Crocodylus porosus	Estuarine crocodile	Mi	V		R & T	Coastal waterways and floodplain wetlands; but may be found hundreds of kilometres upstream, such as in the Fitzroy River and the waterways of the southern Gulf of Carpentaria (Read et al. 2004).	**Unlikely**. Potential habitat does not occur within the Study area.	**Unlikely**. Not found during field surveys.	✓	✓	✓		✓
Rheodytes leukops	Fitzroy River turtle	V	V	H/ H	R & T	Fast-flowing water of the Fitzroy River and its tributaries (Cogger 2014). Rivers with large deep pools and rocky, gravelly or sandy substrates, connected by shallow riffles. Preferred areas have high water clarity, and are often associated with ribbonweed (*Vallisneria* sp.) (DEE 2018).	**Unlikely**. Potential habitat does not occur within the Study area.	**Unlikely**. Not found during field surveys.	✓		✓	✓	✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2018a	DERM 2010	DES 2018b
Elseya albagula	Southern snapping turtle	C E	E	H/ H	P	Permanent flowing water habitats where there are suitable shelters and refuges (DEHP 2018a); clear, flowing, well-oxygenated waters (Todd et al. 2013) of the Fitzroy, Mary and Burnett catchments.	**Unlikely**. Potential habitat does not occur within Study area.	**Unlikely**. Not found during field surveys.	✓			✓	✓

Notes:

E = Endangered, V = Vulnerable, LC = Least Concern, C = Critical Priority, H = High Priority, M = Medium Priority, P = Priority, R&T = Rare and Threatened, Mi = Migratory.

1. EPBC Act = status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
2. NC Act = status under the Queensland *Nature Conservation Act 1992*.
3. Back on Track = status under the DERM (2010) Fitzroy Natural Resource Management Region – Back on Track Actions for Biodiversity.
4. ACA = status under the Aquatic Conservation Assessments using AquaBAMM for riverine and non-riverine wetlands of the Great Barrier Reef catchments (Inglis and Howell 2009; Rollason and Howell 2012).

References:

- Inglis and Howell 2009, Aquatic Conservation Assessments using AquaBAMM for the riverine wetlands of the Great Barrier Reef catchment: Fitzroy region.
- Rollason and Howell 2012, Aquatic Conservation Assessments using AquaBAMM for the non-riverine wetlands of the Great Barrier Reef catchment: Fitzroy region
- Commonwealth Department of the Environment and Energy (DEE) 2018a, EPBC Act Protected Matters Report – created 24/04/2018.
- Queensland Department of Environment and Resource Management (DERM) 2010, Fitzroy Natural Resource Management Region – Back on Track Actions for Biodiversity.
- Queensland Department of Environment and Science (DES) 2018b, Wetland*Info* – Fitzroy Basin – Wetland Summary Information.

Table 14 Priority invertebrate species recorded from the Fitzroy Basin NRM region

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2018a	DERM 2010	DES 2018b
Euastacus eungella	Eungella spiny crayfish				✓	Only a small population restricted to localities >740 m above sea level in tropical rainforest headwaters and seepages in the Clarke Range, 65km west of Mackay (Coughran and Furse 2010).	**Unlikely**. Outside of known distributional range.	**Unlikely**. Not found during field surveys.		✓			
Euastacus monteithorum	A spiny crayfish				✓	Cool, clear, fast-flowing headwaters in rainforest areas at >800 m above sea level. Prefers heavily shaded, well oxygenated waters where it can burrow under logs and rocks. Known from only one location: Kroombit Tops National Park, 62 km south-west of Gladstone (Coughran and Furse 2010).	**Unlikely**. Outside of known distributional range.	**Unlikely**. Not found during field surveys.		✓			

Notes:

1. EPBC Act = status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
2. NC Act = status under the Queensland *Nature Conservation Act 1992*.
3. Back on Track = status under the DERM (2010) Fitzroy Natural Resource Management Region – Back on Track Actions for Biodiversity.
4. ACA = status under the Aquatic Conservation Assessments using AquaBAMM for riverine and non-riverine wetlands of the Great Barrier Reef catchments (Inglis and Howell 2009; Rollason and Howell 2012).

5.8 Introduced Species

5.8.1 Introduced aquatic flora

There are 24 introduced wetland indicator plant species known from the Fitzroy Basin (DES 2018b). Those invasive species considered to pose a particular threat to aquatic biodiversity, and that could potentially occur within the Study area, are listed in Table 15 as either a WoNS or Restricted matter category 3 under the Queensland *Biosecurity Act 2014*. Only two of these species were recorded in the Study area, awnless barnyard grass (*Echinochloa colona*) and white eclipta (*Eclipta prostrata*).

Table 15 Introduced wetland indicator plants known to occur in the Fitzroy Basin, and potentially in the Study area

Scientific name	Common name	National status^	Biosecurity Act status*
Arundo donax			
Cyperus esculentus	Yellow nutgrass		
Cyperus involucratus			
Cyperus papyrus	Papyrus		
Diplachne fusca			
Diplachne fusca var. uninervia			
Echinochloa colona	**Awnless barnyard grass**		
Echinochloa crus-galli	Barnyard grass		
Echinodorus cordifolius subsp. *cordifolius*			
Eclipta prostrata	**White eclipta**		
Eichhornia crassipes	water hyacinth	WoNS	Restricted 3
Eleocharis minuta			
Hymenachne aplexicaulis	Olive hymenachne	WoNS	Restricted 3
Juncus bufonius	Toad rush		
Nymphaea caerulea	Cape waterlily		
Pistia stratiotes	Water lettuce		Restricted 3
Polypogon monspeliensis	annual beardgrass		
Rorippa nasturtium-aquaticum	Watercress		
Salix babylonica	Weeping willow		
Salvinia molesta	Salvinia	WoNS	Restricted 3
Sparganium erectum subsp. stoloniferum	Erect bur-reed		
Spirodela oligorrhiza			
Stenotaphrum secundatum	Buffalo grass		
Urochloa mutica	Para grass		

Notes:

^ Species listed as WoNS; * species listed under the Queensland *Biosecurity Act 2014*.

5.8.2 Pest fish species

Four introduced fish species have been recorded from the Fitzroy Basin: mosquito fish (*Gambusia holbrooki*), guppy (*Poecilia reticulata*), goldfish (*Carassius auratus*) and European carp (*Cyprinus carpio*) (DES 2018b), as well as more recent records of tilapia (*Oreochromus mossambicus*) and platy (*Xiphophorus maculatus*) (Catchment Solutions 2015) (Table 16).

An additional two species are identified in the ACA Expert Panel reports for the Fitzroy section of the GBR catchments (Inglis and Howell 2009; Rollason and Howell 2012): swordtail (*Xiphophorus helleri*) and spotted tilapia (*Tilapia mariae*). Six of these pest fish species have potential to occur in the Study area (Table 16).

Two pest fish species were encountered during the early wet surveys, being tilapia (*Oreochromus mossambicus*) and mosquito fish (*Gambusia holbrooki*). Tilapia is a noxious species listed as restricted categories 3, 5, 6 and 7 under the *Biosecurity Act 2014*. This species was introduced into Australia in the 1970s as an ornamental fish and is now regarded as one of the greatest threats to Australia's native biodiversity (DAF 2017a). Females carry juveniles and eggs in their mouths, and these can survive for a considerable time after the adult dies (DAF 2017a). Consequently, this species is able to persist drying of waterways, aiding their incursion.

Tilapia does not appear in the WetlandInfo list of species recorded from the Fitzroy Basin (DEHP 2018a), owing to its relatively recent discovery in the basin. In 2015, Catchment Solutions Pty Ltd (Catchment Solutions) conducted electrofishing, seine netting and environmental DNA (eDNA) sampling for tilapia at six locations on Grosvenor Creek, Sandy Creek and three locations on the Isaac River. The sampling was undertaken in response to confirmed reports of tilapia at a number of locations around Moranbah, and as part of a wider investigation being conducted by Reef Catchments Limited and the Fitzroy Basin Association. Tilapia were captured by Catchment Solutions in Grosvenor Creek, but only eDNA indications were recorded from the Isaac River itself (downstream of Grosvenor Creek). The confirmation of tilapia in the Study area suggests an incursion pathway along Isaac River and Ripstone Creek.

Mosquito fish is a noxious species listed as restricted categories 3, 5, 6 and 7 under the *Biosecurity Act 2014*. This species was introduced into Australia from North America in 1929 as a biological control for mosquitos, however, this was unsuccessful and the species is now regarded as one of the greatest threats to Australia's native biodiversity (DAF 2017a). The mosquito fish has many traits that make them a good invader such as high reproductive potential, flexible diet, broad environmental tolerances and low vulnerability to predation due to burrowing habit and they have the potential to rapidly outnumber native fish and dominate aquatic communities (DAF 2017a).

Pest fishes can cause a variety of issues within the aquatic environment, such as competing with native fish for food and habitat, preying on native species, habitat disturbance and introduction of disease. Typically, established introduced species have a wide range of environmental tolerances, habitat requirements and food requirements. In addition, they tend to have high reproductive rates and be early maturing, allowing populations to become readily established. These attributes often allow introduced fishes to be more adaptable to changes in the environment, whether natural or manmade, than some native fish species.

Native fish communities within the Study area did not appear to be adversely affected by the presence of tilapia. However, this may change over time as the size and abundance of tilapia increases.

5.8.3 Introduced aquatic reptiles

No introduceed reptile species were recorded during the surveys and none were identified from the desktop review as having potential to occur in the Study area.

Table 16 Introduced fish species recorded from the Fitzroy Basin

Scientific name	Common name	Preferred habitat	Negative impacts on native fish	Likelihood of occurrence in the Study area based on desktop	Likelihood of occurrence in the Study area post field survey	Data Source			
						Inglis and Howell	Rollason and Howell	DES 2018b	Catchment Solutions 2015
Carassius auratus	Goldfish	Inhabits still or slow-flowing water. Able to withstand high temperatures and low dissolved oxygen. Often associated with aquatic flora (Lintermans 2007).	Typically referred to as a "benign" species, with few impacts recorded. Introduced the "goldfish ulcer" disease to other fish (Lintermans 2007).	**Potential**. The species habitat is known to occur in the broader search area and there are records within 50 km of the Study area.	**Potential**. Not found during field surveys.	✓	✓	✓	
Gambusia holbrooki	Mosquito fish	Often found in lakes or still/slow flowing water; typically around edges or vegetation. Tolerant of a wide range of water temperatures, oxygen levels, salinities and turbidity (Lintermans 2007).	High ability to breed leads to plague number in many habitats. Aggressive species, chasing and fin-nipping other species. Prey on eggs of native fish and frogs, and native fish larvae. Implicated in the decline of over 30 fish species worldwide (Lintermans 2007).	**Likely**. The species habitat is known to occur in the broader search area and there are records within 10 km of the Study area.	**Known**. The species habitat is recorded in R3 (tributary of Ripstone Creek) in the Study area.	✓	✓	✓	

Scientific name	Common name	Preferred habitat	Negative impacts on native fish	Likelihood of occurrence in the Study area based on desktop	Likelihood of occurrence in the Study area post field survey	Data Source			
						Inglis and Howell	Rollason and Howell	DES 2018b	Catchment Solutions 2015
Oreochromis mossambicus	Tilapia	Habitat variable, including reservoirs, lakes, ponds, rivers, creeks, drains, swamps, and tidal creeks. Usually over mud bottoms, often in well-vegetated areas (Allen et al. 2002).	Competition with native species for food and space; predation upon the eggs and young of native species; aggressive behaviour toward native species; and destructive nest building by males (NSW DPI 2017).	**Likely**. The species habitat is known to occur in the broader search area and there are records within 10 km of the Study area.	**Known**. Recorded from the Isaac River and a tributary of Ripstone Creek within the Study area.				✓
Poecilia reticulata	Guppy	Wide variety of habitats – pristine to turbid, high to low elevations, fresh to brackish water; usually in small streams and amongst vegetation (Lintermans 2007).	No negative impacts yet known.	**Potential**. The species habitat is known to occur in the broader search area and there are records within 50 km of the Study area.	**Unlikely**. Not found during field surveys.	✓	✓	✓	

Scientific name	Common name	Preferred habitat	Negative impacts on native fish	Likelihood of occurrence in the Study area based on desktop	Likelihood of occurrence in the Study area post field survey	Data Source			
						Inglis and Howell	Rollason and Howell	DES 2018b	Catchment Solutions 2015
Tilapia mariae	Spotted tilapia/ Black mangrove cichlid	Inhabits still or flowing waters in rocky or muddy substrates, tolerating a wide range of environmental conditions. Has little habitat requirements, variable dietary requirements and an ability to rapidly colonise a variety of habitats, including disturbed ecosystems (Bradford et al. 2011).	Competes for resources. Aggressive towards other fish species (Bradford et al. 2011).	**Unlikely**. Although identified in the ACAs (Inglis and Howell 2009, Rollason and Howell 2012), ALA (2018) identifies *T. mariae* as currently restricted to Brisbane, Townsville and Cairns.	**Unlikely**. Not found during field surveys.	✓	✓		
Xiphophorus helleri	Swordtail	Favours warm water near edges of creeks and drains amongst weeds (Allen et al. 2002).	Compete with native fishes for resources. High fecundity and can quickly become the dominant species in a waterbody as a result (Allen et al. 2002).	**Potential**. The species habitat is known to occur in the broader search area and there are records within 50 km of the Study area.	**Unlikely**. Not found during field surveys.	✓	✓		

Scientific name	Common name	Preferred habitat	Negative impacts on native fish	Likelihood of occurrence in the Study area based on desktop	Likelihood of occurrence in the Study area post field survey	Data Source			
						Inglis and Howell	Rollason and Howell	DES 2018b	Catchment Solutions 2015
Xiphophorus maculatus	Platy	Occurs in a few creeks and swamps around Queensland, favouring warmer, static waters (Allen et al 2002).	Compete with native fishes for resources. High fecundity and can quickly become the dominant species in a waterbody as a result (Allen et al. 2002).	**Potential**. The species habitat is known to occur in the broader search area and there are records within 50 km of the Study area.	**Unlikely**. Not found during field surveys.	✓	✓		✓

References:

- Inglis and Howell 2009, Aquatic Conservation Assessments using AquaBAMM for the riverine wetlands of the Great Barrier Reef catchment: Fitzroy region.
- Rollason and Howell 2012, Aquatic Conservation Assessments using AquaBAMM for the non-riverine wetlands of the Great Barrier Reef catchment: Fitzroy region
- Queensland Department of Environment and Science (DES) 2018b, Wetland*Info* – Fitzroy Basin – Wetland Summary Information.

5.9 Groundwater dependent ecosystems

Groundwater-Dependent Ecosystems (or GDEs) are ecosystems that rely upon groundwater for their continued existence. GDEs may be 100% dependent on groundwater, such as aquifer GDEs, or may access groundwater intermittently to supplement their water requirements, such as riparian tree species in arid and semi-arid areas (IESC 2018). Desktop mapping of potential GDEs throughout Queensland (DSITI 2017 and BoM 2017) indicates terrestrial and aquatic ecosystems with possible high, moderate and low potential for groundwater interaction to occur within the Project locality. The desktop GDE mapping (DSITI 2017 and BoM 2017) indicates (Figure 28):

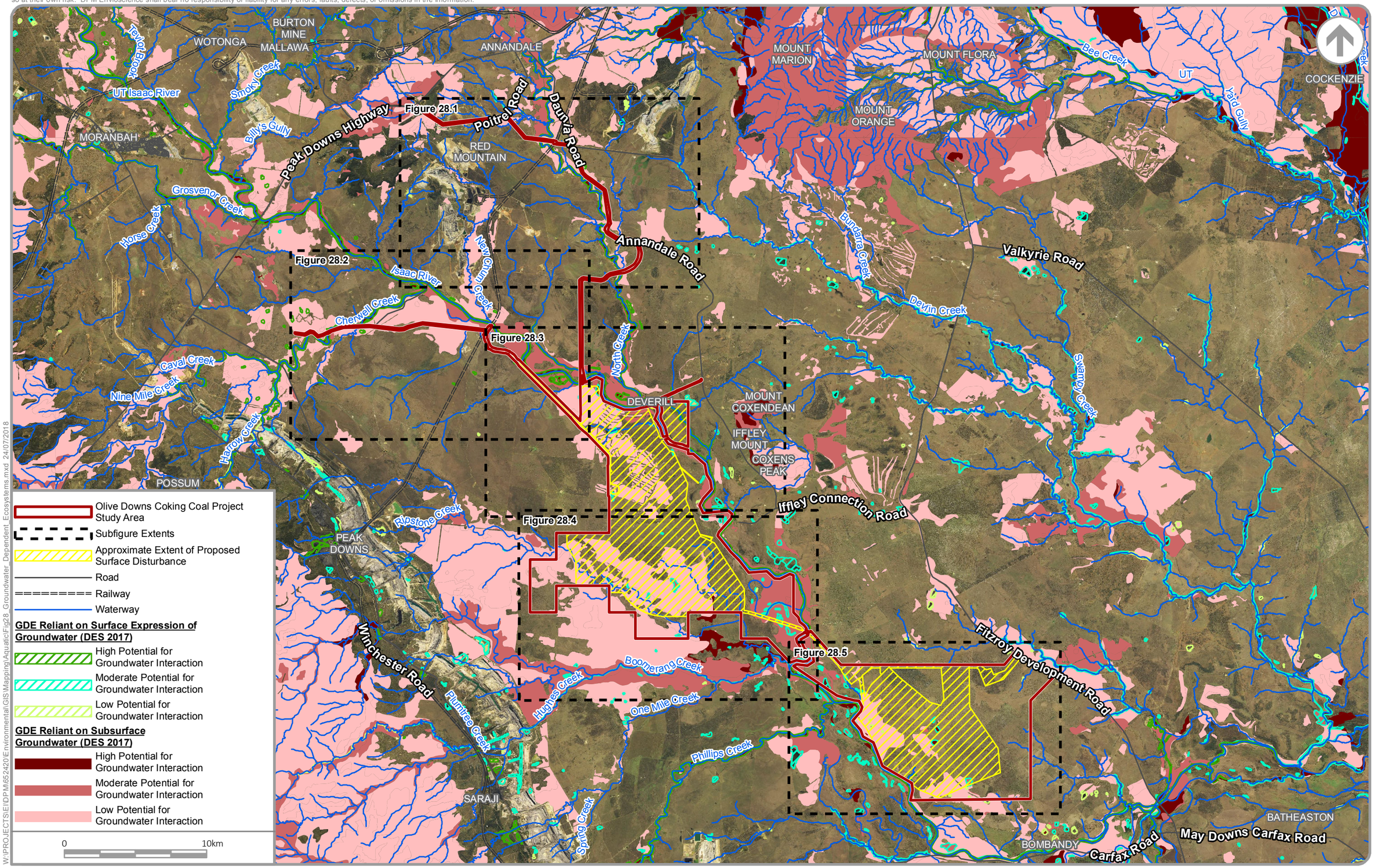
- Terrestrial riparian vegetation associated with the Isaac River, North Creek, Cherwell Creek and Ripstone Creek is mapped as having a high potential to be dependent on subsurface expression of groundwater.
- Aquatic habitat within the Isaac River, North Creek, Cherwell Creek and smaller associated tributaries are mapped as having a high potential to be dependent on the surface expression of groundwater.
- Terrestrial vegetation and aquatic habitat associated with a number of palustrine wetlands surrounding the Olive Downs South and Willunga domains is mapped as having a moderate potential to be associated with the surface expression of groundwater.
- Of the remaining terrestrial vegetation within the Project locality, the majority is shown as having a low to moderate potential to be dependent on subsurface groundwater, with vegetation near creeks / drainage lines mapped as having moderate potential.

The accuracy of the desktop GDE mapping (DSITI 2017 and BoM 2018) of the Project locality has been reviewed by HydroSimulations (2018) and DPM Enviroscences, with the following conclusions made based on site observations:

- The terrestrial riparian vegetation associated with the Isaac River, North Creek, Cherwell Creek and the downstream reaches of Ripstone Creek have a high potential to be dependent on subsurface groundwater. This is because the vegetation (RE 11.3.25) is dominated by forest red gum (*Eucalyptus tereticornis*) and river oak (*Casuarina cunninghamiana*), both species have been shown to access groundwater in other locations (IESC 2018) and the groundwater table in this area is likely to be located at a depth which could be accessed by these species. HydroSimulations (2018) has indicated that the alluvium appears to be saturated at a depth of approximately 10 mbgl adjacent / underlying the Isaac River and lower reaches of the creeks at the confluence with the Isaac River (HydroSimulations 2018).
- Aquatic habitats within the Isaac River, North Creek, Cherwell Creek and smaller associated tributaries also have a high potential to intermittently use the surface expression of groundwater during occasional periods of baseflow from the adjacent / underlying alluvium after prolonged rainfall events or following flood events (HydroSimulations 2018). Under these conditions, recharged alluvium may drain to the watercourses as the hydraulic gradient reverses, the result of which may sustain stream-flow for short periods (in the order of days to possibly weeks in the lower reaches) depending on the sequence of rainfall events (HydroSimulations 2018).
- Terrestrial and aquatic habitat associated with the palustrine wetlands surrounding the Olive Downs South and Willunga domains are unlikely to be dependent on groundwater given that groundwater levels in these areas have been identified as being in excess of 10 mbgl (Hydrosimulations 2018). Localised perched water tables are evident where waterbodies, such as these palustrine wetlands, continue to hold water throughout the dry period, occurring where clay layers slow the percolation of surface water (HydroSimulations 2018). It is likely that these wetlands rely on the slow percolation of surface water after rainfall events rather than direct access to the groundwater system.

- The remaining vegetation communities within the Project locality are dominated by Poplar box (Eucalyptus populnea; a key constituent of RE 11.5.3 and RE 11.3.2), poplar gum (Eucalyptus platyphylla; a common constituent of RE 11.5.17) and Clarkson's bloodwood (Corymbia clarksoniana; a key constituent of RE 11.3.7). While poplar gum and Clarkson's bloodwood have been shown to access groundwater to a depth reaching 10 mbgl (IESC 2018), the maximum rooting depths for poplar box are unknown (Kath et al. 2014) Despite this, it is expected that rooting depths for poplar box would be similar to other eucalypts and corymbias occurring in the vicinity (i.e. up to a maximum of 10 m). Given that HydroSimulations has determined groundwater levels within the Olive Downs South and Willunga domains to range from 10 to 17 mbgl, the vegetation communities beyond the riparian corridors of the Isaac River, North Creek and Cherwell Creek have a low likelihood of being dependent on the presence of groundwater.

In summary, the terrestrial riparian vegetation (RE 11.3.25) and aquatic habitats associated with the Isaac River are likely to be GDEs. The terrestrial riparian vegetation (RE 11.3.25) associated with North Creek, Cherwell Creek and the downstream reaches of Ripstone Creek may also be a GDE.



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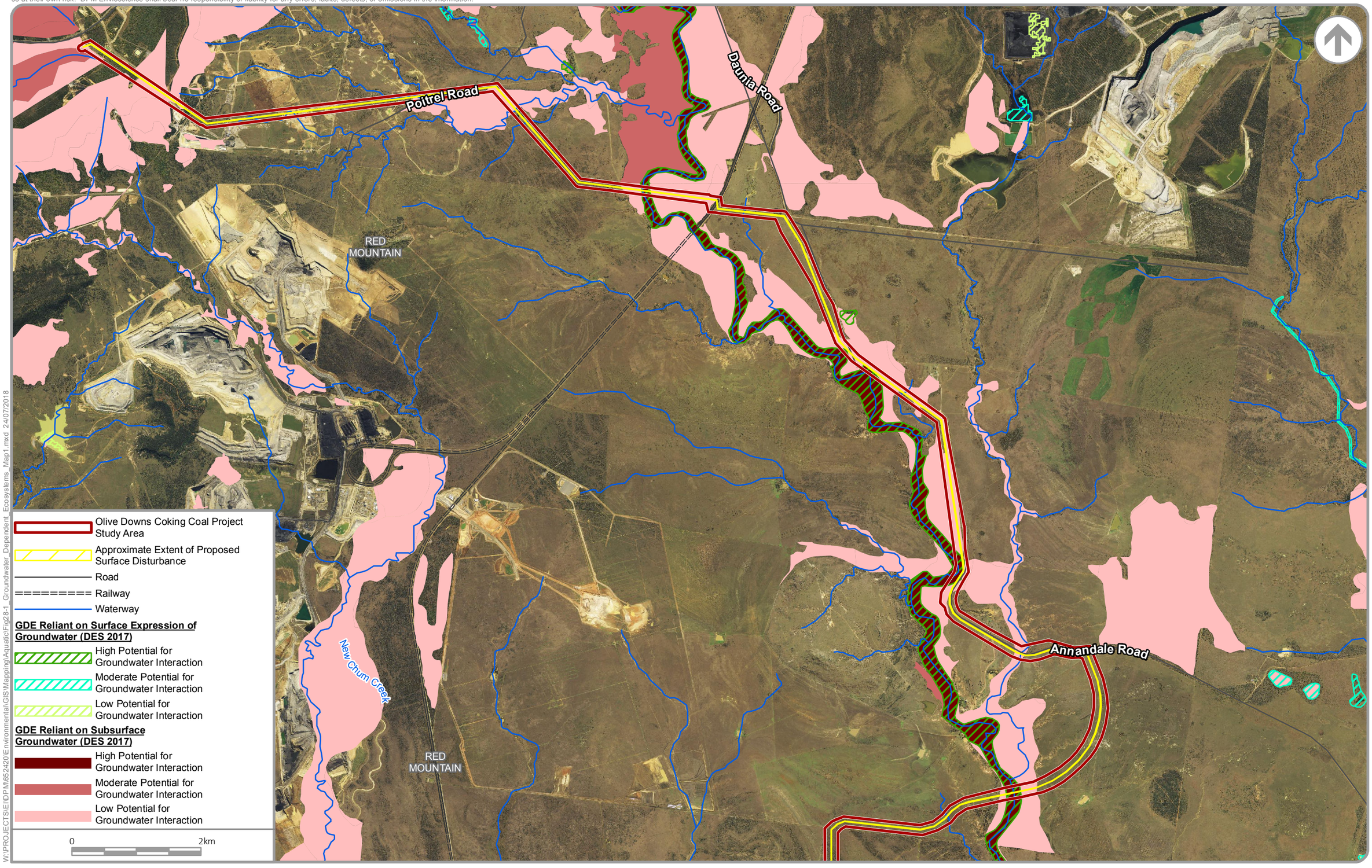
DPM ENVIROSCIENCES

GROUNDWATER DEPENDENT ECOSYSTEMS

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 28



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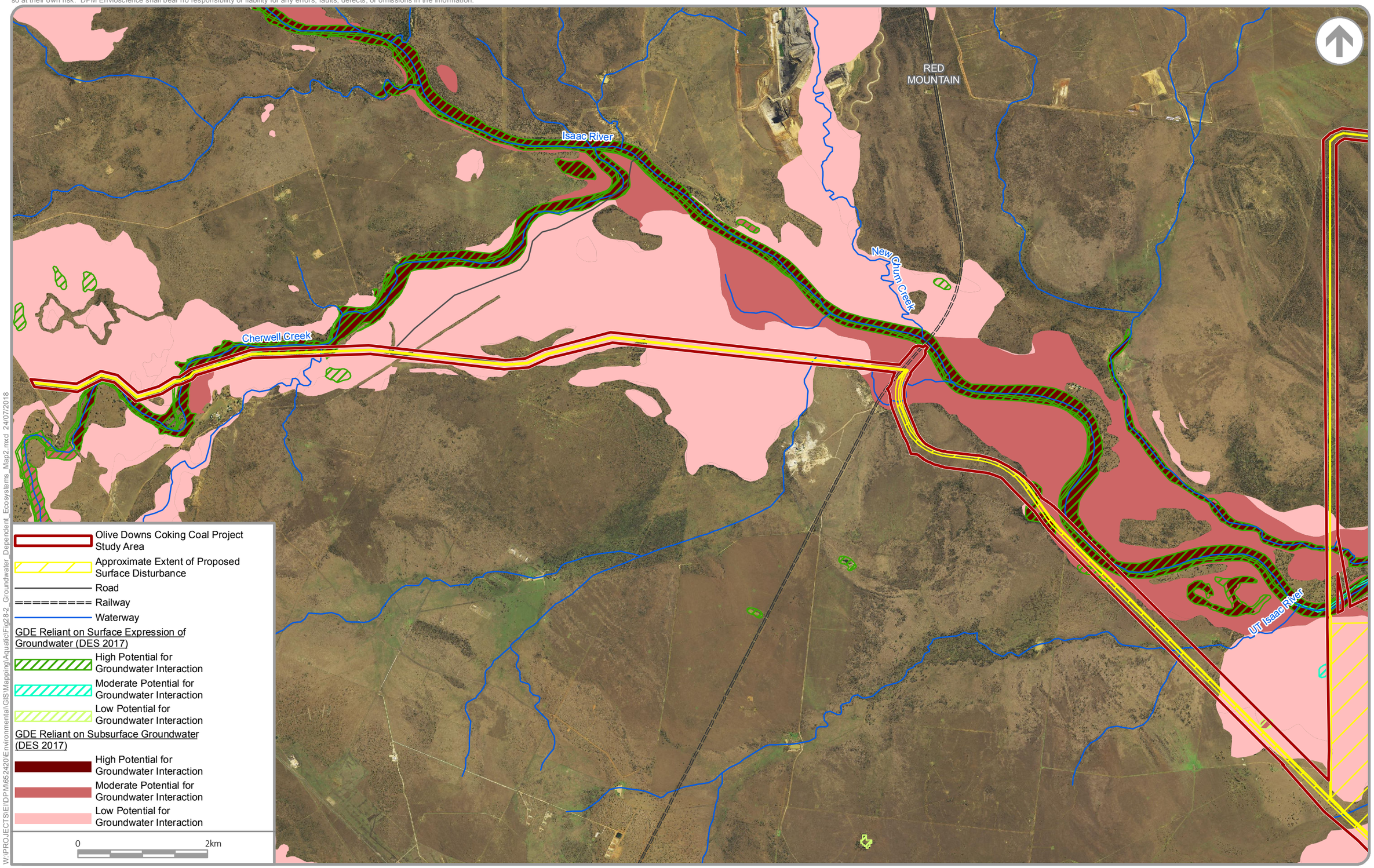
DPM ENVIROSCIENCES

GROUNDWATER DEPENDENT ECOSYSTEMS – MAP 1

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 28.1



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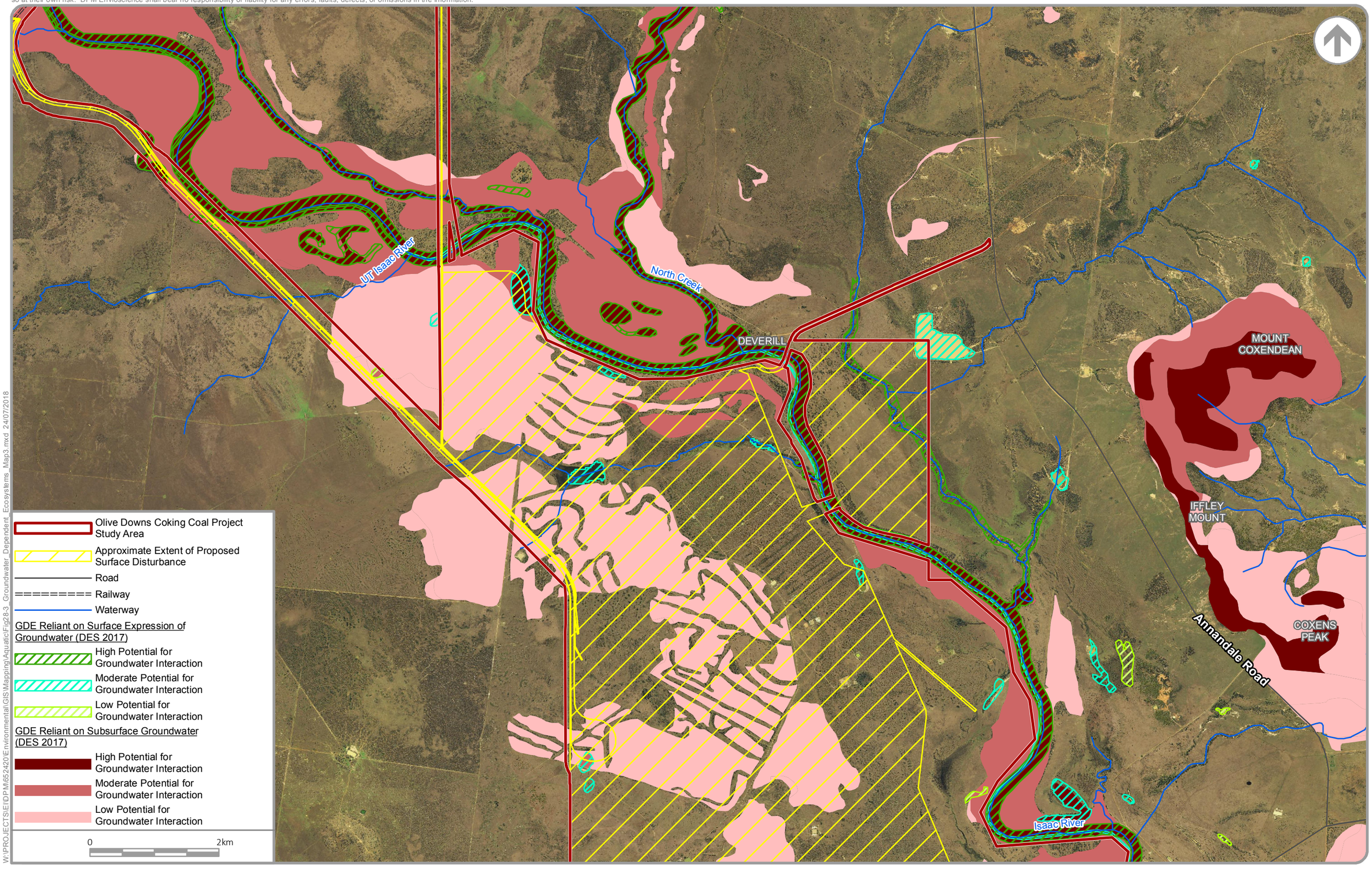
DPM ENVIROSCIENCES

GROUNDWATER DEPENDENT ECOSYSTEMS – MAP 2

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 28.2



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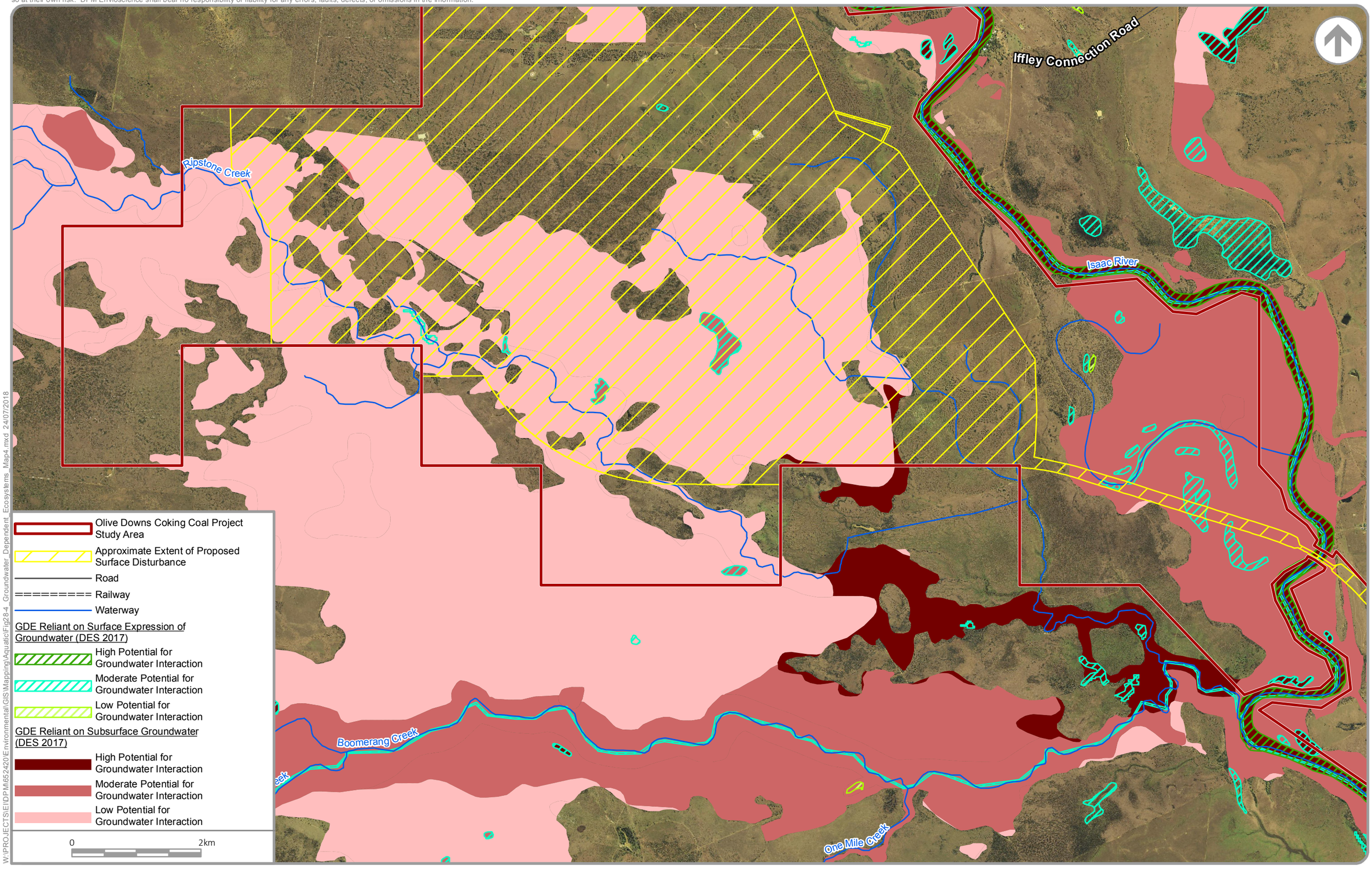
DPM ENVIROSCIENCES

GROUNDWATER DEPENDENT ECOSYSTEMS – MAP 3

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 28.3



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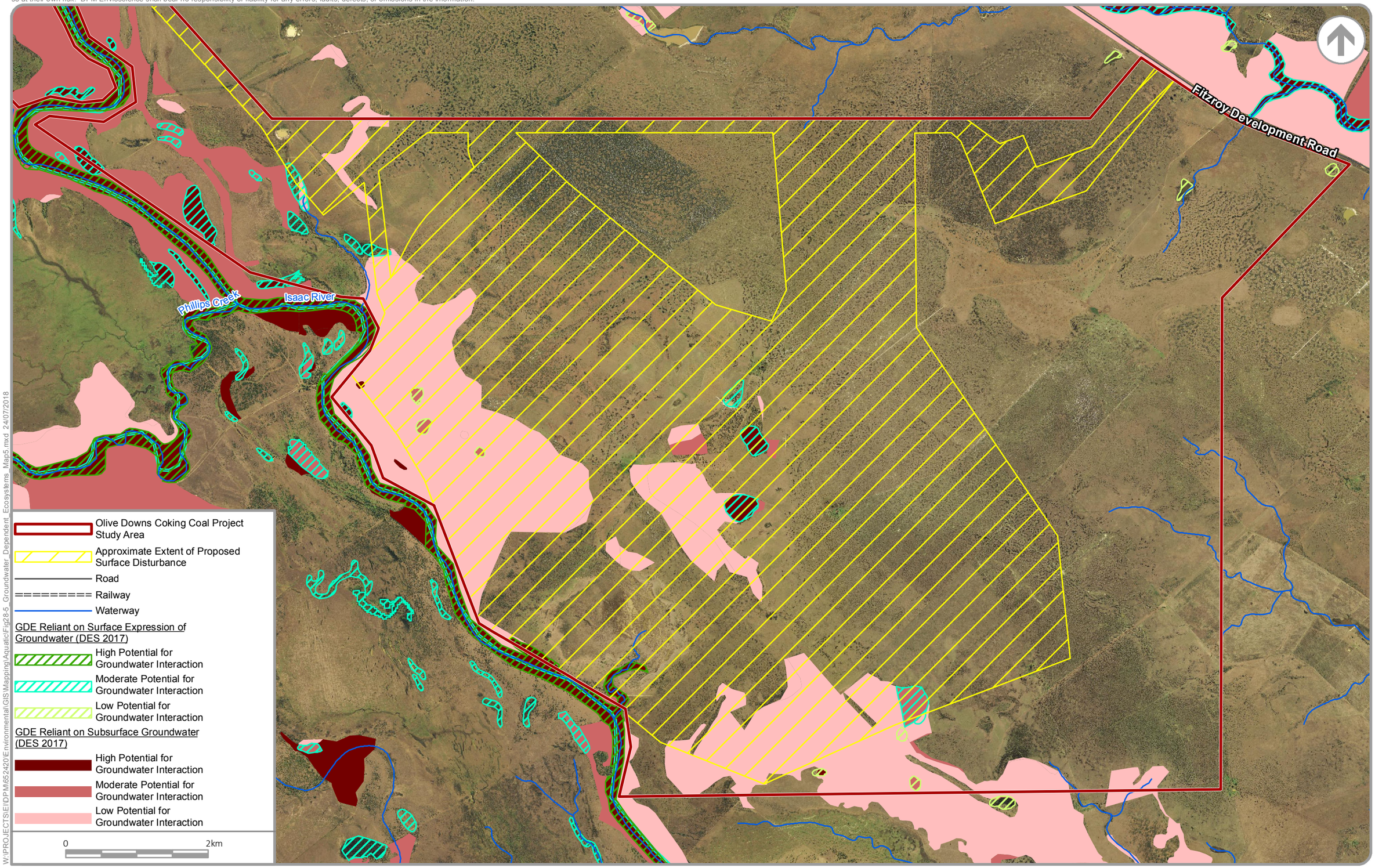
DPM ENVIROSCIENCES

GROUNDWATER DEPENDENT ECOSYSTEMS – MAP 4

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 28.4



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DPM ENVIROSCIENCES

GROUNDWATER DEPENDENT ECOSYSTEMS – MAP 5

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 28.5

5.10 Stygofauna

5.10.1 Desktop review results

As described in Section 4.4.2, the desktop review involved:

- assessing the suitability of local habitat for stygofauna based on local geological and hydrological conditions; and
- determining the presence and composition of stygofauna in the region and Project locality based on previous studies.

Suitability of Local Habitat for Stygofauna

4T Consultants Pty Ltd (4T) (4T 2012) prepared a desktop assessment of at least 13 stygofauna studies in the Bowen Basin and other selected studies in Queensland and established water quality conditions in which stygofauna were likely to be found.

4T (2012) concluded that stygofauna are rare or unlikely to occur in bedrock within the Bowen Basin. Based on site geological logs, the regolith material comprises a heterogeneous distribution of fine to coarse grained sand, clay, sandstone and claystone. The regolith material is generally 15 m to 45 m thick (Figure 29) (HydroSimulations 2018). The regolith material comprises low permeability strata (i.e. clay and claystone), which likely restricts rainfall recharge (HydroSimulations 2018).

Water within the regolith material is generally highly saline, but can be brackish to moderately saline with an average TDS of 9,757 mg/L, ranging between 1,460 mg/L and 18,600 mg/L (HydroSimulations 2018). Further to this, ongoing groundwater monitoring conducted at the Project includes two monitoring bores intersecting the regolith that have remained dry (unsaturated) between June 2017 and February 2018 (HydroSimulations 2018). Similar unsaturated conditions have been recorded for exploration holes intersecting the regolith across the Project site (HydroSimulations 2018) indicating that this material is unlikely to provide suitable habitat for stygofauna.

Overall, the regolith is considered to be largely unsaturated, with the presence of highly saline water occurring in the lower elevation areas along the Isaac River and the lower reaches of its tributaries (i.e. Ripstone Creek).

4T (2012) concluded that stygofauna are likely to occur in the unconsolidated sediments (alluvium) associated with the Isaac River. The alluvium is present in the Project area and surrounds on the northern and eastern edge of the Olive Downs South domain and on the western edge of the Willunga domain. The extent and thickness of the unconsolidated sediments was assessed using a TEM survey, verified with site geological logs, conducted by Groundwater Imaging Pty Ltd in July 2017 (HydroSimulations 2018).

The surficial alluvium along the upper reaches of tributaries to the Isaac River is largely dry, however the alluvium of the Isaac River and lower reaches of the creeks at the confluence with the Isaac River does appear saturated (HydroSimulations 2018).

While water within the Isaac River is largely fresh, water within the alluvium has recorded ranges from fresh to moderately saline with an average TDS of 1,458 mg/L, ranging between 201 mg/L and 3,430 mg/L (HydroSimulations 2018).

For unconsolidated sediments, 4T predict that stygofauna are most likely to be found at shallow depths (<20 m SWL) and at EC levels of 2,000 µS/cm (approximately 1,340 mg/L TDS) or less (fresh to marginal water). 4T (2012) predict that stygofauna are still possible between 20-50 m SWL, and report that stygofauna have not been recorded in Queensland within groundwater with EC greater than 20,000 µS/cm (approximately 13,400 mg/L TDS).

Stygofauna Potential Presence

Consistent with the findings by 4T (2012), the generally poor groundwater quality (indicated by EC levels up to 26,800 µs/cm) within the regolith material suggests the groundwater environment is unsuitable for stygofauna.

Also consistent with the findings by 4T (2012), the available water quality data for the relevant bores (GW01 and GW18 - Table 8) indicate that stygofauna could potentially occur in the unconsolidated sediments (alluvium) associated with the Isaac River. However, no stygofauna were encountered during sampling.

	Geology Unit Name	Rock Type	Group
Ki	Early cretaceous granitoid	Intrustive Unit	-
Pb	Sandstone, siltstone, carbonaceous shale, coal, and sandy coquinite	Sedimentary Rock	Black Creek Group
Pw	Late permian sandstone, ashstone, mudstone and coal	Stratified Unit	Blackwater Group
Pwb	Late permian sandstone, siltstone, mudstone, coal and conglomerate	Arenite-Mudrock	Moranbah Coal Measures
Pwj	sandstone, siltstone, mudstone, coal, tuff, conglomerate	Sedimentary Rock	Rangal/baralaba Coal Measures, Bandanna Formation
Pwt	Permian sandstone, conglomerate, mudstone, shale, coal and cherly tuff	Sedimentary Rock	Fair Hill Formation, Fort Cooper Coal Measures
Re	Middle triassic mudstone and congomerate	Sedimentary Rock	Clematis Group
Rr	Early to middle triassic sandstone, mudstone and minor volcanlithic pebble conglomerate	Arenite-Mudrock	Rewan Group

Olive Downs Coking Coal Project Study Area
Road
Railway
Waterway
Stygofauna Sampling Sites
Fault line

0 10km

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DPM ENVIROSCIENCES

SOLID GEOLOGY AND STRUCTURE

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 29

	Geology Unit Name	Lithology Summary
Kgc	Cretaceous intrusives - central Queensland	Monzogranite, gabbro, diorite
Pb	Early-Permian-Late Permian sedimentary rock	Quartzose to lithic sandstone, siltstone, carbonaceous shale, minor coal and sandy coquinite
Pvz	Lizzie Creek Volcanic Group, Mount Wickham Rhyolite	Basalt and andesite, and interbedded volcaniclastic rocks; generally subordinate dacite, rhyolite, trachyte; conglomerate, labile sandstone, siltstone, calcareous siltstone, shale, carbonaceous shale, locally containing fossil plant fragments; minor coal
Pw	Late Permian sedimentary rock	Feldspathic and lithic sandstone, silty sandstone, calcareous sandstone, ashstone and cherly mudstone, carbonaceous mudstone and coal
Qa	Quaternary alluvium and lacustrine deposits	Sand, silt, mud and gravel
Re	Clematis Group	Medium to coarse-grained quartzose to sublabile, micaceous sandstone, siltstone, mudstone and granule to pebble conglomerate
Rr	Early triassic Arenite-Mudrock	Lithic sandstone, pebbly lithic samdstone, green to reddish brown mudstone and minor volcanilithic pebble conglomerate
TQ	Pliocene-Pleistocene allluvial and lacustrine deposits (including Wondoola beds Armraynald beds)	Poorly consolidated sandstone, mudstone, conglomerate
TQr	Late Tertiary-Quaternary colluvial and residual deposits	Clay, silt, sand, gravel, and soil; colluvial and residual deposits
Tl	Paleocene-Oliocene sedimentary rock	Sandstone, mudstone, conglomerate
Tv	Dundowran Basalt, Gin Gin Basalt, Main Range Volcanics, Minerva Hills Volcanics, Mount Runsome Basalt, Peak Range Volcanics, Waddy Point Volcanics, unnamed basalt and subordinate rhyolite; some plugs	Volcanics, mainly basaltic lavas with local rhyolite and trachyte; some plugs

Olive Downs Coking Coal Project Study Area
Road
Railway
Waterway
Stygofauna Sampling Sites
0 10km

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SURFACE GEOLOGY AND STYGOFAUNA SAMPLING LOCATIONS

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 30

5.11 Physico-chemical water quality

The most relevant in situ water quality guidelines for the Study area are the *Environmental Protection (Water) Policy 2009: Isaac River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Isaac River Sub-basin (including Connors River)* (DEHP 2011). This includes guidelines for moderately disturbed aquatic ecosystems in the upper Isaac River catchment waters (applied to riverine sites R1-R41), as well as freshwater lakes / reservoirs in the broader Isaac River Sub-basin (applied to lacustrine sites L1-L4, as well as palustrine wetland sites P1-P9 in the absence of guidelines specific to wetlands) (Table 17).

Water temperatures were warm across the Study area in the 2016 early wet season, ranging from 26.7°C at site R2 on the Isaac River to 34.5°C at palustrine wetland site P3 (Table 17). Results for the 2017 early wet season were similar, ranging from 22.3 at site R29 on a tributary of North Creek to 33.1 at palustrine wetland site P5. During the 2017 late wet season, temperatures fell, ranging from 13.3°C at palustrine wetland site P7 to 23.0°C at R23 (on the Isaac River) and palustrine wetlands site P4 (Table 17). Water temperatures are variable and influenced by the time of year, time of day, shading and waterbody depth.

EC levels fell within the respective guideline range at each site (Table 17). Each wetted site exhibited 'fresh' water.

pH levels in the early wet season ranged from neutral at palustrine wetland site P2 (6.81 pH units) to very strongly alkaline at palustrine wetland site P3 (9.68 pH units). pH levels at site P3 exceeded the guideline range of 6.5-8.0 for lakes / reservoirs of the Isaac River Sub-basin (DEHP 2011). The relatively high pH at P3 could be due to high photosynthetic activity, eutrophication, groundwater inflow, high contact time with substrates, or a combination of these factors. However, supersaturated DO levels recorded at this site (148.3%) (Table 17) suggest that the elevated pH levels are likely associated with the photosynthetic release of oxygen from algae and / or macrophytes during daytime hours. This site was sampled at 13:00, being the expected peak in diurnal range of DO. DO levels are expected to drop substantially throughout the day and overnight when oxygen producing processes (e.g. photosynthesis) are reduced and oxygen-consuming processes (e.g. anaerobic respiration, nitrification and chemical oxidation) typically dominate. This diurnal variation in DO is expected to be reflected in pH levels also. The lack of fish at this site (Section 4.5.4) may be a reflection of the extreme diurnal fluctuations in DO and pH, or may be due to the complete drying and wetting cycles likely experienced by this wetland. The fluctuations were not as extreme in the 2017 late wet survey, ranging from 6.9 pH units at R3 (Ripstone Creek) to 8.7 pH units at lacustrine wetland site L2 (Table 17).

With the exception of sites P2 and P3, DO levels fell within or slightly below the relevant guideline range of 90-110% for lacustrine waterbodies in the early wet season. In the riverine systems a number of sites fell outside the guideline (R23, R24, R27-29 and R35). In the late wet season, the results were more variable, with DO levels at sites R4 and R23, falling outside the guideline range (85-110% saturation for riverine sites). Half of the palustrine wetland sites (P1, P2, P7 and P8) were outside the guideline range for lacustrine waterbodies.

Turbidity levels exceeded the guideline of 50 NTU at each of the three sites on the Isaac River in the early wet season. The high turbidity is likely a result of recent catchment runoff and associated washload (clay and silt carried in suspension). The slightly elevated turbidity levels at site P3 (Table 17) are likely due to continued disturbance of substrates by cattle directly accessing this waterbody. Turbidity levels were generally lower (higher clarity) during the late wet survey; however, high turbidity was still recorded at three riverine sites, being R19, R24 (tributaries of the Isaac River) and R27 (North Creek).

Table 17 Physico-chemical water quality parameters, December 2016 and June / July 2017 and October / November 2017

Parameter	Units	Relevant guideline (DEHP 2011)*	Riverine sites^											
			R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13
Early wet – December 2016 or October/November 2017															
Date / time	DD/MM 00:00	-	Dry	14/12 10:40	17/12 15:30	Not assessed – Restricted access to site	Dry	14/12 15:00	Not assessed – No access to site	16/12 11:00	Dry	Dry	Dry	Dry	Dry
Temperature	°C	-		26.7	32.6			31.5		31.0					
Electrical conductivity (EC)	µS/cm	<720 (baseflow)^; <250 (high flow)^;		151	221			193		244					
pH	pH units	6.5-8.5^		7.73	7.59			7.24		7.86					
Dissolved oxygen (DO)	% saturation	85-110^		82.5	97.0			88.6		88.3					
	mg/L	-		6.61	6.94			6.50		6.56					
Turbidity	NTU	<50^		**459**	11.7			**275**		**168**					
Late wet – June/July 2017															
Date / time	DD/MM 00:00	-	Land access not available	Unsafe to access site.	08/07 12:00	07/07 10:20	06/07 12:20	09/07 07:45	Dry	10/07 09:10	23/06 07:50	Dry	Dry	Dry	22/06 13:10
Temperature	°C	-			18.6	19.5	20.4	20		20.9	14				17
Electrical conductivity	µS/cm	<720 (baseflow)^; <250 (high flow)^;			220	182	**680**	**293**		**287**	4.5				194
pH	pH units	6.5-8.5^			6.9	7.3	7.6	7.5		7.4	8.1				8.4
Dissolved oxygen	% saturation	85-110^			**77.2**	**59.4**	**81**	**81**		**86.3**	98.9				**115.4**
	mg/L	-			7.1	5.3	7.4	7.4		7.7	9.9				11.2
Turbidity	NTU	<50^,,			27.7	23.4	12.8	51		26.1	20.5				27.9

Table 18 (Continued) Physico-chemical water quality parameters, December 2016 and June / July 2017 and October / November 2017

Parameter	Units	Relevant guideline (DEHP 2011)*	Riverine sites^											
			R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26
Early wet – October 2017															
Date / time	DD/MM 00:00	-	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	6/10 8:20	6/10 10:45	Dry	Dry
Temperature	°C	-										23.6	26.1		
Electrical conductivity (EC)	µS/cm	<720 (baseflow)^; <250 (high flow)^;										319	192		
pH	pH units	6.5-8.5^										8.2	7.3		
Dissolved oxygen (DO)	% saturation	85-110^										**68.8**	**9.1**		
	mg/L	-										5.8	0.75		
Turbidity	NTU	<50^										13.7	**>1000**		
Late wet – June/July 2017															
Date / time	DD/MM 00:00	-	Dry	Dry	Dry	Dry	Dry	24/06 08:45	Dry	Dry	Dry	25/06 15:50	26/06 13:10	Dry	Dry
Temperature	°C	-						15.3				23	17.6		
Electrical conductivity	µS/cm	<720 (baseflow)^; <250 (high flow)^;						**406**				**390**	**277**		
pH	pH units	6.5-8.5^						8				8.3	7.5		
Dissolved oxygen	% saturation	85-110^						**80.6**				**126**	**76.2**		
	mg/L	-						7.8				10.8	7.2		
Turbidity	NTU	<50^						**207**				17.5	**>1000**		

Table 18 (Continued) Physico-chemical water quality parameters, December 2016 and June / July 2017 and October / November 2017

Parameter	Units	Relevant guideline (DEHP 2011)*	Riverine sites^													
			R27	R28	R29	R30	R31	R32	R33	R34	R35	R36	R38	R39	R40	R41
Early wet – October 2017																
Date / time	DD/MM 00:00	-	3/10 14:10	3/10 11:00	3/10 10:05	8/10 13:00	Dry	Dry	Dry	Dry	5/10 7:50	Dry	Dry	Dry	Dry	Dry
Temperature	°C	-	23.1	23	22.3	27.2					23.4					
Electrical conductivity (EC)	µS/cm	<720 (baseflow)^; <250 (high flow)^	50	376	106	450					76.7					
pH	pH units	6.5-8.5^	7.3	7.4	7	7.6					7					
Dissolved oxygen (DO)	% saturation	85-110^	**62.1**	**64.5**	**11.9**	**78.9**					**36.4**					
	mg/L	-	5.23	5.4	1.0	6.0					3.1					
Turbidity	NTU	<50^	**679**	49.1	**>1000**	22.9					**56.5**					
Late wet – June/July 2017																
Date / time	DD/MM 00:00	-	27/06 10:05	27/06 11:20	Dry	27/06 15:45	Dry	Dry	Dry	Dry						
Temperature	°C	-	16.3	17.8		17.7										
Electrical conductivity	µS/cm	<720 (baseflow)^; <250 (high flow)^	**290**	**375**		**373**										
pH	pH units	6.5-8.5^	7.6	7.5		8										
Dissolved oxygen	% saturation	85-110^	**81.8**	86.5		**113.7**										
	mg/L	-	8	8.2		10.8										
Turbidity	NTU	<50^	**64.7**	14.9		12.9										

Table 18 (Continued) Physico-chemical water quality parameters, December 2016 and June / July 2017 and October / November 2017

Parameter	Units	Relevant guideline (DEHP 2011)*	Palustrine sites#									Lacustrine sites#			
			P1	P2	P3	P4	P5	P6	P7	P8	P9	L1	L2	L3	L4
Date / time	DD/MM 00:00	-	Dry	17/12 11:15	18/12 13:00	9/10 8:45	6/10 15:00					Not assessed – No access to site	6/10 11:40	5/10 14:30	18/11 10:00
Temperature	°C	-		29.1	34.5	25.2	33.1						29.7	33.4	25.1
Electrical conductivity (EC)	µS/cm	<250 (no / baseflow)#		117	183	200	179.2						177	223	157
pH	pH units	6.5-8.0#		6.81	**9.68**	**9.4**	**8.4**						**8.8**	**8.5**	8.0
Dissolved oxygen (DO)	% saturation	90-110#		**73.0**	**148.3**	**82.2**	**120.1**						**122.4**	98	98
	mg/L	-		5.41	10.45	6.7	8.8						9.47	7.1	7.8
Turbidity	NTU	1-20#		6.9	**31.5**	**22.7**	**132**						11.8	**38.1**	**310**
Date / time	DD/MM 00:00	-	11/07 08:05	08/07 08:20	05/07 05:30	10/07 15:15	24/06 15:30	Dry	22/06 10:30	24/06 10:15		Dry	04/07 10:45	25/06 16:35	
Temperature	°C	-	20.4	19.5	18.8	23	22.6		13.3	18.2			19.9	22.2	
Electrical conductivity	µS/cm	<250 (no / baseflow)#	156	57	118	198	128		66	175			152	179	
pH	pH units	6.5-8.0#	7.2	7	7.6	**8.8**	7.7		7.2	7.1			**8.7**	7.8	
Dissolved oxygen	% saturation	90-110#	**26.3**	**75.7**	**82.8**	**113.4**	**132.2**		**60.1**	**41.5**			103.4	**115**	
	mg/L	-	2.4	6.9	7.6	90.7	11.4		6.7	3.5			9.2	10	
Turbidity	NTU	1-20#	10.6	13.5	4.7	**42.6**	-		3.1	10.5			18.2	**33.8**	

Notes:

* DEHP (2011) *Environmental Protection (Water) Policy 2009: Isaac River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Isaac River Sub-basin (including Connors River)*.

^ Applies to riverine sites.

Applies to freshwater lakes / reservoirs. Also applied in this instance to palustrine wetland sites in the absence of a more specific guideline.

5.12 Matters of National Environmental Significance

World and National Heritage properties

No World Heritage Properties or National Heritage Places are identified for the search area in the EPBC Act Protected Matters Report (DEE 2018a, Appendix A).

Wetlands of International Importance

No wetlands of International Importance are identified within the search area in the EPBC Act Protected Matters Report (DEE 2018a). Wetlands of International Importance nearest to the search area include those of the Shoalwater and Corio Bays Area, approximately 150 km east of the Study area. These wetlands are well removed from the Study area, and are hydraulically connected only by the Coral Sea.

Threatened Ecological Communities

No EPBC Act listed TECs, relevant to aquatic ecology, are identified from the search area (DEE 2018a). No aquatic TECs are expected to occur within the Study area.

Threatened Species

No MNES aquatic flora or fauna were detected during surveys.

Aquatic fauna species that are Matters of National Environmental Significance (MNES) have been recorded from the broader search area encompassing the Study area. This includes the Critically Endangered southern snapping turtle (*Elseya albagula*) and Silver perch (*Bidyanus bidyanus*) and the Vulnerable Fitzroy River turtle (*Rheodytes leukops*), Murray cod (*Maccullochella peelii*) and Australian lungfish (*Neoceratodus forsteri*), each listed under the EPBC Act. Due to habitat requirements and distributional range (for fish species), it is unlikely these species occur within waterbodies of the Study area as either resident or transient occurrences. Habitat for these species was not encountered within the Study area.

No MNES aquatic flora species are likely to occur within the Study area.

Migratory Species

No aquatic migratory species (i.e. migratory species that live in water for most or all of their lives) are identified from the search area.

Commonwealth Marine Areas

The Study area is located approximately 90 km west (direct line) of any marine area and is separated hydraulically by at least three sub-catchments (Mackenzie River, Dawson River and the Fitzroy River) with varying land use and water quality.

Nuclear actions (including uranium mines)

The Action does not involve any nuclear actions.

Water resource

A water resource, in relation to coal seam gas development and large coal mining development, has been indicated as a controlling provision in the referral decision notice for the Olive Downs Project. It will be addressed in a separate report as per the Information Guidelines for Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals (IESC 2018).

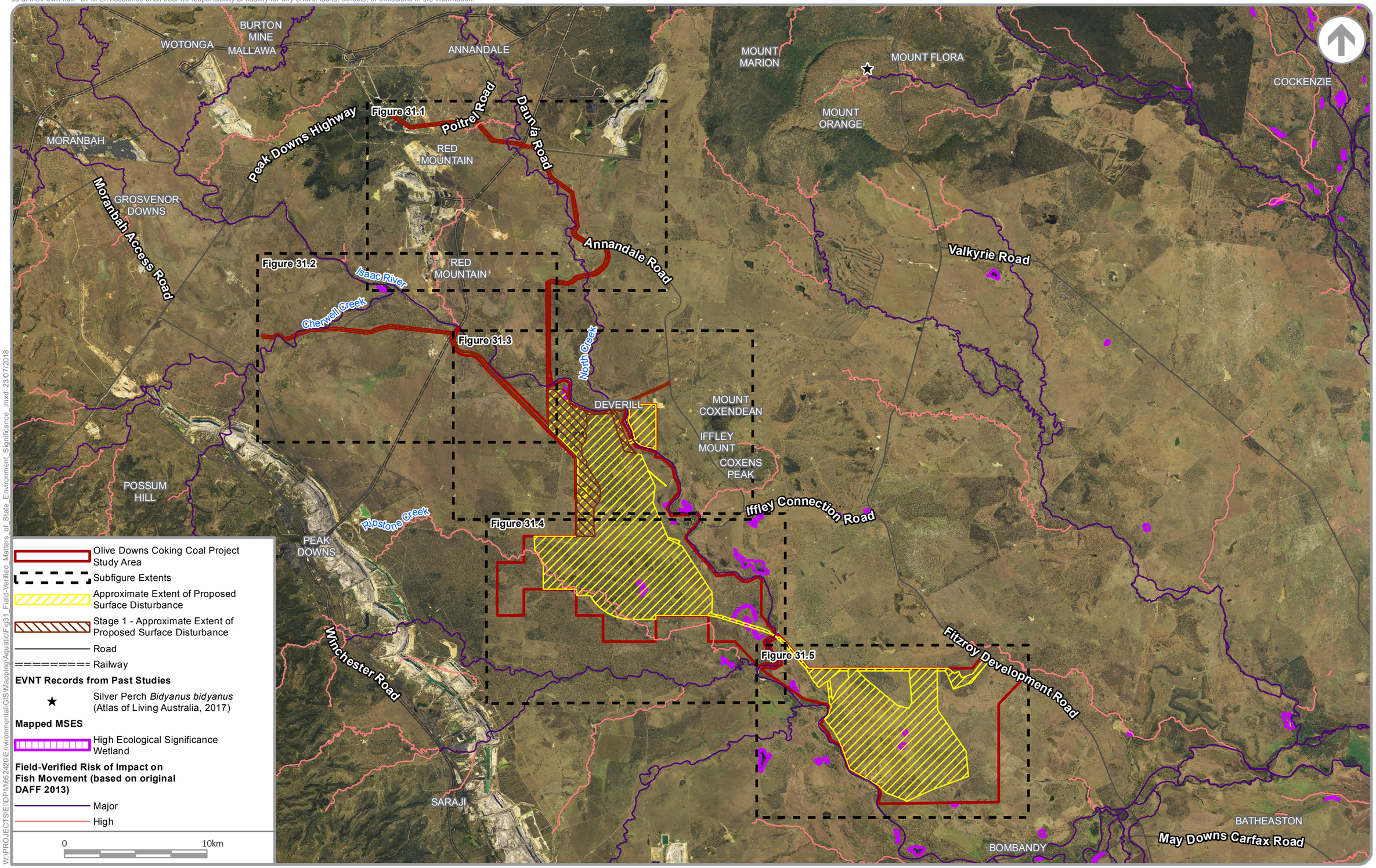
5.13 Matters of State Environmental Significance

The environmental offsets framework in Queensland includes the *Environmental Offsets Act 2014* (EO Act), the *Environmental Offsets Regulation 2014* (EO Regulation) and the *Queensland Environmental Offsets Policy* (EO Policy). MSES are defined in the EO Regulation and are a component of the biodiversity state interest identified in the Queensland State Planning Policy (IESC 2018).

A number of MSES were identified during the desktop review as occurring within the Study area. MSES of relevance to this assessment comprise wetlands and watercourses and waterways providing for fish passage (Table 19).

Table 18 Matters of State Environmental Significance located in the Study area

Prescribed Environmental Matter	Present in the Study area	Detail
Regulated vegetation	Yes	Refer to DPM Enviroscienses (2018a)
Connectivity areas	Yes	Refer to DPM Enviroscienses (2018b)
Wetlands and watercourses	Yes	The Study area does not contain any watercourses in high ecological value waters; however, it does contain wetlands of high ecological significance (Figure 31).
Protected Wildlife Habitat	Yes – fauna	Refer to DPM Enviroscienses (2018b)
Koala Habitat in South-East Queensland	No	The Study area is not located in South-east Queensland
Protected Areas	No	The Study area does not contain protected areas.
Fish Habitat Areas and Highly Protected Zones of State Marine Parks	No	The Study area is not located in a State Marine Park.
Waterway providing for fish passage	Yes	Waterways within the Study area provide for fish passage (Figure 31).
Marine Plants	No	The Study area is not located in a marine environment.
Secured Offset Area	No	The Study area does not contain legally secured offset areas.



