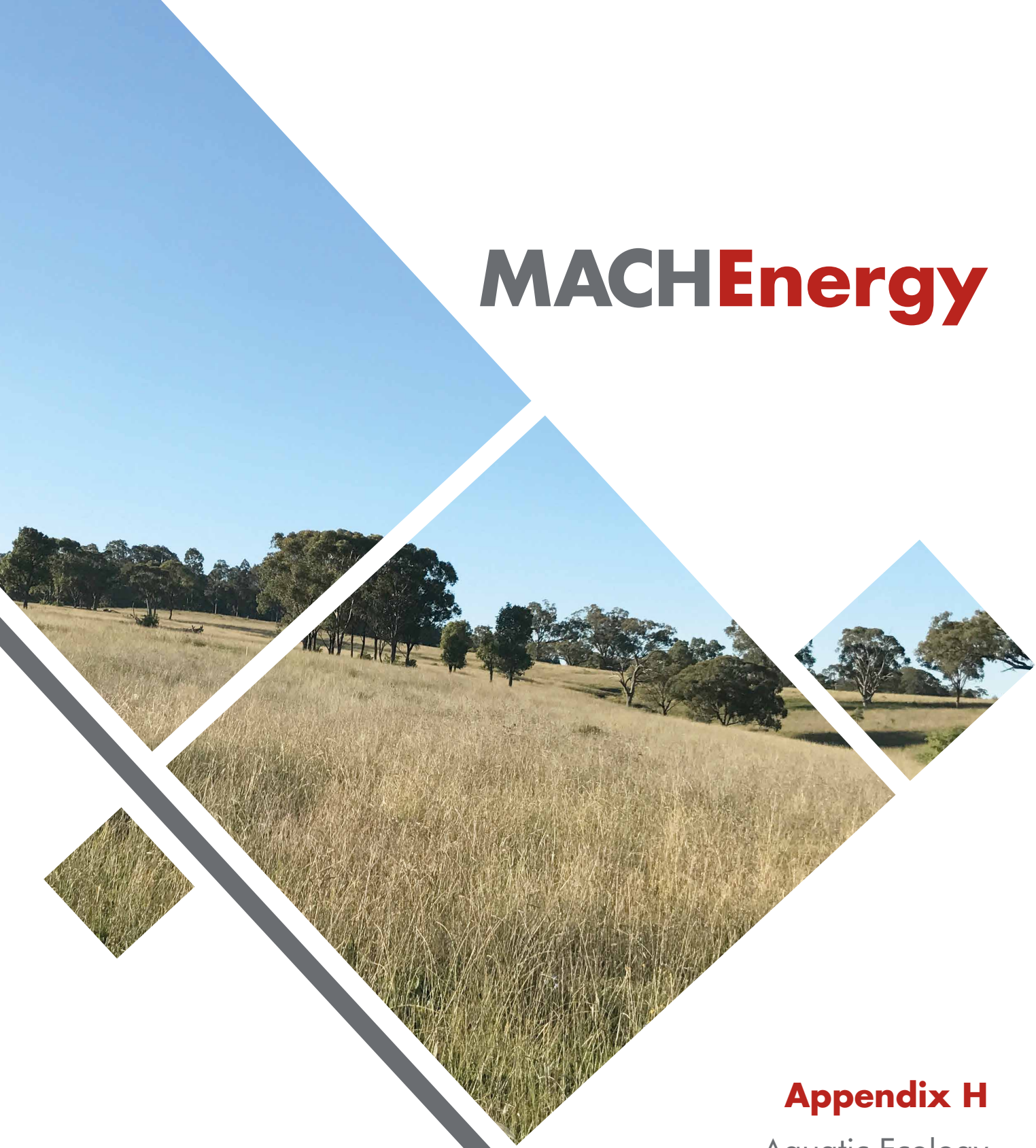
MACHEnergy



Appendix H

Aquatic Ecology Assessment

Final Report

MOUNT PLEASANT OPERATION
AQUATIC ECOLOGY ASSESSMENT

PREPARED FOR
MACH Energy Australia Pty Ltd

19 December 2017

BIO-ANALYSIS Pty Ltd

Marine, Estuarine & Freshwater Ecology

2/1 Botham Close Charmhaven, NSW 2263

(Mobile) 0414 477066, (Email) info@bioanalysis.com.au

EXECUTIVE SUMMARY

The approved Mount Pleasant Operation (MPO) is owned and operated by MACH Energy Australia Pty Ltd. The approved operation includes the construction and operation of an open cut coal mine and associated infrastructure.

MACH Energy is seeking approval from the New South Wales Minister for Planning to modify the Mount Pleasant Operation Development Consent DA 92/97. The Modification (the Rail Modification) would involve construction of a private rail spur and loop and a new water pipeline (buried where located in the floodplain of the Hunter River) and pump station facility located on the Hunter River.

BIO-ANALYSIS Pty Ltd has been commissioned to prepare an aquatic ecology assessment for the Rail Modification. The drainage network in the vicinity of the MPO is generally characterised by steep gullies which drain from the surrounding hills into the flat alluvial plains adjacent to the Hunter River.

No permanently flowing waterways are present within the Modification Area. During the site inspection there was no surface water and the drainage lines were extremely degraded. Riparian and instream habitats within the Study Area appeared to have been substantially altered by historical and agricultural land use practices.

Surface water in the vicinity of the Study Area has moderate to high electrical conductivity, which reflects natural high salinity in soils and groundwater and the anthropogenic effects of numerous land use practices within the region.

River regulation and water extraction have had a substantial effect on flows within the Hunter River catchment. The ‘barrier effect’ of the Glenbawn Dam (situated approximately 16 kilometres upstream of the Study Area) prevents the movement of migratory species and flow of sediments and nutrients.

No aquatic species of conservation significance listed under the *Environment Protection and Biodiversity Conservation Act, 1999, Biodiversity Conservation Act, 2016* or *Fisheries Management Act, 1994* have been recorded within the Study Area.

One endangered species, the Southern Purple-Spotted Gudgeon (*Mogurnda aspersa*), and one endangered population, the Darling River Hardyhead (*Craterocephalus amniculus*) are predicted to occur in the Hunter River drainage system.

The Rail Modification would involve construction of a rail spur across a section of the Hunter River floodplain and an unnamed tributary, which is an ephemeral drainage line that was assessed as providing poor aquatic habitat (there was no flow, free standing water or pools, its channel was poorly defined and mostly colonised by pasture grasses).

Construction of the water supply infrastructure would occur across existing drainage channels (including the ephemeral Rosebrook Creek) and on the bank of the Hunter River. There would be no material impact to the volume of water entering the Hunter River from the Modification Area. Dewatering of the alluvial floodplain is not likely because no material excision of alluvial material is proposed.

Construction of the pump station facility and supporting infrastructure are expected to take approximately 1 – 2 months. Thus, any impacts associated with installation of the pump facility are expected to be short-term and localised. Notwithstanding that, erosion and sediment controls will be in place for the duration in any case.

The Rail Modification incorporates features designed to remove or minimise environmental impacts to watercourses within the Study Area and downstream environments. It is considered unlikely that the Rail Modification will cause a measurable effect to any threatened aquatic species or key threatening processes. Moreover, the Rail Modification is unlikely to affect aquatic biodiversity or ecological processes within the Hunter River.

