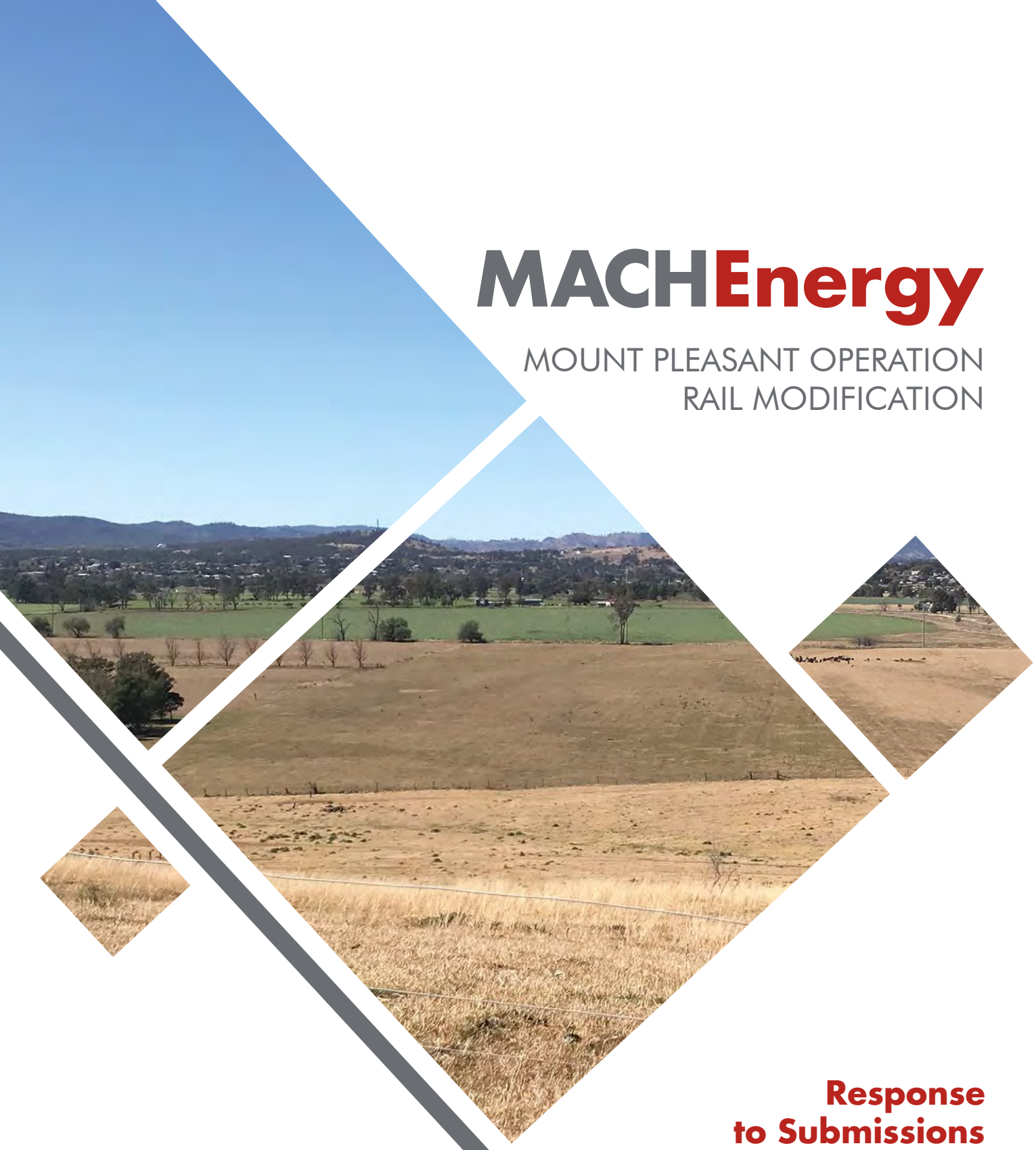
MACHEnergy

MOUNT PLEASANT OPERATION
RAIL MODIFICATION



Response to Submissions

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF GRAPHS

LIST OF ATTACHMENTS

1 INTRODUCTION

MACH Energy Australia Pty Ltd (MACH Energy) acquired the Mount Pleasant Operation from Coal and Allied Operations Pty Ltd (Coal & Allied) on 4 August 2016.

The approved Mount Pleasant Operation includes the construction and operation of an open cut coal mine and associated infrastructure located approximately 3 kilometres (km) north-west of Muswellbrook in the Upper Hunter Valley of New South Wales (NSW). The Mount Pleasant Operation is located in a significant mining region of the Sydney Basin that includes a wide range of existing operational coal mines and a number of proposed coal mining projects.

When the Mount Pleasant Operation was purchased by MACH Energy, only limited engineering and construction works had been undertaken (e.g. surveying, geotechnical investigation and construction of a dam) and no mining operations had been conducted at the site. Construction of the Mount Pleasant Operation re-commenced in November 2016, and the mine is approved to produce up to 10.5 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal. MACH Energy commenced mining operations in late 2017 in accordance with Development Consent DA 92/97 and Commonwealth Approval EPBC 2011/5795.

In mid-2017, MACH Energy (2017a) prepared the *Mount Pleasant Operation Mine Optimisation Modification Environmental Assessment* (the Mod 3 Environmental Assessment) in support of its Modification 3 application which is yet to be determined under the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act).

Subsequently in late-2017, MACH Energy (2017b) prepared the *Mount Pleasant Operation Rail Modification Environmental Assessment* (the Environmental Assessment) in support of its Modification 4 application that is currently being assessed under the EP&A Act. The Environmental Assessment was placed on public exhibition by the NSW Department of Planning and Environment (DP&E) from 18 January 2018 to 2 February 2018.

During this period, Government agencies, Non-government organisations (NGOs), businesses and members of the public were invited to provide submissions on the proposal to the DP&E.

The DP&E has requested that MACH Energy review and respond to the submissions that were received on the Environmental Assessment.

MACH Energy's responses to submissions have been structured as follows:

- Part A – Responses to Government agency submissions (Section 6.1).
- Part B – Responses to Non-Government Organisation (NGO) Submissions (Section 6.2).
- Part C – Responses to Public Submissions (Section 6.3).

This Response to Submissions Report has been structured generally in accordance with *Guideline 5; Responding to Submissions of the Draft Environmental Impact Assessment Guidance Series June 2017* (DP&E, 2017).

It is noted that a number of businesses, NGOs and members of the public supported the Modification (approximately 70% of total submissions received). In the interest of brevity, these submissions have not been reproduced in this document. However, a summary of the key positive factors raised in these submissions is provided in Section 3.5.

2 OVERVIEW OF THE EXHIBITED MODIFICATION

The Modification would primarily comprise the following components:

- duplication of the approved rail spur, rail loop, conveyor and rail load-out facility and associated services;
- duplication of the Hunter River water supply pump station, water pipeline and associated electricity supply that currently follows the rail spur alignment; and
- demolition and removal of the redundant approved infrastructure within the extent of the Bengalla Mine, once the new rail, product loading and water supply infrastructure has been commissioned and is fully operational.

Table 1 provides a comparative summary of the currently approved Mount Pleasant Operation, the Operation incorporating Modification 3 (yet to be determined) and this Modification.

Table 1
Overview of the Approved Mount Pleasant Operation, Modification 3 and the Modification

Project Component	Approved Mount Pleasant Operation	Modification 3 [1]	Rail Modification
ROM Coal Production	ROM coal production at a rate of up to 10.5 Mtpa.	Unchanged.	Unchanged.
General Waste Rock Management	Waste rock will be placed within mine voids, out-of-pit emplacements and the Fines Emplacement Area, and will also be used to construct visual bunds.	Unchanged.	Unchanged.
Waste Rock Production	Waste rock removal at a rate of up to approximately 53 million bank cubic metres per annum.	Unchanged.	Unchanged.
Waste Emplacements	Waste rock emplaced both in-pit, and in four major out-of-pit emplacement areas located to the east of the open cuts and to south-west and north-west of the open cuts.	67 hectare (ha) extension of the Eastern Out of Pit Emplacement.	Unchanged from Modification 3.
Coal Beneficiation	Beneficiation of ROM coal in an on-site Coal Handling and Preparation Plant (CHPP).	Unchanged.	Unchanged.
Coal Transport	Coal will be transported to the Port of Newcastle for export along the Muswellbrook – Ulan Rail Line and then the Main Northern Railway.	Unchanged.	Unchanged – except for the physical location of the product conveyor and rail infrastructure.
	An average of three and a maximum of nine laden trains per day leaving the mine.	Unchanged.	Unchanged.
Coal Rejects	Coarse rejects will be placed within mined out voids and out-of-pit emplacements, and used to build fines emplacement walls. Fine rejects will be stored in the Fines Emplacement Area.	Unchanged.	Unchanged.
Mining Method	Open cut mining incorporating truck and shovel and dragline operations.	Open cut mining method comprising truck and shovel in the Modification period.	Unchanged from Modification 3.
Water Supply and Disposal	Water requirements for the mine and CHPP will be met from pit groundwater inflows, catchment runoff and make-up water from the Hunter River. Potable water for the industrial area will be sourced from the Hunter River and treated on-site to the required standards. Surplus water will be discharged into the Hunter River (or its tributaries) in compliance with the Hunter River Salinity Trading Scheme (HRSTS) and the Environment Protection Licence (EPL).	Largely unchanged. Excess mine water may also be sourced from the Bengalla and Dartbrook Mines.	Unchanged from Modification 3, except for the physical location of the pump station and pipeline from the Hunter River.
Mine Life	21 years from the date of grant of Development Consent DA 92/97 (i.e. from 22 December 1999 until 22 December 2020).	Extended to 22 December 2026*.	Unchanged from Modification 3.
Hours of Operation	Operations are approved to be undertaken 24 hours per day, seven days per week.	Unchanged.	Unchanged.
Operational Workforce	Average operational workforce throughout the life of the mine of approximately 330 people, and an estimated peak of approximately 380 people.	Unchanged.	Unchanged.
Construction Workforce	A construction workforce of up to approximately 250 people will be required.	Construction workforce is expected to peak at approximately 350 people.	Peak construction workforce would be unchanged. The Modification workforce is anticipated to be up to approximately 60 people.

[1] Yet to be determined.

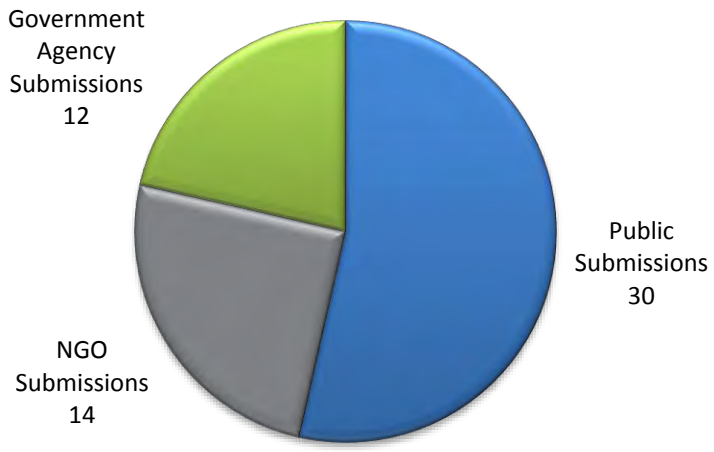
* Remains less than 21 years from commencement of operations.

3 ANALYSIS OF SUBMISSIONS

3.1 NUMBER OF SUBMISSIONS

A total of 56 submissions on the Modification were received from Government Agencies, NGOs, and members of the public. Graph 1 presents a summary of the number of submissions by submitter category.

Graph 1
Summary of All Submissions



3.2 SUMMARY OF GOVERNMENT AGENCY SUBMISSIONS

A total of 12 submissions were received from NSW Government Agencies, of which all were in the form of comments or suggested conditions (i.e. no objections).

It is noted that DP&E also provided a letter to MACH Energy, which summarised the key issues raised in the various submissions. The DP&E advice also requested that a response to submissions report be prepared and submitted.

3.3 SUMMARY OF NON-GOVERNMENT ORGANISATION SUBMISSIONS

A total of 14 submissions were received from NGOs. Of these, 12 supported the Modification and two objected to the Modification (Graph 2).

Graph 2
Summary of NGO Submissions

It is noted that the objecting NGO submissions were from two entities associated with horse breeding in the Upper Hunter Region.

3.4 PUBLIC SUBMISSIONS

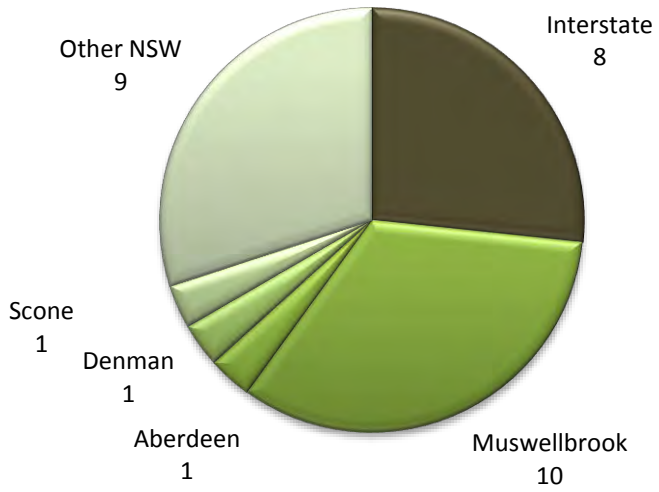
A total of 30 submissions were received from members of the public. Some 29 of the public submissions supported the Modification and one objected to the Modification (Graph 3).

Graph 3
Summary of Public Submissions

Locations of Public Submitters

Public submissions were from a range of locations including Muswellbrook (10), local towns and NSW more generally, or from interstate locations (Graph 4). The one objection to the Modification from a member of the public was from Muswellbrook.

Graph 4
Summary of Public Submissions by Location



3.5 KEY ISSUES RAISED IN SUBMISSIONS

While not exhaustive, the most commonly raised issues or concerns in commenting or objecting submissions pertained to:

- construction or operational noise emissions and management;
- air quality emissions and management;
- water supply and excess water disposal;
- cumulative impacts of mining;
- the local road network and associated changes necessitated by the proposed rail infrastructure;
- potential for land use conflict with other industries;
- concerns associated with the proposed rail infrastructure being located on the Hunter River floodplain;
- management of local heritage items;
- rehabilitation of the existing rail corridor; and
- visual or potential lighting effects.

MACH Energy also notes the most commonly raised points in supporting submissions pertained to:

- employment opportunities, including the potential for the Mount Pleasant Operation employment to offset recent mine closures or reductions in other mine workforces in the region;
- potential economic growth or flow-on effects to the local and regional economies;
- benefits that mining employment can provide, including royalties to the State of NSW;
- the relocated rail infrastructure would remove a source of potential commercial tension with the Bengalla Mine;
- surety of future employment for current employees of the Mount Pleasant Operation; and
- that the rail spur design does not preclude Wybong Road remaining open.

4 ACTIONS TAKEN FOLLOWING EXHIBITION OF ENVIRONMENTAL ASSESSMENT

4.1 ENGAGEMENT ACTIVITIES

Since the lodgement of the application, MACH Energy has continued to consult with key NSW Government agencies regarding the Mount Pleasant Operation and the Modification.

An overview of recent key consultation is provided below.

Department of Planning and Environment (DP&E)

MACH Energy has met on a number of occasions with the DP&E to discuss Modification 3 (yet to be determined) and Modification 4 and the relationship between the two proposed modifications.

The DP&E has required minor amendments to the numbering of the land ownership list, individual residences and Mount Pleasant Operation Noise Assessment Groups in finalising draft Consent Conditions for Modification 3 (yet to be determined). MACH Energy anticipates that the amended Noise Assessment Groups and updated land ownership plans would therefore be adopted for Modification 4. The updated plans are included in Attachment 1 for completeness.

Muswellbrook Shire Council (MSC)

MACH Energy has an ongoing consultation programme with the MSC associated with the development of the approved Mount Pleasant Operation.

MACH Energy has consulted with the MSC with respect to its concerns regarding the Modification flood study and correlation with the Council's flood modelling of the Hunter River.

MACH Energy anticipates that consultation with the MSC will be ongoing throughout the NSW Government assessment of the Modification.

NSW Office of Environment and Heritage (OEH)

MACH Energy met with the OEH in June 2018 to discuss the resolution of the OEH's requests for additional information on the Modification biodiversity and flooding assessments.

4.2 FURTHER ENVIRONMENTAL ASSESSMENT

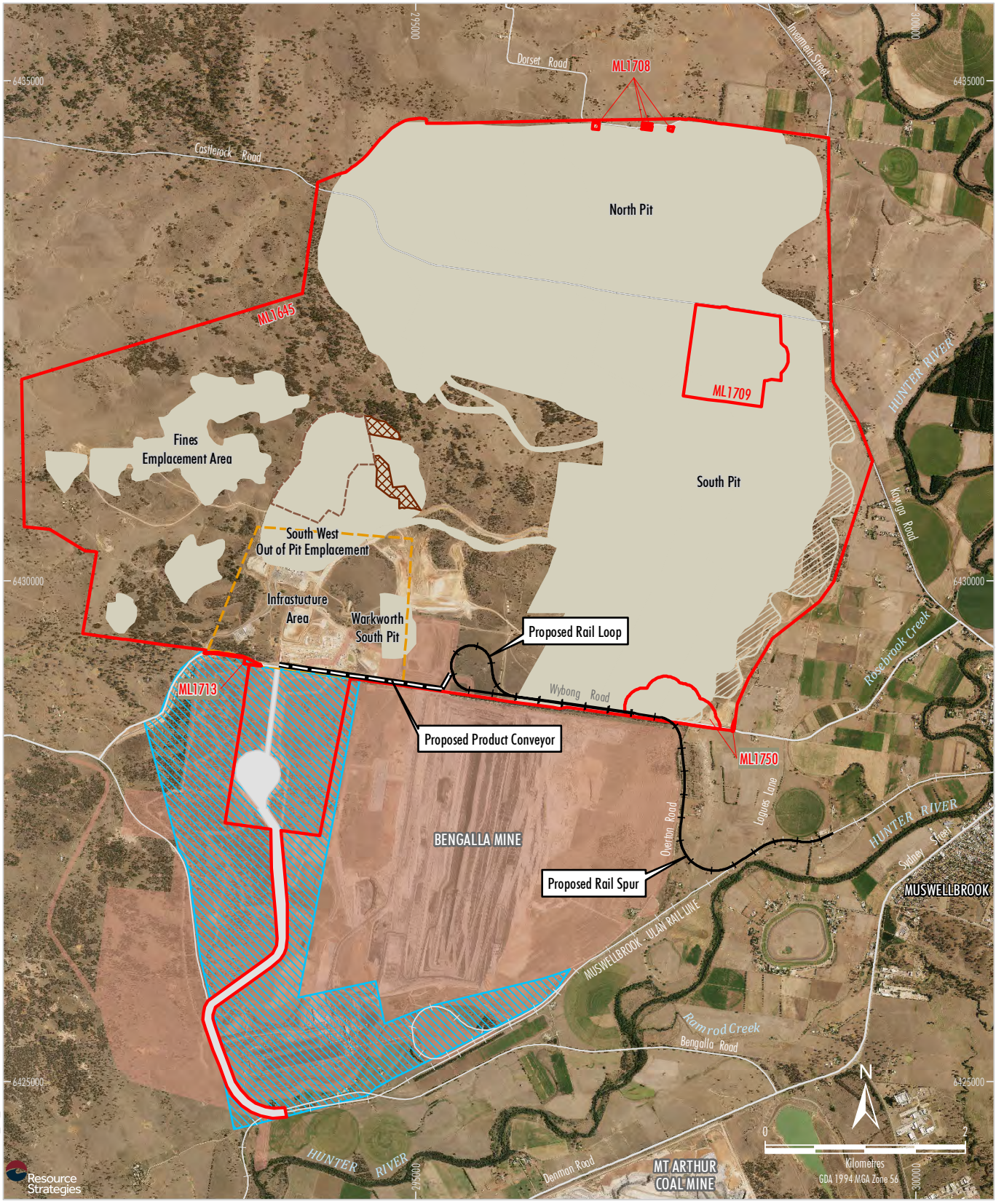
No material further environmental assessment has been required to address the submissions received on the Environmental Assessment.

Notwithstanding, MACH Energy has commissioned some additional documentation with respect to the Modification flood study, for review by the MSC and the OEH (Section 6.1.3) and some additional evaluation of biodiversity related impacts and potential management measures (Section 6.1.9).

5 CHANGES TO THE MODIFICATION

No material changes to the Modification are proposed as a result of MACH Energy's review of the various Government, NGO and public objecting submission on the Modification.

MACH Energy has, however, amended the relinquishment area associated with the Modification, as a result of conducting some further evaluation in the approved South West Out of Pit Emplacement. The proposed revised relinquishment area is described in Section 6.1.9 and shown on Figure 1.



MAC-16-01 MOD4_RS_201B

LEGEND

- Mining Lease Boundary
- Infrastructure Area Envelope
- Indicative Off-site 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
- Additional Area Relinquished for Major Infrastructure - Revised

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. water pipelines, pump station, electricity transmission lines, signalling, access tracks, 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)

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MOUNT PLEASANT OPERATION

General Arrangement of the Mount Pleasant Operation and Key Modification Infrastructure

Figure 1

6 RESPONSES TO SUBMISSIONS

6.1 PART A – RESPONSES TO GOVERNMENT AGENCY SUBMISSIONS

Responses to issues raised by Government agencies are provided in the subsections below.

The following agencies had no specific queries or concerns regarding the Modification and therefore do not require any detailed response:

- NSW Heritage Council.
- Transport for NSW.
- The Resources Regulator.
- Roads and Maritime Services.

Agencies that raised concerns or made some further comments regarding the Modification are as follows, and are addressed in the sub-sections below:

- NSW Environment Protection Authority (EPA).
- MSC.
- Australian Rail Track Corporation Ltd (ARTC).
- OEH.
- NSW Health.
- Subsidence Advisory NSW.
- Department of Industry.

Where relevant, supporting or generally positive comments from relevant Government agencies on the Modification are also referred to in the following subsections.

6.1.1 Operational, Rail Spur and Construction Noise

The following Government agencies raised issues regarding noise:

- EPA; and
- MSC.

It is noted that the EPA (2018) in its submission on the Modification stated that it supported the Modification subject to the following:

1. *Should the application be approved, that the proponent applies to vary their Environment Protection Licence to update noise limits specified in Table 3-9 of the noise assessment.*
2. *That DPE include conditions restricting the proposed construction that are outside of the mining lease to Standard Construction hours outlined in the Interim Construction Noise Guidelines, except for the following:*
    a) *The delivery of materials required by the police or other authorities for safety reasons;*
    b) *Activities required in an emergency to avoid the loss of lives, property or to prevent environmental harm;*

c) Construction that, except with the written agreement of the occupier of a residence or other sensitive land use, results in LAeq(15 minute) levels that are:

- *No more than 5dB above Rating Background Level at any residence; and*
- *No more than the Noise Management Levels specified in Table 3 of the Interim Construction Noise Guideline at sensitive land uses other than residences.*

…

Further, MSC also identified a number of concerns (some related to the EPA comments) regarding the following:

- *construction activities outside of the NSW Interim Construction Noise Guideline (NSW Department of Environment and Climate Change [DECC], 2009) (ICNG) standard construction hours, and the potential for construction related noise exceedances;*
- *the potential for train brake squeal when loaded trains are approaching the Main Line;*
- *the application of the NSW Rail Infrastructure Noise Guideline (EPA, 2013) (RING) to the assessment of train noise on the private rail spur;*
- *treatment of the MACH Energy rail movements on the Main Line as approved; and*
- *utilising the Modification 3 noise model as the basis for evaluating the operational noise implications of the new rail infrastructure in Modification 4.*

These concerns and comments are addressed in turn below.

Requirement to Update Environmental Protection Licence Noise Limits

Issue

The EPA (2018) recommended that the current EPL (20850) be updated to reflect the findings of the Noise Assessment for the Modification (specifically Table 3-9).

Response

MACH Energy concurs with the EPA's recommendation.

Construction Noise and Construction Hours

Issue

The MSC raised a concern that Modification construction activities are proposed outside of the standard construction hours specified in the *Interim Construction Noise Guideline* (ICNG) (Department of Environment and Climate Change, 2009). It also indicated concern that potential short term exceedances of standard and non-standard ICNG construction noise criteria have been identified at some of the most proximal residences (i.e. when the linear construction activities are to be located at their closest).

The EPA (2018) has also recommended that (for works outside of the Mining Lease) only construction that meets specific noise levels or requirements should be permitted outside of the standard construction hours specified in the ICNG.

Response

It is noted that MACH Energy already proposed to restrict the water pipeline and pump station construction to ICNG recommended standard hours.

It is proposed that construction of the new rail spur would occur outside the ICNG's recommended standard hours (e.g. in the afternoon on a Saturday or on a Sunday during the day). Where practical, works outside of the standard construction hours would prioritise lesser noise generating activities.

It is noted that the predicted exceedances of the ICNG as described in the Environmental Assessment would only occur under more adverse weather conditions and for a limited period of time when the working group is at, or nearest to the most proximal receivers. Most of the time, construction noise levels would comply with the 'noise affected' noise management levels specified in the ICNG (Wilkinson Murray, 2017a).

It is also noted that no privately-owned receivers are predicted to experience construction noise levels above the 'Highly noise affected' noise management level described in the ICNG (Wilkinson Murray, 2017a).

Notwithstanding the above, if the Department is of the opinion that greater flexibility should not be provided for the Modification rail spur construction, MACH Energy would be prepared to accept the EPA's recommendation that Modification construction activities outside of the Mining Lease be restricted to the standard ICNG construction hours, unless a negotiated agreement is obtained with the relevant private landowners (or if the activities meet the exempted categories listed in the quotation above).

Train Brake Squeal

Issue

MSC (2018) raised a concern that the loaded trains would be moving downhill slowly and brakes will need to be applied and brake squeal is likely to occur that has not been modelled.

MSC also recommended that no brake squeal should be permitted to be audible at any offsite receiver.

Response

As described in the Environmental Assessment, the Noise Assessment conducted by Wilkinson Murray (2017a) included consideration of the potential for sleep disturbance associated with MACH Energy train movements on the private spur.