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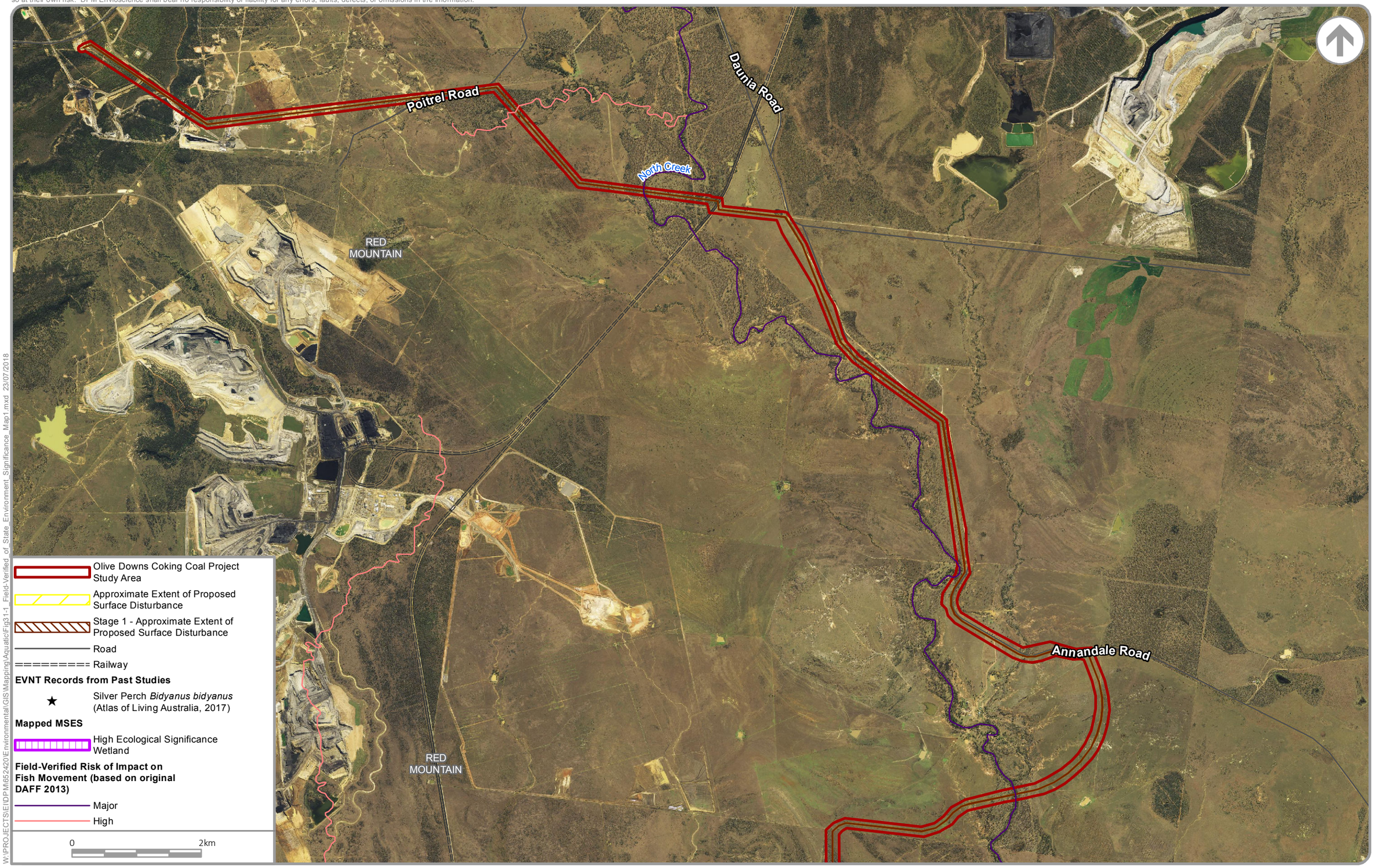
DPM ENVIROSCIENCES

FIELD-VERIFIED MATTERS OF STATE ENVIRONMENTAL SIGNIFICANCE MAP

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 31



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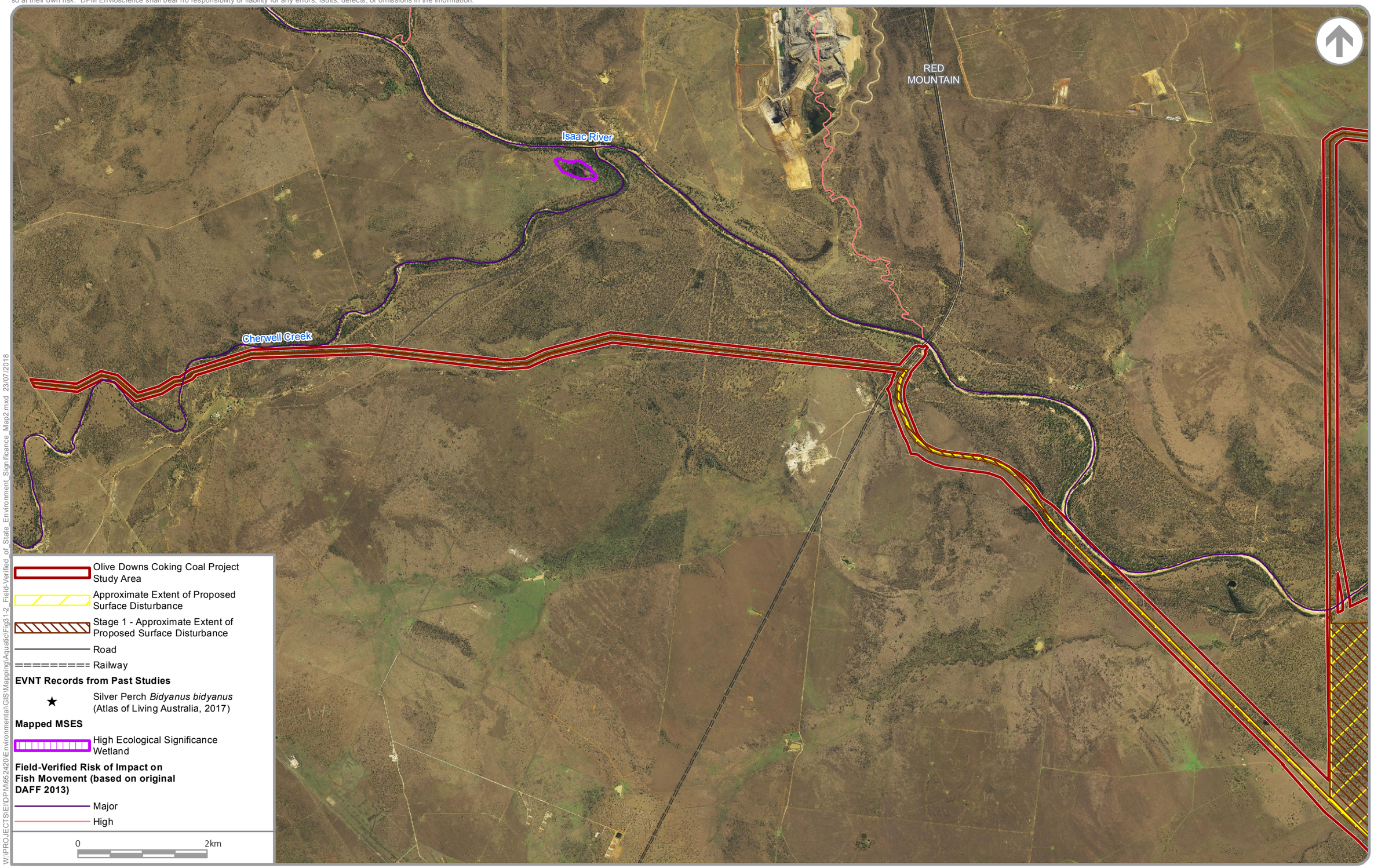
DPM ENVIROSCIENCES

FIELD-VERIFIED MATTERS OF STATE ENVIRONMENTAL SIGNIFICANCE – MAP 1

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 31.1



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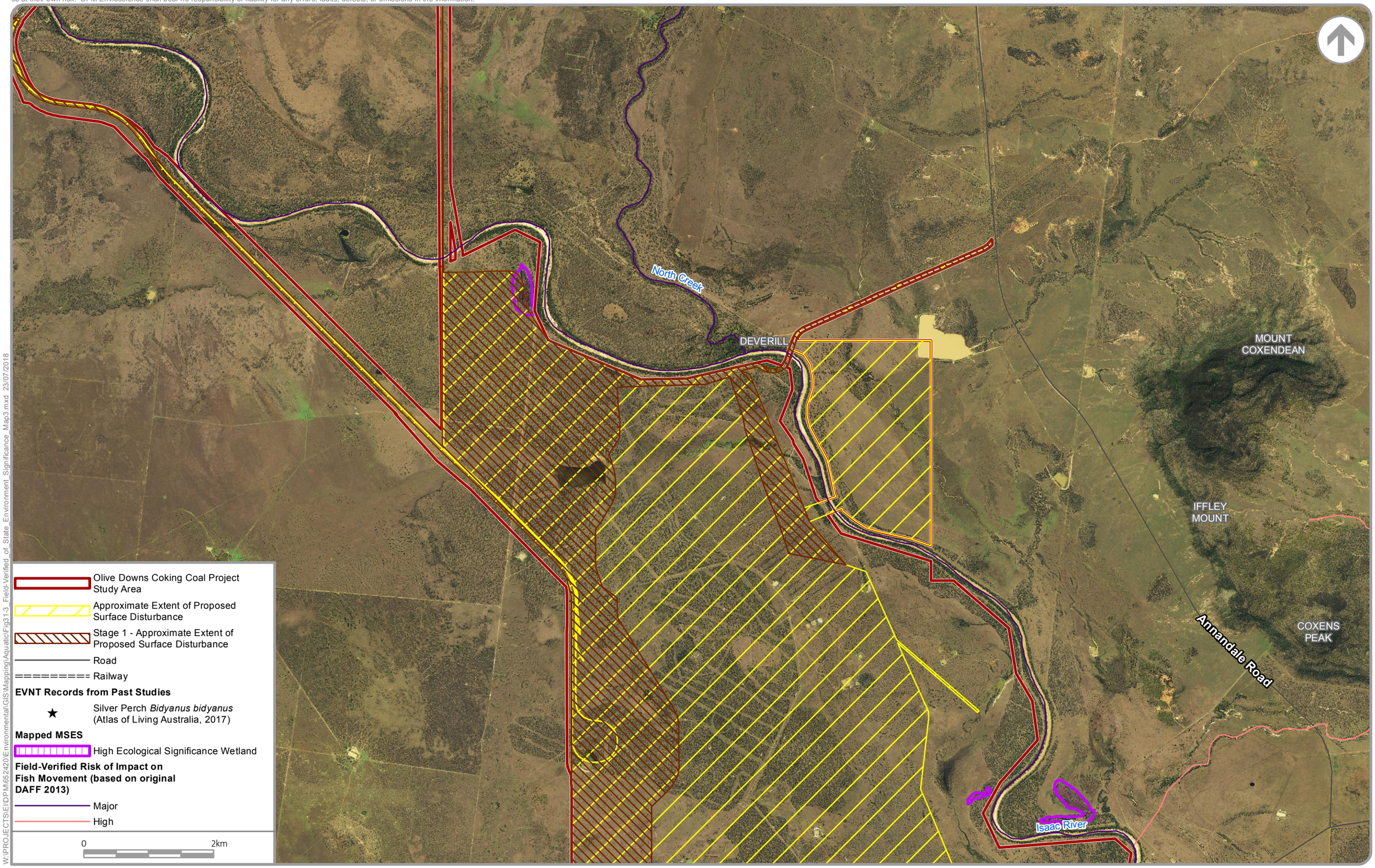
FIELD-VERIFIED MATTERS OF STATE ENVIRONMENTAL SIGNIFICANCE – MAP 2

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 31.2



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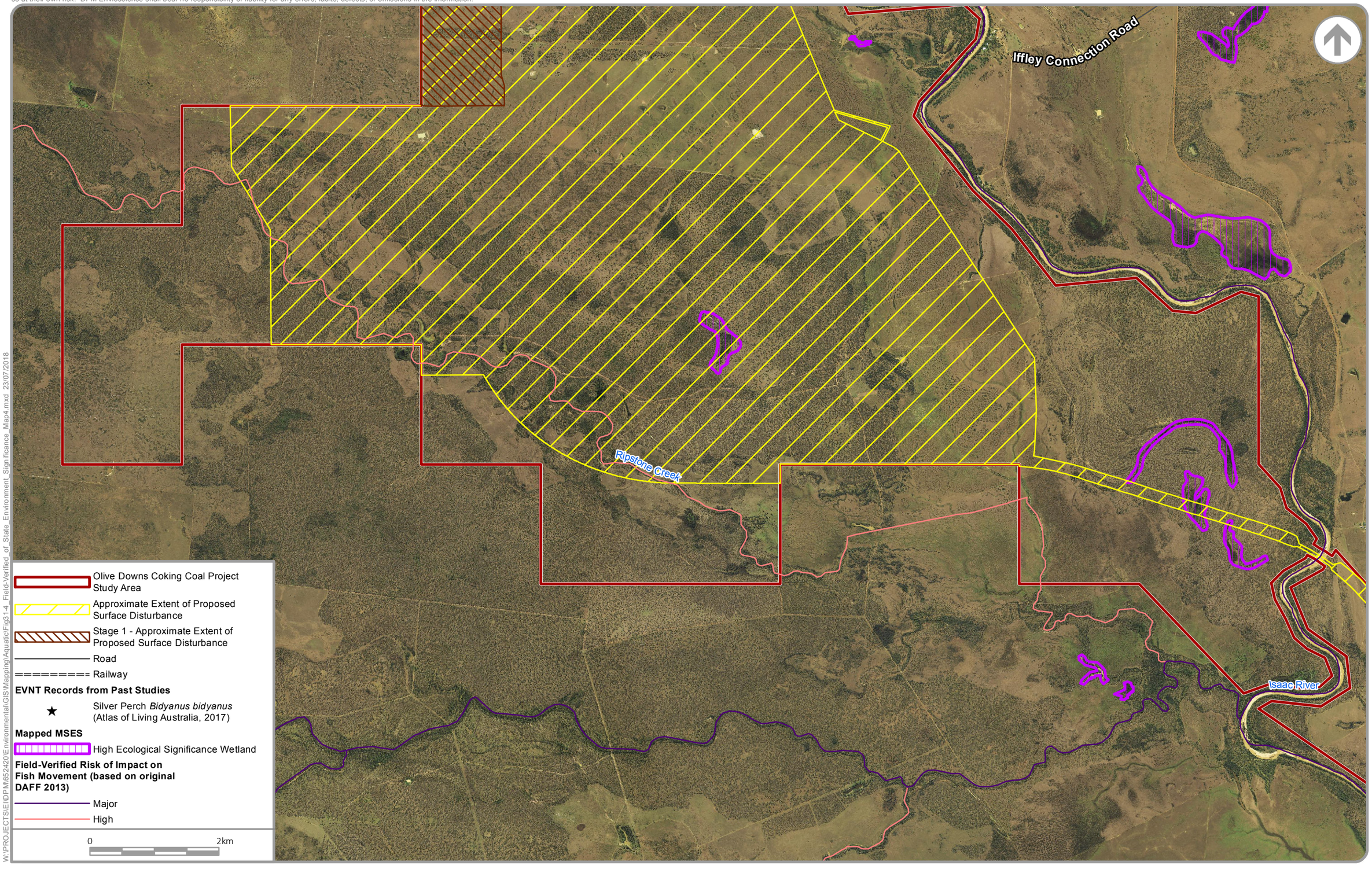
DPM ENVIROSCIENCES

FIELD-VERIFIED MATTERS OF STATE ENVIRONMENTAL SIGNIFICANCE – MAP 3

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 31.3



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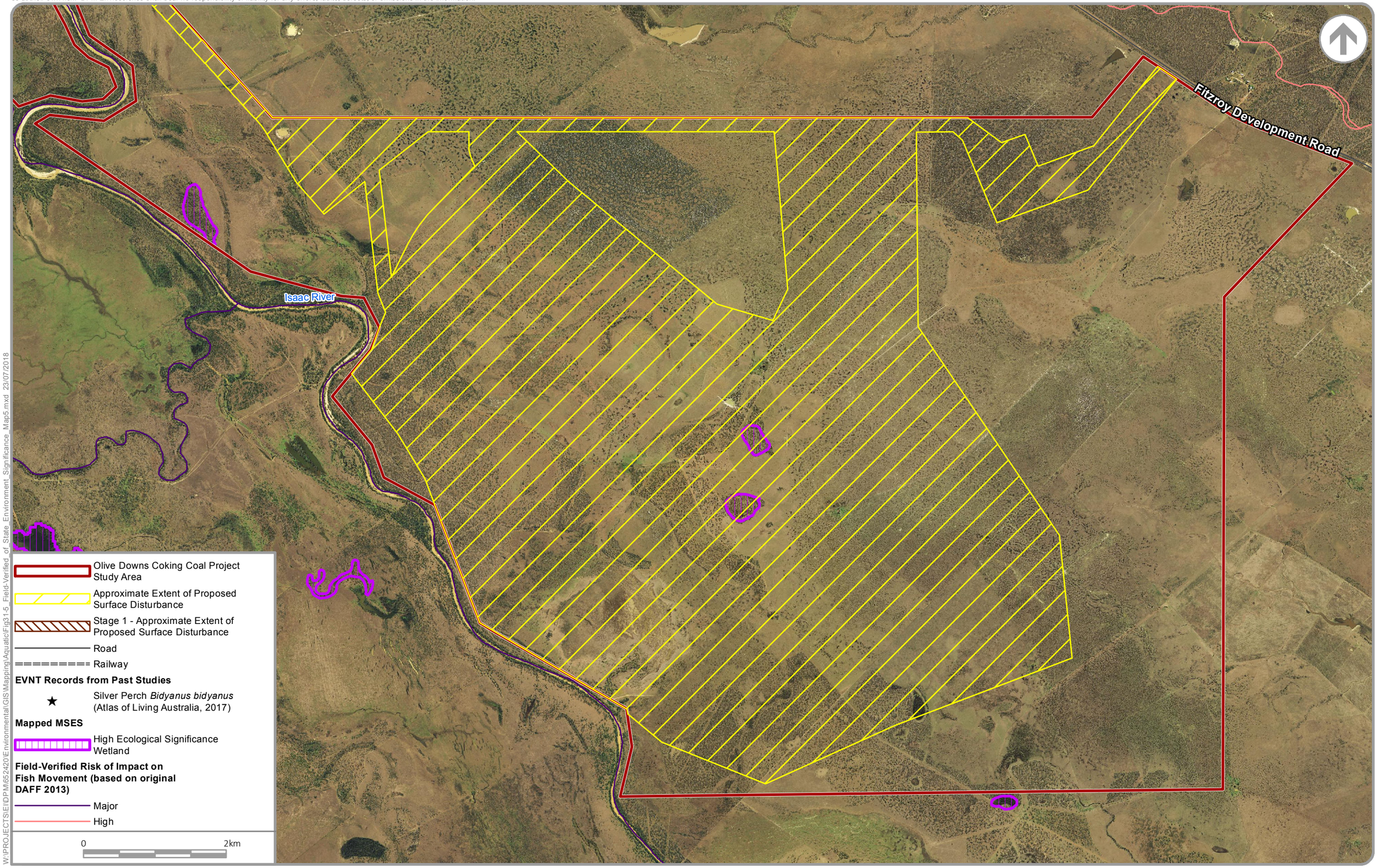
DPM ENVIROSCIENCES

FIELD-VERIFIED MATTERS OF STATE ENVIRONMENTAL SIGNIFICANCE – MAP 4

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 31.4



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DPM ENVIROSCIENCES

FIELD-VERIFIED MATTERS OF STATE ENVIRONMENTAL SIGNIFICANCE – MAP 5

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 31.5

6 POTENTIAL IMPACTS

6.1 Aquatic habitat clearance

6.1.1 General description

The Project would remove aquatic habitat in the Project area, comprising ephemeral watercourses and drainage lines, as well as ephemeral and semi-permanent wetlands (including artificial dams). These habitats are not expected to support aquatic species of conservation significance listed under the NC Act or EPBC Act, given the lack of suitable habitat features (Section 5.7).

Staged Clearance

Land clearing is proposed to occur in the following four stages:

- Stage 1- 2019-2024;
- Stage 2 – 2025-2030;
- Stage 3 – 2031-2050; and
- Stage 4 –2051- end of mine.

Stage 1 of the Project would include the following works:

- construction of each of the infrastructure corridors:
  - rail corridor;
  - ETL;
  - water pipeline;
  - Olive Downs South access road;
- construction of the mine infrastructure area (including offices, workshops, CHPP, ROM pad, ILF cells);
- development of the north-western waste emplacement;
- construction of temporary flood levees located within the Stage 1 boundary; and
- commencement of open cut mining in Pit 1.

The subsequent stages include:

- Stage 2 – all works proposed during the Willunga domain construction period.
- Stage 3 – all works proposed up until year 2050.
- Stage 4 – all works required until completion of the Project.

Pembroke proposes a staged environmental offset in consideration of the staged land clearing as described in Section 8.

6.1.2 Watercourses and wetlands

The only ‘watercourses’ (as defined by the *Water Act 2000*) that would be directly impacted by the Project are the Isaac River, Ripstone Creek and Cherwell Creek (Figure 31) and this direct impact is due to crossings associated with roads and the proposed rail line, along with a permanent watercourse diversion of Ripstone Creek. The other drainage features within the Project area were determined by DNRM to not meet the criteria to be mapped as a ‘watercourse’, and as such, have been determined to be ‘drainage features’ as per the definition in the *Water Act 2000*.

The following is a list of direct impacts related to each of the activities within the Project area:

- Project mining area – the mining activities will result in the removal of aquatic ecosystems located within the Project area. This would include removal of ephemeral drainage lines, clearance of a section of Ripstone Creek and development of a diversion for this section of the watercourse, as well as removal or modification of riverine, palustrine and lacustrine wetlands (including seven HES wetlands) (Figure 14). The Project mining area would also involve the construction of an overland conveyor and haul road between the Olive Downs South and Willunga Domains (Figure 2). The conveyor and haul road would be restricted to a construction corridor of 180 m width, however this would be reduced when crossing the Isaac River where, within 200 m of the defining bank, the construction corridor width would be limited to 45 m to reduce impacts on aquatic habitat (Figure 2). Within the disturbance corridor, aquatic habitat and riparian habitat would be removed.
- Access road – the Olive Downs South Domain access road would require one crossing of the Isaac River and a crossing of an ephemeral drainage line, limited to a 40 m wide disturbance corridor (Figure 10). The crossing of the Isaac River would result in the removal of aquatic habitat and riparian vegetation from the banks of the Isaac River. The crossing would be constructed using selected materials for the pavement with low flow culverts laid under the pavement at the lowest point in the river bed to convey low river flows beneath the access road.
- Haul road – the Olive Downs South Domain haul road (to the eastern waste emplacement) would require one crossing of the Isaac River, limited to a 60 m wide disturbance corridor (Figure 10.3). Construction of the haul road would result in the removal of aquatic habitat and riparian vegetation from the banks of the Isaac River. The watercourse crossing would include low flow culverts to convey low river flows beneath the haul road.
- Project rail spur and loop – the Project rail spur and loop would require require two crossings of ephemeral drainage lines and palustrine wetlands associated with the Isaac River (Figure 10.2). Disturbance associated with the Project rail spur and loop would be limited to a 70 m wide corridor which would be co-located with the proposed water pipeline. New culvert crossings would be installed along the rail spur, with the final locations to be determined during the detailed design.
- Water pipeline – the water pipeline would require two crossings of ephemeral drainage lines associated with the Isaac River and a third crossing of Cherwell Creek, at the location of an existing road crossing (Figure 10.2). Disturbance associated with the water pipeline would be limited to a 20 m wide corridor.
- ETL – the detailed design of the ETL would implement aerial crossings over waterways (including the Isaac River) and thereby avoid clearing of riparian vegetation or instream aquatic habitat (Figure 2).

The Project would result in the removal or modification of approximately 111 ha of palustrine and lacustrine wetlands, including seven HES wetlands (approximately 61 ha). In calculating the area of impact to HES wetlands, the State's Wetland Protection Area – High Ecological Eignificance mapping (DEHP 2014s) has been used. In some cases the mapping does not align with field-verified wetland REs (such as RE 11.3.27 and RE 11.5.17) and includes areas of non-remnant vegetation or other woodland REs (such as RE 11.3.2). These differences are due to boundary realignments in RE mapping as a result of field work. A number of lacustrine waterbodies (farm dams) would also be removed.

6.2 Aquatic flora

All aquatic flora species detected during the surveys are Least Concern under the NC Act. No conservation significant aquatic flora species listed under the NC Act were detected within the Project area.

Six Priority aquatic flora species were detected, being tall flatsedge (*Cyperus exaltatus*), water chestnut (*Eleocharis dulcis*), native hyacinth (*Monochoria cyanea*), red milfoil *(Myriophyllum verrucosum*), water nymph (*Najas tenuifolia*), giant waterlily (*Nymphaea gigantea*) and broad-leaf cumbungi (*Typha orientalis*). With the exception of tall flatsedge (which is common across the Study area and broader region), these species were recorded in relatively few locations in the Project area, mostly within palustrine or lacustrine wetlands. Aquatic flora present within the Project area would be impacted by a loss of habitat as discussed in Section 6.1.

6.3 Aquatic fauna

All aquatic fauna species detected during the surveys are Least Concern under the NC Act. No aquatic fauna species listed under the NC Act, or Priority fauna species, were detected. Aquatic fauna present within the Project area would be impacted by a loss of habitat as discussed in Section 6.1.

The species detected within the Project area are common and have a broad distribution in the region and so the removal of these habitat areas from the Project area is unlikely to have a significant impact on these species.

6.3.1 Waterways for fish passage

The mapped ‘high risk’ waterway within the location of the proposed eastern waste dump runs through a large dam of approximately 30 ha (Figure 12; site L4, Appendix B) which is rarely expected to fill and allow for downstream flow. The other waterway within the proposed eastern waste dump area is a first order stream (Figure 12; site R40, Appendix B). Each of these waterways are highly ephemeral, and are not considered to constitute, nor provide a conduit to, fish habitat areas essential for the breeding and / or survival of native fish.

In the north of the Olive Downs South Domain, two mapped ‘low risk’ waterways run through a large dam of approximately 12 ha (Figure 12; site L2, Appendix B), with a ‘moderate risk’ waterway mapped downstream of the dam (Figure 9; site R7, Appendix B). Fish passage is impeded by this dam, which is rarely expected to fill and allow for downstream flow. These waterways are of low stream order (1 and 2), are highly ephemeral, and are not considered to constitute, nor provide a conduit to, fish habitat areas essential for the breeding and / or survival of native fish.

A paleochannel wetland in the east of the Olive Downs South Domain is mapped as ‘moderate risk’ waterway (Figure 12). Site observations suggest that this paleochannel wetland (site P2, Appendix B), does not connect with the Isaac River except during times of flood. Two seasons of survey effort at this location failed to yield fish catch (Section 5.5.1) and detected macroinvertebrate community compositions typical of temporary ponds and wetlands (Section 5.5.4). This paleochannel wetland is not considered to constitute, nor provide a conduit to, fish habitat areas essential for the breeding and / or survival of native fish.

Other mapped moderate and low risk waterways occur within the Project area (Figure 12). Each of these waterways are highly ephemeral, terminate within the Project area at their upstream extent, and are not considered to constitute, nor provide a conduit to, fish habitat areas essential for the breeding and / or survival of native fish.

'Waterway barrier works' are defined in the *Fisheries Act 1994* to mean a dam, weir or other barrier across a waterway if the barrier limits fish stock access and movement along a waterway.

Consideration of on-ground physical and biological attributes suggests that these waterways are unlikely to be determined (by Queensland Fisheries) as waterways that are necessary to provide for fish passage. In addition, the design of the watercourse crossings would comprise low flow culverts to enable the continued passage of fish throughout the waterway and the Isaac River crossings would be designed in consultation with DAF.

Whether development approvals are required under the *Fisheries Act 1994* will depend upon the detailed design of the barrier works, whether they comply with the *Accepted development requirements for operational work that is constructing or raising waterway barrier works* (Department of Agriculture and Fisheries [DAF], 2017), and whether the works are on-lease or off-lease.

The only Project components located off-lease are the ETL and the western part of the water pipeline. Any waterway barrier works required for these components would be designed in accordance with the DAF's requirements, and would be subject to separate approval (not being sought through this EIS process).

6.4 Surface water

Surface water quality and flows are relevant to the health and productivity of aquatic ecosystems. The following sections (6.4.1 and 6.4.2) discuss surface water and potential impacts of the Project on surface water from an ecological perspective. These sections draw on the key conclusions from the *Olive Downs Coking Coal Project Surface Water Assessment* (Hatch 2018a), the *Olive Downs Coking Coal Project Flood Assessment* (Hatch 2018b) and the *Olive Downs Coking Coal Project Groundwater Assessment* (HydroSimulation 2018).

6.4.1 Water quality

The water quality exhibited across the Study area is reasonably good with temperature, pH and conductivity consistently within the guideline ranges (Section 5.11). The dissolved oxygen and turbidity levels are more variable, but are generally within the relevant guideline ranges, with the exception of a few riverine sites (Section 5.11). These fluctuations in physico-chemical water quality may be temporary in nature and could be due to the ephemeral nature of these waterbodies, high intensity rainfall events, upstream activities or localised impacts from cattle accessing waterways, or a combination of these factors (Section 5.11).

Erosion and Sedimentation

An Erosion and Sediment Control Plan would be developed and implemented throughout construction and operations. A 'best practice' approach would be adopted which is consistent with the International Erosion Control Association (IECA) recommendations. The following broad principles would apply:

- minimise the area of disturbance;
- where possible, apply local temporary erosion control measures;
- intercept runoff from undisturbed areas and divert around disturbed areas; and
- where temporary measures are likely to be ineffective, divert runoff from disturbed areas to sedimentation basins prior to release from the site.

If implemented effectively, environmental risks to water quality from disturbed area runoff are expected to be low (Hatch 2018a).

Mine Water Discharge

The surface water assessment (supported by site water balance modelling) by Hatch (2018a) concludes that:

- No uncontrolled spills of mine-affected water from the worked water dams are predicted under normal operating conditions.
- Some overflow of water from sediment dams (designed in accordance with the Best Practice Erosion and Sediment Control guideline [International Erosion Control Association Australasia 2008]) may occur during wet periods; however, it is unlikely that this would have a measurable impact on receiving water quality.
- There is a predicted negligible impact on the downstream water quality through releases from the Project.

Based on the implementation of management strategies (e.g. Erosion and Sediment Control Plan), the risks of elevated dissolved solids and other contaminants impacting downstream waters is considered to be low (Hatch 2018a).

Based on the analysis undertaken by Hatch (2018a), no measurable impacts on surface water quality are likely to occur from discharge of mine-affected waters. If no measurable impacts on surface water quality are likely to occur, no adverse impacts are likely to occur on aquatic habitats.

Leaks and Spills

Leaks or spills of hydrocarbon-based fluids from construction equipment and spread of coal dust represents a potential risk to aquatic habitat downstream of the Project. The Preliminary Risk Assessment conducted by Operational Risk Montoring (2018) concluded that there is a'Low' risk of this event (or one similar) occurring given the implementation of suitable management measures, including implementation of a spill response and appropriate water management system. As such, the Project is unlikely to result in leaks / spills that would eventuate in serious environmental harm to aquatic species or their habitat.

6.4.2 Water flow

Within the Study area the majority of waterways are ephemeral, only flowing after largely unpredictable rainfall and runoff, ceasing to flow within days, supporting aquatic life whose life cycles are adapted to these conditions (Section 5.1). Flow within Ripstone Creek is ephemeral, however, intermittent pools are expected to persist on Ripstone Creek and its tributaries at locations with less permeable clay substrates (Section 5.2). The Isaac River is a seasonal waterway, alternatively wet and dry most years according to season. Surface flows in the Isaac River typically persist for about half of the year, enough for some macroscopic plants and animals to complete the aquatic stages of their life cycles, as well as allowing for the passage of aquatic fauna upstream and downstream of the Study area (Section 5.1).

The flow of water in Ripstone Creek would be affected by the construction of a permanent watercourse diversion and water usage (Hatch 2018a). During active mining operations, the mine water management system would capture runoff from areas that would have previously flowed to the receiving waters. The maximum mine affected catchment areas represent (Hatch 2018a):

- approximately 13% of the Ripstone Creek catchment to its confluence with the Isaac River; and
- less than 1% of the Isaac River at a location downstream of the Project.

The changed topography as a result of the Project final landform would have the following impacts on catchment areas (Hatch 2018a):

- The catchment draining to Ripstone Creek would reduce by around 19 km^2 (compared to pre-mining conditions), a decrease of less than 7%.
- The catchment draining to the Isaac River would reduce by around 49 km^2 (compared to pre-mining conditions), a decrease of less than 1%.

Based on the analysis undertaken by Hatch (2018a), no measurable impacts on surface water quantity are likely to occur regardless of changes in captured catchment areas. If no measurable impacts on surface water quantity are likely to occur, no adverse impacts are likely to occur on aquatic habitats.

6.5 Groundwater dependent ecosystems

6.5.1 Terrestrial riparian vegetation

As described in Section 5.9, the terrestrial riparian vegetation (11.3.25) associated with the Isaac River is likely to be a GDE. In additiona, the terrestrial riparian vegetation along the downstream reaches of Ripstone Creek may also be a GDE.

Groundwater drawdown predictions have been produced by HydroSimulations (2018), indicating that drawdown in the alluvium is only predicted to reach / extend past the Isaac River in an approximately 4 km stretch of the Isaac River at the very northern extent of the Project area and an approximately 2.5 km stretch of the Isaac River adjacent to the Willunga Domain. The drawdown in these areas is not expected to exceed 2 m, while the potential drawdown at the downstream reaches of Ripstone Creek may reach up to 5 m (HydroSimulations 2018).

Although the potential drawdown of approximately 2 to 5 m is predicted to occur in areas where vegetation may be dependent on subsurface expression of groundwater, it is unlikely that this potential impact would result in a significant impact to terrestrial riparian vegetation surrounding the Project. This is due to the fact that the vegetation in these locations is subject to continuous (natural) wetting and drying cycles which in turn results in continual fluctuations in the groundwater levels in these locations. The Project would not result in a drawdown in the alluvial aquifers that would dewater the aquifer to the extent that it would not recover following rainfall (HydroSimulations 2018).

As described in Section 5.9, the terrestrial riparian vegetation associated with North Creek and Cherwell Creek may also be a GDE. The terrestrial riparian vegetation and aquatic habitats along North Creek and Cherwell Creek are located outside the area of potential drawdown associated with the Project (HydroSimulations 2018). As such, these features are unlikely to be impacted by the Project.

6.5.2 Aquatic habitats

As described in Section 5.9, the aquatic habitat associated with the Isaac River, North Creek, Cherwell Creek and downstream reaches of Ripstone Creek may be a GDE at times for a short period after rainfall events. However, the waterways are ephemeral and the aquatic species that occur within these habitats are prone to wetting and drying cycles.

The Project is unlikely to result in any noticeable changes to baseflow contributions to North Creek or Cherwell Creek given the distance of these waterways from the proposed mining area (HydroSimulations 2018).

HydroSimulations (2018) predicts that the Project would result in a potential 0.5% reduction in flow within the Isaac River during mining operations. It should be noted that this potential reduction is applying to the entire reach of the Isaac River adjacent to the Project area. Given the ephemeral nature of the Isaac River and the small contribution of baseflow, which only occurs after periods of prolonged rainfall, this predicted reduction in baseflow is expected to only have a minimal impact on the presence of aquatic habitat within the Isaac River and associated tributaries. The aquatic species that inhabit these waterways have adapted to wetting and drying cycles and are expected to persist in the environment despite the potential reduction in baseflow.

HydroSimulations (2018) also considered potential baseflow impacts to Ripstone Creek and concluded that there would be no discernible change in baseflow.

6.5.3 Groundwater quality

Waste Rock Emplacement Areas

As the mine progresses, waste rock material will be placed within out-of-pit and in-pit waste rock emplacement areas. Waste rock emplacement areas may produce seepage as a result of rainfall inundation. The waste rock material exhibits similar to improved water quality compared to water within regolith material (HydroSimulations 2018). However, the waste rock material generally exhibits poorer water quality compared to the alluvium (HydroSimulations 2018).

Seepage from in-pit emplacements is not expected to migrate to the surrounding alluvium, as the groundwater level that would ultimately equilibrate within the waste rock would be below the base of the alluvium (HydroSimulations 2018). Given this, the Project is not expected to have a significant impact on groundwater quality that would lead to any adverse impact on potential GDEs.

Final Voids

Water within final voids would evaporate from the lake surface and draw in groundwater from the surrounding geological units. Evaporation from the lake surface would concentrate salts in the lake slowly over time (HydroSimulations 2018). This gradually increasing salinity is not expected to pose a risk to the surrounding groundwater regime as the final voids are predicted to remain permanent sinks (HydroSimulations 2018). Given the final voids would be sinks, the final voids are not expected to result in any adverse groundwater quality related impacts on GDEs.

6.6 Stygofauna

As described in Section 5.10, consistent with the findings by 4T (2012), the generally poor groundwater quality (indicated by EC levels up to 26,800 µs/cm) within the regolith material suggests the groundwater environment is unsuitable for stygofauna. Direct or indirect impacts on groundwater within the unconfined aquifer is unlikely to impact stygofauna (as stygofauna are unlikely to be present).

The stygofauna desktop review and water quality analysis indicate that stygofauna could potentially occur in the unconsolidated sediments (alluvium) associated with the Isaac River (Section 5.10). All available bores (two) were sampled in order to confirm whether stygofauna are present. No stygofauna were found which may suggest that either stygofauna are not present, in low abundance, or the sample size was too low. An assessment is provided here assuming that stygofauna are present within the unconsolidated sediments (alluvium).

The Project would directly intercept groundwater from the unconsolidated sediments (alluvium) and sub-artesian aquifers which could provide potential habitat for stygofauna as identified by 4T (2012). Given this, the Project is expected to result in a drawdown in the unconsolidated sediments associated with the Isaac River of no more than 5 m, predominantly adjacent to the Olive Downs South Domain (HydroSimulations 2018). Drawdown in the unconsolidated sediments adjacent the Willunga Domain would also be less than 5 m and would only occur in a small portion of the alluvium associated with the Isaac River (HydroSimulations 2018).

As indicated by HydroSimulations (2018), the alluvium is not limited to the Project area and appears to be saturated along the Isaac River and lower reaches of the creeks at the confluence with the Isaac River (HydroSimulations 2018). This indicates that the potential habitat for stygofauna (if they were to occur) is much more extensive than the alluvium within the area of influence associated with the Project. Given the extent of the alluvium along the Isaac River, it is considered unlikely that the Project would result in a significant impact to any stygofauna community (if they were to occur).

In summary, although the Project may have local impacts on the stygofauna community (if they were to occur), these are likely to be insignificant when placed in the regional context of the whole groundwater system.

6.7 Cumulative Impacts

The Project is located within the headwaters of the Isaac sub-catchment of the greater Fitzroy Basin. The major rivers and tributaries of the Fitzroy catchment include the Fitzroy, Dawson, Nogoa, Comet, Isaac and Mackenzie Rivers (Hatch 2018a).

The Isaac River is the main watercourse which bisects the Project area and flows in a north-west to south-east direction, passing the township of Moranbah and the Millennium, Poitrel and Daunia coal mines upstream of the Project. The Isaac River flows to the north-east of the Olive Downs South domain and then further downstream to the south of the Willunga domain before continuing in a south-easterly direction (Hatch 2018a).

The site water management system has been designed such that the risk of off-site uncontrolled release of mine affected water during operations is very low and sediment inputs can be controlled through drainage, and erosion and sediment control measures. On this basis, the Project is not expected to make any significant contribution to cumulative sediment loads in the Fitzroy River Basin (Hatch 2018a).

The outcomes from the water balance modelling indicate that the proposed controlled release strategy would achieve the regional WQOs for the Isaac River and therefore not impact on its environmental values (Hatch 2018a).

Given that the Project mine affected water releases would be managed within an overarching strategic framework for management of cumulative impacts of mining activities, the proposed management approach for mine water from the Project is expected to have negligible cumulative impact on surface water quality and associated aquatic habitat values (Hatch 2018a).

The Project is unlikely to result in a significant cumulative impact to the aquatic flora and fauna of the Isaac River system, given the limited potential impacts associated with the Project and the implementation of mitigation and management measures described in Section 7.

6.8 Impacts on Matters of National Environmental Significance

There were no MNES related to aquatic ecology recorded within the Project area or surrounds downstream.

As such, it is concluded that the following components of the Project would not have a significant impact on MNES relevant to aquatic ecology:

- Olive Downs Project Mine Site and Access Road (EPBC 2017/7867);
- Olive Downs Project Water Pipeline (EPBC 2017/7868);
- Olive Downs Project Electricity Transmission Line (EPBC 2017/7869); and
- Olive Downs Project Rail Spur (EPBC 2017/7870).

6.9 Impacts on Matters of State Environmental Significance

The Queensland Environmental Offsets Policy Significant Residual Impact Guideline (DEHP 2014a) is used to determine if a prescribed activity would have a significant residual impact on MSES. A significant residual impact is defined as an adverse impact, whether direct or indirect, of a prescribed activity on all or part of a prescribed environmental matter that:

a) remains, or will or is likely to remain (whether temporarily or permanently), despite on-site avoidance and mitigation measures for the prescribed activity; and

b) is, or will or is likely to be significant.

There are two MSES relevant to aquatic ecology that are known to occur in the Project area that may be subject to impacts from the Project. These species include:

- Wetlands and Watercourses; and
- Waterways Providing for Fish Passage.

Potential impacts on these MSES associated with the Project are discussed below.

6.9.1 Wetlands and Watercourses

The Project would not remove a section of any watercourse in high ecological value waters as identified under Schedule 9 of the *Environmental Protection (Water) Policy 2009*. As such, the Project would not result in a significant residual impact to this MSES.

As described in Section 6.1, the Project would remove 61 ha of HES Wetlands (Figure 13). Additional HES wetlands are mapped within the Study area, and although these would not be removed by the Project, they may be subject to indirect impacts (e.g. changes in flow regimes and surface water quality impacts). An assessment of the potential impacts on this MSES, in accordance with the *Queensland Environmental Offsets Policy Significant Residual Impact Guideline* (DEHP 2014a) is provided in Table 19.

Table 19 Wetlands and Watercourses Significant Residual Impact Assessment

Criteria	Assessment / consideration
An action is likely to have a significant residual impact on prescribed wetlands or watercourses if it is likely that the action will result in environmental values being affected in any of the following ways:	
areas of the wetland or watercourse being destroyed or artificially modified;	The Project would remove or modify seven wetlands mapped as HES Wetlands (totalling approximately 61 ha) (Figure 13).
a measurable change in water quality of the wetland or watercourse—for example a change in the level of the physical and/or chemical characteristics of the water, including salinity, pollutants, or nutrients in the wetland or watercourse, to a level that exceeds the water quality guidelines for the waters; or	No measurable impacts on surface water quality of the remaining wetlands are likely to occur from changes in surface water as (Hatch 2018a): • no uncontrolled spills of mine affected water from the mine water dam are predicted; • release of treated water from sediment dams (designed in accordance with the Best Practice Erosion and Sediment Control [International Erosion Control Association Australasia 2008]) to the downstream environment would only occur in accordance with the EA conditions (once developed) which

Criteria	Assessment / consideration
An action is likely to have a significant residual impact on prescribed wetlands or watercourses if it is likely that the action will result in environmental values being affected in any of the following ways:	
	is unlikely to have a measurable impact on receiving water quality; and • there is a predicted negligible impact on the downstream water quality through controlled releases from the Project in accordance with the EA (once granted).
the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected; or	The Project would remove or modify seven wetlands mapped as HES Wetlands (totalling approximately 61 ha) (Figure 13). The Project would not result in the habitat or lifecycle of native species dependent upon the HES Wetlands that would remain within the Study area being seriously affected, given there would not be any measurable impact to the surface water quality as a result of the Project (Hatch 2018a).
a substantial and measurable change in the hydrological regime or recharge zones of the wetland, e.g. a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland; or	The Project would remove approximately 61 ha of wetlands mapped as HES Wetlands. The potential flow regime changes to the wetlands adjacent the Project has been assessed by Hatch (2018a). In conclusion, it was determined that, despite some catchment excision, potential hydrological changes to these wetlands would be negligible as the wetlands would continue to be inundated during and following rainfall / flood events adjacent the Isaac River.
an invasive species that is harmful to the environmental values of the wetland being established (or an existing invasive species being spread) in the wetland.	The introduction and spread of invasive weeds may occur as a result of the Project; however, threat levels are unlikely to change significantly due to the Project given the current agricultural use of the surrounding area and implementation of mitigation and management measures proposed to be implemented by Pembroke. Given this it is unlikely that the Project would result in an invasive species that is harmful to the HES Wetlands that would remain within the Study area.

6.9.2 Waterways Providing for Fish Passage

As described in Section 5.1.1, waterway crossings would be constructed with consideration to the *Accepted Development Requirements for Operational Work that is Constructing or Raising Waterway Barrier Works* (DAF 2017b) using box culverts to permit crossing during low flow events, enabling fish passage to be maintained within / through the Project area. The Isaac River crossings would be designed in consultation with DAF, including the potential need for artificial daytime lighting to negate the bevioural barrier of a dark tunnel effect on fish passage. Each crossing would be designed to be inundated during moderate to high flow events (which may negate the need for baffling) allowing fish passage above and around the structure.

An assessment of the potential impacts on this MSES, in accordance with the *Queensland Environmental Offsets Policy Significant Residual Impact Guideline* (DEHP 2014a) is provided in Table 20.

In summary, it is concluded that the Project is unlikely to have a significant impact on Waterways Providing for Fish Passage given waterway crossings would be constructed with consideration to the *Accepted Development Requirements for Operational Work that is Constructing or Raising Waterway Barrier Works* (DAF, 2017b), and the Isaac River crossings would be designed in consultation with DAF, so as not to create a barrier to fish movement.

Table 20 Waterways Providing for Fish Passage Significant Residual Impact Assessment

Criteria	Assessment / consideration
An action is likely to have a significant impact on a waterway providing fish passage if there is a real possibility that the action will:	
Result in the mortality or injury of fish	The Project is unlikely to result in barriers that cause the mortality or injury of native fish because: ▪ waterway crossings would be constructed with consideration to the *Accepted Development Requirements for Operational Work that is Constructing or Raising Waterway Barrier Works* (DAF 2017b), and in consultation with DAF for the Isaac River crossings, so as not to create a barrier to fish movement; and ▪ the diversion of Ripstone Creek would be sensitively designed to replicate natural features where possible and provide similar conditions to the original waterway, including stream hydraulics, geomorphology, instream habitat, bank profiles and bank vegetation, to provide habitat and refuge for fish inhabiting or passing through the diversion of Ripstone Creek.
Result in conditions that substantially increase risks to the health, wellbeing and productivity of fish seeking passage such as through the depletion of fishes energy reserves, stranding, increased predation risks, entrapment or confined schooling behaviour in fish.	The Project is unlikely to result in conditions that would substantially increase risks to the health, wellbeing and productivity of fish seeking passage because: ▪ waterway crossings would be constructed so as not to create a barrier to fish movement; and ▪ the diversion of Ripstone Creek would be designed to replicate similar conditions to the original waterway, including stream hydraulics, geomorphology, instream habitat, bank profiles and bank vegetation, to provide habitat and refuge for fish inhabiting or passing through the diversion of Ripstone Creek.
Reduce the extent, frequency or duration of fish passage previously found at a site.	The Project is unlikely to reduce the extent, frequency or duration of fish passage previously found at the Project area because: ▪ waterway crossings would be constructed with consideration to the *Accepted Development Requirements for Operational Work that is Constructing or Raising Waterway Barrier Works* (DAF 2017b), and in consultation with DAF for the Isaac River crossings, so as not to create a barrier to fish movement; and ▪ the diversion of Ripstone Creek would be sensitively designed to replicate natural features where possible and provide similar conditions to the original waterway, including stream hydraulics, geomorphology, instream habitat, bank profiles and bank vegetation, to provide habitat and refuge

Criteria	Assessment / consideration
	for fish inhabiting or passing through the diversion of Ripstone Creek. Further, the Surface Water Assessment (Hatch 2018a) concludes that the Project is unlikely to result in a significant reduction to the extent, frequency and duration of flows encountered in waterways around the Project area.
Substantially modify, destroy or fragment areas of fish habitat (including, but not limited to in-stream vegetation, snags and woody debris, substrate, bank or riffle formations) necessary for the breeding and/or survival of fish.	Waterways mapped as Moderate and Low risk of impact on fish movement would be removed or otherwise impacted by mining activities (Figure 13). However, these waterways are generally of low stream order (1 or 2), are highly ephemeral, and are not considered to constitute, nor provide a conduit to, fish habitat areas essential for the breeding and / or survival of native fish. Ripstone Creek (mapped as High risk of impact on fish movement) would be diverted to the south of its existing alignment to allow for mining operations in this area (Figure 13). This diversion is unlikely to result in a significant impact to fish passage given the proposed diversion would be sensitively designed to replicate natural features where possible and to simulate aquatic habitat attributes of the affected reach of Ripstone Creek and allow the free passage of fish both upstream and downstream in a safe manner.
Result in a substantial and measurable change in the hydrological regime of the waterway, for example, a substantial change to the volume, depth, timing, duration and frequency of flows.	Surface water hydrology would be altered by the Project as a result of capturing water in dams, water loss due to use for Project operation or pond evaporation, and releasing water during flow events. The volume, depth, timing, duration and frequency of flows would continue to reflect the ephemeral and variable flow nature of the waterways around the Project area. The Project is considered unlikely to result in a substantial and measurable change in the hydrological regime of these waterways (Hatch 2018a). The seasonality of fish movements is unlikely to be affected.
Lead to significant changes in water quality parameters such as temperature, dissolved oxygen, pH and conductivity that provide cues to movement in local fish species.	The Project is unlikely to lead to an abrupt or otherwise significant change in water quality parameters (Hatch 2018a) that would be expected to cue local fish movement. Any water releases required by the Project would be managed in accordance with the EA Conditions (once developed). The risk of deteriorating water quality would be mitigated by monitoring stream and release water quality and quantity in accordance with the EA (once granted).

Table 21 provides a summary of the impacts associated with the Project on MSES.

Table 21 Summary of impacts to Matters of State Environmental Significance

Matters of State Environmental Significance			Stage 1 Impact	Stage 2 Impact	Stage 3 Impact	Stage 4 Impact
Regulated Vegetation	'Endangered' or 'of concern' regional ecosystems*	RE11.3.1	Refer to DPM Enviros ciences (2018a)			
		RE11.3.2				
		RE11.3.3				
		RE11.3.4				
		RE11.4.8				
		RE11.4.9				
		RE11.5.17				
	Regional ecosystems within mapped vegetation management wetlands*					
	Regional ecosystems within the defined distance of a vegetation management watercourse*					
Connectivity Areas			Refer to DPM Enviros ciences (2018b)			
Wetlands and Watercourses			9.5 ha	6.0 ha	23.5 ha	22 ha
Designated Precinct in a Strategic Environmental Area			N/A			
Protected Wildlife Habitat*	Ornamental Snake^		Refer to DPM Enviros ciences (2018b)			
	Common Death Adder					
	Australian Painted Snipe^					
	Squatter Pigeon (southern)^					
	Koala^					
	Short-beaked Echidna					
	Greater Glider^					
Protected Areas			N/A			
Highly Protected Zones of State Marine Parks			N/A			
Fish Habitat Areas			N/A			
Waterways Providing for Fish Passage						
Major			121 m	394 m	0 m	0 m
High			11 m	11,545 m	0 m	0 m
Moderate			1,545 m	3,777 m	4,508 m	10,520 m
Low			3,445 m	1,383 m	1,609 m	0 m
Marine Plants			N/A			
Legally Secured Offset Areas			N/A			

Notes: * REs mutually exclusive; ^ Also listed under the EPBC Act.

7 MITIGATION MEASURES

Consistent with DES' management hierarchy, the mitigation strategy for the Project has focused on a hierarchy of:

1. avoidance;
2. minimisation;
3. mitigation; then
4. offset residual impacts.

The avoidance or minimisation of adverse impacts is most relevant to the design phase of the Project, where information collected through desktop analysis and field surveys can be incorporated into the planning and preliminary engineering work (Section 7.1). Mitigation of impacts (including the implementation of monitoring and management plans) is most relevant to the construction and operational phases of the Project. Table 22 provides a summary of the mitigation strategies for the Project, with a brief description of potential impacts and measures that can be implemented at each stage in the life of the Project.

Residual impacts, after the implementation of the mitigation strategy, may be required to be offset. Offset requirements for the Project are discussed in Section 8.

7.1 Measures to avoid and minimise impacts

The following measures would be implemented to avoid and / or minimise impacts on aquatic ecology (Figure 2):

- Mine – The location of the mine and pits are informed by geological surveys and largely determined by the location of the natural resource, as a result the location of mine impacts are relatively inflexible. Where possible, the Isaac River has been avoided in the mine design and a minimum buffer of 200 m between the mine pits and Isaac River (defined bank) has been implemented.
- Overland conveyor – to reduce impacts that would normally be associated with a haul road crossing the Isaac River, an overland conveyor spanning approximately 14 km would be used to link the Willunga Domain to the CHPP within the Olive Downs South Domain. The conveyor would run North-west from the Willunga Domain and cross the Isaac River approximately 4.5 km from its origin point. The conveyor would be restricted to a construction corridor of 180 m however this would be reduced when crossing the Isaac River; where, within 200 m of the defining bank, the construction corridor width would be limited to 45 m to reduce impact on the Isaac River and its associated aquatic habitat.
- Access road – The access road would make use of an existing private dirt road for a distance of 2.3 km before deviating to cross over the Isaac River. The location of the Isaac River crossing was selected due to the constructability of a low impact crossing at this point. The access road would be restricted to 40 m at the crossing point to reduce the impact on the Isaac River.
- Haul road crossing – The haul road crossing would provide access to the waste emplacement at Deverill from the Olive Downs South Domain. The crossing would be located approximately 2 km south-south east of the access road where it crosses the Isaac River. The haul road would be restricted to a construction corridor of 60m.
- Rail spur – options for the location of the rail spur were limited due to the need to connect to the Norwich Park Branch Railway and to avoid existing mining lease areas (and associated mining pits) to the south. The final location would maintain a buffer of

approximately 85 m to the bank of the Isaac River at its closest point (affecting 1.5 km of the rail alignment).

- Water pipeline – the proposed water pipeline would connect to the existing Eungella Pipeline west of the Project. The water pipeline would be approximately 23 km long and has been co-located with the rail corridor as far as possible (for a distance of 15 km from the mine site to the existing Norwich Park Branch to reduce associated clearance, including clearance of aquatic habitat within Cherwell Creek. The corridor for the water pipeline has been reduced to 20 m.
- ETL – the proposed ETL would implement aerial crossings over waterways (including the Isaac River) and thereby avoid clearing of riparian vegetation or instream aquatic habitat. Existing waterway crossings would be used for access / maintenance.

7.2 Impact mitigation

Mitigation measures proposed to be implemented for the Project are detailed in Table 22.

Table 22 Mitigation measures

Potential impact	Mitigation measures
1. Aquatic habitat clearing, particularly waterways and important wetlands	▪ Implement 200 m buffer from the proposed mining pits to the Isaac River (measured from the top of bank). ▪ Implement 85 m buffer between the Isaac River and Project Rail Spur and Loop Corridor. ▪ Design and construct waterway crossings with consideration to the *Accepted Development Requirements for Operational Work that is Constructing or Raising Waterway Barrier Works* (DAF 2017b). ▪ Consult with DAF regarding the design of the Isaac River crossings, including the potential need for artificial daytime lighting in culverts to negate the bevioural barrier of a dark tunnel effect on fish passage. ▪ Design ETL to avoid construction within riparian areas and watercourses. ▪ Clearing of native vegetation undertaken progressively over the life of the mine and only in areas required for mining activities within the following year. This would have the effect of minimising the area of exposed land. ▪ the diversion of Ripstone Creek would be designed to replicate natural features where possible and provide similar conditions to the original waterway. ▪ Implement the Vegetation Clearance Procedure (Section 7.3). ▪ Implement the Erosion and Sediment Control Plan (Section 7.3). ▪ Implement the Fauna Species Management Plan (Section 7.3).
2. Increased numbers of feral animals and weeds	▪ Identify and treat aquatic weed infestations within the Project area. ▪ Strategies for preventing weed spread i.e. machinery wash-down, boot scrubbing facilities, appropriate disposal of weed material. ▪ Implement the Vegetation Clearance Procedure (Section 7.3). ▪ Implement the Weed and Pest Management Plan (Section 7.3).
3. Removal of fish passage	▪ Design and construct waterway crossings with consideration to the *Accepted Development Requirements for Operational Work that is Constructing or Raising Waterway Barrier Works* (DAF 2017b).
4. Alteration to surface water quality and / or quantity	▪ Clearing of native vegetation would be undertaken progressively over the life of the mine and only in areas required for mining activities within the following year. This would have the effect of minimising the area of exposed land. ▪ Release of treated water from sediment dams (designed in accordance with the Best Practice Erosion and Sediment Control [IECAA 2008]) to the downstream environment would only occur in accordance with the EA conditions which is unlikely to have a measurable impact on receiving water quality. ▪ Temporarily clearing native vegetation, excavating, or placing fill in a watercourse necessary for and associated with mining operations would be undertaken in accordance with DNRM's (2012) *Guideline – Activities in a Watercourse, Lake or Spring Associated with Mining Activities*. ▪ Implement the Receiving Environment Monitoring Program (Section 7.3). ▪ Implement the Water Management Plan (Section 7.3).

7.3 Management and monitoring plans

1. Vegetation Clearance Procedure, including:
   - demarcate exclusion zones to protect areas of vegetation to be retained prior to clearing;
   - clearing of native vegetation would be undertaken progressively;
   - salvage of felled vegetation for millable timber, as appropriate;
   - salvage hollow logs, rocks and large debris removed by construction for habitat enhancement in areas for rehabilitation; and
   - collection of native seed from Project area prior to clearing for use in rehabilitation program.
2. Water Management Plan, including:
   - details of the potential sources of contaminants that could impact on water quality;
   - a description of the water management system for the Project;
   - measures to manage and prevent saline drainage and sodicity;
   - measures to manage and prevent acid rock drainage;
   - corrective actions and contingency procedures for emergencies; and
   - a program for monitoring and review of the effectiveness of the Water Management Plan.
3. Fauna Species Management Plan, including:
   - identification of suitable areas to relocate native fish and turtles impacted by dewatering; and measures to manage aquatic fauna when no suitable relocation sites are available;
   - fauna exclusion fencing around construction sites or operational mine areas;
   - use of licenced fauna spotter-catchers for relocation of animals, including native fish and turtles impacted by dewatering habitat;
   - habitat retention and replacement, where possible; and
   - salvage of microhabitat features (e.g. boulders and logs) for use in rehabilitation.
4. Weed and Pest Management Plan, including:
   - identification of feral animal populations;
   - strategies for preventing spread of feral animals (i.e. maintaining a clean, rubbish-free environment);
   - appropriately qualified persons would be engaged to undertake pest animal monitoring;
   - recommended weed feral animal control strategies (e.g. baiting and trapping); and
   - feral animal monitoring protocols and follow-up control methods and protocols.
5. Rehabilitation and Mine Closure Plan, including:
   - identification of desired post-mining land use;
   - protocol for progressive rehabilitation and staging of rehabilitation or natural regeneration and site preparation;
   - rehabilitation criteria to assess the effectiveness of the rehabilitation work;
   - recommended native species to be used during rehabilitation activities; and
   - measures to monitor the success of the rehabilitation strategies.

6. Erosion and Sediment Control Plan, including:
    - design and installation in accordance with the *Best Practice Erosion and Sediment Control* (IECA 2008) and *Soil Erosion and Sediment Control Engineering Guidelines for Queensland Construction Sites* (Institute of Engineers Australia 1996);
    - minimise the area of disturbance;
    - where possible, apply local temporary erosion control measures;
    - intercept runoff from undisturbed areas and divert around disturbed areas; and
    - where temporary measures are likely to be ineffective, divert runoff from disturbed areas to sedimentation basins prior to release from the site.
7. Receiving Environment Monitoring Program, including:
    - monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised mining activity;
    - monitoring the effects of the mine on the receiving environment periodically (under natural flow conditions) and while mine affected water is being discharged from the site; and
    - encompassing any sensitive receiving waters or environmental values downstream of the authorised mining activity that will potentially be directly affected by an authorised release of mine affected water.

8 OFFSETS

The Final ToR for the Project states the following in relation to environmental offsets:

11.27 The EIS must describe the residual impacts of each proposed action for each relevant matter protected by the EPBC Act, after all proposed avoidance and mitigation measures are taken into account.

11.28 The EIS must identify whether the residual impacts are significant with reference to the Matters of National Environmental Significance, Significant impact guidelines 1.1, Environment Protection and Biodiversity Conservation Act 1999.

11.29 If those residual impacts are significant the EIS must propose offsets for relevant matters protected by the EPBC Act consistent with the Environment Protection and Biodiversity Conservation Act 1999, Environmental Offsets Policy.

11.53 The EIS should identify whether the project will result in a significant residual impact on matters of State environmental significance (MSES) with reference to the Queensland Environmental Offsets Policy, Significant Residual Impact Guideline 2014.

11.54 For staged offsets, the full extent of potential impacts on prescribed environmental matters from the entire proposal needs to be taken into account as part of the significant residual impact test.

11.55 The proposed offsets should be in line with the requirements set out in the Queensland Environmental Offsets Policy (Version 1.2) 2016.

It should be noted that, despite the requirements of the ToR, the *Queensland Environmental Offsets Policy (Version 1.2) 2016* has been replaced by the *Queensland Environmental Offsets Policy (Version 1.6)* (DES 2018). The EO Act and EPBC Act and the following related policies are relevant to the environmental offset proposal for the Project:

- *Queensland Environmental Offsets Policy (Version 1.6)* (DES 2018); and
- *EPBC Act Environmental Offsets Policy* (DSEWPC 2012) (and supporting *EPBC Act Offsets Assessment Guide*).

Given the Project would not result in a significant impact to any aquatic ecology values listed under the EPBC Act, the offset strategy has been developed to compensate for potential impacts to MSES (i.e. HES wetlands).

8.1 Significant residual impacts on state and national matters

Land clearing is proposed to occur in multiple stages. Stage 1 would include the following works:

- construction of each of the infrastructure corridors:
  - rail corridor;
  - ETL;
  - water pipeline;
  - Olive Downs South access road;
- construction of the mine infrastructure area (including offices, workshops, CHPP, ROM pad, ILF cells);
- development of the north-western waste emplacement;
- construction of temporary flood levees located within the Stage 1 boundary; and
- commencement of open cut mining in Pit 1.

All other works, not detailed above, would be offset during subsequent stages of the Project life.

The Stage 1 disturbance boundary is shown on Figure 18. The Stage 1 disturbance boundary includes the full extent of the following Actions:

- Olive Downs Project Water Pipeline (EPBC 2017/7868);
- Olive Downs Project Electricity Transmission Line (EPBC 2017/7869); and
- Olive Downs Project Rail Spur (EPBC 2017/7870).

The Stage 1 disturbance boundary would facilitate approximately the first five years of mining of the Olive Downs Project Mine Site and Access Road (EPBC 2017/7867).

Table 23 quantifies the significant residual impacts on MNES and MSES for each stage of clearance. The Offset Strategy proposed to compensate for these significant residual impacts is described below.

Table 23 Summary of matters relevant to the offset package

Matter	Stage 1 Impact (ha)	Stage 2 Impact (ha)	Stage 3 Impact (ha)	Stage 4 Impact (ha)
Matters of National Environmental Significance				
Brigalow Woodland TEC	Refer to DPM Enviros ciences (2018a)			
Australian Painted Snipe	Refer to DPM Enviros ciences (2018b)			
Squatter Pigeon				
Greater Glider				
Koala				
Ornamental Snake				
Matters of State Environmental Significance				
Regulated Vegetation				
Endangered RE Of Concern RE	Refer to DPM Enviros ciences (2018a)			
Regional ecosystems within mapped vegetation management wetlands*				
Regional ecosystems within the defined distance of a vegetation management watercourse				
Connectivity Areas	Refer to DPM Enviros ciences (2018b)			
Protected Wildlife Habitat				
Habitat for an Animal that is Vulnerable Wildlife	Refer to DPM Enviros ciences (2018b)			
Australian Painted Snipe[1]				
Squatter Pigeon[1]				
Greater Glider[1]				
Koala[1]				
Ornamental Snake[1]				
Wetlands and Watercourses				
A wetland of High Ecological Significance	9.5	6.0	23.5	22

Notes:

[1] These species are also listed under the EPBC Act and will be offset under the *EPBC Act Environmental Offsets Policy* (DSEWPC 2012)

8.2 Biodiversity offset strategy

Pembroke propose to offset the significant residual impacts on Matters of National Environmental Significance in accordance with the *EPBC Act Environmental Offsets Policy* (DSEWPC 2012) and offset the significant residual impacts on Matters of State Environmental Significance in accordance with the *Queensland Environmental Offsets Policy* (Version 1.6) (DES 2018).

Pembroke propose a staged environmental offset in consideration of the staged land clearing described above. The offset for each stage of clearance would be provided before clearing the relevant stage. It is likely that the residual significant adverse impacts can be offset given the following:

A land-based proponent-driven offset is proposed to address the relevant impacts from Stage 1. Section 1.4 provides a description of the Stage 1 Offset Area and a description of how it offsets impacts on the HES wetlands listed in Table 14. The terrestrial flora assessment (DPM Enviros ciences 2018a) and terrestrial fauna assessment (DPM Enviros ciences 2018b) describe how the Stage 1 Offset Area would offset impacts on other Matters of State Environmental Significance.

The Stage 1 Offset Area would compensate for the impacts associated with each of the following Actions in full:

- Olive Downs Project Water Pipeline (EPBC 2017/7868);
- Olive Downs Project Electricity Transmission Line (EPBC 2017/7869); and
- Olive Downs Project Rail Spur (EPBC 2017/7870).

In addition, the Stage 1 Offset Area would compensate for the impacts associated with approximately the first five years of mining of the Olive Downs Project Mine Site and Access Road (EPBC 2017/7867).

For subsequent stages (Stage 2 to 4), the offset would be provided before the commencement of each stage. It is likely that the residual significant adverse impacts can be offset given the wetland types proposed to be cleared during the life of the Project occur extensively in the surrounding landscape and subregions.

8.3 Offset for Stage 1

8.3.1 General description for the Stage 1 Offset Area

A land-based offset area is proposed for Stage 1. The Stage 1 Offset Area is comprised of three distinct areas (A, B and C) located approximately 35 km south-east of Moranbah (Figure 19). The proposed offset area occurs within the Isaac-Comet Downs subregion of the North Brigalow Belt Bioregion, within the Fitzroy catchment and is on the eastern side of the Isaac River, adjacent to the Project area.

The closest National Park reserve is the Dipperu National Park located approximately 15 km east of the Stage 1 Offset Area (Figure 19).

The Stage 1 Offset Area covers an overall area of approximately 6,065 ha. There is a combined total of approximately 1,950 ha of remnant vegetation within the Stage 1 Offset Area, which greatly exceeds and is more than 2.5 times the area of remnant vegetation proposed to be cleared as part of Stage 1 (approximately 832.5 ha).

Within the overall boundaries of the Stage 1 Offset Area, there is approximately 1,200 ha which is not required to be included in an offset area for Stage 1 and may be used to offset impacts from subsequent stages. These areas are mapped on Figure 32 as ‘Areas Retained for Future Offset’. These areas would be secured along with the Stage 1 Offset Area.

Pembroke owns the land on which the Stage 1 Offset Area is proposed and there are no other relevant parties with registered interests under the Qld *Land Act 1994* or the Qld *Land Title Act 1994* (Table 24).

Table 24 Relevant offset area details

Reference	Landholder details
Registered Owner on Title	Pembroke Olive Downs Pty Ltd
Real Property Descriptions	Twenty Mile - Lot 5, SP 113322 Deverill - Lot 18, SP 113322

8.3.2 Ecological surveys

Flora and fauna surveys were undertaken by DPM Enviros ciences (2018c) in accordance with contemporary Qld and Commonwealth survey guidelines to assess the suitability of the Stage 1 Offset Area. Field surveys were undertaken by DPM Enviros ciences in March to May 2018 (Appendix D).