TABLE OF CONTENTS

TABLES

FIGURES

PLATES

1.0 INTRODUCTION

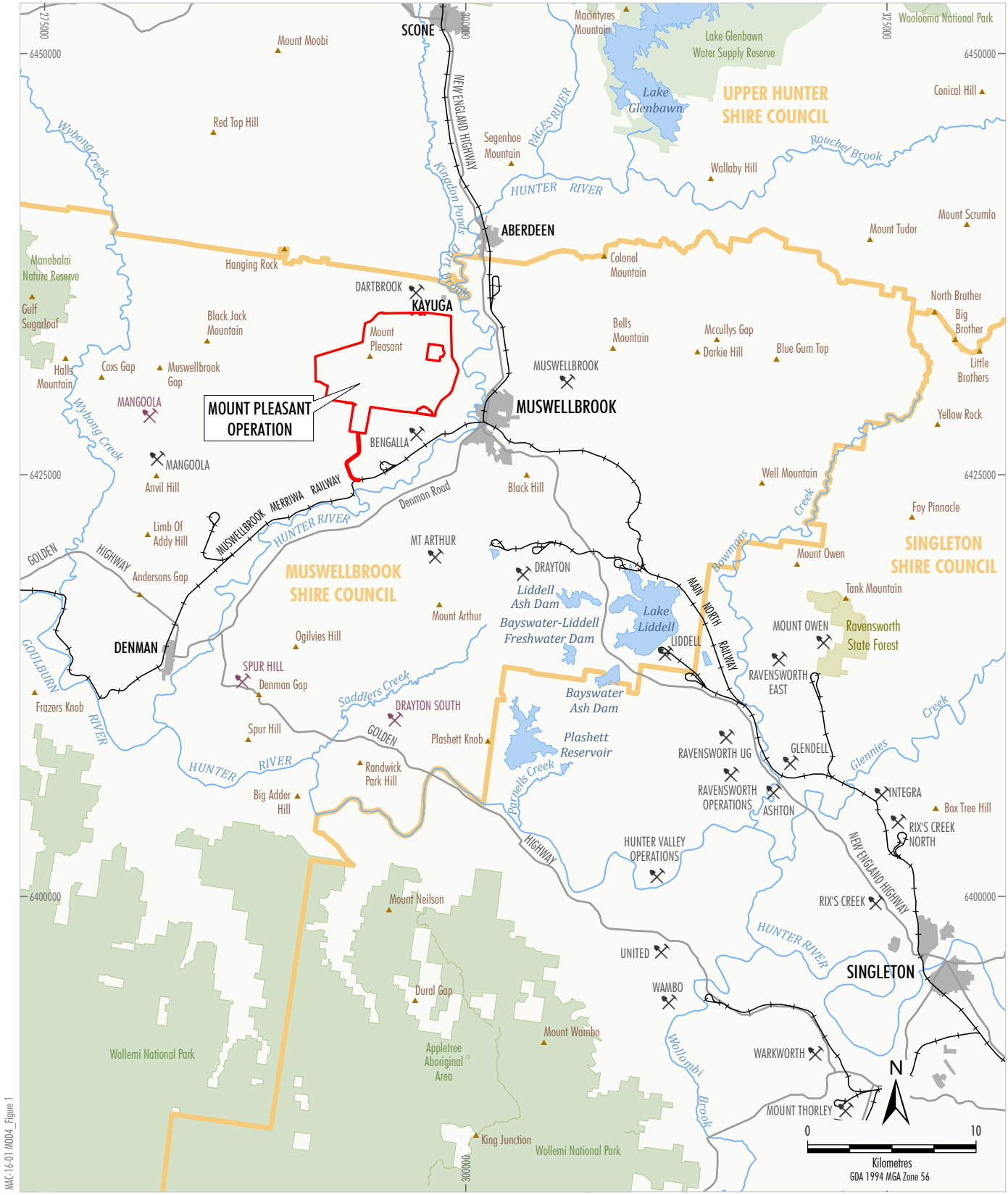
1.1 Background

The approved Mount Pleasant Operation (MPO) is owned and operated by MACH Energy Australia Pty Ltd. The approved operation includes the construction and operation of an open cut coal mine and associated infrastructure. The MPO area is located in the Upper Hunter Valley of New South Wales (NSW), approximately four kilometres (km) north-west of Muswellbrook (Figure 1).

MACH Energy is seeking approval from the NSW Minister for Planning to modify the Mount Pleasant Operation Development Consent DA 92/97 under section 75W of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act). A description of the Rail Modification is provided in Section 1.2

BIO-ANALYSIS Pty Ltd (BA) has been commissioned by MACH Energy to prepare an aquatic ecology assessment for the Rail Modification. The purpose of the aquatic ecology assessment is to identify and describe the conservation significance of aquatic biota and habitat within the Study Area and assess the potential for the Rail Modification to impact aquatic ecology, with particular regard to matters of Federal Environmental Significance listed on the *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) and state environmental significance listed on the *Biodiversity Conservation Act, 2016* (BC Act) and *Fisheries Management Act, 1994* (FM Act).

The Study Area for the aquatic ecology assessment incorporates the Rail Modification component, and associated disturbance (Modification Area), and the Hunter River, given its downstream proximity to the Modification Area and the proposed relocation of the raw water extraction point from the river. The eastern portion of the Modification Area drains via Rosebrook Creek, as well as via other unnamed drainages. Areas in the south of the Modification Area drain via an unnamed drainage line, which is a tributary of the Hunter River.



LEGEND

- Mining Operation
- Proposed Mining Operations (Application Lodged)
- Mining Lease Boundary (Mount Pleasant)
- Railway
- Local Government Boundary
- State Forest
- National Parks and Wildlife Estate

Source: Geoscience Australia (2006); NSW Division of Resources & Geoscience (2017); Office of Environment and Heritage NSW (2017); Land and Property Information (2017)

MACHEnergy

MOUNT PLEASANT OPERATION

Project Location

Figure 1

MAC-16-01 MOD4_Figure 1

The Modification Area is shown on Figures 2 and 3.

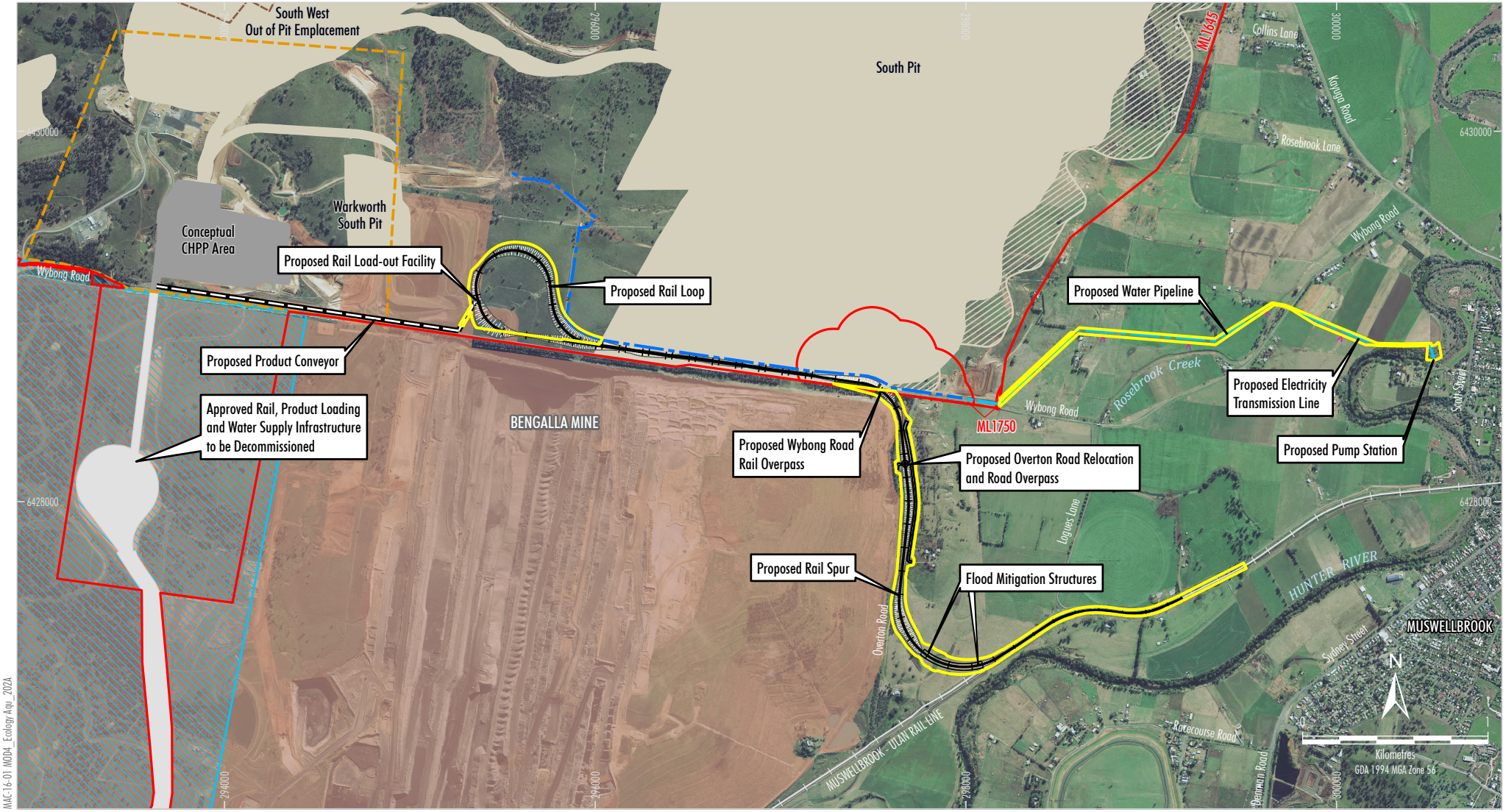
1.2 Overview of the Rail Modification

The ultimate extent of the approved Bengalla Mine open cut intersects the approved MPO rail spur.

While the intersection of the Bengalla Mine open cut with the approved MPO rail infrastructure is still some years away, MACH Energy is proposing a Rail Modification to obtain approval for alternative product transport facilities for the Mount Pleasant Operation.

The Rail Modification would involve construction of:

- Approximately 5 km of private rail spur;
- A rail loop to the east of the coal handling and preparation plant (CHPP);
- A new rail load-out facility and associated services, and water management infrastructure located on the rail loop;
- A new product conveyor and associated services, and water management infrastructure linking the product stockpiles located at the CHPP and the rail load-out facility;
- A new water pipeline (buried where located in the floodplain of the Hunter River), associated electricity supply and pump station facility located on the Hunter River;
- A rail overpass of Wybong Road and road overpass at Overton Road to maintain uninterrupted public road access and avoid the need for rail level crossings;
- Some relocation of internal property access and farm tracks, electrical infrastructure and services to accommodate the new rail spur;
- Suitable flood mitigation infrastructure, including culverts in the new rail spur;



MAC-16-01 MOD4_Ecology Aqu_202A

LEGEND

- Mining Lease Boundary
- Infrastructure Area Envelope
- Indicative Offsite Coal Transport Infrastructure
- Approximate Extent of Approved Surface Development (1997 EIS Year 20)*
- Conveyor/Services Corridor Envelope
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)

Subject to Separate Modification (Modification 3)

- Emplacement Extension
- Area Relinquished for Overburden Emplacement and Major Infrastructure

Key Elements of the Modification #

- Proposed Rail
- Proposed Product Conveyor
- Proposed Water Pipeline - Above Ground
- Proposed Water Pipeline - Buried
- Proposed Pump Station Electricity Transmission Line
- Modification Area

Notes: * Excludes some project components such as water management infrastructure, infrastructure within the Infrastructure Area Envelope, offsite coal transport infrastructure, road diversions, access tracks, topsoil stockpiles, power supply, temporary offices, other ancillary works and construction disturbance.