This sleep disturbance assessment included the potential for bunching and stretching of trains on the rail spur that can occur when braking and accelerating. It was also noted that the occurrence of this type of noise is in part a function of rail stock maintenance status.

It is noted that the maintenance of the rolling stock is outside of the direct control of MACH Energy, as rail transport would be undertaken by various different rail transport providers. MACH Energy therefore does not support DP&E imposing a requirement in the Development Consent that no brake squeal is audible at any offsite residence.

Subject to review of final draft Consent Conditions as recommended to the Determining Authority by DP&E, MACH Energy does, however, generally support the intent of MSC's rail noise management condition suggestions.

MACH Energy would be happy to document reasonable and feasible measures that MACH Energy can undertake to minimise rail brake squeal in the Mount Pleasant Operation Noise Management Plan.

Application of the Rail Infrastructure Noise Guideline

Issue

MSC (2018) raised a concern that the application of the *Rail Infrastructure Noise Guideline* (RING) (EPA, 2013) was not applied conservatively to the location where the proposed MACH Energy rail spur and the Muswellbrook-Ulan Rail Line would join.

Response

MACH Energy notes that the assessment conducted by Wilkinson Murray (2017a) evaluated the rail noise emissions of the approved MACH Energy train movements on the private rail spur against the RING (EPA, 2013) criteria for non-network lines.

Wilkinson Murray (2017a) also evaluated the change in rail noise that would be experienced in practice by the private residents proximal to the proposed junction. This change was found to be nil, as these proximal private residences (all located to the south) would experience the same approved MACH Energy train movements passing on the Muswellbrook-Ulan Rail Line under the approved Mount Pleasant Operation.

This bi-assessment approach was adopted to demonstrate that there would be no practical change in rail noise experienced by the most proximal residents to the new spur junction. It was not conducted to argue against regulation of the MACH Energy private rail spur noise emissions under the RING.

This is demonstrated by the inclusion of the RING non-network rail noise criteria predicted exceedances that met either acquisition upon request, or mitigation upon request, levels specified in the NSW Government's (2014) *Voluntary Land Acquisition and Mitigation Policy For State Significant Mining, Petroleum and Extractive Industry Developments* in the summary of the predicted impacts of the Modification (Table 12 of the Environmental Assessment).

Train Movements on the Muswellbrook-Ulan Rail Line and Main North Railway

Issue

MSC (2018) has suggested that the Modification rail noise assessment should have treated the MACH Energy rail movements as if these were not approved, and then calculated the potential change in rail noise at the nearest private receivers from additional rail movements.

Response

MACH Energy notes that the Mount Pleasant Operation is approved with up to a maximum of nine laden train departures per day from the site under the Development Consent (Table 1). These rail movements will commence in 2018, irrespective of the outcomes of determination of Modification 3 or the Modification.

In addition, the Modification does not seek any extension to the approved mine life, or material changes to coal processing or handling beyond those required to facilitate the use of the replacement rail load-out and rail spur infrastructure.

The Modification 3 Environmental Assessment (yet to be determined) assesses the proposed extension of the life of the Mount Pleasant Operation to 2026, including consideration of the extension of approved rail movements to 2026.

Operational Noise Assessment – Assessment Methodology

Issue

MSC (2018) has suggested that use of the Mount Pleasant Operation noise model developed for Modification 3 by Wilkinson Murray (2017b) to assess the operational noise implications of the proposed changes to coal handling, rail loading and rail transport in the Mining Lease associated with the Modification is illogical.

In addition, MSC (2018) has advised that the mine was approved in 1999, and hence the noise regulation of the site is not based on contemporary requirements.

Response

MACH Energy notes that the Mount Pleasant Operation is approved and has already commenced mining operations. Further, MACH Energy notes that the Development Consent for the Mount Pleasant Operation was amended by Modification 1 (approved in September 2011), that included an assessment of the approved and proposed activities under the *NSW Industrial Noise Policy* (EPA, 2000). Relevant Development Consent noise criteria were updated by the NSW Government to reflect the *NSW Industrial Noise Policy* requirements at that time.

The Modification 3 Environmental Assessment further included assessment of an eastern extension of the approved development (i.e. closer to some private receivers), and also evaluated the proposed modified operational noise emissions under contemporarily derived relevant adverse weather conditions (Wilkinson Murray, 2017b).

The Modification 3 Noise Assessment (Wilkinson Murray, 2017b) concluded the following with respect to the operational noise implications of the proposed changes:

> *Based on the above, the Modification would not materially change the approved noise envelope of the Mount Pleasant Operation.*

Given the Modification 3 noise model is the most contemporary available and noise modelling results for Modification 3 posed no material change from the noise emissions of the previously approved operation, it was therefore logical that this contemporary noise model should also be adopted to evaluate the operational noise implications of the proposed Modification 4.

It should be noted that Modification 4 does not propose any change to mining methods, rates of mining or any other mining related aspects. It only proposes the relocation of a range of approved infrastructure, of which the changes to conveyors, rail loading infrastructure and the rail spur within the Mining Lease have some potential to generate a minor changes to off-site operational noise emissions.

The use of the Modification 3 noise model allowed Wilkinson Murray (2017b) to quickly isolate the potential operational noise implications of relocating the rail infrastructure and associated conveyors etc. (i.e. as no other changes arise from Modification 4).

Wilkinson Murray (2017b) concluded the following with respect to the potential changes to operational noise emissions that would occur with the proposed relocation of the rail loading infrastructure and rail spur:

- *Predicted 10th percentile exceedance levels are shown to increase by up to 1 dB at some of the identified privately-owned receivers with the Rail Modification in place. Such an increase in noise levels is considered negligible and would be undetectable to the human ear.*
- *Predicted noise levels associated with the Mount Pleasant Operation incorporating the Rail Modification would comply with the noise criteria set in Development Consent DA 92/97 when considering the identified pro-active and reactive mitigation measures described in the Modification 3 noise assessment and the proposed changes to the Consent criteria.*
- *…*

This outcome is logical, as the dominant source of noise emissions at the nearest private residences will typically be major mobile plant, that will be located closer to, and in more exposed topographic locations than the proposed relocated conveyors and rail loading infrastructure, that are located more centrally in the site.

It is also noted that the changes to Development Consent criteria proposed in Modification 3 were to correct some previous inconsistencies and also reflect contemporary land ownership, where local mine-owned land holdings have been expanded.

6.1.2 Particulate Matter

NSW Health suggested that all reasonable and feasible measures should be taken to minimise human exposure to particulate matter.

It is noted that the EPA (2018) in its submission on the Modification stated the following:

> *Recommendation*
>
> *EPA supports the proposed modification and no change is required to conditions of approval regarding emissions to air.*

The Mount Pleasant Operation also has an EPL condition that requires the shutdown of all major dust generating activities on-site under a particular combination of adverse winds and measured PM_{10} levels at the OEH Muswellbrook north-west monitor.

MACH Energy would continue to implement the air quality mitigation and management measures, and predictive and real-time air quality management system and associated response protocols, detailed in the Air Quality and Greenhouse Gas Management Plan for the Mount Pleasant Operation. The Air Quality and Greenhouse Gas Management Plan would be reviewed and, if required, revised to reflect any changes to Development Consent DA 92/97 that arise from Modification 3, or the Modification.

6.1.3 Water Resources

Decommissioning of the Existing Hunter River Pump Station

Issue

Department of Industry (2018) provided three recommendations with respect to the timing of the decommissioning of the existing Hunter River pump station at the Mount Pleasant Operations:

1. *Decommissioning of the existing Hunter River water supply pump station is to occur within 6 months of completion of the proposed replacement water supply pump station and water pipeline.*
2. *DoI Water is to be notified of the date of completion of the replacement water supply pump station and water pipeline.*
3. *DoI Water is to be notified of the date the existing pump station is decommissioned.*

Response

MACH Energy accepts this recommendation, subject to review of any applicable draft Consent Conditions. MACH Energy anticipates that prior to 31 October 2022 the replacement water supply pipeline pump station would be completed and the existing Mount Pleasant Operation Hunter River pump station would be decommissioned.

Relationship of Water Supply and Water Release Infrastructure

Issue

NSW Health raised a concern that the proposed water supply station was approximately 1 km downstream of the Muswellbrook town supply offtake, and had a concern that the same pipeline may be utilised for controlled discharge from the site.

Response

The Bengalla Mine obtained Development Consent under SSD-5170 to develop a controlled release system for the Mount Pleasant Operation. The major components of this approved infrastructure to support Mount Pleasant Operation controlled water releases comprise:

- an additional 300 megalitre Mount Pleasant Discharge Dam 1;
- an approximately 6.4 km long, bi-directional water pipeline and pumping system from the Mine Water Dam to the Mount Pleasant Discharge Dam 1;
- associated electrical work required for the above to be constructed and operated; and
- construction of a downstream channel to reduce the potential for scour as a result of the controlled water discharges.

Subject to the approval of Modification 3 (yet to be determined) and obtaining an EPL variation for the controlled releases in accordance with the HRSTS, the Mount Pleasant Operation would make use of this approved infrastructure as required over the life of the mine.

It is noted that the Mount Pleasant Discharge Dam 1 is approved to discharge into a tributary that reports to the Hunter River many kilometres downstream of the Muswellbrook Shire Council town water supply offtake.

Hunter River Salinity Trading Scheme Releases

Issue

NSW Health raised concerns regarding the water quality of potential Mount Pleasant Operation licensed discharges of mine water to the Hunter River in accordance with the HRSTS.

Response

No changes to Mount Pleasant Operation Hunter River controlled discharges are proposed as part of the Modification. Notwithstanding, MACH Energy notes that any such discharges would be undertaken in accordance with:

- the HRSTS; and
- an EPL issued under the *Protection of the Environment Operations Act, 1997*.

Potential Flooding Effects Associated with the Rail Embankment

The following Government agencies raised issues regarding flooding:

- MSC; and
- OEH.

Issue

MSC (2018) outlined some potential concerns with respect to the Modification flood assessment methodology. In particular, that the Modification flood study conducted by WRM Water and Environment (WRM) (2017) may have relied on some of the findings of MSC's 2014 flood study that no longer meets contemporary flood modelling standards, and contained some technical inaccuracies.

Further the OEH requested some additional information to assist with its assessment of the Modification as follows (OEH, 2018):

- *section 4.3 of the flood study should include a box plot or a graph indicating the variability of the peak flows for the critical storm duration*
- *the potential impact of blockages of the existing culverts and the proposed bridge openings, in accordance with ARR 2016 requirements, should be included*
- *impacts for floods greater than the 1% AEP design flood event should be included, up to and including the Probable Maximum Flood (PMF), including the 0.5% AEP and 0.2% AEP design storm events.*

In order to address the concerns raised by the MSC and OEH, WRM (2018) has documented some additional flooding design events (WRM, 2018) (Attachment 2), and MACH Energy has commissioned the MSC's preferred flood consultant (Royal HaskoningDHV) to conduct a review of these additional materials and the Modification flood study against Council's latest Hunter River flood modelling. WRM (2018) (Attachment 2) also specifically addresses each of OEH's three information requests.

The outcome of the Royal HaskoningDHV review indicated that WRM's modelling for the Modification was conservative and fit for purpose (Royal HaskoningDHV, 2018) (Attachment 3). For example, the Royal HaskoningDHV review concluded (Attachment 3):

> *The use of slightly higher design discharge, means that, provided appropriate roughness values are adopted in the hydraulic model, there should be a degree of conservatism in the WRM (2017) assessment.*
>
> *…*
>
> *Overall it is considered that the WRM (2017) model is suitable for determining the impact of the proposed rail spur and that the results are in good agreement with that presented in the Muswellbrook FRMS&P (RHDHV, 2017).*

MACH Energy also notes that Council has advised that it generally concurs with MACH Energy's proposed flooding design criteria for private residences the proposed Modification rail infrastructure (MSC, 2018):

> *The design of the works (Sect 3.2.13) is to have no more than a 0.01m increase in flood height at private residences and no more than 0.1m/sec increase on flow velocities at private residences. These figures would appear acceptable. …*

MACH Energy therefore suggests that the criteria specified in the Modification Environmental Assessment (MACH Energy, 2017b) could be adopted as the flooding design criteria in the Development Consent (Section 3.2.13):

> *The final detailed design of the proposed rail spur (and associated hydraulic structures) would be designed to meet the following criteria for potential flooding impacts for a 1% Annual Exceedance Probability (AEP) flood event:*
>
> - *no more than 0.1 m increase in flood levels on any privately-owned land;*
> - *no more than 0.01 m increase in flood levels at any privately-owned dwellings or commercial spaces;*
> - *no more than 0.01 m increase in flood levels at any public roads servicing privately-owned properties; and*
> - *no more than 0.1 metres per second (m/s) increase in flood velocities at privately-owned dwellings or commercial spaces.*

Various culverts and bridge crossings have been included in the provisional design of the proposed rail embankment to mitigate potential flood impacts. These mitigation measures would be reviewed and developed further as part of the detailed design process to comply with the proposed design criteria.

6.1.4 Rehabilitation

Issue

MSC raised a concern with respect to rehabilitation of the existing rail infrastructure corridor within the footprint of the Bengalla Mine, and recommended that these disturbance areas be stabilised following decommissioning.

Response

MACH Energy and Bengalla Mine have an existing agreement in place with respect to managing the interaction of the two operations, and MACH Energy will stabilise these areas in accordance with this agreement so they can be appropriately managed by Bengalla Mine.

Issue

MSC requested decommissioning and rehabilitation of the Bengalla Link Road bridge where it currently overpasses the Mount Pleasant Rail spur, and recommended re-instatement of the road reserve and associated drainage to Council's satisfaction.

Response

MACH Energy concurs with this recommendation.

6.1.5 Visual/Lighting

Issue

MSC raised a concern that there may be lighting effects from the rail loading infrastructure and trains on the rail spur and loop on drivers on Wybong Road, and recommended shrouding of fixed lighting.

Response

MACH Energy notes that railway lines parallel rural roads throughout NSW, including sections of the nearby New England Highway and no visual lighting mitigation is typically employed.

In this case, MACH Energy has already established visual bunding and screen planting along sections of Wybong Road, and also west of the rail loop. Further, MACH Energy notes that there is likely to be a period of some years prior to rail spur construction, which will assist in vegetation screen establishment to reduce potential direct lighting effects from trains.

MACH Energy also notes that Development Consent Condition 45, Schedule 3 would continue to apply to site fixed infrastructure lighting, include the new rail loading infrastructure, should the Modification be approved.

6.1.6 Subsidence – Old Workings

Issue

Subsidence Advisory NSW raised a concern with respect to the proximity of the abandoned Overton Colliery to the proposed rail spur and recommended a geotechnical investigation to determine the extent of the workings, and grouting to avoid subsidence if required. Subsidence NSW also highlighted that Subsidence Advisory NSW approval would be required prior to construction.

Response

The conceptual rail spur alignment was designed to largely avoid the known extent of underground workings. Notwithstanding MACH Energy concurs with Subsidence Advisory NSW's recommendations (i.e. that a geotechnical investigation be undertaken to design the embankment to a suitable geotechnical factor of safety).

6.1.7 Historic Heritage

The NSW Heritage Council (2018) submission advised that no comment was required from the Heritage Council on the Modification proposal.

MSC raised a number of concerns regarding the management of local heritage items in vicinity of the development. These are addressed below.

Heritage Plan

Issue

MSC recommended that a heritage management plan should be required for the Mount Pleasant Operation rail construction, and that Council be a consultee to the development of the plan.

Response

The Environmental Assessment contains recommendations specific to each heritage item within or near the proposed Modification disturbance areas. Considering the avoidance of impacts to key heritage items (i.e. the Overdene Homestead) and the modest potential impacts to other items, an additional management plan specific to the Modification is not considered warranted.

Notwithstanding, MACH Energy would accept a condition requiring the implementation of the Modification historic heritage management works to be undertaken in consultation with MSC, and a copy of any resulting reports/documentation be provided to MSC for its records.

Overton Orchard and Race Track

Issue

MSC recommended that movement of heavy vehicles and machinery over the parts of the Overton Orchard and Race Track is to be kept to a minimum, sensitive areas be fenced off in consultation with Council, and extant cultural plantings to be retained.

Response

The Statement of Heritage Impact for the Modification (Extent, 2017) contains recommendations that movement of vehicles/machinery be limited and managed in this area via demarcation to avoid damage of particular areas, including garden beds. Areas to be impacted have low potential to contain archaeological relics.

Issue

The MSC recommended that a photographic record is to be made of the Overton Orchard and Race Track, and a copy be provided to Council.

Response

MACH Energy is happy to consult with the MSC on the content of the photographic record and provide a copy to Council for its records.

Blunt's Butter Factory

Issue

The MSC recommended that movement of heavy vehicles and machinery be limited within Blunt's Butter Factory and/or points of access and routes be identified by an archaeologist in consultation with Council.

Response

MACH Energy is happy to consult with the MSC on potential points of access and routes at the Blunt's Butter Factory.

Demarcation of Proximal Features

Issue

The MSC recommended that two cuttings are to have movement of heavy machinery and vehicles prohibited and fenced off in consultation with Council.

Response

These features are located outside of the proposed Modification disturbance area. Notwithstanding, MACH Energy would be happy to consult with the MSC regarding appropriate demarcation.

6.1.8 Road Transport

Transport for NSW (2018) advised that it did not any comments on the Modification.

MSC raised a number of concerns regarding the management of local roads in vicinity of the development. These are addressed below.

Construction Traffic

Issue

MSC raised a concern that rail spur construction traffic would affect Wybong Road and recommended development of a Construction Management Plan to the satisfaction of Council.

Response

MACH Energy is prepared to develop a Construction Management Plan for the Modification to the satisfaction of the Secretary, if the Department concurs that such a plan is necessary.

Western Link Road

Issue

MSC noted that proposal of the Modification suggests that Wybong Road will not be closed and this may have ramifications for the construction of the Mount Pleasant Operation approved Western Link Road and the condition of Wybong Road, and also suggested a nexus with the approved relocation of Bengalla Link Road by the Bengalla Mine.

Response

MACH Energy notes that the proposed Modification does not preclude the option of MACH Energy closing Wybong Road at some stage in the future, and MACH Energy intends to retain this right.

The need for construction of the Western Link Road will be triggered by the planned closure of Wybong Road in accordance with the Mount Pleasant Operation Development Consent. This is consistent with the requirement to construct the Northern Link Road prior to closing Castlerock Road.

MACH Energy has assisted Council with the design of a number of Eastern Link options to confirm that the proposed Modification rail spur would be compatible. However, there is no nexus between the Council's preferred Eastern Link alternative and this proposed Modification.

MACH Energy is, however, prepared to accept a condition requiring MACH Energy contribute proportionally (i.e. based on use) to maintenance of Wybong Road east of the Mount Pleasant Operation access road.

Minor Road Crossings and Works in Road Reserves

Issue

MSC noted that the Modification rail spur would cross Overton Road, Wybong Road and Skippen's Lane, and that Skippen's Lane would be closed as it will be redundant.

Response

MACH Energy has commenced the formal process of closing Skippen's Lane as part of the approved Mount Pleasant Operation.

Overton Road is a local access road that extends south from Wybong Road, is partly sealed, and is a no through road. Overton Road services a small number of Bengalla Mine-owned residences. Wybong Road is a local road connecting Kayuga Road at Muswellbrook, and Golden Highway at Sandy Hollow.

It is anticipated that a rail bridge would be constructed over Wybong Road, subject to detailed design. Due to a difference in topography, Overton Road would require a minor road realignment in the north to facilitate a road bridge over the private rail cutting. The realigned Overton Road would also connect with a new 3 m wide sealed private access road to the east of the new road bridge and rail spur to connect Overton Road to the Overdene Homestead.

Works or structures that disturb the surface of a public road or connect a road to a classified road require consent under section 138 of the NSW *Roads Act, 1993*. The Modification would involve construction activities within the public road network in order to develop underpasses or overpasses of Wybong Road and Overton Road and for water supply pipeline crossings.

If the Modification is approved, MACH Energy would apply to the relevant roads authority for the necessary consents under section 138 of the *Roads Act, 1993* for the new infrastructure within the public road network. It may also be necessary to relocate a small section of Overton Road and purchase the underlying residual land from the MSC in accordance with the requirements of the *Roads Act, 1993*.

Detailed design for any roadworks would be undertaken in accordance with the *Austroads Guide to Road Design 2009* and to the satisfaction of the MSC.

6.1.9 Biodiversity

Issue

The OEH commented that the residual impacts of the Modification on biodiversity should be more clearly identified, including any proposed offset.

Response

The Environmental Assessment contains a detailed assessment of the impacts of the Modification, including the relinquishment of a currently approved disturbance area (i.e. part of the South West Out of Pit Emplacement) at the Mount Pleasant Operation (impact avoidance). The Environmental Assessment describes the biodiversity values of the area to be disturbed by the Modification compared to the area to be relinquished. Considering native vegetation, threatened species habitat and threatened ecological communities, the Environmental Assessment concludes that the Modification would result in a net increase in biodiversity values and a biodiversity offset is not necessary.

The laws regulating biodiversity assessment for major projects, including modifications of such projects, have changed recently as a result of the commencement of the *NSW Biodiversity Conservation Act, 2016* (BC Act) and its associated regulations. Whilst it was considered to be strictly unnecessary, given that this Modification application is a "pending or interim planning application" for the purposes of the *Biodiversity Conservation (Savings and Transitional) Regulation, 2017*, MACH Energy commissioned an assessment of the biodiversity values of the proposed disturbance and relinquishment areas applying the methods prescribed in the *Biodiversity Assessment Method Order, 2017* (OEH, 2017) established under Section 6.7 of the BC Act to further support the biodiversity assessment presented in the Environmental Assessment.

This resulted in the preparation of two additional reports, included as Attachments 4 and 5 of this Response to Submissions Report:

- *MACH Energy Mount Pleasant Operation Rail Modification Biodiversity Development Assessment Report* (Hunter Eco, 2018a).
- *MACH Energy Mount Pleasant Operation Rail Modification South Eastern Relinquishment Area Biodiversity Development Assessment Report* (Hunter Eco, 2018b).

These reports document the Ecosystem Credits and Species Credits associated with the Modification disturbance areas and the relinquishment area (and surrounds). Following review of these reports, MACH Energy has varied the relinquishment area proposed as part of the Modification. The revised relinquishment area is a portion of the area described by Hunter Eco in Attachment 5.

Consistent with the Environmental Assessment, and as expected given the heavily modified landscape, the additional evaluation of the Modification disturbance area (Attachment 4) recorded a very low vegetation condition score. Under the *Biodiversity Assessment Method Order* (OEH, 2017), vegetation condition is calculated and presented as a Vegetation Integrity (VI) score. Generally, a VI score lower than 17 (except for threatened ecological communities, which are not present in the disturbance area) results in a zero ecosystem credit value. Only one part of the Modification disturbance area generated a VI score greater than 17. This was the rail loop area, with a calculated VI score of 17.8. Therefore, only disturbance associated with the rail loop generates ecosystem credits.

The revised Relinquishment Area is presented on Figure 1 and the associated credits are presented in Table 2. Table 3 provides a comparison of threatened ecological communities present within the Modification disturbance area and revised relinquishment area. Table 4 provides a comparison of threatened fauna habitat present within the Modification disturbance area and revised relinquishment area, despite the disturbance area not generating any species credits under the *Biodiversity Assessment Method Order* (OEH, 2017).

As shown in Tables 2, 3 and 4, the values/credits provided by the revised relinquishment area are greater than in the Modification disturbance area. This includes, for example, an additional 674 species credits (Table 2), 5.9 ha of threatened ecological community (Table 3) and 9.7 ha of threatened fauna habitat (12.7 ha relinquished compared to 3.0 ha disturbed – Table 4).

Table 2
Comparison of Ecosystem and Species Credits

Vegetation Community/Species Name	Disturbance Area (Credits)	Revised Relinquishment Area (Credits)
Ecosystem Credits		
Grey Box x White Box Grassy Open Woodland on Basalt Hills in the Merriwa Region, Upper Hunter Valley (PCT 483)	-	27
Narrow-leaved Ironbark - Native Olive Shrubby Open Forest of the Central and Upper Hunter (PCT 1605)	141	51
Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest of the Central and Lower Hunter (PCT 1602)	-	79
Total Ecosystem Credits	**141**	**157**
Species Credits		
Burhinus grallarius / Bush Stone-curlew	-	91
Haliaeetus leucogaster / White-bellied Sea-Eagle	-	91
Hieraaetus morphnoides / Little Eagle	-	139
Lophoictinia isura / Square-tailed Kite	-	139
Petaurus norfolcensis / Squirrel Glider	-	107
Phascogale tapoatafa / Brush-tailed Phascogale	-	107
Total Species Credits	**0**	**674**

Source: Attachments 4 and 5.
Note: PCT = Plant Community Type.

Table 3
Comparison of Listed Threatened Ecological Communities

Threatened Ecological Community		Area to be Disturbed (ha)	Revised Relinquishment Area (ha)
Central Hunter Ironbark-Spotted Gum-Grey Box Forest in the NSW North Coast and Sydney Basin Bioregion	Grassy Woodland	0	3.9
White Box Yellow Box Blakely's Red Gum Woodland	Derived Native Grassland	0	1.0
	Grassy Woodland	0	1.0
Total		**0**	**5.9**

Table 4
Comparison of Threatened Terrestrial Fauna Habitat

Potential Threatened Terrestrial Fauna Habitat	Area to be Disturbed (ha)	Revised Relinquishment Area (ha)
Grassland	0	6.2
Planted Trees/Woodland	3.0[1]	6.5
Total	**3.0**	**12.7**

Note:

[1] Consists solely of planted trees used as a visual screen of the Bengalla Emplacement at the corner of Wybong Road and Overton Road and trees planted in the Overton Orchard (total 2.9 ha), as well as six hollow trees in the rail loop (approximately 0.1 ha).

Fauna surveys undertaken for the Environmental Assessment recorded several threatened species within the revised relinquishment area or immediate surrounds, including:

- Yellow-bellied Sheath-tailed Bat (*Saccolaimus flaviventris*) – Vulnerable (BC Act);
- Eastern Cave Bat (*Vespadelus troughtoni*) – Vulnerable (BC Act);
- Speckled Warbler (*Chthonicola sagittata*) – Vulnerable (BC Act); and
- Squirrel Glider (*Petaurus norfolcensis*) – Vulnerable (BC Act).