The flora surveys were undertaken in accordance with the Qld Herbarium vegetation survey methods described in Neldner *et al.* (2017). Survey techniques included quaternary level surveys, identification of threatened ecological communities, identification of wetlands, targeted searches for conservation significant species and random meanders (DPM Enviros ciences 2018c).

8.3.3 Presence of relevant matters

Overview

The Stage 1 Offset Area contains both remnant and regrowth forest and woodland, as well as broad open grazed grassland and palustrine wetlands (swamps – primarily BVG 15) (Figure 32).

Further detail regarding the wetlands that were identified within the Stage 1 Offset Area is provided in Appendix H of DPM Enviros ciences (2018a), with information relevant to this aquatic ecology assessment summarised below.

Wetlands

The Project would remove or modify seven wetlands in the Stage 1 Impact Area (totalling approximately 9.5 ha) (Figure 9). These wetlands are all palustrine wetland systems and vegetated swamps wetland habitat types.

The impact on these wetlands is proposed to be offset by four wetlands (totalling approximately 38 ha) within the Stage 1 Offset Area (Figure 32). These wetlands have been mapped as the vegetated swamps habitat type (comprising 38 ha). This constitutes an offset ratio of 1:4 and complies with the *Queensland Environmental Offsets Policy* (Version 1.6) (DES 2018).

The wetlands mapped within the Stage 1 Offset Area (Plates 10 and 11) comprise similar vegetation (palustrine wetlands) (Figure 9). The larger wetland (Plate 10 - Figure 32) comprises RE 11.5.17. The fringing vegetation comprises a sparse canopy dominated by Queensland blue gum (*Eucalyptus tereticornis*), with frequent poplar gum (*Eucalyptus platyphylla*). The centre of the wetland is an open treeless swamp, dominated by inland couch (*Brachyachne convergens*) and entire marshwort (*Nymphoides geminata*). The wetland is in good health, but has been impacted by feral pig diggings and direct access by stock.

The smaller wetland (Plate 11 - Figure 32) also comprises RE 11.5.17. There is a sparse canopy dominated by tea tree (*Melaleuca viridiflora*) with occasional Queensland blue gum (*E. tereticornis*) and Clarkson's bloodwood (*Corymbia clarksoniana*). The ground layer is dominated

by *Dinebra decipiens* with occasional sleepy morning (*Waltheria indica*), purple lovegrass (*Eragrostis lacunaria*), spike rush (*Eleocharis blakeana*) and creeping phyllanthus (*Phyllanthus virgatus*). The wetland is in good health, but with some weed and stock impacts.

Plate 10 Wetland in the Stage 1 Offset Area, being a 37 ha largely unmodified vegetated swamp (RE 11.5.17) in a closed depression on the Devlin Creek floodplain, March 2018

Plate 11 Wetland in the Stage 1 Offset Area, being a 1 ha vegetated swamp (RE 11.5.17) in a closed depression on Twenty Mile, May 2018

8.3.4 Management measures

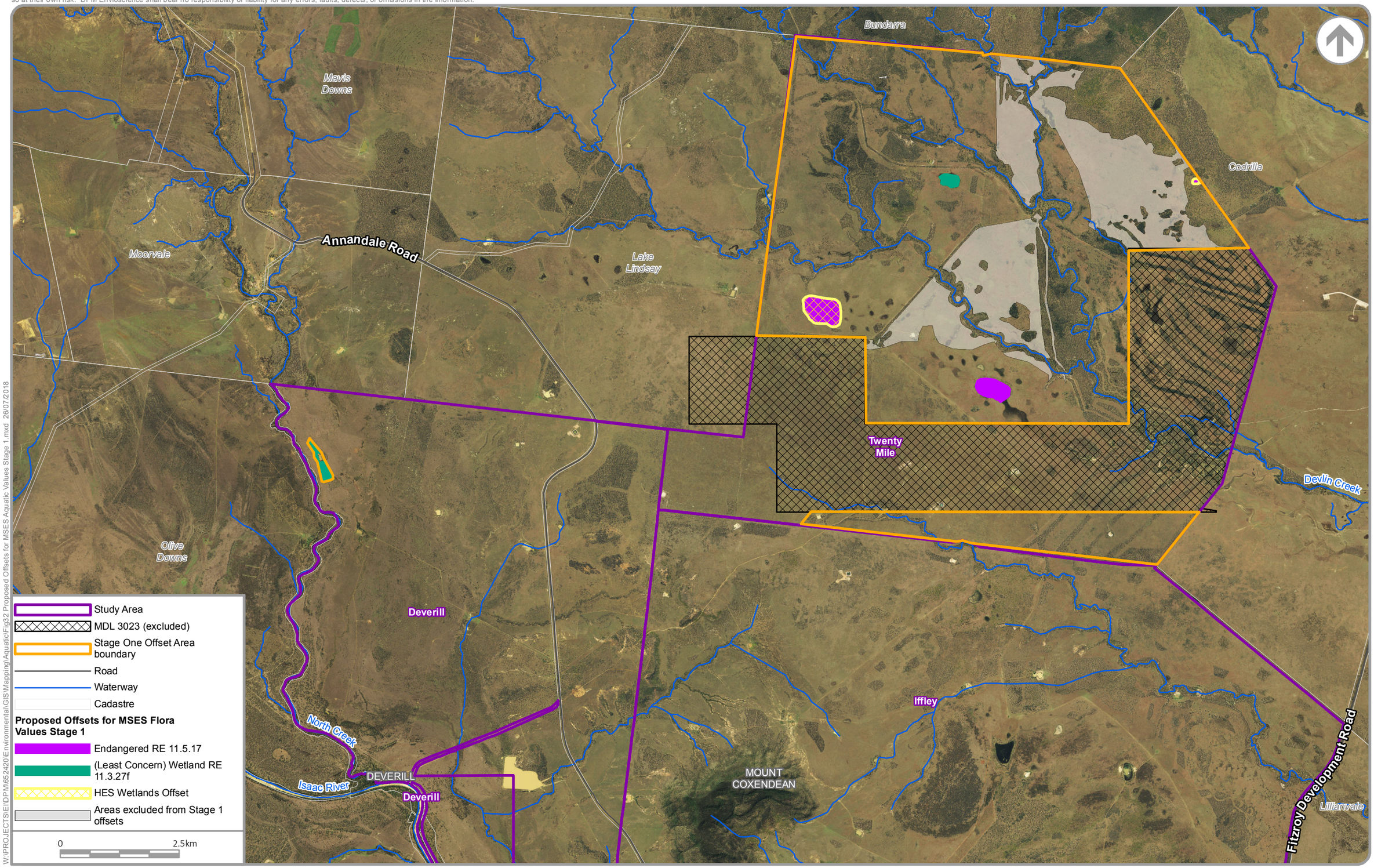
Proposed management actions within the Stage 1 Offset Area wetlands include:

- feral animal control to reduce habitat degradation (particularly by feral pigs);
- reducing weed cover (reducing indirect threats that affect habitat quality);
- implementation of controlled livestock grazing regimes in drier months to encourage natural regeneration of trees and prevent further degradation of habitat; and
- fuel management to avoid high intensity bushfires and loss of native trees.

All management actions are additional to existing obligations for managing the land. The Offset Management Plan will provide further detail on the management of the offset area.

8.3.5 Long-term conservation

Given the offset area would be developed to compensate for impacts to MNES and MSES, Pembroke would seek to secure the offset area as a Nature Refuge, as requested by DNRME and DES during consultation regarding the Project.



W:\PROJECTS\EIDPM652420\Environmental\GIS\Mapping\AquaticFig32 Proposed Offsets for MSES Aquatic Values Stage 1.mxd 26/07/2018

DPM ENVIROSCIENCES

PROPOSED OFFSETS FOR MSES AQUATIC VALUES STAGE ONE

Olive Downs Coking Coal Project – Aquatic Ecology Assessment

FIGURE 32

9 CONCLUSION

The scope of this assessment was to describe the aquatic values, identify any conservation significant species under the Queensland *Nature Conservation Act 1992* (NC Act), *Fisheries Management Act, 1994* and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), to identify the presence of stygofauna, identify and describe any Matters of State and National Environmental Significance; and to identify proposed impact avoidance and mitigation measures to protect the natural values, including consideration of biodiversity offset requirements.

Aquatic ecology surveys were undertaken in accordance with the Australian River Assessment System (AusRivAS) protocols for Queensland streams. In addition, the Queensland *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* was applied and a desktop review was undertaken to assist in determining the likelihood and significance of stygofauna habitat potentially occurring within the Study area. This was supplemented with low-intensity sampling or assessment of nine representative bores (i.e. a pilot survey) within the Study area.

The waterways of the Study area are generally ephemeral and are expected to experience flow only after sustained or intense rainfall and runoff in the catchment. Stream flows are expected to be highly variable, with most channels drying during winter to early spring when rainfall and runoff is historically low.

There are no wetlands of International or National Importance identified within the Study area. A total of 60 palustrine wetlands are mapped as occurring within the Study area. This includes 11 wetlands of High Ecological Significance (HES) and 49 wetlands of General Ecological Significance (GES). An additional 16 wetlands of GES were identified across the Study area as part of the terrestrial flora surveys.

No conservation significant aquatic flora or fauna species listed under the NC Act and / or EPBC Act were recorded within the Study area. In addition, no Matters of National Environmental Significance relevant to aquatic ecology were identified.

The Project would remove aquatic habitat in the Project area, comprising ephemeral watercourses and drainage lines, as well as ephemeral and semi-permanent wetlands (including artificial dams). Matters of State Environmental Significance (MSES) relevant to this assessment identified within the Study area are limited to Wetlands and Watercourses (i.e. HES Wetlands). The Project would remove seven HES Wetlands mapped within the Project area, totalling approximately 61 ha. Although waterways within the Study area were identified as being able to provide for fish passage, it was concluded that the Project would not result in a significant impact on fish passage.

It is considered that the generally poor groundwater quality (indicated by EC levels up to 26,800 µs/cm) within the regolith material in the Study area indicates an environment that is largely unsuitable for stygofauna; however, stygofauna could potentially occur in the unconsolidated sediments (alluvium) associated with the Isaac River. Despite this, no stygofauna were encountered during sampling. Although the Project may have local impacts on a portion of the stygofauna community (if they were to occur), these impacts are likely to be insignificant when placed in the context of the wider extent of similar habitat.

Indirect impacts that have been considered in this assessment include potential impacts associated with changes in water quality, hydrological changes, impacts to groundwater dependant ecosystems and potential cumulative impacts. It is concluded that the Project is unlikely to have a significant impact on aquatic ecology as a result of these potential indirect impacts.

To mitigate unavoidable adverse impacts on aquatic ecology associated with the Project, Pembroke has committed to a number of mitigation and management measures, including:

- vegetation clearance procedures that specify when and how riparian vegetation would be cleared with the view of minimising impacts on aquatic values;
- consideration of the *Accepted Development Requirements for Operational Work that is Constructing or Raising Waterway Barrier Works*;
- design of the Isaac River crossings in consultation with the Department of Agriculture and Fisheries; and
- implementation of a Water Management Plan, Erosion and Sediment Control Plan and a Receiving Environment Monitoring Program.

To address the residual significant adverse impacts (on MSES), an offset strategy has been developed by Pembroke in accordance with relevant State and Commonwealth offset requirements. Pembroke proposes a staged environmental offset in consideration of the staged land clearing described above. The offset for each stage of clearance would be provided before clearing the relevant stage. The result of implementing the offset strategy would be an increase in the area of land (including wetlands) being conserved and managed for conservation in the medium to long term.

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Appendix A: EPBC Act Protected Matters Report

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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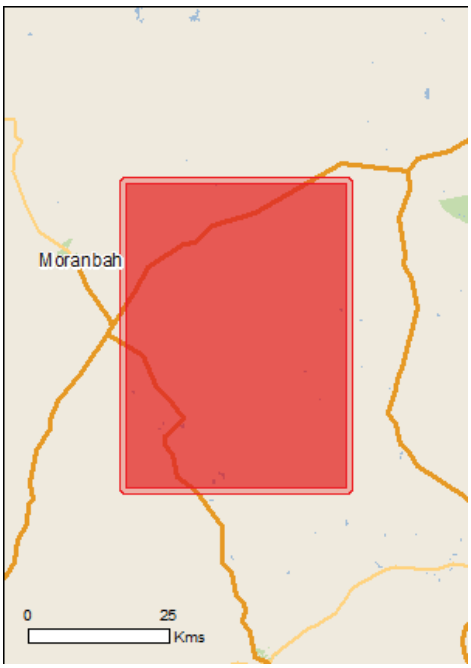

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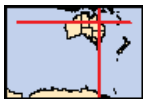

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	3
Listed Threatened Species:	23
Listed Migratory Species:	9

Other Matters Protected by the EPBC Act

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

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

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	15
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

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

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	16
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

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

Name	Status	Type of Presence
Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered	Community known to occur within area
Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin	Endangered	Community likely to occur within area
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat known to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area
Poephila cincta cincta Southern Black-throated Finch [64447]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Mammals		
Dasyurus hallucatus Northern Quoll, Digul [331]	Endangered	Species or species habitat likely to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
Nyctophilus corbeni Corben's Long-eared Bat, South-eastern Long-	Vulnerable	Species or species

Name	Status	Type of Presence
eared Bat [83395]		habitat may occur within area
Petauroides volans		
Greater Glider [254]	Vulnerable	Species or species habitat known to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Other		
Cycas ophiolitica		
[55797]	Endangered	Species or species habitat likely to occur within area
Plants		
Dichanthium queenslandicum		
King Blue-grass [5481]	Endangered	Species or species habitat likely to occur within area
Dichanthium setosum		
bluegrass [14159]	Vulnerable	Species or species habitat may occur within area
Eucalyptus raveretiana		
Black Ironbox [16344]	Vulnerable	Species or species habitat likely to occur within area
Samadera bidwillii		
Quassia [29708]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Denisonia maculata		
Ornamental Snake [1193]	Vulnerable	Species or species habitat known to occur within area
Egernia rugosa		
Yakka Skink [1420]	Vulnerable	Species or species habitat may occur within area
Elseya albagula		
Southern Snapping Turtle, White-throated Snapping Turtle [81648]	Critically Endangered	Species or species habitat likely to occur within area
Furina dunmalli		
Dunmall's Snake [59254]	Vulnerable	Species or species habitat may occur within area
Lerista allanae		
Allan's Lerista, Retro Slider [1378]	Endangered	Species or species habitat may occur within area
Rheodytes leukops		
Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle, White-eyed River Diver [1761]	Vulnerable	Species or species habitat likely to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Cuculus optatus		
Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area
Migratory Wetlands Species		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Cuculus saturatus Oriental Cuckoo, Himalayan Cuckoo [710]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Extra Information

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat likely to occur within area
Mammals		
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Acacia nilotica subsp. indica Prickly Acacia [6196]		Species or species habitat may occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Parthenium hysterophorus Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area
Vachellia nilotica Prickly Acacia, Blackthorn, Prickly Mimosa, Black Piquant, Babul [84351]		Species or species habitat likely to occur within area

Caveat

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

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

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

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

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

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

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

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

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

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

Coordinates

-21.8891 148.1165,-21.8891 148.468,-22.3369 148.468,-22.3369 148.1165,-21.8891 148.1165

Acknowledgements

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

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

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

Please feel free to provide feedback via the Contact Us page.

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Appendix B: Aquatic Survey Site Profiles

Season: Early wet

Site Code: R1 **Location:** Unnamed tributary of the Isaac R, Old Bombandy **Stream order:** 2 **Latitude:** -22.4235 **Longitude:** 148.6042 **Date:** 12/12/2016


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral second order drainage line; dry at the time of assessment; poorly defined bed and banks; little local catchment erosion; bankfull width was approx. 5 m and bankfull height approx. 0.7 m; lacking in-stream habitat features; substrates comprised 95% silt/clay (<0.05 mm) and 5% sand (0.05-2 mm) in the bed habitat and 98% silt/clay and 2% sand in the edge habitat; upstream landuse includes cattle grazing in partly cleared, partly remnant vegetation; adjacent landuse comprised moderate grazing on buffel grass (*Cenchrus ciliaris*)* dominated pasture.

Aquatic and riparian vegetation

Study reach positioned within non-remnant vegetation. Riparian zone approximately 10 m on the left bank and 10 m on the right, comprising woodland with sparse mixed canopy dominated by poplar gum (*Eucalyptus platyphylla*) and carbeen (*Corymbia tessellaris*), with abundant Clarkson's bloodwood (*C. clarksoniana*), forest red gum (*E. tereticornis*), coolabah (*E. coolabah*) and narrow-leaved ironbark (*E. crebra*). Very sparse shrub layer containing bean tree (*Cassia brewsteri*). Ground layer dominated by exotic species buffel grass* and sabi grass (*Urochloa mosambicensis*)*. No macrophytes detected.

Erosion risk

Moderate – Banks appeared to be moderately stable, with 50-79% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

No suitable breeding habitat detected for fish, turtles or platypus.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species.

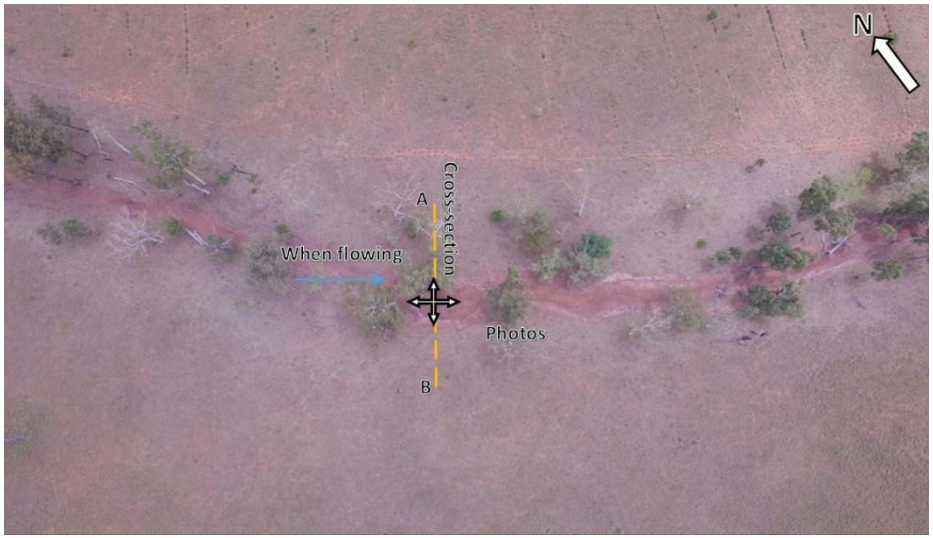
Physico-chemical water quality

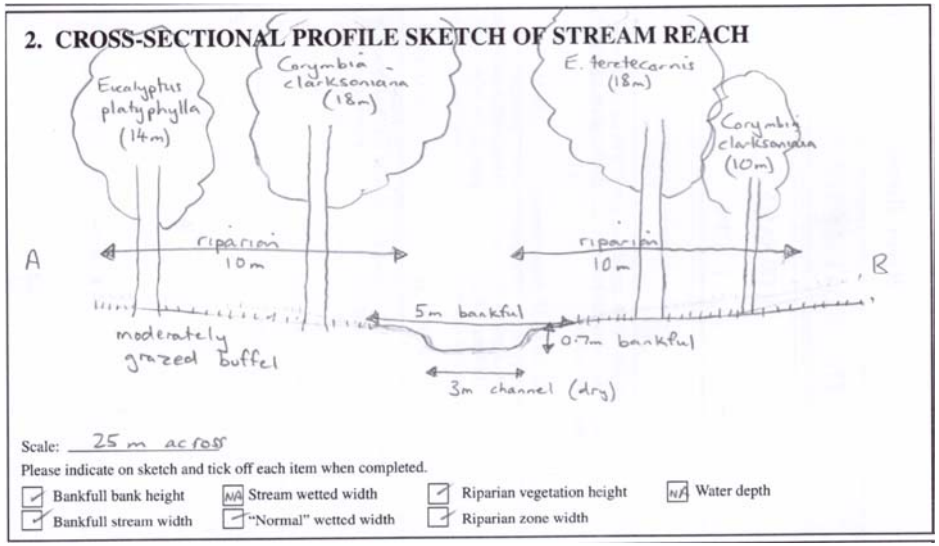
Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for early wet season: Fair (51).

Overall aquatic values – Early wet season: **Low**; Late wet season: Expected to be **Low**





Season: Early wet

Site Code: R2 **Location:** Isaac River, Willunga **Stream order:** 6 **Latitude:** -22.3986 **Longitude:** 148.5257 **Date:** 14/12/2016

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Receding flow in a steeply incised section of the Isaac River; low to moderate flow at the time of assessment; well defined bed and banks; some local catchment erosion; the wetted width along the study reach was approx. 20-25 m, with a mean width of 23 m (estimated); depth >2 m; bankfull width was approx. 40 m and bankfull height approx. 6 m above the water level (depth unknown); in-stream habitat included deep (>0.5 m) pool, large woody debris and undercut banks; substrates comprised 90% sand (0.05-2 mm) and 10% silt/clay (<0.05 mm) in the edge habitat, with a thin surface layer of 100% silt/clay recently deposited; macroinvertebrates sampled from the edge habitat only, as the water body was too deep and the banks too steep and slippery to access the bed habitat; site partly sampled, but abandoned in search of a more preferable, safer location to sample; upstream landuse includes cattle grazing and mining; adjacent landuse includes light cattle grazing in predominantly remnant vegetation.

Aquatic and riparian vegetation

Study reach positioned within RE 11.3.25. Riparian zone approximately 20 m on the left bank and 20 m on the right, comprising riparian forest co-dominated by forest red gum (*Eucalyptus tereticornis*) and weeping tea-tree (*Melaleuca fluviatilis*), with occasional river she-oak (*Casuarina cunninghamiana*) and carbeen (*Corymbia tessellaris*). Sparse shrub layer including bean tree (*Cassia brewsteri*), castor oil weed (*Ricinus communis*)*, sandpaper fig (*Ficus opposita*) and Noogoora burr (*Xanthium orientalis*)*. Ground layer of upper bank dominated by green panic (*Megathyrsus maxima*)*, with frequent parthenium (*Parthenium hysterophorus*)*. Ground layer of lower bank dominated by common couch (*Cynodon dactylon*), with frequent forest bluegrass (*Bothriochloa bladhii*). Fringing macrophytes included rice sedge (*Cyperus difformis*), tall flatsedge (*C. exaltatus*), white eclipta (*Eclipta prostrata*)* and slender knotweed (*Persicaria decipiens*).

Erosion risk

Low – Banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach provides potential breeding habitat for fish and turtles. No suitable platypus breeding habitat detected. No fish or turtle survey techniques deployed (not safe to access due to steep banks, deep water and unconsolidated silt substrates). Aquatic macroinvertebrates were collected from the edge habitat only (Appendix C). Macrocrustaceans included freshwater shrimp (*Paratya australiense*).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

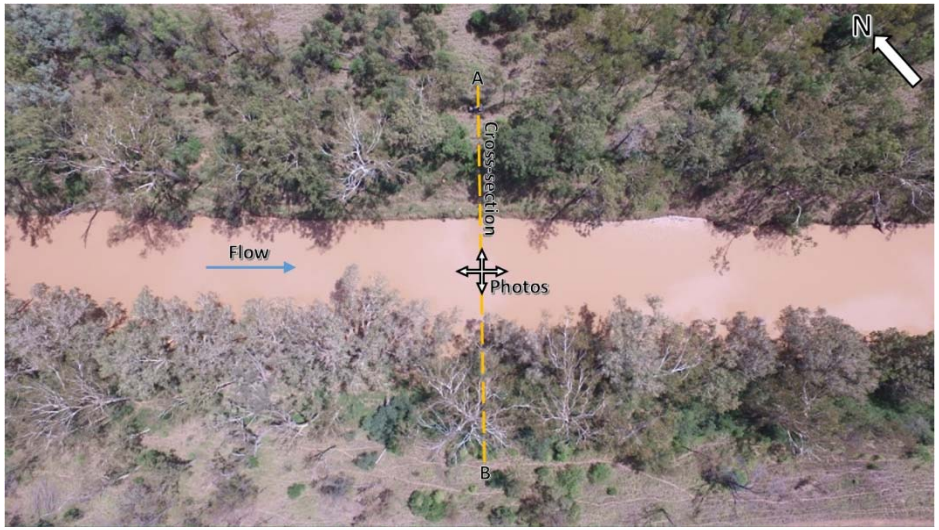
Physico-chemical water quality

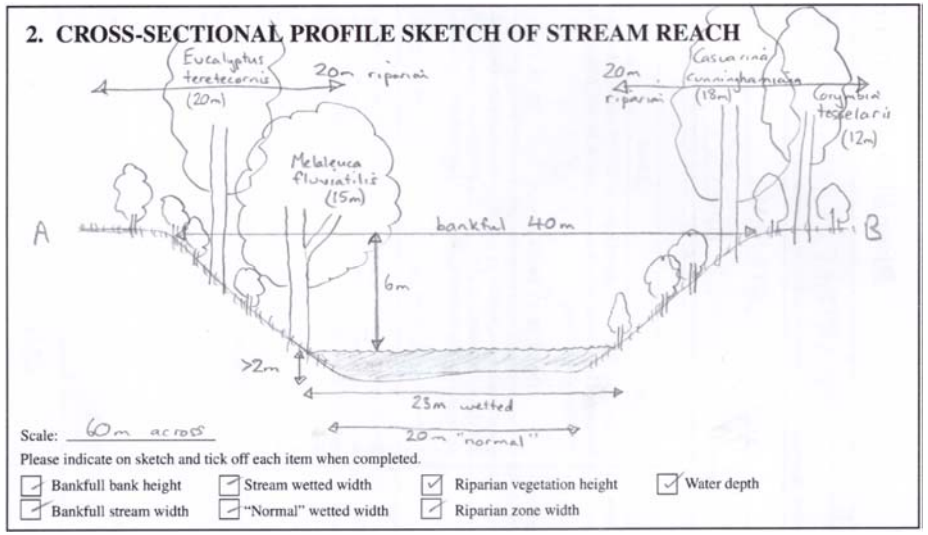
Collection time: 10:36 EST; water temp.: 26.7 °C; conductivity: 151 µS/cm (fresh); turbidity: 459 (poor clarity); dissolved oxygen: 82.5%, 6.6 mg/L; pH 7.7 (mildly alkaline). Summary: Normal.

Bioassessment scores

Habitat assessment score for early wet season: Fair (55); AusRivAS taxonomic richness: 30 (edge); PET richness: 3 (edge); SIGNAL 2 score: 3.07 (edge); tolerant taxa: 61% (edge); AusRivAS OE50 score: 0.96 (Band A) (edge).

Overall aquatic values – Early wet season: **Moderate** (known presence of Priority species), Late wet season: Expected to be **Moderate**





Season: Early wet

Site Code: R3 **Location:** Unnamed tributary of Ripstone Ck, Vermont Park **Stream order:** 3 **Latitude:** -22.3074 **Longitude:** 148.4374 **Date:** 18/12/2016


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Isolated pool on ephemeral third order tributary of Ripstone Creek; no discernible surface flow at the time of assessment; well defined bed and banks; no local catchment erosion detected; the wetted width along the study reach ranged from about 2 to 20 m, with a mean width of 13 m (estimated); mean depth 0.05 m in the edge habitat (i.e. within 0.5 m of the stream edge) and 0.4 m in the bed habitat; bankfull width was approx. 25 m and bankfull height approx. 1.5 m (from the stream bed); in-stream habitat included shallow (<0.5 m) pool, large woody debris and macrophytes; substrates comprised 95% silt/clay (<0.05 mm) and 5% sand (0.05-2 mm) in the bed habitat and 100% silt/clay in the edge habitat; upstream landuse includes agricultural grazing; adjacent landuse includes light grazing on cleared land with young brigalow (*Acacia harpophylla*) regrowth.

Aquatic and riparian vegetation

Study reach positioned within non-remnant vegetation. Riparian zone approximately 5 m on the left bank and 5 m on the right, dominated by sparse coolabah (*Eucalyptus coolabah*), with occasional brigalow. Sparse shrub layer dominated by lignum (*Duma florulenta*). Ground layer dominated by umbrella canegrass (*Leptochloa digitata*) and tall flatsedge (*Cyperus exaltatus*), with frequent musk basil (*Basilicum polystachyon*) and parthenium weed (*Parthenium hysterophorus*)*. Emergent and fringing macrophytes included rice sedge (*Cyperus difformis*), tall flatsedge, pale spikerush (*Eleocharis pallens*), umbrella canegrass, water primrose (*Ludwigia peploides* subsp. *montevidensis*), native hyacinth (*Monochoria cyanea*), lignum, wavy marshwort (*Nymphoides crenata*), swamp lily (*Ottelia ovalifolia*), smartweed (*Persicaria attenuata*) and Prince's feathers (*P. orientalis*).

Erosion risk

Low – Banks appeared to be stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach provides potential foraging and breeding habitat for fish and turtles. No suitable platypus breeding habitat detected. Aquatic fauna detected by backpack electrofishing and overnight deployment of two baited fyke nets and five baited box traps included Agassiz's glassfish (*Ambassis agassizii*), spangled perch (*Leiopotherapon unicolor*), bony

bream (*Nematalosa erebi*), eastern rainbowfish (*Melanotaenia splendida splendida*), gudgeon (*Hypseleotris* sp.), fly-specked hardyhead (*Craterocephalus stercusmuscarum*), and the pest species tilapia (*Oreochromus mossambicus*)*. No turtles detected. Macrocrustaceans included freshwater crab (*Austrothelphusa transversa*). A number of other aquatic macroinvertebrates were also recorded (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge and native hyacinth.

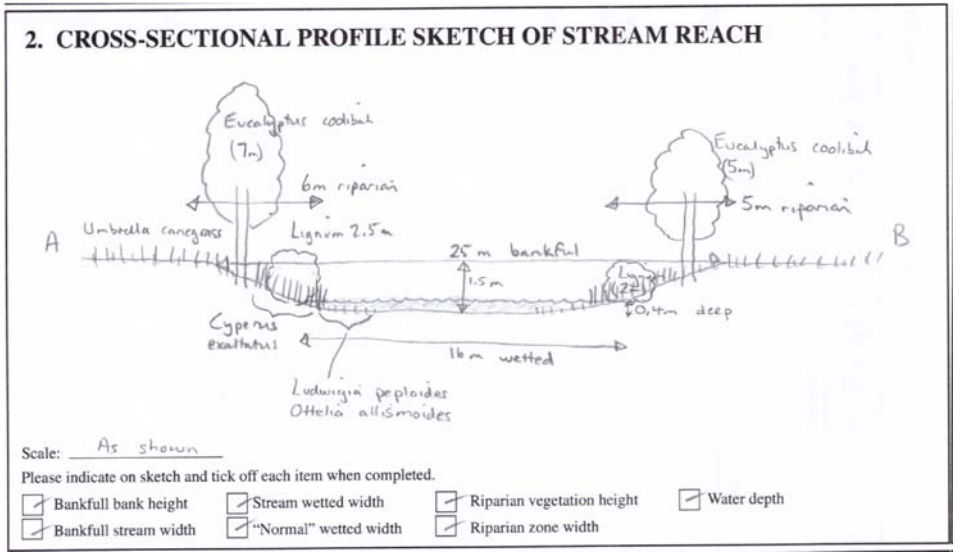
Physico-chemical water quality

Collection time: 15:30 EST; water temp.: 32.6 °C; conductivity: 221 µS/cm (fresh); turbidity: 12 (high clarity); dissolved oxygen: 97.0%, 6.9 mg/L (saturated); pH 7.6 (mildly alkaline). Summary: Normal.

Bioassessment scores

Habitat assessment scores for early wet season: Fair (61); AusRivAS taxonomic richness: 11 (bed), 22 (edge); PET richness: 0 (bed), 2 (edge); SIGNAL 2 score: 2.63 (bed), 3.19 (edge); tolerant taxa: 88% (bed), 52% (edge); AusRivAS OE50 score: 0.33 (Band B) (bed); 0.70 (Band B) (edge).

Overall aquatic values – Early wet season: **Moderate** (known presence of Priority species); Late wet season: See following site profile.



Season: Late wet

Site Code: R3 **Location:** Unnamed tributary of Ripstone Ck, Vermont Park **Stream order:** 3 **Latitude:** -22.3074 **Longitude:** 148.4374 **Date:** 8/07/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Isolated pool on ephemeral third order tributary of Ripstone Creek; no discernible surface flow at the time of assessment; well defined bed and banks; no local catchment erosion detected; the wetted width along the study reach ranged from about 2 to 24 m, with a mean width of 15 m (estimated); mean depth 0.05 m in the edge habitat (i.e. within 0.5 m of the stream edge) and 0.5 m in the bed habitat; bankfull width was approx. 25 m and bankfull height approx. 1.5 m (from the stream bed); in-stream habitat included shallow (<0.5 m) pool, deep pool, large woody debris and macrophytes; substrates comprised 95% silt/clay (<0.05 mm) and 5% sand (0.05-2 mm) in the bed habitat and 100% silt/clay in the edge habitat; upstream landuse includes moderate cattle grazing; adjacent landuse includes light cattle grazing on cleared land with young brigalow (*Acacia harpophylla*) regrowth.

Aquatic and riparian vegetation

Study reach positioned within non-remnant vegetation. Riparian zone approximately 5 m on the left bank and 5 m on the right, dominated by sparse coolabah (*Eucalyptus coolabah*), with occasional brigalow. Sparse shrub layer dominated by lignum (*Duma florulenta*). Ground cover dominated by umbrella canegrass (*Leptochloa digitata*) and tall flatsedge (*Cyperus exaltatus*), with frequent musk basil (*Basilicum polystachyon*) and parthenium weed (*Parthenium hysterophorus*)*. Submerged macrophytes included charophyte algae (*Chara* / *Nitella* sp.). Emergent and fringing macrophytes included rice sedge (*Cyperus difformis*), tall flatsedge, pale spikerush (*Eleocharis pallens*), common rush (*Juncus usitatus*), umbrella canegrass, water primrose (*Ludwigia peploides* subsp. *montevidensis*), native hyacinth (*Monochoria cyanea*), lignum, wavy marshwort (*Nymphoides crenata*), swamp lily (*Ottelia ovalifolia*), smartweed (Persicaria attenuata) and Prince's feathers (*P. orientalis*).

Erosion risk

Low – Banks appeared to be stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach provides potential foraging and breeding habitat for fish and turtles. No suitable platypus breeding habitat detected. Aquatic fauna detected by backpack electrofishing

and overnight deployment of two baited fyke nets and five baited box traps included Agassiz's glassfish (*Ambassis agassizii*), purple-spotted gudgeon (*Mogurnda adspersa*), bony bream (*Nematalosa erebi*), Hyrtyl's tandan (*Neosilurus hyrtlii*), eastern rainbowfish (*Melanotaenia splendida splendida*), gudgeon (*Hypseleotris* sp.), fly-specked hardyhead (*Craterocephalus stercusmuscarum*), and the pest species mosquitofish (*Gambusia holbrooki*)* and tilapia (*Oreochromus mossambicus*)*. No turtles detected. Macrocrustaceans included freshwater prawn (*Macrobrachium australiense*) and orange-fingered yabby (*Cherax depressus*). A number of other aquatic macroinvertebrates were also recorded (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge and native hyacinth.

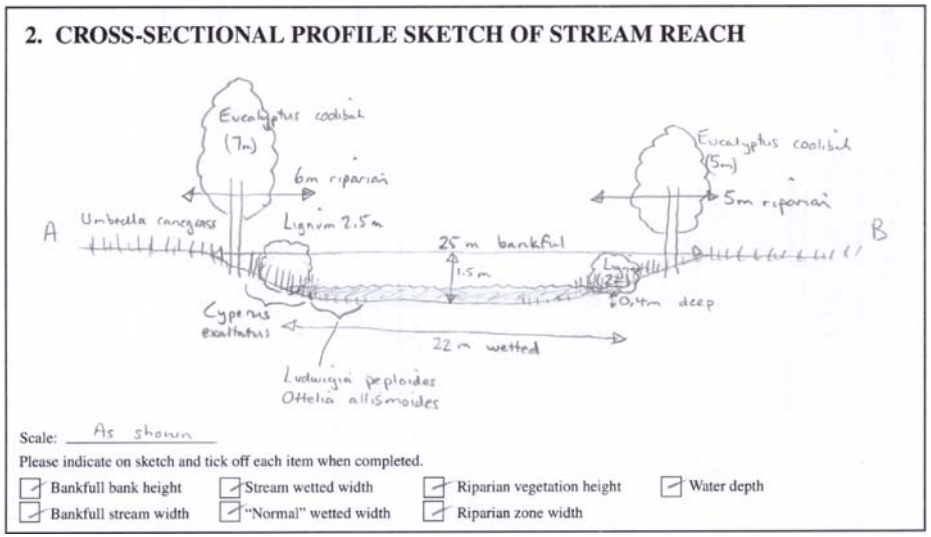
Physico-chemical water quality

Collection time: 12:00 EST; water temp.: 18.6 °C; conductivity: 220 µS/cm (fresh); turbidity: 27.7 (moderate clarity); dissolved oxygen: 77.2%, 7.1 mg/L (relatively low for time of day); pH 7.1 (neutral). Summary: Normal, although low DO likely due to shading by extensive cover of emergent water primrose.

Bioassessment scores

Habitat assessment scores for late wet season: Fair (61); AusRivAS taxonomic richness: 20 (bed), 27 (edge); PET richness: 3 (bed), 3 (edge); SIGNAL 2 score: 3.50 (bed), 3.40 (edge); tolerant taxa: 44% (bed), 48% (edge); AusRivAS OE50 score: 1.01 (Band A) (bed); 1.07 (Band A) (edge).

Overall aquatic values – Late wet season: **Moderate** (known presence of Priority species); Early wet season: See previous site profile.



Season: Late wet

Site Code: R4 **Location:** Unnamed riverine wetland, Vermont Park **Stream order:** 1 **Latitude:** -22.2836 **Longitude:** 148.4171 **Date:** 7/07/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Riverine wetland on ephemeral first order stream, created by water back-up from dam approx. 200 m downstream; semi-permanent pool on an otherwise highly ephemeral drainage line; well defined bed and banks within study reach; little local catchment erosion; moderate water level (=watermark) at time of site visit; isolated pool with no discernible flow; the wetted width along the 100 m survey reach ranged from 5 to 15 m, with a mean width of 11 m (estimated); mean depth 0.3 m in the edge habitat (i.e. within 0.5 m of the stream edge) and 2 m in the bed habitat; some areas deeper than 2 m; bankfull width was approx. 15 m and bankfull height approx. 2.5 m (from the stream bed); in-stream habitat included shallow (<0.5 m) pool, deep pool, large woody debris, undercut banks, emergent, floating and submerged macrophytes; substrates comprised 100% silt/clay (<0.05 mm) in the bed and edge habitats; no riffles or runs; upstream and adjacent landuse includes light cattle grazing on both cleared and remnant vegetation.

Riparian vegetation

Study reach positioned within RE 11.4.9. Riparian zone approximately 10 m on the left bank and 10 m on the right, comprising woodland dominated by brigalow (*Acacia harpophylla*) and Dawson gum (*Eucalyptus cambageana*). Sparse sub-canopy of yellowwood (*Terminalia oblongata*), sandalwood (*Santalum lanceolatum*) and belah (*Casuarina cristata*). Sparse shrub layer including scrub boonaree (*Alectryon diversifolius*) and currant bush (*Carissa ovata*). Ground layer dominated by buffel grass (*Cenchrus ciliaris*)* and sabi grass (*Urochloa mosambicensis*)*. Submerged macrophytes included charophyte algae (*Chara/Nitella* sp.) and bladderwort (*Utricularia* sp.). Floating macrophytes included ferny azolla (*Azolla pinnata*). Emergent and fringing macrophytes included rice sedge (*Cyperus difformis*), *C. concinnus*, tall flatsedge (*C. exaltatus*), awnless barnyard grass (*Echinochloa colona*)*, white eclipta (*Eclipta prostrata*)*, common rush (*Juncus usitatus*), umbrella canegrass (*Leptochloa digitata*), native willow primrose (*Ludwigia octovalvis*), water primrose (*Ludwigia peploides* subsp. *montevidensis*), common nardoo (*Marsilea drummondii*), shiny nardoo (*M. mutica*), native hyacinth (*Monochoria cyanea*), wavy marshwort (*Nymphoides crenata*), swamp lily (*Ottelia ovalifolia*), smartweed (*Persicaria attenuata*) and slender knotweed (*P. decipiens*).

Erosion risk

Low – Banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach provides foraging and likely breeding habitat for fish and turtles. Potential habitat for platypus (relative permanence of water; bank substrates dominated by silt/clay), but no platypus burrows detected, despite targeted searches. Aquatic fauna detected by backpack electrofishing and overnight deployment of two baited fyke nets, two baited cathedral traps and five baited box traps included glassfish (*Ambassis agassizii*), purple-spotted gudgeon (*Mogurnda adspersa*), spangled perch (*Leiopotherapon unicolor*), eastern rainbowfish (*Melanotaenia splendida splendida*), gudgeon (*Hypseleotris* sp.), Hyrtl's tandan (*Neosilurus hyrtlii*), Rendahl's tandan (*Porochilus rendahli*), fly-specked hardyhead (*Craterocephalus stercusmuscarum*), sleepy cod (*Oxyeleotris lineolata*) and the pest species tilapia (*Oreochromus mossambicus*)*. No turtles detected. Macrocrustaceans included freshwater prawn (*Macrobrachium australiense*) and orange-fingered yabby (*Cherax depressus*).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Potential habitat for platypus, although not detected. Priority flora species included tall flatsedge (*C. exaltatus*) and native hyacinth (*M. cyanea*).

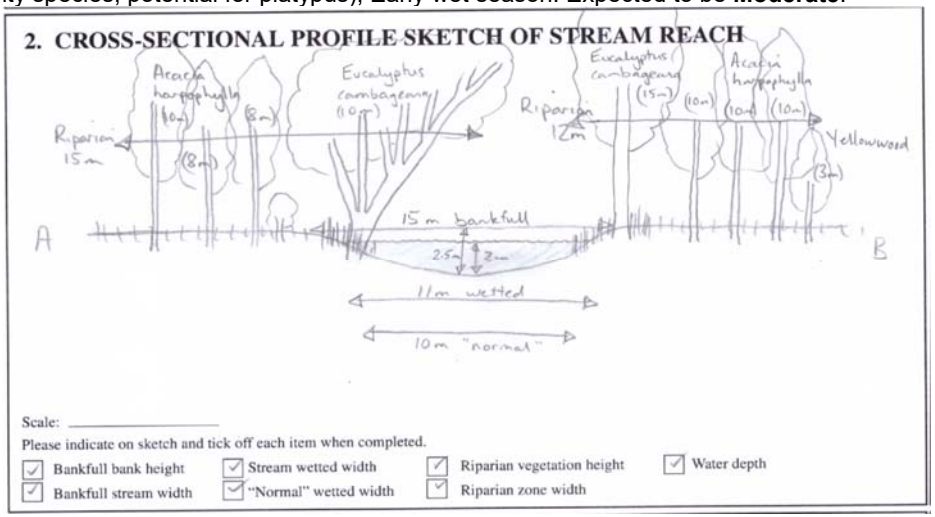
Physico-chemical water quality

Collection time: 10:20 EST; water temp.: 19.5 °C; conductivity: 182 µS/cm (fresh); turbidity: 23.4 (moderate clarity); dissolved oxygen: 59.4%, 5.3 mg/L (low); pH 7.3 (neutral). Summary: Normal (low oxygen levels likely associated with time of day and presence of submerged macrophytes; expecting to rise and peak in the early afternoon).

Bioassessment scores

Habitat assessment scores for late wet season: Good (83); AusRivAS taxonomic richness: 26 (bed), 29 (edge); PET richness: 4 (bed), 3 (edge); SIGNAL 2 score: 3.48 (bed), 3.15 (edge); tolerant taxa: 48% (bed), 55% (edge); AusRivAS OE50 score: 0.98 (Band A) (bed); 1.21 (Band X) (edge).

Overall aquatic values – Late wet season: **Moderate** (semi-permanent waterbody; Priority species; potential for platypus); Early wet season: Expected to be **Moderate**.



Season: Early wet

Site Code: R5-A **Location:** Ripstone Creek, Vermont Park **Stream order:** 3 **Latitude:** -22.2845 **Longitude:** 148.3676 **Date:** 18/12/2016


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral third order watercourse; dry at the time of assessment; well defined bed and banks; little local catchment erosion; bankfull width was approx. 28 m and bankfull height approx. 4 m; substrates comprised 95% sand (0.05-2 mm) and 5% silt/clay (<0.05 mm) in the bed and edge habitats; habitat features included some (10-50%) detritus, some sticks, little (1-10%) branches and little logs; upstream landuse includes coal mining and cattle grazing; adjacent landuse includes light cattle grazing in predominantly remnant vegetation.

Aquatic and riparian vegetation

Study reach positioned within RE 11.3.25. Riparian zone approximately 10 m on the left bank and 15 m on the right, comprising woodland dominated by weeping tea-tree (*Melaleuca fluviatilis*), with frequent forest red gum (*Eucalyptus tereticornis*) and river she-oak (*Casuarina cristata*). Sparse sub-canopy of white bauhinia (*Lysiphyllum hookeri*). No obvious shrub layer. Ground layer of lower bank sparsely occupied by *Carex* sp., spiny-headed mat-rush (*Lomandra longifolia*) and forest blue grass (*Bothriochloa bladhii*). Ground layer of upper bank dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent spiny-headed mat-rush, occasional shrubby stylo (*Stylosanthes scabra*) and wiregrass (*Aristida* sp.). No macrophytes detected.

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

No aquatic fauna detected. May provide suitable foraging habitat for fish in times of flow. No fish, turtle or platypus breeding habitat detected.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide

suitable habitat for these species.

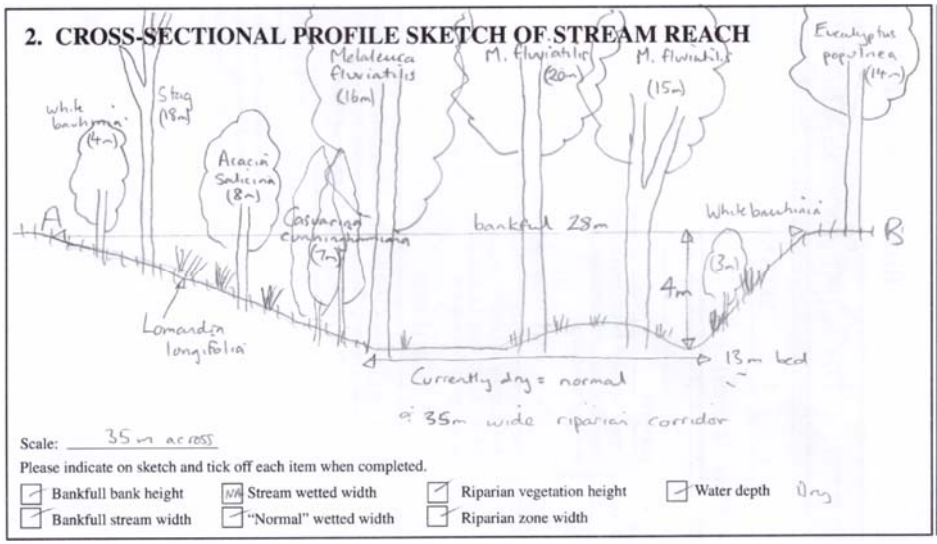
Physico-chemical water quality

Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for early wet season: Fair (46).

Overall aquatic values – Early wet season: **Low**; Late wet season: See following site profile.



Season: Late wet

Site Code: R5-B **Location:** Ripstone Creek, Vermont Park **Stream order:** 3 **Latitude:** -22.2833 **Longitude:** 148.3651 **Date:** 6/07/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Isolated pool on ephemeral third order stream reach of Ripstone Creek; well defined bed and banks; little local catchment erosion; isolated pool, with no discernible flow, approximately 100 m long x 10 m wide; mean depth 0.15 m in the edge habitat (i.e. within 0.5 m of the stream edge) and 0.6 m in the bed habitat; bankfull width was approx. 30 m and bankfull height approx. 5 m (from the stream bed); in-stream habitat included shallow (<0.5 m) pool, deep pool, large woody debris, undercut banks, emergent and submerged macrophytes; substrates comprised approximately 70% silt/clay (<0.05 mm) and 30% sand (0.05-2mm) in the edge habitat and 50% silt/clay and 50% sand in the bed habitat.

Riparian vegetation

Study reach positioned within RE 11.3.25. Riparian zone approximately 20 m on the left bank and 20 m on the right, comprising woodland dominated by forest red gum (*Eucalyptus tereticornis*), with frequent weeping tea-tree (*Melaleuca fluviatilis*) and occasional poplar box (*Eucalyptus populnea*). Sparse sub-canopy with frequent white bauhinia (*Lysiphyllum hookeri*), occasional sally wattle (*Acacia salicina*), brigalow (*Acacia harpophylla*) and false sandalwood (*Eremophila mitchellii*). Scattered shrubs, including Noogoora burr (*Xanthium orientalis*)*, castor oil bush (*Ricinus communis*)*, white bauhinia, currant bush (*Carissa ovata*) and lantana (*Lantana camara*)*. Ground layer dominated by green panic (*Megathyrsus maxima*)*, with frequent sabi grass (*Centipeda minima*)* and buffel grass (*Cenchrus ciliaris*)*. Submerged macrophytes included charophyte algae (*Chara/Nitella* sp.). Fringing and emergent macrophytes included rice sedge (*Cyperus difformis*)*, tall flatsedge (*C. exaltatus*)*, *C. trinervis*, awnless barnyard grass (*Echinochloa colona*)* and common rush (*Juncus usitatus*).

Erosion risk

Moderate – Right bank stable, left bank slumping; however, over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach provides breeding and foraging habitat for fish, and potential breeding and foraging habitat for turtles. The study reach is unlikely to provide foraging or breeding habitat

for platypus (*Ornithorhynchus anatinus*). Aquatic fauna detected by backpack electrofishing and overnight deployment of two fyke nets and five baited box traps included glassfish (*Ambassis agassizii*), purple-spotted gudgeon (*Mogurnda adspersa*), spangled perch (*Leiopotherapon unicolor*), eastern rainbowfish (*Melanotaenia splendida splendida*), gudgeon (*Hypseleotris* sp.), bony bream (*Nematalosa erebi*), Hyrtl's tandan (*Neosilurus hyrtlii*), Rendahl's tandan (*Porochilus rendahli*), freshwater catfish (*Tandanus tandanus*), fly-specked hardyhead (*Craterocephalus stercusmuscarum*) and the pest species tilapia (*Oreochromus mossambicus*)*. No turtles detected. Macrocrustaceans included freshwater prawn (*Macrobrachium australiense*) and freshwater prawn (*Macrobrachium australiense*). A number of other aquatic macroinvertebrates were also recorded (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). Priority flora species included tall flatsedge (*C. exaltatus*).

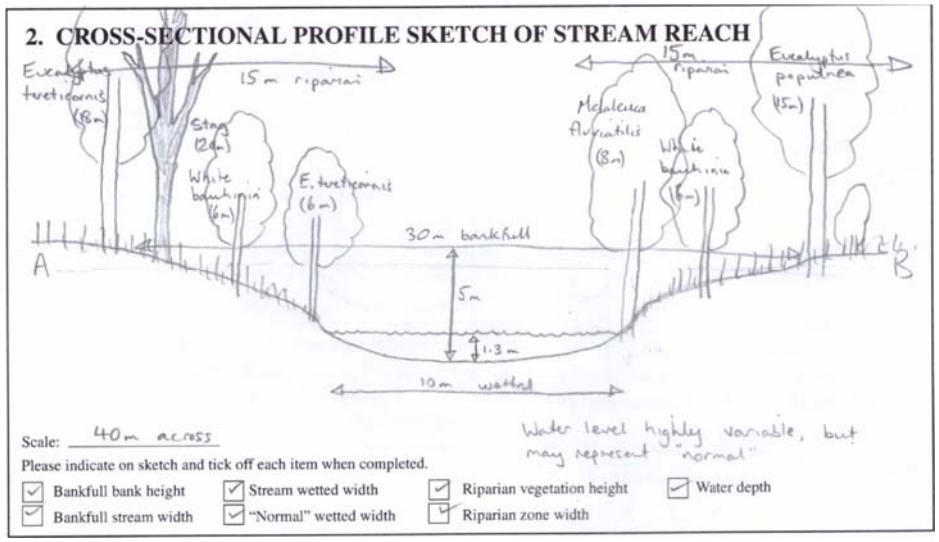
Physico-chemical water quality

Collection time: 12:20 EST; water temp.: 20.4 °C; conductivity: 680 µS/cm (fresh); turbidity: 12.8 (moderately high clarity); dissolved oxygen: 81.0%, 7.4 mg/L; pH 7.6 (mildly alkaline). Summary: Normal.

Bioassessment scores

Habitat assessment scores for late wet season: Fair (65); AusRivAS taxonomic richness: 21 (bed), 28 (edge); PET richness: 4 (bed), 3 (edge); SIGNAL 2 score: 3.60 (bed), 3.37 (edge); tolerant taxa: 45% (bed), 52% (edge); AusRivAS OE50 score: 0.88 (Band A – bed); 1.14 (Band A – edge).

Overall aquatic values – Late wet season: **Moderate** (Priority species present; potential dry season refuge for fish); Early wet season: see previous site profile.



Season: Early wet

Site Code: R6 **Location:** Isaac River, Vermont Park **Stream order:** 6 **Latitude:** -22.2740 **Longitude:** 148.4622 **Date:** 14/12/2016


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Pool and run on the ephemeral Isaac River; low to moderate flow at the time of assessment; well defined bed and banks; little local catchment erosion; the wetted width along the study reach ranged from about 15 to 50 m, with a mean width of 25 m (estimated); mean depth 0.25 m in the edge habitat (i.e. within 0.5 m of the stream edge) and 0.5 m in the bed habitat; some areas >2m depth; bankfull width was approx. 70 m and bankfull height approx. 7 m (from the stream bed); in-stream habitat included shallow (<0.5 m) pool, deep (>0.5 m) pool, large woody debris, undercut banks and macrophytes; substrates comprised 99% sand (0.05-2 mm) and 1% silt/clay (<0.05 mm) in the bed habitat and 95% sand (0.05-2 mm) and 5% silt/clay (<0.05 mm) in the edge habitat; upstream landuse includes agricultural grazing and coal mining; adjacent landuse includes light grazing in predominantly remnant vegetation.

Aquatic and riparian vegetation

Study reach positioned within RE 11.3.25. Riparian zone approximately 20 m on the left bank and 30 m on the right, comprising riparian forest dominated by forest red gum (*Eucalyptus tereticornis*), with occasional river red gum (*Eucalyptus camaldulensis*). Sub-canopy dominated by snow-in-summer (*Melaleuca linariifolia*) on the lower bank, and bean tree (*Cassia brewsteri*), sally wattle (*Acacia salicina*) and ebony (*Diospyros* sp.) on the upper bank. Sparse shrub layer including lantana (*Lantana camara*)* and castor oil bush (*Ricinus communis*)*. Ground layer dominated by the exotic green panic (*Megathyrsus maxima*)* on the upper bank, and forest bluegrass (*Bothriochloa bladhii*) and common couch (*Cynodon dactylon*) on the lower bank. Fringing macrophytes included rice sedge (*Cyperus difformis*), tall flatsedge (*C. exaltatus*), flatsedge (*C. haspan*), common rush (*Juncus usitatus*) and small knotweed (*Polygonum plebeium*).

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach provides foraging habitat for fish, potential breeding habitat for fish, and potential breeding and foraging habitat for turtles. No suitable platypus breeding habitat

detected. Aquatic fauna, detected by backpack electrofishing only (too much flow for overnight deployment of nets), included eastern rainbowfish (*Melanotaenia splendida splendida*), gudgeon (*Hypseleotris* sp.) and bony bream (*Nematalosa erebi*). No turtles detected. Macrocrustaceans included freshwater shrimp (*Paratya australiense*) and freshwater prawn (*Macrobrachium australiense*). A number of other aquatic macroinvertebrates were also recorded (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

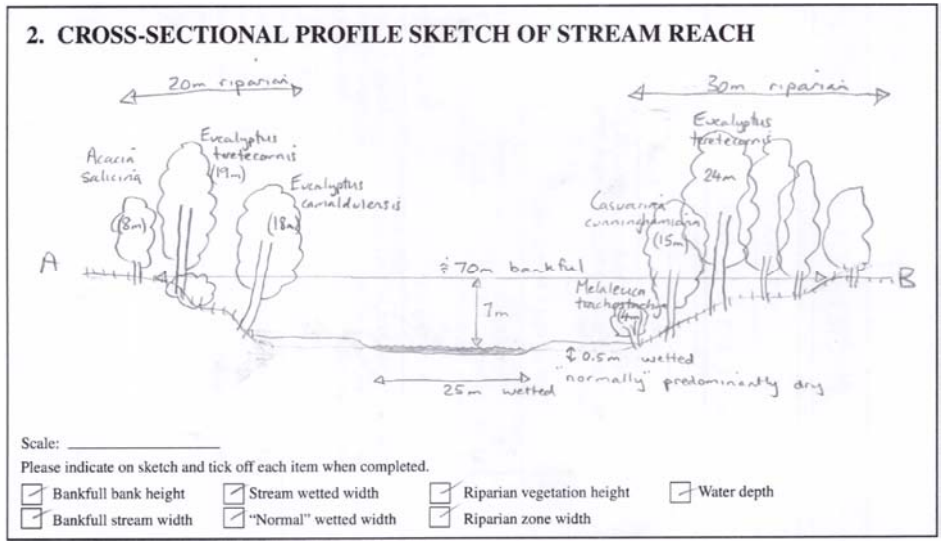
Physico-chemical water quality

Collection time: 15:00 EST; water temp.: 31.5 °C; conductivity: 193 µS/cm (fresh); turbidity: 275 (poor clarity); dissolved oxygen: 88.6%, 6.5 mg/L; pH 7.2 (neutral).
Summary: Normal.

Bioassessment scores

Habitat assessment score for early wet season: Fair (57); AusRivAS taxonomic richness: 7 (bed), 16 (edge); PET richness: 1 (bed), 2 (edge); SIGNAL 2 score: 4.00 (bed), 3.31 (edge); tolerant taxa: 29% (bed), 50% (edge); AusRivAS OE50 score: 0.56 (Band B – bed); 0.79 (Band A – edge).

Overall aquatic values – Early wet season: **Moderate** (Priority species present); Late wet season: see following site profile.



Season: Late wet

Site Code: R6 **Location:** Isaac River, Vermont Park **Stream order:** 6 **Latitude:** -22.2740 **Longitude:** 148.4622 **Date:** 9/07/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Isolated pool on the ephemeral Isaac River; no discernible surface flow at the time of assessment; well defined bed and banks; little local catchment erosion; the wetted width along the study reach averaged about 45 m (estimated); mean depth 0.15 m in the edge habitat (i.e. within 0.5 m of the stream edge) and 0.5 m in the bed habitat; some areas >2m depth; bankfull width was approx. 70 m and bankfull height approx. 7 m (from the stream bed); in-stream habitat included shallow (<0.5 m) pool, deep (>0.5 m) pool, large woody debris, undercut banks and macrophytes; substrates comprised 99% sand (0.05-2 mm) and 1% silt/clay (<0.05 mm) in the bed habitat and 95% sand (0.05-2 mm) and 5% silt/clay (<0.05 mm) in the edge habitat; upstream landuse includes agricultural grazing and mining; adjacent landuse includes light grazing in predominantly remnant vegetation.

Aquatic and riparian vegetation

Study reach positioned within RE 11.3.25. Riparian zone approximately 20 m on the left bank and 30 m on the right, comprising riparian forest dominated by forest red gum (*Eucalyptus tereticornis*), with occasional river red gum (*Eucalyptus camaldulensis*). Sub-canopy dominated by snow-in-summer (*Melaleuca linariifolia*) on the lower bank, and bean tree (*Cassia brewsteri*), sally wattle (*Acacia salicina*) and ebony (*Diospyros* sp.) on the upper bank. Sparse shrub layer including lantana (*Lantana camara*)* and castor oil bush (*Ricinus communis*)*. Ground layer dominated by the exotic green panic (*Megathyrsus maximus*)* on the upper bank, and by forest bluegrass (*Bothriochloa bladhii*) and common couch (*Cynodon dactylon*) on the lower bank. Fringing macrophytes included rice sedge (*Cyperus difformis*), tall flatsedge (*C. exaltatus*), flatsedge (*C. haspan*), white eclipta (*Eclipta prostrata*)*, common rush (*Juncus usitatus*) and spiny mudgrass (*Pseudoraphis spinescens*).

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach provides foraging habitat for fish and turtles, and potential breeding habitat for fish and turtles. No suitable platypus breeding habitat detected. Aquatic fauna, detected by backpack electrofishing and overnight deployment of two baited fyke nets, two baited cathedral traps and five baited box traps, included Agassiz's glassfish (*Ambassis*

agassizii), barred grunter (*Amniataba percoides*), marbled eel (*Anguilla reinhardtii*), gudgeon (*Hypseleotris* sp.), spangled perch (*Leiopotherapon unicolor*), eastern rainbowfish (*Melanotaenia splendida splendida*), purple-spotted gudgeon (*Mogurnda adspersa*), bony bream (*Nematalosa erebi*), Hyrtyl's tandan (*Neosilurus hyrtlii*), sleepy cod (*Oxyeleotris lineolata*) and the pest species tilapia (*Oreochromus mossambicus*)*. Turtles included Krefft's river turtle (*Emydura macquarii krefftii*). Macrocrustaceans included freshwater prawn (*Macrobrachium australiense*) and redclaw (*Cherax quadricarinatus*). A number of other aquatic macroinvertebrates were also recorded (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

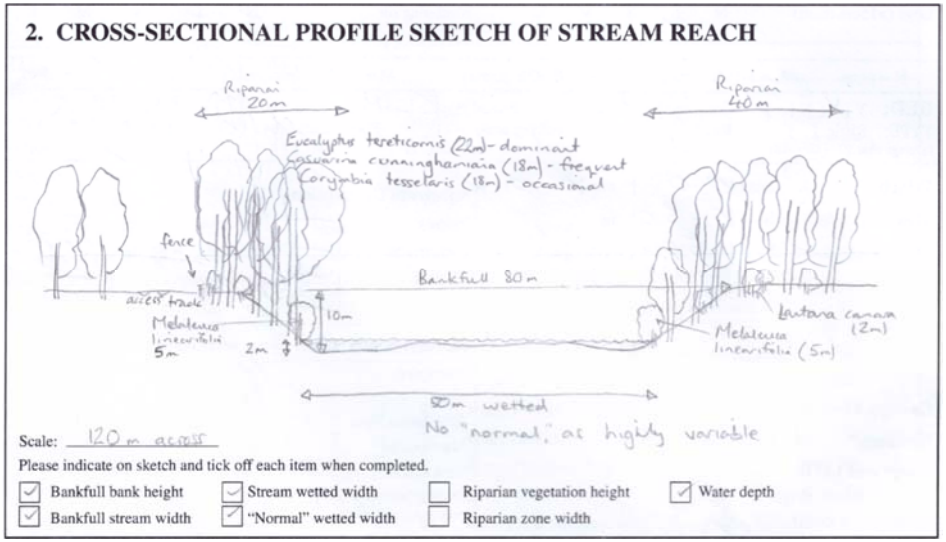
Physico-chemical water quality

Collection time: 7:45 EST; water temp.: 20.0 °C; conductivity: 293 µS/cm (fresh); turbidity: 51 NTU (low to moderate clarity); dissolved oxygen: 81.0%, 7.4 mg/L; pH 7.4 (mildly alkaline). Summary: Normal.

Bioassessment scores

Habitat assessment score for 'late wet' season: Fair (56); AusRivAS taxonomic richness: 10 (bed), 32 (edge); PET richness: 3 (bed), 4 (edge); SIGNAL 2 score: 4.22 (bed), 3.27 (edge); tolerant taxa: 22% (bed), 57% (edge); AusRivAS OE50 score: 1.25 (Band X – bed); 1.43 (Band X – edge).

Overall aquatic values – Late wet season: **Moderate** (Priority species; potentially a semi-permanent pool); Early wet season: See previous site profile.



Season: Late wet

Site Code: R7 **Location:** Unnamed tributary of the Isaac River, Iffley **Stream order:** 2 **Latitude:** -22.1801 **Longitude:** 148.3689 **Date:** 4/07/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral second order stream, dry at the time of assessment; drainage feature, with poorly defined bed and banks; little local catchment erosion; bankfull width was approx. 12 m and bankfull height approx. 0.8 m; lacking in-stream habitat features; substrates comprised 100% silt/clay (<0.05 mm) in the bed and edge habitats.

Riparian vegetation

Study reach positioned within non-remnant vegetation comprised of young brigalow (*Acacia harpophylla*) regrowth. Riparian zone approximately 10 m on the left bank and 15 m on the right, dominated by young brigalow regrowth, with occasional yellowwood (*Terminalia oblongata*). Sparse shrub layer of native lime (*Citrus glauca*), currant bush (*Carissa ovata*) and *Capparis* sp. Ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent umbrella canegrass (*Leptochloa digitata*), parthenium (*Parthenium hysterophorus*)* and *Sida* sp. Macrophytes included rice sedge (*Cyperus difformis*), tall flatsedge (*C. exaltatus*) and umbrella canegrass.

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach may provide very marginal foraging habitat for fish in times of flow. No suitable fish, turtle or platypus breeding habitat detected. Aquatic fauna not sampled due to lack of water.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

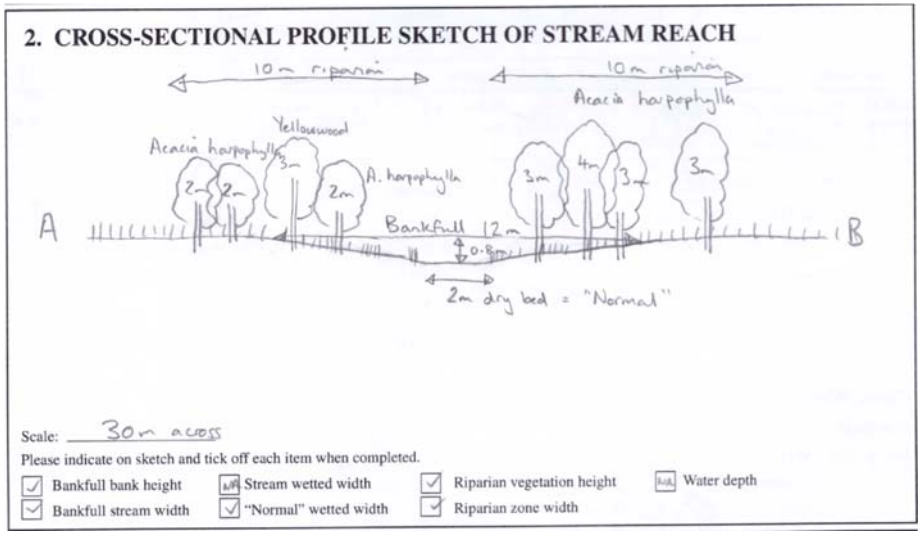
Physico-chemical water quality

Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for late wet season: Poor (38).

Overall aquatic values – Late wet season: **Low**; Early wet season: Expected to be **Low**.