Modification would also include additional minor components not shown, e.g. access tracks, rail signalling and electricity supply etc.

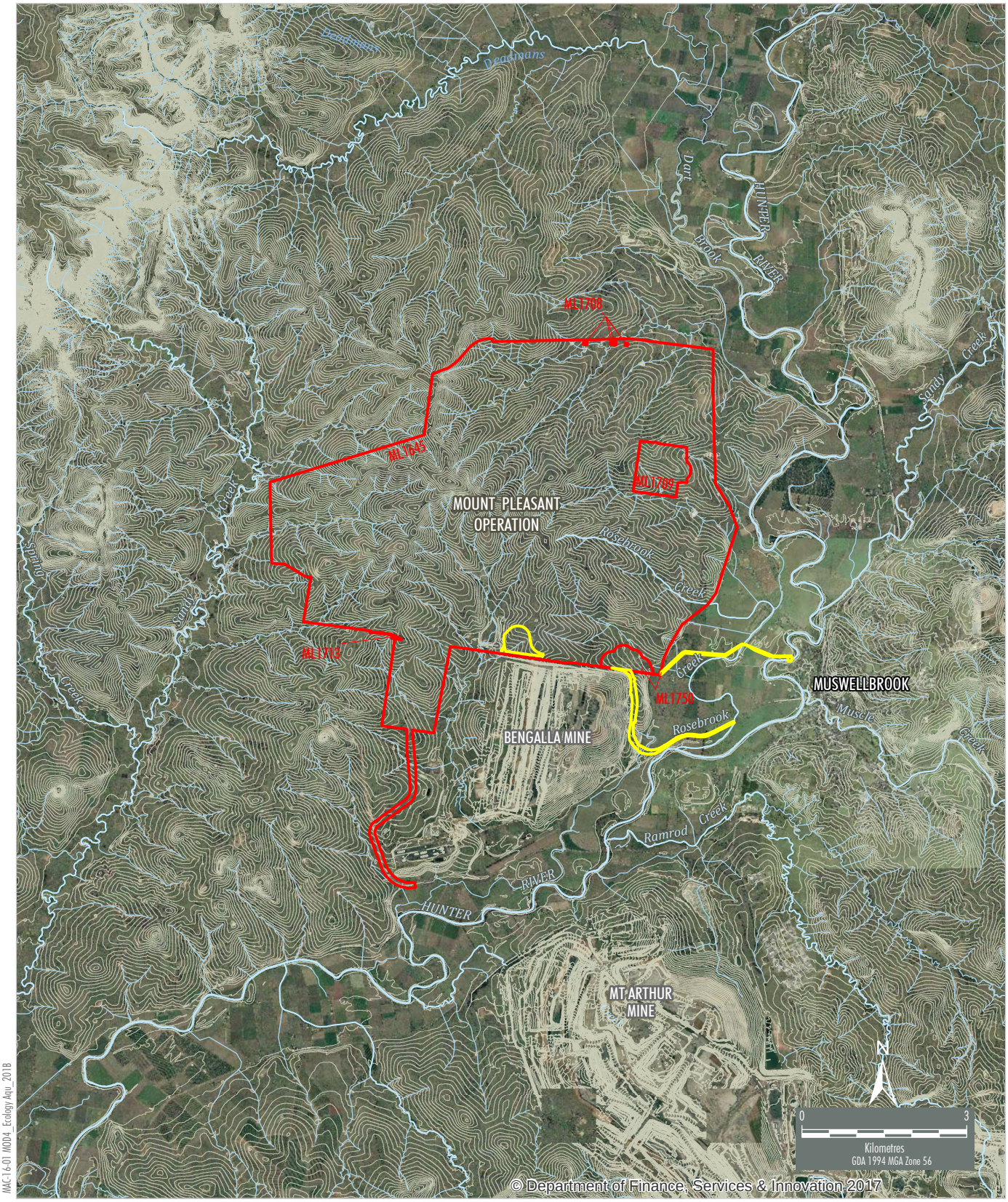
Source: NSW Land & Property Information (2017); NSW Division of Resources & Geoscience (2017); Department of Planning and Environment (2016); MACH Energy (2017)
Orthophoto: MACH Energy (July 2017)

MACHEnergy

MOUNT PLEASANT OPERATION

Modification General Arrangement

Figure 2



MAC-16-01 MOD4_Ecology Aqu_201B

LEGEND
Mining Lease Boundary
Contour (5 m Intervals)
Modification Area

Source: NSW Land & Property Information (2017); NSW Division of Resources & Geoscience (2017)

MACHEnergy
MOUNT PLEASANT OPERATION

Topography and Drainage

Figure 3

- Removal of redundant infrastructure associated with the current approved rail spur, loop, conveyors, rail loading and water pipeline; and
- Access tracks, hardstands and minor supplementary works that may be required to facilitate the proposed construction activities.

The provisional location[1] of the key elements to be constructed are shown on Figure 2.

It is anticipated that the construction of the new infrastructure would occur over a period of approximately 12 months and the removal of redundant rail infrastructure would then occur approximately over the subsequent 6 month period.

Further description of the Rail Modification is provided in the Main Text of the Environmental Assessment.

1.2.1 Proposed Rail Spur and Loop

The private rail spur construction will primarily comprise earthworks (i.e. cut and fill), provision of rail ballast (gravel material) to support rail sleepers, rail track, rail fixings and signalling.

Sections of the new rail spur would also require flood mitigation works (e.g. series of box culverts) and signalling/switching facilities.

Limited short-term truck haulage of some fill material along the corridor or between the rail corridor and the MPO mining or temporary borrow pit areas authorised in the Mining Operations Plan (MOP) may be required to manage the cut and fill materials balance or geotechnical requirements.

---

1 The location is provisional subject to detailed engineering design being completed prior to construction.

The new rail turnout associated with the Rail Modification would require the construction of new supporting infrastructure within the Australian Rail Track Corporation (ARTC) controlled rail corridor on the Muswellbrook – Ulan Rail Line.

This infrastructure is anticipated to comprise rail interlocking systems, trenching beside the existing rail line to establish electrical connections to an existing Signal Equipment Room (signal hut), establishment of new location cases and train signals located up to approximately 400 m up-rail or down-rail of the rail spur turnout.

If required, works in the ARTC rail corridor may also involve upgrades to, or relocation of, an existing passive level crossing that provides property access across the Muswellbrook – Ulan Rail Line to two residences in the vicinity of the new rail turnout.

1.2.2 Water Pipeline and Hunter River Pump Station

Approximately 6.4 km of new water supply pipeline would be constructed between the Hunter River and the Mine Water Dam (MWD). Construction of the replacement water supply infrastructure would occur across existing drainage channels (including the ephemeral Rosebrook Creek) and on the bank of the Hunter River.

The pipeline would comprise a high density polyethylene pipe with a series of concrete pipe supports where above ground (approximately 3.4 km) or alternatively will be buried at approximately 600 mm depth within the Hunter River floodplain (approximately 2.8 km). The pipeline diameter would be subject to detailed design but would nominally be between 650 mm and 850 mm in diameter.

The pump station would be supplied with electricity by a 22 kV electricity transmission line from the MPO substation. A transfer pump station would be required to efficiently address the head difference between the Hunter River and the MWD. The main transfer pumps would nominally comprise two 400 kilowatt electrical 200 litres per second centrifugal pumps and associated electrical supply and enclosures/hardstands.

The pump station facility would largely be above ground, however, would also include submerged pumps and a water inlet system adjacent to the Hunter River. The pump station would be designed and operated to minimise potential impacts on fish in the vicinity of the inlet (Section 4.2).

The transfer pump station would be located following detailed design and would comprise the pump infrastructure and any necessary noise attenuation enclosure (e.g. insulated cladding) on a concrete pad.

1.3 Purpose and Scope

The primary objectives of this aquatic ecology assessment are to:

- Review existing literature relevant to the aquatic ecology in the vicinity of the Study Area;
- Assess the potential impacts of the Rail Modification on aquatic habitats and native biota, including any threatened species, endangered populations or endangered ecological communities recorded or likely to occur within the Study Area; and
- Recommend mitigation measures that can be undertaken to minimise potential impacts associated with the Rail Modification.

2.0 DESCRIPTION OF THE AQUATIC ENVIRONMENT

2.1 Review of Existing Information

Existing information on aquatic habitats and associated biota within and surrounding the Study Area was obtained by a review of aquatic surveys, monitoring reports and assessments that have been undertaken across the MPO area and surrounds, as well as search for relevant literature using the internet.

2.1.1 Physical Setting, Land Use and Climate

The MPO is located within the Muswellbrook Local Government Area (LGA). Kayuga is located immediately to the north of the mine and the town of Aberdeen is located further north east, on the eastern side of the Hunter River. Muswellbrook is located 4 km south-east of the MPO (Figure 1).

The town of Denman is also located some 18 km to the south west near the confluence of the Hunter and Goulburn Rivers (Figure 1).

The drainage network in the vicinity of the MPO is generally characterised by steep gullies which drain from the surrounding hills into the flat alluvial plains adjacent to the Hunter River. The river, which flows in a southerly direction approximately 1 km to the east of the MPO Mining Lease boundary, is the largest drainage feature within the catchment (Figure 3).