The surveys also identified possible calls of two other threatened bats, including Eastern False Pipistrelle and Greater Broad-nosed Bat, both listed as Vulnerable under the BC Act.

The implementation of the revised relinquishment area in the approved South West Out of Pit Emplacement as a component of the Modification would result in a net increase in biodiversity values (regardless of the assessment approach) without the need for a biodiversity offset.

This approach was discussed with the OEH at a meeting in June 2018 and the attending staff indicated general agreement with the proposed approach, subject to review of this Response to Submissions and the associated Attachments 4 and 5.

6.1.10 Activities in the ARTC Rail Corridor

Issue

The ARTC raised a query regarding whether the Environmental Assessment considered the potential environmental impacts of Modification activities in the Muswellbrook-Ulan Rail Line corridor.

Response

Modification Activities with the Muswellbrook-Ulan Rail Line corridor are a component of the proposed Modification and are considered in the Modification Environmental Assessment. Where relevant, potential impacts of proposed activities in the corridor have also been evaluated in the specialist appendices (e.g. potential impacts associated with local disturbance on biodiversity, and noise emissions).

6.2 PART B – RESPONSES TO NON-GOVERNMENT ORGANISATION SUBMISSIONS

Responses to issues or concerns raised by NGOs are provided in the subsections below.

Two objecting submissions were submitted by NGOs, comprising submissions from:

- Godolphin Australia; and
- Hunter Thoroughbred Breeders Association.

MACH Energy notes that these NGOs also submitted objections to Modification 3. The submissions from the two NGOs for the Modification were very similar to the objections lodged on Modification 3, being general in nature and/or repeating objections presented to Modification 3 (i.e. location of the approved Mount Pleasant Operation relative to horse breeding industries, concerns regarding potential impacts on water resources, heritage, air quality, noise and visual amenity). MACH Energy considers that the issues raised have already been comprehensively addressed in MACH Energy's *Mount Pleasant Operation Mine Optimisation Modification Response to Submissions* (MACH Energy, 2017c).

Notwithstanding, one issue raised is considered further below.

6.2.1 Critical Industry Clusters

Issue

Concerns were raised regarding the potential environmental and economic impacts on critical industry clusters (CICs) in the Hunter Valley, particularly potential impacts on the equine CIC.

Response

MACH Energy notes that the Mount Pleasant Operation was approved in 1999, and therefore has been part of the approved cumulative impacts of industry in the Hunter Valley since that time. The Mount Pleasant Operation is operated in accordance with Development Consent DA 92/97.

MACH Energy understands that the approved Mount Pleasant Operation was considered when the NSW Government drew up boundaries of critical industry clusters in the vicinity of Muswellbrook.

MACH Energy also notes that the Mount Pleasant Operation is located in a well established mining precinct between the Bengalla Mine and the Dartbrook Mine.

The Proposed relocation of the rail spur and water supply pipeline would not materially alter potential impacts of the approved Mount Pleasant Operation on CICs (i.e. approximately 3 ha of CIC would be disturbed by the Modification).

6.3 PART C – RESPONSES TO PUBLIC SUBMISSIONS

One objecting submission was received from a member of the public. Responses to issues raised in this submission are outlined in the subsections below.

6.3.1 Flooding

Issue

A concern was raised that the relocation of the infrastructure corridor from its originally approved location to the Hunter River floodplain would present potential flooding impacts to the Muswellbrook community.

Response

Various culverts and bridge crossings have been included in the provisional design of the proposed Modification rail embankment to mitigate potential flood impacts.

WRM prepared a Flood Assessment (2017) to support the Modification Environmental Assessment, which considered the change in flood levels estimated from the relocation of the infrastructure corridor (including the potential for alterations of flood levels in Muswellbrook).

Refer to the discussion in Section 6.1.3 for further details.

6.3.2 Cumulative Land Clearing

Issue

A concern was raised regarding the potential cumulative impacts of land clearing on the surrounding Muswellbrook community, with reference to potential air quality and climatic changes.

Response

MACH Energy notes that the Mount Pleasant Operation was approved in 1999, and therefore has been part of the approved cumulative impacts of industry in the Hunter Valley since that time.

It is conventional environmental assessment practice to undertake cumulative assessment based on the proposal at hand, in combination with other approved projects that may be of environmental relevance. The development or expansion of local mining operations since the original approval was granted in 1999 were considered and cumulatively assessed where relevant in the air quality assessment.

MACH Energy notes that the proposed Modification infrastructure would involve approximately 50 ha of additional land disturbance. Much of the disturbance area is existing cleared agricultural land associated with farming enterprises on the highly disturbed Hunter River floodplain and surrounds.

As part of the Modification, MACH Energy would also further restrict the area in the South West Out of Pit Emplacement footprint that could be used for development of major infrastructure, thereby reducing the area of native vegetation to be disturbed by the Modification

Further detail is provided in Section 6.1.9.

6.3.3 Potential Impacts of Modified Landforms

Issue

A concern was raised regarding the potential for noise and dust to be funnelled towards Muswellbrook between the Bengalla mine landforms and mine landforms associated with the Mount Pleasant Operation, including the proposed rail infrastructure.

Response

MACH Energy has assessed the potential cumulative noise impacts of the Modification infrastructure on Muswellbrook resulting from the concurrent operation of the surrounding mine operations (including the Bengalla Mine) in the Noise Assessment.

Cumulative noise impacts resulting from the concurrent operation of the Mount Pleasant Operation incorporating the Modification and surrounding mines were assessed against the cumulative noise criteria in Development Consent DA 92/97. As described in the Environmental Assessment, the Noise Assessment indicated that cumulative noise levels from concurrent operation of surrounding mines would comply with the relevant criteria at all privately-owned receivers assessed.

MACH Energy assessed the potential cumulative air quality impacts of the Modification infrastructure on Muswellbrook resulting from the concurrent operation of the surrounding mine operations (including the Bengalla Mine) in the Air Quality Assessment.

As described in the Air Quality Assessment, the cumulative levels, including background levels and the emissions from all other mines, showed no discernible change as a result of the Modification. In addition, no additional privately-owned receptor locations were predicted to exceed any of the relevant Development Consent DA 92/97 air quality criteria as a result of the Modification.

6.3.4 Location of Mount Pleasant Operation Infrastructure

Issue

A concern was raised that the original Mount Pleasant Operation was proposed with the infrastructure area in the west, away from Muswellbrook, and that this would change with the Modification.

Response

MACH Energy notes that the proposed Modification would only make modest changes to the approved Mount Pleasant Operation infrastructure, the vast majority of which would continue to remain, remote from Muswellbrook (e.g. CHPP, workshops, coal stockpiles etc.).

In addition, the proposed rail spur is in part parallel to the Muswellbrook-Ulan Rail Line and MACH Energy trains are already approved to operate on this line.

6.3.5 Other

Issue

The objection also raised a number of other concerns about the approved Mount Pleasant Operation, or mining in the region generally, that were philosophical in nature.

Response

MACH Energy acknowledges that some people philosophically oppose coal mining projects, and the Mount Pleasant Operation specifically.

However, the Mount Pleasant Operation is an approved coal mine, and the Modification is a permissible proposal within the NSW approval processes.

7 PROJECT EVALUATION

Based on MACH Energy's consideration of the submissions by regulatory agencies, NGOs and members of the public, MACH Energy considers that the justification provided in the Environmental Assessment remains unchanged.

8 REFERENCES

Department of Environment and Climate Change (2009) *Interim Construction Noise Guideline*.

Extent (2017) *Mount Pleasant Operation Rail Modification Statement of Heritage Impact.*

Hunter Eco (2018a) *MACH Energy Mount Pleasant Operation Rail Modification Biodiversity Development Assessment Report.*

Hunter Eco (2018b) *MACH Energy Mount Pleasant Operation Rail Modification South Eastern Relinquishment Area Biodiversity Development Assessment Report.*

MACH Energy Australia Pty Ltd (2017a) *Mount Pleasant Operation Mine Optimisation Modification Environmental Assessment.*

MACH Energy Australia Pty Ltd (2017b) *Mount Pleasant Operation Rail Modification Environmental Assessment*.

MACH Energy Australia Pty Ltd (2017c) *Mount Pleasant Operation Mine Optimisation Modification Response to Submissions*

NSW Department of Planning and Environment (2017) *Guideline 5; Responding to Submissions of the Draft Environmental Impact Assessment Guidance Series June 2017*.

NSW Environment Protection Authority (2000) *NSW Industrial Noise Policy.*

NSW Environment Protection Authority (2013) *Rail Infrastructure Noise Guideline*.

NSW Government (2014) *Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments.*

NSW Office of Environment and Heritage (2017) *Biodiversity Assessment Method Order*.

Royal HaskoningDHV (2018) *Mount Pleasant – Rail Modification Flood Assessment Review.*

Wilkinson Murray (2017a) *Mount Pleasant Operation Rail Modification Noise Assessment*.

Wilkinson Murray (2017b) *Mount Pleasant Operation Mine Optimisation Modification Noise Assessment*.

WRM Water and Environment (2017) *Mount Pleasant Operation Rail Modification Flood Assessment.*

WRM Water and Environment (2018) *Mount Pleasant Operation Rail Modification Flood Assessment – Responses to NSW Office of Environment and Heritage.*

MACHEnergy

Attachment 1

Updated Land Ownership Plans and Noise Assessment Groups

Ref No	Landholder
1	MACH ENERGY AUSTRALIA PTY LTD
2	BENGALLA MINING COMPANY PTY LTD
3	ANGLO COAL (DARTBROOK MANAGEMENT) PTY LTD
4	JR SCRIVEN
5	COAL OPERATIONS AUSTRALIA LTD
6	MUSWELLBROOK RACE CLUB LTD
7	MUSWELLBROOK COAL COMPANY LTD
8	MANGOOLA COAL OPERATIONS PTY LTD
19	DP ENGLEBRECHT
20	KB & JA BARNETT
21	MJ MCGOLDRICK
23	JABETIN PTY LTD
35	C HORNE
43	JB MOORE
45	BA & TE STRACHAN
47	BL & ML BATES
67	JM SIMPSON
68	RK & NV GOOGE
74	N & M SORMAZ
77	DM PURSER
79	DW ADNUM
80	WJ ADNUM
82	CK BIRCH
83	LG & CM KELMAN
84	GE PITMAN
86	COWTIME INVESTMENTS PTY LTD
96	RP GRAY
102	AJPS MATHER
108	JS GIBSON
112	BD BARRY
118	JM & CA HAYES
120	DL & PA MOORE
121	C & JM MOORE
136	DG YORE
139	RW & LP UPTON
140	DAPKOS PTY LTD
143	JS & NM LONERGAN
147	MJ & RG ADNUM
153	GM CASEY
154	PD & F STANDING
156	JE & JL LONERGAN
157	RB PARKINSON
158	JM HOATH
159	JE & MS DUCEY
169	L GREENSILL & J WATTUS
172	RL & CE THOMPSON
173	TL KING & JA WARD
174	TJ & ML POWER
176	JAF & LA ALLAN
177	FW & HM & SA WHEATLEY
178	PA NEELY
179	FW WHEATLEY
180	FA WHEATLEY & SON PTY LTD
181	KL & HR DAY PTY LTD
182	JG & AJ SADLER
189	OB O'BRIEN
191	JA & JE FIBBINS
192	IG & CW INGLE
193	GM & KL SMITH
194	TC & JBA HARRIS
195	T & RK YOUNG
198	TJ & NP GOLDRICK
199	NA BURLING
200	R EASTON
201	PA & MP O'BRIEN
202	DN RAPHAEL
203	RF & MA MILLARD
206	WJ HARDES
207	SW & KL BARKLEY
208	FK & WDG ALMOND & PW HUME
212	DR & CJ TUBB
213	ENGLEBRECHT RACING STABLES PTY LTD
214	AL THOMSON-WEIR & RC WEIR
215	WJ & CB MCINTOSH
216	NJ KEEVERS
217	RRA FARNSWORTH
218	SY JOHNSON
219	GL & KL ANDREWS
220	RA BYRNES & MA MOLLER
221	TD BARRON
222	ML & EA SWEENEY
223	MC & LJ DOBIE
224	DL ROBINSON
225	MR CRANFIELD & JR GLEESON
249	TW ROOTS
252	RM & KF MERRICK
257	PG & CM LANE
258	NJ & RY ELLIS
259	MR PEEL
260	PSJ MURRAY
261	PR ELLIS
271	DE KILGANNON & DS MACDOUGALL
272	GC SPARRE
273	IJ & CM RICHARDS
280	MONADELPHOUS PROPERTIES PTY LTD
281	JR & JA BUCKLEY
282	JE ANDERSON & KL & J CAMPBELL & MV & DJ & SE & TP HALLETT
283	SRP & RF RAY
285	THE NEW SOUTH WALES GREYHOUND BREEDERS OWNERS & TRAINERS ASSOCIATION LTD
286	MUSWELLBROOK SHIRE COUNCIL
287	TELSTRA CORPORATION LTD
288	LA & JM WEBSTER
289	RA & EA LAWMAN
292	GR & MK WALSH
293	MG & LJ LATHAM
296	JM WILD
302	MJ & MJ DUNCAN
305	RH ENGLEBRECHT
400	ROSSGOLE PASTORAL COMPANY PTY LTD
401	JL & DG DAY
402	PC BRITTAN
403	WILCROW PTY LTD
404	JL & DG & RW DAY
405	GL & JL DANIELS
406	LE & SR HOLDSWORTH
407	AD LONERGAN
408	SN BATEMAN
409	AP CORLISS
410	V BATEMAN
411	DL CADDEY
412	JA BAILEY
413	MJH LUMBY
414	PG LUCK
415	SJ FRANKLAND
416	RV MITCHELL
417	M & JA CASTELLANA
418	PB WATTS
419	KM BATES & TG WOODS
420	D COLLINS
421	GW RICHARDS
422	ME DANIELS
423	DB WRIGHT
424	TJ & AD & J LONERGAN & DM MCGUIGAN
425	JE LONERGAN
426	J BIRCH
427	IJ BYFIELD
428	JM GOWING
429	KP & MD & JJ COLLINS & ML WILLIAMSON
430	DJ HULBERT
431	GJ DAY
432	REN & TR ADAM & KL CONE
433	CJ ASHFORD & JP BRENNAN
434	GJ & RL JONES
435	MN FRASER
436	MEDEGATE PTY LTD
437	BG & S CANVIN
438	WALFERTAN PROCESSORS PTY LTD
439	PITNACREE (BLAIRMORE) PTY LTD
440	DARLEY AUSTRALIA PTY LTD
441	MACQUEEN PROJECTS PTY LTD
442	WJ BOURKE
443	RG & K BRADLEY
444	JW & VL BRACE
445	AUSGRID
446	W CLARKE & G HURST & W KELYMACK & G LANE & G WOOLNOUGH
447	NM & JS LONERGAN
448	JS LONERGAN
449	KM LEE
450	KL & GM SMITH

MAC-16-01 MLMod_RAInfo_002A

Source: NSW Land & Property Information (2018)

MACHEnergy

MOUNT PLEASANT OPERATION

Landholder List

Figure 5-1

Ref No	Landholder	Ref No	Landholder
451	GK & HM SANSOM	506	SA & RP WITHERS
452	AJR MADDEN	507	NE GOLLAN
453	SC & ME DEVER	508	VG FOSTER
454	AP & PE MCMANUS	509	GJ DAY & J WATTUS
455	RP KEAST	510	YR & SG WILKS
456	GT KEAST	511	MJ & KM FARRELL
457	AM PRATT	512	GR & EA MEDHURST
458	HJ WRIGHT	513	DC & GJ WILTON
459	AJ & LL MARTIN	514	BROADCAST AUSTRALIA PTY LTD
460	RG GOWING	515	SB & JA REICHEL
462	SH JENNAR	516	MP CLIFFORD
463	IV & CA INGOLD	517	FL COLEMAN & JC THOMAS
464	KL BALMER & JL SMITH	518	VM FRENCH
465	FN & WL GOOGE	520	JEHOVAH'S WITNESSES CONGREGATIONS
466	GT MCNEILL	522	BJ & VR PASSLOW
467	MWJ & LC WALTON	523	HG & MG COPE & PM & FP FARRELL
468	S.R. & J.W. LAWSON (LINDISFARNE) PTY LTD	524	G GILLFEATHER
469	FN GOOGE	525	IR & F WEBBER
470	JI & PJ BROWN	526	DL WICKS
471	PJ BROWN	527	DJ & GH CORK
472	JDM MARKHAM	528	AS CHICK
473	MR & M PEEL	529	TH HAMILTON & AM SMITH
474	AA & BT MEYER	530	SC & NJ BULLARD & JM HARRISON
475	EJ & CA DENTON	531	GJ & EA MUNZENBERGER
476	LA & CA MACPHERSON	532	VL ROSE
477	MW TURNER	533	MJ BROWN
478	RL ANGUS	534	EE MARKS
479	HM WENG & FYP ZHU	535	GL & DN HORTON
480	HR & BC GRUGEON	536	LJ CUMMINS
481	RL WILKS	537	TJ D'HERVILLE
482	DJ PHILLIPS	538	KD POWER & T VERO
483	RW JONES	539	PH CURTAIN & CA SINGLETON
484	TR & KM PAULSEN	540	GRENTELL PTY LTD
485	PR & M BURGMANN	541	JG HINDER & VG MATHEWS
486	GW & HM BLAKE	542	PE & GJ CHAPMAN
487	E RANKIN	543	KD CLOSE
488	E & WJ RANKIN	544	DS & RM NEWTON
489	ALIFORM PTY LTD	545	JA GREEN
490	RL GORDON	546	SJ SCOTT
491	PW GILLIGAN	547	LA & FK & G BRYANT
492	HM & CR GOODSELL	548	WANARUAH LOCAL ABORIGINAL LAND COUNCIL
493	AW & JC YOUNG	549	TTW KEAST & RA SUMNER
494	BJ & K FLAHERTY	550	SR PAGE
495	DAVHAM NOMINEES PTY LTD	551	PA & SL RYAN
496	RW DAVIS	552	MT PERRAM
498	SCONE POLO CLUB INCORPORATED	553	MF & AV DOHERTY
499	RD & TL JONES	554	K CASBEN
500	GWRD HOLDINGS PTY LTD	555	GLENDOWER PASTORAL CO PTY LTD & GYARRAN PTY LTD
501	JW TAYLOR		
502	LC SCOWEN	556	CS JACOBSEN
503	JR GORDON	557	CJ & LE DUCK
504	MT O'CONNELL		
505	GC O'HARA		

MAC-16-01 ML Mod_RAInfo_002A

Source: NSW Land & Property Information (2018)

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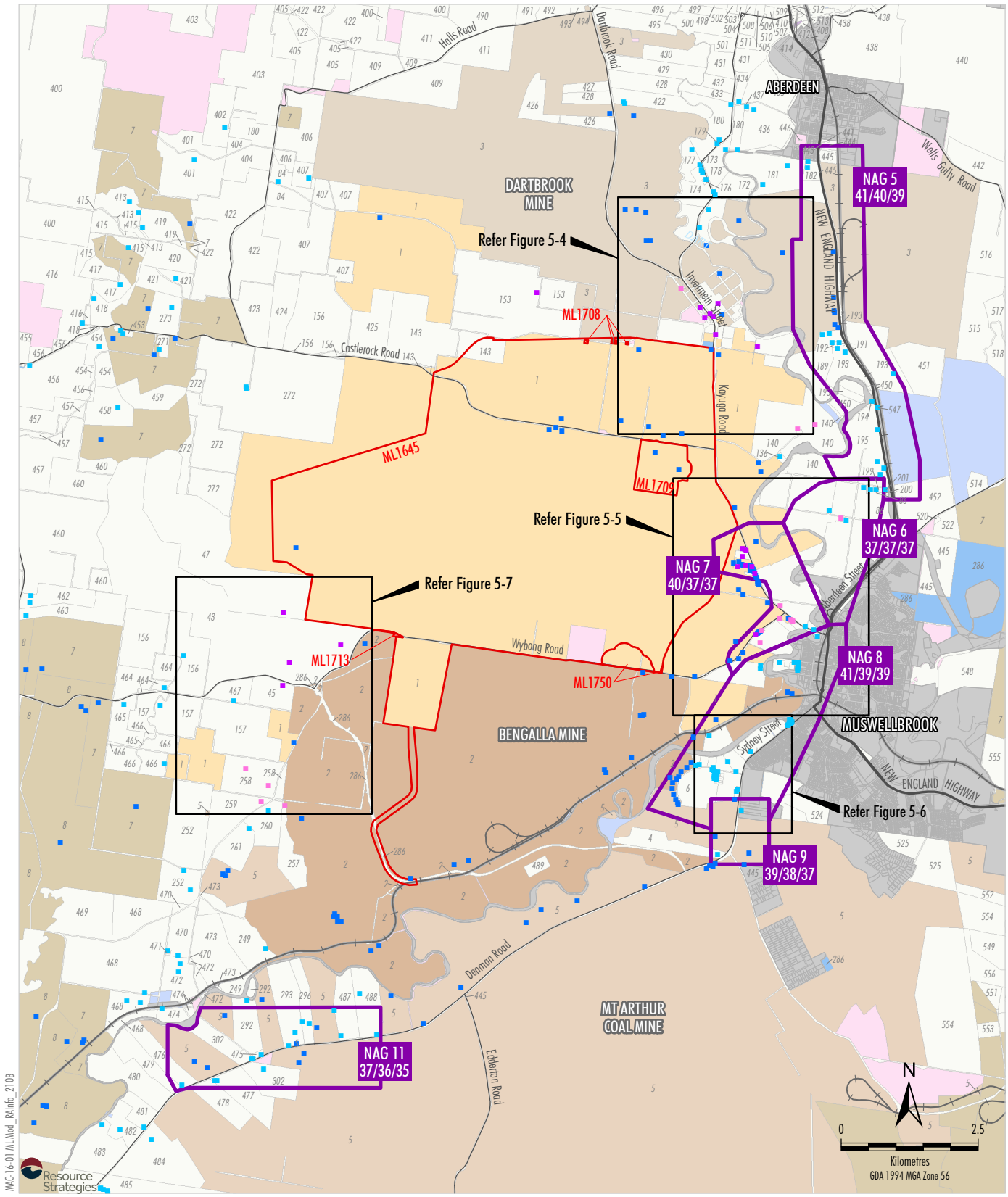
MOUNT PLEASANT OPERATION

Landholder List

Figure 5-2



LEGEND

- Mining Lease Boundary
- Muswellbrook and Upper Hunter LEPs Zones B2, B5, IN1, SP2, R2, R5, RE1, RE2 and W1
- Crown
- Crown/State of NSW
- The State of NSW
- Muswellbrook Shire Council
- Upper Hunter Shire Council
- Mount Pleasant Controlled
- Bengalla Controlled
- Dartbrook Controlled
- Mt Arthur Controlled
- Other Mining/Resource Company Controlled
- Privately Owned Land
- Mine-owned Dwelling
- Privately-owned Residence - MPO Acquisition on Request
- Privately-owned Residence - MPO Mitigation on Request
- Other Privately-owned Residence
- Noise Assessment Group (NAG)
- 37/36/35 Default NAG Noise Criteria for Day/Evening/Night

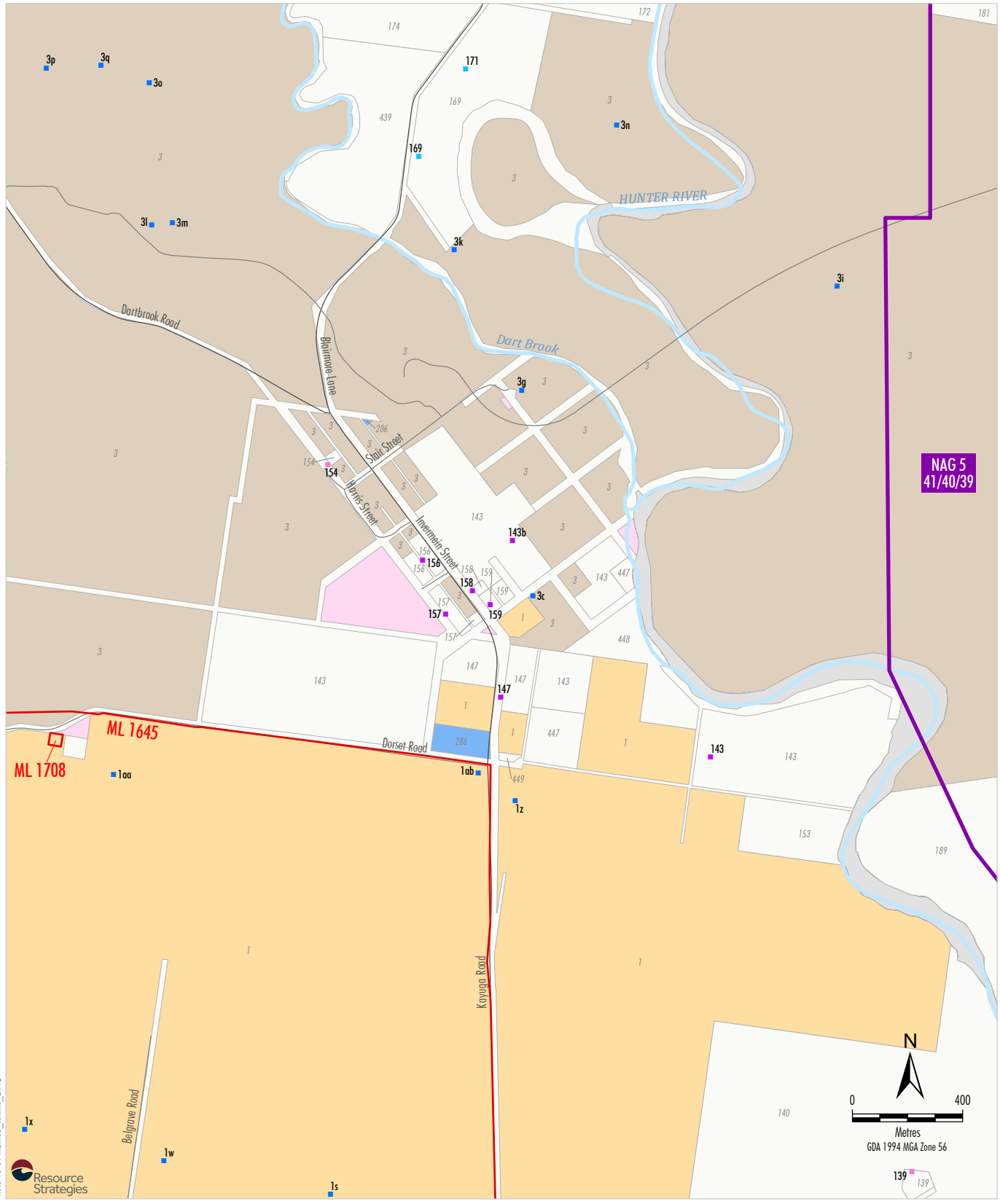
Source: NSW Land & Property Information (2017); NSW Division of Resources & Energy (2017)