Season: Early wet

Site Code: R8 **Location:** Isaac River, Seloh Nolem / Vermont Park **Stream order:** 6 **Latitude:** -22.3181 **Longitude:** 148.4719 **Date:** 16/12/2016


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Pool (potentially semi-permanent) on the ephemeral Isaac River; low to moderate flow at the time of assessment; well defined bed and banks; some local catchment erosion; the wetted width along the study reach ranged from about 10 to 25 m, with a mean width of 20 m (estimated); mean depth 0.2 m in the edge habitat (i.e. within 0.5 m of the stream edge) and 0.8 m in the bed habitat; some areas >2m depth; bankfull width was approx. 80 m and bankfull height approx. 7 m (from the stream bed); in-stream habitat included shallow (<0.5 m) pool, deep pool, large woody debris and undercut banks; substrates comprised 97% sand (0.05-2 mm) and 3% silt/clay (<0.05 mm) in the bed habitat and 95% sand and 5% silt/clay in the edge habitat; upstream landuse includes agricultural grazing and coal mining; adjacent landuse includes light grazing in predominantly remnant vegetation.

Aquatic and riparian vegetation

Study reach positioned within RE 11.3.25. Riparian zone approximately 20 m on the left bank and 20 m on the right, comprising riparian forest dominated by forest red gum (*Eucalyptus tereticornis*), with abundant river she-oak (*Casuarina cunninghamiana*) and occasional coolabah (*E. coolabah*), with white bauhinia (*Lysiphyllum hookeri*), sally wattle (*Acacia salicina*) and snow-in-summer (*Melaleuca linariifolia*) in the sub-canopy. Sparse shrub layer including *Cassia* sp. and the weeds lantana (*Lantana camara*)* and castor oil bush (*Ricinus communis*)*. Ground layer dominated by exotic species green panic (*Megathyrsus maxima*)* and buffel grass (*Cenchrus ciliaris*)*. Sparse fringing macrophytes, including tall flatsedge (*Cyperus exaltatus*) and the exotic white eclipta (*Eclipta prostrata*)*.

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach provides foraging habitat and potential breeding habitat for fish and turtles. No suitable platypus breeding habitat detected. Aquatic fauna, detected by backpack electrofishing and overnight deployment of two baited fyke nets, two baited cathedral traps and five baited box traps, included barred grunter (*Amniataba percoides*), purple-

spotted gudgeon (*Mogurnda adspersa*), bony bream (*Nematalosa erebi*), Hyrtyl's tandan (*Neosilurus hyrtlii*), spangled perch (*Leiopotherapon unicolor*), eastern rainbowfish (*Melanotaenia splendida splendida*), gudgeon (*Hypseleotris* sp.), fly-specked hardyhead (*Craterocephalus stercusmuscarum*), sleepy cod (*Oxyeleotris lineolata*) and the pest species tilapia (*Oreochromus mossambicus*)*. Turtles captured included eastern snake-necked turtle (*Chelodina longicollis*) and Krefft's river turtle (*Emydura macquarii krefftii*). Macrocrustaceans included freshwater shrimp (*Paratya australiense*) and freshwater prawn (*Macrobrachium australiense*). A number of other aquatic macroinvertebrates were also recorded (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

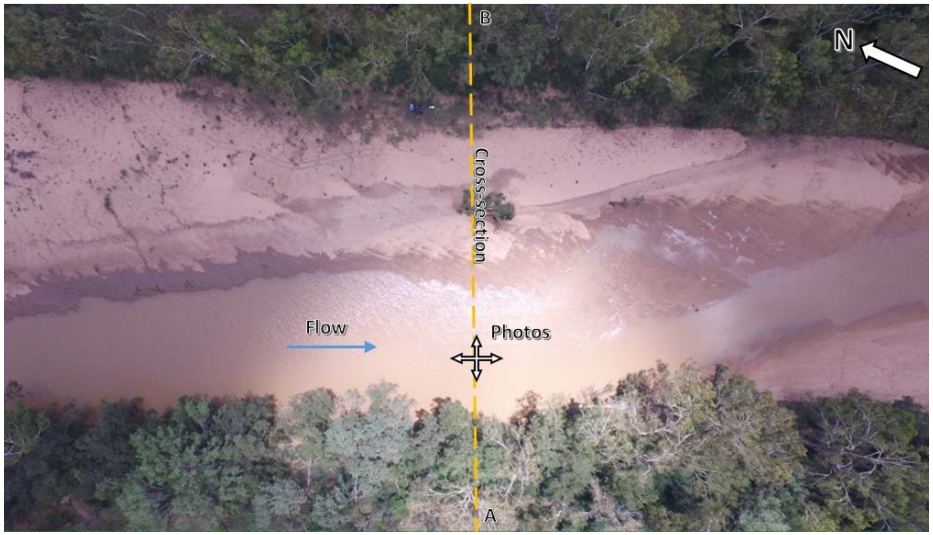
Physico-chemical water quality

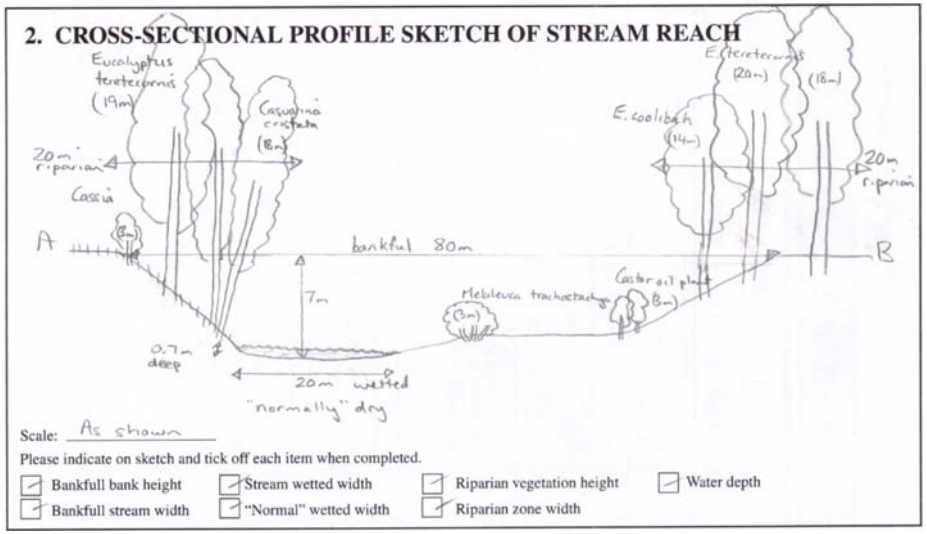
Collection time: 11:00 EST; water temp.: 31.0 °C; conductivity: 244 µS/cm (fresh); turbidity: 168 (poor clarity); dissolved oxygen: 88.3%, 6.6 mg/L; pH 7.9 (moderately alkaline). Summary: Normal.

Bioassessment scores

Habitat assessment scores for early wet season: Fair (53); AusRivAS taxonomic richness: 7 (bed), 24 (edge); PET richness: 3 (bed), 2 (edge); SIGNAL 2 score: 4.43 (bed), 3.50 (edge); tolerant taxa: 14% (bed), 50% (edge); AusRivAS OE50 score: 0.56 (Band B – bed); 0.96 (Band A – edge).

Overall aquatic values – Early wet season: **Moderate** (Priority flora species; potentially a semi-permanent pool); Late wet season: See following site profile.





Season: Late wet

Site Code: R8 **Location:** Isaac River, Seloh Nolem / Vermont Park **Stream order:** 6 **Latitude:** -22.3181 **Longitude:** 148.4719 **Date:** 10/07/2017

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Isolated pool (potentially semi-permanent) on the ephemeral Isaac River; no discernible surface flow at the time of assessment; well defined bed and banks; some local catchment erosion; the wetted width along the study reach ranged from about 15 to 20 m, with a mean width of 17 m (estimated); mean depth 0.2 m in the edge habitat (i.e. within 0.5 m of the stream edge) and 0.6 m in the bed habitat; some areas >2m depth; bankfull width was approx. 80 m and bankfull height approx. 7 m (from the stream bed); in-stream habitat included shallow (<0.5 m) pool, deep pool, large woody debris and undercut banks; substrates comprised 98% sand (0.05-2 mm) and 2% silt/clay (<0.05 mm) in the bed habitat and 96% sand and 4% silt/clay (<0.05 mm) in the edge habitat; upstream landuse includes agricultural grazing and mining; adjacent landuse includes light grazing in predominantly remnant vegetation.

Aquatic and riparian vegetation

Study reach positioned within RE 11.3.25. Riparian zone approximately 20 m on the left bank and 20 m on the right, comprising riparian forest dominated by forest red gum (*Eucalyptus tereticornis*), with abundant river she-oak (*Casuarina cunninghamiana*) and occasional coolabah (*E. coolabah*), with white bauhinia (*Lysiphyllum hookeri*), sally wattle (*Acacia salicina*) and snow-in-summer (*Melaleuca linariifolia*) in the sub-canopy. Sparse shrub layer including *Cassia* sp. and the weeds lantana (*Lantana camara*)* and castor oil bush (*Ricinus communis*)*. Ground layer dominated by exotic species green panic (*Megathyrsus maxima*)* and buffel grass (*Cenchrus ciliaris*)*. Sparse fringing macrophytes, including rice sedge (*Cyperus difformis*), tall flatsedge (*C. exaltatus*) and the introduced white eclipta (*Eclipta prostrata*)*.

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach provides foraging and potential breeding habitat for both fish and turtles. No suitable platypus breeding habitat detected. Aquatic fauna detected by backpack

electrofishing and overnight deployment of two baited fyke nets, two baited cathedral traps and five baited box traps, included purple-spotted gudgeon (*Mogurnda adspersa*), bony bream (*Nematalosa erebi*), spangled perch (*Leiopotherapon unicolor*), golden perch (*Macquaria ambigua*), eastern rainbowfish (*Melanotaenia splendida splendida*), gudgeon (*Hypseleotris* sp.), fly-specked hardyhead (*Craterocephalus stercusmuscarum*), sleepy cod (*Oxyeleotris lineolata*) and the pest species tilapia (*Oreochromus mossambicus*)*. No turtles detected (although detected in early wet season). Macrocrustaceans included freshwater prawn (*Macrobrachium australiense*) and redclaw (*Cherax quadricarinatus*). A number of other aquatic macroinvertebrates were also recorded (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

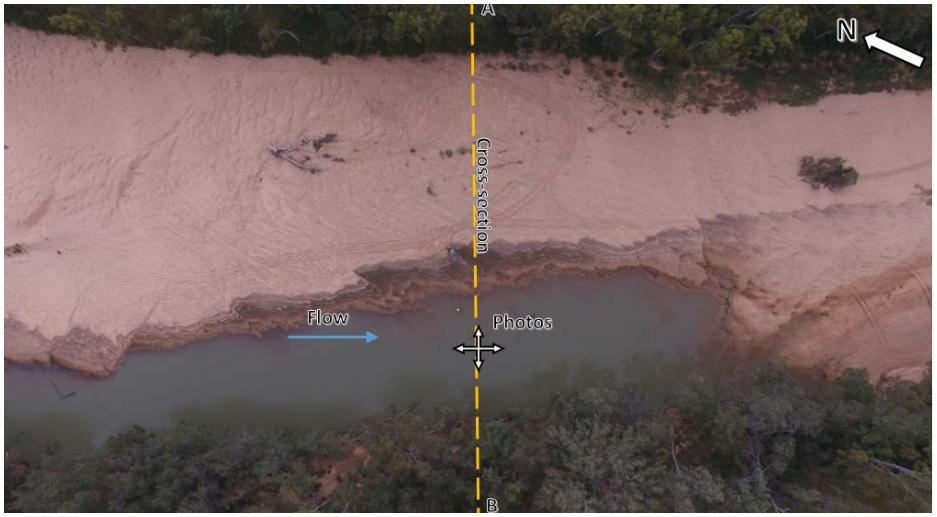
Physico-chemical water quality

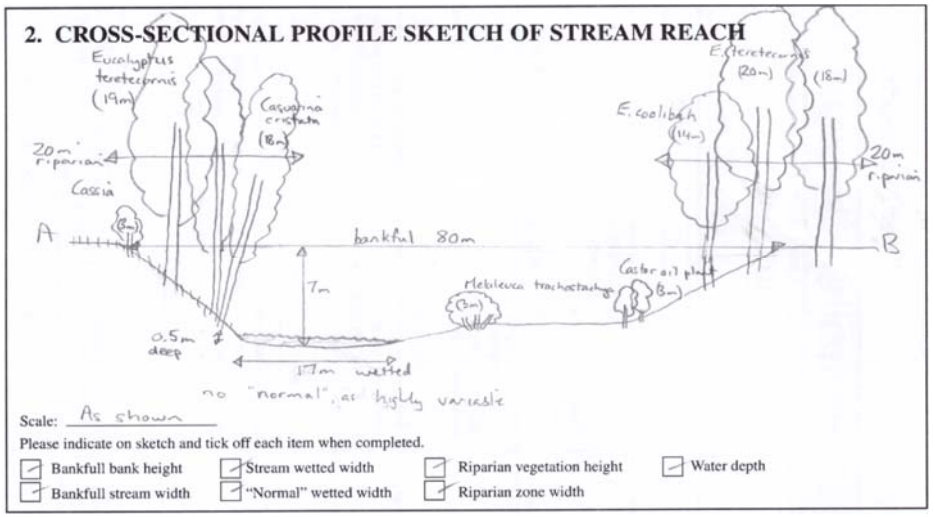
Collection time: 9:10 EST; water temp.: 20.9 °C; conductivity: 287 µS/cm (fresh); turbidity: 26.1 (moderate clarity); dissolved oxygen: 86.3%, 7.7 mg/L; pH 7.4 (mildy alkaline). Summary: normal.

Bioassessment scores

Habitat assessment score for 'late wet' season: Fair (51); AusRivAS taxonomic richness: 22 (bed), 31 (edge); PET richness: 3 (bed), 5 (edge); SIGNAL 2 score: 3.65 (bed), 3.73 (edge); tolerant taxa: 45% (bed), 47% (edge); AusRivAS OE50 score: 1.58 (Band X – bed); 1.28 (Band X – edge).

Overall aquatic values – Late wet season: **Moderate** (Priority species present; potentially semi-permanent habitat); Early wet season: See previous site profile.





Season: Early wet

Site Code: R15 **Location:** Unnamed tributary of the Isaac R., Iffley **Stream order:** 1 **Latitude:** -22.1927 **Longitude:** 148.3469 **Date:** 5/10/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral first order drainage line; dry at the time of assessment; poorly defined bed and banks; little local catchment erosion; bankfull width was approx. 25 m and bankfull height approx. 0.4 m; lacking in-stream habitat features; bed substrates comprised approx. 2% gravel (2-4 mm), 18% sand (0.05-2 mm) and 80% silt/clay (<0.05 mm); drainage line dammed approximately 340 m upstream; upstream and adjoining landuse includes moderate cattle grazing within predominantly remnant vegetation.

Riparian vegetation

Study reach positioned within RE 11.4.9. Riparian zone approximately 20 m on the left bank and 10 m on the right, comprising woodland with sparse canopy dominated by brigalow (*Acacia harpophylla*), with occasional poplar box (*E. populnea*). Sparse to very sparse sub-canopy of sandalwood (*Santalum lanceolatum*), white bauhinia (*Lysiphyllum hookeri*), brigalow and emu apple (*Owenia acidula*). Very sparse shrub layer containing shiny-leaved canthium (*Psydrax odorata* subsp. *buxifolia*), sandalwood, currant bush (*Carissa ovata*), poison peach (*Ehretia membranifolia*), water vine (*Clematicissus opaca*) and northern silk pod (*Personsia lanceolata*). Ground layer dominated by buffel grass (*Cenchrus ciliaris*)* and green panic (*Megathyrsus maximus*)*, with occasional sabi grass (*Urochloa mosambicensis*)* and native grasses windmill grass (*Enteroppogon acicularis*), fairy grass (*Sporobolous caroli*), wiregrass (*Aristida calycina*), shot grass (*Paspalidium distans*), brigalow grass (*P. caespitosum*) and *P. rarum*. Macrophytes included tall flatsedge (*C. exaltatus*), brown beetle grass (*Diplachne fusca* var. *fusca*), awnless barnyard grass (*Echinochloa colona*)*, and umbrella canegrass (*Leptochloa digitata*) bordering a recently dried pool.

Erosion risk

Low – banks appeared to be stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach may provide marginal foraging habitat for fish in times of flow. No suitable turtle or platypus breeding or foraging habitat detected. Aquatic fauna not sampled due to lack of water.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species.

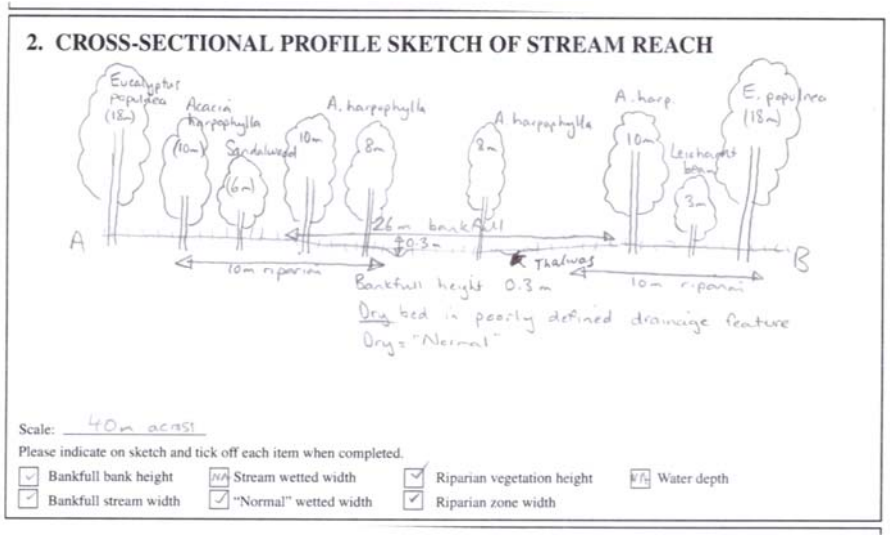
Physico-chemical water quality

Not sampled. Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for early wet season: Fair (45)

Overall aquatic values –Early wet season: **Low**. Late wet season: See following site profile



Season: Late wet

Site Code: R15 **Location:** Unnamed tributary of the Isaac R., Iffley **Stream order:** 1 **Latitude:** -22.1927 **Longitude:** 148.3469 **Date:** 25/06/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral first order drainage line; dry at the time of assessment; poorly defined bed and banks; little local catchment erosion; bankfull width was approx. 25 m and bankfull height approx. 0.4 m; lacking in-stream habitat features; bed substrates comprised approx. 2% gravel (2-4 mm), 18% sand (0.05-2 mm) and 80% silt/clay (<0.05 mm); drainage line dammed approximately 340 m upstream; upstream and adjoining landuse includes moderate cattle grazing within predominantly remnant vegetation.

Riparian vegetation

Study reach positioned within RE 11.4.9. Riparian zone approximately 20 m on the left bank and 10 m on the right, comprising woodland with sparse canopy dominated by brigalow (*Acacia harpophylla*), with occasional poplar box (*E. populnea*). Sparse to very sparse sub-canopy of sandalwood (*Santalum lanceolatum*), white bauhinia (*Lysiphyllum hookeri*), brigalow and emu apple (*Owenia acidula*). Very sparse shrub layer containing shiny-leaved canthium (*Psydrax odorata* subsp. *buxifolia*), sandalwood, currant bush (*Carissa ovata*), poison peach (*Ehretia membranifolia*), water vine (*Clematicissus opaca*) and northern silk pod (*Personsia lanceolata*). Ground layer dominated by buffel grass (*Cenchrus ciliaris*)* and green panic (*Megathyrsus maximus*)*, with occasional sabi grass (*Urochloa mosambicensis*)* and native grasses windmill grass (*Enteroppogon acicularis*), fairy grass (*Sporobolous caroli*), wiregrass (*Aristida calycina*), shot grass (*Paspalidium distans*), brigalow grass (*P. caespitosum*) and *P. rarum*. Macrophytes included rice sedge (*Cyperus difformis*), tall flatsedge (*C. exaltatus*), brown beetle grass (*Diplachne fusca* var. *fusca*), awnless barnyard grass (*Echinochloa colona*)*, umbrella canegrass (*Leptochloa digitata*), native willow primrose (*Ludwigia octovalvis*) and native hyacinth (*Monochoria cyanea*), bordering a recently dried pool.

Erosion risk

Low – banks appeared to be stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach may provide marginal foraging habitat for fish in times of flow. No suitable turtle or platypus breeding or foraging habitat detected. Aquatic fauna not sampled due to lack of water.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species.

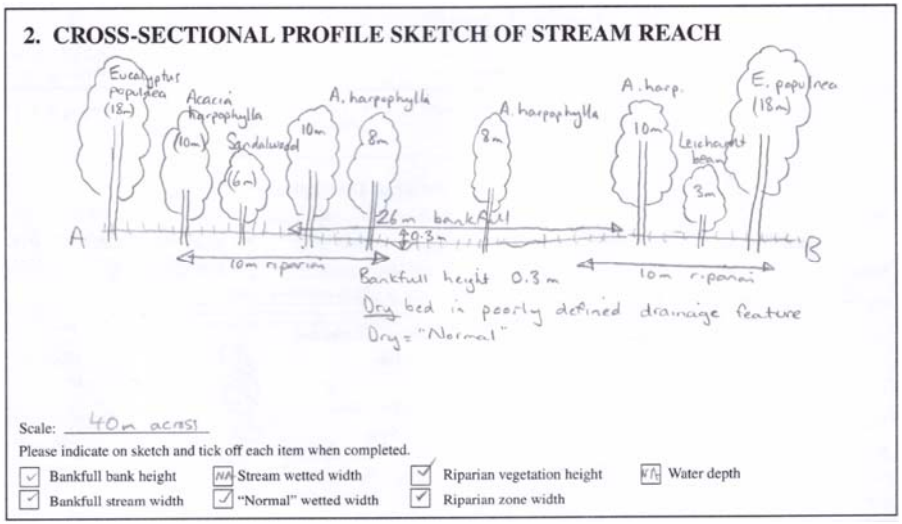
Physico-chemical water quality

Not sampled. Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for late wet season: Fair (48)

Overall aquatic values – Late wet season: **Low**; Early wet season: See previous site profile.



Season: Early wet

Site Code: R18 **Location:** Unnamed tributary of the Isaac R., Wynette **Stream order:** 1 **Latitude:** -22.1834 **Longitude:** 148.3361 **Date:** 4/10/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral first order drainage line; dry at the time of assessment; poorly defined bed and banks; no local catchment erosion detected; bankfull width was approx. 5 m and bankfull height 0.3 m; lacking in-stream habitat features; bed substrates comprised 100% silt/clay (<0.05 mm); upstream and adjoining landuse includes moderate cattle grazing on predominantly cleared land.

Riparian vegetation

Study reach positioned within non-remnant vegetation with very sparse regrowth of brigalow (*Acacia harpophylla*) and sandalwood (*Santalum lanceolatum*). Ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent common couch (*Cynodon dactylon*), Indian couch (*Bothriochloa pertusa*)* and parthenium (*Parthenium hysterophorus*)*, and occasional flatsedge (*Cyperus haspan*), umbrella canegrass (*Leptochloa digitata*), *Chloris* sp., musk basil (*Basilicum polystachyon*) and Queensland bluegrass (*Dicanthium sericeum*). Flatsedge and umbrella canegrass were the only macrophytes detected.

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The drainage line provides unlikely habitat for fish, turtles or platypus. Aquatic fauna not sampled due to lack of water.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species.

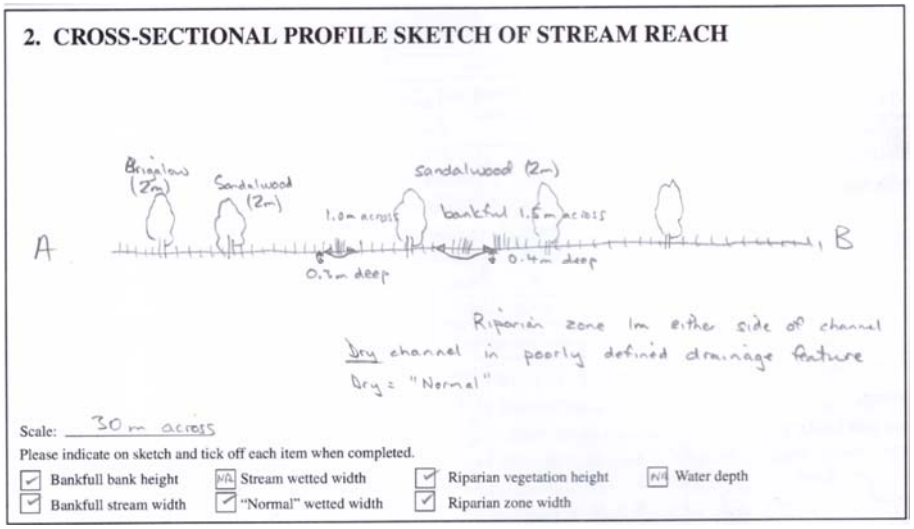
Physico-chemical water quality

Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for early wet season: Poor (35)

Overall aquatic values – Early wet season: **Low**; Late wet season: See following site profile



Season: Late wet

Site Code: R18 **Location:** Unnamed tributary of the Isaac R., Wynette **Stream order:** 1 **Latitude:** -22.1834 **Longitude:** 148.3361 **Date:** 24/06/2017

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Ephemeral first order drainage line; dry at the time of assessment; poorly defined bed and banks; no local catchment erosion detected; bankfull width was approx. 5 m and bankfull height 0.3 m; lacking in-stream habitat features; bed substrates comprised 100% silt/clay (<0.05 mm); upstream and adjoining landuse includes moderate cattle grazing on predominantly cleared land.

Riparian vegetation

Study reach positioned within non-remnant vegetation with very sparse regrowth of brigalow (*Acacia harpophylla*) and sandalwood (*Santalum lanceolatum*). Ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent common couch (*Cynodon dactylon*), Indian couch (*Bothriochloa pertusa*)* and parthenium (*Parthenium hysterophorus*)*, and occasional flatsedge (*Cyperus haspan*), umbrella canegrass (*Leptochloa digitata*), *Chloris* sp., musk basil (*Basilicum polystachyon*) and Queensland bluegrass (*Dicanthium sericeum*). Flatsedge and umbrella canegrass were the only macrophytes detected.

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The drainage line provides unlikely habitat for fish, turtles or platypus. Aquatic fauna not sampled due to lack of water.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species.

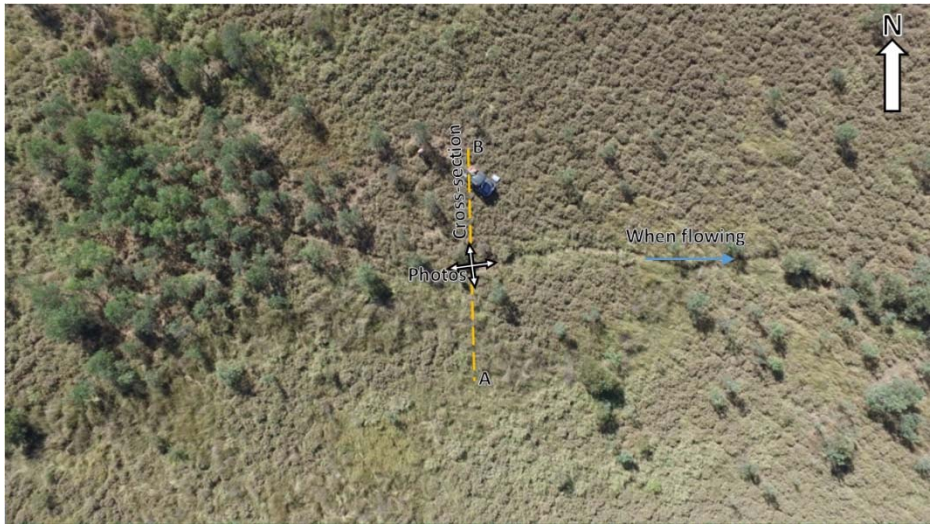
Physico-chemical water quality

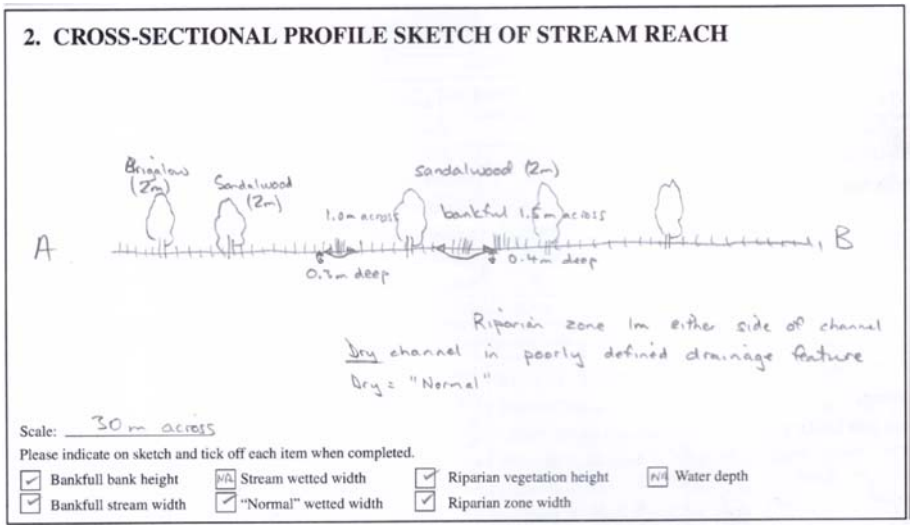
Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for late wet season: Poor (35)

Overall aquatic values – Late wet season: **Low**; Early wet season: See previous site profile





Season: Early wet

Site Code: R19 **Location:** Unnamed tributary of the Isaac River, Wynette **Stream order:** 2 **Latitude:** -22.1592 **Longitude:** 148.3134 **Date:** 4/10/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral second order drainage line; predominantly dry at the time of assessment, with isolated, senescing pools; drainage feature, with poorly defined bed and banks; little local catchment erosion; bankfull width was approx. 18 m and bankfull height 2 m; in-stream habitat features included shallow pools and large woody debris; clay banks; bed substrates variable, with sections of sands, although dominant substrate is silt/clay; bed substrates along the 100 m reach comprised approx. 30% sand (0.05-2 mm) and 70% silt/clay (<0.05 mm); upstream landuse includes coal seam gas extraction infrastructure and moderate cattle grazing on predominantly cleared land; adjacent landuse includes moderate cattle grazing on cleared land.

Riparian vegetation

Study reach positioned within approximately 50 m wide corridor of RE 11.4.8. Woodland with sparse canopy of coolabah (*Eucalyptus coolabah*). Sparse sub-canopy dominated by brigalow (*Acacia harpophylla*), with occasional red bauhinia (*Lysiphyllum carronii*), white bauhinia (*L. hookeri*) and *Acacia* sp. Very sparse shrub layer containing yellowwood (*Terminalia oblongata*), native lime (*Citrus glauca*) and harrisia cactus (*Harrisia martinii*). Ground layer dominated by umbrella canegrass (*Leptochloa digitata*) in drainage line and by buffel grass (*Cenchrus ciliaris*)* on upper bank and plain, with frequent musk basil (*Basilicum polystachion*), parthenium (*Parthenium hysterophorus*)*, forest bluegrass (*Bothriochloa bladhii*), *Sida* sp., Queensland bluegrass (*Dichanthium sericeum*), sabi grass (*Urochloa mosambicensis*)*, sneezeweed (*Centipeda minima*) and lesser joyweed (*Alternanthera denticulata*). Macrophytes included extensive umbrella canegrass and sparse *Cyperus concinnus* and flatsedge (*C. haspan*).

Erosion risk

Low-moderate – banks appeared to be moderately stable, with 50-79% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach may provide marginal foraging habitat for fish in times of flow. No suitable turtle or platypus breeding habitat detected. Aquatic fauna not sampled due to scarcity of water.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species.

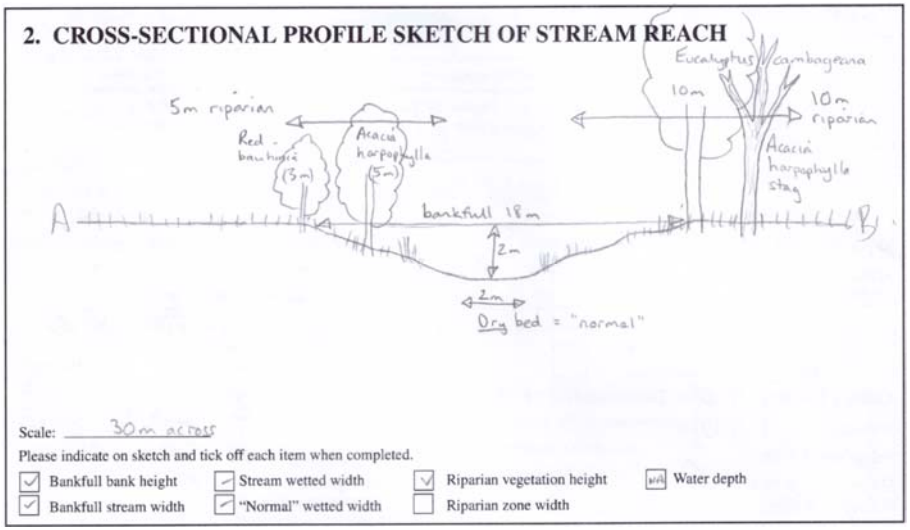
Physico-chemical water quality

Not sampled. Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for early wet season: Fair (43)

Overall aquatic values – Early wet season: **Low**; Late wet season: See following site profile.



Season: Late wet

Site Code: R19 **Location:** Unnamed tributary of the Isaac River, Wynette **Stream order:** 2 **Latitude:** -22.1592 **Longitude:** 148.3134 **Date:** 24/06/2017

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Ephemeral second order drainage line; predominantly dry at the time of assessment, with isolated, senescing pools; drainage feature, with poorly defined bed and banks; little local catchment erosion; bankfull width was approx. 18 m and bankfull height 2 m; in-stream habitat features included shallow pools and large woody debris; clay banks; bed substrates variable, with sections of sands, although dominant substrate is silt/clay; bed substrates along the 100 m reach comprised approx. 30% sand (0.05-2 mm) and 70% silt/clay (<0.05 mm); upstream landuse includes coal seam gas extraction infrastructure and moderate cattle grazing on predominantly cleared land; adjacent landuse includes moderate cattle grazing on cleared land.

Riparian vegetation

Study reach positioned within approximately 50 m wide corridor of RE 11.4.8. Woodland with sparse canopy of coolabah (*Eucalyptus coolabah*). Sparse sub-canopy dominated by brigalow (*Acacia harpophylla*), with occasional red bauhinia (*Lysiphyllum carronii*), white bauhinia (*L. hookeri*) and *Acacia* sp. Very sparse shrub layer containing yellowwood (*Terminalia oblongata*), native lime (*Citrus glauca*) and harrisia cactus (*Harrisia martinii*). Ground layer dominated by umbrella canegrass (*Leptochloa digitata*) in drainage line and by buffel grass (*Cenchrus ciliaris*)* on upper bank and plain, with frequent musk basil (*Basilicum polystachion*), parthenium (*Parthenium hysterophorus*)*, forest bluegrass (*Bothriochloa bladhii*), *Sida* sp., Queensland bluegrass (*Dichanthium sericeum*), sabi grass (*Urochloa mosambicensis*)*, sneezeweed (*Centipeda minima*) and lesser joyweed (*Alternanthera denticulata*). Macrophytes included extensive umbrella canegrass and sparse *Cyperus concinnus*, flatsedge (*C. haspan*) and common rush (*Juncus usitatus*).

Erosion risk

Low-moderate – banks appeared to be moderately stable, with 50-79% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach may provide marginal foraging habitat for fish in times of flow. No suitable turtle or platypus breeding habitat detected. Aquatic fauna not sampled due to scarcity of water.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species.

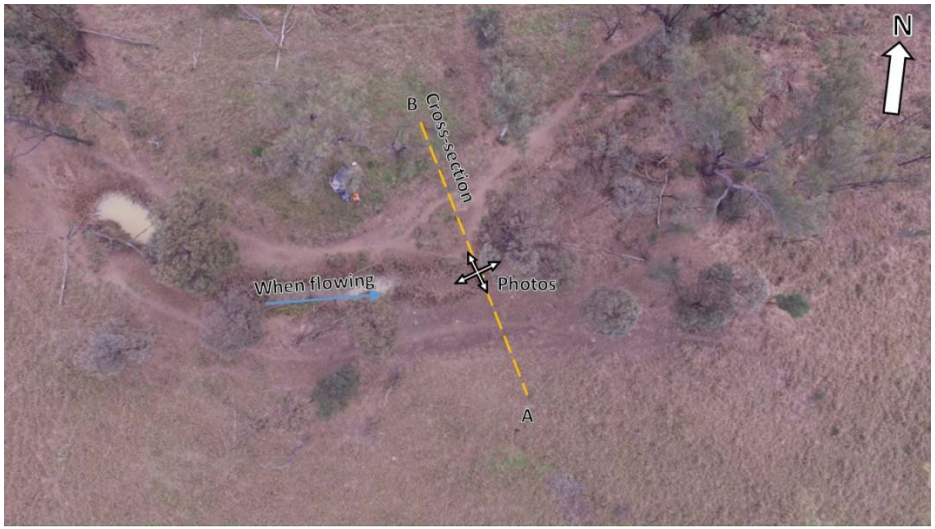
Physico-chemical water quality

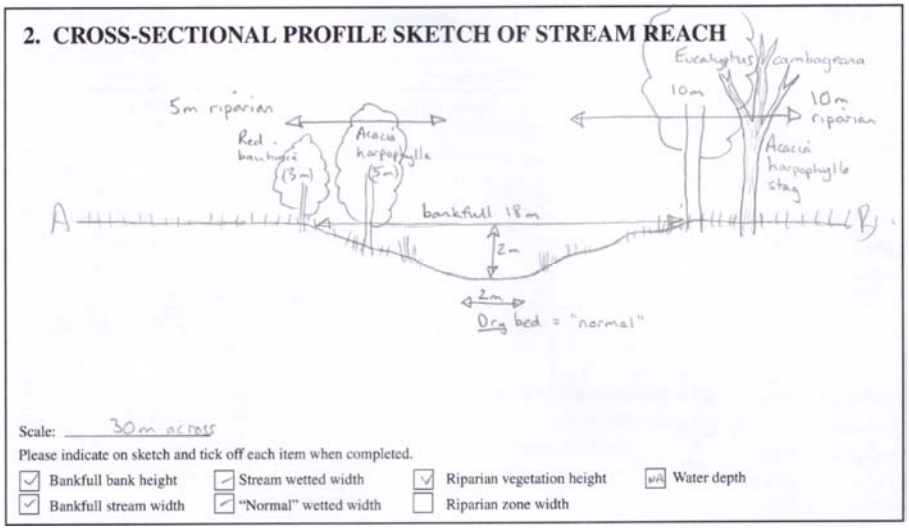
Not sampled. Isolated, senescing pools, turbid and heavily disturbed by cattle.

Bioassessment scores

Habitat assessment score for late wet season: Fair (44)

Overall aquatic values – Late wet season: **Low**; Early wet season: See previous site profile





Season: Early wet

Site Code: R20 **Location:** Unnamed tributary of the Isaac River, Wynette **Stream order:** 1 **Latitude:** -22.1823 **Longitude:** 148.3364 **Date:** 4/10/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral first order drainage line; dry at the time of assessment; poorly defined bed and banks; no local catchment erosion detected; bankfull width was approx. 8 m and bankfull height 0.3 m; lacking in-stream habitat features; bed substrates comprised 100% silt/clay (<0.05 mm); upstream and adjoining landuse includes moderate cattle grazing on predominantly cleared land.

Riparian vegetation

Study reach positioned within non-remnant vegetation with very sparse regrowth of brigalow (*Acacia harpophylla*) and sandalwood (*Santalum lanceolatum*). Ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent common couch (*Cynodon dactylon*), Indian couch (*Bothriochloa pertusa*)* and parthenium (*Parthenium hysterophorus*)*, and occasional flatsedge (*Cyperus haspan*), umbrella canegrass (*Leptochloa digitata*), *Chloris* sp., musk basil (*Basilicum polystachyon*) and Queensland bluegrass (*Dicanthium sericeum*). Flatsedge and umbrella canegrass were the only macrophytes detected.

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The drainage line provides unlikely habitat for fish, turtles or platypus. Aquatic fauna not sampled due to lack of water.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species.

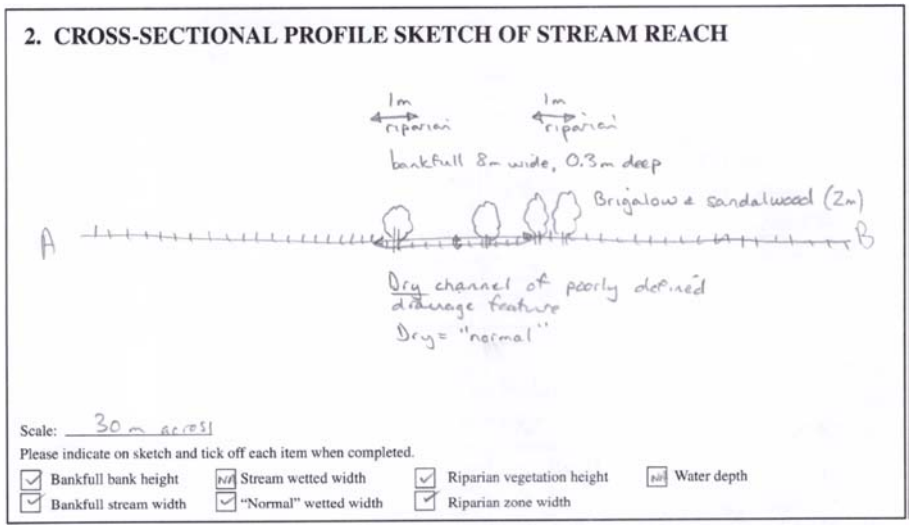
Physico-chemical water quality

Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for early wet season: Poor (35)

Overall aquatic values – Early wet season: **Low**; Early wet season: See following site profile.



Season: Late wet

Site Code: R20 **Location:** Unnamed tributary of the Isaac River, Wynette **Stream order:** 1 **Latitude:** -22.1823 **Longitude:** 148.3364 **Date:** 24/06/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral first order drainage line; dry at the time of assessment; poorly defined bed and banks; no local catchment erosion detected; bankfull width was approx. 8 m and bankfull height 0.3 m; lacking in-stream habitat features; bed substrates comprised 100% silt/clay (<0.05 mm); upstream and adjoining landuse includes moderate cattle grazing on predominantly cleared land.

Riparian vegetation

Study reach positioned within non-remnant vegetation with very sparse regrowth of brigalow (*Acacia harpophylla*) and sandalwood (*Santalum lanceolatum*). Ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent common couch (*Cynodon dactylon*), Indian couch (*Bothriochloa pertusa*)* and parthenium (*Parthenium hysterophorus*)*, and occasional flatsedge (*Cyperus haspan*), umbrella canegrass (*Leptochloa digitata*), *Chloris* sp., musk basil (*Basilicum polystachyon*) and Queensland bluegrass (*Dicanthium sericeum*). Flatsedge and umbrella canegrass were the only macrophytes detected.

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The drainage line provides unlikely habitat for fish, turtles or platypus. Aquatic fauna not sampled due to lack of water.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species.

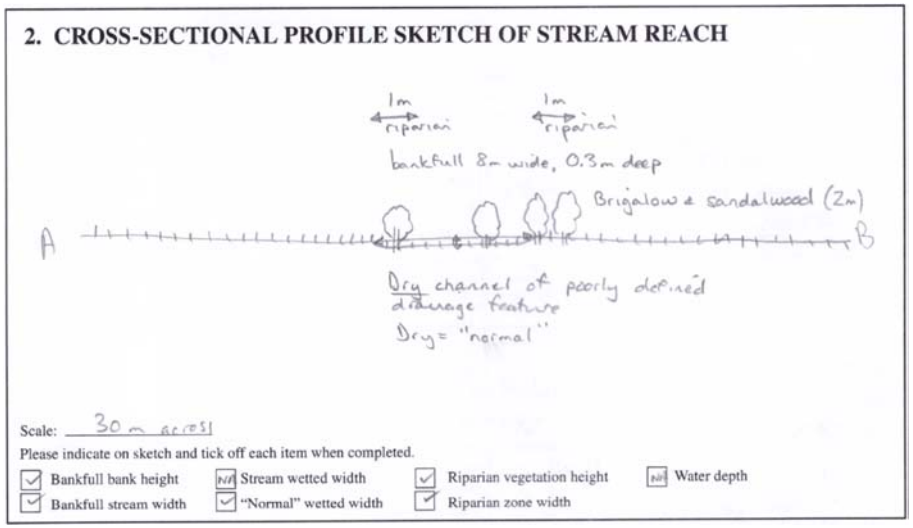
Physico-chemical water quality

Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for late wet season: Poor (35)

Overall aquatic values – Late wet season: **Low**; Early wet season: See previous site profile.



Season: Early wet

Site Code: R21 **Location:** Unnamed tributary of the Isaac River, Wynette **Stream order:** 1 **Latitude:** -22.1911 **Longitude:** 148.3482 **Date:** 5/10/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral first order drainage line; dry at the time of assessment; poorly defined bed and banks; little local catchment erosion; bankfull width was approx. 30 m and bankfull height approx. 0.1 m; lacking in-stream habitat features; bed substrates comprised 100% silt/clay (<0.05 mm); drainage line dammed approximately 570 m upstream; upstream and adjoining landuse includes moderate cattle grazing within predominantly remnant vegetation.

Riparian vegetation

Study reach positioned on the boundary of non-remnant vegetation and RE 11.5.3. Riparian zone approximately 5 m on the left bank and 20 m on the right, comprising woodland with sparse canopy dominated by poplar box (*Eucalyptus populnea*). Sparse sub-canopy of sandalwood (*Santalum lanceolatum*), brigalow (*Acacia harpophylla*), white bauhinia (*Lysiphyllum hookeri*), sally wattle (*Acacia salicina*), bean tree (*Cassia brewsteri*) and emu apple (*Owenia acidula*). Very sparse shrub layer containing shiny-leaved canthium (*Psydrax odorata* subsp. *buxifolia*), sandalwood, currant bush (*Carissa ovata*), poison peach (*Ehretia membranifolia*), water vine (*Clematicissus opaca*) and northern silk pod (*Personsia lanceolata*). Ground layer dominated by windmill grass (*Enteroppogon acicularis*) and *Paspalidium* spp., with occasional buffel grass (*Cenchrus ciliaris*)*, sabi grass (*Urochloa mosambicensis*)*, fairy grass (*Sporobolous caroli*), wiregrass (*Aristida calycina*), shrubby stylo (*Stylosanthes scabra*) and forest bluegrass (*Bothriochloa bladhii*). Only two macrophyte species detected, being *Cyperus concinnus* and slender sedge (*C. gracilis*).

Erosion risk

Low – banks appeared to be stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach may provide very marginal foraging habitat for fish in times of flow. No suitable turtle or platypus breeding habitat detected. Aquatic fauna not sampled due to lack of water.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species.

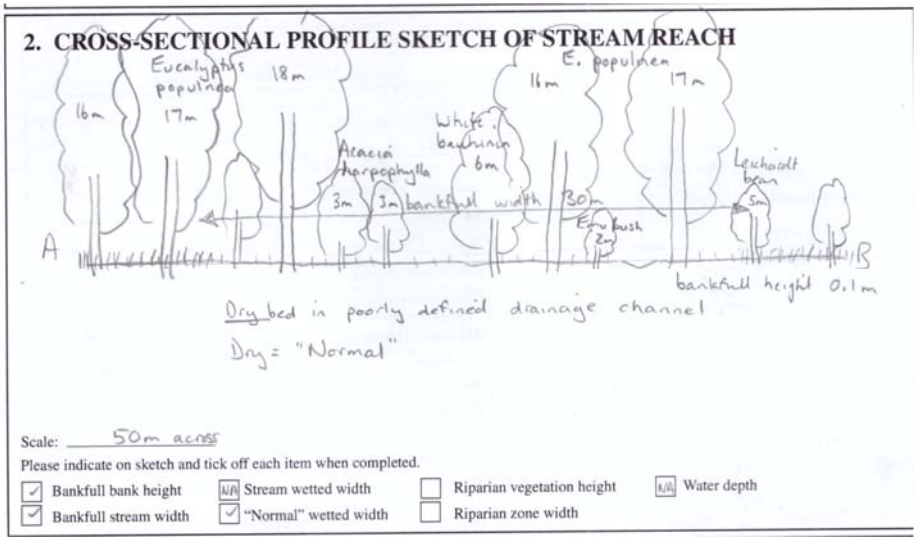
Physico-chemical water quality

Not sampled. Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for early wet season: Fair (42)

Overall aquatic values – Early wet season: **Low**; Late wet season: See following site profile



Season: Late wet

Site Code: R21 **Location:** Unnamed tributary of the Isaac River, Wynette **Stream order:** 1 **Latitude:** -22.1911 **Longitude:** 148.3482 **Date:** 25/06/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral first order drainage line; dry at the time of assessment; poorly defined bed and banks; little local catchment erosion; bankfull width was approx. 30 m and bankfull height approx. 0.1 m; lacking in-stream habitat features; bed substrates comprised 100% silt/clay (<0.05 mm); drainage line dammed approximately 570 m upstream; upstream and adjoining landuse includes moderate cattle grazing within predominantly remnant vegetation.

Riparian vegetation

Study reach positioned on the boundary of non-remnant vegetation and RE 11.5.3. Riparian zone approximately 5 m on the left bank and 20 m on the right, comprising woodland with sparse canopy dominated by poplar box (*Eucalyptus populnea*). Sparse sub-canopy of sandalwood (*Santalum lanceolatum*), brigalow (*Acacia harpophylla*), white bauhinia (*Lysiphyllum hookeri*), sally wattle (*Acacia salicina*), bean tree (*Cassia brewsteri*) and emu apple (*Owenia acidula*). Very sparse shrub layer containing shiny-leaved canthium (*Psydrax odorata* subsp. *buxifolia*), sandalwood, currant bush (*Carissa ovata*), poison peach (*Ehretia membranifolia*), water vine (*Clematicissus opaca*) and northern silk pod (*Personsia lanceolata*). Ground layer dominated by windmill grass (*Enteroppogon acicularis*) and *Paspalidium* spp., with occasional buffel grass (*Cenchrus ciliaris*)*, sabi grass (*Urochloa mosambicensis*)*, fairy grass (*Sporobolous caroli*), wiregrass (*Aristida calycina*), shrubby stylo (*Stylosanthes scabra*) and forest bluegrass (*Bothriochloa bladhii*). Only two macrophyte species detected, being *Cyperus concinnus* and flatsedge (*C. haspan*).

Erosion risk

Low – banks appeared to be stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach may provide very marginal foraging habitat for fish in times of flow. No suitable turtle or platypus breeding habitat detected. Aquatic fauna not sampled due to lack of water.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species.

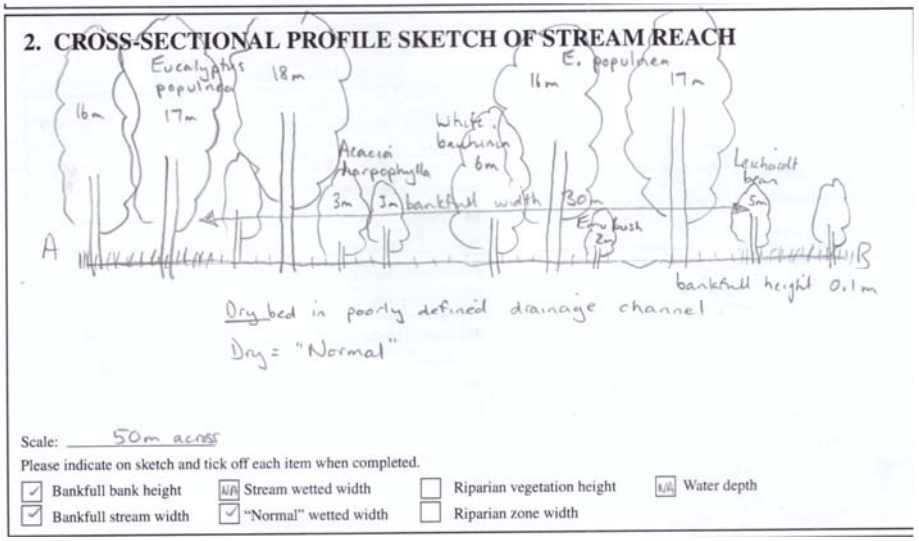
Physico-chemical water quality

Not sampled. Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for late wet season: Fair (42)

Overall aquatic values – Late wet season: **Low**; Early wet season: See previous site profile



Season: Early wet

Site Code: R22 **Location:** Unnamed tributary of the Isaac R., Wynette **Stream order:** 1 **Latitude:** -22.1816 **Longitude:** 148.3387 **Date:** 4/10/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral first order drainage line; dry at the time of assessment; poorly defined bed and banks; no local catchment erosion detected; bankfull width was approx. 5 m and bankfull height 0.5 m; lacking in-stream habitat features; bed substrates comprised 100% silt/clay (<0.05 mm); upstream and adjoining landuse includes moderate cattle grazing on predominantly cleared land.

Riparian vegetation

Study reach positioned within non-remnant vegetation with sparse brigalow (*Acacia harpophylla*) sucker regrowth. Ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent common couch (*Cynodon dactylon*), Indian couch (*Bothriochloa pertusa*)* and parthenium (*Parthenium hysterophorus*)*, and occasional sedge (*Cyperus concinnus*), umbrella canegrass (*Leptochloa digitata*), *Chloris* sp., musk basil (*Basilicum polystachyon*) and Queensland bluegrass (*Dicanthium sericeum*). Umbrella canegrass and *C. concinnus* were the only macrophytes detected.

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The drainage line provides unlikely habitat for fish, turtles or platypus. Aquatic fauna not sampled due to lack of water.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species.

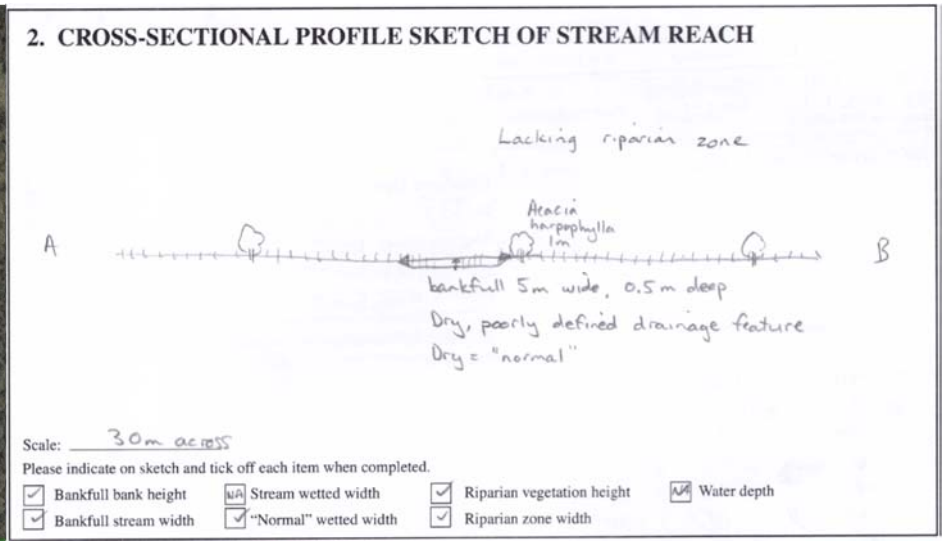
Physico-chemical water quality

Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for early wet season: Fair (44)

Overall aquatic values – Early wet season: **Low**; Late wet season: See following site profile.



Season: Late wet

Site Code: R22 **Location:** Unnamed tributary of the Isaac R., Wynette **Stream order:** 1 **Latitude:** -22.1816 **Longitude:** 148.3387 **Date:** 24/06/2017

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Ephemeral first order drainage line; dry at the time of assessment; poorly defined bed and banks; no local catchment erosion detected; bankfull width was approx. 5 m and bankfull height 0.5 m; lacking in-stream habitat features; bed substrates comprised 100% silt/clay (<0.05 mm); upstream and adjoining landuse includes moderate cattle grazing on predominantly cleared land.

Riparian vegetation

Study reach positioned within non-remnant vegetation with sparse brigalow (*Acacia harpophylla*) sucker regrowth. Ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent common couch (*Cynodon dactylon*), Indian couch (*Bothriochloa pertusa*)* and parthenium (*Parthenium hysterophorus*)*, and occasional flatsedge (*Cyperus haspan*), umbrella canegrass (*Leptochloa digitata*), *Chloris* sp., musk basil (*Basilicum polystachyon*) and Queensland bluegrass (*Dicanthium sericeum*). Flatsedge and umbrella canegrass were the only macrophytes detected.

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The drainage line provides unlikely habitat for fish, turtles or platypus. Aquatic fauna not sampled due to lack of water.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species.

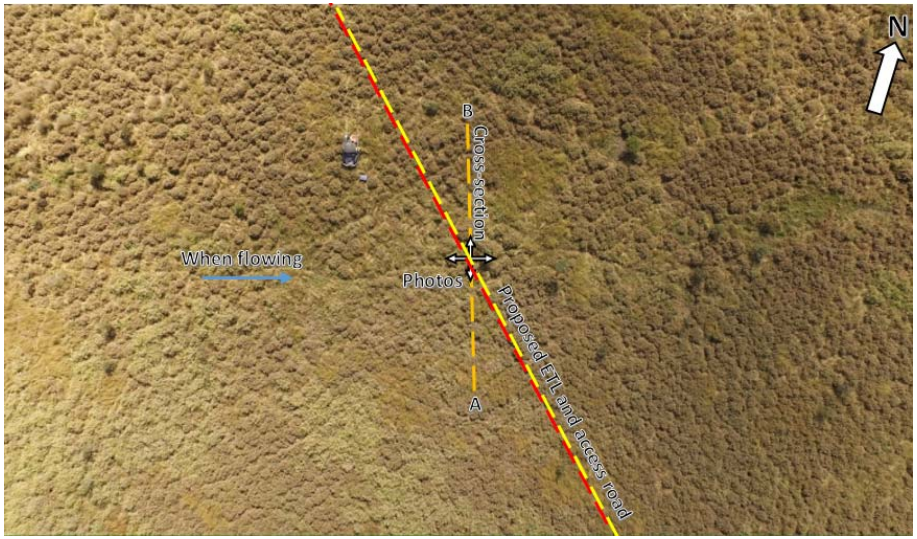
Physico-chemical water quality

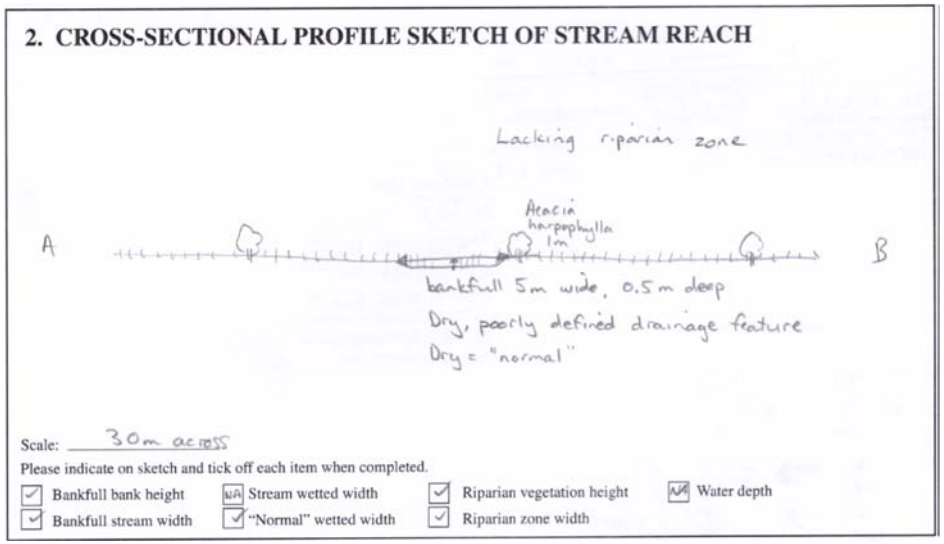
Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for late wet season: Fair (44)

Overall aquatic values – Late wet season: **Low**; Early wet season: See previous site profile.





Season: Early wet

Site Code: R23 **Location:** Isaac River, Iffley / Olive Downs **Stream order:** 6 **Latitude:** -22.1523 **Longitude:** 148.3355 **Date:** 6/10/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Isolated pools on the ephemeral Isaac River; no discernible surface flow at the time of assessment; well defined bed and banks; some local catchment erosion as a result of earthworks on the stream bank to re-establish vehicle access; larger pool upstream of proposed infrastructure centre line was approx. 50 m long by 10-15 m wide; mean depth 0.15 m in the edge habitat (i.e. within 0.5 m of the stream edge) and 0.3 m in the bed habitat; some areas to 1.3 m depth; substrates of this larger pool underlain by siltstone bedrock, creating semi-permanent pool; bankfull width was approx. 90 m and bankfull height approx. 8 m (from the stream bed); in-stream habitat included shallow (<0.5 m) pool, deep pool, large woody debris, undercut banks and macrophytes; substrates comprised 20% bedrock, 78% sand (0.05-2 mm) and 2% silt/clay (<0.05 mm) in the bed habitat, and 20% bedrock, 70% sand (0.05-2 mm) and 10% silt/clay (<0.05 mm) in the edge habitat; widespread filamentous algae cover (approx. 80%) across bed in shallows; upstream landuse includes agricultural grazing and coal mining; adjacent landuse includes light grazing in predominantly remnant vegetation.

Aquatic and riparian vegetation

Study reach positioned within RE 11.3.25. Riparian zone approx. 40 m on the left bank and 40 m on the right, comprising riparian forest dominated by forest red gum (*Eucalyptus tereticornis*), with occasional river she-oak (*Casuarina cunninghamiana*). Sub-canopy dominated by snow-in-summer (*Melaleuca linariifolia*), confined to the lower banks. Sparse shrub layer dominated by lantana (*Lantana camara*)*. Ground layer dominated by the exotic green panic (*Megathyrsus maximus*)* on the upper bank, and forest bluegrass (*Bothriochloa bladhii*) and common couch (*Cynodon dactylon*) on the lower bank. Fringing macrophytes included tall flatsedge (*C. exaltatus*). No other macrophytes detected.

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach provides foraging and potential breeding habitat for fish. Marginal foraging and potential breeding habitat for turtles, although none detected. Suitable platypus habitat not detected. Aquatic fauna, detected by backpack electrofishing and overnight deployment of two baited fyke nets and five baited box traps, included Agassiz's glassfish

(*Ambassis agassizii*), gudgeon (*Hypseleotris* sp.), spangled perch (*Leiopotherapon unicolor*), eastern rainbowfish (*Melanotaenia splendida splendida*), purple-spotted gudgeon (*Mogurnda adspersa*), bony bream (*Nematalosa erebi*), sleepy cod (*Oxyeleotris lineolata*) and the pest species tilapia (*Oreochromus mossambicus*)*. Turtles captured included: Eastern snake-necked turtle (*Chelodina longicolis*). Macrocrustaceans included freshwater shrimp (*Paratya australiense*), freshwater prawn (*Macrobrachium australiense*), redclaw (*Cherax quadricarinatus*) and orange-fingered yabby (*C. depressus*). A diversity of other aquatic macroinvertebrates were also recorded (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

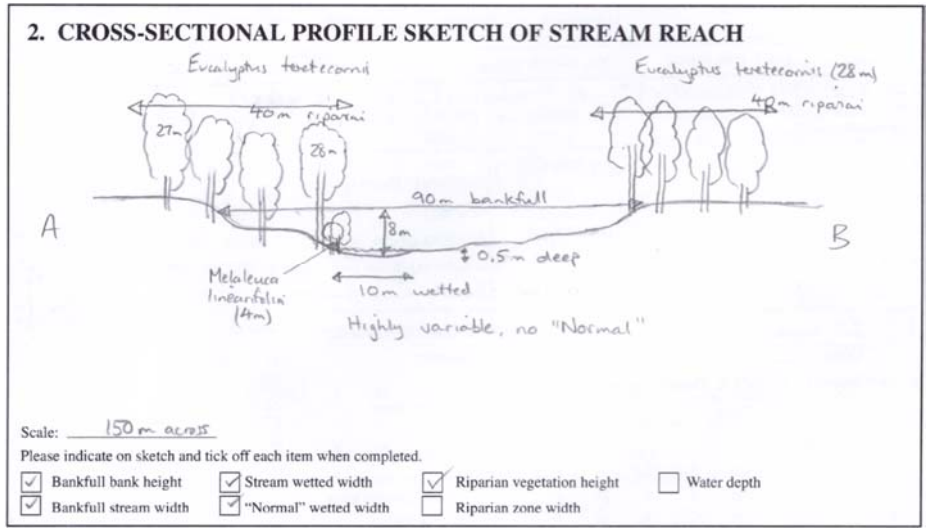
Physico-chemical water quality

Collection time: 08:20 EST; water temp.: 23.6 °C; conductivity: 319 µS/cm (fresh); turbidity: 13.7 NTU (high clarity); dissolved oxygen: 69%, 5.8 mg/L; pH 8.2 (moderately alkaline). Summary: Normal (lower DO likely a result of overnight oxygen consumption by respiration from filamentous algae).

Bioassessment scores

Habitat assessment scores for early wet season: Poor (38); AusRivAS taxonomic richness: 14 (bed), 30 (edge); PET richness: 2 (bed), 3 (edge); SIGNAL 2 score: 3.45 (bed), 3.31 (edge); tolerant taxa: 45% (bed), 55% (edge); AusRivAS OE50 score: 1.01 (Band A – bed); 1.14 (Band A – edge).

Overall aquatic values – Early wet season: **Moderate** (Priority flora species; potentially semi-permanent pool); Late wet season: See following site profile.



Season: Late wet

Site Code: R23 **Location:** Isaac River, Iffley / Olive Downs **Stream order:** 6 **Latitude:** -22.1523 **Longitude:** 148.3355 **Date:** 25/06/2017

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Isolated pools on the ephemeral Isaac River; no discernible surface flow at the time of assessment; well defined bed and banks; some local catchment erosion as a result of earthworks on the stream bank to re-establish vehicle access; larger pool upstream of proposed infrastructure centre line was approx. 50 m long by 10-15 m wide; mean depth 0.2 m in the edge habitat (i.e. within 0.5 m of the stream edge) and 0.3 m in the bed habitat; some areas to 1.3 m depth; substrates of this larger pool underlain by siltstone bedrock, creating semi-permanent pool; bankfull width was approx. 90 m and bankfull height approx. 8 m (from the stream bed); in-stream habitat included shallow (<0.5 m) pool, deep pool, large woody debris, undercut banks and macrophytes; substrates comprised 20% bedrock, 78% sand (0.05-2 mm) and 2% silt/clay (<0.05 mm) in the bed habitat, and 20% bedrock, 70% sand (0.05-2 mm) and 10% silt/clay (<0.05 mm) in the edge habitat; some filamentous algae cover (approx. 40%) across bed in shallows; upstream landuse includes agricultural grazing and coal mining; adjacent landuse includes light grazing in predominantly remnant vegetation.

Aquatic and riparian vegetation

Study reach positioned within RE 11.3.25. Riparian zone approx. 40 m on the left bank and 40 m on the right, comprising riparian forest dominated by forest red gum (*Eucalyptus tereticornis*), with occasional river she-oak (*Casuarina cunninghamiana*). Sub-canopy dominated by snow-in-summer (*Melaleuca linariifolia*), confined to the lower banks. Sparse shrub layer dominated by lantana (*Lantana camara*)*. Ground layer dominated by the exotic green panic (*Megathyrsus maxima*)* on the upper bank, and forest bluegrass (*Bothriochloa bladhii*) and common couch (*Cynodon dactylon*) on the lower bank. Fringing macrophytes included tall flatsedge (*C. exaltatus*). No other macrophytes detected.