A number of ephemeral drainage lines traverse the MPO area and drain into the Hunter River. The eastern portion of the MPO area drains via Rosebrook Creek (Figure 2), as well as other ephemeral, unnamed drainages. Areas in the south and west of the MPO boundary drain to an ephemeral drainage line (commonly referred to as Dry Creek) and Sandy Creek, respectively, both of which flow into the Hunter River (Figure 3). No permanently flowing waterways are present within the Modification Area.

Surrounding land uses include agriculture (grazing, dairy, vineyards, horse and cattle studs, turf, flower and market gardens) and mining. As such, the catchment area has been cleared extensively. The Bengalla Mine adjoins the southern boundary of the MPO area, with Mount Arthur Coal Mine further south (Figure 1). Mangoola Coal is located west of the MPO area and surface facilities for the Dartbrook Mine are to the north.

Climate within the vicinity of Muswellbrook is warm temperate with an average annual rainfall of approximately 600 mm (BOM, 2017).

2.1.2 Surface Waters

River regulation and water extraction have had a substantial effect on flows within the Hunter River catchment (WMAwater, 2013).

The natural flow regime of the Hunter River system has been heavily disrupted by construction of the Glenbawn Dam, situated approximately 16 km upstream of the Study Area, which has the largest water storage capacity (750,000 ML) in the catchment (Kingsford and Hankin, 2010).

Impacts from regulation and water extraction from the Hunter River have resulted in alteration of its natural geomorphology, characterised by old alluvial or floodplain terraces and disrupted flood regimes (WMAwater, 2013). The ‘barrier effect’ of the dam prevents the movement of migratory species and flow of sediments and nutrients (Morita and Yamamoto, 2002).

Under current catchment conditions (i.e. since the Glenbawn Dam was completed), flow records show that base flow tends to persist over long periods, with the exception of prolonged dry spells. Flow at Muswellbrook generally exceeds 348.5 ML/day. The relative low frequency of zero flow-days has been attributed to groundwater inflow from the alluvial groundwater systems adjacent to the Hunter River and its tributaries.

The Hunter River catchment includes a large proportion of salt bearing sedimentary rocks and soils and surface and underground drainage from this contributes natural salinity to the river. Salinity levels within the Hunter River are typically in the range of 400-800 µS/cm, with occasional spikes above 1,000 µS/cm (DPI NSW, 2014a). The recommended ANZECC/ARMCANZ (2000) guideline values for the protection of aquatic ecosystems in lowland rivers are 125 – 2,200 µS/cm.

Median pH values at creek sites show that surface water within the Modification Area ranged between 6.2 and 7.6, while values at the Hunter River sites ranged between 8.0 and 8.1 (MACH, 2017). Median total suspended solids ranged between 6 and 292 mg/L at the creek sites and 8 mg/L at the Hunter River sites (MACH, 2017).

Water Quality sampling has been attempted within Rosebrook Creek on several occasions. On each occasion the creek has been dry and sampling was not possible (Scott McDonald pers. Com., 7 December 2017). Given the highly ephemeral and disturbed nature of the creek alignment and surrounds, it is expected that the water quality of any water present within the creek (other than during high flow events such as floods) would be poor.

2.1.3 Groundwaters

Two distinct water-bearing geological units occur within the Study Area. A thin layer of alluvial sediments occurs along the Hunter River and other creek valleys, with the underlying and surrounding rock strata consisting of Permian Coal sequence (MACH Energy, 2017).

2.1.4 Aquatic Habitats and Biota

Within the Study Area, the Hunter River, Rosebrook Creek, Muscle Creek, Ramrod Creek and Sandy Creek (which joins the Hunter River just north of Muswellbrook) are considered "Key Fish Habitat" under NSW Department of Primary Industries (DPI) guidelines for aquatic habitats (DPI NSW, 2017a).

The majority of watercourses within the Study Area have been cleared to the bank, with the few remaining strips of native vegetation restricted to the Hunter River. River Oak (*Casuarina cunninghamiana*) and River Red Gum (*Eucalyptus camaldulensis*) commonly occur. Remaining riparian habitat has been heavily infested by weeds including *Ipomoea indica* (Morning Glory), Privet (*Ligustrum* species) and Willow (*Salix* sp.). Within the Modification Area, exotic grasses mostly associated with agriculture boarder the riparian zone.

Numerous studies of aquatic habitat and biota have been carried out within the Hunter River.

In 2002, the Healthy Rivers Commission determined that water quality within the river was variable and almost two thirds of streams were in a degraded condition. Approximately 30 % of native fish species were estimated to have been lost from the river and between 40 and 70 % of sites sampled for macroinvertebrates were assessed as being in poor condition (Healthy Rivers Commission, 2002).

In a later study of stream health at four sites[2] within the vicinity of the Study Area using the Australian River Systems (AUSRIVAS) protocol, one site (Hunt854) was rated as being similar to reference condition while three (Hunt571, Hunt585 and Hunt506) were rated 'significantly impaired' (Hose and Turak, 2004).

[2] Site's Hunt854 (Hunter River, ~ 3 km upstream of Muswellbrook), Hunt571 (Hunter River @ Muswellbrook), Hunt585 (Dart Brook) and Hunt506 (Muscle Creek @ Muswellbrook)

Previous surveys and published distributions indicate up to 26 species of fish may be present within the Hunter River, including 21 native species (Table 1). The Eastern Snake-necked Tortoise (*Chelodina longicollis*) has also been recorded in the river (Howell and Creese, 2010) and is likely to be found in farm dams and pools in creeks.

No aquatic species of conservation significance listed under the EPBC Act, BC Act or FM Act have been recorded within the Study Area.

Table 1. Species of Fish that may occur, or Suitable Habitat may occur, within the Hunter – Central Rivers Region.

Family	Species	Common Name	McDowall 1996	DPI 2006a	Howell & Creese 2010
Anguillidae	*Anguilla australis*	Short-finned Eel			
Anguillidae	*Anguilla reinhardtii*	Speckled Longfin			
Ariidae	*Neoarius graeffei*	Blue Catfish			
Clupeidae	*Potamalosa richmondia*	Freshwater Herring			
Galaxiidae	*Galaxias brevipinnis*	Climbing Galaxias			
Galaxiidae	*Galaxias olidus*	Mountain Galaxias			
Galaxiidae	*Galaxias maculatus*	Common Jollytail			
Salmonidae	*Oncorhynchus mykiss*	Rainbow Trout*			
Salmonidae	*Salmo trutta*	Brown Trout*			
Retropinnidae	*Retropinna semoni*	Australian Smelt			
Cyprinidae	*Carassius auratus*	Goldfish*			
Cyprinidae	*Cyprinus carpio*	Common Carp*			
Plotosidae	*Tandanus tandanus*	Freshwater Catfish			
Poeciliidae	*Gambusia holbrooki*	Eastern Mosquito Fish*			
Scorpaenidae	*Notesthes robusta*	Bullrout			
Percichthyidae	*Macquaria novemaculeata*	Australian Bass			
Terapontidae	*Leiopotherapon unicolor*	Spangled Perch			
Mugilidae	*Mugil cephalus*	Sea Mullet			
Mugilidae	*Trachystoma petardi*	Freshwater Mullet			
Gobiidae	*Gobiomorphus australis*	Striped Gudgeon			
Gobiidae	*Gobiomorphus coxii*	Cox's Gudgeon			
Gobiidae	*Hypseleotris compressa*	Empire Gudgeon			
Gobiidae	*Hypseleotris galii*	Firetail Gudgeon			
Gobiidae	*Philypnodon macrostomus*	Dwarf Flathead Gudgeon			
Gobiidae	*Philypnodon grandiceps*	Flathead Gudgeon			
Gobiidae	*Hypseleotris klunzingeri*	Western Carp Gudgeon			

*Introduced species

2.2 Site Inspection

A site inspection of aquatic habitat within the Modification Area and nearby reaches of the Hunter River was carried out on 6 September 2017 with further relevant work undertaken in November 2017[3].

In general, aquatic habitat within the Modification Area was extremely limited and restricted to a small ephemeral drainage line (referred to as the unnamed tributary) and its tributary gullies and Rosebrook Creek[4].

At the time of the site inspection, the unnamed tributary and its tributary gullies were completely dry and their channels had been colonised by pasture grasses (Plate 1). Temporary pools would form along the tributary after periods of high rainfall.

Plate 1. Aquatic Habitats within the Modification Area

1a) View across the Hunter River floodplain, towards Muswellbrook

1b) Upper reaches of the unnamed tributary (looking downstream), with the Hunter River and Mt Arthur Coal Mine in the background

3 Stream Health monitoring using the AUSRIVAS protocol was undertaken by BA at nine sites within the Study Area (6 sites along the Hunter River and 1 site on each of Dart Brook, Muscle Creek and Sandy Creek) on 28 November 2017. Results will be presented in the 'Assessment of Stream Health (Spring 2017) Report' prepared for the MPO by BA.

4 Surface water quality monitoring of Rosebrook Creek (Site W14) commenced in October 2017, in accordance with the requirements of MACH's Surface Water Management Plan. To date, samples were not able to be collected because the creek was dry (Scott McDonald pers. comm., 7 December 2017).

1c) A dry gully tributary of the unnamed tributary

1d) The unnamed tributary, looking downstream

The banks of the tributary were almost entirely cleared of trees and riparian vegetation and there was evidence that livestock regularly grazed and trampled the stream bank and channel (Plate 1). Habitat for aquatic fauna, such as rocks, snags and aquatic macrophytes, were largely absent. Therefore, drainage lines within the Modification Area were considered unlikely to provide fish habitat.