MACHEnergy

MOUNT PLEASANT OPERATION

Land Ownership

Figure 5-3



LEGEND

- Mining Lease Boundary
- Muswellbrook and Upper Hunter LEPs Zones B2, B5, IN1, SP2, R2, R5, RE1, RE2 and W1
- Crown
- Muswellbrook Shire Council
- Mount Pleasant Controlled
- Dartbrook Controlled
- Privately Owned Land
- Noise Assessment Group (NAG)
- 37/36/35 Default NAG Noise Criteria for Day/Evening/Night
- Mine-owned Dwelling
- Privately-owned Residence - MPO Acquisition on Request
- Privately-owned Residence - MPO Mitigation on Request
- Other Privately-owned Residence

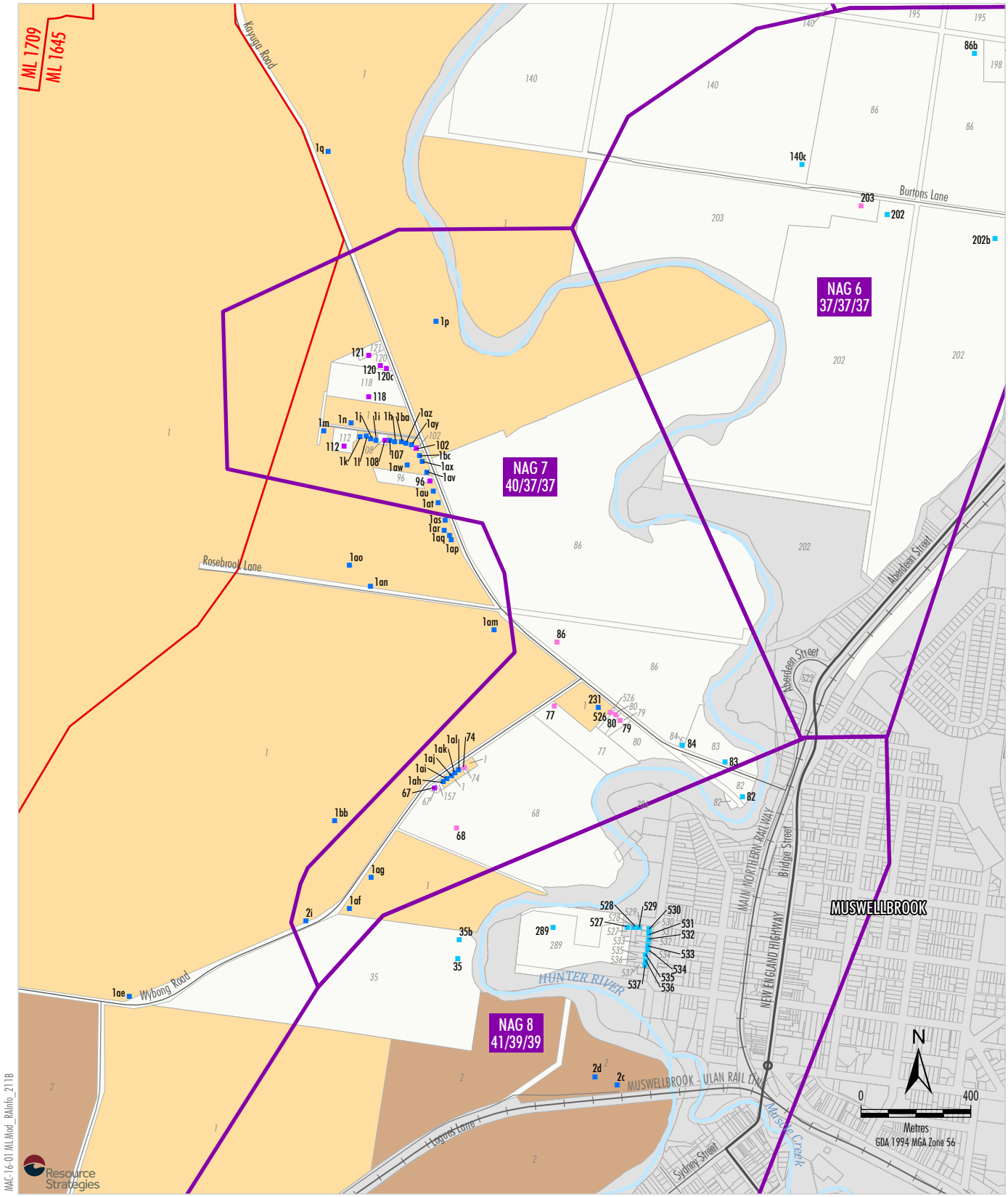
Source: NSW Land & Property Information (2016); NSW Division of Resources & Energy (2016); MACH Energy (2016)

MACHEnergy

MOUNT PLEASANT OPERATION

Land Ownership Dartbrook Inset

Figure 5-4



LEGEND

- Mining Lease Boundary
- Muswellbrook and Upper Hunter LEPs Zones B2, B5, IN1, SP2, R2, R5, RE1, RE2 and W1
- Muswellbrook Shire Council
- Mount Pleasant Controlled
- Bengalla Controlled
- Privately Owned Land

- Mine-owned Dwelling
- Privately-owned Residence - MPO Acquisition on Request
- Privately-owned Residence - MPO Mitigation on Request
- Other Privately-owned Residence

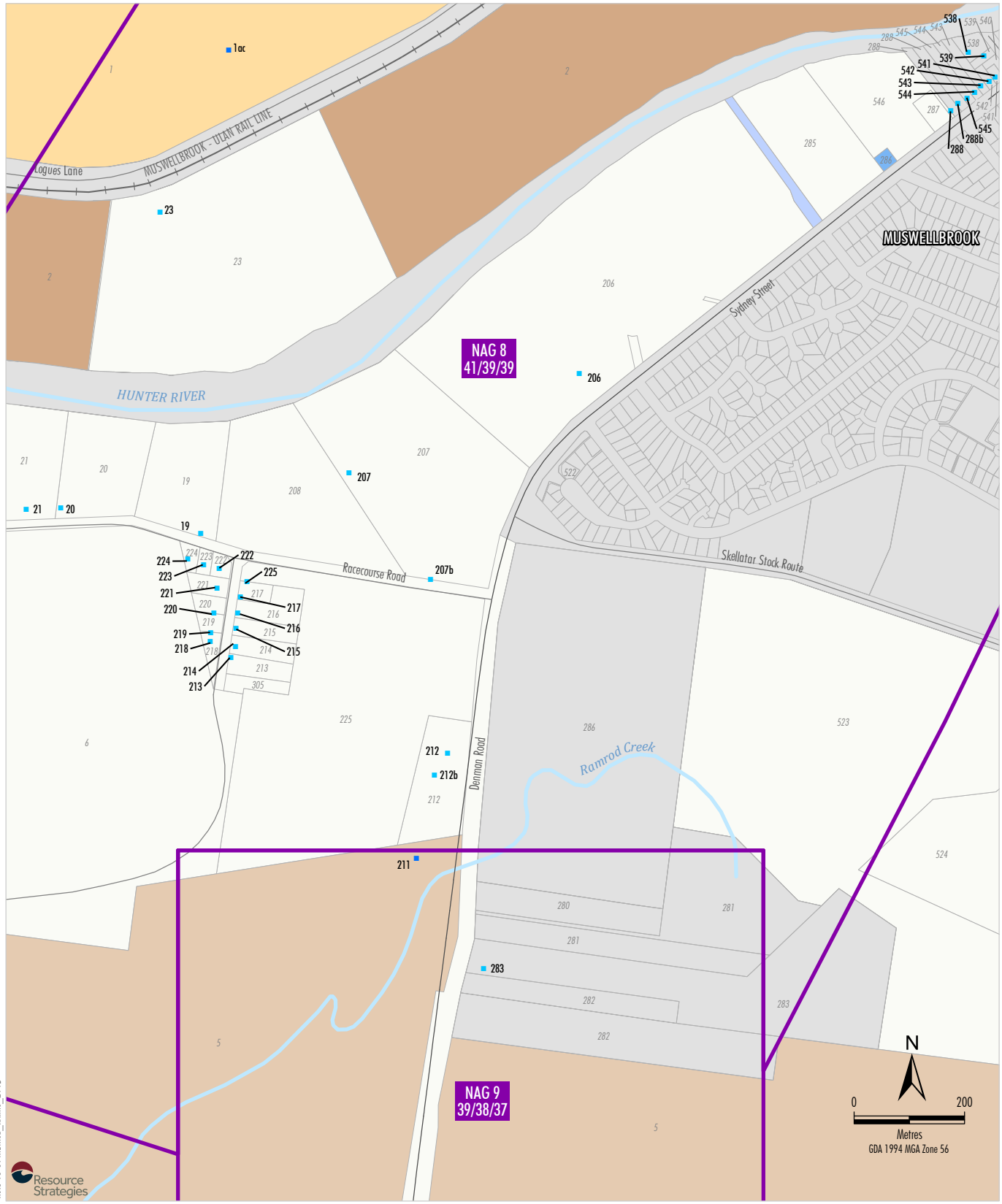
37/36/35 Noise Assessment Group (NAG)
Default NAG Noise Criteria for Day/Evening/Night

Source: NSW Land & Property Information (2016); NSW Division of Resources & Energy (2016); MACH Energy (2016)

MACHEnergy
MOUNT PLEASANT OPERATION

Land Ownership
Kayuga Road Inset

Figure 5-5



MAC-16-01 MLMod_RAInfo_211B

LEGEND

- Muswellbrook and Upper Hunter LEPs Zones B2, B5, IN1, SP2, R2, R5, RE1, RE2 and W1
- The State of NSW
- Muswellbrook Shire Council
- Mount Pleasant Controlled
- Bengalla Controlled
- Mt Arthur Controlled
- Privately Owned Land
- Noise Assessment Group (NAG)
- 37/36/35 Default NAG Noise Criteria for Day/Evening/Night
- Mine-owned Dwelling
- Other Privately-owned Residence

Source: NSW Land & Property Information (2016); NSW Division of Resources & Energy (2016); MACH Energy (2016)

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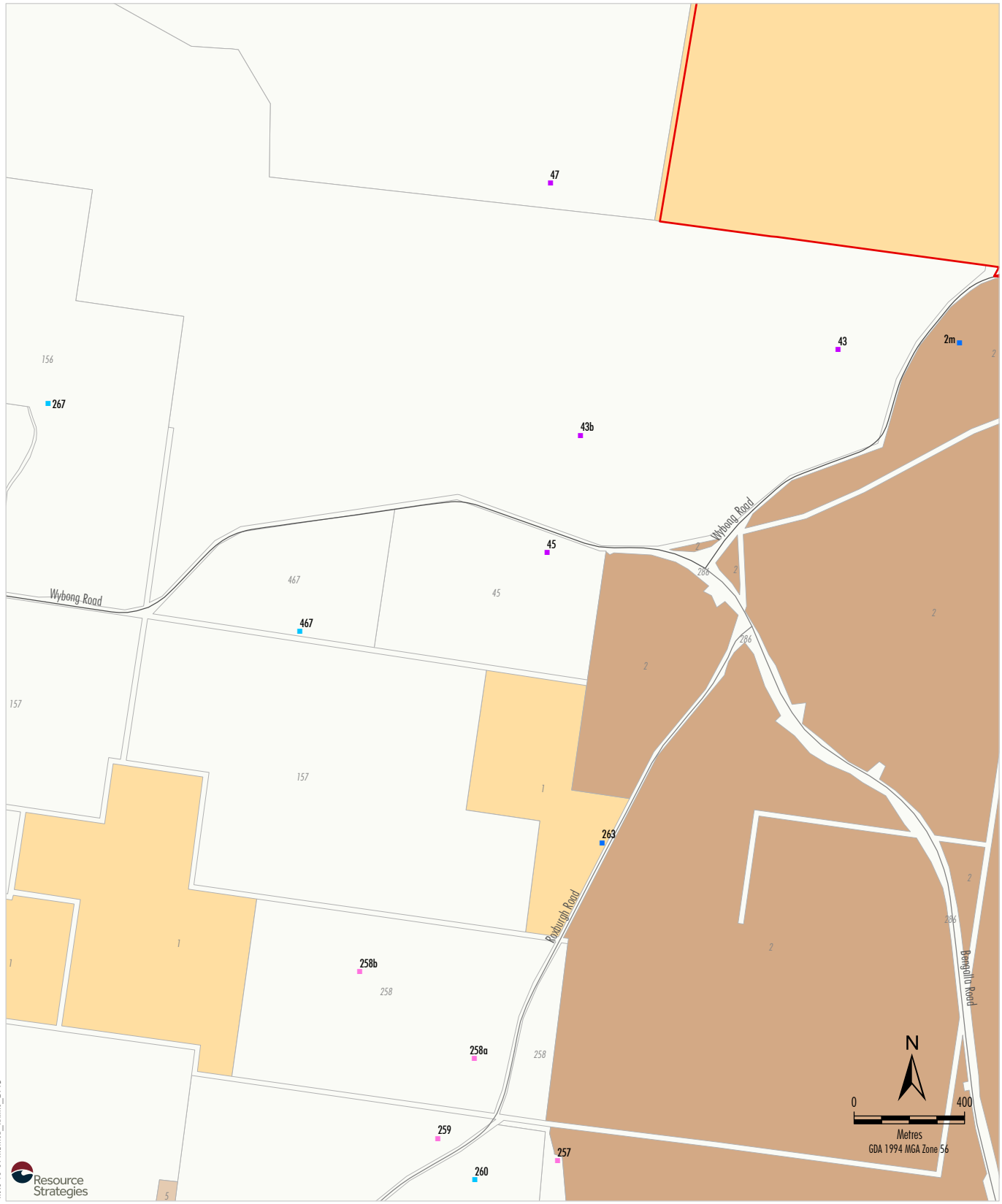
MOUNT PLEASANT OPERATION

Land Ownership
Denman Road Inset

Figure 5-6



LEGEND

- Mining Lease Boundary
- Mount Pleasant Controlled
- Bengalla Controlled
- Mt Arthur Controlled
- Privately Owned Land
- Mine-owned Dwelling
- Privately-owned Residence - MPO Acquisition on Request
- Privately-owned Residence - MPO Mitigation on Request
- Other Privately-owned Residence
- Noise Assessment Group (NAG)
- 37/36/35 Default NAG Noise Criteria for Day/Evening/Night

Source: NSW Land & Property Information (2016); NSW Division of Resources & Energy (2016); MACH Energy (2016)

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MOUNT PLEASANT OPERATION

Land Ownership
Wybong Road Inset

Figure 5-7

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Attachment 2

Supplementary Flood Modelling Advice

Memorandum

Date	8 June 2018	Pages	11
Attention	Chris Lauritzen		
Company	MACH Energy Australia Pty Ltd (c/o Resource Strategies)		
Job No.	0744-09-D1		
Subject	Mount Pleasant Operation Rail Modification Flood Assessment - Responses to NSW Office of Environment & Heritage		

Dear Chris,

Background

WRM Water & Environment Pty Ltd (WRM) prepared a flood impact assessment for the Mount Pleasant Operation Rail Modification for MACH Energy in 2017. The study (WRM, 2017) assessed the potential impacts of the new rail spur on Hunter River flooding and provided advice on appropriate design criteria and mitigation measures to prevent adverse flooding impacts on nearby private properties and public infrastructure.

In February 2018, NSW Office of Environment & Heritage (OEH) provided recommendations and comments on the study. The additional information requested by OEH (2018) is summarised as follows:

- Section 4.3 of the flood study should include a box plot or a graph indicating the variability of the peak flows for the critical storm duration;
- the potential impact of blockages of the existing culverts and the proposed bridge openings, in accordance with ARR 2016 requirements, should be included;
- impacts for floods greater than the 1% AEP design flood event should be included, up to and including the Probable Maximum Flood (PMF), including the 0.5% AEP and 0.2% AEP design storm events.

This memorandum provides further information in response to the OEH comments.

Design discharges

A flood frequency analysis (FFA) was undertaken on the Hunter River at Muswellbrook Bridge gauge in the WRM (2017) flood study. The FFA was undertaken using the Bayesian inference methodology recommended in Australian Rainfall and Runoff (ARR) 2016 (Ball et al., 2016) using the FLIKE software.

The calibrated Hunter River RAFTS model developed by WorleyParsons (2014) was reproduced using the detailed configuration and parameters reported in the 2014 Hunter River flood study report (WorleyParsons, 2014) and was used for the flood assessment. The design discharge hydrographs were determined in accordance

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with the methodology recommended in ARR 2016, replacing ARR 1987 (Pilgrim, 1987). ARR 2016 includes the use of an ensemble of 10 temporal patterns to derive the design discharges (the temporal pattern that gives the peak discharge closest to the mean is used).

Table 1 shows the 5% AEP to Probable Maximum Precipitation Design Flood (PMPDF) RAFTS design discharges and comparison to the FFA results at Hunter River at Muswellbrook Bridge gauge. The RAFTS predicted design discharges match reasonably well to FFA and hence the RAFTS design discharges were adopted in the hydraulic model to estimate design flood levels and velocities.

Table 1 - Comparison of RAFTS predicted design discharges and FFA at Muswellbrook Bridge gauge

Design Event (AEP)	FFA (m^3/s)	RAFTS (m^3/s)	Difference (RAFTS minus FFA)
5%	1,731	1,776	2.6%
1%	3,721	3,841	3.2%
0.5%	4,872	5,022	3.1%
0.2%	6,705	6,899	2.9%
PMPDF	-	26,919	-

Figure 1 to Figure 4 show the box plots of design discharges at Muswellbrook Bridge gauge for the design events from 5% AEP to 0.2% AEP. The distribution is represented as a box and whisker plot, which is a standardised way of presenting the distribution of data. For each duration, the box represents the 25%ile and 75%ile (1st and 3rd quartile, the interquartile range or IQR) bound of the estimate. The black horizontal lines (whiskers) represents the upper and lower estimates. The values outside the whiskers are considered outliers. The black horizontal dotted line within the box is the median value and the red horizontal line represents the mean value.

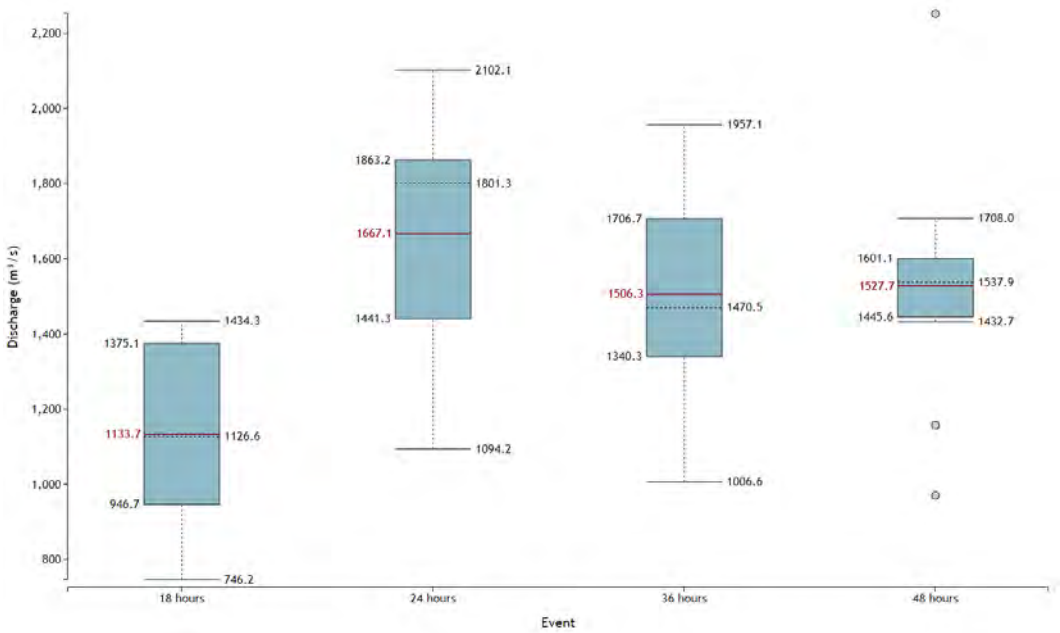


Figure 1 - Box plots of design discharges at Muswellbrook Bridge gauge, 5% AEP design event

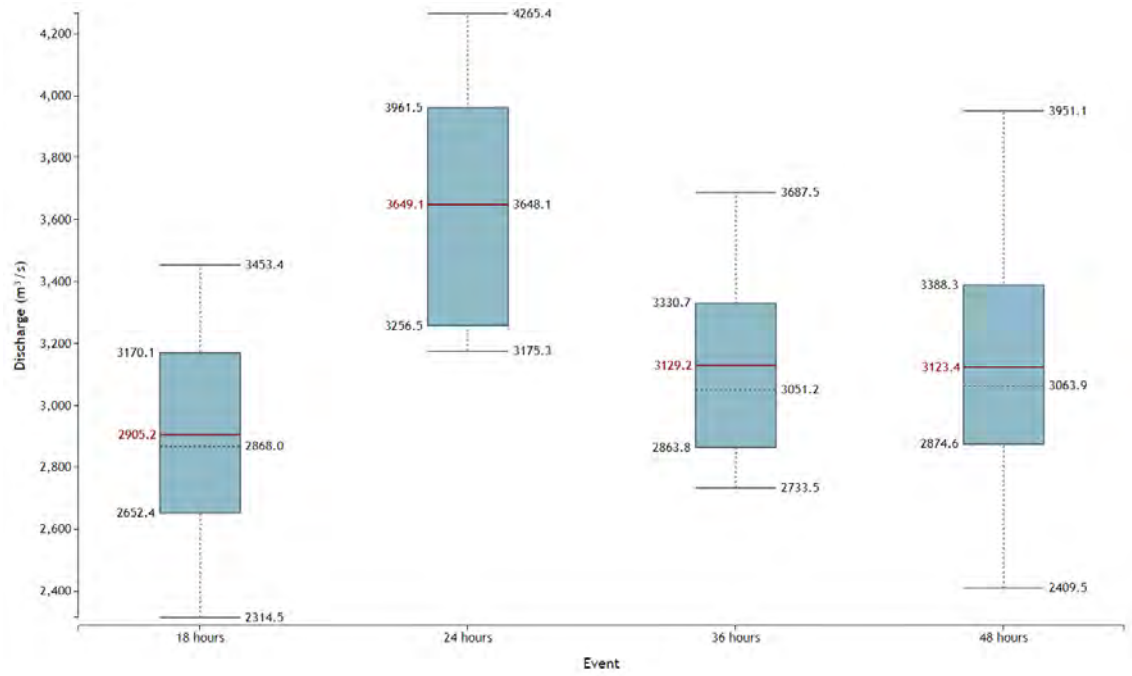


Figure 2 - Box plots of design discharges at Muswellbrook Bridge gauge, 1% AEP design event

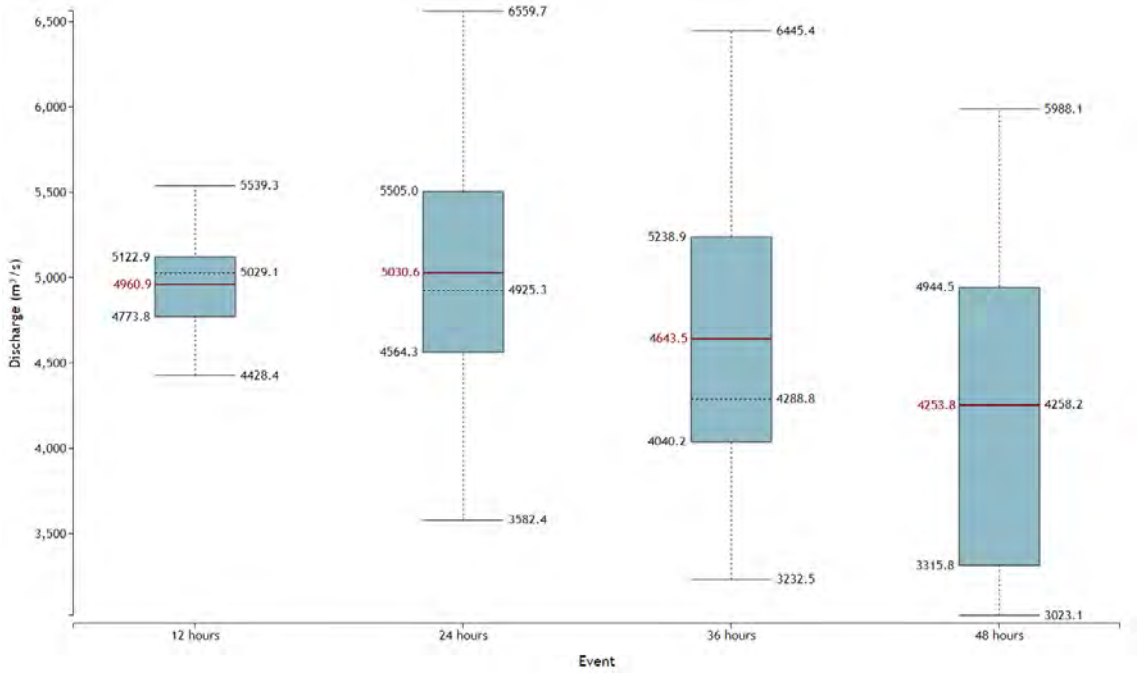


Figure 3 - Box plots of design discharges at Muswellbrook Bridge gauge, 0.5% AEP design event

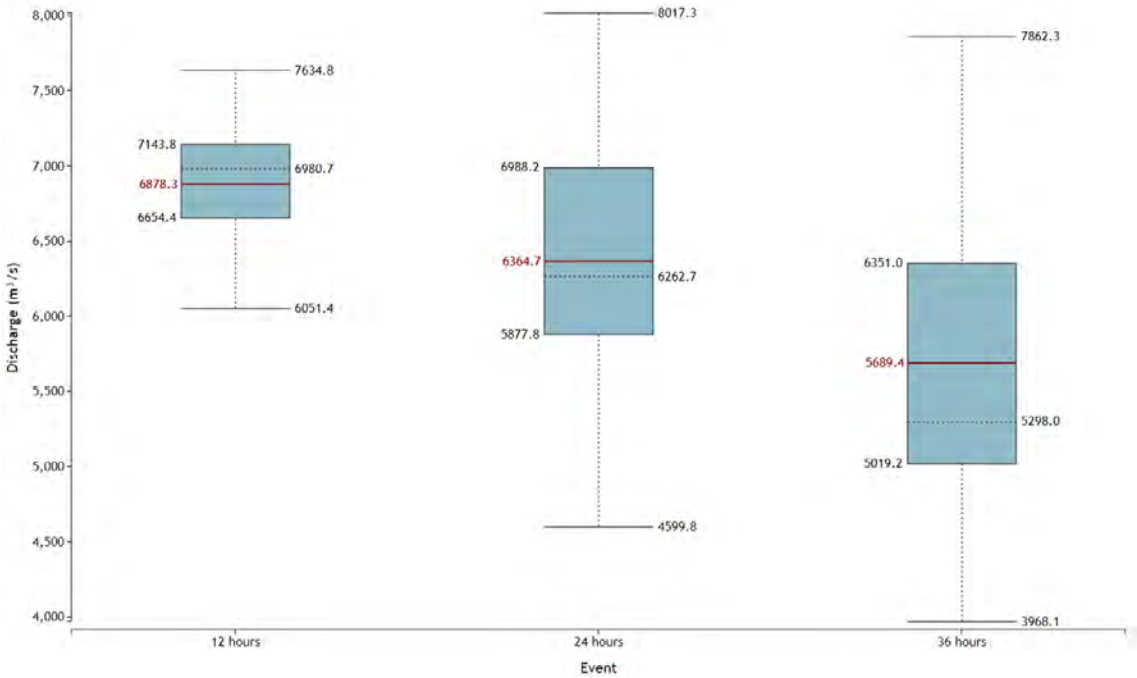


Figure 4 - Box plots of design discharges at Muswellbrook Bridge gauge, 0.2% AEP design event

Blockage of existing culverts and proposed bridge openings

An assessment of the design blockage for the proposed rail spur bridge openings has been undertaken, in accordance with ARR 2016 Book 6 Chapter 6. The assessment procedure outlines the key design criteria including debris availability, mobility and transportability. These criteria are used to determine the 1% AEP debris potential, AEP adjusted debris potential and the design inlet blockage.