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach provides foraging and potential breeding habitat for fish. Marginal foraging and potential breeding habitat for turtles, although none detected. Suitable platypus habitat not detected. Aquatic fauna, detected by backpack electrofishing and overnight deployment of two baited fyke nets and five baited box traps, included Agassiz's glassfish

(*Ambassis agassizii*), gudgeon (*Hypseleotris* sp.), spangled perch (*Leiopotherapon unicolor*), eastern rainbowfish (*Melanotaenia splendida splendida*), purple-spotted gudgeon (*Mogurnda adspersa*), bony bream (*Nematalosa erebi*), freshwater catfish (*Tandanus tandanus*), sleepy cod (*Oxyeleotris lineolata*) and the pest species tilapia (*Oreochromus mossambicus*)*. Macrocrustaceans included freshwater shrimp (*Paratya australiense*), freshwater prawn (*Macrobrachium australiense*), redclaw (*Cherax quadricarinatus*) and orange-fingered yabby (*C. depressus*). A diversity of other aquatic macroinvertebrates were also recorded (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

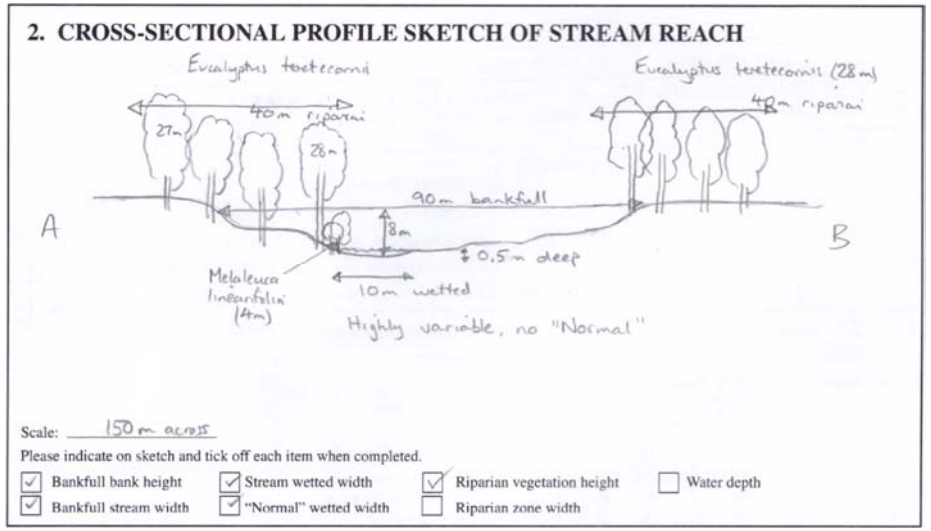
Physico-chemical water quality

Collection time: 15:52 EST; water temp.: 23.0 °C; conductivity: 390 µS/cm (fresh); turbidity: 17.5 NTU (high clarity); dissolved oxygen: 126%, 10.8 mg/L (supersaturated); pH 8.3 (moderately alkaline). Summary: Normal (supersaturated DO likely a result of photosynthetic release of oxygen from the filamentous algae, shallow waterbody and time of day).

Bioassessment scores

Habitat assessment scores for late wet season: Poor (38); AusRivAS taxonomic richness: 13 (bed), 31 (edge); PET richness: 4 (bed), 5 (edge); SIGNAL 2 score: 4.08 (bed), 3.42 (edge); tolerant taxa: 33% (bed), 55% (edge); AusRivAS OE50 score: 1.15 (Band A – bed); 1.35 (Band X – edge).

Overall aquatic values – Late wet season: **Moderate** (Priority flora species; potentially semi-permanent pool); Early wet season: See previous site profile.



Season: Early wet

Site Code: R24 **Location:** Unnamed tributary of the Isaac R, Olive Downs **Stream order:** 2 **Latitude:** -22.1444 **Longitude:** 148.3339 **Date:** 06/10/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral second order drainage line; predominantly dry at the time of assessment, with isolated, senescing pools; little local catchment erosion, including gullying; bankfull width was approx. 13 m and bankfull height 1.5 m; in-stream habitat features in times of flow would include large woody debris; clay banks; bed substrates along the 100 m reach comprised approximately 5% gravel (2-4 mm), 45% sand (0.05-2 mm) and 50% silt/clay (<0.05 mm); upstream landuse includes coal mining (Daunia) and moderate cattle grazing on predominantly cleared land; adjacent landuse includes moderate cattle grazing in predominantly remnant vegetation.

Riparian vegetation

Study reach positioned within approximately 40 m wide corridor of RE 11.3.25, adjoining RE 11.4.8 on the left bank floodplain and RE 11.3.2 on the right bank floodplain. Woodland with sparse canopy dominated by coolabah (*Eucalyptus coolabah*), with occasional brigalow (*Acacia harpophylla*), poplar box (*E. populnea*) and narrow-leaved ironbark (*E. crebra*). Very sparse sub-canopy of sally wattle (*Acacia salicina*), coolabah, Dallachy's gum (*Corymbia dallachiana*) and white bauhinia (*Lysiphyllum hookeri*). Very sparse shrub layer containing sally wattle and mimosa (*Vachellia farnesiana*). Ground layer dominated by green panic (*Megathyrsus maximus*)* and Indian couch (*Bothriochloa pertusa*)*. Occasional fringing macrophytes, including tall flatsedge (*Cyperus exaltatus*), common rush (*Juncus usitatus*) and umbrella canegrass (*Leptochloa digitata*).

Erosion risk

Moderate – banks moderately unstable, although over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach may provide foraging habitat for fish in times of flow. No suitable turtle or platypus breeding habitat detected. Aquatic fauna not sampled.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

Physico-chemical water quality

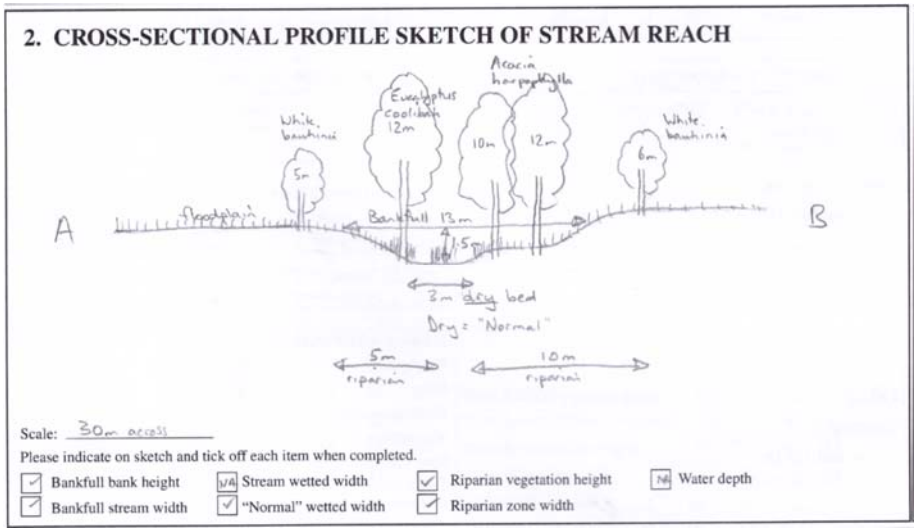
Isolated, senescing pool sampled. Collection time: 10:45 EST; water temp.: 26.1 °C; conductivity: 297 µS/cm (fresh); turbidity: >1000 NTU (opaque); dissolved oxygen: 9.1%, 0.8 mg/L (anoxic); pH 7.6 (mildly alkaline).

Summary: Typical of drying pool heavily disturbed by cattle with direct access.

Bioassessment scores

Habitat assessment score for early season: Fair (42)

Overall aquatic values – Early wet season: **Low** (Priority flora species present, but unlikely to constitute important aquatic habitat); Late wet season: See following site profile.



Season: Late wet

Site Code: R24 **Location:** Unnamed tributary of the Isaac R, Olive Downs **Stream order:** 2 **Latitude:** -22.1444 **Longitude:** 148.3339 **Date:** 26/06/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral second order drainage line; predominantly dry at the time of assessment, with isolated, senescing pools; little local catchment erosion, including gullying; bankfull width was approx. 13 m and bankfull height 1.5 m; in-stream habitat features in times of flow would include large woody debris; clay banks; bed substrates along the 100 m reach comprised approximately 5% gravel (2-4 mm), 45% sand (0.05-2 mm) and 50% silt/clay (<0.05 mm); upstream landuse includes coal mining (Daunia) and moderate cattle grazing on predominantly cleared land; adjacent landuse includes moderate cattle grazing in predominantly remnant vegetation.

Riparian vegetation

Study reach positioned within approximately 40 m wide corridor of RE 11.3.25, adjoining RE 11.4.8 on the left bank floodplain and RE 11.3.2 on the right bank floodplain. Woodland with sparse canopy dominated by coolabah (*Eucalyptus coolabah*), with occasional brigalow (*Acacia harpophylla*), poplar box (*E. populnea*) and narrow-leaved ironbark (*E. crebra*). Very sparse sub-canopy of sally wattle (*Acacia salicina*), coolabah, Dallachy's gum (*Corymbia dallachiana*) and white bauhinia (*Lysiphyllum hookeri*). Very sparse shrub layer containing sally wattle and mimosa (*Vachellia farnesiana*). Ground layer dominated by green panic (*Megathyrsus maximus*)* and Indian couch (*Bothriochloa pertusa*)*. Occasional fringing macrophytes, including tall flatsedge (*Cyperus exaltatus*), common rush (*Juncus usitatus*) and umbrella canegrass (*Leptochloa digitata*).

Erosion risk

Moderate – banks moderately unstable, although over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach may provide foraging habitat for fish in times of flow. No suitable turtle or platypus breeding habitat detected. Aquatic fauna not sampled.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

Physico-chemical water quality

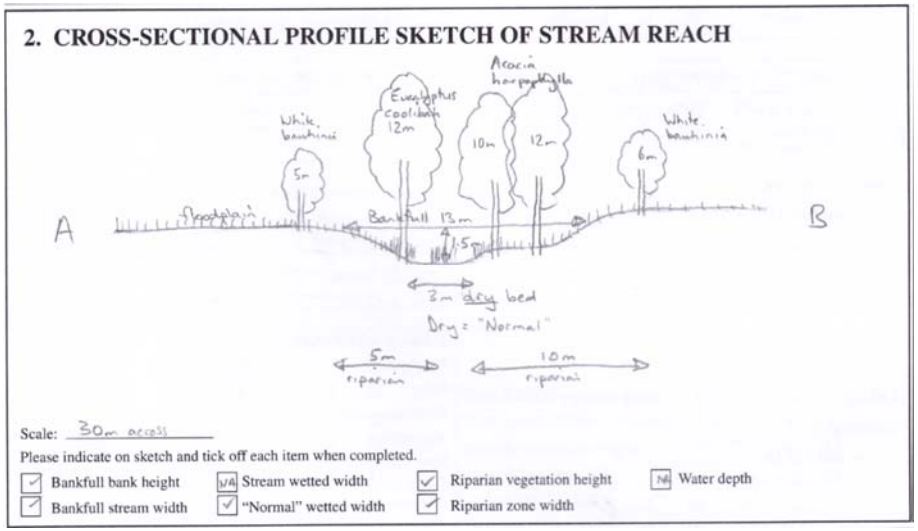
Isolated, senescing pool sampled. Collection time: 13:10 EST; water temp.: 17.6 °C; conductivity: 277 µS/cm (fresh); turbidity: >1000 NTU (opaque); dissolved oxygen: 76.2%, 7.2 mg/L (low for time of day); pH 7.5 (mildly alkaline).

Summary: Typical of drying pool heavily disturbed by cattle with direct access.

Bioassessment scores

Habitat assessment score for late wet season: Fair (43)

Overall aquatic values – Late wet season: **Low** (Priority flora species present, but unlikely to constitute important aquatic habitat); Early wet season: See previous site profile.



Season: Early wet

Site Code: R25 **Location:** Unnamed tributary of North Ck, Moorvale **Stream order:** 1 **Latitude:** -22.0867 **Longitude:** 148.3494 **Date:** 8/10/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral first order drainage line; predominantly dry at the time of assessment, with an isolated, senescing pool; poorly defined bed and banks; some local catchment erosion; bankfull width was approx. 15 m and bankfull height 1.5 m; lacking in-stream habitat features; clay banks; bed substrates comprised 60% sand (0.05-2 mm) and 40% silt/clay (<0.05 mm); upstream and adjoining landuse includes moderate cattle grazing on cleared land.

Riparian vegetation

Study reach positioned within non-remnant vegetation. Very sparse canopy of brigalow (*Acacia harpophylla*), with occasional sandalwood (*Santalum lanceolatum*) and yellowwood (*Terminalia oblongata*). Very sparse shrub layer, including native lime (*Citrus glauca*), currant bush (*Carissa ovata*), white bauhinia (*Lysiphyllum hookeri*) and scrub boonaree (*Alectryon diversifolius*). Very sparse fringing macrophytes, including tall flatsedge (*Cyperus exaltatus*) and common rush (*Juncus usitatus*).

Erosion risk

Moderate – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The drainage line provides unlikely habitat for fish, turtles or platypus. Aquatic fauna not sampled.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species including tall flatsedge (*C. exaltatus*).

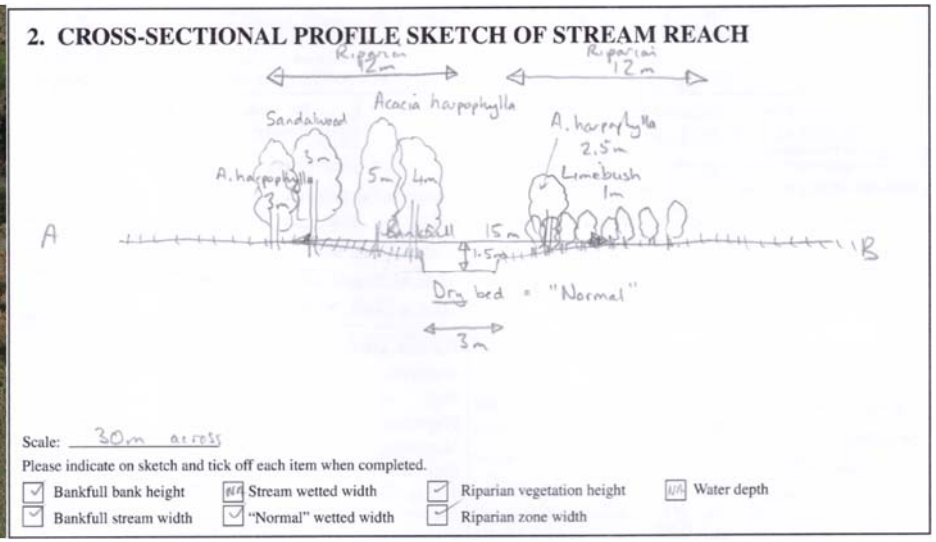
Physico-chemical water quality

Not sampled; isolated senescing pool not suitable for sampling.

Bioassessment scores

Habitat assessment score for early wet season: Poor (24)

Overall aquatic values – Early wet season: **Low** (Priority flora species present, but unlikely to constitute important aquatic habitat); Late wet season: See following site profile.



Season: Late wet

Site Code: R25 **Location:** Unnamed tributary of North Ck, Moorvale **Stream order:** 1 **Latitude:** -22.0867 **Longitude:** 148.3494 **Date:** 27/06/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral first order drainage line; dry at the time of assessment; poorly defined bed and banks; some local catchment erosion; bankfull width was approx. 15 m and bankfull height 1.5 m; lacking in-stream habitat features; clay banks; bed substrates comprised 60% sand (0.05-2 mm) and 40% silt/clay (<0.05 mm); upstream and adjoining landuse includes moderate cattle grazing on cleared land.

Riparian vegetation

Study reach positioned within non-remnant vegetation. Very sparse canopy of brigalow (*Acacia harpophylla*), with occasional sandalwood (*Santalum lanceolatum*) and yellowwood (*Terminalia oblongata*). Very sparse shrub layer, including native lime (*Citrus glauca*), currant bush (*Carissa ovata*), white bauhinia (*Lysiphyllum hookeri*) and scrub boonaree (*Alectryon diversifolius*). Very sparse fringing macrophytes, including tall flatsedge (*Cyperus exaltatus*) and common rush (*Juncus usitatus*).

Erosion risk

Moderate – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The drainage line provides unlikely habitat for fish, turtles or platypus. Aquatic fauna not sampled.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species including tall flatsedge (*C. exaltatus*).

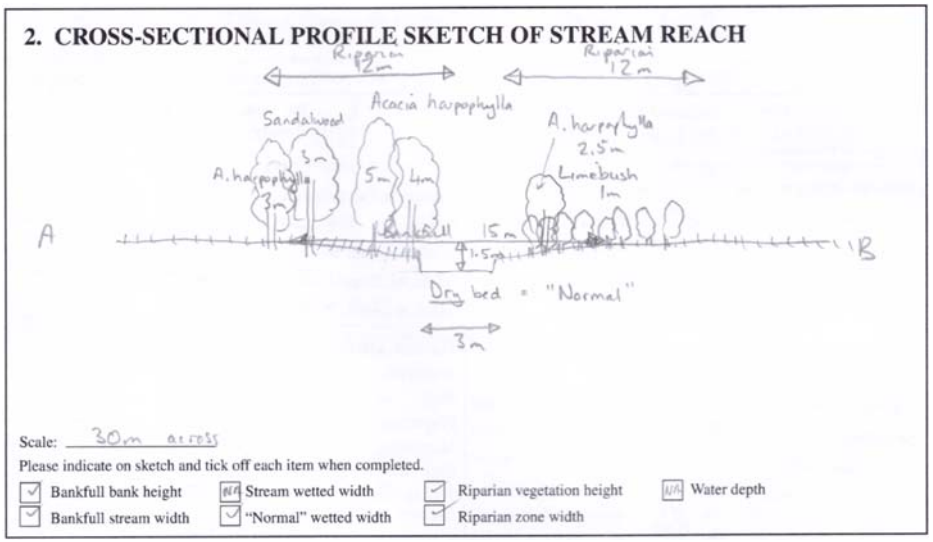
Physico-chemical water quality

Not sampled; dry at the time of assessment.

Bioassessment scores

Habitat assessment score for late wet season: Poor (25)

Overall aquatic values – Late wet season: **Low** (Priority flora species present, but unlikely to constitute important aquatic habitat); Early wet season: See previous site profile.



Season: Early wet

Site Code: R26 **Location:** North Creek, Moorvale **Stream order:** 4 **Latitude:** -22.0833 **Longitude:** 148.3584 **Date:** 08/10/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral fourth order watercourse; dry at the time of assessment; well defined bed and banks; some little local catchment erosion; bankfull width was approx. 70 m and bankfull height approx. 10 m; in-stream habitat in times of flow would include large woody debris and fringing macrophytes; substrates comprised 100% sand (0.05-2 mm) in the bed and banks; upstream landuse includes coal mining, coal seam gas extraction, and cattle grazing; adjacent landuse includes moderate cattle grazing on a mix of cleared land and remnant vegetation.

Riparian vegetation

Study reach positioned within RE 11.3.25, with RE 11.3.2 on the adjoining floodplains. Riparian zone approximately 20 m on the left bank and 20 m on the right, comprising woodland with sparse canopy dominated by forest red gum (*Eucalyptus tereticornis*), with abundant river she-oak (*Casuarina cunninghamiana*), frequent carbeen (*Corymbia tessellaris*) and occasional Clarkson's bloodwood (*C. clarksoniana*). Very sparse sub-canopy of forest red gum, carbeen and ironwood (*Acacia excelsa*). Very sparse shrub layer of white bauhinia (*Lysiphyllum hookeri*), lantana (*Lantana camara*)*, sandpaper fig (*Ficus opposita*) and bean tree (*Cassia brewsteri*). Ground layer dominated by green panic (*Megathyrsus maximus*)*, with frequent spiny-headed mat-rush (*Lomandra longifolia*). Sparse fringing macrophytes, including rice sedge (*Cyperus difformis*), tall flatsedge (*C. exaltatus*) and common rush (*Juncus usitatus*).

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

Aquatic fauna not sampled. The reach is expected to provide breeding and foraging habitat when wetted. Reach likely facilitates fish passage during times of flow. May also provide suitable temporary habitat for turtles when wet. Unlikely habitat for platypus.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

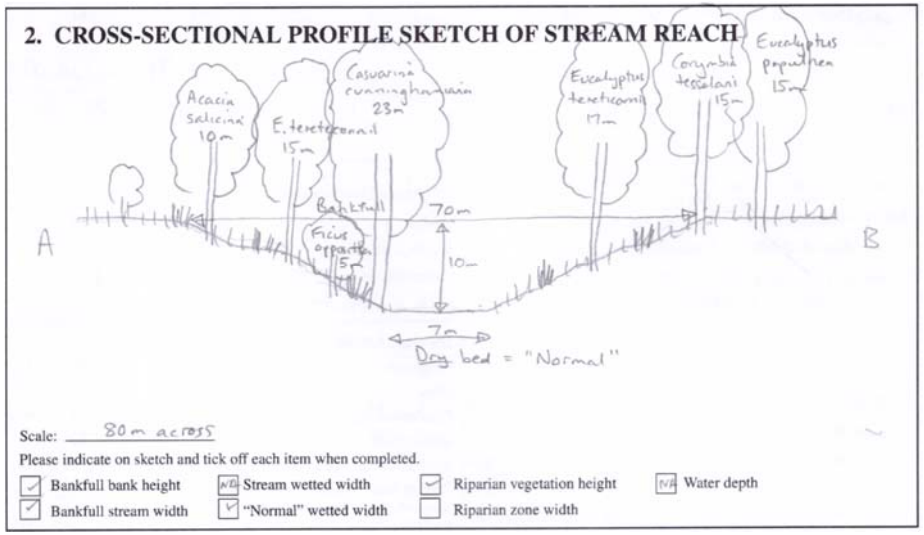
Physico-chemical water quality

Not sampled; dry at the time of assessment.

Bioassessment scores

Habitat assessment score for early wet season: Poor (26)

Overall aquatic values – Early wet season: **Moderate** (Priority flora species); Late wet season: See following site profile.



Season: Late wet

Site Code: R26 **Location:** North Creek, Moorvale **Stream order:** 4 **Latitude:** -22.0833 **Longitude:** 148.3584 **Date:** 27/06/2017

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Ephemeral fourth order watercourse; dry at the time of assessment; well defined bed and banks; some little local catchment erosion; bankfull width was approx. 70 m and bankfull height approx. 10 m; in-stream habitat in times of flow would include large woody debris and fringing macrophytes; substrates comprised 100% sand (0.05-2 mm) in the bed and banks; upstream landuse includes coal mining, coal seam gas extraction, and cattle grazing; adjacent landuse includes moderate cattle grazing on a mix of cleared land and remnant vegetation.

Riparian vegetation

Study reach positioned within RE 11.3.25, with RE 11.3.2 on the adjoining floodplains. Riparian zone approximately 20 m on the left bank and 20 m on the right, comprising woodland with sparse canopy dominated by forest red gum (*Eucalyptus tereticornis*), with abundant river she-oak (*Casuarina cunninghamiana*), frequent carbeen (*Corymbia tessellaris*) and occasional Clarkson's bloodwood (*C. clarksoniana*). Very sparse sub-canopy of forest red gum, carbeen and ironwood (*Acacia excelsa*). Very sparse shrub layer of white bauhinia (*Lysiphyllum hookeri*), lantana (*Lantana camara*)*, sandpaper fig (*Ficus opposita*) and bean tree (*Cassia brewsteri*). Ground layer dominated by green panic (*Megathyrsus maximus*)*, with frequent spiny-headed mat-rush (*Lomandra longifolia*). Sparse fringing macrophytes, including rice sedge (*Cyperus difformis*), tall flatsedge (*C. exaltatus*), flatsedge (*C. haspan*) and common rush (*Juncus usitatus*).

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

Aquatic fauna not sampled. The reach is expected to provide breeding and foraging habitat when wetted. Reach likely facilitates fish passage during times of flow. May also provide suitable temporary habitat for turtles when wet. Unlikely habitat for platypus.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

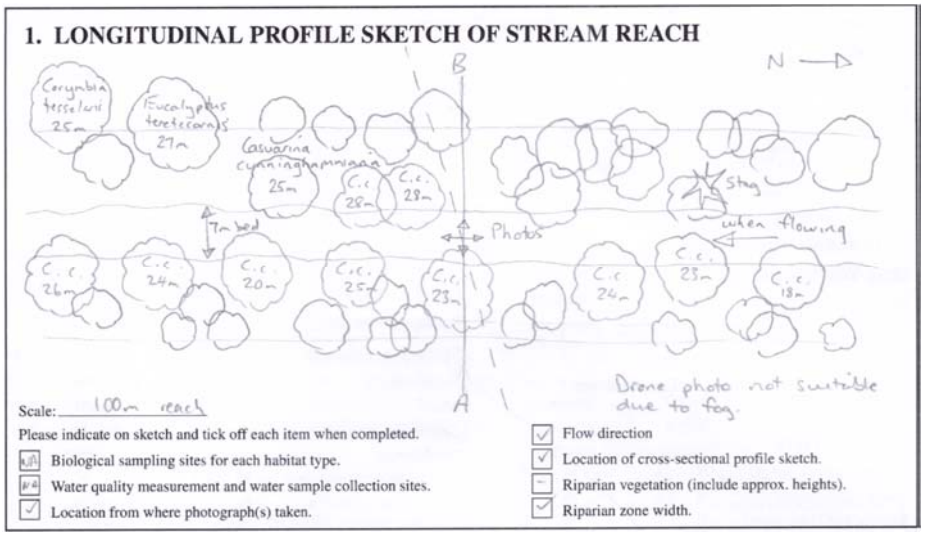
Physico-chemical water quality

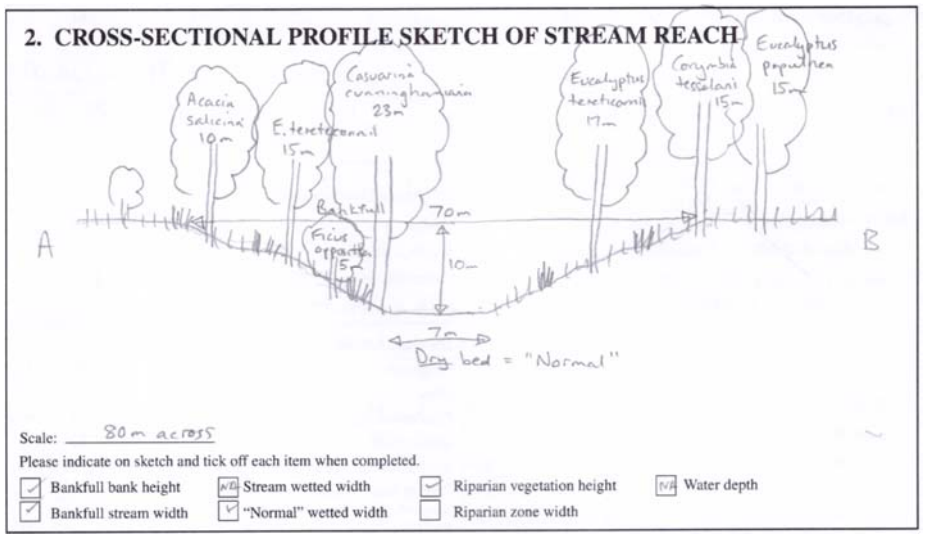
Not sampled; dry at the time of assessment.

Bioassessment scores

Habitat assessment score for late wet season: Poor (26)

Overall aquatic values – Late wet season: **Moderate** (Priority flora species); Early wet season: See previous site profile.





Season: Early wet

Site Code: R27 **Location:** Unnamed tributary of North Ck, Moorvale **Stream order:** 2 **Latitude:** -22.0632 **Longitude:** 148.3603 **Date:** 3/10/2016


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral second order drainage line; isolated pools, with no discernible flow; well defined bed and banks within study reach; extensive local catchment erosion, including deep gullying and bank slumping; the wetted width along the 100 m survey reach ranged from 0 to 6 m, with a mean width of 5 m (estimated); depth to approx. 0.6 m; bankfull width was approx. 8 m and bankfull height approx. 2.5 m (from the stream bed); in-stream habitat included shallow (<0.5 m) pool, deep pool, undercut banks, large woody debris, and fringing macrophytes; bank substrates comprised sands and light clays; bed substrates comprised 90% sand (0.05-2 mm) and 10% silt/clay (<0.05 mm); upstream landuse includes coal mining, coal seam gas extraction, and cattle grazing; adjacent landuse includes moderate cattle grazing on a mix of cleared land and remnant vegetation.

Riparian vegetation

Study reach positioned within RE 11.3.25, with cleared land on the adjoining floodplains. Riparian zone approximately 20 m on the left bank and 20 m on the right, comprising woodland with sparse canopy dominated by forest red gum (*Eucalyptus tereticornis*), with occasional carbeen (*Corymbia tessellaris*) and brigalow (*Acacia harpophylla*). Very sparse sub-canopy of white bauhinia (*Lysiphyllum hookeri*), yellowwood (*Terminalia oblongata*) and brigalow. Sparse to very sparse shrub layer of yellowwood, Cassinia (*Elaeodendron australe*), cocaine tree (*Erythroxylum australe*), scrub boonaree (*Alectryon diversifolius*), narrow-leaved bumbil (*Capparis loranthifolia*), wild orange (*C. mitchellii*), currant bush (*Carissa ovata*) and whitewood (*Atalaya hemiglauca*). Ground layer dominated by Indian couch (*Bothriochloa pertusa*)* and green panic (*Megathyrsus maximus*)*. Submerged macrophytes included charophyte algae (*Chara/Nitella* sp.). Fringing macrophytes included rice sedge (*Cyperus difformis*), tall flatsedge (*C. exaltatus*), slender sedge (*C. gracilis*), white eclipta (*Eclipta prostrata*)*, common rush (*Juncus usitatus*) and umbrella canegrass (*Leptochloa digitata*).

Erosion risk

Moderate – banks appeared to be moderately unstable, but with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

Aquatic fauna not sampled. The reach is expected to provide breeding and foraging habitat for fish when wetted. Reach likely facilitates fish passage during times of flow. May also provide suitable temporary habitat for turtles when wet. No suitable turtle or platypus breeding habitat detected.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

Physico-chemical water quality

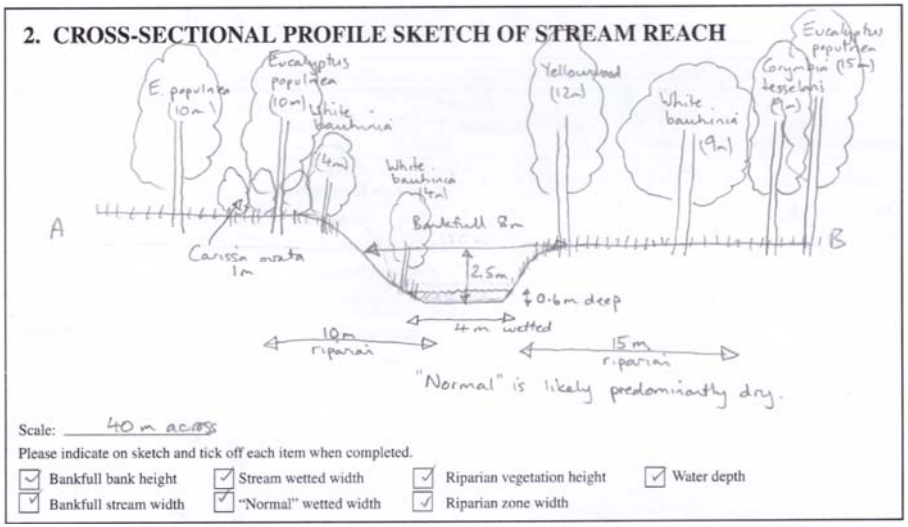
Collection time: 14:10 EST; water temp.: 23.1 °C; conductivity: 50 µS/cm (fresh); turbidity: 679 (poor clarity); dissolved oxygen: 62.1%, 5.2 mg/L (low for time of day); pH 7.3 (neutral).

Summary: Normal (Typical of drying pool disturbed by cattle).

Bioassessment scores

Habitat assessment score for early wet season: Fair (43)

Overall aquatic values – Early wet season: **Moderate** (Priority flora species); Late wet season: See following site profile.



Season: Late wet

Site Code: R27 **Location:** Unnamed tributary of North Ck, Moorvale **Stream order:** 2 **Latitude:** -22.0632 **Longitude:** 148.3603 **Date:** 27/06/2016


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral second order drainage line; isolated pools, with no discernible flow; well defined bed and banks within study reach; extensive local catchment erosion, including deep gullying and bank slumping; the wetted width along the 100 m survey reach ranged from 0 to 6 m, with a mean width of 5 m (estimated); depth to approx. 0.6 m; bankfull width was approx. 8 m and bankfull height approx. 2.5 m (from the stream bed); in-stream habitat included shallow (<0.5 m) pool, deep pool, undercut banks, large woody debris, and fringing macrophytes; bank substrates comprised sands and light clays; bed substrates comprised 90% sand (0.05-2 mm) and 10% silt/clay (<0.05 mm); upstream landuse includes coal mining, coal seam gas extraction, and cattle grazing; adjacent landuse includes moderate cattle grazing on a mix of cleared land and remnant vegetation.

Riparian vegetation

Study reach positioned within RE 11.3.25, with cleared land on the adjoining floodplains. Riparian zone approximately 20 m on the left bank and 20 m on the right, comprising woodland with sparse canopy dominated by forest red gum (*Eucalyptus tereticornis*), with occasional carbeen (*Corymbia tessellaris*) and brigalow (*Acacia harpophylla*). Very sparse sub-canopy of white bauhinia (*Lysiphyllum hookeri*), yellowwood (*Terminalia oblongata*) and brigalow. Sparse to very sparse shrub layer of yellowwood, Cassinia (*Elaeodendron australe*), cocaine tree (*Erythroxylum australe*), scrub boonaree (*Alectryon diversifolius*), narrow-leaved bumbil (*Capparis loranthifolia*), wild orange (*C. mitchellii*), currant bush (*Carissa ovata*) and whitewood (*Atalaya hemiglauca*). Ground layer dominated by Indian couch (*Bothriochloa pertusa*)* and green panic (*Megathyrsus maximus*)*. Submerged macrophytes included charophyte algae (*Chara/Nitella* sp.). Fringing macrophytes included rice sedge (*Cyperus difformis*), tall flatsedge (*C. exaltatus*), slender sedge (*C. gracilis*), white eclipta (*Eclipta prostrata*)*, common rush (*Juncus usitatus*) and umbrella canegrass (*Leptochloa digitata*).

Erosion risk

Moderate – banks appeared to be moderately unstable, but with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

Aquatic fauna not sampled. The reach is expected to provide breeding and foraging habitat for fish when wetted. Reach likely facilitates fish passage during times of flow. May also provide suitable temporary habitat for turtles when wet. No suitable turtle or platypus breeding habitat detected.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

Physico-chemical water quality

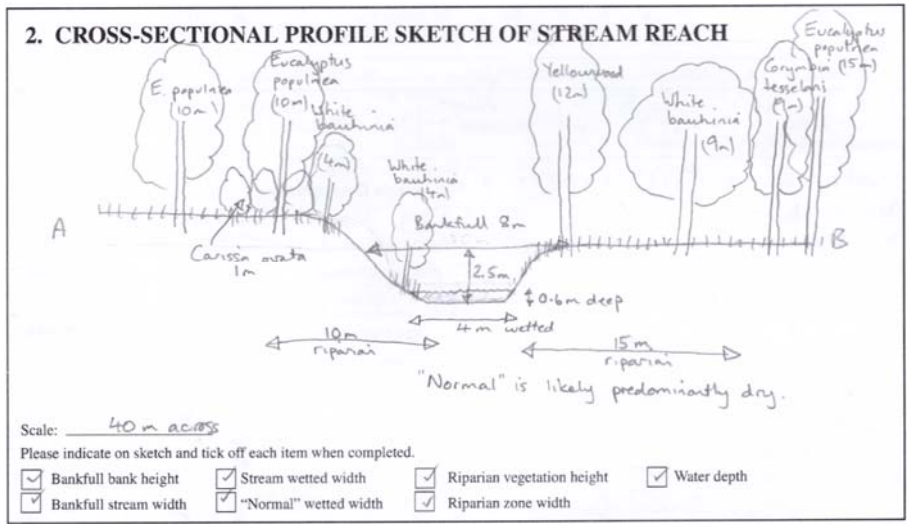
Collection time: 10:05 EST; water temp.: 16.3 °C; conductivity: 290 µS/cm (fresh); turbidity: 64.7 (moderate to poor clarity); dissolved oxygen: 81.8%, 8.0 mg/L (good); pH 8.0 (moderately alkaline).

Summary: Normal (moderately alkaline levels typical of standing surface water on silts/clays with high contact time with substrates).

Bioassessment scores

Habitat assessment score for late wet season: Fair (45)

Overall aquatic values – Late wet season: **Moderate** (Priority flora species); Early wet season: See previous site profile.



Season: Early wet

Site Code: R28 **Location:** North Creek, Moorvale **Stream order:** 4 **Latitude:** -22.0528 **Longitude:** 148.3508 **Date:** 3/10/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Semi-permanent pool on fourth order reach of North Creek; naturally dammed by bedrock outcrop downstream; semi-permanent pool on an otherwise highly ephemeral drainage line; well defined bed and banks within study reach; some local catchment erosion, including gullying between waterbody and road; moderate water level (=watermark) at time of site visit; isolated pool with no discernible flow; the wetted width along the 100 m survey reach ranged from 5 to 15 m, with a mean width of 10 m (estimated); mean depth 0.15 m in the edge habitat (i.e. within 0.5 m of the stream edge) and 1.5 m in the bed habitat; bankfull width was approx. 50 m and bankfull height approx. 8 m (from the stream bed); in-stream habitat included shallow (<0.5 m) pool, deep pool, large woody debris, undercut banks and fringing macrophytes; substrates comprised 5% bedrock, 85% sand (0.05-2 mm) and 10% silt/clay (<0.05 mm) in the edge habitat and 20% bedrock and 80% sand (0.05-2 mm) in the bed habitat; no riffles or runs detected.

Aquatic and riparian vegetation

Study reach positioned within RE 11.3.25. Riparian zone approximately 20 m on the left bank and 30 m on the right, comprising woodland with sparse canopy dominated by forest red gum (*Eucalyptus tereticornis*), with abundant river she-oak (*Casuarina cunninghamiana*), occasional carbeen (*Corymbia tessellaris*) and poplar box (*E. populnea*). Very sparse sub-canopy of white bauhinia (*Lysiphyllum hookeri*). Very sparse shrub layer of white bauhinia, bean tree (*Cassia brewsteri*), lantana (*Lantana camara*)* and sandpaper fig (*Ficus opposita*). Ground layer dominated by green panic (*Megathyrsus maximus*)* and sabi grass (*Urochloa mosambicensis*)*. Fringing macrophytes included tall flatsedge (*Cyperus exaltatus*), flatsedge (*C. haspan*); rice sedge (*C. difformis*) and common rush (*Juncus usitatus*).

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach provides breeding and foraging habitat for fish, as well as potential breeding and foraging habitat for turtles. Suitable platypus habitat not detected. Aquatic fauna detected by backpack electrofishing and overnight deployment of two baited fyke nets, two baited cathedral traps and five baited box traps, included glassfish (*Ambassis*

agassizii), bony bream (*Nematalosa erebi*); purple-spotted gudgeon (*Mogurnda adspersa*), spangled perch (*Leiopotherapon unicolor*), eastern rainbowfish (*Melanotaenia splendida splendida*), gudgeon (*Hypseleotris* sp.), Hyrtl's tandan (*Neosilurus hyrtlii*), Rendahl's tandan (*Porochilus rendahli*), fly-specked hardyhead (*Craterocephalus stercusmuscarum*), sleepy cod (*Oxyeleotris lineolata*) and the pest species tilapia (*Oreochromus mossambicus*)*. No turtles detected. Macrocrustaceans included freshwater shrimp (*Paratya australiense*); freshwater prawn (*Macrobrachium australiense*) and redclaw (*Cherax quadricarinatus*). A number of other aquatic macroinvertebrates were also recorded (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*), Critically Endangered silver perch (*Bidyanus bidyanus*) and the Special Least Concern platypus (*Ornithorhynchus anatinus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

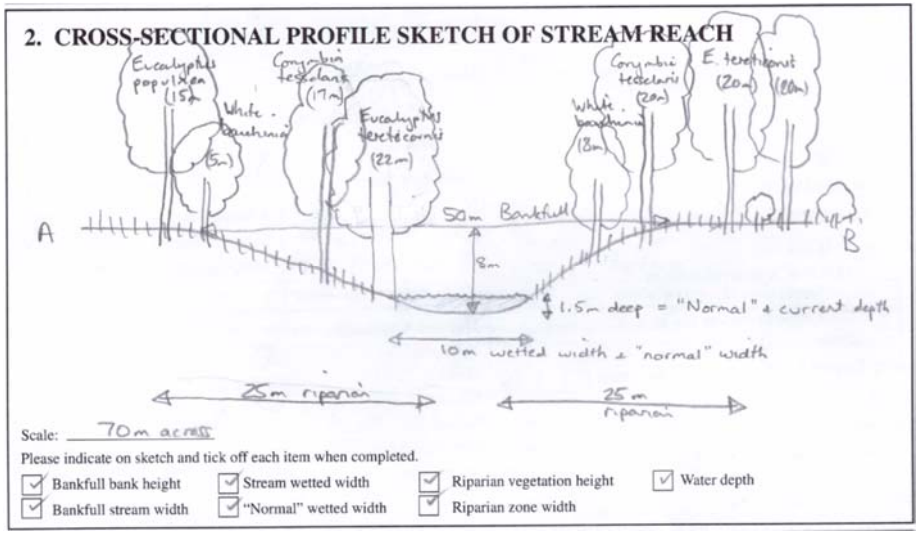
Physico-chemical water quality

Collection time: 11:00 EST; water temp: 23.0 °C; conductivity: 376 µS/cm (fresh); turbidity: 49.1 (moderate clarity); dissolved oxygen: 64.5%, 5.4 mg/L; pH 7.4 (mildly alkaline). Summary: Normal.

Bioassessment scores

Habitat assessment scores for early wet season: Good (73); AusRivAS taxonomic richness: 26 (bed), 21 (edge); PET richness: 6 (bed), 2 (edge); SIGNAL 2 score: 3.81 (bed), 3.38 (edge); tolerant taxa: 42% (bed), 57% (edge); AusRivAS OE50 score: 1.23 (Band X – bed); 0.70 (Band B – edge).

Overall aquatic values – Early wet season: **Moderate** (semi-permanent pool; Priority flora species); Late wet season: See following site profile.



Season: Late wet

Site Code: R28 **Location:** North Creek, Moorvale **Stream order:** 4 **Latitude:** -22.0528 **Longitude:** 148.3508 **Date:** 27/06/2016

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Semi-permanent pool on fourth order reach of North Creek; naturally dammed by bedrock outcrop downstream; semi-permanent pool on an otherwise highly ephemeral drainage line; well defined bed and banks within study reach; some local catchment erosion, including gullying between waterbody and road; moderate water level (=watermark) at time of site visit; isolated pool with no discernible flow; the wetted width along the 100 m survey reach ranged from 5 to 15 m, with a mean width of 10 m (estimated); mean depth 0.15 m in the edge habitat (i.e. within 0.5 m of the stream edge) and 1.5 m in the bed habitat; bankfull width was approx. 50 m and bankfull height approx. 8 m (from the stream bed); in-stream habitat included shallow (<0.5 m) pool, deep pool, large woody debris, undercut banks and fringing macrophytes; substrates comprised 5% bedrock, 85% sand (0.05-2 mm) and 10% silt/clay (<0.05 mm) in the edge habitat and 20% bedrock and 80% sand (0.05-2 mm) in the bed habitat; no riffles or runs detected.

Aquatic and riparian vegetation

Study reach positioned within RE 11.3.25. Riparian zone approximately 20 m on the left bank and 30 m on the right, comprising woodland with sparse canopy dominated by forest red gum (*Eucalyptus tereticornis*), with abundant river she-oak (*Casuarina cunninghamiana*), occasional carbeen (*Corymbia tessellaris*) and poplar box (*E. populnea*). Very sparse sub-canopy of white bauhinia (*Lysiphyllum hookeri*). Very sparse shrub layer of white bauhinia, bean tree (*Cassia brewsteri*), lantana (*Lantana camara*)* and sandpaper fig (*Ficus opposita*). Ground layer dominated by green panic (*Megathyrsus maximus*)* and sabi grass (*Urochloa mosambicensis*)*. Fringing macrophytes included tall flatsedge (*Cyperus exaltatus*), flatsedge (*C. haspan*) and common rush (*Juncus usitatus*).

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach provides breeding and foraging habitat for fish, as well as potential breeding and foraging habitat for turtles. Suitable platypus habitat not detected. Aquatic fauna detected by backpack electrofishing and overnight deployment of two baited fyke nets, two baited cathedral traps and five baited box traps, included glassfish (*Ambassis*

agassizii), purple-spotted gudgeon (*Mogurnda adspersa*), spangled perch (*Leiopotherapon unicolor*), eastern rainbowfish (*Melanotaenia splendida splendida*), gudgeon (*Hypseleotris* sp.), Hyrtl's tandan (*Neosilurus hyrtlii*), Rendahl's tandan (*Porochilus rendahli*), fly-specked hardyhead (*Craterocephalus stercusmuscarum*), sleepy cod (*Oxyeleotris lineolata*) and the pest species tilapia (*Oreochromus mossambicus*)*. No turtles detected. Macrocrustaceans included freshwater shrimp (*Paratya australiense*) and freshwater prawn (*Macrobrachium australiense*). A number of other aquatic macroinvertebrates were also recorded (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*), Critically Endangered silver perch (*Bidyanus bidyanus*) and the Special Least Concern platypus (*Ornithorhynchus anatinus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

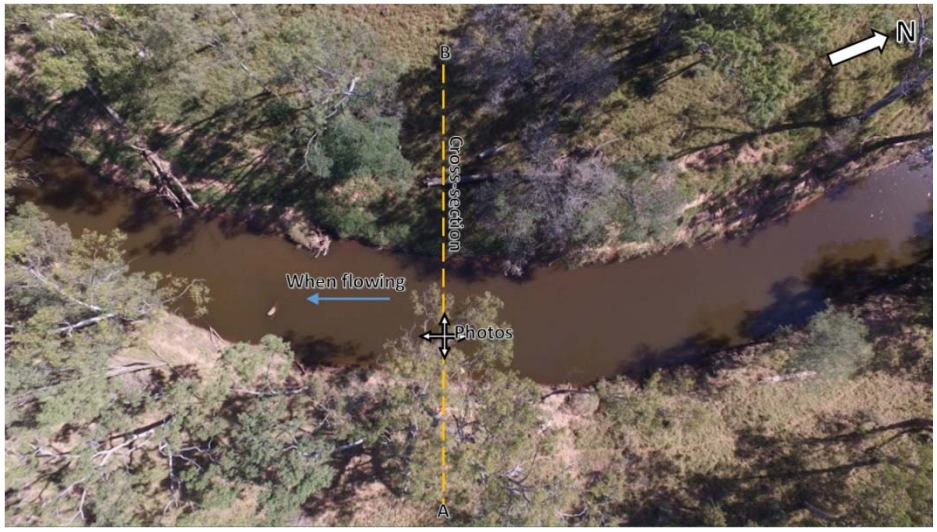
Physico-chemical water quality

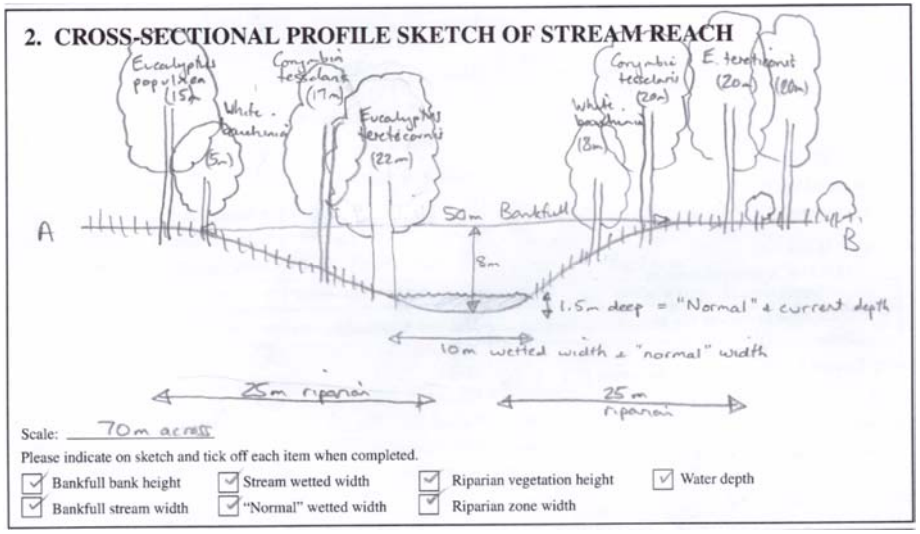
Collection time: 11:20 EST; water temp.: 17.8 °C; conductivity: 375 µS/cm (fresh); turbidity: 14.9 (high clarity); dissolved oxygen: 86.5%, 8.2 mg/L; pH 7.5 (mildly alkaline). Summary: Normal.

Bioassessment scores

Habitat assessment scores for late wet season: Good (75); AusRivAS taxonomic richness: 10 (bed), 21 (edge); PET richness: 2 (bed), 4 (edge); SIGNAL 2 score: 3.90 (bed), 3.35 (edge); tolerant taxa: 40% (bed), 55% (edge); AusRivAS OE50 score: 0.77 (Band B – bed); 0.93 (Band A – edge).

Overall aquatic values – Late wet season: **Moderate** (semi-permanent pool; Priority flora species); Early wet season: See previous site profile.





Season: Early wet

Site Code: R29 **Location:** Unnamed tributary of North Ck, Annandale Rd **Stream order:** 1 **Latitude:** -22.0273 **Longitude:** 148.3440 **Date:** 3/10/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral first order drainage line transecting road corridor; predominantly dry at the time of assessment, with an isolated, senescing pool; drainage feature, with poorly defined bed and banks; little local catchment erosion; bankfull width was approx. 5 m and bankfull height 1 m; lacking in-stream habitat features; light clay banks; bed substrates comprised 10% sand (0.05-2 mm) and 90% clay (<0.05 mm); upstream landuse includes moderate cattle grazing on cleared land.

Riparian vegetation

Study reach positioned within non-remnant vegetation. Very sparse canopy of brigalow (*Acacia harpophylla*), with occasional yellowwood (*Terminalia oblongata*) and poplar box (*Eucalyptus populnea*). Very sparse shrub layer, including bean tree (*Cassia brewsteri*) and white bauhinia (*Lysiphyllum hookeri*). Ground layer dominated by buffel grass (*Cenchrus ciliaris*)* and Indian couch (*Bothriochloa pertusa*)*, with frequent sabi grass (*Urochloa mosambicensis*)*, *Sida* sp., common couch (*Cynodon dactylon*) and sneezeweed (*Centipeda minima*). Very sparse fringing macrophytes, including tall flatsedge (*Cyperus exaltatus*); rice sedge (*C. difformis*); brown bettle grass (*Diplachne fusca var. fusca*) and common rush (*Juncus usitatus*).

Erosion risk

Moderate – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The drainage line provides unlikely habitat for fish, turtles or platypus. Aquatic fauna not sampled.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species including tall flatsedge (*C. exaltatus*).

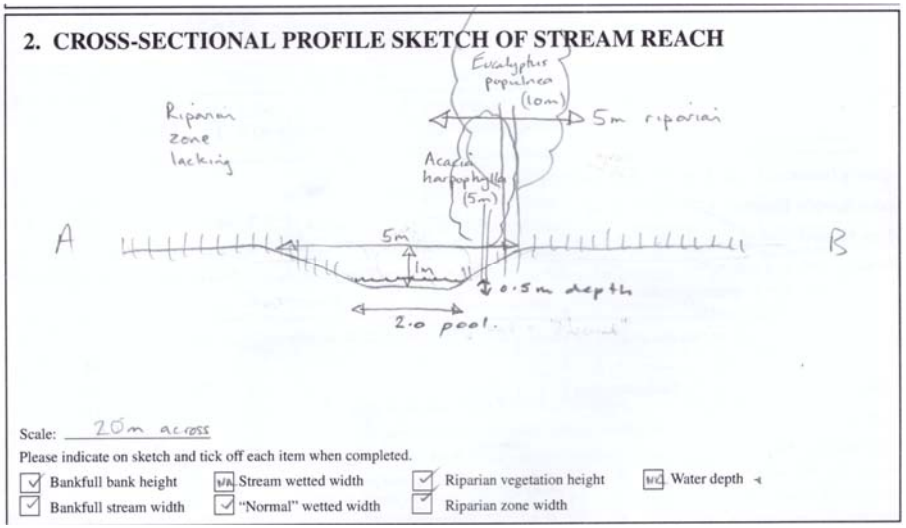
Physico-chemical water quality

Collection time: 10:05 EST; water temp: 22.3 °C; conductivity: 106 µS/cm (fresh); turbidity: >1000 NTU (poor clarity); dissolved oxygen: 11.9%, 1.0 mg/L; pH 7.1 (neutral).

Bioassessment scores

Habitat assessment score for early wet season: Fair (51)

Overall aquatic values – Early wet season: **Moderate** (Priority flora species dominate upstream pool); Late wet season: See following site profile.



Season: Late wet

Site Code: R29 **Location:** Unnamed tributary of North Ck, Annandale Rd **Stream order:** 1 **Latitude:** -22.0273 **Longitude:** 148.3440 **Date:** 28/06/2016


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral first order drainage line transecting road corridor; dry at the time of assessment; drainage feature, with poorly defined bed and banks; little local catchment erosion; bankfull width was approx. 5 m and bankfull height 1 m; lacking in-stream habitat features; light clay banks; bed substrates comprised 10% sand (0.05-2 mm) and 90% clay (<0.05 mm); upstream landuse includes moderate cattle grazing on cleared land.

Riparian vegetation

Study reach positioned within non-remnant vegetation. Very sparse canopy of brigalow (*Acacia harpophylla*), with occasional yellowwood (*Terminalia oblongata*) and poplar box (*Eucalyptus populnea*). Very sparse shrub layer, including bean tree (*Cassia brewsteri*) and white bauhinia (*Lysiphyllum hookeri*). Ground layer dominated by buffel grass (*Cenchrus ciliaris*)* and Indian couch (*Bothriochloa pertusa*)*, with frequent sabi grass (*Urochloa mosambicensis*)*, *Sida* sp., common couch (*Cynodon dactylon*) and sneezeweed (*Centipeda minima*). Very sparse fringing macrophytes, including tall flatsedge (*Cyperus exaltatus*) and common rush (*Juncus usitatus*).

Erosion risk

Moderate – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The drainage line provides unlikely habitat for fish, turtles or platypus. Aquatic fauna not sampled.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species including tall flatsedge (*C. exaltatus*).

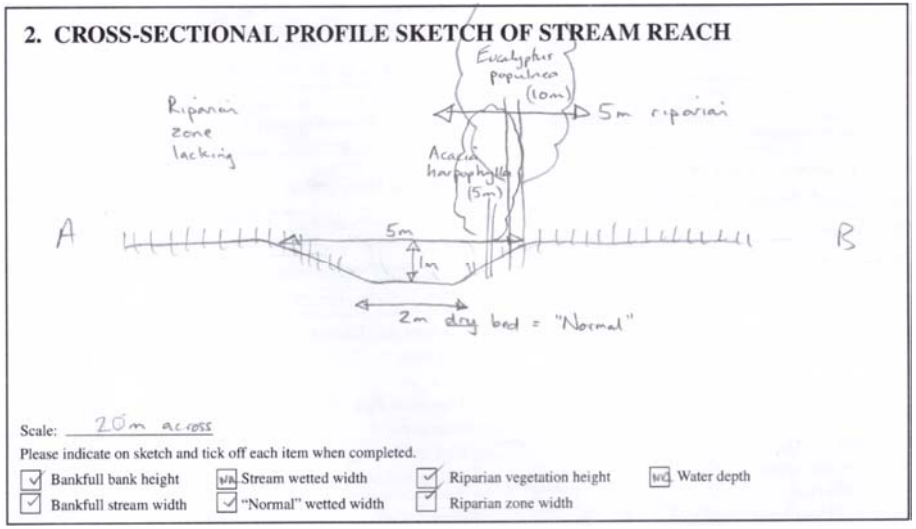
Physico-chemical water quality

Not sampled; dry at the time of assessment.

Bioassessment scores

Habitat assessment score for late wet season: Fair (51)

Overall aquatic values – Late wet season: **Moderate** (Priority flora species dominate upstream pool); Early wet season: See previous site profile.



Season: Early wet

Site Code: R30 **Location:** North Creek, Moorvale **Stream order:** 4 **Latitude:** -21.9995 **Longitude:** 148.3074 **Date:** 8/10/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral pool on fourth order reach of North Creek; well defined bed and banks within study reach; some local catchment erosion; water level receding; isolated pools with no discernible flow; loosely compacted sandy substrate; filamentous algae along edges; the wetted width along the 100 m survey reach ranged from 9 to 11 m, with a mean width of 10 m (estimated); mean depth 0.2 m in the edge habitat (i.e. within 0.5 m of the stream edge) and 0.2 m in the bed habitat, with some areas to 1 m depth; bankfull width was approx. 40 m and bankfull height approx. 8 m (from the stream bed); in-stream habitat included shallow (<0.5 m) pool, deep pool, large woody debris, undercut banks and fringing macrophytes; substrates comprised 80% sand (0.05-2 mm) and 20% silt/clay (<0.05 mm) in the edge habitat and 100% sand in the bed habitat; no riffles or runs detected.

Aquatic and riparian vegetation

Study reach positioned within RE 11.3.25. Riparian zone approximately 20 m on the left bank and 20 m on the right, comprising woodland with sparse canopy dominated by forest red gum (*Eucalyptus tereticornis*), with abundant river she-oak (*Casuarina cunninghammiana*) and frequent carbeen (*Corymbia tessellaris*). Very sparse sub-canopy of white bauhinia (*Lysiphyllum hookeri*) and sally wattle (*Acacia salicina*). Ground layer dominated by green panic (*Megathyrsus maximus*) on the upper bank and common couch (*Cynodon dactylon*) on the lower bank. Fringing macrophytes included: tall flatsedge (*C. exaltatus*) and common rush (*Juncus usitatus*).

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach provides breeding and foraging habitat for fish, and marginal potential breeding and foraging habitat for turtles. Suitable platypus habitat not detected. Aquatic fauna detected by backpack electrofishing and overnight deployment of two baited fyke nets and five baited box traps, included glassfish (*Ambassis agassizii*), bony bream (*Nematalosa erebi*); flyspecked hardyhead (*Craterocephalus stercusmuscarum*); purple-spotted gudgeon (*Mogurnda adspersa*), spangled perch (*Leiopotherapon unicolor*), eastern rainbowfish (*Melanotaenia splendida splendida*) and gudgeon (*Hypseleotris* sp.). No turtles were detected. Macrocrustaceans included freshwater shrimp (*Paratya australiense*), freshwater

prawn (*Macrobrachium australiense*) and orange-fingered yabby (*Cherax depressus*). A number of other aquatic macroinvertebrates were also recorded (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*), Critically Endangered silver perch (*Bidyanus bidyanus*) and the Special Least Concern platypus (*Ornithorhynchus anatinus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*Cyperus exaltatus*).

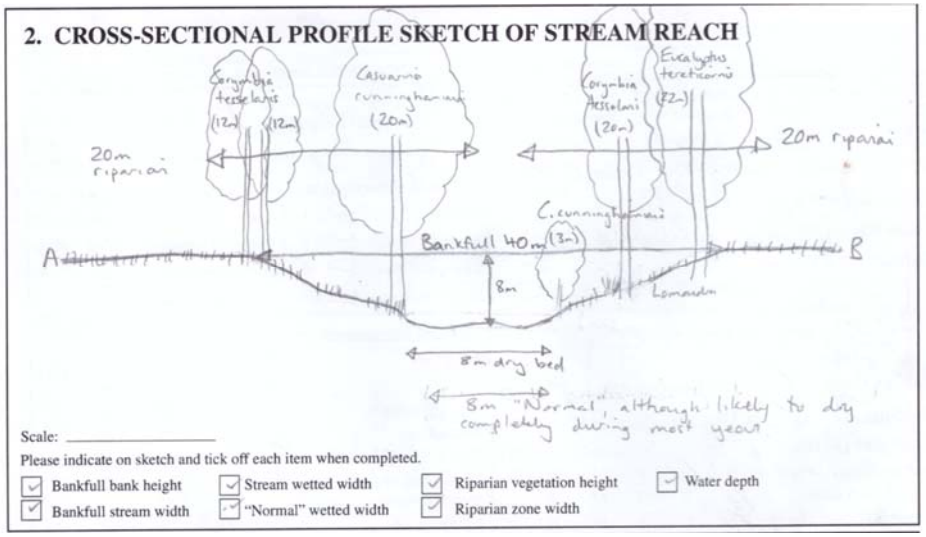
Physico-chemical water quality

Collection time: 13:00 EST; water temp.: 27.2 °C; conductivity: 450 µS/cm (fresh); turbidity: 22.9 (high clarity); dissolved oxygen: 78.9%, 6.0 mg/L; pH 7.6 (mildly alkaline). Summary: Normal.

Bioassessment scores

Habitat assessment scores for 2017 early wet season: Fair (40); AusRivAS taxonomic richness: 18 (bed), 33 (edge); PET richness: 3 (bed), 5 (edge); SIGNAL 2 score: 3.25 (bed), 3.50 (edge); tolerant taxa: 50% (bed), 53% (edge); AusRivAS OE50 score: 1.01 (Band A – bed); 1.41 (Band X – edge).

Overall aquatic values – Early wet season: **Moderate** (Priority flora species); Late wet season: See following site profile.



Season: Late wet

Site Code: R30 **Location:** North Creek, Moorvale **Stream order:** 4 **Latitude:** -21.9995 **Longitude:** 148.3074 **Date:** 27/06/2016


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral pool on fourth order reach of North Creek; well defined bed and banks within study reach; some local catchment erosion; water level receding; isolated pools with no discernible flow; loosely compacted sandy substrate; filamentous algae along edges; bankfull width was approx. 40 m and bankfull height approx. 8 m (from the stream bed); in-stream habitat included shallow (<0.5 m) pool, large woody debris, undercut banks and fringing macrophytes; substrates comprised 80% sand (0.05-2 mm) and 20% silt/clay (<0.05 mm) in the edge habitat and 100% sand in the bed habitat; no riffles or runs detected.

Aquatic and riparian vegetation

Study reach positioned within RE 11.3.25. Riparian zone approximately 20 m on the left bank and 20 m on the right, comprising woodland with sparse canopy dominated by forest red gum (*Eucalyptus tereticornis*), with abundant river she-oak (*Casuarina cunninghammiana*) and frequent carbeen (*Corymbia tessellaris*). Very sparse sub-canopy of white bauhinia (*Lysiphyllum hookeri*) and sally wattle (*Acacia salicina*). Ground layer dominated by green panic (*Megathyrsus maximus*) on the upper bank and common couch (*Cynodon dactylon*) on the lower bank. Fringing macrophytes included: rice sedge (*Cyperus difformis*), tall flatsedge (*Cyperus exaltatus*), common rush (*Juncus usitatus*) and spiny-headed mat-rush (*Lomandra longifolia*).

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach provides breeding and foraging habitat for fish, and marginal potential breeding and foraging habitat for turtles. Suitable platypus habitat not detected. Aquatic fauna detected by backpack electrofishing and overnight deployment of two baited fyke nets and five baited box traps, included glassfish (*Ambassis agassizii*), purple-spotted gudgeon (*Mogurnda adspersa*), spangled perch (*Leiopotherapon unicolor*), eastern rainbowfish (*Melanotaenia splendida splendida*) and gudgeon (*Hypseleotris* sp.). Macrocrustaceans included freshwater shrimp (*Paratya australiense*), freshwater prawn (*Macrobrachium australiense*) and orange-fingered yabby (*Cherax depressus*). A number of other aquatic

macroinvertebrates were also recorded (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*), Critically Endangered silver perch (*Bidyanus bidyanus*) and the Special Least Concern platypus (*Ornithorhynchus anatinus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*Cyperus exaltatus*).

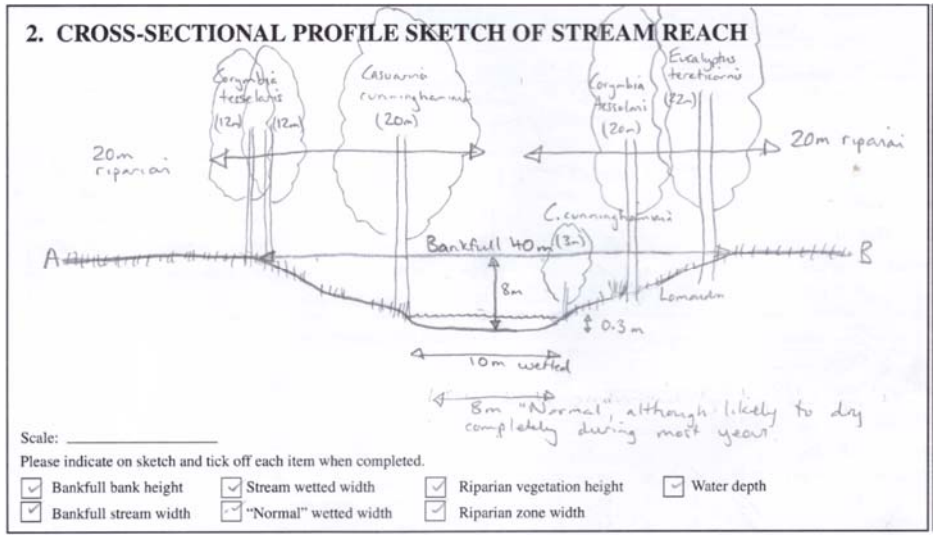
Physico-chemical water quality

Collection time: 11:20 EST; water temp.: 17.8 °C; conductivity: 375 µS/cm (fresh); turbidity: 14.9 (high clarity); dissolved oxygen: 86.5%, 8.2 mg/L; pH 7.5 (mildly alkaline). Summary: Normal.

Bioassessment scores

Habitat assessment scores for 2017 late wet season: Low (40); AusRivAS taxonomic richness: 19 (bed), 29 (edge); PET richness: 3 (bed), 5 (edge); SIGNAL 2 score: 3.82 (bed), 3.78 (edge); tolerant taxa: 35% (bed), 44% (edge); AusRivAS OE50 score: 1.14 (Band A – bed); 1.21 (Band X – edge).

Overall aquatic values – Late wet season: **Moderate** (Priority flora species); Early wet season: See previous site profile.



Season: Early wet

Site Code: R31 **Location:** Unnamed tributary of North Ck, Moorvale **Stream order:** 1 **Latitude:** -21.9899 **Longitude:** 148.2904 **Date:** 8/10/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral first order drainage line; dry at the time of assessment; poorly defined bed and banks, although channelisation occurring; moderate local catchment erosion; bankfull width was approx. 5 m and bankfull height 1.5 m; lacking in-stream habitat features; clay banks; bed substrates comprised 95% sand (0.05-2 mm) and 5% silt/clay (<0.05 mm); upstream and adjacent landuse includes moderate cattle grazing on cleared land.

Riparian vegetation

Non-remnant vegetation. Sparse regrowth (6-7 m tall) dominated by brigalow (*Acacia harpophylla*) and yellowwood (*Terminalia oblongata*). Very sparse shrub layer including false sandalwood (*Eremophila mitchellii*) and currant bush (*Carissa ovata*). Ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent Indian couch (*Bothriochloa pertusa*)* and *Sida* sp. No macrophytes detected.

Erosion risk

Moderate to high – Banks appeared to be unstable, with bank slumping occurring. Banks with over 80% of streambank surfaces covered by vegetation or tree roots. Heavier grazing in harder times would reduce vegetative cover and bank stability, leading to a high erosion risk.