The unnamed tributary drains in a south west direction through the southern part of the Modification Area, before joining the Hunter River. In the vicinity of the Study Area, the riparian vegetation of the Hunter River is a relatively narrow band (approximately < 10 m wide) mostly dominated by exotic trees and vines.

The Hunter River represents major fish habitat (Class 1 Waterway) [5] and functions as a significant environmental corridor (Category 1 waterway and riparian zone).

Within the vicinity of the proposed water intake site, the river was up to about 30 m wide and 1.5 m deep near the middle of the channel (Plate 2). The channel substratum was composed primarily of silty sand and had a considerable cover of detritus. Large woody debris were present in places (Plate 2).

---

5 Four species of fish were collected at the Hunter River sites sampled by the Stream Health Monitoring survey undertaken by BA on 28 November 2017: Sea Mullet (*Mugil cephalus*), Speckled Longfin Eel (*Anguilla reinhardtii*), Common Carp (*Cyprinus carpio*) and Eastern Mosquito Fish (*Gambusia holbrooki)*. Results will be presented in the 'Assessment of Stream Health (Spring 2017) Report' prepared for the MPO by BA.

The river banks were relatively degraded due to weed invasion (including Morning Glory, Privet and Willow Trees) and grazing by animals in some areas (Plate 2). River Oak and River Red Gum were common (Plate 2).

Plate 2. The Hunter River

2a) Hunter River, ~ 2 km downstream of Muswellbrook

2b) Hunter River, within the vicinity of the proposed water intake, looking upstream

2c) Hunter River, within the vicinity of the proposed water intake, looking downstream

2d) Hunter River, within the vicinity of the proposed water intake

3.0 THREATENED SPECIES ISSUES FOR AQUATIC ECOSYSTEMS

No aquatic species of conservation significance listed under the EPBC Act, BC Act or FM Act have been recorded within the Study Area (after Section 2.0).

Relevant threatened species or populations and their habitats that do, or may, occur within the area were identified by reviewing current listings on databases maintained by the Department of the Environment and Energy (DOEE), NSW DPI and the Office of Environment and Heritage (OEH) and NSW Government database BioNet.

3.1 Listings Under the EPBC Act

3.1.1 Threatened Species

The DOEE Protected Matters Search Tool indicated that no relevant threatened species or suitable habitat occurred within the vicinity (i.e. a 10 km radius) of the Study Area.

The Flathead Galaxais (*Galaxias rostratus*), Murray Cod (*Maccullochella peelii*), Macquarie Perch (*Macquaria australasica*) and Australian Grayling (*Prototroctes maraena*) may either occur, or suitable habitat may occur within the Muswellbrook Shire LGA, which is an area substantially larger than the Study Area.

Murray Cod are generally found in the Murray-Darling Basin but overfishing and changes in the environment have drastically reduced its numbers (Morris et al., 2001). Murray Cod have also been translocated into a number of river systems in NSW, Victoria and Western Australia, but has generally failed to establish in those areas.

It is unlikely that Flathead Galaxais, Murray Cod, Macquarie Perch or Australian Grayling occur within the Study Area, therefore these species will not be considered further.

3.1.2 Invasive Species

The DOEE search tool indicated that the invasive aquatic weed Salvinia (*Salvinia molesta*) may either occur or suitable habitat for it may occur in the vicinity of the Study Area. Salvinia has been declared a Class 3 Noxious Weed in the Muswellbrook Shire Local Government Area (LGA) and as such *"the plant must be fully and continuously suppressed and destroyed"*.

3.2 Listings Under the BC Act

3.2.1 Threatened Species

The OEH and the NSW Government database, BioNet, indicated that no relevant threatened species or suitable habitat occurred within the vicinity (i.e. a 10 km radius) of the Study Area. No relevant Endangered Ecological Communities (EECs) were listed.

The Giant Dragonfly (*Petalura gigantea*), which is listed as Endangered under Schedule 1 of the NSW BC Act, or suitable habitat for it is predicted to occur within the Muswellbrook LGA, but in the Wollemi sub-region, not within the Hunter sub-region of the Hunter/Central Rivers Catchment Management Authority (CMA) Region.

It is unlikely that Giant Dragonfly occurs within the Study Area, therefore this species will not be considered further.

3.2.2 Key Threatening Processes

One key threatening process listed under Schedule 4 of the BC Act is relevant to the Rail Modification: *Alteration to the natural flow regime of rivers and streams and their floodplains and wetlands.*

The flow regime is the key driver of river ecology. Impacts on aquatic habitats and biota associated with altering natural flow regimes include:

- Increased erosion causing degradation of the riparian zone, restricted access to habitat for foraging, refuge or reproduction and sedimentation impacts such as smothering;
- Changes in the amount of organic material on which many aquatic biota depend upon;
- Changes in patterns of natural environmental cues necessary for reproductive cycles;
- Altered water quality variables such as dissolved oxygen, turbidity and temperature and concomitant effects on biota; and
- Deeper and more permanent standing water, which can enhance establishment and spread of exotic species (Walker, 1985; Kingsford, 2000; Gehrke and Harris, 2001).

These alterations can cause a large number of species, populations or ecological communities that rely on flows for their short term and long term survival to become threatened. Potential effects of the Rail Modification on this process are assessed in Section 4.0 of this report.

3.3 Listings Under the FM Act

3.3.1 Threatened Species, Populations and Endangered Ecological Communities

One endangered species, the Southern Purple-Spotted Gudgeon (*Mogurnda adspersa*), and one endangered population, the Darling River Hardyhead (*Craterocephalus amniculus*) population in the Hunter catchment, listed currently under the FM Act are predicted to occur in the Hunter River drainage system (DPI NSW, 2014b; 2017a). There are no aquatic EECs listed under the FM Act within the Hunter sub-region of the Hunter/Central Rivers CMA Region.

Southern Purple-Spotted Gudgeon

Two populations of Southern Purple-Spotted Gudgeon occur in NSW: an eastern population found in coastal catchments north of the Clarence River and a western population found throughout Murray-Darling Basin (DPI NSW, 2017a). Despite targeted sampling, there have been few recent records of the eastern population. Only two extant populations are known, one in the Richmond catchment and the other in the Hunter Valley. However, the population in the Hunter Valley (in Goorangoola Creek) is outside what was previously considered the natural range of the species, so there is some uncertainty as to whether the population is endemic or recently introduced (DPI NSW, 2017a).

Most remnant populations of Southern Purple-Spotted Gudgeon in NSW occur in small to medium streams although they have been found in a variety of habitats such as rivers, creeks and billabongs with slow-moving waters or in streams with low turbidity. Cover provided by aquatic and riparian vegetation, leaf litter, rocks or snags are important for this species (Lintermans, 2007; DPI NSW, 2017a).

They are a benthic species that mostly feed on terrestrial insects and their larvae, worms, small fish, tadpoles and some plant material. Southern Purple-Spotted Gudgeon spawn during summer when water temperatures exceed 20 ºC and food is abundant. Adhesive eggs are attached to hard substrata. The species can reach 120 mm but is more commonly found at 70 mm and reaches maturity at 45-50 mm (DPI NSW, 2017a).

Threats to the Southern Purple-Spotted Gudgeon include:

- Predation by introduced fish such as Eastern Gambusia (*Gambusia holbrooki*) and Redfin Perch (*Perca fluviatilis*);
- Habitat degradation, particularly loss of aquatic plants;

- Fluctuation in water levels as a result of river regulation, causing impacts on reproduction and recruitment;
- Increased turbidity and damage to stream banks by livestock access; and
- Decreased water quality due to agricultural runoff and siltation (DPI NSW, 2017a).

Potential effects of the Rail Modification on this species are assessed in Section 4.0 of this report.

Darling River Hardyhead

The Darling River Hardyhead is found in the upper tributaries of the Darling River including the Border Rivers and the Gwydir and Naomi catchments. It is also found in the headwaters of the Hunter System in NSW (DPI NSW, 2014b). However, despite extensive sampling, no individuals have been detected from the Hunter River catchment since 2003 (DPI NSW, 2014b).

This species is usually found in slow flowing, clear, shallow waters or in aquatic vegetation near the stream bank although they have also been recorded from the edge of fast-flowing habitats such as the runs at the head of pools. It primarily eats algae and fly larvae and has been seen to eat small insects (DPI NSW, 2014b).

The Darling River Hardyhead is a small species of fish that grows up to 80 mm in length but is generally around 42 mm in length. Little is known about the reproductive biology of this species however, it is closely related to the Murray Hardyhead (*Craterocephalus fluviatilis*), which is considered a short lived (annual) species with an extended breeding season from spring through to autumn. The eggs are usually deposited amongst aquatic vegetation (DPI NSW, 2014b).

Potential effects of the Rail Modification on this species are assessed in Section 4.0 of this report.

3.3.2 Key Threatening Processes

Three of the key threatening processes listed under the FM Act are likely to be relevant to the Rail Modification:

- *Degradation of Native Riparian Vegetation along NSW Water Courses* (DPI NSW, 2005a);
- *Removal of Large Woody Debris from NSW Rivers and Streams* (DPI NSW, 2005b); and
- *Installation and Operation of Instream Structures and Mechanisms that Alter Natural Flows* (DPI NSW, 2005c);

Degradation of Native Riparian Vegetation

Riparian vegetation has several primary physical and biological functions, which are important in maintaining the health of aquatic systems (Turak and Bickel, 1994; Pusey and Arthington, 2003, DPI NSW, 2005a). Riparian vegetation:

- Stabilises river beds and banks, binds soil and protects against erosion and slumping;
- Provides a source of organic matter, which is an important source of energy for aquatic ecosystems;
- Provides shade and shelter, buffers temperature and creates habitat for aquatic biota;
- Provides a supply of large woody debris, which is used as habitat and spawning sites by many native species of fish; and
- Acts as a filter for sediments, phosphorous and organic nitrogen thus improving the quality of water entering watercourses.