The blockage assessment for the proposed rail spur bridge openings indicates a very low blockage potential and resulted in a 0% blockage for the most likely inlet blockage level. The basis on the selected criteria is listed below:

- Debris availability (Table 6.6.1, ARR 2016) – the dominant land use type upstream of the proposed bridge opening is well maintained paddocks. This results in **'Low'** debris availability.
- Debris mobility (Table 6.6.2, ARR 2016) – the proposed rail spur bridge openings are located on a flat floodplain and are well away from the Hunter River. The debris mobility is considered to be **'Medium'**.
- Debris transportability (Table 6.6.3, ARR 2016) – the slope of the floodplain upstream of the proposed bridge opening is very flat at approximately 0.3%. The transportability of debris is likely to be **'Low'**.
- The 1% AEP debris potential is **'Low'** based on the above three criteria (Table 6.6.4, ARR 2016). A **'Medium'** debris potential is adopted for design event rarer than the 0.5% AEP (Table 6.6.5, ARR 2016).
- The average length of the longest 10% of the debris (L10) is assumed to be 3 m, which represents the upper end of medium floating debris. The span length of the proposed rail bridge openings is about 15 m, which is more than 3 times of the L10. In accordance with ARR 2016 Table 6.6.6, the most likely inlet blockage is 0% for the proposed bridge openings for **'Medium'** and **'Low'** debris potential at the structure (i.e. all design events).

The proposed extension of two existing culvert crossings will have the same design blockage risk as the existing culvert crossings. Any potential blockage of the existing culvert crossings and the culvert crossing extension will not change the flood impacts.

Flood impacts assessment

The 5% AEP and 1% AEP predicted flood level and velocity impacts of the proposed conditions (with proposed rail spur and mitigation measures) have been provided in the WRM 2017 flood study. Figure 5 to Figure 7 show the flood level impacts for the additional 0.5% AEP, 0.2% AEP design events and PMPDF as requested by OEH. The following is of note:

- For the 0.5% AEP design flood, peak flood levels at a number of private dwellings to the south of the existing railway increase by just over 0.01 m, compared to existing conditions.
- For the 0.2% AEP design flood, peak flood levels at a number of private dwellings to the south of the existing railway increase by 0.02 m, compared to existing conditions.
- For the PMPDF, peak flood levels at the private dwellings to the south of the existing railway increase by up to 0.1 m, except for one private dwelling immediately south of the existing railway where the peak flood level increases by 0.11 m. There are no significant changes to the PMPDF extent.

The PMPDF existing conditions peak flood depths are shown in attached Figure 8. During a PMPDF, the private dwellings to the south of the proposed rail spur are inundated to flood depths of about 4 m to 5 m irrespective of the Rail Modification.

It is noted that the above design events are outside of the proposed design criteria for the Rail Modification embankment and therefore are provided for OEH information purposes only.

Independent Review

Haskoning Australia Pty Ltd (2018) also undertook an independent review of the Mount Pleasant Operation - Rail Modification Flood Assessment (WRM, 2017). The main aim of the independent review report was to review the technical adequacy of the flood assessment and provide a comparison to design flows and water levels calculated as part of the Hunter River (Muswellbrook to Denman) Floodplain Risk Management Study and Plan (FRMS&P) undertaken by Royal HaskoningDHV (RHDHV, 2017) on behalf of Muswellbrook Council and OEH.

The independent review concluded that the methodology and the magnitude of the Hunter River design discharges in the WRM (2017) flood study are appropriate for the Mount Pleasant Rail Modification Flood Assessment. The independent review also concluded that the WRM (2017) model is suitable for determining the impact of the proposed rail spur and that the results are in good agreement with those presented in the Muswellbrook FRMS&P (RHDHV, 2017). The independent review also concluded that the ARR 2016 blocakge assessment on the proposed rail spur appears appropriate given the large size of the openings and the location of the proposed bridging elements on shallow areas of the floodplain, a significant distance from the main Hunter River channel.

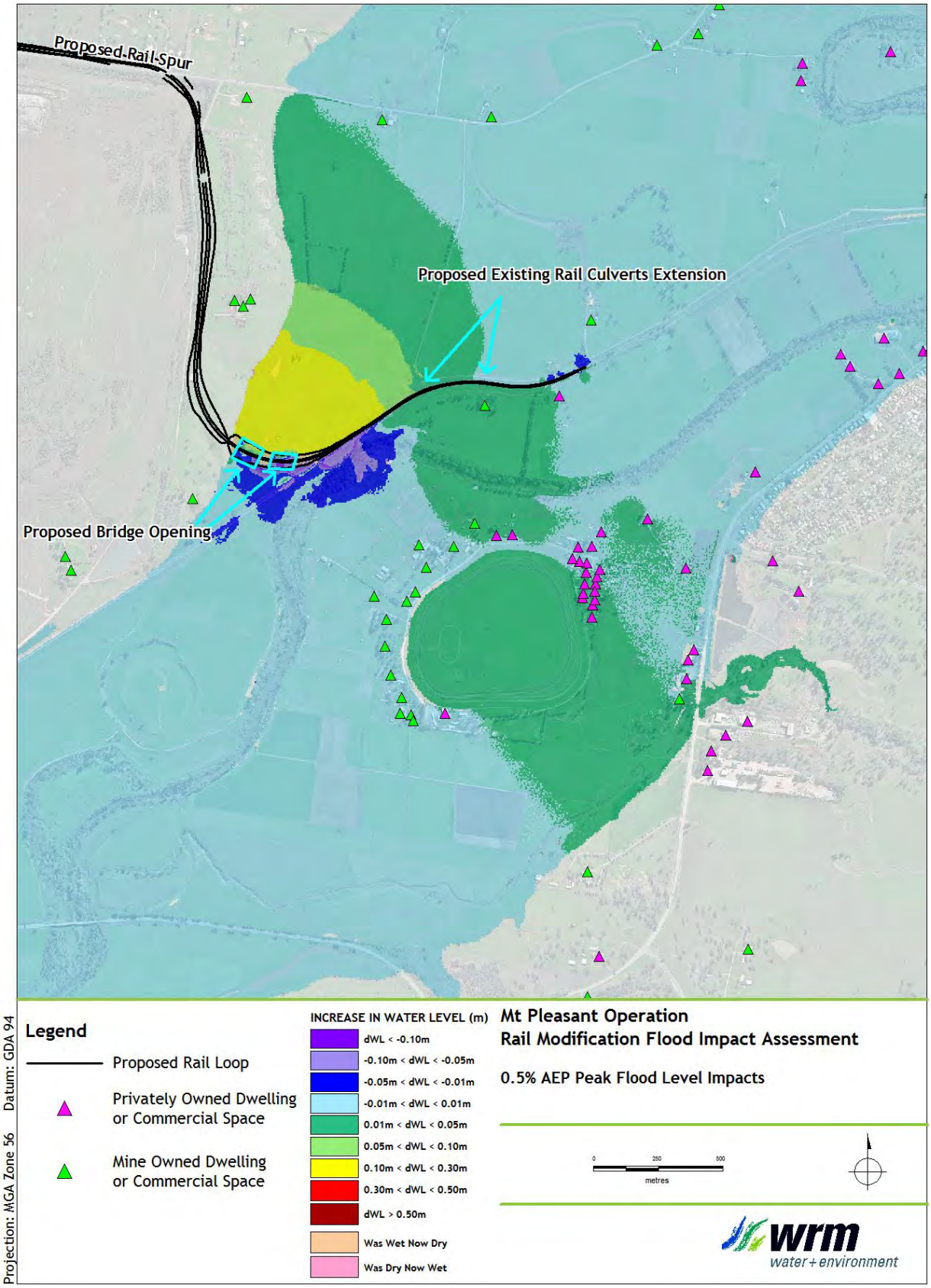


Figure 5 - Peak flood level impacts, 0.5% AEP design event

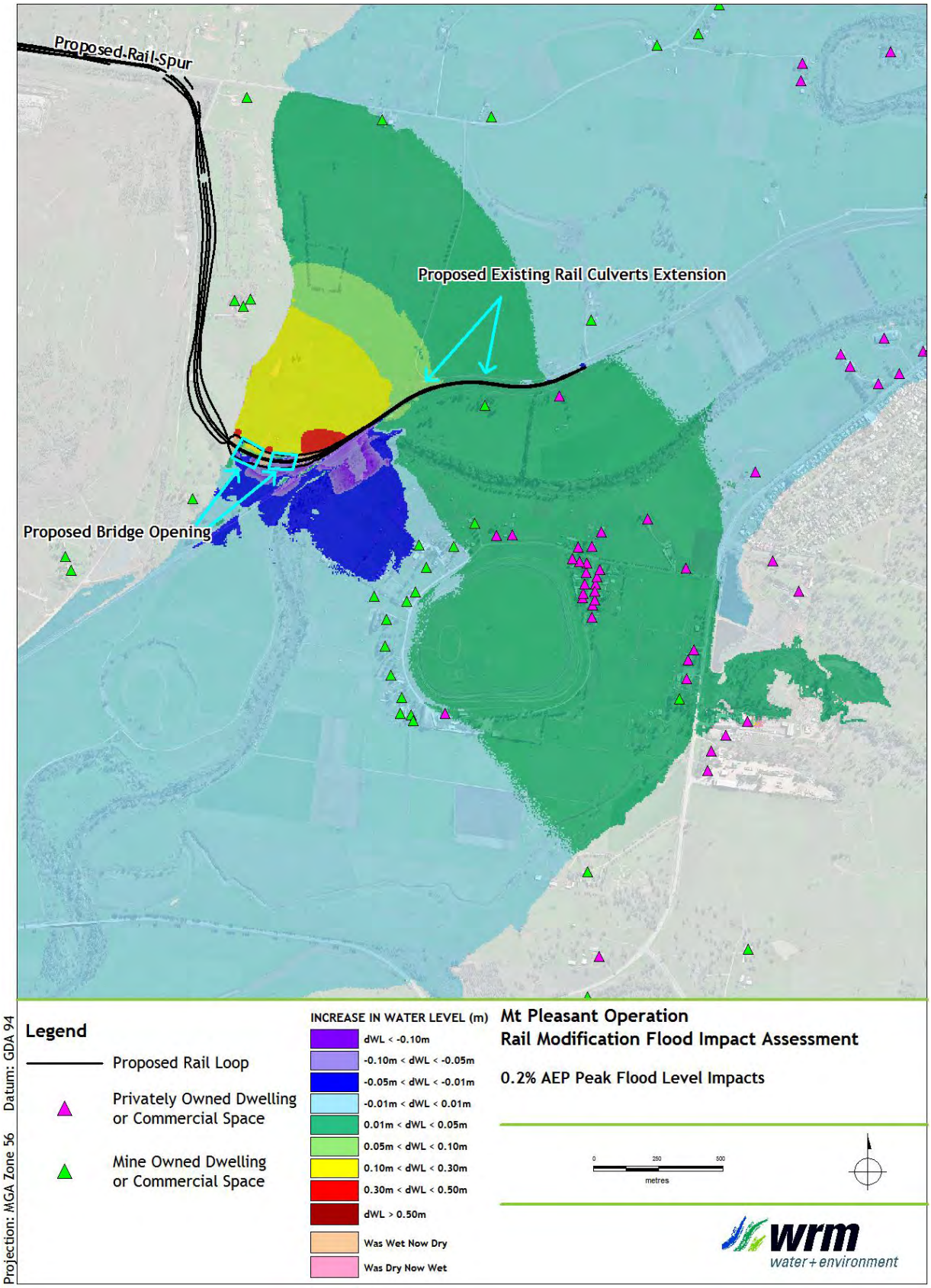


Figure 6 - Peak flood level impacts, 0.2% AEP design event

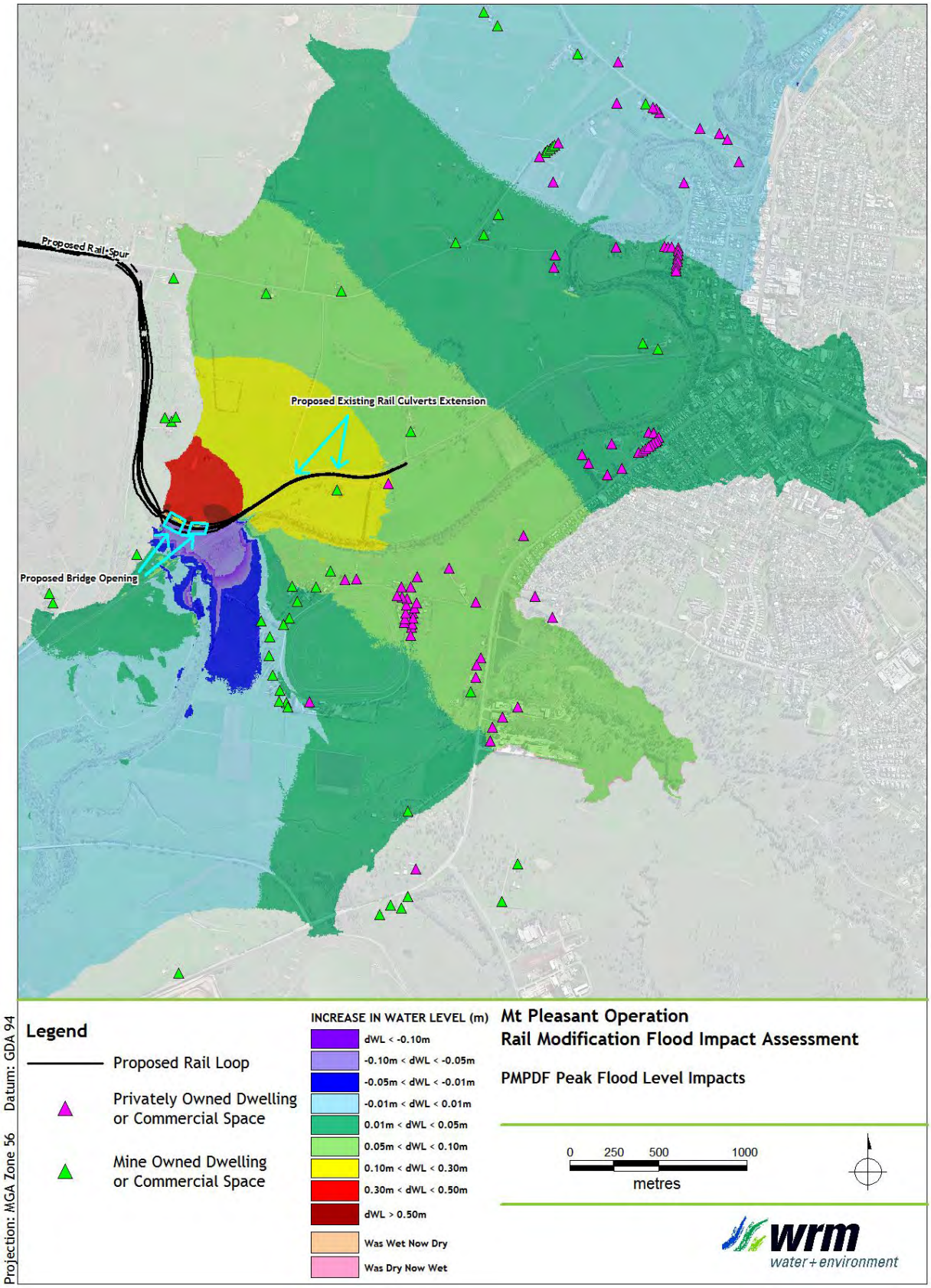


Figure 7 - Peak flood level impacts, PMPDF

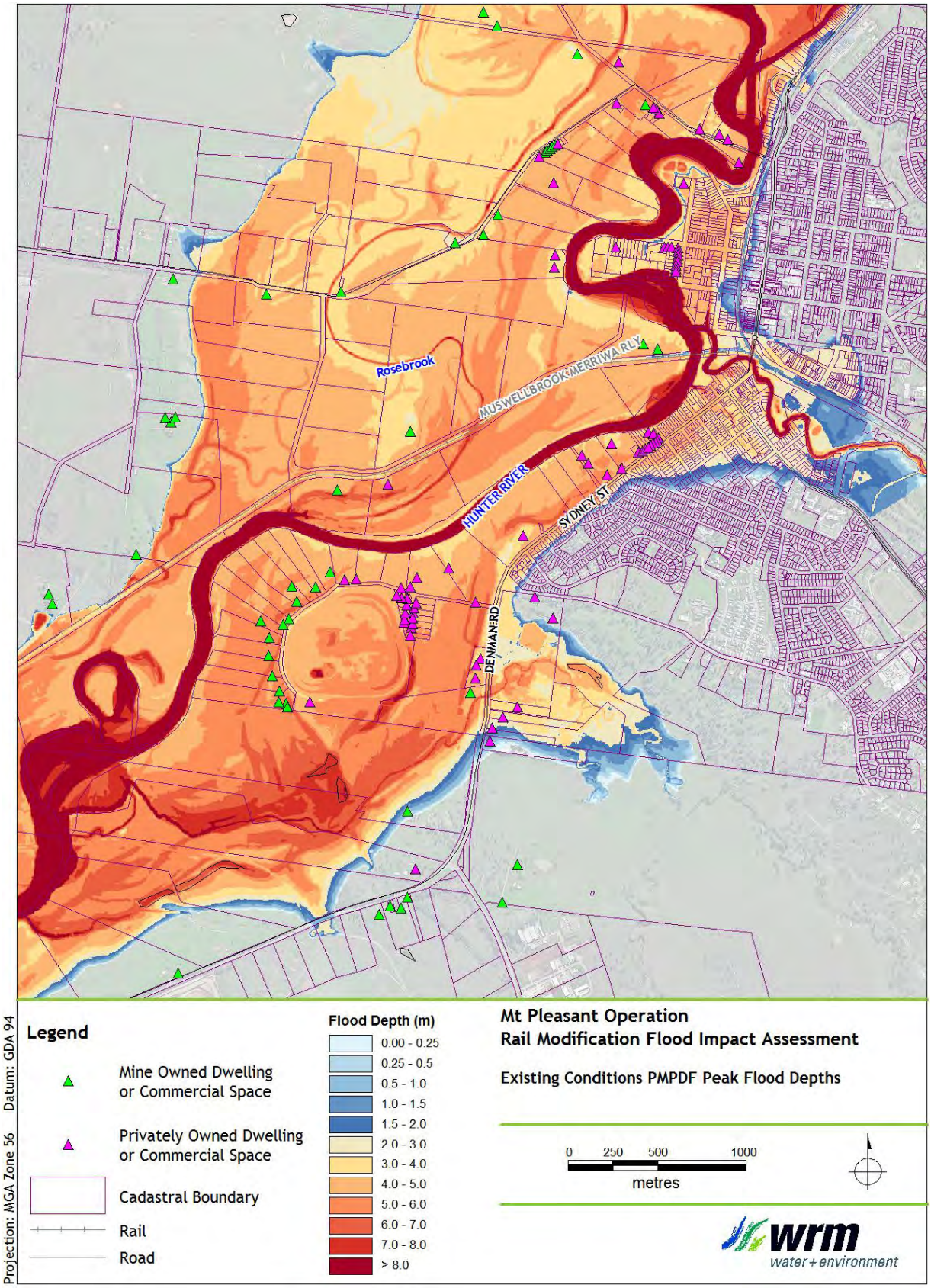
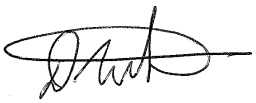


Figure 8 - Existing conditions peak flood depths, PMPDF

For and on behalf of

WRM Water & Environment Pty Ltd



David Newton

Director

References:

Ball et al., 2016	*'Australian Rainfall and Runoff – A Guide to Flood Estimation',* Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), © Commonwealth of Australia (Geoscience Australia), 2016.
Haskoning, 2018	*'Mount Pleasant - Rail Modification Flood Assessment Review'*, Report prepared for MACH Energy Australia Pty Ltd by Haskoning Pty Ltd, 30 May 2018.
OEH, 2018	*Recommendations and comments on 'Mount Pleasant Coal Mine - Modification 4 (MOD 4)',* NSW Office of Environment & Heritage, DOC18/26046-1, DA 9297 MOD4, 9 February 2018.
Pilgrim, 1987	*'Australian Rainfall and Runoff – A Guide to Flood Estimation',* Pilgrim DH (Editor), Institution of Engineers, Australia, Barton, Australian Capital Territory, 1987.
RHDHV, 2017	*'Hunter River Flood Study (Muswellbrook to Denman): Model Revisions Report',* Royal HaskoningDHV (on behalf Muswellbrook Shire Council), dated 19 October 2017.
WorleyParsons, 2014	*'Hunter River Flood Study (Muswellbrook To Denman)',* Report prepared for Muswellbrook Shire Council by WorleyParsons Services Pty Ltd, 8 September 2014. *'XP-RAFTS User Manual'*, XP Software, Australia, 2013.
WRM, 2017	*'Mount Pleasant Operation - Rail Modification Flood Assessment'*, Report prepared for MACH Energy Australia Pty Ltd by WRM Water & Environment Pty Ltd, 0744-09-B, 19 December 2017.

MACHEnergy

Attachment 3

Flood Assessment Review

Rail Modification Flood Assessment Review

Client: MACH Energy (c/o Resource Strategies)

Reference: PA1841 Mount Pleasant – Rail Modification Flood Assessment Review

Revision: 01/Final

Date: 13 June 2018

Royal HaskoningDHV

Enhancing Society Together

HASKONING AUSTRALIA PTY LTD.

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NSW 2300 Newcastle
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royalhaskoningdhv.com **W**

Document title:	Rail Modification Flood Assessment Review
Document short title:	
Reference:	PA1841 Mount Pleasant – Rail Modification Flood Assessment Review
Revision:	01/Final
Date:	13 June 2018
Project name:	PA1841 Mount Pleasant – Rail Modification Flood Assessment Review
Project number:	PA1841
Author(s):	Rohan Hudson

Drafted by:	Rohan Hudson
Checked by:	Luke Kidd
Date / initials:	13/06/18 LK
Approved by:	Ben Patterson
Date / initials:	

Classification
Final

Disclaimer

Royal HaskoningDHV

Table of Contents

Table of Tables

Table of Figures

1 Introduction

MACH Energy has commissioned Royal HaskoningDHV (RHDHV) to undertake an independent review of the Mount Pleasant – Rail Modification Flood Assessment Report (WRM, 2017).

The proposed Rail Spur is located on the Hunter River floodplain between Muswellbrook and Denman. Details of the proposed rail spur are presented in Figure 1-1. The proposed rail spur has the potential to cause an impact on flood levels on the Hunter River floodplain.

The proposed rail modification involves construction of a new rail spur across part of the floodplain of the Hunter River. The rail modification also includes the construction of a water supply pump station and associated water pipeline, however, these are not considered to have any material effect on flooding given the water supply pipeline would be buried within the Hunter River floodplain and therefore would not impede overland flow during a flood event. Further details of the proposed rail modification are provided in the Flood Assessment Report (WRM, 2017) and should be referred to as necessary.

The aim of this report is to provide an independent desktop review of the WRM Report 0744-09-B3, dated 19 December 2017 and titled: Mount Pleasant Operation - Rail Modification Flood Assessment. The Flood Assessment Report (WRM, 2017) aim was to assess the potential impacts of the new rail spur on Hunter River flooding and provide advice on appropriate design criteria and mitigation measures to prevent adverse flooding impacts on nearby private properties and public infrastructure. The WRM (2017) flood assessment report includes detailed hydrologic and hydraulic modelling of the Hunter River floodplain in the area of interest, which is used to assess the potential impacts of the proposed rail spur on flood levels and velocities.