Aquatic fauna, including breeding habitat

Aquatic fauna not sampled. The reach is expected to convey stormwater runoff for very short duration following rainfall and runoff in the catchment, and is unlikely to provide foraging or breeding habitat for fish, turtles or platypus.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species.

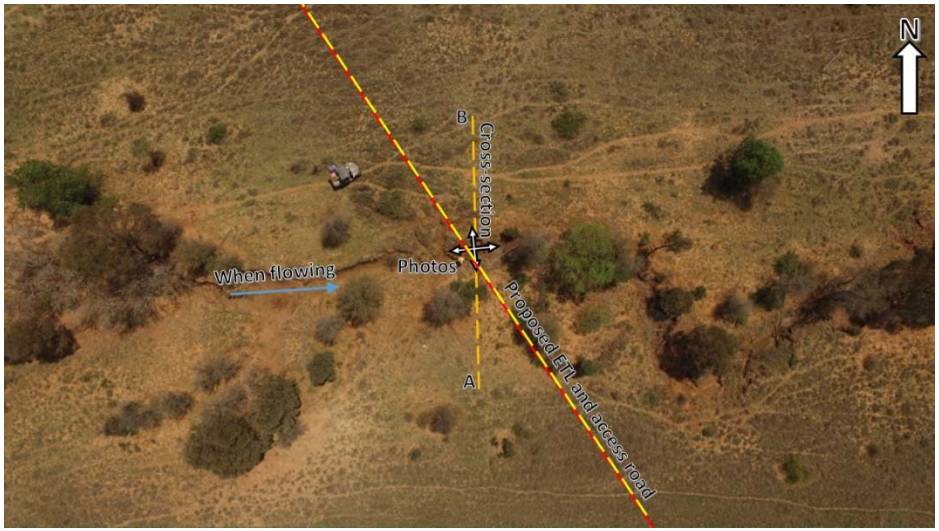
Physico-chemical water quality

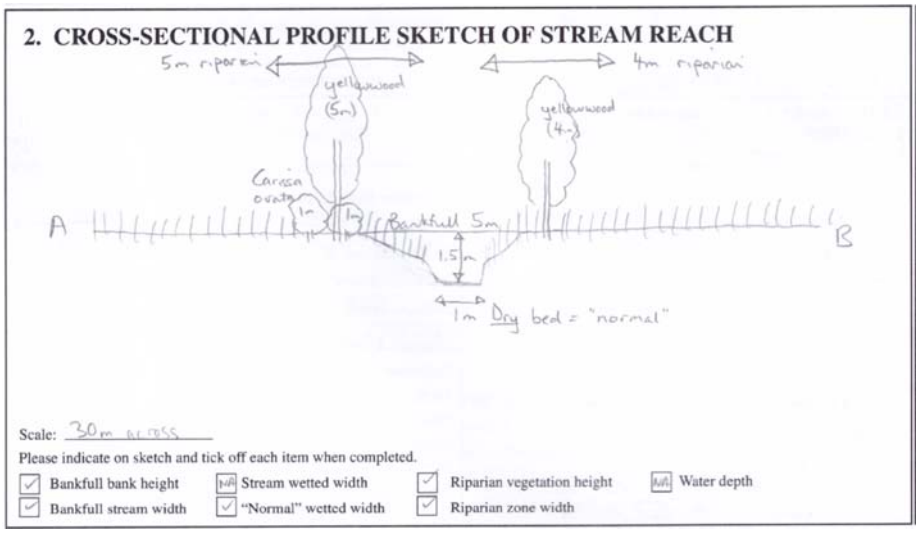
Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for early wet season: Poor (36)

Overall aquatic values – Early wet season: **Low**; Late wet season: See following site profile.





Season: Late wet

Site Code: R31 **Location:** Unnamed tributary of North Ck, Moorvale **Stream order:** 1 **Latitude:** -21.9899 **Longitude:** 148.2904 **Date:** 28/06/2016


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral first order drainage line; dry at the time of assessment; poorly defined bed and banks, although channelisation occurring; moderate local catchment erosion; bankfull width was approx. 5 m and bankfull height 1.5 m; lacking in-stream habitat features; clay banks; bed substrates comprised 95% sand (0.05-2 mm) and 5% silt/clay (<0.05 mm); upstream and adjacent landuse includes moderate cattle grazing on cleared land.

Riparian vegetation

Non-remnant vegetation. Sparse regrowth (6-7 m tall) dominated by brigalow (*Acacia harpophylla*) and yellowwood (*Terminalia oblongata*). Very sparse shrub layer including false sandalwood (*Eremophila mitchellii*) and currant bush (*Carissa ovata*). Ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent Indian couch (*Bothriochloa pertusa*)* and *Sida* sp. No macrophytes detected.

Erosion risk

Moderate to high – Banks appeared to be unstable, with bank slumping occurring. Banks with over 80% of streambank surfaces covered by vegetation or tree roots. Heavier grazing in harder times would reduce vegetative cover and bank stability, leading to a high erosion risk.

Aquatic fauna, including breeding habitat

Aquatic fauna not sampled. The reach is expected to convey stormwater runoff for very short duration following rainfall and runoff in the catchment, and is unlikely to provide foraging or breeding habitat for fish, turtles or platypus.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species.

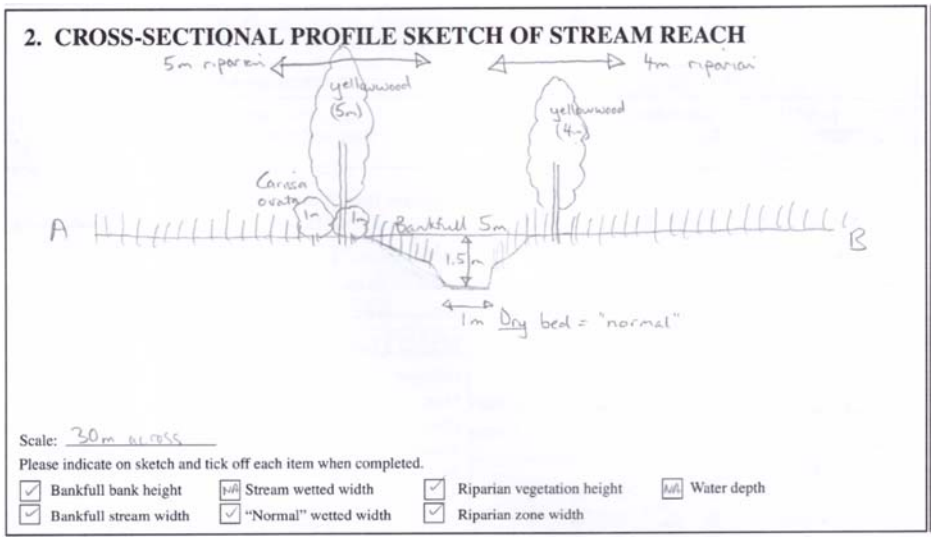
Physico-chemical water quality

Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for 2017 late wet season: Fair (40)

Overall aquatic values – Late wet season: **Low**; Early wet season: See previous site profile.



Season: Early wet

Site Code: R32 **Location:** Unnamed tributary of North Ck, Moorvale **Stream order:** 3 **Latitude:** -21.9882 **Longitude:** 148.2889 **Date:** 8/10/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral third order drainage line; dry at the time of assessment; well defined bed and banks; little local catchment erosion, but extensive deposition of sand from the broader catchment; bankfull width was approx. 17 m and bankfull height 3 m; natural in-stream habitat features likely buried by deposited sand; sand and light clay banks; bed substrates comprised 90% sand (0.05-2 mm) and 10% silt/clay (<0.05 mm); upstream landuse includes coal mining and moderate cattle grazing on predominantly cleared land; adjacent landuse includes moderate cattle grazing on a mix of cleared land (beyond right bank) and remnant vegetation (beyond left bank).

Riparian vegetation

Study reach positioned within approximately 50 m wide corridor of RE 11.3.25, adjoining RE 11.5.3 on the left bank. Woodland with sparse canopy dominated by forest red gum (*Eucalyptus tereticornis*), with occasional poplar box (*E. populnea*). Sparse sub-canopy dominated by brigalow (*Acacia harpophylla*), yellowwood (*Terminalia oblongata*) and white bauhinia (*Lysiphyllum hookeri*). Very sparse shrub layer containing cocaine tree (*Erythroxylum australe*) and currant bush (*Carissa ovata*). Ground layer dominated by green panic (*Megathyrsus maximus*)*, with frequent Indian couch (*Bothriochloa pertusa*)* and occasional spiny-headed mat-rush (*Lomandra longifolia*), black speargrass (*Heteropogon contortus*), kangaroo grass (*Themeda triandra*), red Natal grass (Melinis repens)*, wombat berry (*Eustrephus latifolius*), golden beard grass (*Chrysopogon fallax*) and *Stylo* sp. The only macrophytes detected were the occasional spiny-headed mat-rush (*L. longifolia*) and tall flatsedge (*Cyperus exaltatus*).

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach may provide marginal habitat for fish in times of flow. No suitable turtle or platypus breeding habitat detected.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

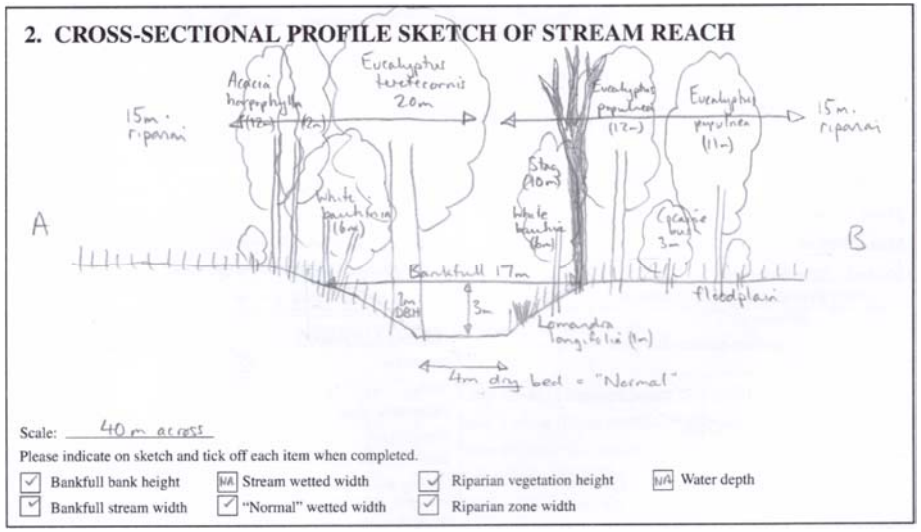
Physico-chemical water quality

Not sampled. Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for early wet season: Poor (33).

Overall aquatic values – Early wet season: **Low** (heavy sand deposition; Priority flora species not a dominant feature). Late wet season: See following site profile.



Season: Late wet

Site Code: R32 **Location:** Unnamed tributary of North Ck, Moorvale **Stream order:** 3 **Latitude:** -21.9882 **Longitude:** 148.2889 **Date:** 28/06/2016


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral third order drainage line; dry at the time of assessment; well defined bed and banks; little local catchment erosion, but extensive deposition of sand from the broader catchment; bankfull width was approx. 17 m and bankfull height 3 m; natural in-stream habitat features likely buried by deposited sand; sand and light clay banks; bed substrates comprised 90% sand (0.05-2 mm) and 10% silt/clay (<0.05 mm); upstream landuse includes coal mining and moderate cattle grazing on predominantly cleared land; adjacent landuse includes moderate cattle grazing on a mix of cleared land (beyond right bank) and remnant vegetation (beyond left bank).

Riparian vegetation

Study reach positioned within approximately 50 m wide corridor of RE 11.3.25, adjoining RE 11.5.3 on the left bank. Woodland with sparse canopy dominated by forest red gum (*Eucalyptus tereticornis*), with occasional poplar box (*E. populnea*). Sparse sub-canopy dominated by brigalow (*Acacia harpophylla*), yellowwood (*Terminalia oblongata*) and white bauhinia (*Lysiphyllum hookeri*). Very sparse shrub layer containing cocaine tree (*Erythroxylum australe*) and currant bush (*Carissa ovata*). Ground layer dominated by green panic (*Megathyrsus maximus*)*, with frequent Indian couch (*Bothriochloa pertusa*)* and occasional spiny-headed mat-rush (*Lomandra longifolia*), black speargrass (*Heteropogon contortus*), kangaroo grass (*Themeda triandra*), red Natal grass (Melinis repens)*, wombat berry (*Eustrephus latifolius*), golden beard grass (*Chrysopogon fallax*) and *Stylo* sp. The only macrophytes detected were the occasional spiny-headed mat-rush (*L. longifolia*) and tall flatsedge (*Cyperus exaltatus*).

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach may provide marginal habitat for fish in times of flow. No suitable turtle or platypus breeding habitat detected.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

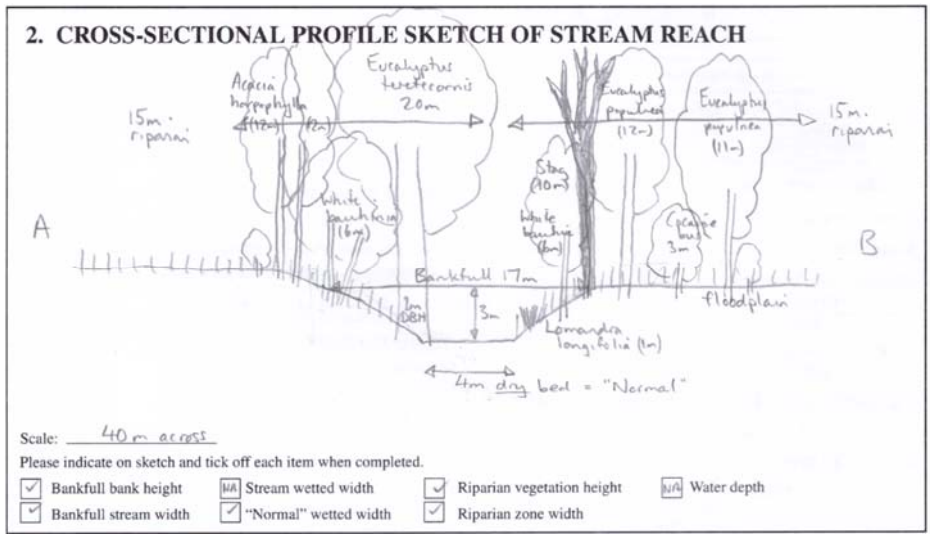
Physico-chemical water quality

Not sampled. Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for late wet season: Poor (33)

Overall aquatic values – Late wet season: **Low** (heavy sand deposition; Priority flora species not a dominant feature); Early wet season: See previous site profile.



Season: Early wet

Site Code: R33 **Location:** Unnamed tributary of North Ck, Moorvale **Stream order:** 2 **Latitude:** -21.9882 **Longitude:** 148.2889 **Date:** 8/10/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral second order stream; dry at the time of assessment; some local catchment erosion; bankfull width was approx. 15 m and bankfull height 2 m; lacking in-stream habitat features; sand and light clay banks; bed substrates comprised 5% bedrock, 5% boulder (>256 mm), 5% cobble (64-256 mm), 5% pebble (4-64 mm), 5% gravel (2-4 mm) and 75% sand (0.05-2 mm); reach falls within a 132 kV electricity transmission line easement; adjacent landuse includes moderate cattle grazing on cleared land; upstream landuse includes coal seam gas extraction infrastructure and moderate cattle grazing on a mix of cleared land and remnant vegetation

Riparian vegetation

Non-remnant vegetation. Very sparse regrowth of Clarkson's bloodwood (*Corymbia clarksoniana*), carbeen (*C. tessellaris*), brigalow (*Acacia harpophylla*), sally wattle (*A. salicina*), quinine tree (*Petalostigma pubescens*) and sandalwood (*Santalum lanceolatum*). Very sparse shrub layer, including currant bush (*Carissa ovata*) and dysentery plant (*Grewia latifolia*). Ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent Indian couch (*Bothriochloa pertusa*)* and occasional spear grass (*Aristida* sp.), red Natal grass (*Melinis repens*)*, kangaroo grass (*Themeda triandra*), golden beard grass (*Chrysopogon fallax*), black spear grass (*Heteropogon contortus*) and shrubby stylo (*Stylosanthes scabra*). The only macrophytes detected were the occasional spiny-headed mat-rush (*L. longifolia*) and tall flatsedge (*Cyperus exaltatus*).

Erosion risk

Low – Banks appeared to be moderately stable, and with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

Aquatic fauna not sampled. The reach is expected to convey stormwater runoff for very short duration following rainfall and runoff in the catchment, and is unlikely to provide foraging or breeding habitat for fish, turtles or platypus.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

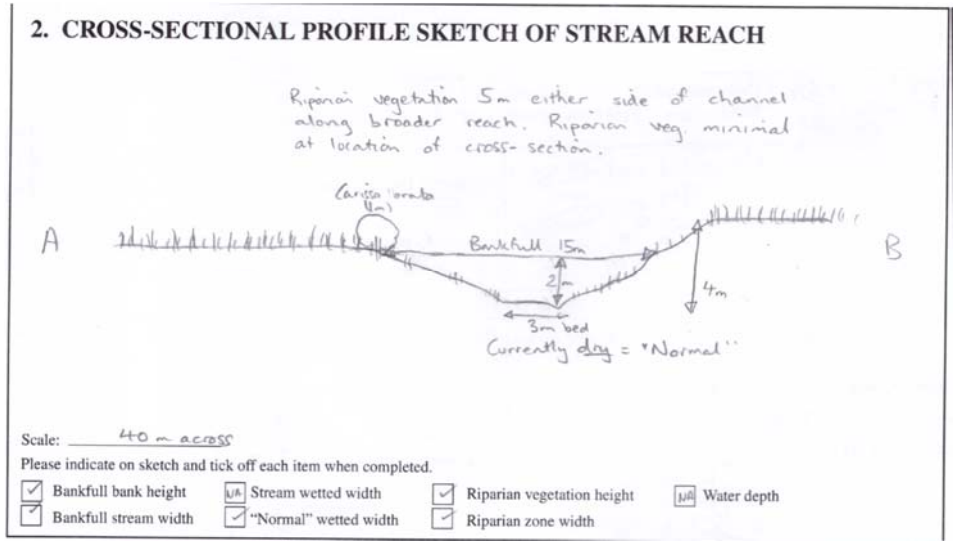
Physico-chemical water quality

Not sampled. Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for early wet season: Poor (35)

Overall aquatic values – Early wet season: **Low** (Priority flora species not a dominant feature); Late wet season: See following site profile.



Season: Late wet

Site Code: R33 **Location:** Unnamed tributary of North Ck, Moorvale **Stream order:** 2 **Latitude:** -21.9882 **Longitude:** 148.2889 **Date:** 28/06/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral second order stream; dry at the time of assessment; some local catchment erosion; bankfull width was approx. 15 m and bankfull height 2 m; lacking in-stream habitat features; sand and light clay banks; bed substrates comprised 5% bedrock, 5% boulder (>256 mm), 5% cobble (64-256 mm), 5% pebble (4-64 mm), 5% gravel (2-4 mm) and 75% sand (0.05-2 mm); reach falls within a 132 kV electricity transmission line easement; adjacent landuse includes moderate cattle grazing on cleared land; upstream landuse includes coal seam gas extraction infrastructure and moderate cattle grazing on a mix of cleared land and remnant vegetation

Riparian vegetation

Non-remnant vegetation. Very sparse regrowth of Clarkson's bloodwood (*Corymbia clarksoniana*), carbeen (*C. tessellaris*), brigalow (*Acacia harpophylla*), sally wattle (*A. salicina*), quinine tree (*Petalostigma pubescens*) and sandalwood (*Santalum lanceolatum*). Very sparse shrub layer, including currant bush (*Carissa ovata*) and dysentery plant (*Grewia latifolia*). Ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent Indian couch (*Bothriochloa pertusa*)* and occasional spear grass (*Aristida* sp.), red Natal grass (*Melinis repens*)*, kangaroo grass (*Themeda triandra*), golden beard grass (*Chrysopogon fallax*), black spear grass (*Heteropogon contortus*) and shrubby stylo (*Stylosanthes scabra*). The only macrophytes detected were the occasional spiny-headed mat-rush (*L. longifolia*) and tall flatsedge (*Cyperus exaltatus*).

Erosion risk

Low – Banks appeared to be moderately stable, and with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

Aquatic fauna not sampled. The reach is expected to convey stormwater runoff for very short duration following rainfall and runoff in the catchment, and is unlikely to provide foraging or breeding habitat for fish, turtles or platypus.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

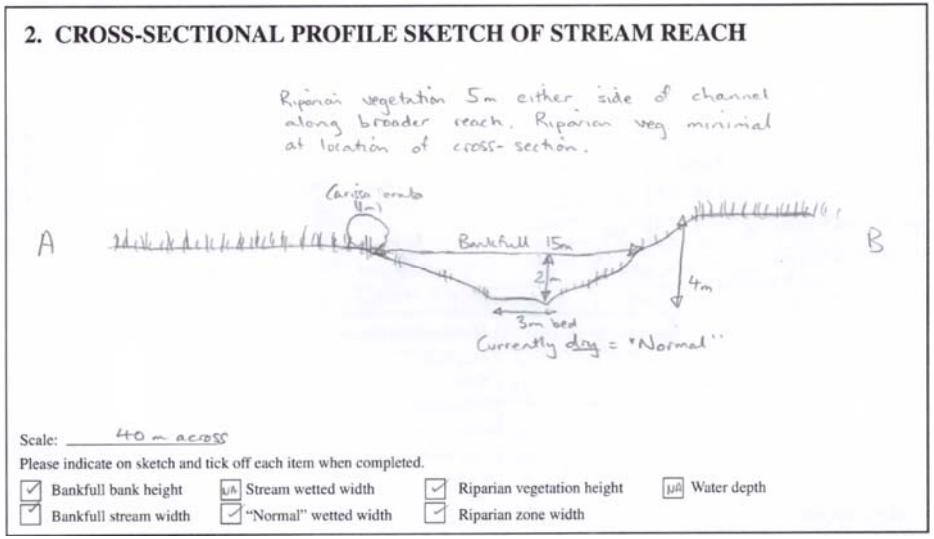
Physico-chemical water quality

Not sampled. Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for late wet season: Poor (35)

Overall aquatic values – Late wet season: **Low** (Priority flora species not a dominant feature); Early wet season: See previous site profile.



Season: Early wet

Site Code: R34 **Location:** Unnamed tributary of North Ck, Moorvale **Stream order:** 1 **Latitude:** -21.9863 **Longitude:** 148.2759 **Date:** 8/10/2017

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Ephemeral first order stream; dry at the time of assessment; little local catchment erosion; bankfull width was approx. 6 m and bankfull height 2 m; lacking in-stream habitat features; sand and light clay banks; bed substrates comprised 5% boulder (>256 mm), 5% cobble (64-256 mm), 5% pebble (4-64 mm), 10% gravel (2-4 mm) and 75% sand (0.05-2 mm); reach falls within a 132 kV electricity transmission line easement; adjacent landuse includes moderate cattle grazing on cleared land; upstream landuse includes coal seam gas extraction infrastructure and moderate cattle grazing on a mix of cleared land and remnant vegetation

Riparian vegetation

Non-remnant vegetation. No trees detected within 100 m reach. Very sparse shrub layer including white bauhinia (*Lysiphyllum hookeri*), sesbania pea (*Sesbania cannabina*) and brigalow (*Acacia harpophylla*) suckers. Ground layer dominated by Indian couch (*Bothriochloa pertusa*)*, with frequent buffel grass (*Cenchrus ciliaris*)* and black spear grass (*Heteropogon contortus*), occasional red Natal grass (*Melinis repens*)*, shrubby stylo (*Stylosanthes scabra*), *Chloris* sp., common couch (*Cynodon dactylon*) and sabi grass (*Urochloa mosambicensis*)*. The only macrophytes detected were the occasional tall flatsedge (*Cyperus exaltatus*) and white eclipta (*Eclipta prostrata*)*.

Erosion risk

Low – Banks appeared to be moderately stable, and with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

Aquatic fauna not sampled. The reach is expected to convey stormwater runoff for very short duration following rainfall and runoff in the catchment, and is unlikely to provide foraging or breeding habitat for fish, turtles or platypus.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

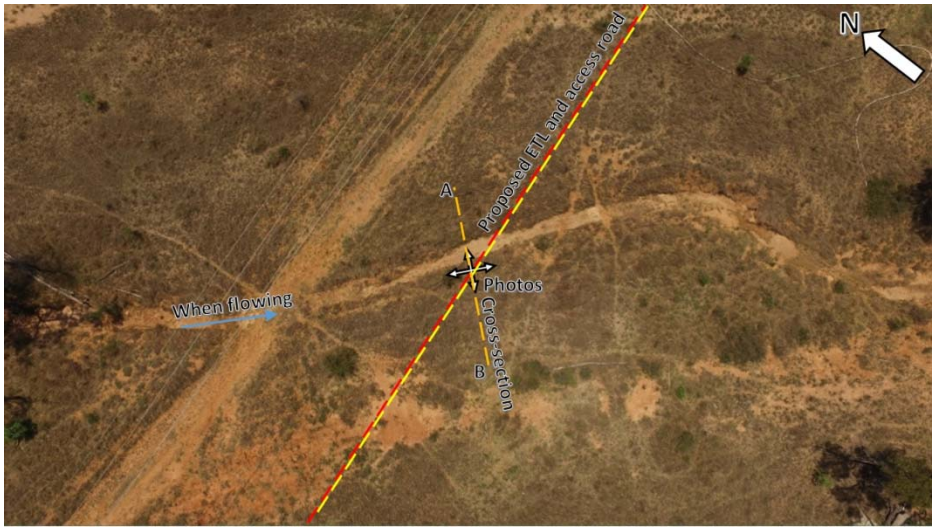
Physico-chemical water quality

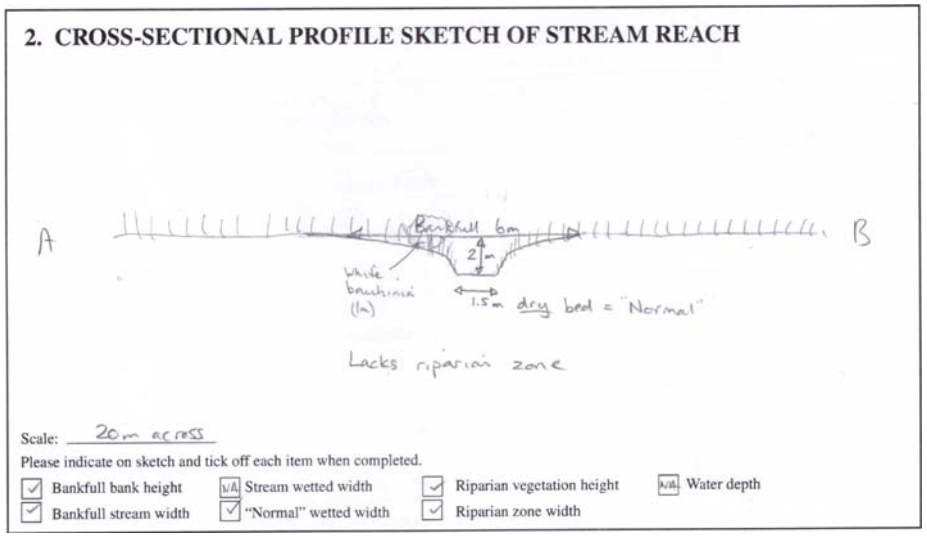
Not sampled. Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for early wet season: Poor (34)

Overall aquatic values – Early wet season: **Low** (Priority flora species not a dominant feature); Late wet season: See following site profile.





Season: Late wet

Site Code: R34 **Location:** Unnamed tributary of North Ck, Moorvale **Stream order:** 1 **Latitude:** -21.9863 **Longitude:** 148.2759 **Date:** 28/06/2016

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Ephemeral first order stream; dry at the time of assessment; little local catchment erosion; bankfull width was approx. 6 m and bankfull height 2 m; lacking in-stream habitat features; sand and light clay banks; bed substrates comprised 5% boulder (>256 mm), 5% cobble (64-256 mm), 5% pebble (4-64 mm), 10% gravel (2-4 mm) and 75% sand (0.05-2 mm); reach falls within a 132 kV electricity transmission line easement; adjacent landuse includes moderate cattle grazing on cleared land; upstream landuse includes coal seam gas extraction infrastructure and moderate cattle grazing on a mix of cleared land and remnant vegetation

Riparian vegetation

Non-remnant vegetation. No trees detected within 100 m reach. Very sparse shrub layer including white bauhinia (*Lysiphyllum hookeri*), sesbania pea (*Sesbania cannabina*) and brigalow (*Acacia harpophylla*) suckers. Ground layer dominated by Indian couch (*Bothriochloa pertusa*)*, with frequent buffel grass (*Cenchrus ciliaris*)* and black spear grass (*Heteropogon contortus*), occasional red Natal grass (*Melinis repens*)*, shrubby stylo (*Stylosanthes scabra*), *Chloris* sp., common couch (*Cynodon dactylon*) and sabi grass (*Urochloa mosambicensis*)*. The only macrophytes detected were the occasional tall flatsedge (*Cyperus exaltatus*) and white eclipta (*Eclipta prostrata*)*.

Erosion risk

Low – Banks appeared to be moderately stable, and with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

Aquatic fauna not sampled. The reach is expected to convey stormwater runoff for very short duration following rainfall and runoff in the catchment, and is unlikely to provide foraging or breeding habitat for fish, turtles or platypus.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

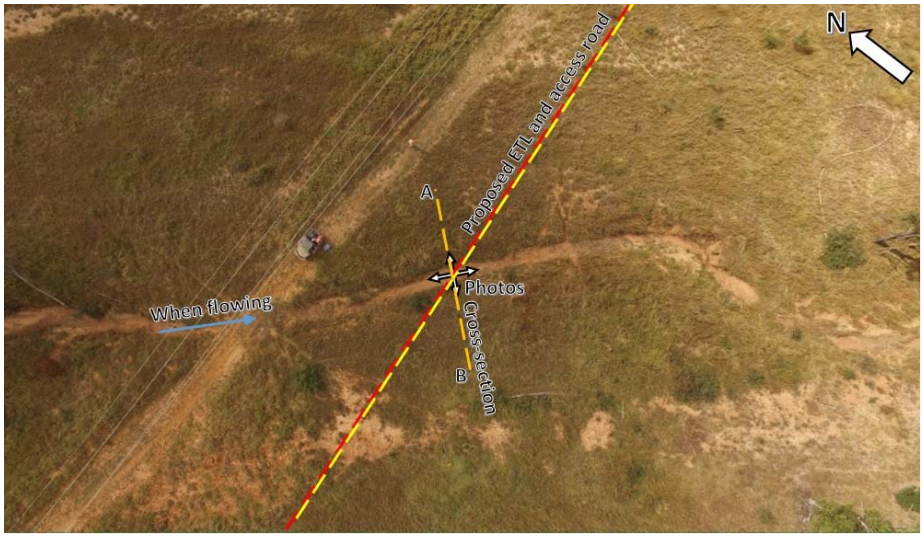
Physico-chemical water quality

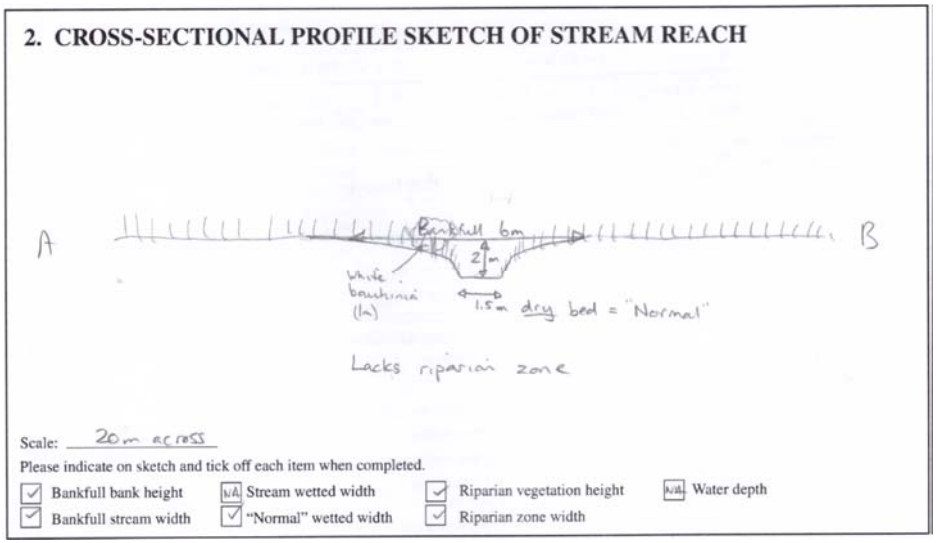
Not sampled. Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for late wet season: Poor (34)

Overall aquatic values – Late wet season: **Low** (Priority flora species not a dominant feature); Early wet season: See previous site profile.





Season: Early wet

Site Code: R35 **Location:** Unnamed tributary of Isaac Rv, Winchester Downs **Stream order:** 2 **Latitude:** -21.1249 **Longitude:** 148.2731 **Date:** 5/10/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral second order drainage line; a shallow isolated pool (<0.1m) at time of assessment, with no discernible flow, well defined bed and banks; some local catchment erosion, moderate deposition of sands (0.05-2 mm) and a minor deposition of silt / clays (<0.05mm); bed substrates variable comprised of 5% boulders (>256 mm), 20% gravel (2-4mm), 70% sands and 5% silt / clays, bankfull width was approx. 80 m and bankfull height 3 m; upstream landuse includes coal mining and moderate cattle grazing on predominantly cleared land.

Riparian vegetation

Study reached positioned within poplar box (*Eucalyptus populnea*) woodland. Riparian zone width approximately 100m consisting of a sparse canopy dominated by coolabah (*Eucalyptus coolabah*) and frequently occurring Dallachy's gum (*Corymbia dallachiana*). Sparse sub-canopy dominated by brigalow (*Acacia harpophylla*), yellowwood (*Terminalia oblongata*) and frequent white bauhinia (*Lysiphyllum hookeri*). Ground layer dominated by green panic (*Megathyrsus maximus*)* and buffel grass (*Cenchrus ciliaris*)* wit frequently occurring sabi grass (*Urochloa mosambicensis*)*, black speargrass (*Heteropogon contortus*), paddy's lucerne (*Sida rhombifolia*)*, forest bluegrass (*Bothriochloa bladhii*), parthenium (*Parthenium hysterophorus*)*, *Cyperus* sp. and umbrella canegrass (*Leptochloa digitata*). Macrophytes included occasional tall flat sedge (*Cyperus exaltatus*) and umbrella canegrass.

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach may provide marginal foraging habitat for fish in times of flow. No suitable turtle or platypus breeding or foraging habitat detected. Aquatic fauna not sampled due to lack of suitable waterbody.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flat sedge (*C. exaltatus*).

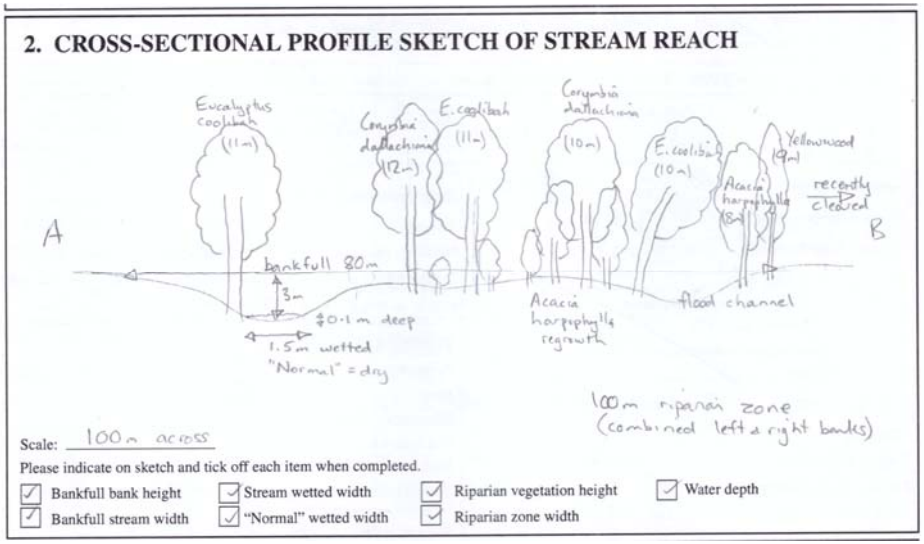
Physico-chemical water quality

Collection time: 07:50EST; water temp.: 23.4 °C; conductivity: 77 µS/cm (fresh); turbidity: 56.5 (moderate clarity); dissolved oxygen: 36.4%, 3.1 mg/L (low); pH 7.0 (neutral). Summary: Normal (diurnal range in DO expected to be variable, with lowest levels expected within the early morning).

Bioassessment scores

Habitat assessment score for early wet season: Fair (55).

Overall aquatic values – Early wet season: **Low** (Priority flora species only the common *C. exaltatus*); Late wet season: Expected to be **Low**.



Season: Early wet

Site Code: R36 **Location:** Unnamed tributary of the Isaac R., Wynette **Stream order:** 2 **Latitude:** -21.1592 **Longitude:** 148.3118 **Date:** 5/10/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral second order drainage line; dry at the time of assessment; with poorly defined bed and banks; some local catchment erosion with moderate deposition of sands within channel; bankfull width was approx. 35 m and bankfull height 1.5 m; in-stream habitat features large woody debris; bed substrates along the 100 m reach comprised approx. 5% gravel (2-4mm),90% sand (0.05-2 mm) and 5% silt/clay (<0.05 mm); upstream landuse includes coal seam gas extraction infrastructure and moderate cattle grazing on predominantly cleared land; adjacent landuse includes moderate cattle grazing on cleared land.

Riparian vegetation

Study reach positioned within approximately 40 m wide riparian corridor of RE 11.4.9. Woodland with sparse upper canopy of coolabah (*Eucalyptus coolabah*) or Dawson gum (*Eucalyptus cambageana*). A sub-canopy dominated by brigalow (*Acacia harpophylla*), with frequently occurring white bauhinia (*Lysiphyllum hookeri*) and occasional yellowwood (*Terminalia oblongata*). Very sparse shrub layer containing native lime (*Citrus glauca*), scrub boonaree (*Alectryon diversifolius*) and yellowwood. Ground layer dominated by buffel grass (*Cenchrus ciliaris*)* with frequently occurring umbrella canegrass (*Leptochloa digitata*), parthenium (*Parthenium hysterophorus*)*, crumbweed, and occasional *Cyperus concinnus* ad musk basil (*Basilicum polystachion*). Macrophytes included frequent umbrella canegrass and *C. concinnus.*

Erosion risk

Low-moderate – banks appeared to be moderately stable, with 50-79% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach may provide marginal foraging habitat for fish in times of flow. No suitable turtle or platypus breeding habitat detected. Aquatic fauna not sampled due to scarcity of water.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species.

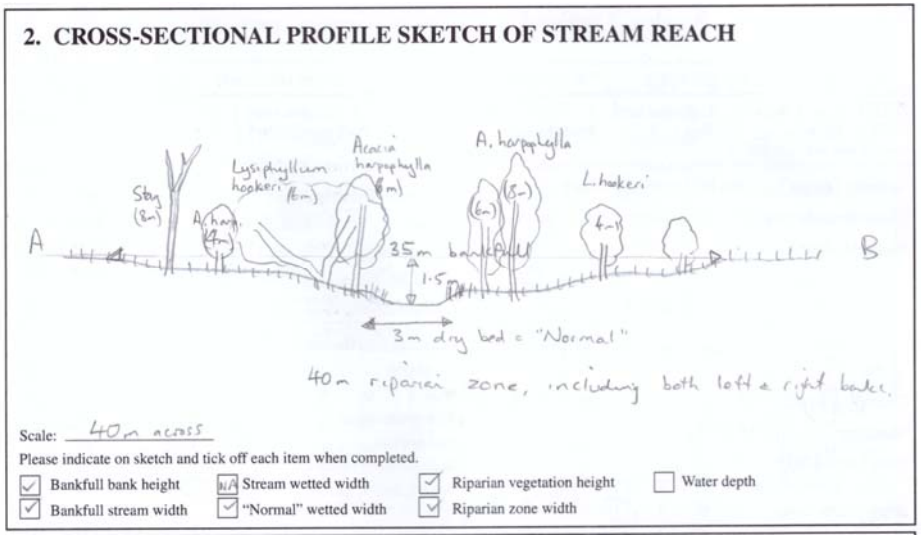
Physico-chemical water quality

Not sampled. Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for early wet season: Fair (48).

Overall aquatic values – Early wet season: **Low** (heavy sand deposition; No Priority flora species detected). Late wet season: Expected to be **Low**.



Season: Early wet

Site Code: R38 **Location:** Cherwell Ck, **Stream order:** 5 **Latitude:** -21.1216 **Longitude:** 148.1738 **Date:** 14/11/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral fifth order watercourse (Cherwell Creek); dry with no discernible surface flow at the time of assessment; well defined bed and banks; some local catchment erosion; heavy deposition of sands within channel from upstream erosion; bankfull width approx.100 m and bankfull height 10 m; no notable in-stream habitat features; bed substrates along the 100 m reach comprised of approx.. 5% gravel (2-4mm) and 95% sands (0.05-2mm); upstream landuse includes coal mining (Peak Downs) and moderate cattle grazing on predominantly cleared lands, adjacent landuse include moderate cattle grazing on cleared land.

Riparian vegetation

Study reach positioned within RE 11.3.25. Riparian zone approximately 30m on the right bank and 20m on the left, dominated by forest red gum (*Eucalyptus tereticornis*) and river she-oak (*Casuarina cunninghamiana*) with occasional weeping tea-tree (*Melaleuca fluviatilis*) and carbeen (*Corymbia tessellaris*). On the lower banks the sub-canopy is dominated by black tea-tree (*Melaleuca bracteata*), with frequent river she-oak (*Casuarina cunninghamiana*) and white bauhinia (*Lysiphyllum hookeri*). Shrubs absent, with ground cover dominated by green panic (*Megathyrsus maximus*)*, buffel grass (*Cenchrus ciliaris*)*, sabi grass (*Urochloa mosambicensis*)* and frequently occurring parthenium (*Parthenium hysterophorus*)*, red Natal grass (*Melinis repens*)*, Paddy's lucerne (*Sida rhombifolia*), lesser joyweed (*Alternanthera denticulata*), common couch (*Cynodon dactylon*), and dominant forest bluegrass (*Bothriochloa bladhii*) on the lower bank. Macrophytes present included tall flatsedge (*Cyperus exaltatus*), bunchy sedge (*Cyperus polystachyos*), common rush (*Juncus usitatus*), spiny-headed mat-rush (*Lomandra longifolia*) and slender knotweed (*Persicaria decipiens*).

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach may provide marginal habitat for fish in times of flow. No suitable turtle or platypus breeding habitat detected.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

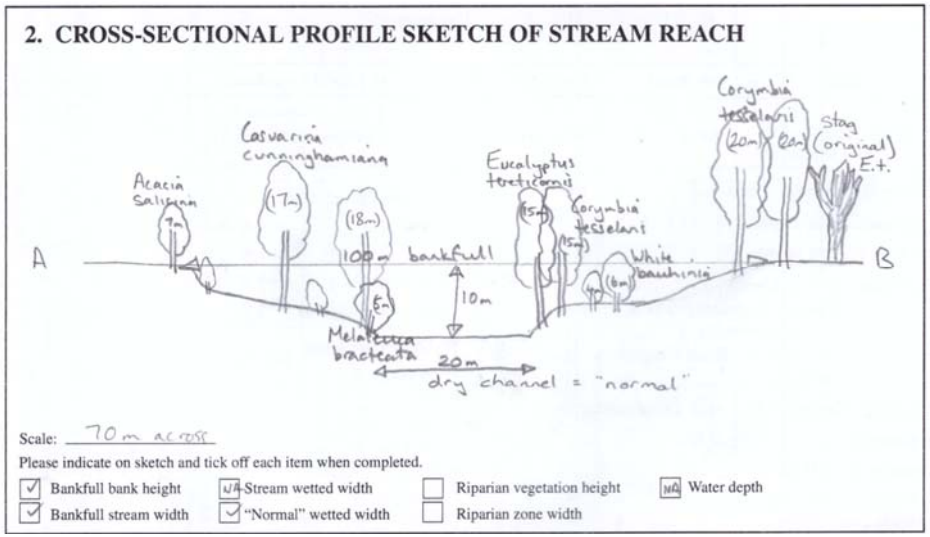
Physico-chemical water quality

Not sampled. Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for early wet season: Poor (38).

Overall aquatic values – Early wet season: **Moderate** (Priority flora species present); Late wet season: Expected to be **Moderate**.



Season: Early wet

Site Code: R39 **Location:** Unnamed tributary of Cherwell Ck **Stream order:** 2 **Latitude:** -21.1178 **Longitude:** 148.1931 **Date:** 15/11/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral second order drainage line; dry at the time of assessment; well defined bed and banks; little local catchment erosion; minor deposition of sands and silts; bankfull width was approx. 30 m and bankfull height approx. 5 m; in- stream habitat in times of flow would include large woody debris, undercut banks and fringing macrophytes; bed substrates comprised 2% pebble ((4-64mm), 10% gravel (2-4 mm), 10% sand (0.05-2 mm) and 78% silt/clay (<0.05 mm). upstream landuse includes coal mining (Peak Downs) and moderate cattle grazing on predominantly cleared lands, adjacent landuse includes moderate cattle grazing on remnant vegetation.

Riparian vegetation

Study reach positioned within RE 11.3.25. Riparian zone approximately 30m on the right bank and 20m on the left, dominated by forest red gum (*Eucalyptus tereticornis*) and occasional carbeen (*Corymbia tessellaris*). A sub-canopy dominated white bauhinia (*Lysiphyllum hookeri*), and frequent occurance of black tea-tree (M*elaleuca bracteata*) and sally wattle (*Acacia salicina*). *A* shrub layer containing frequent currant bush (*Carissa ovata*), with ocassional sandpaper fig (*Ficus opposita*) and *Acacia* sp. Ground layer dominated buffel grass (*Cenchrus ciliaris*)*, Indian couch (*Bothriochloa pertusa*)*, green panic (*Megathyrsus maximus*)* with frequently occurring sabi grass (*Urochloa mosambicensis*)*, parthenium (*Parthenium hysterophorus*)*, common couch (*Cynodon dactylon*). The only macrophyte detected was spiny-headed mat-rush (*Lomandra longifolia*).

Erosion risk

Low – banks appeared to be moderately stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach may provide marginal habitat for fish in times of flow. No suitable turtle or platypus breeding habitat detected.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species.

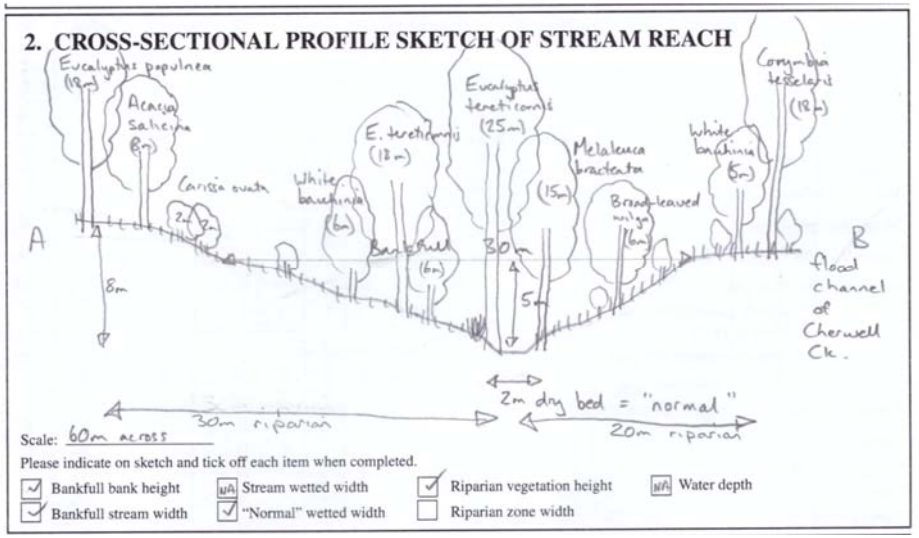
Physico-chemical water quality

Not sampled. Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for early wet season: Fair (49).

Overall aquatic values – Early wet season: **Low** (No Priority flora species detected). Late wet season: Expected to be **Low**.



Season: Early wet

Site Code: R40 **Location:** Unnamed tributary of Isaac Rv **Stream order:** 1 **Latitude:** -21.1686 **Longitude:** 148.3905 **Date:** 18/11/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral first order drainage line; dry at the time of assessment with an isolated, senescing pool; poorly defined bed and banks; some local catchment erosion and deposition of sands in-stream; bankfull width was approx. 20 m and bankfull height 2 m; lacking in-stream habitat features; clay banks; bed substrates comprised 30% sand (0.05-2 mm) and 70% silt/clay (<0.05 mm); upstream and adjoining landuse includes moderate cattle grazing on partially cleared land.

Riparian vegetation

Non-remnant vegetation. Riparian zone approximately 15 m wide on both banks. Woodland with sparse canopy dominated by brigalow (*Acacia harpophylla*),also occasional coolabah (*Eucalyptus coolabah)* and yellowwood (*Terminalia oblongata*). Sparse sub-canopy dominated by frequent white bauhinia (*Lysiphyllum hookeri*), occasional snow-in-summer (*Melaleuca linariifolia*) and black tea-tree (*melaleuca bracteata*). Sparse shrub layer including white bauhinia (*Lysiphyllum hookeri*), red bauhinia (*Lysiphyllum carronii*), and whitewood (*Atalaya hemiglauca*). Ground layer dominated by common couch (*Cynodon dactylon*), and buffel grass (*Cenchrus ciliaris*)*, with occasional green panic (*Megathyrsus maximus*) and umbrella canegrass (*Leptochloa digitata*). Macrophytes included tall flatsedge (*Cyperus exaltatus*), common rush (*Juncus usitatus*), umbrella canegrass and smartweed (*Persicaria attenuata*).

Erosion risk

Low – banks appeared to be moderately stable, with 50-79% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

No suitable turtle or platypus breeding habitat detected.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

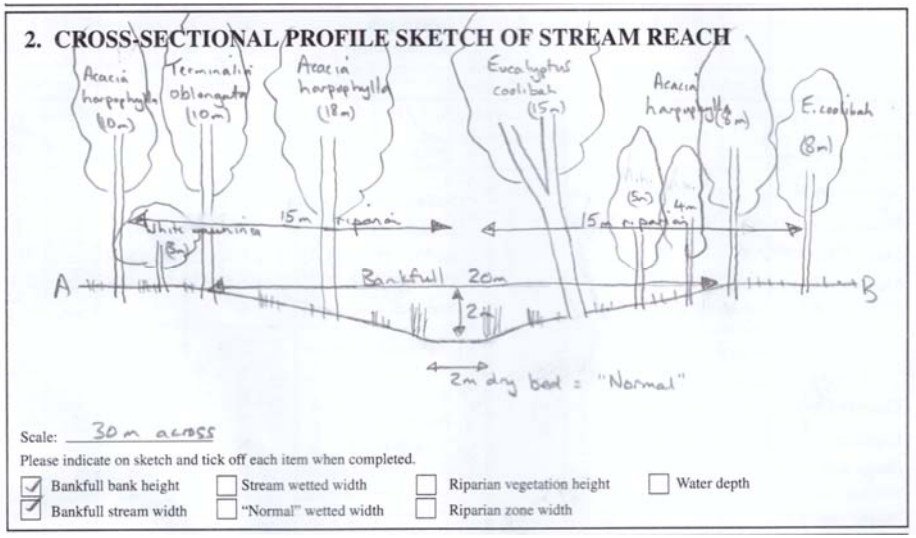
Physico-chemical water quality

Not sampled. Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for early wet season: Fair (47).

Overall aquatic values – Early wet season: **Low** (Priority flora species unlikely to be utilised by aquatic fauna); Late wet season: Expected to be **Low**.



Season: Early wet

Site Code: R41 **Location:** Unnamed tributary of Isaac Rv **Stream order:** 1 **Latitude:** -21.1599 **Longitude:** 148.3905 **Date:** 18/11/2017


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral first order drainage line; dry at the time of assessment; poorly defined bed and banks; little local catchment erosion and sediment deposition in-stream; bankfull width was approx. 13 m and bankfull height 1 m; substrates comprised 100% silt/clay (<0.05 mm) in the bed and edge habitats; extensive emergent macrophytes along banks otherwise lacking in-stream habitat features; upstream and adjoining landuse includes moderate cattle grazing on partially cleared land.

Riparian vegetation

Non-remnant vegetation. Riparian zone approximately 15 meters wide comprising a very sparse canopy of coolabah (*Eucalyptus coolabah*) and brigalow (*Acacia harpophylla*). No shrubs identified, though a dense ground cover dominated by tall flatsedge (*Cyperus exaltatus*), umbrella canegrass (*Leptochloa digitata*), and occasional common couch (*Cynodon dactylon*). Macrophytes include rice sedge (*Cyperus difformis*), tall flatsedge, awnless barnyard grass (*Echinochloa colona*), umbrella canegrass, slender knotweed (*Persicaria decipiens*), prince's feathers (*Persicaria orientalis*) and small knotweed (*Polygonum plebeium*).

Erosion risk

Low – banks appeared to be stable, with over 80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach unlikely to provide marginal habitat for fish in times of flow. No suitable turtle or platypus breeding habitat detected.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The study reach is unlikely to provide suitable habitat for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

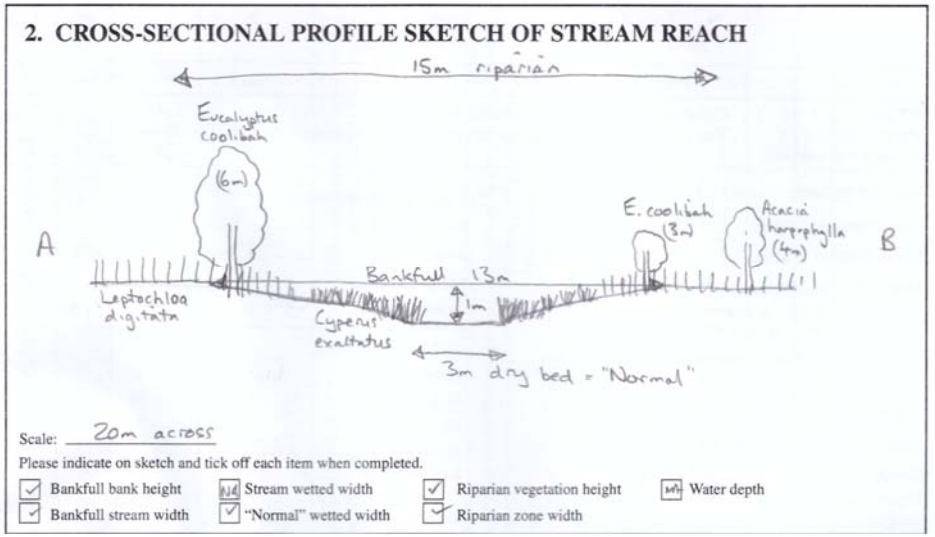
Physico-chemical water quality

Not sampled. Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for early wet season: Fair (60).

Overall aquatic values – Early wet season: **Low** (Priority flora species unlikely to be utilised by aquatic fauna); Late wet season: Expected to be **Low**.



Site Code: P1 **Location:** Palustrine wetland, Willunga **Stream order:** NA **Latitude:** -22.3727 **Longitude:** 148.5587 **Date:** 12/12/2016 **Season:** Early wet


North


East


South


West

General Site Description

Site attributes

Palustrine wetland; mapped as referable wetland of High Ecological Significance (HES); dry at the time of assessment; no erosion detected, with the exception of pugging by cattle with direct access; habitat features in wetter times would include large woody debris; substrates comprised 95% silt/clay (<0.05 mm) and 5% sand (0.05-2 mm). Upstream and adjoining landuse includes moderate cattle grazing in both cleared and remnant vegetation. Wetland itself heavily grazed by cattle.

Aquatic and riparian vegetation

Wetland comprises RE 11.5.17 – '*Eucalyptus tereticornis* woodland on Cainozoic sand plains and remnant surfaces'. Dominated by forest red gum (*Eucalyptus tereticornis*), with occasional carbeen (*Corymbia tessellaris*). Shrub layer absent. Ground layer dominated by common couch (*Cynodon dactylon*), sneezeweed (*Centipeda minima*), sabi grass (*Urochloa mosambicensis*)* and ruby saltbush (*Enchylaena tomentosa*). No macrophytes detected.

Erosion risk

Low – banks stable, and over 80% of surfaces covered by vegetation.

Aquatic fauna, including breeding habitat

The wetland may provide marginal foraging and breeding habitat for turtles during wetter periods. Unlikely to constitute fish habitat due to high ephemerality and lack of connectivity with waterways. May provide foraging habitat for Least Concern turtles during the wetter months of the year. Habitat not suitable for platypus (*Ornithorhynchus anatinus*). No aquatic fauna, or signs of aquatic fauna, detected at the time of assessment.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT, SLC or Priority aquatic flora or fauna species were detected at the time of the site visit. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The wetland lacks habitat features suitable for these species.

Physico-chemical water quality

Wetland was dry at the time of assessment. Summary: Normal.

Overall aquatic values

Early wet season: **High** (mapped as HES wetland); Late wet season: see following site profile.

Site Code: P1 **Location:** Palustrine wetland, Willunga **Stream order:** NA **Latitude:** -22.3727 **Longitude:** 148.5587 **Date:** 11/07/2017 **Season:** Late wet


North


East


South


West

General Site Description

Site attributes

Palustrine wetland; mapped as referable wetland of High Ecological Significance (HES); no erosion detected, with the exception of some pugging by cattle; wetted diameter approximately 200 m in each of two waterbodies (see aerial photo taken at time of assessment); depth to approx. 0.3m; bankfull extent approx. 400 m diameter in each waterbody; bankfull height approximately 2 m; in-stream habitat included shallow (<0.5 m) pool, large woody debris and macrophytes; substrates comprised 95% silt/clay (<0.05 mm) and 5% sand (0.05-2 mm). Upstream and adjoining landuse includes moderate cattle grazing in both cleared and remnant vegetation.

Aquatic and riparian vegetation

Wetland comprises RE 11.5.17 – '*Eucalyptus tereticornis* woodland on Cainozic sand plains and remnant surfaces'. Dominated by forest red gum (*Eucalyptus tereticornis*), with occasional carbeen (*Corymbia tessellaris*). Shrub layer largely absent, with the exception of forest red gum regrowth in some areas. Ground layer dominated by common couch (*Cynodon dactylon*), sneezeweed (*Centipeda minima*) and lesser joyweed (*Alternanthera denticulata*), with abundant brown beetle grass (*Diplachne fusca* var. *fusca*), sabi grass (*Urochloa mosambicensis*)* and buffel grass (*Cenchrus ciliaris*)*. Submerged macrophytes included water nymph (*Najas tenuifolia*) and bladderwort (*Utricularia* sp.). Emergent and fringing macrophytes included tall flatsedge (*Cyperus exaltatus*), starfruit (*Damasonium minus*), brown beetle grass, white eclipta (*Eclipta prostrata*)*, ribbed spikerush (*E. plana*), common rush (*Juncus usitatus*), native willow primrose (*Ludwigia octovalvis*), shiny nardoo (*Marsilea mutica*), swamp lily (*Ottelia ovalifolia*), small knotweed (*Persicaria plebeium*) and bogrush (*Schoenus* sp.).

Erosion risk

Low – banks stable, and over 80% of surfaces covered by vegetation.

Aquatic fauna, including breeding habitat

The wetland may provide marginal foraging and breeding habitat for fish during, and for a number of months following, flooding events in the Isaac River. Provides foraging and potential breeding habitat for Least Concern turtles. Lacks suitable foraging or breeding habitat for the SLC platypus (*Ornithorhynchus anatinus*). No fish detected at the time of assessment, despite backpack electrofishing and overnight deployment of two baited fyke nets and five baited box traps. Eastern snake-necked turtle (*Chelodina longicollis*) captured. No

macrocrustaceans were detected. Other aquatic macroinvertebrates were collected (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species were detected at the time of the site visit. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The wetland lacks habitat features for these species. Priority flora species included tall flatsedge (*C. exaltatus*), water chestnut (*E. dulcis*) and water nymph (*Najas tenuifolia*).

Physico-chemical water quality

Collection time: 8:05 EST; water temp.: 20.4 °C; conductivity: 156 µS/cm (fresh); turbidity: 10.6 NTU (high clarity); dissolved oxygen: 26.3%, 2.4 mg/L (low); pH 7.2 (neutral).

Summary: Normal (diurnal range in DO expected to be extreme as a result of extensive submerged macrophyte cover and breakdown of organic matter (inundated terrestrial grasses); DO levels are expected to peak in the early afternoon).

Bioassessment scores

AusRivAS taxonomic richness: 20 (combined bed and edge); PET richness: 1; SIGNAL 2 score: 2.83; tolerant taxa: 67%.

Overall aquatic values

Late wet season: **High** (mapped as HES wetland); Early wet: see previous site profile.

Site Code: P2 **Location:** Palustrine wetland / paleochannel **Stream order:** NA **Latitude:** -22.2942 **Longitude:** 148.4541 **Date:** 18/12/2016 **Season:** Early wet


Upstream


Left bank


Downstream


Right bank

General Site Description

Site attributes

Paleochannel wetland on the Isaac River floodplain; mapped as referable wetland of High Ecological Significance (HES); little local catchment erosion; extensive pugging of substrates by cattle with direct access to water body; wetland approx. 3.5 km long, 25 m wide; up to approximately 1.2 m deep; bankfull width approx. 45 m; bankfull height approx. 2.5 m (from the bed); in-stream habitat included shallow (<0.5 m) pool, deep pool, large woody debris and macrophytes; substrates comprised 95% silt/clay (<0.05 mm) and 5% sand (0.05-2 mm) in the bed and edge habitats; little macrophyte cover. The presence of fairy shrimp (*Branchinella* sp.), that are found only in temporary ponds and wetlands, combined with a distinct lack of fish, suggests that this wetland is subject to complete drying and wetting cycles. The clay-rich substrates of this waterbody are likely to hold surface run-on for extended periods.

Aquatic and riparian vegetation

Wetland comprises RE 11.3.27b – Lacustrine wetland. Fringing woodland approximately 25 m wide, dominated by coolabah (*Eucalyptus coolabah*), with occasional carbeen (*Corymbia tessellaris*), forest red gum (*E. tereticornis*), swamp mahogany (*Lophostemon suaveolens*) and sally wattle (*Acacia salicina*). Very sparse shrub layer of bean tree (*Cassia brewsteri*), snow-in-summer (*Melaleuca linariifolia*) and young swamp mahogany. Sparse ground layer with scattered black spear grass (*Heteropogon contortus*), wiregrass (*Aristida* sp.), musk basil (*Basilicum polystachyon*), buffel grass (*Cenchrus ciliaris*)* and parthenium (*Parthenium hysterophorus*)*. Submerged macrophytes included bladderwort (*Utricularia* sp.). Emergent and fringing macrophytes included pennywort (*Centella asiatica*), tall flatsedge (*Cyperus exaltatus*), slender sedge (*C. gracilis*), white eclipta (*Eclipta prostrata*)*, common rush (*Juncus usitatus*), umbrella canegrass (*Leptochloa digitata*), water primrose (*Ludwigia peploides* subsp. *montevidensis*), swamp lily (*Ottelia ovalifolia*) and slender knotweed (*Persicaria decipiens*).

Erosion risk

Low – Banks appear to be stable; flow rarely encountered.

Aquatic fauna, including breeding habitat

The wetland provides potential foraging and breeding habitat for turtles (none detected at the time of assessment). No fish were detected at the time of assessment, despite thorough backpack electrofishing effort and overnight deployment of two baited fyke nets, one baited cathedral trap, and five baited box traps. The wetland is unlikely to provide breeding habitat for fish. The wetland also lacks suitable foraging or breeding habitat for platypus (*Ornithorhynchus anatinus*). Macro-crustaceans included freshwater crab (*Austrothelphusa transversa*) and fairy shrimp (*Branchinella* sp.). A diversity of other aquatic macroinvertebrates were collected (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species were detected during the site visit. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The wetland lacks habitat features for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

Physico-chemical water quality

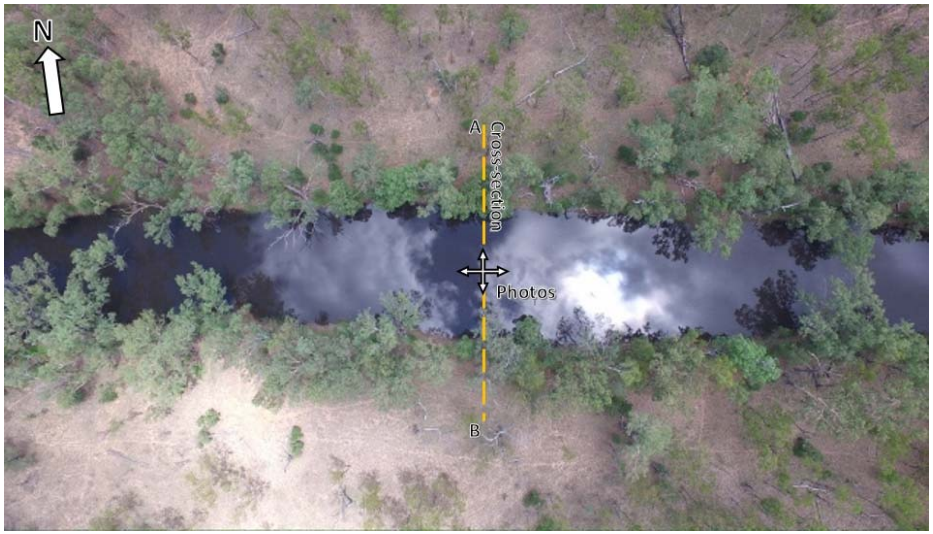
Collection time: 11:15 EST; water temp.: 29.1 °C; conductivity: 117 µS/cm (fresh); turbidity: 6.9 NTU (high clarity); dissolved oxygen: 73.0%, 5.4 mg/L (moderately low); pH 6.8 (neutral). Summary: Normal (diurnal range in DO expected to be variable, with levels expected to peak in the early afternoon).

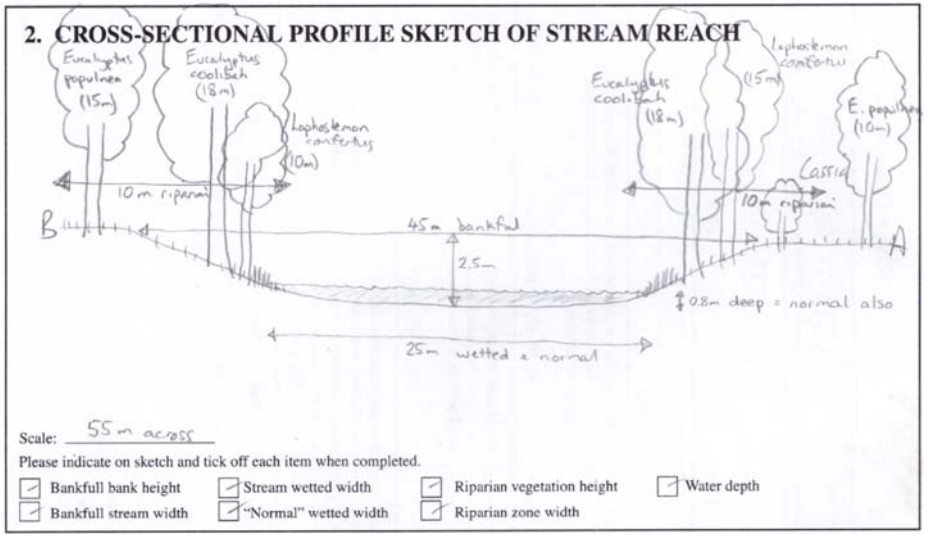
Bioassessment scores

AusRivAS taxonomic richness: 26 (combined bed and edge); PET richness: 1; SIGNAL 2 score: 2.74; tolerant taxa: 65%.