Removal of Large Woody Debris

Snags consisting of trees, limbs and root masses that are partly or wholly submerged are one of the most important habitat components for macroinvertebrates and fish within a stream (DPI NSW, 2005b). Snags not only provide fish with shelter and a substratum for food but also facilitate oxygenation of water, slow and alter stream flow and are used as breeding sites by some species (DPI NSW, 2005b).

Instream Structures and other Mechanisms that Alter Natural Flow

The installation and operation of instream structures (including dams, weirs, canals, flow regulators, erosion control structures and causeways, among others) and other mechanisms (e.g. pumping and diversion of water) can alter natural flow regimes (Walker, 1985; Kingsford, 2000; Gehrke and Harris, 2001).

Potential effects of the Rail Modification on these processes are assessed in Section 4.0 of this report.

4.0 ASSESSMENT OF IMPACTS

Potential impacts of the Rail Modification associated with aquatic habitat and biota within the Study Area were identified as:

- Potential obstruction of flow impacts associated with construction of new rail spur infrastructure within the floodplain of the Hunter River; and
- Land disturbance activities associated with construction of the new infrastructure.

Key aspects would include:

- Loss of on-site aquatic habitat;
- Surface water flow and aquatic biota;
- Surface water quality and aquatic biota;
- Barriers to fish movement; and
- Groundwater and aquatic biota.

4.1 Rail Spur and Loop

4.1.1 Loss of On-Site Aquatic Habitat

The majority of the Rail Modification would be located on MPO and Bengalla Mine owned land and the ARTC rail corridor.

However, the Rail Modification would involve construction of a rail spur across a section of the Hunter River floodplain and the unnamed tributary, which is an ephemeral drainage line that was assessed as providing poor aquatic habitat because there was no flow, free standing water or pools, its channel was poorly defined and mostly colonised by pasture grasses (Section 2.2).

The rail spur and loop is unlikely to involve removal of riparian vegetation or large woody debris from within the Modification Area.

Based on the above, that unnamed tributaries within the Modification Area are not classified as "Key Fish Habitat" under DPI guidelines for aquatic habitats (DPI NSW, 2017a) and that much of the disturbance area is existing cleared agricultural land associated with farming enterprises on the highly disturbed Hunter River floodplain and surrounds, it is considered unlikely that construction of the rail spur and rail line would have a negative effect on the aquatic ecology within the Study Area.

4.1.2 Surface Water Flow and Aquatic Biota

Changes to the flood regime, and the timing and magnitude of flows in watercourses have the potential to impact on aquatic ecology.

Modelling done by WRM Water and Environment (2017) led to the prediction that the Rail Modification may result in increased flood depths in flood plain areas immediately upstream and downstream of the proposed rail spur.

Various culverts and bridge crossings have been included in the indicative design of the proposed rail embankment to mitigate potential flood impacts and potential impacts to flow. These mitigation measures would be reviewed and developed further as part of the detailed design process to comply with the predicted changes in flood level and velocity described by WRM Water and Environment (2017).

Whilst it may take marginally longer for flood water upstream of the rail spur to drain to the Hunter River, the Modification would not restrict water from flowing down the Hunter River, including flood flows (WRM Water and Environment, 2017).

Based on the above, in consideration that a change to flooding during a 1:100 year event would not result in a material change to water availability or water reporting to the Hunter River and given the poor habitat rating for ephemeral drainage lines within the Modification Area, there would be nil or negligible change to the aquatic ecology within the Study Area as a result of predicted changes to surface water flow.

4.1.3 Surface Water Quality and Aquatic Biota

Alteration of the surface water quality in aquatic ecosystems can cause loss of biodiversity and a shift towards more pollution-tolerant taxa. Changes to surface water quality can generally occur due to soil disturbance (sedimentation and mobilisation of nutrients and saline materials), nutrient leachates and pollution leaks (e.g. associated with heavy vehicles and machinery).

Deterioration in surface water quality is considered a threat to Southern Purple-Spotted Gudgeon, Darling River Hardyhead and the Hunter River aquatic ecological community.

An Erosion Sediment Control Plan (ESCP) has been developed at the MPO to manage potential erosion impacts and to monitor the effectiveness of erosion and sediment controls and is included in the Water Management Plan.

The ESCP would be updated if required for the Rail Modification, and the following measures would be adhered to in areas where disturbance from construction occurs:

- Relevant internal approvals and permits would be obtained before commencement of surface disturbance (e.g. Ground Disturbance Permits);
- The extent of disturbance (including trafficable areas) would be minimised and identified using appropriate pegging, barriers or signage;
- Appropriate erosion and sediment controls would be approved and established prior to land disturbance and would remain in place until exposed areas are stabilised;

- Clean water runoff from undisturbed catchments would be diverted around the disturbance areas via diversion drains and banks to discharge into natural watercourses, where practical;
- Runoff from disturbed areas would be diverted into sediment dams;
- Drains, diversion banks and channels would be stabilised and scour protection would be provided as necessary; and
- Temporary erosion and sediment control measures would be used and may include silt fences, hay bales, jute mesh, check dams, cross banks, contour banks, armouring and straw mulching.

Providing sufficient erosion and sediment controls and control of potential pollutants, it is considered unlikely that water quality associated with the Rail Modification would affect the ecology of surface waters.

4.1.4 Barriers to Fish Movement

The Rail Modification would not involve construction (nor result in the creation) of physical barriers within watercourses in the Study Area that might impede fish passage. Various culverts and bridge crossings have been included in the indicative design of the proposed rail embankment to mitigate potential flood impacts and potential impacts to flow. Furthermore, the Modification would not restrict water from flowing down the Hunter River, including flood flows (WRM Water and Environment, 2017).

4.1.5 Groundwater and Aquatic Biota

The National Atlas of Groundwater Dependent Ecosystems (GDEs) (BOM, 2017) does not identify any potential GDEs in the vicinity of the Rail Modification. However, the Hunter River is considered to be a GDE (i.e. the river and associated riparian vegetation) and is known to be augmented by groundwater.

Dewatering of the alluvial floodplain is not likely because no material excision of alluvial material is proposed. For this reason, it is considered unlikely that the Rail Modification would have a measurable impact on aquatic habitat and biota within the Study Area.

4.2 Water Pipeline/ETL and Hunter River Pump Station

4.2.1 Loss of Aquatic Habitat

Vegetation clearing and earthworks near and within waterways of the Modification Area may decrease the amount of habitat for aquatic fauna.

Construction of the water supply infrastructure would occur across existing drainage channels (including the ephemeral Rosebrook Creek) and on the bank of the Hunter River.
Proposed construction of the water pipeline, Electricity Transmission Line (ETL) and river pump station is likely to result in disturbance of up to 0.5 ha in the vicinity of the Hunter River (including some disturbance of exotic vegetation in the riparian zone), which is classified as "Key Fish Habitat" under DPI guidelines for aquatic habitats (DPI NSW, 2017a). The water pipeline and ETL have been designed to avoid the planted trees along Rosebrook Creek.

Typically, riparian vegetation was degraded along this reach of the Hunter River and at Rosebrook Creek, due to weed invasion and extensive farming enterprises on the Hunter River floodplain.

Providing that native endemic riparian plant species are used to rehabilitate areas where riparian vegetation is disturbed, with erosion controls (e.g. sediment traps) remaining in place until vegetation cover has been re-established and fences erected to exclude stock access, it is considered unlikely that the proposed works could further degrade riparian vegetation such that there would be a significant impact on aquatic ecology within Rosebrook Creek and the Hunter River.

Excavation around the water intake within the river could require removal of woody debris from the flow channel.

Where removal of large woody debris from within the river channel or banks is unavoidable, the debris should be replaced after construction works. Plans to re-introduce large woody debris should consider factors such as the use of native trees rather than introduced species (willows), spread of invasive aquatic weeds, stream width, bank slope, flow regime and the long-term stability of the reused trees.

Providing the recommended management for disturbance to riparian vegetation and removal of large woody debris are implemented, where appropriate, it is considered that the proposed works would result in nil or negligible loss of aquatic habitat within the Study Area.

4.2.2 Surface Water Flow and Aquatic Biota

The installation and operation of instream structures (e.g. pumping and diversion of water) can alter natural flow regimes

The Rail Modification water supply pipeline would be buried and the pump station facility would largely be above ground. However, the design would include submerged pumps and a water inlet system adjacent to the Hunter River.

Nevertheless, it is considered unlikely that the pump station infrastructure would cause measurable effects on surface water flow and aquatic biota within the Hunter River. This is further mitigated by the fact that the Rail Modification is for the relocation of an existing approved/operating extraction point, not an additional extraction point.

4.2.3 Surface Water Quality and Aquatic Biota

In the absence of mitigation measures, vegetation clearing and earthworks have the potential to increase runoff to watercourses, resulting in increased turbidity, nutrients and other contaminants.

Turbid waters reduce light available for photosynthesis by algae and aquatic plants, decrease the ability of fish to find food or to detect predators and prey and smother aquatic habitat, fish gills and filter feeding apparatus of macroinvertebrates, among others.