The main aim of this report is to review the technical adequacy of the WRM 2017 flood assessment and provide a comparison to design flows and peak water levels calculated as part of the Hunter River (Muswellbrook to Denman) Floodplain Risk Management Study and Plan (FRMS&P) undertaken by Royal HaskoningDHV on behalf of Muswellbrook Council. The focus of this includes a review of the:

- Adopted hydrology (i.e. estimates of design (i.e. 1% AEP or 100-year Average Recurrence Interval (ARI))) river/catchment discharge)
- Parameterisation of the hydraulic (flood) model, including a review of adopted:
    - model setup
    - elevation data
    - roughness assumptions
    - structure parameterisation
    - achieved model calibration and verification
    - parameterisation of the proposed developed condition scenario.
- Validity of the conclusions regarding the impact of the rail modification project.

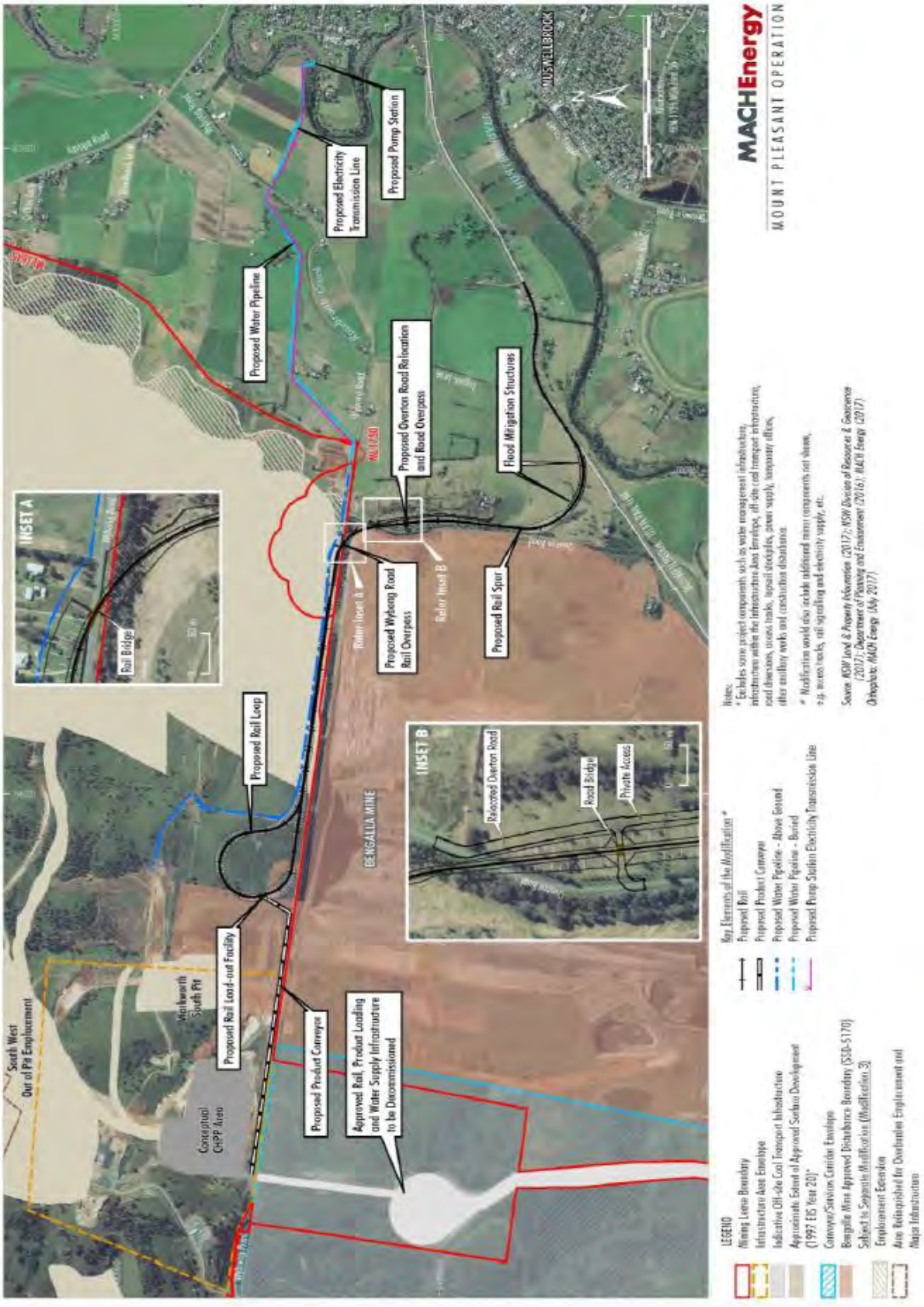

Figure 1-1: Alignment of Proposed Rail Spur (Fig 1.2 (WRM, 2017))

1.1 Background to Hunter River Model Revision Study

Background to Hunter River Model Revision Study (RHDHV, 2017) is provided as this is the work the WRM (2017) model is being compared to, in order to ensure consistency with outcomes with the forthcoming Hunter River FRMS&P, which uses the hydrological estimates and TUFLOW model developed during the Model Revision Study (RHDHV 2017).

Muswellbrook Shire Council (Council) commissioned Royal HaskoningDHV (RHDHV) to produce the Hunter River (Muswellbrook to Denman) Floodplain Risk Management Study (FRMS) on behalf of Council and The NSW Office of Environment and Heritage (OEH). The FRMS builds on the Hunter River Flood Study (Muswellbrook to Denman) that was prepared by WorleyParsons in 2014.

One of the initial tasks of the FRMS was to undertake a technical adequacy review of the 2014 flood study. That review was prepared by RHDHV in March 2016 and identified a number of issues regarding the reliability of the Hunter River Flood Models that were developed as part of the 2014 study.

Subsequent to that review being completed, OEH were made aware that rating curves for many of the Upper Hunter stream gauges had been recently revised by NSW Office of Water (NOW). The revised rating curves substantially reduce the estimated flow rate for a given stage height at the gauging location. The revisions are due to the increase in vegetation densities both within the channel and on the channel banks over the last two decades (see Figure 3-4).

A meeting was held on 29 October 2016 to discuss the need to recalibrate and verify the Hunter River Flood Models that were developed by Worley Parsons in 2014 as part of the Flood Study. It was decided that the Hunter River model calibration and design event verification needed to be revisited to ensure confidence in the outcomes of the FRMS and potential future uses of the model.

The model revision process also provided an opportunity to update the models to be consistent with the recently formalised Australian Rainfall and Runoff 2016 (Commonwealth of Australia) guidelines. The 2014 flood study applied the methods documented in the Australian Rainfall and Runoff 1987 (IEAust) guideline.

The following scope for the model revision process was established by RHDHV in consultation with OEH and Council:

- Review and analysis of recent changes to stream gauge rating curves.
- Modification to the Hunter River hydraulic model to more reliably represent the current floodplain characteristics.
- Recalibration of the Hunter River hydrologic and hydraulic models using stream gauging data for flood events that occurred in 1988 and 2000.
- Flood frequency analysis using data from the Muswellbrook stream gauge.
- Establishment of revised design event conditions for a full range of Annual Exceedance Probability (AEP) flood events based on the outcomes from the model calibration and verification process and the Australian Rainfall and Runoff 2016 methods.
- Verification of the revised design model outcomes using available data from the 1955 and 1971 events.

An example of the review and modelling of rating curve changes in RHDHV (2017) is presented in Figure 3-4.

2 Review of Flood Discharge Estimates

2.1 Design Discharge Estimation Techniques

Estimates of design discharge for a given annual exceedance probability (AEP) can either be based on:

- **Flood Frequency Analysis (FFA):** If a sufficient duration (normally > 50 years) of river discharge data is available, extreme value analysis can be used to estimate design discharges. The use of FFA is preferable as it removes uncertainty between the amount of rainfall and resulting river discharge that is inherent in hydrological modelling. However, FFA depends on the availability of a sufficient length of good quality discharge data. Issues with rating curves (used to determine river discharge based on the measurement of water levels) can reduce the accuracy of design discharge based on FFA.

- **Hydrological modelling (using design rainfall data):** if no (or insufficient) river discharge data is available (i.e. the catchment or site is not "gauged"), then hydrological modelling is the most accurate method of determining design discharge. A hydrological (or catchment) model uses a parameterisation of the catchment to calculate the rate of river discharge from a given rainfall event. Typical hydrological models used in Australia include: XP-RAFTS, RORB, WBNM and ILSAX.

2.2 WRM (2017) Flood Frequency Analysis

2.2.1 Introduction and Review of Method

WRM (2017) reports that: *an FFA was undertaken on the Hunter River at Muswellbrook Bridge gauge (Station No. 210002). The catchment area to Muswellbrook Bridge gauge is 4,220 km² and includes Glenbawn Dam. The catchment area of Glenbawn Dam is 1,300 km². Glenbawn Dam provides some 120,000 ML of flood storage between the full supply level and the spillway level. The available flood storage volume has a significant impact on the downstream discharge. Hence, hydrology of the Hunter River at Muswellbrook would be expected to be different after the upgrade of Glenbawn Dam in 1987.*

Muswellbrook Bridge gauge has recorded streamflow data from 1913 to present. However, significant data was missing prior to 1961. A FFA reflecting post-dam hydrology would use data from 1987 onwards. However, this would only provide 30 years of data.

An additional 26 years of data is available if the full record from 1961 is adopted. However it is noted that this period includes data prior to the dam upgrade in 1987. Hence, a FFA based on data since 1961 is likely to slightly overestimate design discharges at Muswellbrook Bridge gauge. This is considered acceptable because it is a conservative approach for estimation of design discharges and also acceptable for a flood assessment. The model results will not be used to set design flood levels for the proposed rail spur which are determined by the existing rail embankment levels.

Royal HaskoningDHV (2017) notes that the Muswellbrook Flood Study (1986) examined a study performed by Hayes (1982) which analysed the impact of Glenbawn Dam on floods at Muswellbrook. **The study found that the original and upgraded dams have effectively the same mitigation effect**. The upgraded dam was increased in capacity; however the available flood mitigation storage was reduced leading to a negligible net difference in flood mitigation properties. The RHDHV (2017) study sought to investigate this hypothesis via statistical analysis.

Statistical analysis using the t-test and the Mann-Whitney U-test was undertaken on the post-dam and post upgrade data sets. The t-test and the Mann-Whitney U-test analyse the mean and median

of each of these data sets. The results of these tests showed that the impact of the dam on the two data sets is not statistically significant (p>0.05).

This analysis verified that the Post Glenbawn Dam and Post Glenbawn Dam Upgrades were statistically similar. Accordingly, it was considered appropriate to merge the two data sets to form a single post dam annual series for the 1956 to 2016 period.

A comparison of the annual maxima series adopted between WRM (2017) and RHDHV (2017) indicates that 5 more years of data could have been used by WRM (2017). Also RHDHV (2017) undertook a complex Bayesian Methods to incorporate Pre-Glenbawn Dam data and historical flood events into the post dam FFA to further extend the available annual maxima series.

2.2.2 WRM (2017) FFA Results and Comparison to RHDHV (2017)

The WRM (2017) FFA was undertaken using the Bayesian inference methodology recommended in the ARR 2016 using the FLIKE software. The FFA results are given in Table 2.1, and represented graphically in Figure 2.1. There is a 90% likelihood that the design discharge is within the 90% confidence limits shown in Figure 2.1. The 5 percent (%) Annual Exceedance Probability (AEP) and 1% AEP design peak discharges are 1,732 cubic metres per second (m^3/s) and 3,721 m^3/s, respectively.

A comparison of the WRM (2017) to RHDHV (2017) FFA results is presented in Table 2-2. It shows that the WRM (2017) design discharge estimates are between 1.1 and 6.3% higher (i.e. are considered conservative) than those reported in RHDHV (2017) for AEP events ranging from 5% to 0.2% AEP (i.e. 20-year to 500-year ARI). While the RHDHV (2017) is likely to be more accurate (i.e. more of the historical stream gauge record was used) there is good agreement between the estimates of design discharges adopted by the two studies.

Table 2-1: WRM (2017) Flood frequency analysis results for Muswellbrook Bridge gauge

Source: WRM (2017) Table 4.2

AEP	Design Discharge (m^3/s)
5%	1,732
2%	2,754
1%	3,721
0.5%	4,872
0.2%	6,705
0.1%	8,348

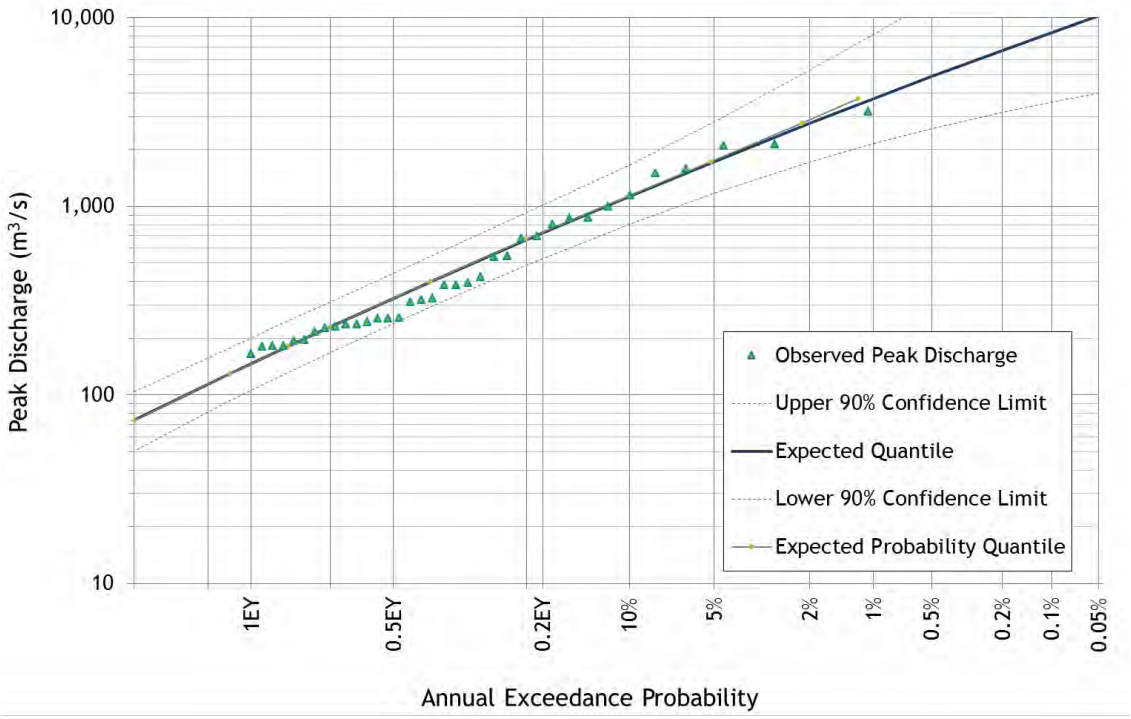

***Figure 2-1:* FFA for the Muswellbrook Bridge gauge**

Source: WRM (2017) Figure 4.1

Table 2-2: Flood Frequency Analysis: Design Flows at the Muswellbrook Gauge (Comparison)

Event (AEP)	WRM (2017) FFA Flow (m^3/s)	FRMS&P FFA Flow (m^3/s)	90% Confidence Limits		% Difference to FRMS&P
			Lower Flow (m^3/s)	Upper Flow (m^3/s)	
5%	1,732	**1714**	1297	2295	1.1%
2%	2,754	**2682**	1954	3861	2.7%
1%	3,721	**3583**	2493	5571	3.9%
0.5%	4,872	**4643**	3056	7884	4.9%
0.2%	6,705	**6308**	3825	12106	6.3%

2.3 WRM (2017) Hydrological Modelling

2.3.1 Introduction and Review of Method (WRM (2017) XP-RAFTS Model)

WRM (2017) also calculated design flood discharges for the Hunter River using XP-RAFTS hydrological software (XP Software, 2013). The XP-RAFTs model configuration and parameters of the calibrated Hunter River RAFTS model developed by WorleyParsons (2014) were generally unchanged, however, the IFD data, losses, ARF and temporal pattern were updated to ARR 2016.

It is important to note that the WorleyParsons (2014) supplied two XP-RAFTS models:

- **Calibration model** – with standard catchment lags that were defined during the model calibration exercise.
- **Design model** – with increased catchment lags (i.e. uncalibrated) though no reason for this was provided in WorleyParsons (2014).

It is assumed that WRM (2017) used the calibration XP-RAFTS model with calibrated catchment lags.

Catchment modelling using XP-RAFTS is an appropriate technique to determine discharges for the study. A review of the important elements of the catchment modelling is provided in Table 2-3. Overall the assumptions and methodology are appropriate and the design discharges as presented in Table 4.7 of WRM (2017) (and reproduced in Table 2-4 of this report) are appropriate for the study. The adoption of ARR2016 techniques is considered appropriate as it produced design discharge that were in good agreement (i.e. to within 2-3%) with FFA (refer Table 2-4).

Table 2-3 – Review of XP-RAFTS Catchment Modelling

Review Element	Comment
Model Origin	WRM (2017) used the model configuration and parameters of the calibrated Hunter River RAFTS model developed by WorleyParsons (2014).
Initial and Continuing Losses	For the WRM (2017) study, the rainfall losses were adjusted so that the XP-RAFTS peak design discharges matched the results of the FFA. The WRM (2017) losses are in reasonable agreement to that adopted in RHDHV (2017) and appear to be appropriate.
IFD Data	Design rainfall depths were obtained from the Commonwealth Bureau of Meteorology (BoM) for a range of design AEP events and storm durations and are assumed to be correct.
Temporal Pattern	Temporal patterns define the variability of rainfall during an event. The ensemble event approach described in ARR 2016 has been used for this analysis. This approach uses an 'ensemble' of 10 temporal patterns for each storm duration to derive a range of estimated flood peaks for each AEP up to the 1% AEP event. It is assumed that WRM (2017) selected the 6th highest discharge to adopt for the design events which is recommended in ARR 2016 guidance. The temporal patterns of relevance to the Hunter River (South-East Coast temporal patterns) were obtained from the ARR 2016 Data Hub (Geoscience Australia, 2016) and hence are assumed to be appropriate.
Critical Duration	No information on the resulting critical duration is specified in the WRM (2017) report, however from Figure 2-2 it is apparent that the 36 hour duration was used for the 1% and 0.5% AEP, while the 24 hour event was used for the 0.2% AEP. RHDHV (2017) found that the 24 hour rainfall event was the critical duration. This may is due to difference in the XP-RAFTS model, most likely the use of a different Bx factor (refer Section 2.3.2). The slightly longer duration (and hence higher volume) hydrograph may produce a slightly higher flood level estimate in the WRM (2017) assessment.
Extreme Event / PMF	No information on the PMP/PMF is provided in the WRM (2017) report. It is assumed to be the same used in Worley Parsons (2014) and if so is considered appropriate. The adopted PMF hydrograph is presented in Figure 2-2.

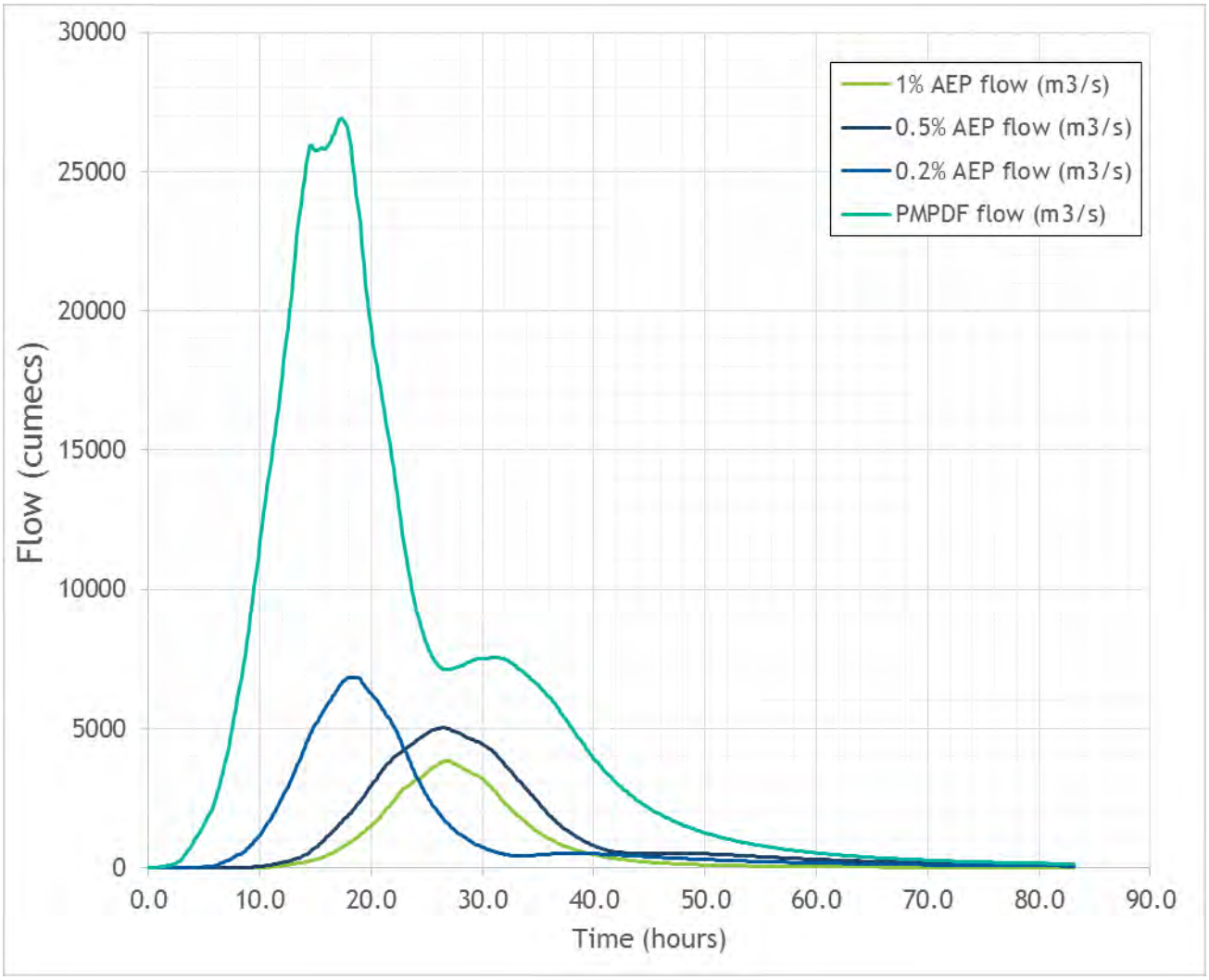

Figure 2-2: Hydrographs at Muswellbrook (WRM, 2017)

2.3.2 Difference to RHDHV (2017) XP-RAFTS Model

Due to errors with the gauge rating data, RHDHV undertook a complete hydrological and hydraulic model calibration exercise as part of the Model Revision Study (RHDHV, 2017). The following adjustments were made to model parameters to improve the overall calibration outcome:

- The Storage Coefficient Multiplication Factor (Bx) was adjusted from 1.0 to 1.2. This moderately increases the attenuation of runoff hydrographs from the model's sub catchments, reducing peak flows.
- Initial and continuing loss (IL & CL) rates were simplified. The 2014 model calibration included six different IL and CL zones which ranged from IL 5mm and CL 1 mm/hr to IL 15 mm and CL 2.5 mm/hr. The following loss rates were adopted for all Upper Hunter River Catchments in the revised calibration:
    - **Initial Loss Rate**: 15 mm (1998 event, i.e. wetter antecedent conditions) and 30 mm (2000 event, i.e. drier antecedent conditions)
    - **Continuing Loss Rate**: 1.5 mm/hr (both events).

2.3.3 WRM (2017) Hydrological Modelling Results and Comparison to RHDHV (2017)

A comparison of WRM (2017) FFA and hydrologic model flows to the RHDHV (2017) equivalent is presented in Table 2-4. The WRM hydrologic flows (adopted for use in the hydraulic model) are up to 8.6% higher for events up to the 1% AEP when compared to hydrologic design flows presented in RHDHV (2017). The use of slightly higher design discharge, means that, provided appropriate roughness values are adopted in the hydraulic model, there should be a degree of conservatism in the WRM (2017) assessment.

Differences between the larger 0.2% AEP and 0.5% AEP events (of between 20 to 30%) are likely to be due to the use of a different Bx factor (partly because the Worley Parsons model was calibrated to incorrectly rated gauge data) used in the XP-RAFTS models. It may also be that WRM (2017) adopted even lower loss parameters in these rarer events so that there is better agreement to FFA design discharges. While this is appropriate for smaller events where there is good confidence in the FFA, for rarer/larger events, there is less confidence in the FFA (i.e. where there is a divergence of the 90% confidence limits away from the expected quantile) and hence standard losses should be used.

Table 2-4: Comparison of Design Flows Estimates at the Muswellbrook Gauge

Event (AEP)	**WRM (2017) FFA Flow (m^3/s)**	**WRM (2017) Hydrologic Model Flows (m3/s)**	**% Difference to FFA**	FRMS&P FFA Flow (m^3/s)	**FRMS&P Hydrologic Model Flows (m^3/s)**	**% Difference to FRMS&P**
5%	1,732	**1,776**	2.5%	1714	**1650**	7.1%
2%	2,754	**-**	-	2682	**2900**	**-**
1%	3,721	**3,841**	3.1%	3583	**3510**	8.6%
0.5%	4,872	**5,022**	3.0%	4643	**4070**	19.0%
0.2%	6,705	**6,835**	1.9%	6308	**4860**	28.9%

2.3.4 Conclusions Regarding the Review of Hunter River Design Discharge

A review of the method and magnitude of the Hunter River design discharges provided in the WRM (2017) indicate that they are appropriate for the Mount Pleasant Rail Modification Flood Assessment. Both the design discharge estimates from the FFA and hydrological model are in good agreement with the more sophisticated (but necessary) analysis undertaken in RHDHV (2017) that form the basis of the Muswellbrook FRMS&P.