Overall aquatic values

Early wet season: **High** (HES wetland); Late wet: See following site profile.





Site Code: P2 **Location:** Palustrine wetland / paleochannel **Stream order:** NA **Latitude:** -22.2942 **Longitude:** 148.4541 **Date:** 8/07/2017 **Season:** Late wet


Upstream


Left bank


Downstream


Right bank

General Site Description

Site attributes

Paleochannel wetland on the Isaac River floodplain; mapped as referable wetland of High Ecological Significance (HES); little local catchment erosion; extensive pugging of substrates by cattle with direct access to water body; wetland approx. 3.5 km long, 25 m wide; up to approximately 1.2 m deep; bankfull width approx. 45 m; bankfull height approx. 2.5 m (from the bed); in-stream habitat included shallow (<0.5 m) pool, deep pool, large woody debris and macrophytes; substrates comprised 95% silt/clay (<0.05 mm) and 5% sand (0.05-2 mm) in the bed and edge habitats; little macrophyte cover. A distinct lack of fish suggests that this wetland is subject to complete drying and wetting cycles. The clay-rich substrates of this waterbody are likely to hold surface run-on for extended periods.

Aquatic and riparian vegetation

Wetland comprises RE 11.3.27b – Lacustrine wetland. Fringing woodland approximately 25 m wide, dominated by coolabah (*Eucalyptus coolabah*), with occasional carbeen (*Corymbia tessellaris*), forest red gum (*E. tereticornis*), swamp mahogany (*Lophostemon suaveolens*) and sally wattle (*Acacia salicina*). Very sparse shrub layer of bean tree (*Cassia brewsteri*), snow-in-summer (*Melaleuca linariifolia*) and young swamp mahogany. Sparse ground layer with scattered black spear grass (*Heteropogon contortus*), wiregrass (*Aristida* sp.), musk basil (*Basilicum polystachyon*), buffel grass (*Cenchrus ciliaris*)* and parthenium (*Parthenium hysterophorus*)*. Submerged macrophytes included water nymph (*Najas tenuifolia*) and bladderwort (*Utricularia* sp.). Emergent and fringing macrophytes included tall flatsedge (*Cyperus exaltatus*), slender sedge (*C. gracilis*), *C. trinervis*, brown beetle grass (*Diplachne fusca* var. *fusca*), white eclipta (*Eclipta prostrata*)*, common rush (*Juncus usitatus*), umbrella canegrass (*Leptochloa digitata*), water primrose (*Ludwigia peploides* subsp. *montevidensis*), swamp lily (*Ottelia ovalifolia*) and spiny mudgrass (*Pseudoraphis spinescens*).

Erosion risk

Low – Banks appear to be stable; flow rarely encountered.

Aquatic fauna, including breeding habitat

The wetland provides potential foraging and breeding habitat for turtles, with eastern snake-necked turtle (*Chelodina longicollis*) detected at the time of assessment. No fish were detected at the time of assessment, despite thorough backpack electrofishing effort and overnight deployment of two baited fyke nets, one baited cathedral trap, and five baited box traps. The wetland is unlikely to provide breeding habitat for fish. The wetland also lacks suitable foraging or breeding habitat for platypus (*Ornithorhynchus anatinus*). No macrocrustaceans detected, although a diversity of other aquatic macroinvertebrates were collected (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species were detected during the site visit. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). Priority flora species included tall flatsedge (*C. exaltatus*) and water nymph (*N. tenuifolia*).

Physico-chemical water quality

Collection time: 8:20 EST; water temp.: 19.5 °C; conductivity: 57 µS/cm (fresh); turbidity: 13.5 NTU (high clarity); dissolved oxygen: 75.7%, 6.9 mg/L; pH 6.9 (neutral).

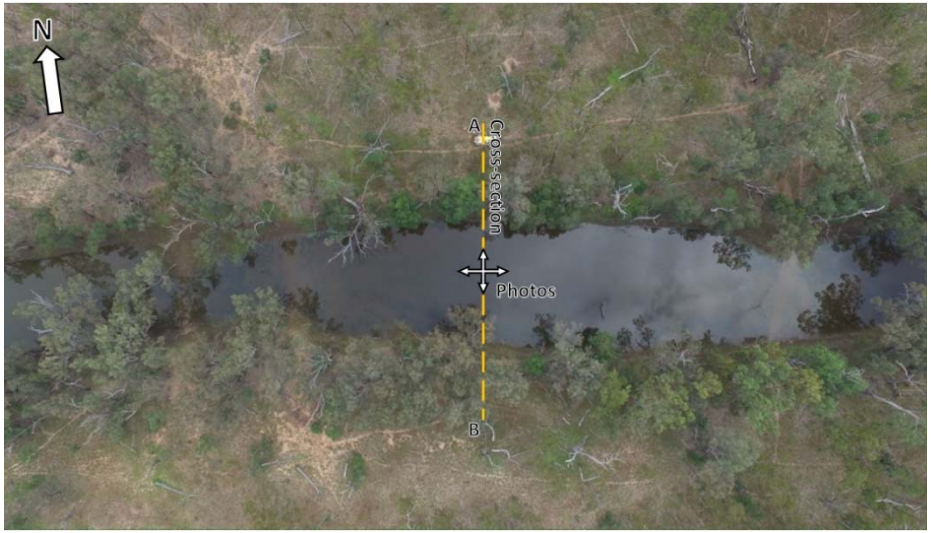
Summary: Normal (diurnal range in DO expected to be variable, with levels expected to peak in the early afternoon).

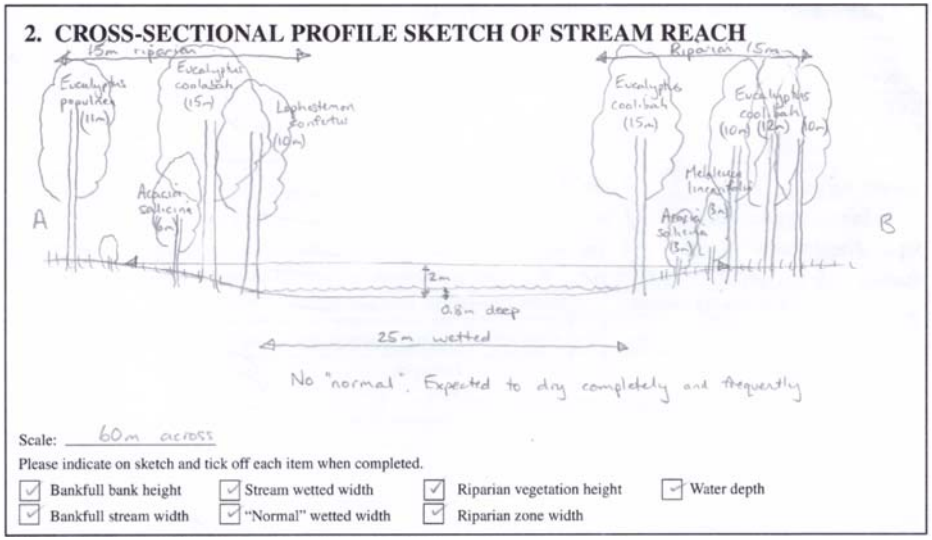
Bioassessment scores

AusRivAS taxonomic richness: 32 (bed and edge habitats combined); PET richness: 2; SIGNAL 2 score: 2.77; tolerant taxa: 67%.

Overall aquatic values

Late wet season: **High** (mapped as HES wetland); Early wet: see previous site profile.





Site Code: P3 **Location:** Palustrine wetland **Stream order:** NA **Latitude:** -22.2821 **Longitude:** 148.3627 **Date:** 19/12/2016 **Season:** Early wet


North


East


South


West

General Site Description

Site attributes

Originally a palustrine wetland, now predominantly lacustrine as a result of earthmoving to dam this depression; mapped as referable wetland of General Ecological Significance (GES); little local catchment erosion; waterbody approx. 300 m long, 25 m wide, to >2 m deep; bankfull extent approx. 350 m long x 50 m wide, and bankfull height approx. 4 m (from the bed); in-stream habitat included shallow (<0.5 m) pools, deep pools, and macrophytes; substrates comprised 95% silt/clay (<0.05 mm) and 5% sand (0.05-2 mm) in both the bed and edge habitats. Upstream and adjacent landuse includes moderate cattle grazing on both cleared land and remnant vegetation.

Aquatic and riparian vegetation

Wetland comprises RE 11.3.27b – Lacustrine wetland. Fringing woodland dominated by river red gum (*Eucalyptus camaldulensis*) and forest red gum (*E. tereticornis*), with frequent carbeen (*Corymbia tessellaris*) and poplar gum (*E. platyphylla*). Very sparse sub-canopy of white bauhinia (*Lysiphyllum hookeri*) and brigalow (*Acacia harpophylla*). Very sparse shrub layer of currant bush (*Carissa ovata*). Ground layer includes a high diversity of wetlands species. Submerged macrophytes include water nymph (*Najas tenuifolia*). Emergent and fringing macrophytes include rice sedge (*Cyperus difformis*), tall flatsedge (*C. exaltatus*), awnless barnyard grass (*Echinochloa colona*)*, water primrose (*Ludwigia peploides* subsp. *montevidensis*), white eclipta (*Eclipta prostrata*)*, water chestnut (*Eleocharis dulcis*), native willow primrose (*Ludwigia octovalvis*), wavy marshwort (*Nymphoides crenata*), swamp lily (*Ottelia ovalifolia*), smartweed (*Persicaria attenuata*), slender knotweed (*P. decipiens*) and small knotweed (*P. plebeium*).

Erosion risk

Low – Banks appear to be stable, and over 80% of surfaces covered by vegetation.

Aquatic fauna, including breeding habitat

The wetland provides potential foraging and breeding habitat for fish and turtles. Survey effort for aquatic fauna included backpack electrofishing and overnight deployment of two baited fyke nets and five baited box traps. Fish species detected included Agassiz's glassfish (*Ambassis agassizii*), flyspecked hardyhead (*Craterocephalus stercusmuscarum*), gudgeon (*Hypseleotris* sp.), spangled perch (*Leiopotherapon unicolor*), eastern rainbowfish (*Melanotaenia splendida splendida*), bony bream (*Nematalosa erebi*) and Hyrtyl's tandan (*Neosilurus hyrtlii*). Turtles included eastern snake-necked turtle (*Chelodina longicollis*) and Krefft's river turtle (*Emydura macquarii krefftii*). The wetland lacks suitable

foraging or breeding habitat for platypus (*Ornithorhynchus anatinus*). Macrocrustaceans included freshwater shrimp (*Paratya australiense*) and freshwater prawn (*Macrobrachium australiense*). A high diversity of other aquatic macroinvertebrates were also collected (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species were detected during the site visit. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The wetland lacks suitable habitat features for these species. Priority flora species included tall flatsedge (*C. exaltatus*), water chestnut (*E. dulcis*) and water nymph (*N. tenuifolia*).

Physico-chemical water quality

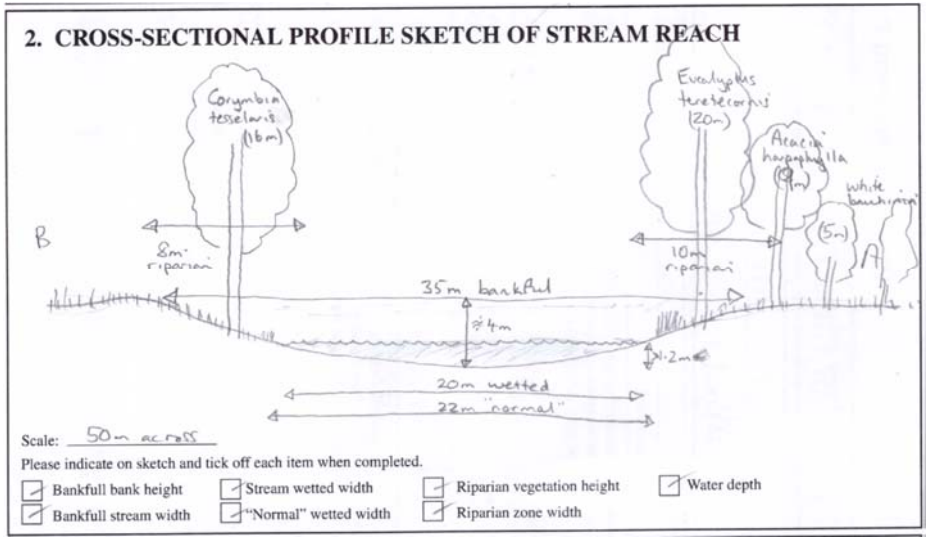
Collection time: 13:00 EST; water temp.: 34.5 °C; conductivity: 183 µS/cm (fresh); turbidity: 32 NTU (moderate clarity); dissolved oxygen: 148.3%, 10.5 mg/L (supersatured); pH 9.7 (very strongly alkaline). Summary: Normal; diurnal range in DO expected to be extreme as a result of extensive submerged macrophyte cover; DO levels are expected to peak in the early afternoon; high pH likely reflective of high contact time between water and substrates.

Bioassessment scores

AusRivAS taxonomic richness: 21 (combined bed and edge); PET richness: 3; SIGNAL 2 score: 3.37; tolerant taxa: 53%.

Overall aquatic values

Early wet season: **High** (permanent waterbody); Late wet: See following site profile.



Site Code: P3 **Location:** Palustrine wetland **Stream order:** NA **Latitude:** -22.2821 **Longitude:** 148.3627 **Date:** 5/07/2017 **Season:** Late wet


North


East


South


West

General Site Description

Site attributes

Originally a palustrine wetland, now predominantly lacustrine as a result of earthmoving to dam this depression; mapped as referable wetland of General Ecological Significance (GES); little local catchment erosion; waterbody approximately 330 m long, 40 m wide, to >2 m deep; bankfull extent approx. 350 m long x 50 m wide, and bankfull height approx. 4 m (from the bed); in-stream habitat included shallow (<0.5 m) pools, deep pools, large woody debris and macrophytes; substrates comprised 95% silt/clay (<0.05 mm) and 5% sand (0.05-2 mm) in both the bed and edge habitats. Upstream and adjacent landuse includes moderate cattle grazing in both cleared and remnant vegetation.

Aquatic and riparian vegetation

Wetland comprises RE 11.3.27b – Lacustrine wetland. Fringing woodland dominated by river red gum (*Eucalyptus camaldulensis*) and forest red gum (*E. tereticornis*), with frequent carbeen (*Corymbia tessellaris*) and poplar gum (*E. platyphylla*). Very sparse sub-canopy of white bauhinia (*Lysiphyllum hookeri*) and brigalow (*Acacia harpophylla*). Very sparse shrub layer of currant bush (*Carissa ovata*). Ground layer includes a high diversity of wetlands species. Floating macrophytes include ferny azolla (*Azolla pinnata*). Submerged macrophytes include charophyte algae (*Chara/Nitella* sp.), water nymph (*Najas tenuifolia*) and bladderwort (*Utricularia* sp.). Emergent and fringing macrophytes include *Cyperus concinnus*, rice sedge (*C. difformis*), tall flatsedge (*C. exaltatus*), starfruit (*Damasonium minus*), brown beetle grass (*Diplachne fusca* var. *fusca*), waterwort (*Elatine gratioloides*), awnless barnyard grass (*Echinochloa colona*)*, white eclipta (*Eclipta prostrata*)*, water chestnut (*Eleocharis dulcis*), ribbed spikerush (*E. plana*), common rush (*Juncus usitatus*), native willow primrose (*Ludwigia octovalvis*), water primrose (*Ludwigia peploides* subsp. *montevidensis*), native hyacinth (*Monochoria cyanea*), giant waterlily (*Nymphaea gigantea*), wavy marshwort (*Nymphoides crenata*), swamp lily (*Ottelia ovalifolia*), smartweed (*Persicaria attenuata*), prickly smartweed (*P. strigosa*), small knotweed (*P. plebeium*) and spiny mudgrass (*Pseudoraphis spinescens*).

Aquatic fauna, including breeding habitat

The wetland provides potential foraging and breeding habitat for fish and turtles. Survey effort for aquatic fauna included backpack electrofishing and overnight deployment of two baited fyke nets and five baited box traps. Fish species detected included Agassiz's glassfish (*Ambassis agassizii*), flyspecked hardyhead (*Craterocephalus stercusmuscarum*), gudgeon (*Hypseleotris* sp.), spangled perch (*Leiopotherapon unicolor*), eastern rainbowfish (*Melanotaenia splendida splendida*), purple-spotted gudgeon (*Mogurnda adspersa*),

bony bream (*Nematalosa erebi*), Hyrtyl's tandan (*Neosilurus hyrtlii*), Rendahl's tandan (*Porochilus rendahli*) and freshwater catfish (*Tandanus tandanus*). No turtles captured. Lacks suitable foraging or breeding habitat for platypus (*Ornithorhynchus anatinus*). Macrocrustaceans included freshwater shrimp (*Paratya australiense*) and freshwater prawn (*Macrobrachium australiense*). A high diversity of other aquatic macroinvertebrates were also collected (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species were detected during the site visit. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The wetland lacks habitat features for these species. Priority flora species included tall flatsedge (*C. exaltatus*), water chestnut (*E. dulcis*), water nymph (*N. tenuifolia*), native hyacinth (*M. cyanea*) and giant waterlily (*N. gigantea*).

Physico-chemical water quality

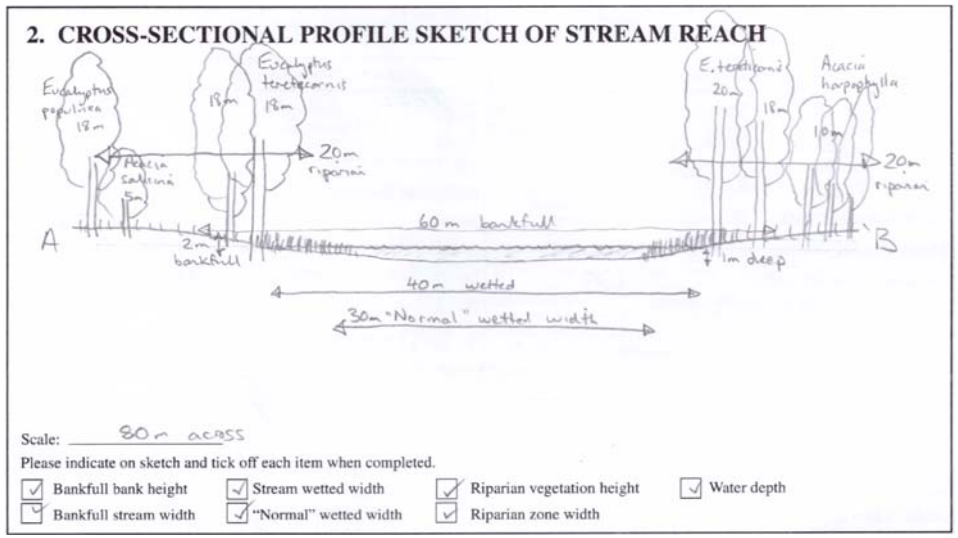
Collection time: 8:05 EST; water temp.: 18.8 °C; conductivity: 118 µS/cm (fresh); turbidity: 4.7 NTU (high clarity); dissolved oxygen: 82.8%, 7.6 mg/L; pH 7.6 (mildly alkaline). Summary: Normal.

Bioassessment scores

AusRivAS taxonomic richness: 36 (combined bed and edge); PET richness: 2; SIGNAL 2 score: 3.09; tolerant taxa: 60%.

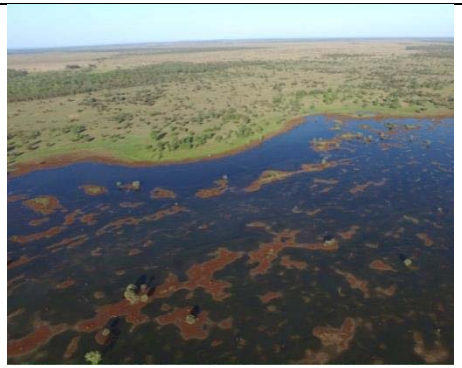
Overall aquatic values

Late wet season: **High** (permanent waterbody); Early wet: See previous site profile.



Site Code: P4 **Location:** Large palustrine wetland **Stream order:** NA **Latitude:** -22.3931 **Longitude:** 148.5431 **Date:** 9/10/2017 **Season:** Early wet


North


East


South


West

General Site Description

Site attributes

Large palustrine wetland on the Isaac River floodplain, retaining water from heavy rainfall and runoff from the local catchment associated with Cyclone Debbie in late March 2017; approx. 1 km^2; 0.3 m average depth encountered near the centre; no erosion detected; in-stream habitat included shallow (<0.5 m) pool, deep pool, large woody debris and macrophytes; substrates comprised 100% silt/clay (<0.05 mm); extensive cover of submerged and emergent red watermilfoil (*Myriophyllum verrucosum*); water level receding / drying, although likely to retain water throughout wet season.

Aquatic and riparian vegetation

Wetland comprises non-remnant vegetation. Terrestrial groundcover on outer edge dominated by common couch (*Cynodon dactylon*), Indian couch (*Bothriochloa pertusa*), sneezeweed (*Centipeda minima*), buffel grass (*Cenchrus ciliaris*)* and sabi grass (*Urochloa mosambicensis*)*, umbrella canegrass (*Leptochloa digitata*) and lesser joyweed (*Alternanthera denticulata*). Submerged macrophytes included extensive red watermilfoil (*Myriophyllum verrucosum*). Emergent macrophytes included red watermilfoil, tall flatsedge (*C. exaltatus*), common rush (*Juncus usitatus*), umbrella canegrass (*Leptochloa digitata*), native willow primrose (*Ludwigia octovalvis*), water primrose (*Ludwigia peploides* subsp. *montevidensis*), common nardoo (*Marsilea drummondii*), hairy nardoo (*M. hirsuta*), Prince's feathers (*Persicaria orientalis*), small knotweed (*Polygonum plebeium*) and floating pondweed (*Potamogeton sulcatus*).

Erosion risk

Low – Banks appeared to be stable, and over 80% of surfaces covered by vegetation.

Aquatic fauna, including breeding habitat

The wetland provides foraging and breeding habitat for fish and turtles during, and for a number of months following, significant rainfall and runoff in the catchment. Lacks suitable foraging or breeding habitat for platypus (*Ornithorhynchus anatinus*). Aquatic fauna detected by backpack electrofishing and overnight deployment of two baited fyke nets and five baited box traps included the native fish Agassiz's glassfish (*Ambassis agassizii*), gudgeon (*Hypseleotris* sp.), spangled perch (*Leiopotherapon unicolor*), eastern rainbowfish (*Melanotaenia splendida splendida*). No exotic fish detected. Turtles included Krefft's river turtle (*Emydura macquarii krefftii*). No macrocrustaceans detected. A diversity of other

aquatic macroinvertebrates were collected (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species were detected during the site visit. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The wetland lacks habitat features for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

Physico-chemical water quality

Collection time: 08:45 EST; water temp.: 25.2 °C; conductivity: 200 µS/cm (fresh); turbidity: 22.7 NTU (good clarity); dissolved oxygen: 82.2%, 6.7 mg/L (good); pH 9.4 (very strongly alkaline). Summary: Normal (strongly alkaline pH likely a reflection of the shallow water body and relatively long contact time with substrates).

Bioassessment scores

AusRivAS taxonomic richness: 18 (combined bed and edge); PET richness: 1; SIGNAL 2 score: 2.56; tolerant taxa: 75%.

Overall aquatic values

Early wet season: **Moderate** (known presence of Priority species; moderate quality habitat); Late wet: see following site profile.

Site Code: P4 **Location:** Large palustrine wetland **Stream order:** NA **Latitude:** -22.3931 **Longitude:** 148.5431 **Date:** 10/07/2017 **Season:** Late wet


North


East


South


West

General Site Description

Site attributes

Large palustrine wetland on the Isaac River floodplain, retaining water from heavy rainfall and runoff from the local catchment associated with Cyclone Debbie in late March 2017; approx. 1 km^2; 0.5 m average depth encountered near the centre; reaching depths of 1.2 m in some areas; no erosion detected; in-stream habitat included shallow (<0.5 m) pool, deep pool, large woody debris and macrophytes; substrates comprised 100% silt/clay (<0.05 mm); extensive cover of submerged and emergent red watermilfoil (*Myriophyllum verrucosum*); water level receding / drying, although has retained water through to next wet season (see previous site profile).

Aquatic and riparian vegetation

Wetland comprises non-remnant vegetation. Terrestrial groundcover on outer edge dominated by common couch (*Cynodon dactylon*), Indian couch (*Bothriochloa pertusa*), sneezeweed (*Centipeda minima*), buffel grass (*Cenchrus ciliaris*)* and sabi grass (*Urochloa mosambicensis*)*, with frequent white eclipta (*Eclipta prostrata*)*, umbrella canegrass (*Leptochloa digitata*) and lesser joyweed (*Alternanthera denticulata*). Submerged macrophytes included red watermilfoil (*Myriophyllum verrucosum*). Emergent macrophytes included red watermilfoil, *Cyperus concinnus*, rice sedge (*C. difformis*), tall flatsedge (*C. exaltatus*), awnless barnyard grass (*Echinochloa colona*)*, white eclipta (*Eclipta prostrata*)*, ribbed spikerush (*E. plana*), common rush (*Juncus usitatus*), umbrella canegrass (*Leptochloa digitata*), native willow primrose (*Ludwigia octovalvis*), water primrose (*Ludwigia peploides* subsp. *montevidensis*), common nardoo (*Marsilea drummondii*), hairy nardoo (*M. hirsuta*) and floating pondweed (*Potamogeton sulcatus*).

Erosion risk

Low – Banks appeared to be stable, and over 80% of surfaces covered by vegetation.

Aquatic fauna, including breeding habitat

The wetland provides foraging and breeding habitat for fish and (likely) turtles during, and for a number of months following, significant rainfall and runoff in the catchment. Lacks suitable foraging or breeding habitat for platypus (*Ornithorhynchus anatinus*). Aquatic fauna detected by backpack electrofishing and overnight deployment of two baited fyke nets and five baited box traps included the native fish Agassiz's glassfish (*Ambassis agassizii*), gudgeon (*Hypseleotris* sp.), spangled perch (*Leiopotherapon unicolor*), eastern rainbowfish (*Melanotaenia splendida splendida*), purple-spotted gudgeon (*Mogurnda adspersa*), bony bream (*Nematalosa erebi*) and Australian smelt (*Retropinna semoni*). No

exotic fish detected. No turtles detected. No macrocrustaceans detected. A diversity of other aquatic macroinvertebrates were collected (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species were detected during the site visit. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The wetland lacks habitat features for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

Physico-chemical water quality

Collection time: 15:15 EST; water temp.: 23.0 °C; conductivity: 198 µS/cm (fresh); turbidity: 42.6 NTU (moderate clarity); dissolved oxygen: 113.4%, 9.7 mg/L (saturated); pH 8.8 (strongly alkaline). Summary: Normal (strongly alkaline pH likely a reflection of the shallow water body and relatively long contact time with substrates).

Bioassessment scores

AusRivAS taxonomic richness: 24 (combined bed and edge); PET richness: 2; SIGNAL 2 score: 3.29; tolerant taxa: 57%.

Overall aquatic values

Late wet season: **Moderate** (known presence of Priority species); Early wet: See previous site profile.

Site Code: P5 **Location:** Palustrine wetland, Iffley **Stream order:** NA **Latitude:** -22.2230 **Longitude:** 148.3531 **Date:** 6/10/2017 **Season:** Early wet


North


East


South


West

General Site Description

Site attributes

Palustrine wetland dry at time of assessment, lacustrine waterbody (dam) at southern end retaining water and providing refugia for aquatic fauna during drier periods; lacustrine wetland approx. 95 m long, 120 m wide; >2 m depth; mapped as referable wetland of General Ecological Significance (GES); no erosion detected; in-stream habitat included shallow (<0.5 m) pools, deep pools, and macrophytes; substrates comprised 100% silt/clay (<0.05 mm); upstream and adjacent landuse includes moderate cattle grazing on both cleared land and remnant vegetation.

Aquatic and riparian vegetation

Wetland comprises RE 11.5.17. Palustrine wetland with fringing woodland of poplar box (*Eucalyptus populnea*), with a very sparse sub-canopy of poplar box. No shrub layer. Terrestrial groundcover on periphery of wetland dominated by sabi grass (*Urochloa mosambicensis*)*, buffel grass (*Cenchrus ciliaris*)* and common couch (*Cynodon dactylon*). Wetland contains a diversity of macrophytes. Emergent macrophytes included, tall flatsedge (*Cyperus exaltatus*), *Eleocharis philippinensis*, ribbed spikerush (*E. plana*), common rush (*Juncus usitatus*), umbrella canegrass (*Leptochloa digitata*), water primrose (*Ludwigia peploides* subsp. *montevidensis*), shiny nardoo (*Marsilea mutica*), swamp lily (*Ottelia ovalifolia*), and spiny mudgrass (*Pseudoraphis spinescens*).

Erosion risk

Low – Banks appear to be stable, and over 80% of surfaces covered by vegetation.

Aquatic fauna, including breeding habitat

The wetland provides foraging and breeding habitat for fish and turtles. Lacks suitable foraging or breeding habitat for platypus (*Ornithorhynchus anatinus*). Aquatic fauna detected by backpack electrofishing and overnight deployment of two baited fyke nets and five baited box traps included Agassiz's glassfish (*Ambassis agassizii*), flyspecked hardyhead (*Craterocephalus stercusmuscarum*), gudgeon (*Hypseleotris* sp.), spangled perch (*Leiopotherapon unicolor*), eastern rainbowfish (*Melanotaenia splendida splendida*), Hyrtyl's tandan (*Neosilurus hyrtlii*), Rendahl's tandan (*Porochilus rendahli*), and the pest species tilapia (*Oreochromus mossambicus*)*. Turtles captured included broad-shelled turtle (*Chelodina expansa*) and Krefft's river turtle (*Emydura macquarii krefftii*). Macrocrustaceans included freshwater prawn (*Macrobrachium australiense*). A high diversity of

other aquatic macroinvertebrates were also collected (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species were detected during the site visit. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The wetland lacks habitat features for these species. Priority flora species included tall flatsedge (*C. exaltatus*) and native hyacinth (*M. cyanea*).

Physico-chemical water quality

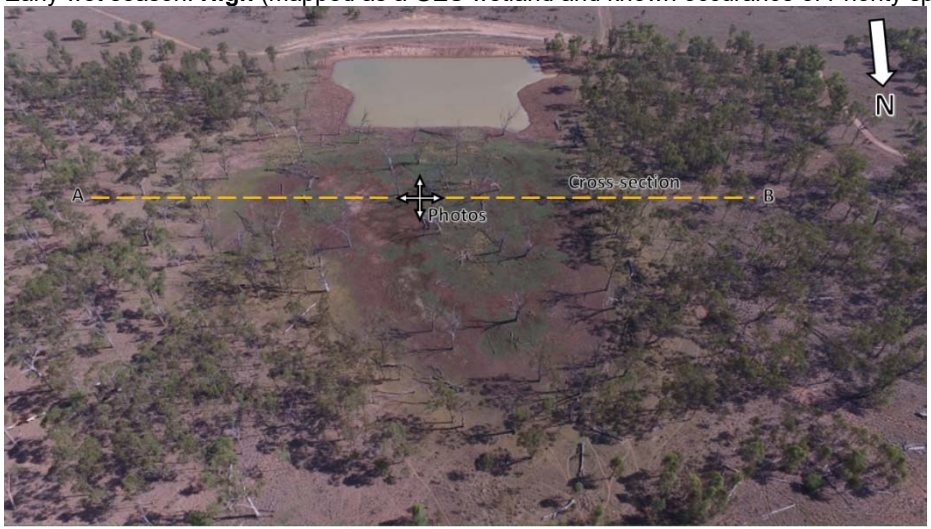
Collection time: 15:00 EST; water temp: 33.1 °C; conductivity: 179 µS/cm (fresh); turbidity: 132 NTU (low clarity); dissolved oxygen: 120.1%, 8.8 mg/L (supersaturated); pH 8.4 (moderatley alkaline). Summary: Normal (diurnal range in DO expected to peak in the early afternoon, increased in pH a likely result of a relatively long contact time with substrates).

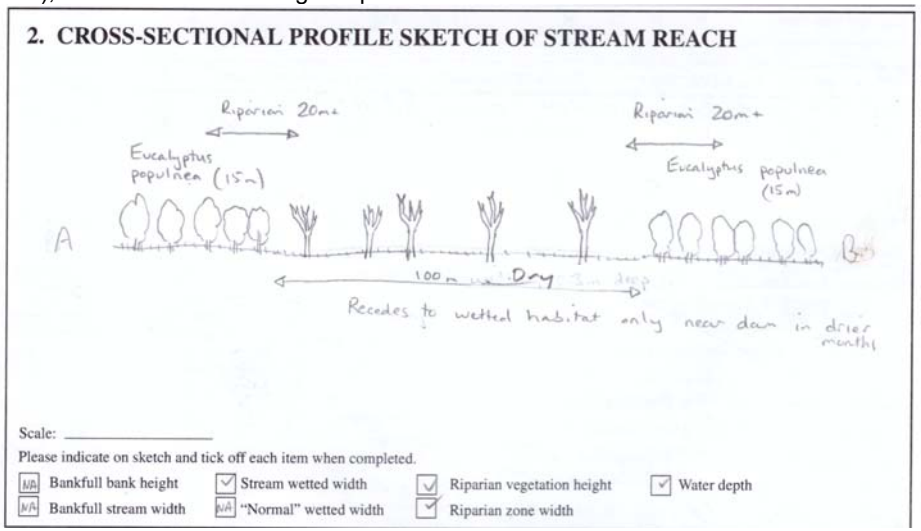
Bioassessment scores

AusRivAS taxonomic richness: 25 (combined bed and edge); PET richness: 2; SIGNAL 2 score: 3.26; tolerant taxa: 48%.

Overall aquatic values

Early wet season: **High** (mapped as a GES wetland and known occurance of Priority species); Late wet: See following site profile.





Site Code: P5 **Location:** Palustrine wetland, Iffley **Stream order:** NA **Latitude:** -22.2230 **Longitude:** 148.3531 **Date:** 24/06/2017 **Season:** Late wet


North


East


South


West

General Site Description

Site attributes

Palustrine wetland, with lacustrine waterbody (dam) at southern end; mapped as referable wetland of General Ecological Significance (GES); no erosion detected; wetland approx. 280 m long, 120 m wide; average depth approx. 0.3 m across palustrine component; >2 m depth in dam; in-stream habitat included shallow (<0.5 m) pools, deep pools, large woody debris and macrophytes; substrates comprised 100% silt/clay (<0.05 mm); extensive cover of submerged and emergent macrophytes; dense biomass of terrestrial grasses accumulated on bed; no anoxic odour; water level receding/drying; high diversity of waterbirds utilising this water body, including the Migratory (EPBC Act) species Latham's snipe (*Gallinago hardwickii*) and Caspian tern (*Hydroprogne caspia*); likely forms an important dry season refuge for waterbirds inhabiting the Study area; upstream and adjacent landuse includes moderate cattle grazing on both cleared land and remnant vegetation.

Aquatic and riparian vegetation

Wetland comprises RE 11.5.17. Palustrine wetland with fringing woodland of poplar box (*Eucalyptus populnea*), with a very sparse sub-canopy of poplar box. No shrub layer. Terrestrial groundcover on periphery of wetland dominated by sabi grass (*Urochloa mosambicensis*)*, buffel grass (*Cenchrus ciliaris*)* and common couch (*Cynodon dactylon*). Wetland contains a diversity of macrophytes. Submerged macrophytes included bladderwort (*Utricularia* sp.). Floating macrophytes included duckweed (*Spirodela* sp.). Emergent and fringing macrophytes included rice sedge (*Cyperus difformis*), tall flatsedge (*C. exaltatus*), starfruit (*Damasonium minus*), *Eleocharis philippinensis*, ribbed spikerush (*E. plana*), common rush (*Juncus usitatus*), water primrose (*Ludwigia peploides* subsp. *montevidensis*), shiny nardoo (*Marsilea mutica*), native hyacinth (*Monochoria cyanea*), swamp lily (*Ottelia ovalifolia*), floating pondweed (*Potamogeton sulcatus*) and spiny mudgrass (*Pseudoraphis spinescens*).

Erosion risk

Low – Banks appear to be stable, and over 80% of surfaces covered by vegetation.

Aquatic fauna, including breeding habitat

The wetland provides foraging and breeding habitat for fish and turtles. Lacks suitable foraging or breeding habitat for platypus (*Ornithorhynchus anatinus*). Aquatic fauna detected by backpack electrofishing and overnight deployment of two baited fyke nets and five baited box traps included Agassiz's glassfish (*Ambassis agassizii*), flyspecked

hardyhead (*Craterocephalus stercusmuscarum*), gudgeon (*Hypseleotris* sp.), spangled perch (*Leiopotherapon unicolor*), eastern rainbowfish (*Melanotaenia splendida splendida*), Hyrtyl's tandan (*Neosilurus hyrtlii*), Rendahl's tandan (*Porochilus rendahli*), freshwater catfish (*Tandanus tandanus*) and the pest species tilapia (*Oreochromus mossambicus*)*. Turtles captured included broad-shelled turtle (*Chelodina expansa*) and Krefft's river turtle (*Emydura macquarii krefftii*). Macrocrustaceans included freshwater prawn (*Macrobrachium australiense*). A high diversity of other aquatic macroinvertebrates were also collected (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species were detected during the site visit. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The wetland lacks habitat features for these species. Priority flora species included tall flatsedge (*C. exaltatus*) and native hyacinth (*M. cyanea*).

Physico-chemical water quality

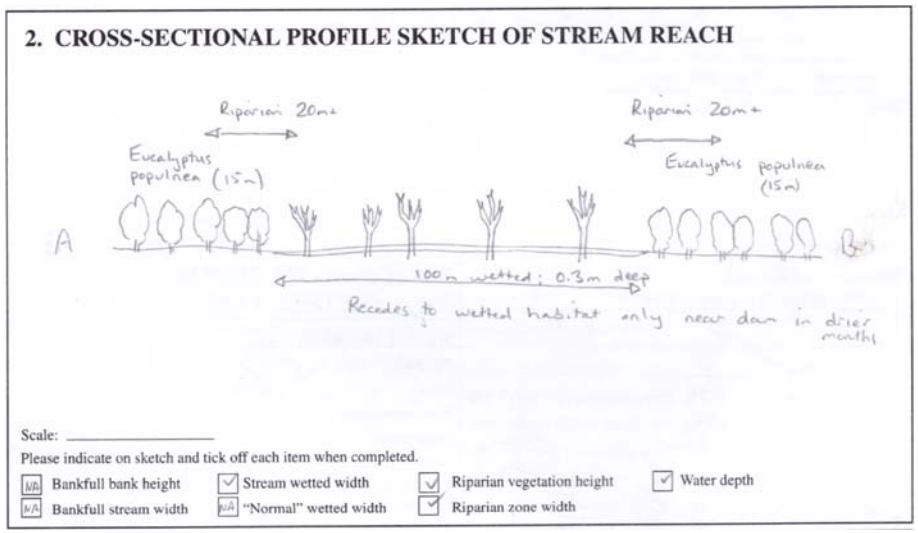
Collection time: 15:30 EST; water temp.: 22.6 °C; conductivity: 128 µS/cm (fresh); turbidity: not recorded; dissolved oxygen: 132.2%, 11.4 mg/L (supersaturated); pH 7.7 (mildly alkaline). Summary: Normal (diurnal range in DO expected to be extreme as a result of extensive submerged macrophyte cover, and low water level; DO levels are expected to peak in the early afternoon).

Bioassessment scores

AusRivAS taxonomic richness: 27 (combined bed and edge); PET richness: 2; SIGNAL 2 score: 3.04; tolerant taxa: 58%.

Overall aquatic values

Late wet season: **High** (permanent waterbody); Early wet: See previous site profile.



Site Code: P6 **Location:** Palustrine wetland, Iffley **Stream order:** NA **Latitude:** -22.2272 **Longitude:** 148.3538 **Date:** 25/06/2017 **Season:** Late wet


North


East


South


West

General Site Description

Site attributes

Palustrine wetland; mapped as referable wetland of General Ecological Significance (GES); dry at the time of assessment; no erosion detected; wetted habitat reduced to small isolated pool approx. 10 m^2 and 0.05 m deep; habitat features include macrophytes; substrates comprised 95% silt/clay (<0.05 mm) and 5% sand (0.05-2 mm); upstream and adjacent landuse includes moderate grazing on cleared land.

Aquatic and riparian vegetation

Non-remnant vegetation. Tree layer absent. Very sparse shrub layer, comprising dead finish (*Archidendropsis basaltica*), bean tree (*Cassia brewsteri*) and *Acacia* sp. Ground layer dominated by brown beetle grass (*Diplachne fusca* var. *fusca*), with frequent forest bluegrass (*Bothriochloa bladhii*), Queensland bluegrass (*Dicanthium sericeum*) and curly bluegrass (*D. fecundum*). Isolated pool contains rice sedge (*Cyperus difformis*), tall flatsedge (*C. exaltatus*), native hyacinth (*Monochoria cyanea*), starfruit (*Damasonium minus*) and awnless barnyard grass (*Echinochloa colona*)*.

Erosion risk

Low – Banks appeared to be stable, and over 80% of surfaces covered by vegetation.

Aquatic fauna, including breeding habitat

The wetland is unlikely to provide habitat for fish, turtles or platypus (*Ornithorhynchus anatinus*). May provide temporary habitat for aquatic macroinvertebrates, frogs and wader birds for short duration following substantial rainfall and runoff events.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

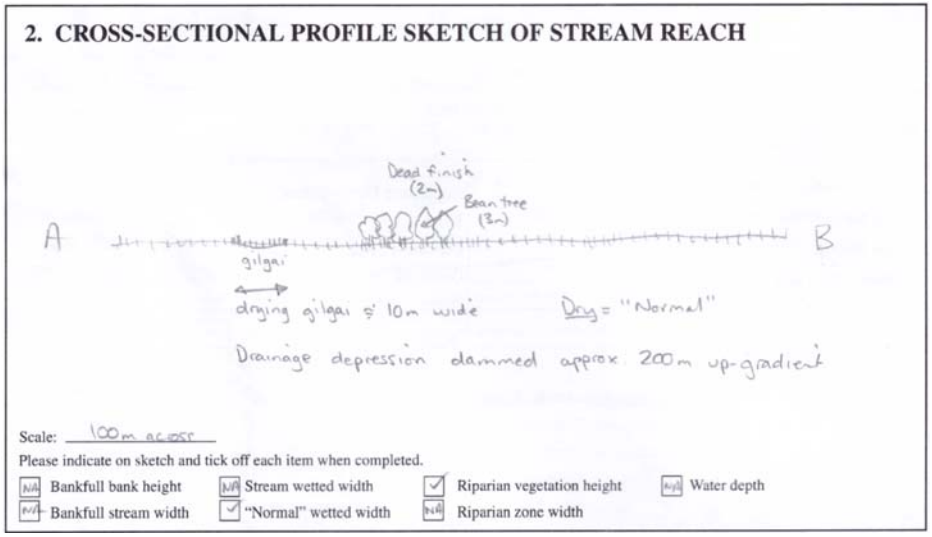
No EVNT or SLC aquatic flora or fauna species were detected at the time of the site visit. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The wetland lacks habitat features for these species.

Physico-chemical water quality

Wetland was essentially dry at the time of assessment. Summary: Normal.

Overall aquatic values

Late wet season: **Moderate** (wetland of GES; known presence of Priority flora species); Early wet: Expected to be **Moderate**.



Site Code: P7 **Location:** Palustrine wetland, Winchester **Stream order:** NA **Latitude:** -22.1417 **Longitude:** 148.2941 **Date:** 4/10/2017 **Season:** Early wet


North


East


South


West

General Site Description

Site attributes

Palustrine wetland on closed depression of the Isaac River floodplain; mapped as referable wetland of General Ecological Significance (GES); no erosion detected; wetland dry at the time of early wet assessment; bankfull extent approx. 310 m x 150 m; and bankfull height approx. 1 m (from the bed); substrates comprised 5% sand (0.05-2 mm) and 95% silt/clay (<0.05 mm); moderate cover of emergent macrophytes.

Aquatic and riparian vegetation

Wetland comprises RE 11.3.27f. Fringing woodland approximately 20 m wide, dominated by forest red gum (*Eucalyptus tereticornis*) and coolabah (*E. coolabah*), with occasional carbeen (*Corymbia tessellaris*) and poplar box (*E. populnea*). Very sparse sub canopy of forest red gum and coolabah; Very sparse shrub layer of coolabah regrowth. Open areas contained a diversity of emergent wetland plants. Emergent macrophytes included rice sedge (*Cyperus difformis*), tall flatsedge (*C. exaltatus*), brown beetle grass (*Diplachne fusca* var. *fusca*), white eclipta (*Eclipta prostrata*)*, water chestnut (*Eleocharis dulcis*), pale spikerush (*E. pallens*), *E. philippinensis*, ribbed spikerush (*E. plana*), native willow primrose (*Ludwigia octovalvis*), smartweed (*Persicaria attenuata*) and spiny mudgrass (*Pseudoraphis spinescens*).

Erosion risk

Low – Banks appeared to be stable, and over 80% of surfaces covered by vegetation.

Aquatic fauna, including breeding habitat

The wetland may provide temporary foraging and breeding habitat for fish and turtles following substantial rainfall and runoff events, or following flooding of the Isaac River. Unlikely habitat for platypus (*Ornithorhynchus anatinus*). May provide temporary habitat for aquatic macroinvertebrates, frogs and wader birds for short durations when wet.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species were detected during the site visit. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The wetland lacks habitat features for these species. Priority flora species included tall flatsedge (*C. exaltatus*), and water chestnut (*E. dulcis*).

Physico-chemical water quality

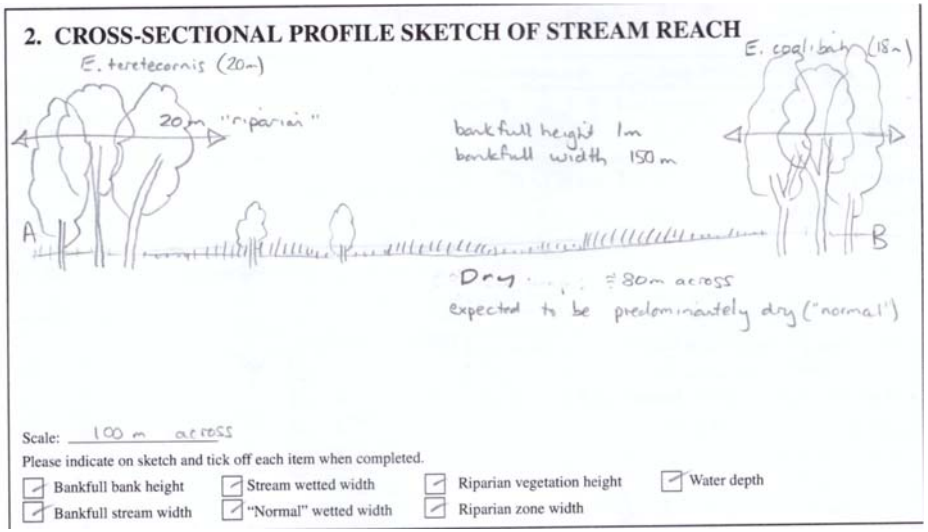
Dry at the time of assessment

Bioassessment scores

Dry at the time of assessment

Overall aquatic values

Early wet season: **Moderate** (wetland of GES; known presence of Priority species); Late wet: See following site profile.



Site Code: P7 **Location:** Palustrine wetland, Winchester **Stream order:** NA **Latitude:** -22.1417 **Longitude:** 148.2941 **Date:** 22/06/2017 **Season:** Late wet


North


East


South


West

General Site Description

Site attributes

Palustrine wetland on closed depression of the Isaac River floodplain; mapped as referable wetland of General Ecological Significance (GES); no erosion detected; wetland approximately 250 m long, 90 m wide; ranging in depth from 0.0 – 0.4 m, with mean depth 0.2 m (estimated); bankfull extent approx. 310 m x 150 m; and bankfull height approx. 1 m (from the bed); in-stream habitat included shallow (<0.5 m) pools, large woody debris and macrophytes; substrates comprised 5% sand (0.05-2 mm) and 95% silt/clay (<0.05 mm); extensive cover of submerged and emergent macrophytes; water level receding/drying.

Aquatic and riparian vegetation

Wetland comprises RE 11.3.27f. Fringing woodland approximately 20 m wide, dominated by forest red gum (*Eucalyptus tereticornis*) and coolabah (*E. coolabah*), with occasional carbeen (*Corymbia tessellaris*) and poplar box (*E. populnea*). Very sparse sub canopy of forest red gum and coolabah; Very sparse shrub layer of coolabah regrowth. Open areas contained a diversity of wetland plants. Submerged macrophytes included water nymph (*Najas tenuifolia*), bladderwort (*Utricularia* sp.) and charophyte algae (*Chara* / *Nitella* sp.). Emergent macrophytes included rice sedge (*Cyperus difformis*), tall flatsedge (*C. exaltatus*), starfruit (*Damasonium minus*), brown beetle grass (*Diplachne fusca* var. *fusca*), white eclipta (*Eclipta prostrata*)*, water chestnut (*Eleocharis dulcis*), pale spikerush (*E. pallens*), *E. philippinensis*, ribbed spikerush (*E. plana*), native willow primrose (*Ludwigia octovalvis*), shiny nardoo (*Marsilea mutica*), wavy marshwort (*Nymphoides crenata*), smartweed (*Persicaria attenuata*) and spiny mudgrass (*Pseudoraphis spinescens*).

Erosion risk

Low – Banks appeared to be stable, and over 80% of surfaces covered by vegetation.

Aquatic fauna, including breeding habitat

The wetland may provide temporary foraging and breeding habitat for fish and turtles following substantial rainfall and runoff events, or following flooding of the Isaac River. Unlikely habitat for platypus (*Ornithorhynchus anatinus*). May provide temporary habitat for aquatic macroinvertebrates, frogs and wader birds for short durations when wet. No fish were detected at the time of assessment, despite thorough backpack electrofishing effort. No macrocrustaceans were detected. A high diversity of other aquatic macroinvertebrates were collected (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species were detected during the site visit. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The wetland lacks habitat features for these species. Priority flora species included tall flatsedge (*C. exaltatus*), water chestnut (*E. dulcis*) and water nymph (*Najas tenuifolia*).

Physico-chemical water quality

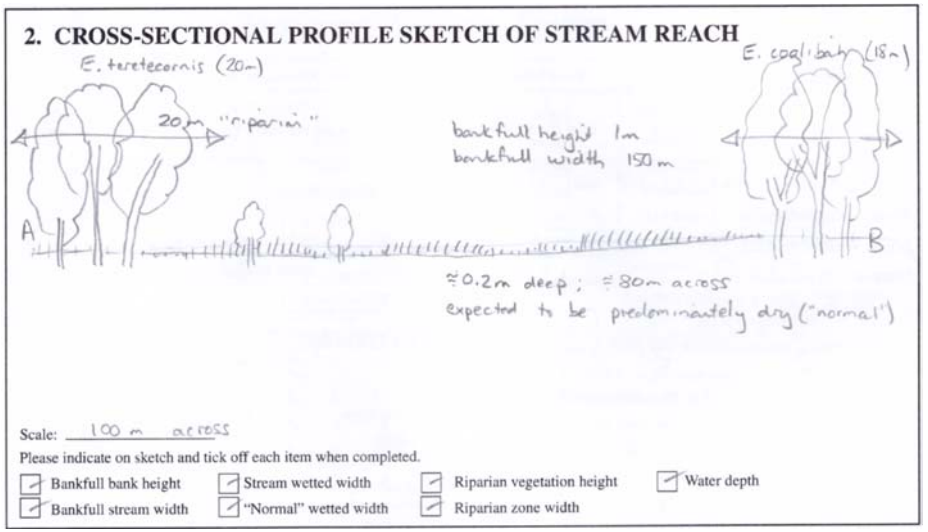
Collection time: 10:30 EST; water temp.: 13.3 °C; conductivity: 66 µS/cm (fresh); turbidity: 3.1 NTU (high clarity); dissolved oxygen: 60.1%, 6.7 mg/L (low); pH 7.2 (neutral). Summary: normal (diurnal range in DO expected to be extreme as a result of extensive submerged macrophyte cover, and low water level; DO levels are expected to peak in the early afternoon).

Bioassessment scores

AusRivAS taxonomic richness: 26 (combined bed and edge); PET richness: 2; SIGNAL 2 score: 2.83; tolerant taxa: 65%.

Overall aquatic values

Late wet season: **Moderate** (wetland of GES; known presence of Priority species); Early wet: See previous site profile.



Site Code: P8 **Location:** Palustrine wetland, Wynette **Stream order:** NA **Latitude:** -22.1695 **Longitude:** 148.3246 **Date:** 4/10/2017 **Season:** Early wet


North


East


South


West

General Site Description

Site attributes

Palustrine wetland on closed depression of the Isaac River floodplain; mapped as referable wetland of General Ecological Significance (GES); no erosion detected; wetland dry at the time of early wet assessment; bankfull extent approx. 200 m diameter; and bankfull height approx. 0.8 (from the bed); bed substrates comprised approx. 80% sand (0.05-2 mm) and 20% silt/clay (<0.05 mm); upstream and adjacent landuse includes moderate cattle grazing in predominantly remnant vegetation.

Aquatic and riparian vegetation

Wetland comprises RE 11.5.17 – Palustrine wetland; forest red gum (*Eucalyptus tereticornis*) woodland in depressions on Cainozoic sand plans and remnant surfaces. Vegetation comprised woodland with sparse canopy dominated by forest red gum, with surrounding vegetation dominated by poplar box (*E. populnea*). No discernible sub-canopy. Sparse shrub layer of young forest red gum. Ground layer dominated by brown beetle grass (*Diplachne fusca* var. *fusca*), with abundant *Cyperus victoriensis* and clustered lovegrass (*Eragrostis elongata*), frequent white eclipta (*Eclipta prostrata*)* and common couch (*Cynodon dactylon*). Fringing and emergent macrophytes included *C. victoriensis*, tall flatsedge (*Cyperus exaltatus*), brown beetle grass (*Diplachne fusca* var. *fusca*), native willow primrose (*Ludwigia octovalvis*), smartweed (*Persicaria attenuata*) and white eclipta*.

Erosion risk

Low – Banks appeared to be stable, and over 80% of surfaces covered by vegetation.

Aquatic fauna, including breeding habitat

The wetland may provide marginal foraging and breeding habitat for fish during, and for a number of months following, flooding events in the Isaac River. Provides potential foraging habitat for turtles during, and for a number of months following, rainfall and runoff events in the local catchment. Lacks suitable foraging or breeding habitat for platypus (*Ornithorhynchus anatinus*).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

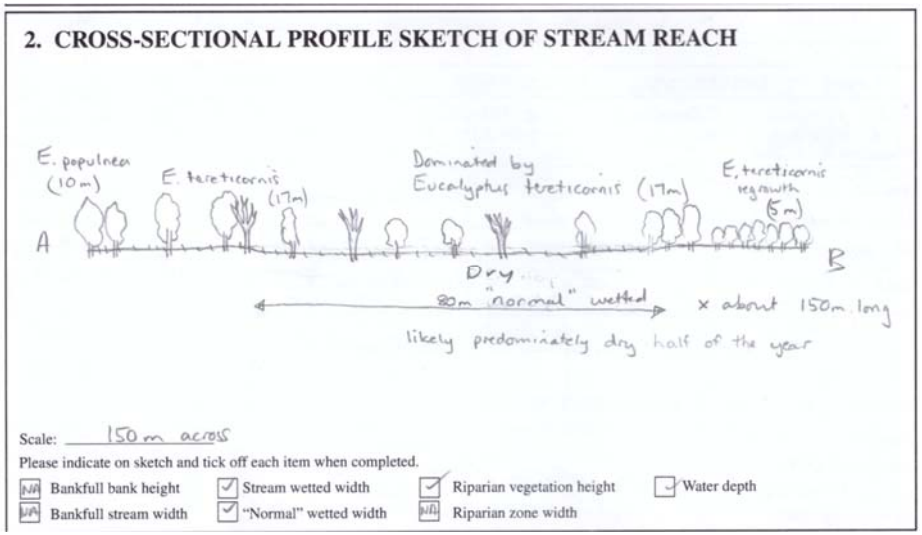
No EVNT or SLC aquatic flora or fauna species are likely to inhabit this wetland. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The wetland lacks habitat features suitable for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

Physico-chemical water quality

Dry at the time of assessment

Overall aquatic values

Early wet season: **Moderate** (wetland of GES; known presence of Priority species); Late wet: See following site profile.



Site Code: P8 **Location:** Palustrine wetland, Wynette **Stream order:** NA **Latitude:** -22.1695 **Longitude:** 148.3246 **Date:** 24/06/2017 **Season:** Late wet


North


East


South


West

General Site Description

Site attributes

Palustrine wetland on closed depression of the Isaac River floodplain; mapped as referable wetland of General Ecological Significance (GES); no erosion detected; wetland approximately 80 m diameter; water level receding/senescing; to approx. 0.2 m deep; bankfull extent approx. 200 m diameter; and bankfull height approx. 0.8 (from the bed); in-stream habitat included shallow (<0.5 m) pools, large woody debris and macrophytes; bed substrates comprised approx. 80% sand (0.05-2 mm) and 20% silt/clay (<0.05 mm); extensive periphytic algae. Upstream and adjacent landuse includes moderate cattle grazing in predominantly remnant vegetation.

Aquatic and riparian vegetation

Wetland comprises RE 11.5.17 – Palustrine wetland; forest red gum (*Eucalyptus tereticornis*) woodland in depressions on Cainozoic sand plans and remnant surfaces. Vegetation comprised woodland with sparse canopy dominated by forest red gum, with surrounding vegetation dominated by poplar box (*E. populnea*). No discernible sub-canopy. Sparse shrub layer of young forest red gum. Ground layer dominated by brown beetle grass (*Diplachne fusca* var. *fusca*), with abundant *Cyperus victoriensis* and clustered lovegrass (*Eragrostis elongata*), frequent white eclipta (*Eclipta prostrata*)* and common couch (*Cynodon dactylon*). Fringing and emergent macrophytes included *C. victoriensis*, tall flatsedge (*Cyperus exaltatus*), native willow primrose (*Ludwigia octovalvis*), smartweed (*Persicaria attenuata*) and white eclipta*.

Erosion risk

Low – Banks appeared to be stable, and over 80% of surfaces covered by vegetation.

Aquatic fauna, including breeding habitat

The wetland may provide marginal foraging and breeding habitat for fish during, and for a number of months following, flooding events in the Isaac River. Provides potential foraging habitat for turtles during, and for a number of months following, rainfall and runoff events in the local catchment. Lacks suitable foraging or breeding habitat for platypus (*Ornithorhynchus anatinus*). No fish observed at the time of assessment. Aquatic fauna survey not undertaken, only habitat assessment.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species are likely to inhabit this wetland. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The wetland lacks habitat features suitable for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

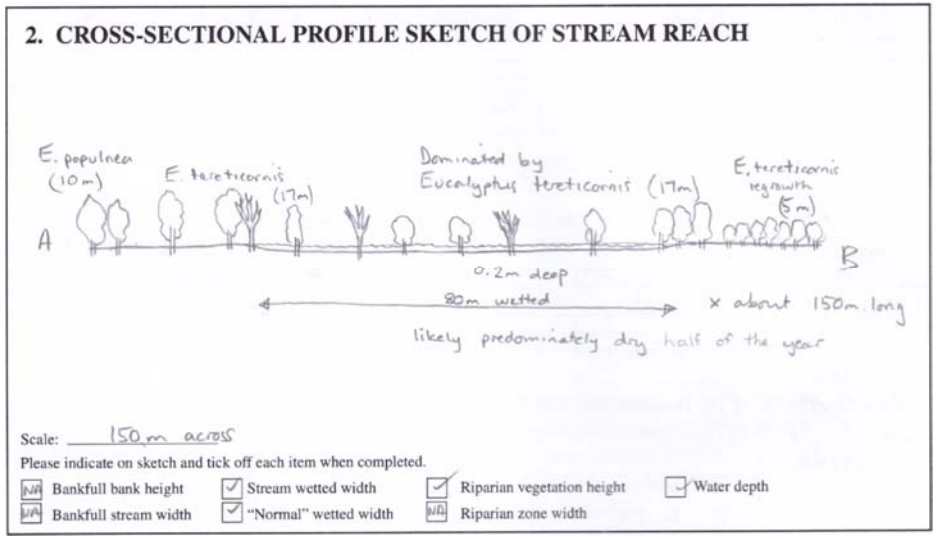
Physico-chemical water quality

Collection time: 10:15 EST; water temp.: 18.2 °C; conductivity: 175 µS/cm (fresh); turbidity: 10.5 NTU (high clarity); dissolved oxygen: 41.5%, 3.5 mg/L (low); pH 7.1 (neutral).

Summary: Normal (diurnal range in DO expected to be extreme as a result of extensive periphytic algae and breakdown of organic matter [inundated terrestrial grasses]; DO levels are expected to peak in the early afternoon).

Overall aquatic values

Late wet season: **Moderate** (wetland of GES; known presence of Priority species); Early wet: See previous site profile.



Site Code: P9 **Location:** Palustrine wetland, Winchester **Stream order:** NA **Latitude:** -22.1494 **Longitude:** 148.3017 **Date:** 5/10/2017 **Season:** Early wet


North


East


South


West

General Site Description

Site attributes

Palustrine wetland on closed depression of the Isaac River floodplain; mapped as referable wetland of General Ecological Significance (GES); no erosion detected; dry at the time of assessment; wetland bankfull extent approx. 500 m x 150 m; and bankfull height approx. 1 m (from the bed); moderate cover of emergent macrophytes; substrates comprised 100% silt/clay (<0.05 mm); upstream and adjacent landuse includes moderate grazing on cleared land.

Aquatic and riparian vegetation

Wetland comprises RE 11.3.27f. Fringing woodland dominated by coolabah (*Eucalyptus coolabah*), with occasional brigalow (*Acacia harpophylla*). Very sparse shrub layer comprising of bean tree (*Cassia brewsteri*) and lantana (*Lantana camara*)*. Ground layer dominated by red Natal grass (*Melinis repens*)*, tall oat grass (*Themeda avenacea*), black speargrass (*Heteropogon contortus*), Paddy's lucerne (*Sida rhombifolia*)* and buffel grass (*Cenchrus ciliaris*)*. Emergent macrophytes included *Cyperus concinnus*,), tall flatsedge (*Cyperus exaltatus*), awnless barnyard grass (*Echinochloa colona*), pale spikerush (*Eleocharis pallens*), *Eleocharis philippinensis*, ribbed spikerush (*Eleocharis plana*), common rush (*Juncus usitatus*), umbrella canegrass (*Leptochloa digitata*), native willow primrose (*Ludwigia octovalvis*), and common nardoo (*Marsilea drummondii*).

Erosion risk

Low – Banks appeared to be stable, and over 80% of surfaces covered by vegetation.

Aquatic fauna, including breeding habitat

The wetland may provide temporary foraging and breeding habitat for fish and turtles following substantial rainfall and runoff events, or following flooding of the Isaac River. Not suitable habitat for platypus (*Ornithorhynchus anatinus*). May provide temporary habitat for aquatic macroinvertebrates, frogs and wader birds for short durations when wet.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

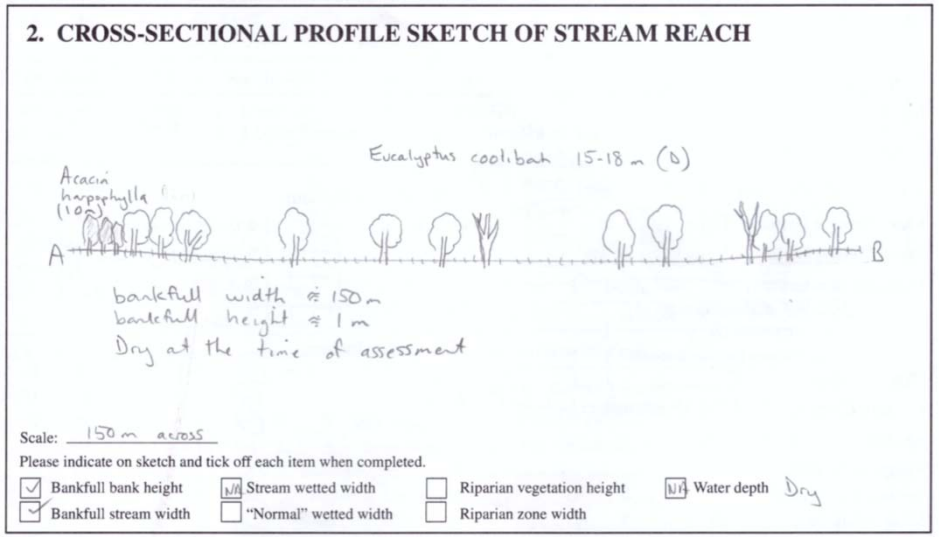
No EVNT or SLC aquatic flora or fauna species were detected during the site visit. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The wetland lacks habitat features for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

Physico-chemical water quality

Wetland was dry at the time of assessment.

Overall aquatic values

Early wet season: **Moderate** (wetland of GES; known presence of Priority flora species); Late wet: Expected to be **Moderate**.



Site Code: L1 **Location:** Mapped lacustrine wetland, Iffley **Stream order:** NA **Latitude:** -22.1797 **Longitude:** 148.3778 **Date:** 5/07/2017 **Season:** Late wet

North

East

South

West

General Site Description

Site attributes

Palustrine wetland, mapped as lacustrine; no erosion detected; dry at the time of assessment; bankfull extent approx. 140 m x 80 m; bankfull height approx. 0.5 m; substrates comprised 100% sand (0.05-2 mm); extensive cover of grasses and sedges, primarily wetland species. Upstream and adjacent landuse includes moderate cattle grazing on agricultural grassland cleared of remnant vegetation.

Aquatic and riparian vegetation

Wetland comprises non-remnant vegetation. Isolated regrowth (to a height of 7 m) of poplar gum (*Eucalyptus platyphylla*), poplar box (*E. populnea*), Clarkson's bloodwood (*Corymbia clarksoniana*), beefwood (*Grevillea striata*) and bean tree (*Cassia brewsteri*). Ground layer dominated by sneezeweed (*Centipeda minima*), lesser joyweed (*Alternanthera denticulata*) and wetland indicator species, including brown beetle grass (*Diplachne fusca* var. *fusca*), rice sedge (*Cyperus difformis*), tall flatsedge (*C. exaltatus*), *C. concinnus*, awnless barnyard grass (*Echinochloa colona*), white eclipta (*Eclipta prostrata*)*, common rush (*Juncus usitatus*), native hyacinth (*Monochoria cyanea*) and wavy marshwort (*Nymphoides crenata*).

Erosion risk

Low – banks stable, and over 80% of surfaces covered by vegetation.

Aquatic fauna, including breeding habitat

The wetland provides negligible habitat for fish, turtles or platypus. May provide temporary habitat for aquatic macroinvertebrates, frogs and wader birds for short duration following substantial rainfall and runoff events.

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species were detected during the site visit. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The wetland lacks habitat features suitable for these species. Priority flora species included tall flatsedge (*C. exaltatus*) and native hyacinth (*M. cyanea*).

Physico-chemical water quality

Dry at the time of assessment

Overall aquatic values

Late wet season: **Low**; Early wet: expected to be **Low**.

Site Code: L2 **Location:** Lacustrine wetland, Iffley **Stream order:** NA **Latitude:** -22.1837 **Longitude:** 148.3534 **Date:** 6/10/2017 **Season:** Early wet


North


East


South


West

General Site Description

Site attributes

Lacustrine wetland, with some palustrine components; no erosion detected; dammed at eastern end; wetland approximately 600 m long, 250 m wide, and >2 m deep near the dam wall, more commonly 0.5 deep throughout broader waterbody; in-stream habitat included shallow (<0.5 m) pool, deep pool, large woody debris and macrophytes; substrates comprised 100% silt/clay (<0.05 mm); extensive cover of submerged and emergent macrophytes; high diversity of waterbirds utilising this water body; likely forms an important dry season refuge for waterbirds inhabiting the Study area.