Nutrient inputs can lead to blooms of algal and/or aquatic macrophytes and associated effects on aquatic biota (e.g. reduced light availability, fluctuations in levels of dissolved oxygen, production of harmful toxins, among others.

Rosebrook Creek is mostly ephemeral. Providing appropriate erosion and sedimentation control measures are implemented, it is predicted that burial of the pipe across the creeks channel will contribute negligible sediments, nutrients and contaminants to downstream environments.

At the Hunter site, construction of the pump station facility and supporting infrastructure are expected to take approximately 1 – 2 months. Thus, any impacts associated with installation of the pump facility are expected to be short-term and localised. Notwithstanding that erosion and sediment controls will be in place for the duration in any case.

Providing sufficient erosion and sediment controls and control of potential pollutants, it is considered unlikely that any impacts to water quality associated with the Water Pipeline and Hunter River Pump Station would significantly affect the aquatic ecology of surface waters.

4.2.4 Barriers to Fish Movement

Early life-history (eggs and larvae) stages of fish are particularly susceptible to diversion or extraction from main river channels by water extraction practices. Water intake can also cause injury and mortality on screens (impingement) and pumps and increase the risk of predation by increasing levels of stress in fish and/or providing habitat for predators (Blackley, 2003).

Pumps with rotating impellors are commonly used but can physically injure or kill fish during operation, with certain species and size classes particularly susceptible to injury. High-volume pump systems (150 ML/d) have been shown to cause greater injury and mortality than lower volume (36 ML/day) pump systems (Baumgartner et al., 2009).

Currently, the water intake is covered by a mesh that is 8 mm bars at 100 mm centres in both directions. The intake on the river, which is orientated parallel to river flow, flows (at approximately 0.08 m/s through the mesh) to a wet well away from the river. This should limit fish intake when the wet well pump starts as it would only potentially collect fish in the wet well (that have passed through the mesh) and not directly from the Hunter River. In addition, it is recommended that the pumps are operated or designed to achieve a slow ramp up and slow stop. This should further limit the potential for fish getting collected.

Several species of native fish exhibit migrations at specific times of the year, thus restricting water diversions to periods where fish are unlikely to be migrating could represent an effective method to limit their extraction. However, water requirements at the MPO do not allow for seasonal restrictions. Notwithstanding, in practise, the pumps are only run for a small percentage of the year. For example, Hydro Engineering and Consulting (2017) indicate that in the majority of years of the MPO at least 700 ML would need to be sourced from the Hunter River. Using a 200 L/s pump it would take approximately 40 days total (regardless of how many campaigns are needed) to pump 700 ML. Therefore the pumps would not be operating for the majority of any given year, thereby reducing the potential for fish and eggs to be entrained in the system.

If unmitigated, extraction of water from the Hunter River for use in the mine could reduce the population of native (and introduced) fish in the river. If appropriate designs for screens and operational procedures are implemented, the impact of water extraction on fish populations in the Hunter River could be minimised.

MACH Energy has already implemented a number of mitigation strategies to reduce the incidence of entrainment and impingement of fish associated with pumping water from the river. In addition, the Rail Modification pump station is a replacement system that when constructed and operational would replace the existing pump station (which would be decommissioned). Thereby resulting in not net increase in potential impacts to fish from pumping.

4.2.5 Groundwater and Aquatic Biota

The Hunter River alluvial aquifer is not likely to be impacted because no drawdown effects are expected. For this reason, it is considered unlikely that the Rail Modification would have a measurable impact on groundwater habitat and stygofauna within the Study Area.

4.3 Cumulative Impacts

Cumulative impacts include the effects from concurrent operations that are close enough to cause additive effect on the receiving environment. Relevant approved or proposed mining operations near the Rail Modification include:

- Bengalla Mining Company owns the existing Bengalla Mine, which is an open cut coal mine located immediately south of the MPO;
- Hunter Valley Energy Coal (a wholly owned subsidiary of BHP) owns the existing Mt Arthur Coal Mine, which is an open cut coal mine located approximately 8 km south of the MPO;
- Mangoola Coal Operations Pty Limited owns and operates Mangoola Coal, which is an open cut coal mine located approximately 8 km west of the MPO;
- Australian Pacific Coal Limited owns the Dartbrook Mine, which is an approved underground coal mine located immediately north of the MPO; and
- Muswellbrook Coal Company (a wholly owned subsidiary of Idemitsu) owns the Muswellbrook Coal Mine which is an open cut and underground coal mine located north east of Muswellbrook.

Potential interactions with these mines are typically limited to shared use of the Main Northern Railway, shared use of supporting contractors, contributions to regional background air quality and traffic movements and socio-economic effects on the area (e.g. support industries based in Muswellbrook and other centres in the Hunter Valley).

Cumulative impacts need to also consider existing and historic impacts from other industries and land practises. The significant existing disturbance to the flow regime and aquatic environment from past damming and regulation of the Hunter River is described in Section 2.1.

Considering the limited impacts of the Rail Modification on aquatic ecology and also the existing significant number of extraction points along the Hunter River, it is not considered that there would be a material increase in cumulative impacts.

4.4 Threatened Species Under the EPBC Act, BC Act and FM Act

As stated in Section's 2 & 3, no aquatic species of conservation significance listed under the EPBC Act, BC Act or FM Act have been recorded within the Study Area.

Assessments of significance using the Seven Part Test in accordance with section 220ZZ of the FM Act have been undertaken and it is concluded that the Rail Modification would not result in a significant impact to any listed threatened aquatic species or ecological communities (Appendix 1).

4.5 Conclusions & Recommendations

In conclusion, the design of the proposed Rail Modification, particularly those components related to water management, address many of the potential impacts that might otherwise occur. Consequently, the direct impacts of the Rail Modification on aquatic ecology would likely be minimal and the potential indirect impacts on aquatic ecology downstream of the Rail Modification would be minimised with the continuation of a number of existing mitigation measures currently implemented at the MPO.

While the design of the Rail Modification indicates that impacts to aquatic habitats and biota can generally be managed by implementation of MACH Energy's Water Management Plan, it is recommended that surface water and stream health monitoring programs continue to monitor potential changes in the Hunter River, Rosebrook Creek and suitable control systems within the region.

5.0 ACKNOWLEDGEMENTS

This report was written by Sharon Cummins. Danny Roberts (BIO-ANALYSIS), Josh Peters and Danielle Wallace (Resource Strategies) and Klay Marchant (MACH Energy) are thanked for providing management support. Scott McDonald (AECOM Australia) provided background information on Rosebrook Creek.

6.0 REFERENCES

Baumgartner, L. J., Reynoldson, N. K., Cameron, L., Stanger, J. G. (2009). Effects of irrigation pumps on riverine fish. *Fisheries Management and Ecology* 15: 429-437.

Blackley, T. (2003). Screening Irrigation Off takes in the Murray-Darling Bason to Reduce Loss of Native Fish. In: *Downstream Movement of Fish in the Murray-Darling Basin*. Eds. M. Linterman, W. Phillips. Murray-Darling Commission.

Bureau of Meteorology (2017). *Climate Data Online.* Website: www.bom.gov.au/climate/data/ Accessed: October 2017.

DPI NSW (2005a). *Primefact 12. Key Threatening Processes in NSW. Degradation of Native Riparian Vegetation along NSW Water Courses.* *https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0010/634546/Primefact_Degradation_of_Native_Riparian_Vegetation.pdf* (Accessed October 2017).

NSW Department of Primary Industries (2005b). *Primefact 11. Key Threatening Processes in NSW. Removal of Large Woody Debris from NSW Rivers and Streams.* https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0011/634529/Primefact_Removal_of_large_woody_debris.pdf (Accessed October 2017).

NSW Department of Primary Industries (2005c). *Primefact 10. Installation and Operation of Instream Structures and Mechanisms that Alter Natural Flows.* https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/634518/Primefact_Instream_structures.pdf (Accessed October 2017).

NSW Department of Primary Industries (2014a). *Hunter Water Salinity Trading Scheme Report of Operation*.

NSW Department of Primary Industries (2014b). DPI NSW Primefact 1304. *Darling River Hardyhead population in the Hunter River catchment – Craterocephalus amniculus*. https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/635937/primefact-1304-darling-river-hardyhead-population-hunter-river-catchment.pdf (Accessed October 2017).

NSW Department of Primary Industries (2017a). Key Fish Habitat Maps: Muswellbrook. Website: http://www.dpi.nsw.gov.au/fisheries/habitat/publications/key-fish-habitat-maps/Muswellbrook (Accessed: October 2017).

NSW Department of Primary Industries (2017b). Primefact 1275. *Southern Purple Spotted Gudgeon – Mogurnda adspersa*. https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/635290/Primefact-1275-Southern-Purple-Spotted-Gudgeon-Mogurnda-adspersa.pdf (Accessed October 2017).

Gehrke, P. C., Harris, J. H. (2001). Regional-scale effects of flow regulation on lowland riverine fish communities in the Murray-Darling System, Australia. *Regulated Rivers: Research and Management* 11: 363-375.

Healthy Rivers Commission (2002). *Independent Inquiry into the Hunter River, Final Report*. Healthy Rivers Commission. May 2002.

Hose, G, Turak, E. (2004). *River Health in the New South Wales Lower North Coast, Hunter and Central Coast Catchments*. Report prepared for the NSW Environment Protection Authority.

Howell, T., Creese, B. (2010). *Freshwater Fish Communities in the Hunter, Manning, Karuah and Macquarie-Tuggerah Catchments: a 2004 Status Report*. Industry and Investment NSW, Cronulla, NSW.