3 Review of Flood (Hydraulic) Model Predictions

Hydraulic (flood) models are a representation of the channel and floodplain and are used to calculate flood depths and velocity for a given river discharge. One-dimensional (1D) hydraulic models, (i.e. MIKE11, Estry) use cross-sections (X and Z coordinates) to represent the conveyance of the main channel and floodplain, while two-dimensional (2D) models, (i.e. TUFLOW, MIKE21) represent the channel and floodplain using small "cells" with a given elevation and allow water to flow in two (X and Y) directions improving the definition of floodplain storage, and allowing for complex flow behaviours to be modelled rather than applying assumptions or simplification on flow conditions to be made. 2D models are far more computationally intensive than 1D, however, given modern increases in computing power this is now less of an issue.

Software selection: The use of TUFLOW as the hydraulic model for the study is considered appropriate. TUFLOW (BMT WBM) estimates flood levels and velocities on a fixed grid pattern by solving the full two-dimensional depth averaged momentum and continuity equations for free surface flow. It also incorporates a one-dimensional or quasi two-dimensional modelling system (ESTRY). The one-dimensional (ESTRY) and two-dimensional (TUFLOW) schemes are solved independently, but are dynamically linked at the boundary to ensure continuity (mass) is conserved. The hydraulic modelling by WRM (2017) was undertaken using TUFLOW HPC solver with GPU hardware (version 2017-09-AC) which is the same as used by RHDHV (2017).

3.1 Review of Hunter River (WRM, 2017) Model

3.1.1 Model Overview

Full details of the Hunter River model are presented in WRM (2017). The model extends approximately 6 km upstream and 13 km downstream of the Project and covers an area of some 70 km^2 including Sandy Creek. The model features and extents are provided in Figure 3-1. The model was used to assess:

A summary of hydraulic model configuration includes:

- 5 metre by 5 metre grid TUFLOW model
- Hydrology for the Hunter from XP-RAFTS hydrologic model using ARR 2016 methods and data (as reviewed in Section 2.3)
- Ground elevation data based on LiDAR flown in August 2016
- 1D structure representation of road and rail infrastructure including: 26 culvert structures and 16 bridge structures
- Calibrated/validated to the 1998 and 2000 flood events.

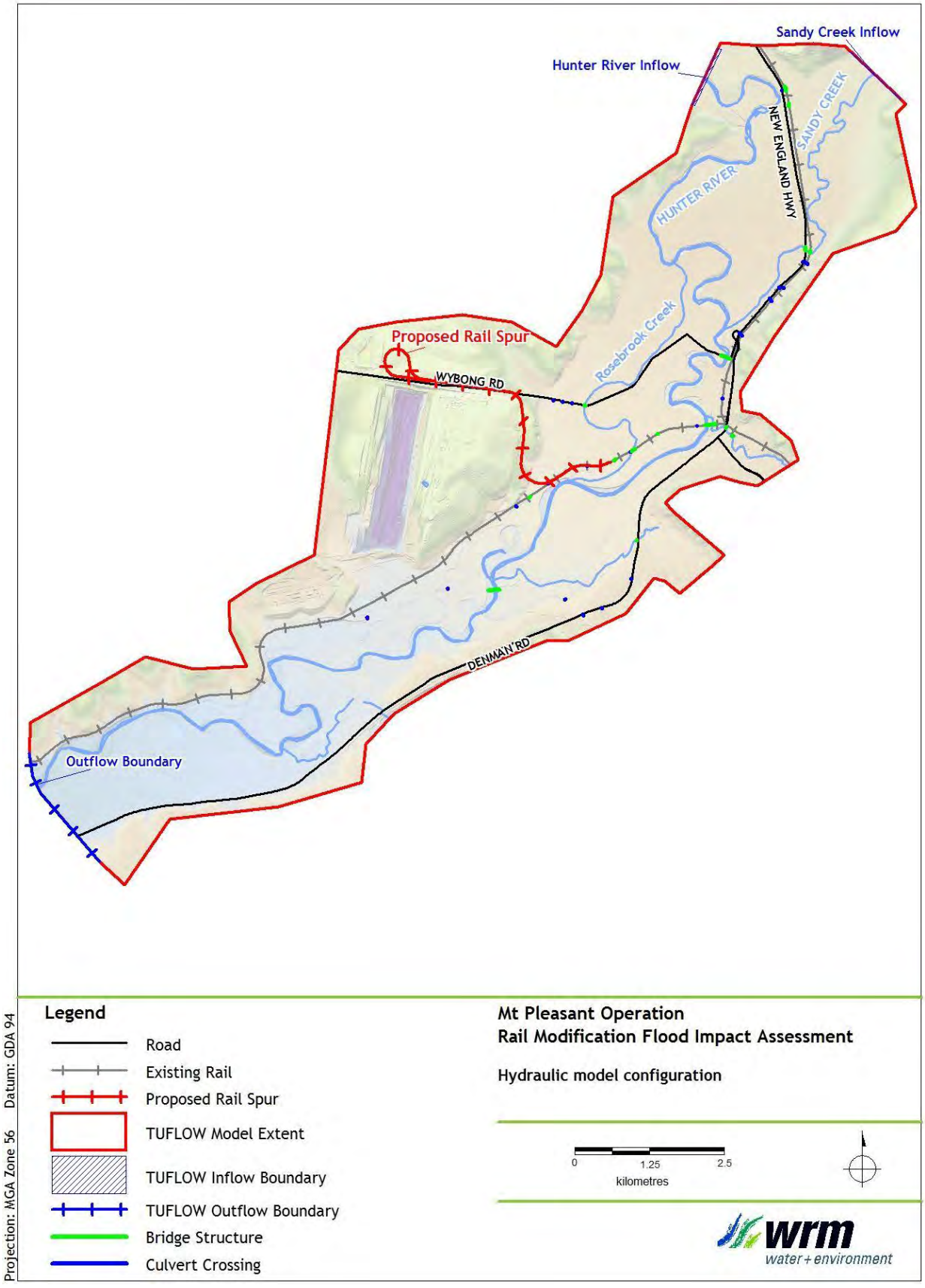

Figure 3-1: Hunter River TUFLOW model configuration (Fig 5.1 WRM (2017))

3.1.2 Detailed Hunter River Model Review

A review of the important elements of the Hunter River TUFLOW modelling is provided in Table 3-1. Overall the assumptions and methodology, and the assessment of the existing conditions appear to be appropriate.

Table 3-1 – Review of Hunter River TUFLOW Model

Review Element	Comment
Model Extents	The model extents are considered appropriate for the study area although are slightly smaller than that used in RHDHV (2017).
Model Resolution	A 5 metre grid resolution is considered appropriate for the study area and provides sufficient spatial resolution for the modelling assessment.
Inflow Boundary	Design inflows for the Hunter River were reviewed in Chapter 2 and appear appropriate. Calibration and validation event inflow are based on observed discharges so are assumed to be correct.
Downstream Boundary	A single normal depth outflow boundary was adopted for the Hunter River model. The outflow boundary of this model is located approximately 13 km downstream of the Rail Spur and as such would not impact on peak flood levels at the Project area. This is considered appropriate.
Elevation Data	Topographic data for the hydraulic model used elevation data based on LiDAR flown in August 2016. It is assumed this data is correct and appropriate. However, it is important to note that the LiDAR may not be able to accurately represent the channel bathymetry of deeper channel pools where standing water is present. RHDHV (2017) lowered pools by up to 2 metres to better represent observed channel stage-discharge characteristics.
Surface Roughness	A detailed discussion of the adopted hydraulic roughness (Manning's 'n') is presented in Section 3.1.3 of this report. Overall the range of values are considered appropriate.
Structures	Adopted hydraulic structures used in the hydraulic model are discussed in Section 5.2.5 of WRM (2017). Survey information on the existing hydraulic structures including culvert crossings and bridges were provided by FYFE (surveyors) dated 15 November 2017. A total of 26 culvert structures and 16 bridge structures were included in the hydraulic model based on the survey information. Figure 3-1 shows the locations of the modelled culvert and bridge structures.
Calibration/ validation	The Hunter River hydraulic model was calibrated/validated to the available observed data for the 1998 and 2000 flood event. Observed flows were applied to the model with a 1.5 hour lag used to account for shift in location to the model boundary. The expected good match between observed and model flows is presented in Figure 3-2. The TUFLOW model was able to reproduce observed peak flood levels (see Figure 3-3) to within between 0.1metres for both events. However, away from the flood peak, differences in water levels of greater than 0.5 metres indicate issues with the WRM (2017) model channel stage-discharge characteristics. This may be due to the LiDAR based elevation data not accurately defining the channel bed in channel pool areas (noted above) and also slight overestimation of bank vegetation channel roughness (for

Review Element	Comment
	pre 2000 conditions). While a good match to peak water levels was achieved it is important to recognise that changes to near bank channel vegetation mean that the channel stage-discharge characteristics have changed between 2000 and 2015 (RHDHV, 2015). This is further discussed in Section 3.1.3 of this report.
Proposed Conditions Model Updates	Section 6.1 to Section 6.3 of WRM (2017) provides some detail of the updates to the model required to represent the proposed conditions which included: • incorporation of an earthworks (i.e. elevation data) model into the hydraulic model, and • incorporation of conceptual mitigation measure into the model which included: the extension of two existing railway culvert crossings and two bridge openings of 105 metres and 90 metres with assumed 15 metre span lengths. Provided the structures were incorporated using appropriate loss parameters the schematisation of the concept rail spur it is considered a suitable tool for quantifying the potential impact. If the final design is different from the concept it should be re-assessed in the model.

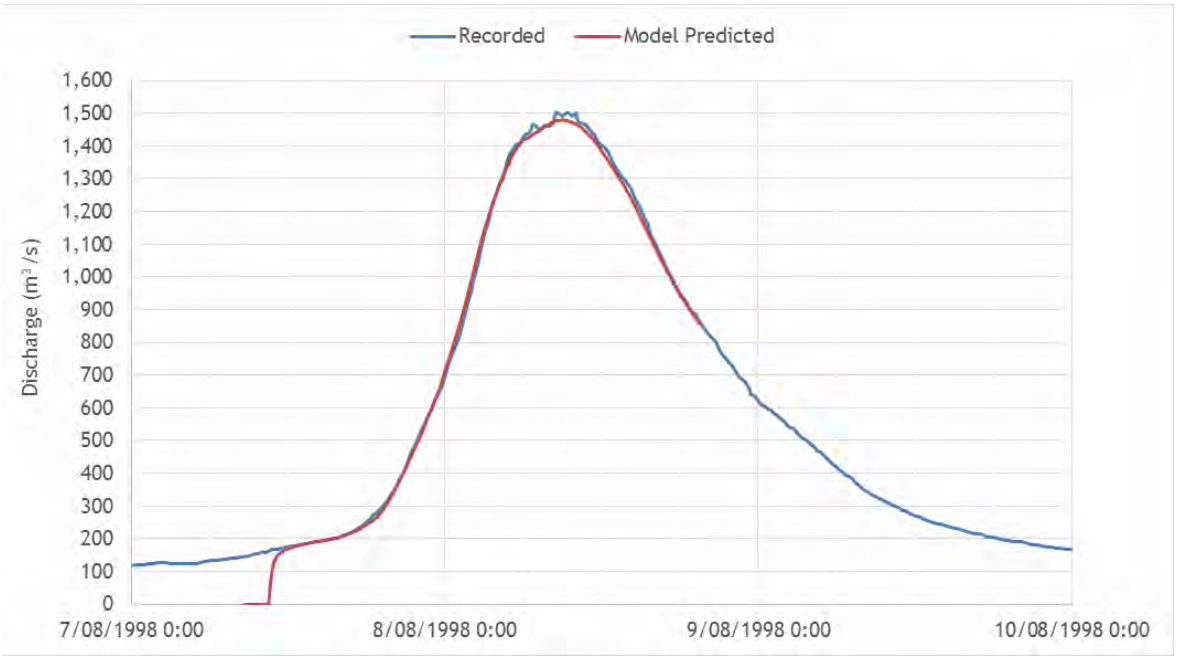

Figure 3-2: **Comparison of recorded and predicted flow hydrographs, Hunter River at Muswellbrook Bridge, August 1998 flood event**

Source: WRM (2017) Figure 5.2

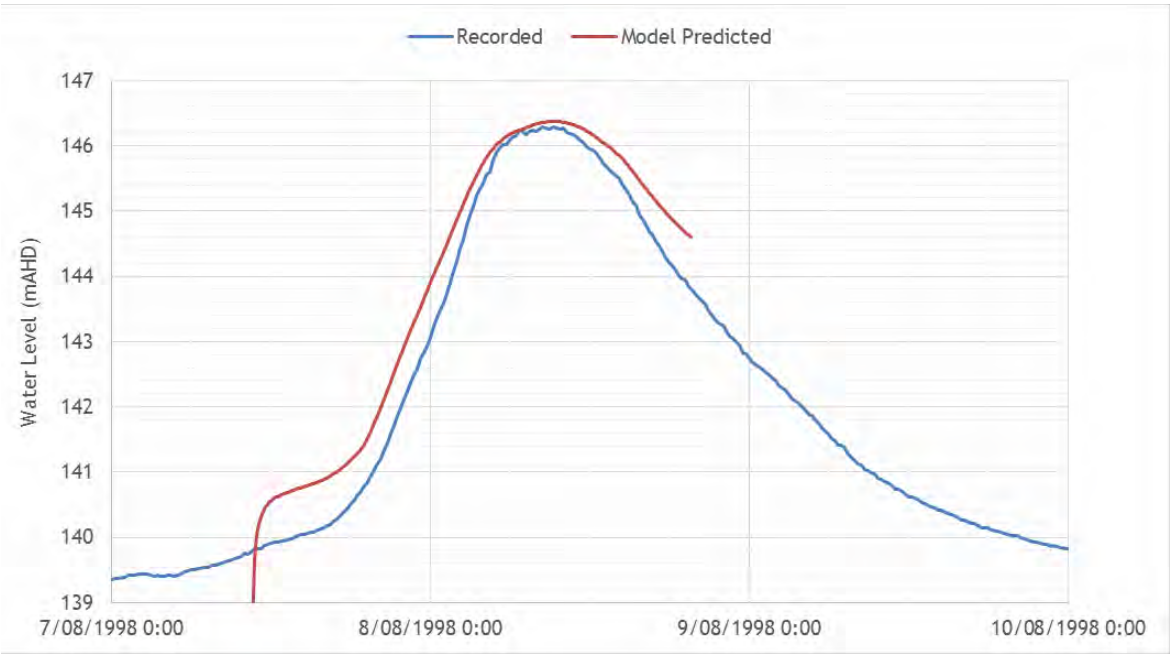

Figure 3-3: **Comparison of recorded and predicted water level hydrographs, Hunter River at Muswellbrook Bridge, August 1998 flood event**

Source: WRM (2017) Figure 5.3

3.1.3 Detailed Review or WRM (2017) vs RHDHV (2017) Roughness Parameterisation

A comparison of the adopted roughness values used in the three recent flood studies (i.e. WRM (2017), WorleyParsons (2014) and RHDHV (2017)) is presented in Table 3-2. The spatial distribution of material roughness (land uses and surface types) is presented in Figure 3-5. It appears consistent with that adopted in RHDHV (2017) and includes a representation of bank channel vegetation that was omitted from Worley Parsons (2017) model.

The main differences between the roughness values adopted in WRM (2017) and RHDHV (2017) are:

- WRM (2017) adopted a slightly higher pasture/overbank roughness. This will slightly increase predicted flood levels, especially for the larger design events.
- WRM (2017) **did not** account for increasing roughness of dense channel bank vegetation that has significantly reduced the in-bank channel capacity of the Hunter River over the past 30 years. This will tend to reduce predicted flood levels, especially for the smaller design events.

Table 3-2 – Comparison of Adopted Roughness Values

Land use	WRM (2017)	WorleyParsons (2014)	R3* (Pre 2001)	R4* (Intermediate)	R5* (Post 2010)
Pasture / Overbank	0.040	0.035	0.035	0.035	0.035
Channel	0.030	0.035	0.03	0.035	0.035
Dense channel bank vegetation	0.065	n/a	0.06	0.1	0.15
Dense vegetation	0.065	0.065	0.06	0.06	0.06
Road	0.020	0.02	0.02	0.02	0.02
Urban area	0.100	0.08	0.08	0.08	0.08

Note: * R3, R4 and R5 are different roughness parameterisation used in RHDHV (2017) to represent the changes to observed channel ratings from 1990 to now (refer Figure 3-4).

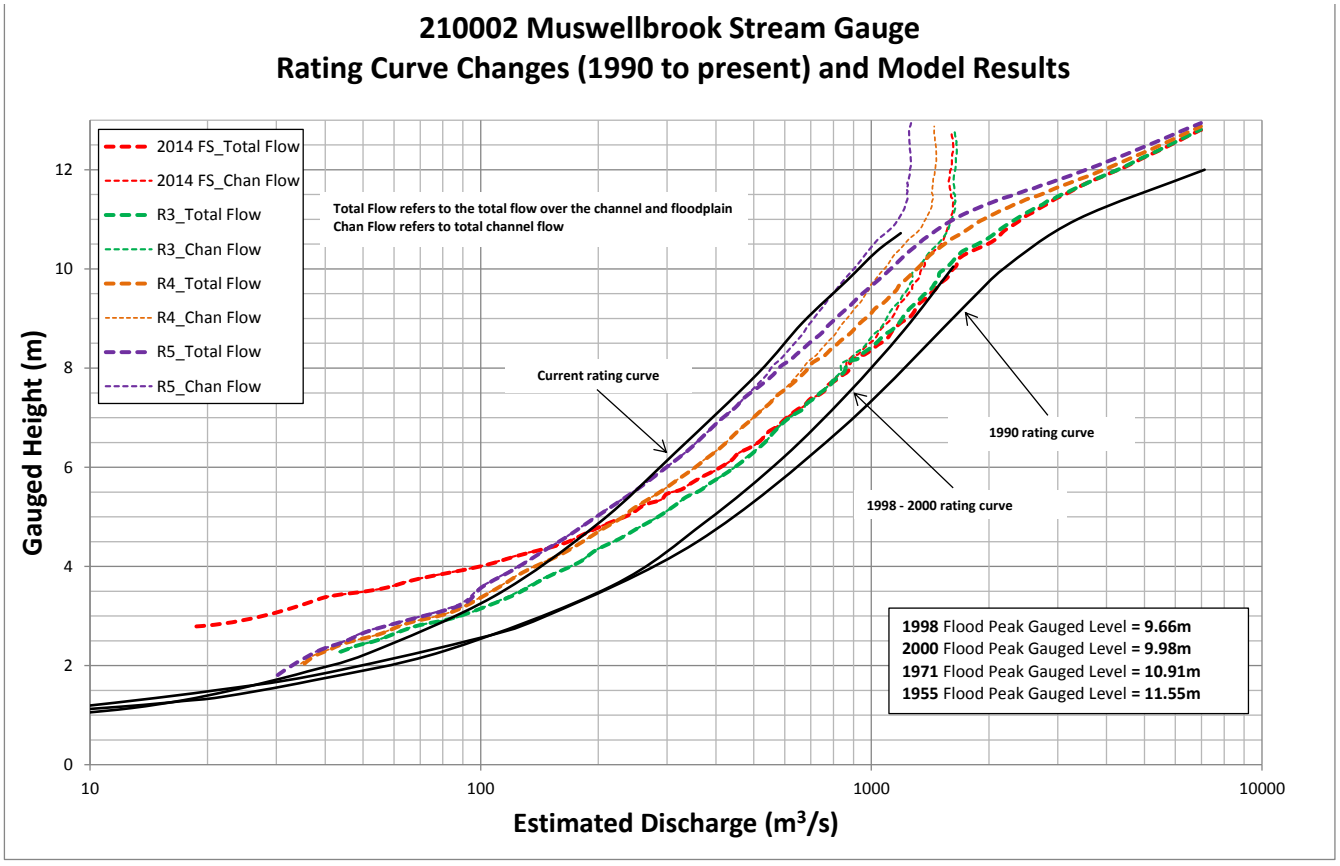

Figure 3-4: **Rating Curve data and RHDHV (2017) Model Results (Muswellbrook Gauge: 21002)**
Source: RHDHV (2017) Figure 5

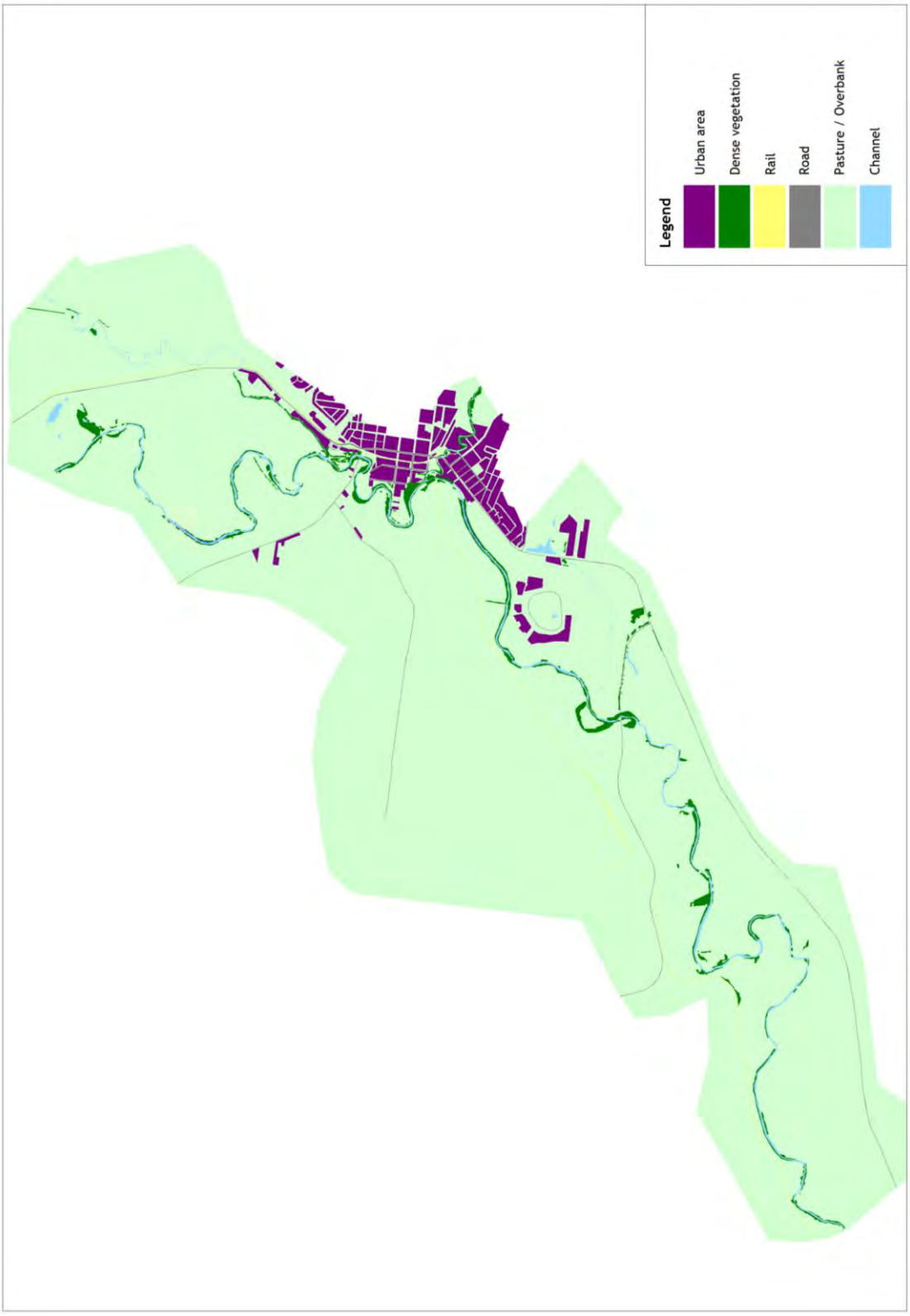

Figure 3-5: Hunter River TUFLOW model Roughness Distribution (WRM (2017))

3.2 Review of Existing Condition Model Results and Comparison to RHDHV (2017)

Figure 6.1, Figure 6.2 and Figure 6.3 of WRM (2017) show the predicted peak flood depths and extents along the Hunter River floodplain for the 5% AEP, 1% AEP and 1% AEP +20% discharge design events respectively. The presentation of results is considered appropriate to evaluate the project and are in-line with expectations of flood behaviour for a large floodplain. The inclusion of contours of peak flood level would assist interpretation of results but are not essential to the aims of the assessment.

For the purpose of this review, gridded model results were also provided by WRM for comparison to the equivalent RHDHV (2017) model results. A map showing the difference in 1% AEP (i.e. 100-year ARI) peak water levels between the two models is presented in Figure 3-6 while a graph presenting the statistical difference in water level predictions between the two models is presented in Figure 3-7. In both figures, a positive value is where the WRM (2017) modelled water level is higher than the RHDHV (2017) modelled water level.

From an examination of the statistical difference in water level predictions (Figure 3-7) there is good overall agreement between the two models with virtually no bias in results present. The analysis shows that approximately 65% of the modelled area lies within ±0.1m of the RHDHV (2017) model 1% AEP results and that 80% of the modelled area sits within the range -0.15 to 0.12m of the RHDHV (2017) model 1% AEP result. Less than 5% of the modelled area is associated with water level differences ± 0.3m.

The spatial variation in 1% AEP (i.e. 100-year ARI) water level difference also shows negligible identifiable patterns indicating a key control or source contributing to the modelled difference.

It is interesting to see that while the WRM (2017) discharge was 8.6% higher than that used in RHDHV (2017), because lower channel roughness values were used, there was no systematic increase in predicted water levels for the 1% AEP design event.

Overall it is considered that the WRM (2017) model is suitable for determining the impact of the proposed rail spur and that the results are in good agreement with that presented in the Muswellbrook FRMS&P (RHDHV, 2017).