Aquatic and riparian vegetation

Waterbody positioned within non-remnant vegetation. Fringing vegetation dominated by poplar box (*Eucalyptus populnea*). Shrub layer lacking. Submerged macrophytes included red watermilfoil (*Myriophyllum verrucosum*), water nymph (*Najas tenuifolia*) and curly pondweed (*Potamogeton crispus*). Fringing and emergent macrophytes included red watermilfoil (*Myriophyllum verrucosum*), water nymph (*Najas tenuifolia*), curly pondweed (*Potamogeton crispus*) and floating pondweed (*Potamogeton sulcatus*). Fringing and emergent macrophytes included tall flatsedge (*Cyperus exaltatus*), brown beetle grass (*Diplachne fusca* var. *fusca*), white eclipta (*Eclipta prostrata*)*, common rush (*Juncus usitatus*), umbrella canegrass (*Leptochloa digitata*), native willow primrose (*Ludwigia octovalvis*), water primrose (*Ludwigia peploides* subsp. *montevidensis*), common nardoo (*Marsilea drummondii*), hairy nardoo (*M. hirsuta*), smartweed (*Persicaria attenuata*), slender knotweed (*P. decipiens*), and spiny mudgrass (*Pseudoraphis spinescens*).

Erosion risk

Low – banks stable, and over 80% of surfaces covered by vegetation.

Aquatic fauna, including breeding habitat

The wetland provides potential foraging and breeding habitat for fish and turtles. Unlikely habitat for platypus (*Ornithorhynchus anatinus*). Survey effort included backpack electrofishing and overnight deployment of two baited fyke nets, two baited cathedral traps and five baited box traps. Fish species detected included Agassiz's glassfish (*Ambassis agassizii*), flyspecked hardyhead (*Craterocephalus stercusmuscarum*), gudgeon (*Hypseleotris* sp.), spangled perch (*Leiopotherapon unicolor*), eastern rainbowfish (*Melanotaenia splendida splendida*), purple-spotted gudgeon (*Mogurnda adspersa*), bony bream (*Nematalosa erebi*), Hyrtyl's tandan (*Neosilurus hyrtlii*), Rendahl's tandan (*Porochilus rendahli*), and the pest

species tilapia (*Oreochromus mossambicus*)*. Turtles included Krefft's river turtle (*Emydura macquarii krefftii*). Macro-crustaceans included freshwater shrimp (*Paratya australiense*) and freshwater prawn (*Macrobrachium australiense*). A diversity of other aquatic macroinvertebrates were collected in the combined bed/edge sample (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species were detected during the site visit. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The wetland lacks habitat features suitable for these species. Priority flora species included tall flatsedge (*C. exaltatus*), red milfoil (*M. verrocosum*) and water nymph (*Nanas tenuifolia*).

Physico-chemical water quality

Collection time: 11:40 EST; water temp.: 29.7°C; conductivity: 177 µS/cm (fresh); turbidity: 11.8 NTU (high clarity); dissolved oxygen: 122.4%, 9.5 mg/L (saturated); pH 8.8 (strongly alkaline). Summary: Normal (strongly alkaline pH levels likely a reflection of high contact time with substrates).

Bioassessment scores

AusRivAS taxonomic richness: 33 (combined bed and edge); PET richness: 3; SIGNAL 2 score: 2.83; tolerant taxa: 67%.

Overall aquatic values

Early wet season: **High** (permanent waterbody); Early wet: See following site profile

Site Code: L2 **Location:** Lacustrine wetland, Iffley **Stream order:** NA **Latitude:** -22.1837 **Longitude:** 148.3534 **Date:** 4/07/2017 **Season:** Late wet


North


East


South


West

General Site Description

Site attributes

Lacustrine wetland, with some palustrine components; no erosion detected; dammed at eastern end; wetland approximately 600 m long, 250 m wide, and >2 m deep near the dam wall, more commonly 0.5 deep throughout broader waterbody; in-stream habitat included shallow (<0.5 m) pool, deep pool, large woody debris and macrophytes; substrates comprised 100% silt/clay (<0.05 mm); extensive cover of submerged and emergent macrophytes; high diversity of waterbirds utilising this water body; likely forms an important dry season refuge for waterbirds inhabiting the Study area.

Aquatic and riparian vegetation

Waterbody positioned within non-remnant vegetation. Fringing vegetation dominated by poplar box (*Eucalyptus populnea*). Shrub layer lacking. Submerged macrophytes included red watermilfoil (*Myriophyllum verrucosum*), water nymph (*Najas tenuifolia*) and curly pondweed (*Potamogeton crispus*). Fringing and emergent macrophytes included red watermilfoil (*Myriophyllum verrucosum*), water nymph (*Najas tenuifolia*), curly pondweed (*Potamogeton crispus*) and floating pondweed (*Potamogeton sulcatus*). Fringing and emergent macrophytes included tall flatsedge (*Cyperus exaltatus*), brown beetle grass (*Diplachne fusca* var. *fusca*), white eclipta (*Eclipta prostrata*)*, *E. philippinensis*, umbrella canegrass (*Leptochloa digitata*), native willow primrose (*Ludwigia octovalvis*), water primrose (*Ludwigia peploides* subsp. *montevidensis*), common nardoo (*Marsilea drummondii*), hairy nardoo (*M. hirsuta*), shiny nardoo (*M. mutica*), smartweed (*Persicaria attenuata*) and spiny mudgrass (*Pseudoraphis spinescens*).

Erosion risk

Low – banks stable, and over 80% of surfaces covered by vegetation.

Aquatic fauna, including breeding habitat

The wetland provides potential foraging and breeding habitat for fish and turtles. Unlikely habitat for platypus (*Ornithorhynchus anatinus*). Survey effort included backpack electrofishing and overnight deployment of two baited fyke nets, two baited cathedral traps and five baited box traps. Fish species detected included Agassiz's glassfish (*Ambassis agassizii*), flyspecked hardyhead (*Craterocephalus stercusmuscarum*), gudgeon (*Hypseleotris* sp.), spangled perch (*Leiopotherapon unicolor*), eastern rainbowfish (*Melanotaenia splendida splendida*), purple-spotted gudgeon (*Mogurnda adspersa*), bony bream (*Nematalosa erebi*), Australian smelt (*Retropinna semoni*), freshwater catfish (*Tandanus tandanus*) and the pest

species tilapia (*Oreochromus mossambicus*)*. Turtles included Krefft's river turtle (*Emydura macquarii krefftii*). Macro-crustaceans included freshwater shrimp (*Paratya australiense*) and freshwater prawn (*Macrobrachium australiense*). A diversity of other aquatic macroinvertebrates were collected in the combined bed/edge sample (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species were detected during the site visit. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The wetland lacks habitat features suitable for these species. Priority flora species included tall flatsedge (*C. exaltatus*), red milfoil (*M. verrocosum*) and water nymph (*Nanas tenuifolia*).

Physico-chemical water quality

Collection time: 10:45 EST; water temp.: 19.9°C; conductivity: 152 µS/cm (fresh); turbidity: 8.2 NTU (high clarity); dissolved oxygen: 103.4%, 9.2 mg/L (saturated); pH 8.7 (strongly alkaline). Summary: Normal (strongly alkaline pH levels likely a reflection of high contact time with substrates).

Bioassessment scores

AusRivAS taxonomic richness: 29 (combined bed and edge); PET richness: 3; SIGNAL 2 score: 3.08; tolerant taxa: 62%.

Overall aquatic values

Late wet season: **High** (permanent waterbody); Early wet: See previous site profile.

Site Code: L3 **Location:** Lacustrine wetland, Iffley **Stream order:** NA **Latitude:** -22.1837 **Longitude:** 148.3534 **Date:** 5/10/2017 **Season:** Early wet


North


East


South


West

General Site Description

Site attributes

Lacustrine wetland, including dam, on unmapped drainage feature; contains both lacustrine and palustrine components, but predominantly lacustrine; no local catchment erosion detected; >2 m deep in some sections; in-stream habitat included shallow (<0.5 m) pool, deep pool and macrophytes; substrates comprised 100% silt/clay (<0.05 mm); fringing macrophytes extensive.

Aquatic and riparian vegetation

Non-remnant vegetation. Scattered poplar box (*Eucalyptus populnea*) in fringing vegetation. Ground layer dominated by tall flatsedge (*Cyperus exaltatus*), with abundant brown beetle grass (*Diplachne fusca* var. *fusca*). Other macrophytes included tall flatsedge (*C. exaltatus*), brown beetle grass (*Diplachne fusca* var. *fusca*), awnless barnyard grass (*Echinochloa colona*)*, umbrella canegrass (*Leptochloa digitata*), native willow primrose (*Ludwigia octovalvis*), water primrose (*Ludwigia peploides* subsp. *montevidensis*), smartweed (*Persicaria attenuata*) common nardoo (*Marsilea drummondii*), shiny nardoo (*M. mutica*), hairy nardoo (*M. hirsuta*), water nymph (*Najas tenuifolia*), ferny azolla (*Azolla pinnatta*), and swamp lily (*Ottelia ovalifolia*).

Erosion risk

Low – banks appear to be stable, and over 80% of surfaces covered by vegetation.

Aquatic fauna, including breeding habitat

Aquatic fauna not surveyed (habitat assessment only). The wetland provides potential foraging and breeding habitat for fish and turtles. The wetland lacks habitat features suitable for platypus (*Ornithorhynchus anatinus*).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species were detected during the site visit. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The wetland lacks habitat features suitable for these species. Priority flora species included tall flatsedge (*C. exaltatus*) and water nymph (*N. tenuifolia*),

Physico-chemical water quality

Collection time: 16:30 EST; water temp.: 33.4 °C; conductivity: 223 µS/cm (fresh); turbidity: 38.1 NTU (moderate clarity); dissolved oxygen: 98.0%, 7.2 mg/L (saturated); pH 8.5 (strongly alkaline). Summary: Normal (strongly alkaline pH levels likely a reflection of high contact time with substrates).

Overall aquatic values

Early wet season: **High** (permanent waterbody); Late wet: See following site profile.

Site Code: L3 **Location:** Lacustrine wetland, Iffley **Stream order:** NA **Latitude:** -22.1837 **Longitude:** 148.3534 **Date:** 4/07/2017 **Season:** Late wet

North

East

South

West

General Site Description

Site attributes

Lacustrine wetland, including dam, on unmapped drainage feature; contains both lacustrine and palustrine components, but predominantly lacustrine; no local catchment erosion detected; >2 m deep in some sections; in-stream habitat included shallow (<0.5 m) pool, deep pool and macrophytes; substrates comprised 100% silt/clay (<0.05 mm); fringing macrophytes extensive.

Aquatic and riparian vegetation

Non-remnant vegetation. Scattered poplar box (*Eucalyptus populnea*) in fringing vegetation. Ground layer dominated by tall flatsedge (*Cyperus exaltatus*), with abundant brown beetle grass (*Diplachne fusca* var. *fusca*). Other fringing macrophytes included rice sedge (*Cyperus difformis*), tall flatsedge (*C. exaltatus*), starfruit (*Damasonium minus*), awnless barnyard grass (*Echinochloa colona*)*, white eclipta (*Eclipta prostrata*)*, umbrella canegrass (*Leptochloa digitata*), native willow primrose (*Ludwigia octovalvis*), water primrose (*Ludwigia peploides* subsp. *montevidensis*), shiny nardoo (*Marsilea mutica*), hairy nardoo (*M. hirsuta*) and swamp lily (*Ottelia ovalifolia*).

Erosion risk

Low – banks appear to be stable, and over 80% of surfaces covered by vegetation.

Aquatic fauna, including breeding habitat

Aquatic fauna not surveyed (habitat assessment only). The wetland provides potential foraging and breeding habitat for fish and turtles. The wetland lacks habitat features suitable for platypus (*Ornithorhynchus anatinus*).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species were detected during the site visit. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The wetland lacks habitat features suitable for these species. Priority flora species included tall flatsedge (*C. exaltatus*).

Physico-chemical water quality

Collection time: 16:35 EST; water temp.: 22.2 °C; conductivity: 179 µS/cm (fresh); turbidity: 33.8 NTU (moderate clarity); dissolved oxygen: 115.0%, 10.0 (saturated); pH 7.8 (mildly alkaline). Summary: Normal.

Overall aquatic values

Late wet season: **High** (permanent waterbody); Early wet: See previous site profile.

Site Code: L4 **Location:** Lacustrine wetland, Olive Downs **Stream order:** NA **Latitude:** -22.1641 **Longitude:** 148.4024 **Date:** 19/11/2017 **Season:** Early wet


North


East


South


West

General Site Description

Site attributes

Large dammed lacustrine wetland diverting waters from a steam order three watercourse; no erosion detected; in-stream habitat included shallow (<0.5 m) pool, deep pool and macrophytes; substrates comprised 100% silt/clay (<0.05 mm); little fringing and submergent macrophytes around margins; upstream and adjacent landuse includes moderate grazing on cleared land.

Aquatic and riparian vegetation

Wetland comprises non-remnant vegetation. Isolated regrowth of narrow-leaved ironbark (*E. crebra*) Clarkson's bloodwood (*C. clarksoniana*), forest red gum (*E. tereticornis*), and poplar box (*E. populnea*). Ground layer with red Natal grass (*Melinis repens*)*, kangaroo grass (*Themeda triandra*), common rush (*Juncus usitatus*), umbrella canegrass (*Leptochloa digitata*), lovegrass (*Eragrostis* sp.), wiregrass (*Aristida* sp.) and tall flatsedge (*Cyperus exaltatus*). Fringing and emergent macrophytes include; tall flatsedge (*C. exaltatus*), white eclipta (*Eclipta prostrata*)*, common rush (*J. usitatus*), native willow primrose (*Ludwigia octovalvis*), water primrose (*Ludwigia peploides* subsp. *montevidensis*), red watermilfoil (*Myriophyllum verrucosum*), smartweed (*Persicaria attenuata*), slender knotweed (*Persicaria decipiens*), and cumbungi (*Typha orientalis*).

Erosion risk

Low – banks appear to be stable, and over 80% of surfaces covered by vegetation.

Aquatic fauna, including breeding habitat

The wetland provides potential foraging and breeding habitat for fish and turtles. Unlikely habitat for platypus (*Ornithorhynchus anatinus*). Survey effort included backpack electrofishing and overnight deployment of two baited fyke nets, two baited cathedral traps and five baited box traps. Fish species detected included flyspecked hardyhead (*Craterocephalus stercusmuscarum*), gudgeon (*Hypseleotris* sp.), spangled perch (*Leiopotherapon unicolor*), eastern rainbowfish (*Melanotaenia splendida splendida*), bony bream (*Nematalosa erebi*), sleepy cod (*Oxyeleotris lineolata*), Rendahl's tandan (*Porochilus rendahli*). Turtles included Eastern snake-necked turtle (*Chelodina longicollis*). Macro-crustaceans included freshwater shrimp (*Paratya australiense*), freshwater prawn (*Macrobrachium australiense*) and orange-fingered crayfish (*Cherax depressus*). A diversity of other aquatic macroinvertebrates were collected in the combined bed/edge sample (Appendix C).

Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT or SLC aquatic flora or fauna species were detected during the site visit. The Critically Endangered (EPBC Act) southern snapping turtle (*Elseya albagula*), Vulnerable Fitzroy River turtle (*Rheodytes leukops*) and Critically Endangered silver perch (*Bidyanus bidyanus*) are recorded from the Isaac River catchment (DEHP 2017). The wetland lacks habitat features suitable for these species. Priority flora species included tall flatsedge (*C. exaltatus*) and red watermilfoil (*M. verrucosum*),

Physico-chemical water quality

Collection time: 10:00 EST; water temp.: 25.1 °C; conductivity: 157 µS/cm (fresh); turbidity: 310 NTU (high); dissolved oxygen: 98.0%, 7.8 mg/L (saturated); pH 8.0 (moderately alkaline). Summary: Normal.

Overall aquatic values

Early wet season: **High** (permanent waterbody); Late wet: Expected to be **High**.

Appendix C: Aquatic Flora and Fauna Data

Table C1A Aquatic flora detected within the riverine aquatic survey sites (R1-R12) during the pre-wet and post-wet surveys

Species name	Common name	R1	R1	R2	R2	R3	R3	R4	R4	R5	R5	R6	R6	R7	R7	R8	R8	R9	R9	R10	R10	R11	R11	R12	R12
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet
Surveyed:		2016	x	2016	x	2016	2017	x	2017	2016	2017	2016	2017	x	2017	2016	2017	2017	2017	2017	2017	2017	2017	2017	2017
Azolla pinnatta	Ferny azolla		Land access not available during the 2017 late wet survey period		Site abandoned / replaced due to unsafe access			No access to study area in 2016 due to elevated river flow and no alternative access available	S					No access to study area in 2016 due to elevated river flow and no alternative access available										
Centella asiatica	Pennywort																								
Chara / Nitella sp.	Charophyte algae						L		L		L								M						
Cyperus concinnus	-								L									L	L						
Cyperus difformis	rice sedge			L		S	L		L		L	L	L		L		L	L	L						
Cyperus exaltatus	Tall flatsedge			L		E	M		S		L	L	L		L	L	L	L	S						
Cyperus gracilis	Slender sedge																								
Cyperus haspan	flatsedge											L	L												

Species name	Common name	R1	R1	R2	R2	R3	R3	R4	R4	R5	R5	R6	R6	R7	R7	R8	R8	R9	R9	R10	R10	R11	R11	R12	R12
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet
Surveyed:		2016	x	2016	x	2016	2017	x	2017	2016	2017	2016	2017	x	2017	2016	2017	2017	2017	2017	2017	2017	2017	2017	2017
Cyperus trinervis	-										L														
Cyperus victoriensis	-																								
Damasonium minus	Starfruit																								
Diplachne fusca var. *fusca*	Brown beetle grass																								
*Echinochloa colona**	Awnless barnyard grass								L		L							L	S						
*Eclipta prostrata**	White eclipta*			L					L				L			L	L			L				L	L
Elatine gratioloides	Waterwort																								
Eleocharis dulcis	Water chestnut																								

Species name	Common name	R1	R1	R2	R2	R3	R3	R4	R4	R5	R5	R6	R6	R7	R7	R8	R8	R9	R9	R10	R10	R11	R11	R12	R12
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet
Surveyed:		2016	x	2016	x	2016	2017	x	2017	2016	2017	2016	2017	x	2017	2016	2017	2017	2017	2017	2017	2017	2017	2017	2017
Eleocharis pallens	Pale spikerush					L	S																		
Eleocharis philippinensis	-																								
Eleocharis plana	Ribbed spikerush																								
Juncus usitatus	Common rush						L		L		L	L	L					L	L						
Leptochloa digitata	Umbrella canegrass					M	M		L						S			L	S					L	L
Lomandra longifolia	Spiny-headed mat rush																					L		L	
Ludwigia octovalvis	Native willow primrose								L									L	L						
Ludwigia peploides subsp. montevidensis	Water primrose					S	M		L																

Species name	Common name	R1	R1	R2	R2	R3	R3	R4	R4	R5	R5	R6	R6	R7	R7	R8	R8	R9	R9	R10	R10	R11	R11	R12	R12
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet
Surveyed:		2016	x	2016	x	2016	2017	x	2017	2016	2017	2016	2017	x	2017	2016	2017	2017	2017	2017	2017	2017	2017	2017	2017
Marsliea drummondii	Common nardoo								L																
Marsiliea hirsuta	Hairy nardoo																								
Marsilea mutica	Shiny nardoo								S																
Monochoria cyanea	Native hyacinth					S	L		L																
Muehlenbeckia florulenta	Lignum					S	S																		
Myriophyllum verrucosum	Red watermilfoil																								
Najas tenuifolia	Water nymph																								
Nymphaea gigantea	Giant waterlily																								

Species name	Common name	R1	R1	R2	R2	R3	R3	R4	R4	R5	R5	R6	R6	R7	R7	R8	R8	R9	R9	R10	R10	R11	R11	R12	R12
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet
Surveyed:		2016	x	2016	x	2016	2017	x	2017	2016	2017	2016	2017	x	2017	2016	2017	2017	2017	2017	2017	2017	2017	2017	2017
Nymphoides crenata	Wavy marshwort					L	L		L																
Ottelia ovalifolia	Swamp lily					S	S		L																
Persicaria attenuata	Smartweed					L	L		L																
Persicaria decipiens	Slender knotweed			L					L							L									
Persicaria orientalis	Prince's feathers					L	L																		
Persicaria strigosa	Prickly smartweed																								
Polygonum plebeium	Small knotweed											L													
Potamogeton crispus	Curly pondweed																								

Species name	Common name	R1	R1	R2	R2	R3	R3	R4	R4	R5	R5	R6	R6	R7	R7	R8	R8	R9	R9	R10	R10	R11	R11	R12	R12
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet
Surveyed:		2016	x	2016	x	2016	2017	x	2017	2016	2017	2016	2017	x	2017	2016	2017	2017	2017	2017	2017	2017	2017	2017	2017
Potamogeton sulcatus	Floating pondweed																								
Pseudoraphis spinescens	Spiny mudgrass												L												
Schoenus sp.	Bogrush																								
Spirodela sp.	Duckweed																								
domingensis	Cumbungi																	S	S						
Utricularia sp.	Bladderwort								L																

Notes: * Denotes introduced species; L = little (1-10% cover); S = some (10-50%); M = moderate (50-75%); E = extensive (>75%) as per AusRivAS protocol (DNRM 2001).

Table C1B Aquatic flora detected within the riverine aquatic survey sites (R13-R23) during the pre-wet and post-wet surveys

Species name	Common name	R13	R13	R14	R14	R15	R15	R16	R16	R17	R17	R18	R18	R19	R19	R20	R20	R21	R21	R22	R22	R23	R23
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet
Surveyed:		2017	2017	2017	2017	2016	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017
Azolla pinnatta	Ferny azolla																						
Centella asiatica	Pennywort																						
Chara / Nitella sp.	Charophyte algae																						
Cyperus concinnus	-	S	S						L					L	L			L	L	L			
Cyperus difformis	rice sedge	L	S			L	L																
Cyperus exaltatus	Tall flatsedge	L	S			L	L															L	L
Cyperus gracilis	Slender sedge																	L					
Cyperus haspan	flatsedge		L							L	L	L	L	L	L	L	L	L	L	L	L		

Species name	Common name	R13	R13	R14	R14	R15	R15	R16	R16	R17	R17	R18	R18	R19	R19	R20	R20	R21	R21	R22	R22	R23	R23
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet
Surveyed:		2017	2017	2017	2017	2016	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017
Cyperus trinervis	-																						
Cyperus victoriensis	-																						
Damasonium minus	Starfruit																						
Diplachne fusca var. *fusca*	Brown beetle grass					L	S																
*Echinochloa colona**	Awnless barnyard grass					L	L																
Eclipta prostrata	White eclipta																						
Elatine gratioloides	Waterwort																						
Eleocharis dulcis	Water chestnut																						

Species name	Common name	R13	R13	R14	R14	R15	R15	R16	R16	R17	R17	R18	R18	R19	R19	R20	R20	R21	R21	R22	R22	R23	R23
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet
Surveyed:		2017	2017	2017	2017	2016	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017
Eleocharis pallens	Pale spikerush	L																					
Eleocharis philippinensis	-																						
Eleocharis plana	Ribbed spikerush																						
Juncus usitatus	Common rush	S	S												L							L	
Leptochloa digitata	Umbrella canegrass	S		L	L	L	L	E	E		L	S	S	S	S	S	M			L	L		
Ludwigia octovalvis	Native willow primrose						L																
Ludwigia peploides subsp. montevidensis	Water primrose		L																				
Marsliea drummondii	Common nardoo																						

Species name	Common name	R13	R13	R14	R14	R15	R15	R16	R16	R17	R17	R18	R18	R19	R19	R20	R20	R21	R21	R22	R22	R23	R23
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet
Surveyed:		2017	2017	2017	2017	2016	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017
Marsiliea hirsuta	Hairy nardoo																						
Marsilea mutica	Shiny nardoo																						
Monochoria cyanea	Native hyacinth						L																
Muehlenbeckia florulenta	Lignum		L																				
Myriophyllum verrucosum	Red watermilfoil	L	E																				
Najas tenuifolia	Water nymph																						
Nymphaea gigantea	Giant waterlily																						
Nymphoides crenata	Wavy marshwort																						

Species name	Common name	R13	R13	R14	R14	R15	R15	R16	R16	R17	R17	R18	R18	R19	R19	R20	R20	R21	R21	R22	R22	R23	R23
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet
Surveyed:		2017	2017	2017	2017	2016	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017
Ottelia ovalifolia	Swamp lily																						
Persicaria attenuata	Smartweed																						
Persicaria decipiens	Slender knotweed	L	L																			L	
Persicaria orientalis	Prince's feathers																						
Persicaria strigosa	Prickly smartweed																						
Polygonum plebeium	Small knotweed																						
Potamogeton crispus	Curly pondweed																						
Potamogeton sulcatus	Floating pondweed		L																				

Species name	Common name	R13	R13	R14	R14	R15	R15	R16	R16	R17	R17	R18	R18	R19	R19	R20	R20	R21	R21	R22	R22	R23	R23
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet
Surveyed:		2017	2017	2017	2017	2016	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017
Pseudoraphis spinescens	Spiny mudgrass																						
Schoenus sp.	Bogrush																						
Spirodela sp.	Duckweed																						
Typha domingensis	Cumbungi	L	L																			L	
Utricularia sp.	Bladderwort																						

Notes: * Denotes introduced species; L = little (1-10% cover); S = some (10-50%); M = moderate (50-75%); E = extensive (>75%) as per AusRivAS protocol (DNRM 2001).

Table C1C Aquatic flora detected within the riverine aquatic survey sites (R24-R34) during the pre-wet and post-wet surveys

Species name	Common name	R24	R24	R25	R25	R26	R26	R27	R27	R28	R28	R29	R29	R30	R30	R31	R31	R32	R32	R33	R33	R34	R34
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet
Surveyed:		2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017
Azolla pinnatta	Ferny azolla																System dry. No aquatic flora detected.						
Centella asiatica	Pennywort																						
Chara / Nitella sp.	Charophyte algae							L	L					S									
Cyperus concinnus	-																						
Cyperus difformis	rice sedge					L	S	L	L			L	L	L	L								
Cyperus exaltatus	Tall flatsedge	L	L	L	L	L	L	L	L	L	L	L	S	L	L			L	L		L	L	S
Cyperus gracilis	Slender sedge							L	L														
Cyperus haspan	flatsedge						L			L	L												

Species name	Common name	R24	R24	R25	R25	R26	R26	R27	R27	R28	R28	R29	R29	R30	R30	R31	R31	R32	R32	R33	R33	R34	R34
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet
Surveyed:		2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017
Cyperus trinervis	-																						
Cyperus victoriensis	-																						
Damasonium minus	Starfruit																						
Diplachne fusca var. *fusca*	Brown beetle grass											L											
*Echinochloa colona**	Awnless barnyard grass																						
Eclipta prostrata	White eclipta							L	L													L	L
Elatine gratioloides	Waterwort																						
Eleocharis dulcis	Water chestnut																						

Species name	Common name	R24	R24	R25	R25	R26	R26	R27	R27	R28	R28	R29	R29	R30	R30	R31	R31	R32	R32	R33	R33	R34	R34
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet
Surveyed:		2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017
Eleocharis pallens	Pale spikerush																						
Eleocharis philippinensis	-																						
Eleocharis plana	Ribbed spikerush																						
Juncus usitatus	Common rush	L	L		L	L	L	L	L	S	S	L		S	S								
Leptochloa digitata	Umbrella canegrass	L	S					L	L														
Lomandra longifolia	Spiny-headed mat rush					S	S			L	L			L				S		L			
Ludwigia octovalvis	Native willow primrose																						
Ludwigia peploides subsp. montevidensis	Water primrose																						

Species name	Common name	R24	R24	R25	R25	R26	R26	R27	R27	R28	R28	R29	R29	R30	R30	R31	R31	R32	R32	R33	R33	R34	R34
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet
Surveyed:		2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017
Marsliea drummondii	Common nardoo																						
Marsiliea hirsuta	Hairy nardoo																						
Marsilea mutica	Shiny nardoo																						
Monochoria cyanea	Native hyacinth																						
Muehlenbeckia florulenta	Lignum																						
Myriophyllum verrucosum	Red watermilfoil																						
Najas tenuifolia	Water nymph																						
Nymphaea gigantea	Giant waterlily																						

Species name	Common name	R24	R24	R25	R25	R26	R26	R27	R27	R28	R28	R29	R29	R30	R30	R31	R31	R32	R32	R33	R33	R34	R34
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet
Surveyed:		2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017
Nymphoides crenata	Wavy marshwort																						
Ottelia ovalifolia	Swamp lily																						
Persicaria attenuata	Smartweed																						
Persicaria decipiens	Slender knotweed																						
Persicaria orientalis	Prince's feathers																						
Persicaria strigosa	Prickly smartweed																						
Polygonum plebeium	Small knotweed																						
Potamogeton crispus	Curly pondweed																						

Species name	Common name	R24	R24	R25	R25	R26	R26	R27	R27	R28	R28	R29	R29	R30	R30	R31	R31	R32	R32	R33	R33	R34	R34
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet
Surveyed:		2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017
Potamogeton sulcatus	Floating pondweed																						
Pseudoraphis spinescens	Spiny mudgrass																						
Schoenus sp.	Bogrush																						
Spirodela sp.	Duckweed																						
Typha domingensis	Cumbungi																						
Utricularia sp.	Bladderwort																						

Notes: * Denotes introduced species; L = little (1-10% cover); S = some (10-50%); M = moderate (50-75%); E = extensive (>75%) as per AusRivAS protocol (DNRM 2001).

Table C1C Aquatic flora detected within the riverine aquatic survey sites (R35-R41) during the pre-wet and post-wet surveys

Species name	Common name	R35	R36	R38	R39	R40	R41
		Early wet	Early wet	Early wet	Early wet	Early wet	Early wet
Surveyed:		2017	2017	2017	2017	2017	2017
Azolla pinnatta	Ferny azolla						
Centella asiatica	Pennywort						
Chara / Nitella sp.	Charophyte algae						
Cyperus concinnus	-		S				
Cyperus difformis	rice sedge						L
Cyperus exaltatus	Tall flatsedge	L		L		L	E
Cyperus gracilis	Slender sedge						

Species name	Common name	R35	R36	R38	R39	R40	R41
		Early wet	Early wet	Early wet	Early wet	Early wet	Early wet
Surveyed:		2017	2017	2017	2017	2017	2017
Cyperus haspan	flatsedge						
*Cyperus polystachyos**	bunchy sedge			L			
Cyperus trinervis	-						
Cyperus victoriensis	-						
Damasonium minus	Starfruit						
Diplachne fusca var. *fusca*	Brown beetle grass						
*Echinochloa colona**	Awnless barnyard grass						L
Eclipta prostrata	White eclipta						

Species name	Common name	R35	R36	R38	R39	R40	R41
		Early wet	Early wet	Early wet	Early wet	Early wet	Early wet
Surveyed:		2017	2017	2017	2017	2017	2017
Elatine gratioloides	Waterwort						
Eleocharis dulcis	Water chestnut						
Eleocharis pallens	Pale spikerush						
Eleocharis philippinensis	-						
Eleocharis plana	Ribbed spikerush						
Juncus usitatus	Common rush			L		L	
Leptochloa digitata	Umbrella canegrass	L	S			L	E
Lomandra longifolia	Spiny-headed mat rush			L	L		

Species name	Common name	R35	R36	R38	R39	R40	R41
		Early wet	Early wet	Early wet	Early wet	Early wet	Early wet
Surveyed:		2017	2017	2017	2017	2017	2017
Ludwigia octovalvis	Native willow primrose						
Ludwigia peploides subsp. montevidensis	Water primrose						
Marsliea drummondii	Common nardoo						
Marsiliea hirsuta	Hairy nardoo						
Marsilea mutica	Shiny nardoo						
Monochoria cyanea	Native hyacinth						
Muehlenbeckia florulenta	Lignum						
Myriophyllum verrucosum	Red watermilfoil						

Species name	Common name	R35	R36	R38	R39	R40	R41
		Early wet	Early wet	Early wet	Early wet	Early wet	Early wet
Surveyed:		2017	2017	2017	2017	2017	2017
Najas tenuifolia	Water nymph						
Nymphaea gigantea	Giant waterlily						
Nymphoides crenata	Wavy marshwort						
Ottelia ovalifolia	Swamp lily						
Persicaria attenuata	Smartweed					L	
Persicaria decipiens	Slender knotweed			L			L
Persicaria orientalis	Prince's feathers						L
Persicaria strigosa	Prickly smartweed						

Species name	Common name	R35	R36	R38	R39	R40	R41
		Early wet	Early wet	Early wet	Early wet	Early wet	Early wet
Surveyed:		2017	2017	2017	2017	2017	2017
Polygonum plebeium	Small knotweed						S
Potamogeton crispus	Curly pondweed						
Potamogeton sulcatus	Floating pondweed						
Pseudoraphis spinescens	Spiny mudgrass						
Schoenus sp.	Bogrush						
Spirodela sp.	Duckweed						
Typha domingensis	Cumbungi						
Utricularia sp.	Bladderwort						

Notes: * Denotes introduced species; L = little (1-10% cover); S = some (10-50%); M = moderate (50-75%); E = extensive (>75%) as per AusRivAS protocol (DNRM 2001).

Table C1D Aquatic flora detected within the wetland aquatic survey sites (P1-P9 and L1-L3) during the pre-wet and post-wet surveys

Species name	Common name	P1	P1	P2	P2	P3	P3	P4	P4	P5	P5	P6	P7	P7	P8	P8	P9	L1	L2	L2	L3	L3	L4
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet
Surveyed:		X	2017	2016	2017	2016	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017
Azolla pinnatta	Ferny azolla	System dry. No aquatic flora detected.					L		L		L	L		L				S			S	L	
Centella asiatica	Pennywort			L					L		E	M		S		L		S		E		E	
Chara / Nitella sp.	Charophyte algae						L																
Cyperus concinnus	-						L					S					L						
Cyperus difformis	rice sedge					L	L						L										
Cyperus exaltatus	Tall flatsedge		L	S	L	M	M	L		M			S		L	M	L		M		E		S
Cyperus gracilis	Slender sedge			L	L						S	S		L								L	

Species name	Common name	P1	P1	P2	P2	P3	P3	P4	P4	P5	P5	P6	P7	P7	P8	P8	P9	L1	L2	L2	L3	L3	L4
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet
Surveyed:		X	2017	2016	2017	2016	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017
Cyperus haspan	flatsedge											E		L				E		L		M	
Cyperus trinervis	-				L				L			S						E				L	
Cyperus victoriensis	-								L					L	M			L		S		L	
Damasonium minus	Starfruit		L				L																
Diplachne fusca var. *fusca*	Brown beetle grass		L		L		L						L	E	L				L		L		
*Echinochloa colona**	Awnless barnyard grass					L	L							L			L				L		
*Eclipta prostrata**	White eclipta*		L	S	L	L	L				S		S	L	L	L			S	S		L	L
Elatine gratioloides	Waterwort						L		L		S			E									

Species name	Common name	P1	P1	P2	P2	P3	P3	P4	P4	P5	P5	P6	P7	P7	P8	P8	P9	L1	L2	L2	L3	L3	L4
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet
Surveyed:		X	2017	2016	2017	2016	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017
Eleocharis dulcis	Water chestnut					L	S		L		L		S					L					
Eleocharis pallens	Pale spikerush								S				S				M			M		L	
Eleocharis philippinensis	-								L	L			L	L		S	M			S		L	
Eleocharis plana	Ribbed spikerush		L				S		L	S	M		M				S			E		S	
Juncus usitatus	Common rush		S	L	L		L	L	L	L							L		L	L			L
Leptochloa digitata	Umbrella canegrass			L	L			S	L	L							L		S	L	S	L	
Ludwigia octovalvis	Native willow primrose		L			L	L	L			L		L	S	S				L	S	L	L	L
Ludwigia peploides subsp. montevidensis	Water primrose			L	S	L	L	L		E	L	L					S	L	E		S		L

Species name	Common name	P1	P1	P2	P2	P3	P3	P4	P4	P5	P5	P6	P7	P7	P8	P8	P9	L1	L2	L2	L3	L3	L4
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet
Surveyed:		X	2017	2016	2017	2016	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017
Marsliea drummondii	Common nardoo							L									L		L		L		
Marsiliea hirsuta	Hairy nardoo							L	E										L	E	L		
Marsilea mutica	Shiny nardoo		L							L				L						L	L		
Monochoria cyanea	Native hyacinth						L																
Muehlenbeckia florulenta	Lignum													L				L					
Myriophyllum verrucosum	Red watermilfoil							E			S								E			S	L
Najas tenuifolia	Water nymph		M		M	E	E							L		L			M	L	L		
Nymphaea gigantea	Giant waterlily						L																

Species name	Common name	P1	P1	P2	P2	P3	P3	P4	P4	P5	P5	P6	P7	P7	P8	P8	P9	L1	L2	L2	L3	L3	L4
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet
Surveyed:		X	2017	2016	2017	2016	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017
Nymphoides crenata	Wavy marshwort					L	L																
Ottelia ovalifolia	Swamp lily		L	L	L	L	M			L											L		
Persicaria attenuata	Smartweed					L	S						L		L				L		L		S
Persicaria decipiens	Slender knotweed			L		L													L	M			L
Persicaria orientalis	Prince's feathers							L	L		L									L			
Persicaria strigosa	Prickly smartweed						L				E			M						S			
Polygonum plebeium	Small knotweed		S			L	L	M															
Potamogeton crispus	Curly pondweed										L								S				

Species name	Common name	P1	P1	P2	P2	P3	P3	P4	P4	P5	P5	P6	P7	P7	P8	P8	P9	L1	L2	L2	L3	L3	L4
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet
Surveyed:		X	2017	2016	2017	2016	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017
Potamogeton sulcatus	Floating pondweed																		S				
Pseudoraphis spinescens	Spiny mudgrass				S		M			M	E		S	L					S				
Schoenus sp.	Bogrush		L						L		L	L		L				S				L	
Spirodela sp.	Duckweed								L		E	M		S		L		S		E		E	
Typha domingensis	Cumbungi																						
Typha orientalis	Cumbungi																						L
Utricularia sp.	Bladderwort		M	L	L		S					S											

Notes: * Denotes introduced species; L = little (1-10% cover); S = some (10-50%); M = moderate (50-75%); E = extensive (>75%) as per AusRivAS protocol (DNRM 2001).

Table C2 Fish species recorded from the Study area during pre-wet and post-wet surveys

Common name	Species name	R3		R4		R5	R6		R8		R9	R10	R11	R12	R13		R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R23
		Early wet	Late wet	Early wet	Late wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Early wet	Early wet	Early wet	Early wet	Late wet	Early wet	Early wet	Early wet	Early wet	Early wet	Early wet	Early wet	Early wet	Early wet	Early wet	Late wet
Ambassis agassizii	Agassiz's glassfish	42	167	5	7	87	0	7	0	0						18										5	674
Amniataba percoides	Barred grunter	0	0	0	0	0	0	1	1	0						0										0	0
Anguilla reinhardtii	Marbled eel	0	0	0	0	0	0	2	0	0						1										0	0
Craterocephalus stercusmuscarum	Flyspecked hardyhead	0	10	14	10	15	0	0	14	4						6										0	0
*Gambusia holbrooki**	Mosquitofish*	0	15	0	0	0	0	0	0	0						0										0	0
Hypseleotris sp.	Gudgeon	2	22	31	36	118	11	66	7	91						52										81	25
Leiopotherapon unicolor	Spangled perch	21	0	44	3	18	0	8	14	6						13										23	29
Macquaria ambigua	Golden perch	0	0	0	0	0	0	0	0	1						0										0	0
Melanotaenia splendida splendida	Eastern rainbowfish	13	316	26	47	99	4	49	39	84						250										48	69
Mogurnda adspersa	Purple-spotted gudgeon	0	11	0	1	4	0	6	2	3						2										8	29
Nematalosa erebi	Bony bream	2	9	0	0	3	1	3	87	2						0										1	9
Neosilurus hyrtlii	Hyrtyl's tandan	0	12	8	2	3	0	2	7	0						4										0	0
*Oreochromus mossambicus**	Tilapia*	2	3	4	10	1	0	2	2	2						19										61	1
Oxyeleotris lineolata	Sleepy cod	0	0	20	3	0	0	8	8	9						4										1	4
Porochilus rendahli	Rendahl's tandan	0	0	0	10	1	0	0	0	0						0										0	0
Retropinna semoni	Australian smelt	0	0	0	0	0	0	0	0	0						0										0	0
Tandanus tandanus	Freshwater catfish	0	0	0	0	1	0	0	0	0						0										0	1
																										0	
Number of individuals		82	565	152	129	350	16	154	181	202						369										228	841
Species richness		10		10		11	11		11						10											9	

Common name	Species name	R24	R25	R26	R27	R28		R29	R30		R31	R32	R33	R34
		Early wet	Early wet	Early wet	Early wet	Early wet	Late wet	Early wet	Early wet	Late wet	Early wet	Early wet	Early wet	Early wet
Ambassis agassizii	Agassiz's glassfish					121	93		5	19				
Amniataba percoides	Barred grunter					0	0		0	0				
Anguilla reinhardtii	Marbled eel					0	0		0	0				
Craterocephalus stercusmuscarum	Flyspecked hardyhead					11	8		5	0				
*Gambusia holbrooki**	Mosquitofish*					0	0		0	0				
Hypseleotris sp.	Gudgeon					109	65		79	139				
Leiopotherapon unicolor	Spangled perch					45	61		15	9				
Macquaria ambigua	Golden perch					0	0		0	0				
Melanotaenia splendida splendida	Eastern rainbowfish					163	56		184	9				
Mogurnda adspersa	Purple-spotted gudgeon					8	4		3	2				
Nematalosa erebi	Bony bream					6	0		14	0				
Neosilurus hyrtlii	Hyrtyl's tandan					7	4		0	0				
*Oreochromus mossambicus**	Tilapia*					77	25		0	0				
Oxyeleotris lineolata	Sleepy cod					3	6		0	0				
Porochilus rendahli	Rendahl's tandan					1	4		1	0				
Retropinna semoni	Australian smelt					0	0		0	0				
Tandanus tandanus	Freshwater catfish					0	0		0	0				
Number of individuals						551	326		306	178				
Species richness						11			8					

Common name	Species name	P1	P2		P3		P4		P5		P6	P7		P8	L2	L3	L4
		Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Early wet	Late wet	Early wet	Late wet	Early wet	Early wet
Ambassis agassizii	Agassiz's glassfish	0	0	0	26	168	1175	948	56	66			0		200		0
Amniataba percoides	Barred grunter	0	0	0	0	0	0	0	0	50			0		0		0
Anguilla reinhardtii	Marbled eel	0	0	0	0	0	0	0	0	0			0		0		0
Craterocephalus stercusmuscarum	Flyspecked hardyhead	0	0	0	17	7	0	0	16	2			0		64		21
*Gambusia holbrooki**	Mosquitofish*	0	0	0	0	0	0	0	0	0			0		0		0
Hypseleotris sp.	Gudgeon	0	0	0	12	80	50	2	686	300			0		98		9
Leiopotherapon unicolor	Spangled perch	0	0	0	83	8	24	27	8	1			0		14		1
Macquaria ambigua	Golden perch	0	0	0	0	0	0	0	0	0			0		0		0
Melanotaenia splendida splendida	Eastern rainbowfish	0	0	0	45	8	308	159	72	75			0		7		49
Mogurnda adspersa	Purple-spotted gudgeon	0	0	0	0	2	0	2	0	0			0		2		0
Nematalosa erebi	Bony bream	0	0	0	17	15	0	33	0	0			0		15		16
Neosilurus hyrtlii	Hyrtyl's tandan	0	0	0	9	1	0	0	5	5			0		0		0
*Oreochromus mossambicus**	Tilapia*	0	0	0	0	13	0	0	30	19			0		5		0
Oxyeleotris lineolata	Sleepy cod	0	0	0	0	0	0	0	43	0			0		0		22
Porochilus rendahli	Rendahl's tandan	0	0	0	0	106	0	0	0	5			0		0		1
Retropinna semoni	Australian smelt	0	0	0	0	0	0	112	0	0			0		1		0
Tandanus tandanus	Freshwater catfish	0	0	0	0	1	0	0	0	4			0		6		0
																	0
Number of individuals		0	0	0	209	409	1557	1283	916	527			0		412		119
Species richness		0	0	0	11		4	7	9				0		10		7

Notes: * Denotes introduced species;

Table C3 Turtle species recorded from the Study area during pre-wet and post-wet surveys

Common name	Species name	R3		R4		R5		R6		R8		R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Early wet	Early wet	Early wet	Early wet	Early wet	Early wet	Early wet	Early wet	Early wet	Early wet	Early wet	Early wet	Early wet
Chelodina expansa	Broad-shelled turtle	0	0	0	0	0	0	0	0	0	0														
Chelodina longicollis	Eastern snake-necked turtle	0	0	1	0	0	0	0	0	1	0														
Emydura macquarii krefftii	Krefft's river turtle	0	0	4	0	0	0	0	2	1	0														

Common name	Species name	R23		R24	R25	R26	R27	R28		R29	R30		R31	R32	R33	R34	P1	P2		P3	
		Early wet	Late wet	Early wet	Early wet	Early wet	Early wet	Early wet	Late wet	Early wet	Early wet	Late wet	Early wet	Early wet	Early wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet
Chelodina expansa	Broad-shelled turtle		0						0			0					0	0	0	0	0
Chelodina longicollis	Eastern snake-necked turtle	1	0						0			0					3	0	2	2	0
Emydura macquarii krefftii	Krefft's river turtle		0						0			0					0	0	0	3	0

Common name	Species name	P4		P5		P6	P7	P8	L2	L3	L4
		Early wet	Late wet	Early wet	Late wet	Early wet	Early wet	Early wet	Late wet	Early wet	Early wet
Chelodina expansa	Broad-shelled turtle	0	0	0	1				0		
Chelodina longicollis	Eastern snake-necked turtle	0	0	0	0				0		5
Emydura macquarii krefftii	Krefft's river turtle	2	0	0	2				3		

Note: Many sites could not be accessed or were not suitable for sampling for turtles at the time of survey. These sites are omitted from the results.

Table C4 Macrocrustacean species recorded from the Study area during pre-wet and post-wet surveys

Common name	Species name	R2	R3		R4		R5	R6		R8		R13	
		Early wet	Early wet	Late wet	Early wet	Late wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet
Austrothelphusa transversa	freshwater crab		2										
Branchinella sp.	fairy shrimp												
Cherax depressus	orange-fingered yabby			3		1	8		1		1		
Cherax quadricarinatus	red claw								1		1		
Macrobrachium australiense	freshwater prawn			6		19	10	11	17	31	17		18
Paratya australiense	freshwater shrimp	2				7	16	1	2	1	16		4

Common name	Species name	R23		R28		R30		P2		P3		P5		L2	L2	L4
		Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Late wet	Early wet	Early wet	Early wet	Late wet	Late wet	Early wet	Early wet
Austrothelphusa transversa	freshwater crab							3								
Branchinella sp.	fairy shrimp						4	1								
Cherax depressus	orange-fingered yabby		3				16									1
Cherax quadricarinatus	red claw		2	1												
Macrobrachium australiense	freshwater prawn	7	28	36	21	19	82	1		1	40	19		36		10
Paratya australiense	freshwater shrimp	3	2	6	4	6		8		8	11			3	3	9

Note: Many sites could not be accessed or were not suitable for sampling at the time of survey. These sites are omitted from the results.

Table C5 Macroinvertebrate species recorded from the Study area within riverine BED HABITAT during pre-wet and post-wet surveys

Taxa	SIGNAL 2	AUSRIVAS	R3		R4	R5	R6		R8		R13	R23		R28		R30	
			early wet 16	late wet 17	late wet 17	late wet 17	early wet 16	late wet 17	early wet 16	late wet 17	late wet 17	late wet 17	early wet 17	late wet 17	early wet 17	late wet 17	early wet 17
cl. Hydrozoa																	
Hydridae	2	IB019999															
ph. Nematoda	3	II999999	1														
s.c. Hirudinea																	
Glossiphoniidae	1	LH019999															
Hirudinidae	4	LH999999															
ph. Annelida																	
s.c. Oligochaeta	2	LO999999	1		1						2		3		1		
cl. Bivalvia																	
Corbiculidae	4	KP029999						2		1			6				
Hyriidae	5	KP019999															
Sphaeriidae	5	KP039999															
cl. Gastropoda																	
Ancylidae	4	KG069999															
Bithyniidae	3	KG039999															
Lymnaeidae	1	KG059999		1	1												
Physidae	1	KG089999									1						
Planorbidae	2	KG079999	9												1		
Thiaridae	4	KG049999			5												
Viviparidae	4	KG019999															
cl. Arachnida																	

Taxa	SIGNAL 2	AUSRIVAS	R3		R4	R5	R6		R8		R13	R23		R28		R30	
			early wet 16	late wet 17	late wet 17	late wet 17	early wet 16	late wet 17	early wet 16	late wet 17	late wet 17	late wet 17	early wet 17	late wet 17	early wet 17	late wet 17	early wet 17
s.c. Acarina	6	MM999999	21	2	9	17	1	18	6	9	7			1	18	11	9
o. Cladocera	-	OG999999	25		2					1	6		6			7	
s.c. Copepoda	-	OJ999999	58	7	12			17		1	2	1	2		7	19	12
o. Conchostraca	1	OF999999															
cl. Ostracoda	-	OH999999	1	6	5	7					5		1				3
o. Decapoda																	
Atyidae	3	OT019999			2	11				8	3			1	1		1
Palaemonidae	4	OT029999								4					2	1	5
Parastacidae	4	OV019999				1											
Gerarcinucidae	4	OZ999999															
o. Anostraca																	
Thamnocephalidae	1	OD039999															
s.c. Collembola	1	QA999999															
o. Lepidoptera																	
Crambidae	2	QL999999															
o. Coleoptera																	
Chrysomelidae	2	QCAH9999															
Curculionidae	2	QCAN9999															
Dytiscidae	2	QC099999	4	25	4	8				6	12	4	17	8	11	14	15
Gyrinidae	4	QC109999								1						1	
Haliplidae	2	QC069999				1				1							
Hydraenidae	3	QC139999		1	5	1				1	1			6	3	2	3

Taxa	SIGNAL 2	AUSRIVAS	R3		R4	R5	R6		R8		R13	R23		R28		R30	
			early wet 16	late wet 17	late wet 17	late wet 17	early wet 16	late wet 17	early wet 16	late wet 17	late wet 17	late wet 17	early wet 17	late wet 17	early wet 17	late wet 17	early wet 17
Hydrochidae	4	QCAO9999		1	1	1				1	1			2	7	1	3
Hydrophilidae	2	QC119999		2		1							4		2		1
Hygrobiidae	1	QC079999															
Noteridae	4	QC089999															
Scirtidae	6	QC209999															
Spercheidae	2	-															
Staphylinidae	3	QC189999															
o. Diptera																	
Ceratopogonidae	4	QD099999					5	1	2	1		2		4	1	1	1
s.f. Chironominae	3	QDAJ9999	49	7	12	10	1	11	8	5	6	15	12	8	36	25	8
s.f. Orthocladiinae	4	QDAF9999		1	1										1	3	
s.f. Tanypodinae	4	QDAE9999		19	10	11	2	2	8	3	3	12	9	1	11	11	7
Culicidae	1	QD079999														1	1
Empididae	5	QD359999															
Ephydridae	2	QD789999															
Simuliidae	5	QD109999															
Stratiomyidae	2	QD249999													1		
Tabanidae	3	QD239999															
Tipulidae	5	QD019999					2										
o. Ephemeroptera																	
Baetidae	5	QE029999		1	5	4		1			6	1			4	4	1
Caenidae	4	QE089999		1	3	4	38	7	31	10		25	16	6	10		2

Taxa	SIGNAL 2	AUSRIVAS	R3		R4	R5	R6		R8		R13	R23		R28		R30	
			early wet 16	late wet 17	late wet 17	late wet 17	early wet 16	late wet 17	early wet 16	late wet 17	late wet 17	late wet 17	early wet 17	late wet 17	early wet 17	late wet 17	early wet 17
Leptophlebiidae	8	QE069999								1		5			4	1	
o. Hemiptera																	
Belostomatidae	1	QH629999															
Corixidae	2	QH659999	5	2	3	1	1	12		7	11	2					
Gerridae	4	QH579999		1	1	1				2	2				1		
Hydrometridae	3	QH549999															
Mesoveliidae	2	QH529999									3						
Micronectidae	2	-			2					1	2		3			12	8
Naucoridae	2	QH669999															
Nepidae	3	QH619999													1		
Notonectidae	1	QH679999	14												1	1	2
Ochteridae	2	QH639999															
Pleidae	2	QH689999		1						2							
Veliidae	3	QH569999			1	1					3						
s.o. Zygoptera																	
Coenagrionidae	2	QO029999		4	3	4				5	8	4			1		
s.o. Epiprocta																	
Aeshnidae	4	QO129999		2							2						
Gomphidae	5	QO139999										2	3		1		
Hemicorduliidae	5	QO309999		2	3	3									1		
Libellulidae	4	QO179999			5	2					3	2	8			2	9
Lindeniidae	3	QO229999			1												

Taxa	SIGNAL 2	AUSRIVAS	R3		R4	R5	R6		R8		R13	R23		R28		R30	
			early wet 16	late wet 17	late wet 17	late wet 17	early wet 16	late wet 17	early wet 16	late wet 17	late wet 17	late wet 17	early wet 17	late wet 17	early wet 17	late wet 17	early wet 17
o. Trichoptera																	
Calamoceratidae	7	QT249999													5		
Ecnomidae	4	QT089999			4	2			2						1		
Leptoceridae	6	QT259999		1	6	7		4	2	16		7	5	1	13	3	

Note: Many sites could not be accessed or were not suitable for sampling at the time of survey. These sites are omitted from the results.

Table C6 Macroinvertebrate species recorded from the Study area within riverine EDGE HABITAT during pre-wet and post-wet surveys

Taxa	SIGNAL 2	AUSRIVAS	R2	R3		R4	R5	R6		R8		R13	R23		R28		R30	
			early wet 16	early wet 16	late wet 16	late wet 17	late wet 17	early wet 16	late wet 17	early wet 16	late wet 17	late wet 17	late wet 17	early wet 17	late wet 17	early wet 17	late wet 17	early wet 17
cl. Hydrozoa																		
Hydridae	2	IB019999																
ph. Nematoda	3	II999999																
s.c. Hirudinea																		
Glossiphoniidae	1	LH019999																
Hirudinidae	4	LH999999			1	3	1											
ph. Annelida																		
s.c. Oligochaeta	2	LO999999	2			2	2		2		6		2	2				
cl. Bivalvia																		
Corbiculidae	4	KP029999							5		6			4				
Hyriidae	5	KP019999																
Sphaeriidae	5	KP039999					1											
cl. Gastropoda																		
Ancylidae	4	KG069999		1														
Bithyniidae	3	KG039999																
Lymnaeidae	1	KG059999		14		1						3						
Physidae	1	KG089999	2				4		2	3		1	1	4		1		1
Planorbidae	2	KG079999		4	1	2	1		1		1	1	1	10		1		1
Thiaridae	4	KG049999				3												
Viviparidae	4	KG019999		9								2						
cl. Arachnida																		

Taxa	SIGNAL 2	AUSRIVAS	R2	R3		R4	R5	R6		R8		R13	R23		R28		R30	
			early wet 16	early wet 16	late wet 16	late wet 17	late wet 17	early wet 16	late wet 17	early wet 16	late wet 17	late wet 17	late wet 17	early wet 17	late wet 17	early wet 17	late wet 17	early wet 17
s.c. Acarina	6	MM999999	7		1		7		5	13	13		2	4		3	3	7
o. Cladocera	-	OG999999	3							7		8				1	1	4
s.c. Copepoda	-	OJ999999	31		3	1			3	12				3	1		1	8
o. Conchostraca	1	OF999999																
cl. Ostracoda	-	OH999999		7	7	1	1		1		1	13	1					5
o. Decapoda																		
Atyidae	3	OT019999	2			5	5	1	2	1	8		2	1	3	3	4	4
Palaemonidae	4	OT029999					1	11		1	3	1	4	1	8	1	4	7
Parastacidae	4	OV019999																
Gerarcinucidae	4	OZ999999																
o. Anostraca																		
Thamnocephalidae	1	OD039999																
s.c. Collembola	1	QA999999							2					3	1			
o. Lepidoptera																		
Crambidae	2	QL999999				2												
o. Coleoptera																		
Chrysomelidae	2	QCAH9999										1						
Curculionidae	2	QCAN9999										1						
Dytiscidae	2	QC099999	17	13	21	17	17	4	9	13	14	24	9	8	10	33	16	14
Gyrinidae	4	QC109999		1														
Haliplidae	2	QC069999	1	3														
Hydraenidae	3	QC139999	2	2	7				6	2	2	13	2	2	11	9	8	7

Taxa	SIGNAL 2	AUSRIVAS	R2	R3		R4	R5	R6		R8		R13	R23		R28		R30	
			early wet 16	early wet 16	late wet 16	late wet 17	late wet 17	early wet 16	late wet 17	early wet 16	late wet 17	late wet 17	late wet 17	early wet 17	late wet 17	early wet 17	late wet 17	early wet 17
Hydrochidae	4	QCAO9999	7	25	1	2	5	38	2	8	3	5	3	7		5		7
Hydrophilidae	2	QC119999	12	2	4	1	2	4	2	4	2	3	5	6	5	16	1	6
Hygrobiidae	1	QC079999																
Noteridae	4	QC089999			2	1		1				7	2	1	5	1	2	3
Scirtidae	6	QC209999		3						1						9		
Spercheidae	2	-																2
Staphylinidae	3	QC189999			2												2	1
o. Diptera																		
Ceratopogonidae	4	QD099999	9		3		1		3	1	1			1	1		2	
s.f. Chironominae	3	QDAJ9999	9	1	8	20	11	1	19	3	9		8	1	28		13	2
s.f. Orthocladiinae	4	QDAF9999							1				1				2	
s.f. Tanypodinae	4	QDAE9999	10	3	2	9	14		6	6	13	5	16	10	5		5	5
Culicidae	1	QD079999							2			1			1	1		
Empididae	5	QD359999																
Ephydridae	2	QD789999			1													
Simuliidae	5	QD109999						2										
Stratiomyidae	2	QD249999																1
Tabanidae	3	QD239999					1		2		3			1				
Tipulidae	5	QD019999				2				4	1							
o. Ephemeroptera																		
Baetidae	5	QE029999	2		1	1	1		2		3	2	8		2		3	5
Caenidae	4	QE089999	25	2	2	2	7	46	21	35	54	1	20	10	5		2	3

Taxa	SIGNAL 2	AUSRIVAS	R2	R3		R4	R5	R6		R8		R13	R23		R28		R30	
			early wet 16	early wet 16	late wet 16	late wet 17	late wet 17	early wet 16	late wet 17	early wet 16	late wet 17	late wet 17	late wet 17	early wet 17	late wet 17	early wet 17	late wet 17	early wet 17
Leptophlebiidae	8	QE069999							4		1		1				3	1
o. Hemiptera																		
Belostomatidae	1	QH629999	2															
Corixidae	2	QH659999	12		13	1		7			7	3	1	5				
Gerridae	4	QH579999	1	1	1	1	4	10	8	2	6	6	4	9	13	3	4	4
Hydrometridae	3	QH549999	1			1	2									1	3	
Mesoveliidae	2	QH529999											1			2		
Micronectidae	2	-				6			4			15	1	4			3	5
Naucoridae	2	QH669999	2							1								
Nepidae	3	QH619999	4			1	1	2	1	3	3		1	1	1	4		
Notonectidae	1	QH679999	5	3	5	4	1	1	7		6	2	2			3	4	1
Ochteridae	2	QH639999	2					3		4			2	2			1	2
Pleidae	2	QH689999	6	1	1		3		2	7	2		4	9	1			2
Veliidae	3	QH569999			1	3	8		11	3	10	6	9	4	11	10	13	11
s.o. Zygoptera																		
Coenagrionidae	2	QO029999	10	19	8	14	3		19	25	16	8	25		1		3	1
s.o. Epiprocta																		
Aeshnidae	4	QO129999	1		4	1						2					2	
Gomphidae	5	QO139999							4		1		1	2				1
Hemicorduliidae	5	QO309999	1		1		3			1	1						1	2
Libellulidae	4	QO179999	4	7	4	7	3	2	17	1	13	17	16	8		6	4	13
Lindeniidae	3	QO229999		1														

Taxa	SIGNAL 2	AUSRIVAS	R2	R3		R4	R5	R6		R8		R13	R23		R28		R30	
			early wet 16	early wet 16	late wet 16	late wet 17	late wet 17	early wet 16	late wet 17	early wet 16	late wet 17	late wet 17	late wet 17	early wet 17	late wet 17	early wet 17	late wet 17	early wet 17
o. Trichoptera																		
Calamoceratidae	7	QT249999									2		2	1	6	10	2	5
Ecnomidae	4	QT089999																
Leptoceridae	6	QT259999	31	39	20	13	20	8	18	22	24	21	28	17	13	15	17	4

Note: Many sites could not be accessed or were not suitable for sampling at the time of survey. These sites are omitted from the results.

Table C7 Macroinvertebrate species recorded from the Study area within WETLANDS during pre-wet and post-wet surveys

Taxa	SIGNAL 2	AUSRIVAS	P1	P2		P3		P4		P5		P7	L2		L4
			late wet 17	early wet 16	late wet 17	early wet 16	late wet 17	late wet 17	early wet 17	late wet 17	early wet 17	late wet 17	late wet 17	early wet 17	early wet 17
cl. Hydrozoa															
Hydridae	2	IB019999		1											
ph. Nematoda	3	II999999													
s.c. Hirudinea															
Glossiphoniidae	1	LH019999		2	4									1	
Hirudinidae	4	LH999999													2
ph. Annelida															
s.c. Oligochaeta	2	LO999999	1	6	1		5				3	3		3	1
cl. Bivalvia															
Corbiculidae	4	KP029999													1
Hyriidae	5	KP019999									2				
Sphaeriidae	5	KP039999													
cl. Gastropoda															
Ancylidae	4	KG069999													
Bithyniidae	3	KG039999						2							
Lymnaeidae	1	KG059999		2	8		2			5		3	8		
Physidae	1	KG089999	5		4				13		1			8	3
Planorbidae	2	KG079999		18	7		10	9	1	2		3	10	6	
Thiaridae	4	KG049999									12				1

Taxa	SIGNAL 2	AUSRIVAS	P1	P2		P3		P4		P5		P7	L2		L4
			late wet 17	early wet 16	late wet 17	early wet 16	late wet 17	late wet 17	early wet 17	late wet 17	early wet 17	late wet 17	late wet 17	early wet 17	early wet 17
Viviparidae	4	KG019999													
cl. Arachnida															
s.c. Acarina	6	MM999999	2	11	15	150	10	10		12	6	1	11	7	1
o. Cladocera	-	OG999999		11				24	4	4		2	4	7	
s.c. Copepoda	-	OJ999999	1	3	6	2		13		15	4	4	2	6	
o. Conchostraca	1	OF999999													4
cl. Ostracoda	-	OH999999	44	4	1	3	4	30	8	20	2	12	15	50	8
o. Decapoda															
Atyidae	3	OT019999				8	11						3	2	24
Palaemonidae	4	OT029999				1	1			2	5		2		2
Parastacidae	4	OV019999													
Gerarcinucidae	4	OZ999999		3											
o. Anostraca															
Thamnocephalidae	1	OD039999		1											
s.c. Collembola	1	QA999999													
o. Lepidoptera															
Crambidae	2	QL999999							2		2		2	4	
o. Coleoptera															
Chrysomelidae	2	QCAH9999													
Curculionidae	2	QCAN9999					1		1			2		1	1
Dytiscidae	2	QC099999	7	4	17	16	18	3	15	12	13	13	7	10	5
Gyrinidae	4	QC109999					1					4			

Taxa	SIGNAL 2	AUSRIVAS	P1	P2		P3		P4		P5		P7	L2		L4
			late wet 17	early wet 16	late wet 17	early wet 16	late wet 17	late wet 17	early wet 17	late wet 17	early wet 17	late wet 17	late wet 17	early wet 17	early wet 17
Haliplidae	2	QC069999					1								
Hydraenidae	3	QC139999			7	1	7	6		3			1		
Hydrochidae	4	QCAO9999	2	16	5	1	7	2		9	1	6		1	5
Hydrophilidae	2	QC119999	3	4	2	1	5	1	1	2	8	2	1	2	
Hygrobiidae	1	QC079999				2									
Noteridae	4	QC089999			1		1				3				
Scirtidae	6	QC209999													
Spercheidae	2	-													
Staphylinidae	3	QC189999					1								
o. Diptera															
Ceratopogonidae	4	QD099999		14	7	11	2	1	1	7	10		2	8	2
s.f. Chironominae	3	QDAJ9999	44	45	73	4	44	34	30	46	16	23	19	12	21
s.f. Orthocladiinae	4	QDAF9999				1					1			1	
s.f. Tanypodinae	4	QDAE9999	1	19	8	12	4	17	5	7	8	2	7	11	7
Culicidae	1	QD079999	1		3		2			2		2			
Empididae	5	QD359999					1								
Ephydridae	2	QD789999													
Simuliidae	5	QD109999													
Stratiomyidae	2	QD249999													
Tabanidae	3	QD239999			1		1							3	1
Tipulidae	5	QD019999					1								
o. Ephemeroptera															

Taxa	SIGNAL 2	AUSRIVAS	P1	P2		P3		P4		P5		P7	L2		L4
			late wet 17	early wet 16	late wet 17	early wet 16	late wet 17	late wet 17	early wet 17	late wet 17	early wet 17	late wet 17	late wet 17	early wet 17	early wet 17
Baetidae	5	QE029999				4	3	1		13	1	16	16	9	5
Caenidae	4	QE089999				6							12	3	15
Leptophlebiidae	8	QE069999													
o. Hemiptera															
Belostomatidae	1	QH629999		3	2							9		3	
Corixidae	2	QH659999	13	8	22		4	36	19	5	8	1	18	3	4
Gerridae	4	QH579999	1		6		1						3		
Hydrometridae	3	QH549999											1		
Mesoveliidae	2	QH529999			1		2	1	1	6	2	10	16	11	
Micronectidae	2	-	4		1		10	12	10	7	17			11	29
Naucoridae	2	QH669999				1	3			2			3	5	
Nepidae	3	QH619999			2									1	
Notonectidae	1	QH679999	6	6	13		4	5	15	9	2	10	2	14	3
Ochteridae	2	QH639999													
Pleidae	2	QH689999	2	3	1	8	1			2		6	2	8	
Veliidae	3	QH569999	1		7		4	2				1	2		
s.o. Zygoptera															
Coenagrionidae	2	QO029999	13	9	14	4	13	21	15	24	6	12	18	16	4
s.o. Epiprocta															
Aeshnidae	4	QO129999		5	1		2	2		6		3	9	1	
Gomphidae	5	QO139999													4
Hemicorduliidae	5	QO309999						1		3					

Taxa	SIGNAL 2	AUSRIVAS	P1	P2		P3		P4		P5		P7	L2		L4
			late wet 17	early wet 16	late wet 17	early wet 16	late wet 17	late wet 17	early wet 17	late wet 17	early wet 17	late wet 17	late wet 17	early wet 17	early wet 17
Libellulidae	4	QO179999	2	12	13		17	5	2	23	1	13	12	8	10
Lindeniidae	3	QO229999		1		1									
o. Trichoptera															
Calamoceratidae	7	QT249999													
Ecnomidae	4	QT089999			1										2
Leptoceridae	6	QT259999	9	36	27	1	6	15	5	8	10	1	29	13	7

Note:

A number of sites could not be accessed or were not suitable for sampling at the time of survey. These sites are omitted from the results.