Kingsford, R. T (2000). Review: Ecological impacts of dams, water diversions and river management of floodplain wetlands in Australia. *Austral Ecology* 25: 109-127.

Kingsford, R. T., Hankin, C. J. (2010). *The Impact of the Proposed Tillegra Dam on the Hunter River Estuary, its Ramsar Wetland and Migratory Shorebirds*. Australian Wetlands and Rivers Centre. The University of New South Wales.

Lintermans, M. (2007). *Fishes of the Murray-Darling Basin: An Introductory Guide*. Murray Darling Basin Commission, Canberra. 157 pp.

MACH Energy (2017). *Mount Pleasant Operation Water Management Plan*.

McDowall, R. M. (1996). *Freshwater Fishes of South-Eastern Australia*. 2nd.Edition. Reed Books, Chatswood, NSW.

Morita, K., Yamamoto, S. (2002). Effects of habitat fragmentation by damming on the persistence of stream-dwelling charr populations. *Conservation Biology* 16: 1318-1323.

Morris, S. A., Pollard, D. A., Gehrke, P., Pogonoski, J. J. (2001). *Threatened and Potentially Threatened Freshwater Fishes of Coastal New South Wales and the Murray-Darling Basin*. Prepared for: Commonwealth Government's Fisheries Action Program/World Wide Fund for Nature. NSW Fisheries Office of Conservation, NSW.

Pusey, B. J. and Arthington, A. H. (2003) Importance of the riparian zone to the conservation and management of freshwater fish: a review. *Marine and Freshwater Research* 54: 1-16.

Turak, E. and Bickel, D. (1994) *Using Biological Indicators to Monitor the Health of Freshwater Ecosystems*. Technical Report 94/69, NSW Environment Protection Authority.

Walker, K. F. (1985). A review of the effects of river regulation in Australia. *Hydrobiologia* 125: 111-129.

WMAwater (2013). *Aberdeen Flood Study*. Prepared for Upper Hunter Shire Council.

WRM Water and Environment (2017). *Mount Pleasant Operation Rail Modification Flood Impact Assessment.* Report prepared for MACH Energy.

7.0 APPENDICES

APPENDIX 1: THREATENED SPECIES ASSESSMENTS

The NSW Department of Primary Industries (DPI) Fisheries indicated one endangered species of fish, Southern Purple-Spotted Gudgeon (*Mogurnda adspersa*), and one endangered population, Darling River Hardyhead (*Craterocephalus amniculus*), may occur within the Study Area. Potential impacts on the Southern Purple-Spotted Gudgeon and the Darling River Hardyhead are assessed below in accordance with the relevant Seven Part Test, section 220ZZ of the FM Act (questions below are paraphrased).

The assessments of the significance of impacts have been prepared based on the Rail Modification Description and BIO-ANALYSIS Pty Ltd's understanding of the likely impacts of the Rail Modification on instream ecology. Each assessment considers the potential direct and indirect impacts of the construction and operational phases of the proposed rail spur and rail loop and the Water Pipeline and Hunter River Pump Station on the Southern Purple-Spotted Gudgeon and the Darling River Hardyhead.

Southern Purple-Spotted Gudgeon

Although Southern Purple-Spotted Gudgeon has not been recorded from within the Study Area, DPI NSW (2017a) consider that the Hunter River and Rosebrook Creek provide suitable habitat for this species. Ephemeral drainage lines within the Modification Area are not expected to provide suitable habitat for this species.

Is the Project likely to have an adverse effect on the lifecycle of the threatened species?
The potential for adverse effects on the life-cycle of threatened species of fish depends on whether the Rail Modification is likely to remove or modify habitat or change the nature of periodic disturbances such as flood.

Southern Purple-Spotted Gudgeon spawn during summer when water temperatures exceed 20 ºC and food is abundant (DPI NSW, 2017a). Adhesive eggs are attached to hard substrata, such as rocks or submerged woody debris.

If this species is present within the Study Area, it is possible that any increase in turbidity and siltation or removal of riparian vegetation and large woody debris associated with construction activities could adversely affect the life-cycle of Southern Purple-Spotted Gudgeon.

Entrainment of eggs and larvae associated with water abstraction could also have an adverse effect on the lifecycle of this species.

Implementation of erosion and sediment controls and recommendations relating to removal of riparian vegetation and large woody debris should mitigate these potential threats. Implementation of controls to avoid entrainment of fish eggs and larvae would minimise effects of water extraction, assuming that a viable population of this species is present within the Study Area.

How is the Project likely to affect the habitat of a threatened species, population or ecological community?

Most remnant populations of Southern Purple-Spotted Gudgeon in NSW occur in permanent water such as slow-flowing streams and wetlands with low turbidity (DPI NSW, 2017a). Cover provided by aquatic and riparian vegetation, leaf litter, rocks or snags are important for this species (Lintermans, 2009; DPI NSW, 2017a). They are a benthic species that mostly feed on terrestrial insects and their larvae, worms, small fish, tadpoles and some plant material.

Threats that the Rail Modification poses to potential habitat of Southern Purple-Spotted Gudgeon are reduced flows, increased turbidity, poor water quality and loss of aquatic plants.

Various culverts and bridge crossings have been included in the indicative design of the proposed rail embankment to mitigate potential flood impacts and potential impacts to flow. Furthermore, the Modification would not restrict water from flowing down the Hunter River, including flood flows (WRM Water and Environment, 2017). Therefore, the Modification is not expected to alter the number of pools that connect to habitats upstream.

Proposed construction of the water pipeline, Electricity Transmission Line (ETL) and river pump station is likely to result in disturbance of up to 0.5 ha in the vicinity of the Hunter River (including some disturbance of exotic vegetation in the riparian zone). The water pipeline and ETL have been designed to avoid the planted trees along Rosebrook Creek.

Providing that native endemic riparian plant species are used to rehabilitate areas where riparian vegetation is disturbed and that adequate erosion/sediment controls are implemented, it is considered unlikely that the proposed works could further degrade, fragment or isolate areas of riparian or instream habitat within the Hunter River.

Is the proposal likely to have an adverse effect on critical habitat for the threatened species?
There are no critical habitats listed for the Southern Purple-Spotted Gudgeon.

Is the Proposal consistent with the objectives or actions of a recovery plan or a threat abatement plan?
There is currently no recovery plan or a threat abatement plan for the Southern Purple-Spotted Gudgeon.

Erosion/sediment controls and replanting of disturbed riparian vegetation with native endemic species are proposed under the Rail Modification.

Conclusion

It is unlikely that the Rail Modification will significantly impact a local or regional population of the Southern Purple-Spotted Gudgeon.

Darling River Hardyhead

DPI NSW (2017a) consider that the headwaters of the Hunter River provide suitable habitat for this species.

The Study Area is a considerable distance from the distribution limits of this species.

Is the Project likely to have an adverse effect on the lifecycle of an endangered population?

Little is known about the reproductive biology of this species however, it is closely related to the Murray Hardyhead (*Craterocephalus fluviatilis*), which is considered a short lived (annual) species with an extended breeding season from spring through to autumn. The eggs are usually deposited amongst aquatic vegetation (DPI NSW, 2014b).

If this species is present within the Study Area, it is possible that increased turbidity and siltation, smothering of beds of aquatic macrophytes, removal of riparian habitat or large woody debris associated with construction activities could adversely affect the life-cycle of Darling River Hardyhead.

Entrainment of eggs and larvae associated with water abstraction could also have an adverse effect on the lifecycle of this species.

Implementation of erosion and sediment controls and recommendations relating to removal of riparian vegetation and large woody debris should mitigate these potential threats. Implementation of controls to avoid entrainment of fish eggs and larvae would minimise effects of water extraction, assuming that a viable population of this species is present within the Study Area.

How is the Project likely to affect the habitat of a threatened species, population or ecological community?

The Darling River Hardyhead is found in the upper tributaries of the Darling River including the Border Rivers and the Gwydir and Naomi catchments. It is also found in the headwaters of the Hunter System in NSW (DPI NSW, 2014b). However, despite extensive sampling, no individuals have been detected from the Hunter River catchment since 2003 (DPI NSW, 2014b).

Key threats that the Rail Modification poses to potential habitat of Darling River Hardyhead are reduced flows, increased turbidity, poor water quality, loss of aquatic plants and predation by introduced fish, particularly Gambusia.

Modelling indicated that there would be no material impact to the volume of water entering the Hunter River from the Modification Area, thus altering the number of pools that connect to habitats upstream.

Proposed construction of the water pipeline, ETL and river pump station is likely to result in disturbance of up to 0.5 ha in the vicinity of the Hunter River (including some disturbance of exotic vegetation in the riparian zone). The water pipeline and ETL have been designed to avoid the planted trees along Rosebrook Creek.

Providing that native endemic riparian plant species are used to rehabilitate areas where riparian vegetation is disturbed and that adequate erosion/sediment controls are implemented, it is considered unlikely that the proposed works could further degrade, fragment or isolate areas of riparian or instream habitat within the Hunter River.

How is the Project likely to affect critical habitat?

There are no critical habitats listed for the Darling River Hardyhead.

Is the Proposal consistent with the objectives or actions of a recovery plan or a threat abatement plan?

There is currently no recovery plan or a threat abatement plan for the Darling River Hardyhead.

Erosion/sediment controls and replanting of disturbed riparian vegetation with native endemic species are proposed under the Rail Modification.

Conclusion

It is unlikely that the Rail Modification will impact on a local or regional population of the Darling River Hardyhead.