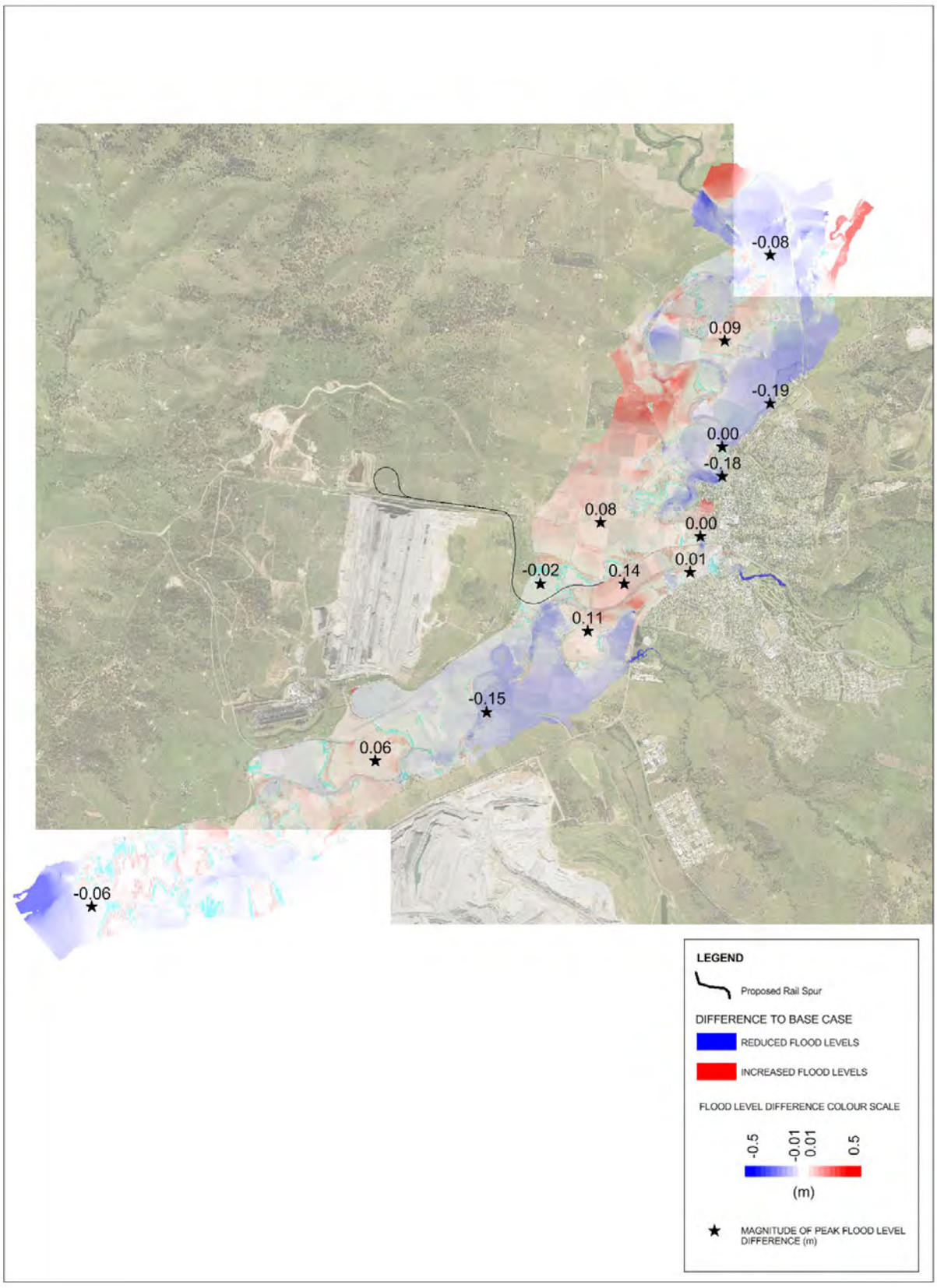

Figure 3-6: Comparison of WRM (2017) 1% AEP Design Flood Level to RHDHV (2017)

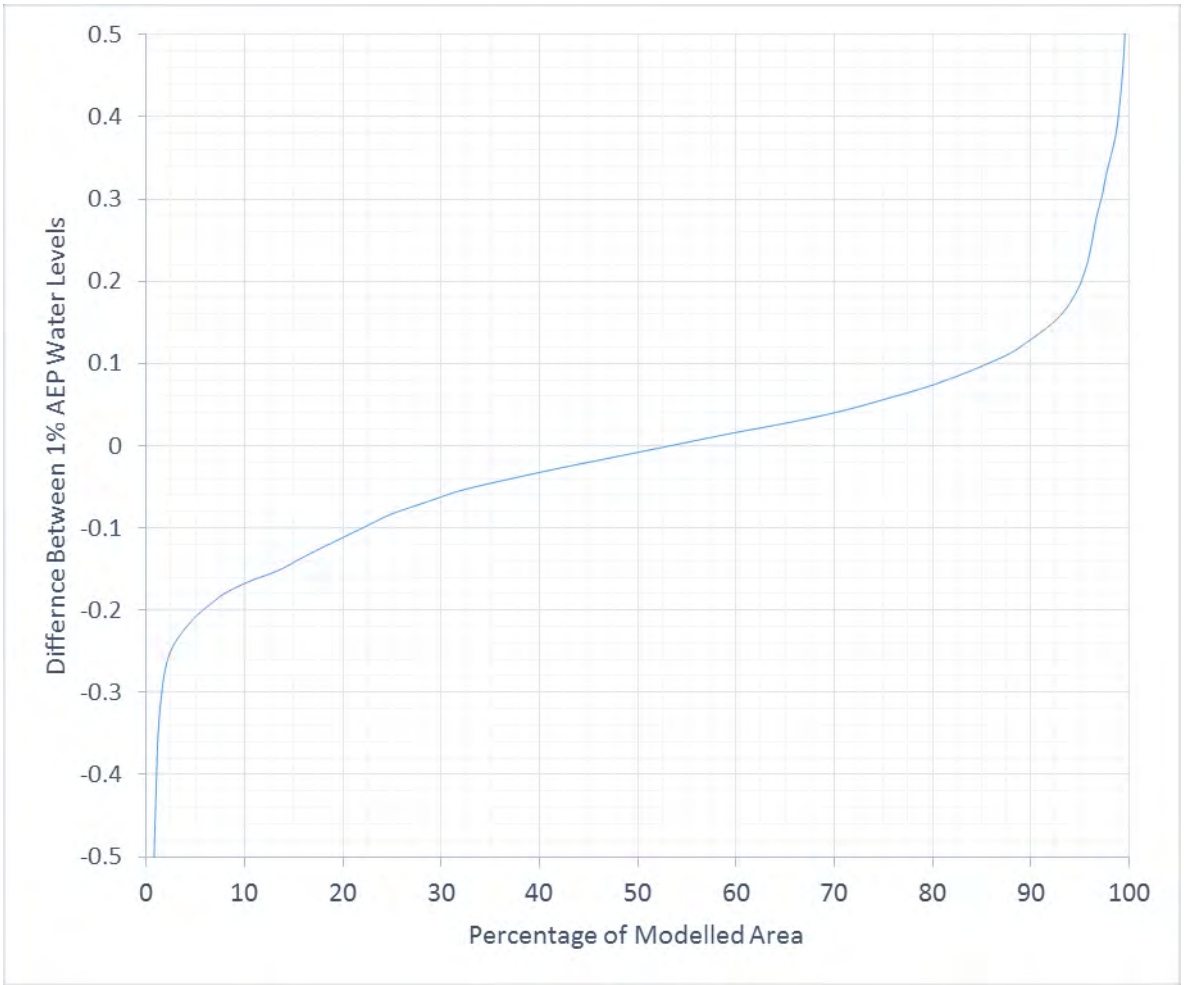

Figure 3-7: Statistical Comparison of WRM (2017) 1% AEP Design Flood Level to RHDHV (2017)

3.3 Review of Proposed Condition Model Results and Impact Assessment

A conceptual design of the proposed rail spur was modelled by WRM (2017) to consider potential impacts of the Rail Modification on flooding. The final detailed design of the proposed rail spur (and associated hydraulic structures) is to be designed to meet the following criteria for potential flooding impacts for a 1% AEP flood event:

- no more than 0.1 metre increase in flood levels on any privately owned land
- no more than 0.01 metre (1 cm) increase in flood levels at any privately owned dwellings or commercial spaces
- no more than 0.01 m increase in flood levels at any public roads servicing privately owned properties
- no more than 0.1 metres per second (m/s) increase in flood velocities on privately owned dwellings or commercial spaces.

Conceptual mitigation measures were included in the modelled design to confirm that the proposed rail spur can be designed to meet the criteria above. The modelled mitigation measures include extension of two existing railway culvert crossings and two bridge openings in the rail embankment.

Figure 3-8 shows the proposed mitigation measures, which consist of two bridge openings of 105 metres and 90 metres. Rail bridges each with 15 metre span length were assumed at the two proposed bridge openings.

Figure 3-8 show the predicted flood level impacts while Figure 3-9 shows the predicted velocity impact for the 1% AEP design event. The resulting afflux appears consistent with the partial blockage of the floodplain, while the increase in velocity is associated with accelerated flow through the proposed bridge openings. The results indicate that the concept design meets the specified impact criteria.

For the sensitivity run with 1% AEP plus 20% flow, peak flood levels at several private dwellings to the south of the existing rail way increase by just over 0.01 m, compared to existing conditions (refer Figure 3-10). The 1% AEP plus 20% flow would be of a magnitude between the 0.5 and 0.2% AEP design events (adopting the RHDHV (2017) estimates of design discharge).

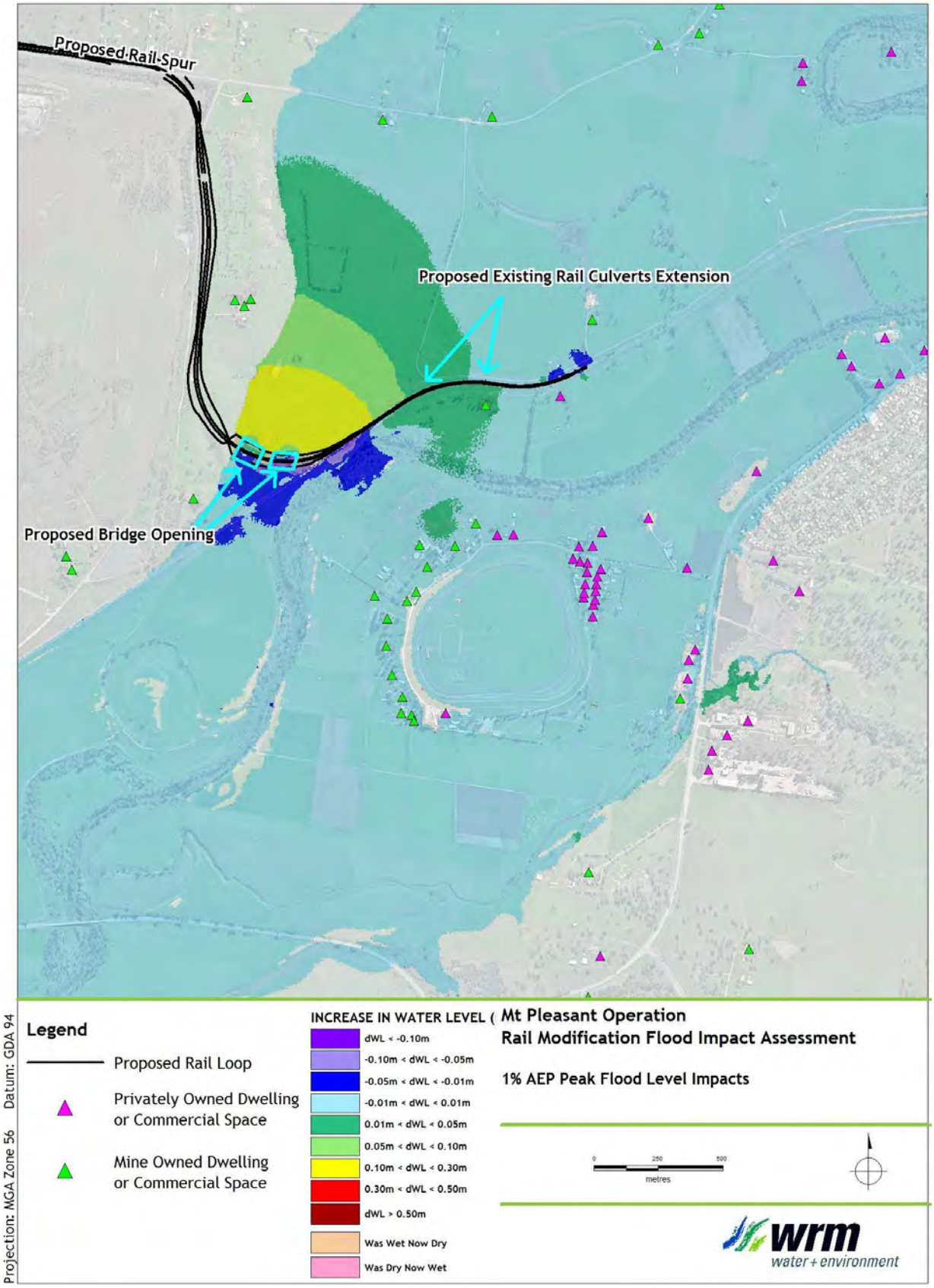

Figure 3-8: Peak flood level impacts, 1% AEP design event (Fig 6.5 WRM (2017))

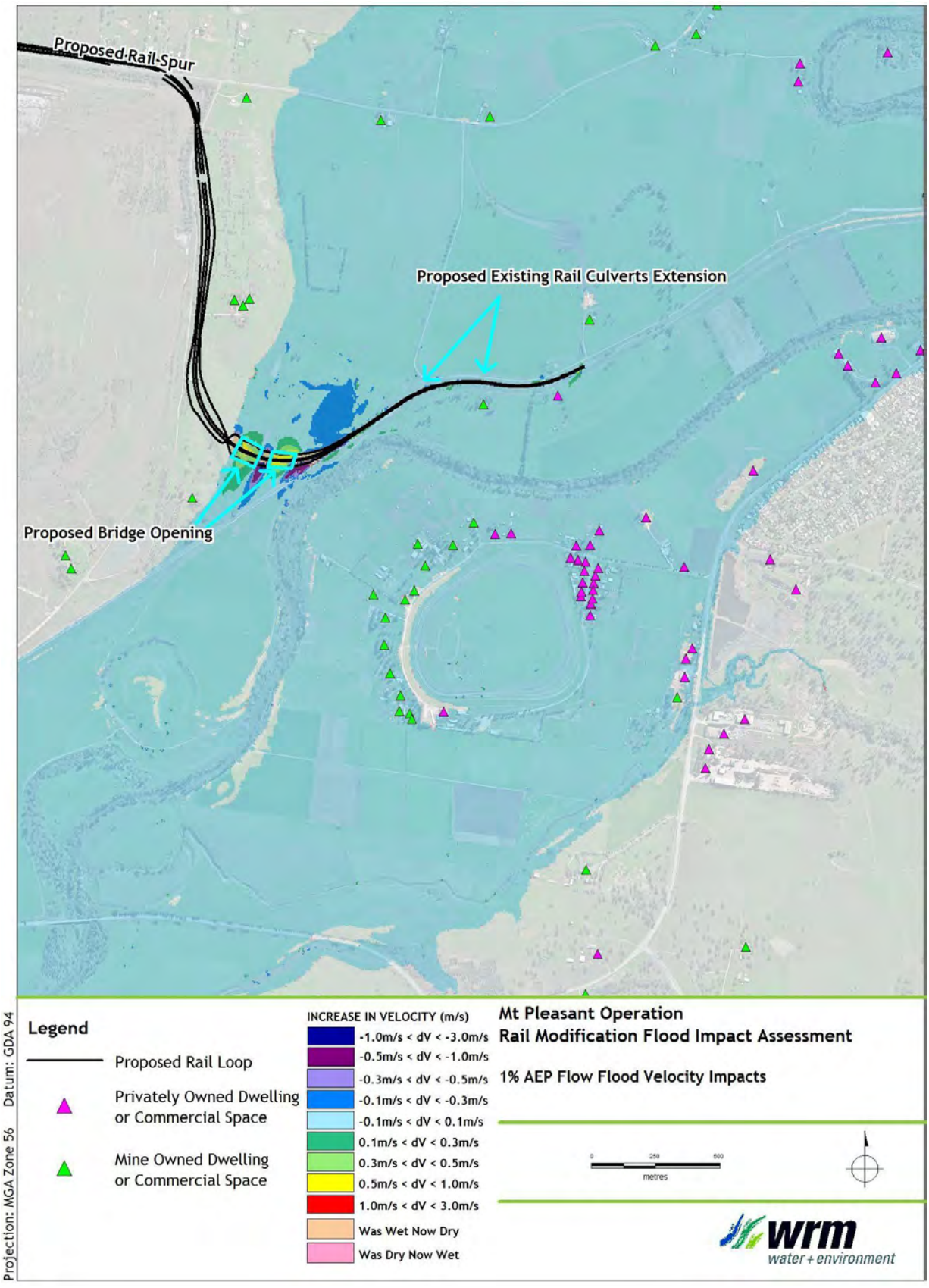

Figure 3-9: Flood velocity impacts, 1% AEP design event (Fig 6.8 WRM (2017))

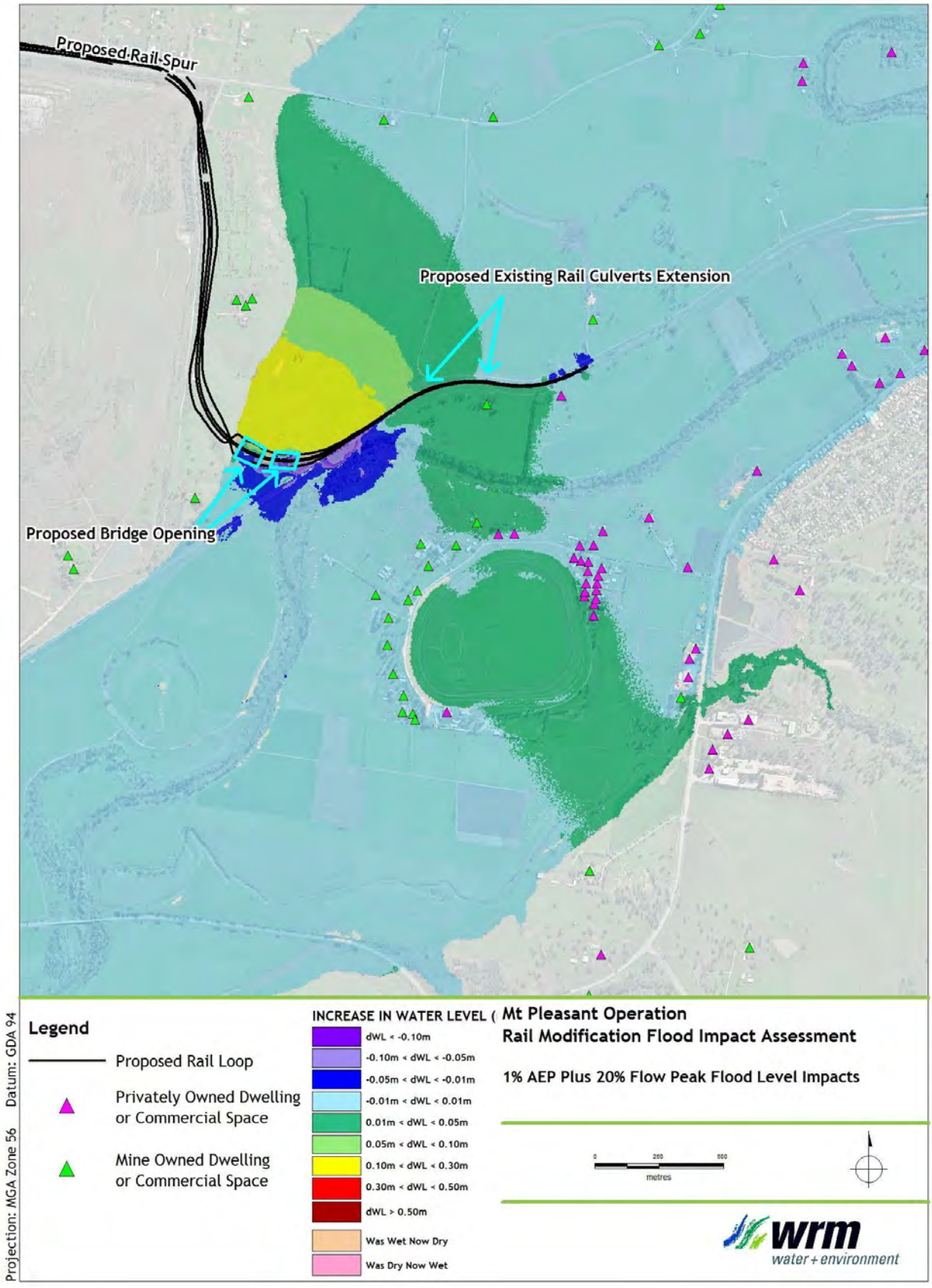

Figure 3-10: Peak flood level impacts, 1% AEP plus 20% flow design event (Fig 6.6 WRM (2017))

3.4 Review of ARR 2016 Blockage Assessment

WRM provided an overview of the initial ARR 2016 blockage as presented below. It appears appropriate given the large size of the openings and the location of the proposed bridging elements on shallow areas of the floodplain located a significant distance from the main Hunter River channel.

We have undertaken assessment on the design blockage for the proposed rail spur bridge openings, in accordance with ARR 2016 Book 6 Chapter 6. The assessment procedure outlines the key design criteria including debris availability, mobility and transportability. These criteria will be used to determine the 1% AEP debris potential, AEP adjusted debris potential and the design inlet blockage. The design standard and adopted design criteria have been provided in the attached design sheet.

The blockage assessment for the proposed rail spur bridge openings indicates a very low blockage potential and resulted a 0% blockage for the most likely inlet blockage level. The basis on the selected criteria is listed below:

- ***Debris availability** (Table 6.6.1, ARR 2016) – the dominant land use type upstream of the proposed bridge opening is well maintained paddocks. This results in **'Low'** debris availability.*
- ***Debris mobility** (Table 6.6.2, ARR 2016) – the proposed rail spur bridge openings are located on a flat floodplain and is well away from the Hunter River. The debris mobility is considered to be **'Medium'**.*
- ***Debris transportability** (Table 6.6.3, ARR 2016) – the slope of the floodplain upstream of the proposed bridge opening is very flat at approximately 0.3%. The transportability of debris is likely to be **'Low'**.*
- *The 1% AEP debris potential is **'Low'** based on the above three criteria (Table 6.6.4, ARR 2016). A **'Medium'** debris potential is adopted for design event rarer than the 0.5% AEP (Table 6.6.5, ARR 2016).*
- *The average length of the longest 10% of the debris (L_{10}) is assumed to be 3 m, which represents the upper end of medium floating debris. The span length of the proposed rail bridge openings is about 15 m, which is more than 3 times of the L_{10}. In accordance with ARR 2016 Table 6.6.6, the most likely inlet blockage is **0%** for the proposed bridge openings for **'Medium'** and **'Low'** debris potential at structure (i.e. all design events).*

4 Summary and Conclusions

A summary of the independent review of the Mount Pleasant – Rail Modification Flood Assessment Report (WRM, 2017) includes:

Hunter River Design Flood Discharge Estimates

A review of the method and magnitude (compared to RHDHV (2017)) of the Hunter River design discharges provided in the WRM (2017) indicate that they are appropriate for the Mount Pleasant – Rail Modification Flood Assessment Report.

A comparison of the WRM (2017) to RHDHV (2017) FFA shows that the WRM (2017) values are between 1.1 and 6.3% higher (i.e. conservative more liberal estimate) than those reported in RHDHV (2017) for AEP events ranging from 5% to 0.2% AEP (i.e. 20-year to 500-year ARI). While the RHDHV (2017) is likely to be more accurate (i.e. more data was used) there is good agreement between the two estimates of design discharges between the two studies.

A comparison of WRM (2017) hydrologic model (XP-RAFTS) flows to the RHDV (2017) equivalent shows that the WRM hydrologic flows (adopted for use in the hydraulic model) are up to 8.6% higher for events up to the 1% AEP when compared to hydrologic design flows adopted in RHDHV (2017). The main difference in flows is likely to be attributed to the additional model calibration (required due to correction of gauge rating tables) undertaken in the RHDHV study that resulted in the adoption of a higher Bx (catchment storage) parameter.

A review of the method and magnitude of the Hunter River design discharges provided in the WRM (2017) indicate that they are appropriate for the Mount Pleasant Rail Modification Flood Assessment. Both the design discharge estimates from the FFA and hydrological model are in good agreement with the more sophisticated analysis undertaken in RHDHV (2017) that forms the basis of the Muswellbrook FRMS&P.

The use of slightly higher design discharge means that, provided appropriate roughness values are adopted in the hydraulic model, there should be a degree of conservatism in the WRM (2017) assessment.

Hunter River Model Review

A review of the important elements of the Hunter River TUFLOW modelling is provided in Table 3-1. Overall the assumptions and methodology appear appropriate and the assessment of the existing conditions appears to be appropriate.

The main difference between the WRM (2017) and RHDHV (2017) are in the selection of roughness values and the representation of deeper (channel pool) sections of the Hunter River. While WRM (2017) adopted a slightly higher pasture/overbank roughness (which will tend to increase flood levels in larger events), the use of lower roughness of dense channel bank vegetation (that has significantly reduced the in bank channel capacity of the Hunter River over the past 30 years) will tend to reduce predicted flood levels, especially for the smaller design events.

A comparison of the WRM (2017) to the RHDHV (2017) model 1% AEP result shows that a majority (i.e > 80%) of the modelled area lies within the water level difference range of ±0.15 metres of the RHDHV (2017) model 1% AEP result. This indicates that while the WRM (2017) discharge was 8.6% higher than that used in RHDHV (2017), because lower channel roughness values were used, there was no substantial overall increase in predicted water levels for the 1% AEP design event.

Overall it is considered that the WRM (2017) model is suitable for determining the impact of the proposed rail spur and that the results are in good agreement with that presented in the Muswellbrook FRMS&P (RHDHV, 2017).

Review of Impact Assessment

Conceptual mitigation measures were included in the modelled design to confirm that the proposed rail spur can be designed to meet the specified criteria. The modelled mitigation measures included extension of two existing railway culvert crossings and two bridge openings in the rail embankment.

Figure 3-8 showed that the predicted flood level impacts while Figure 3-9 showed the predicted velocity impact for the 1% AEP design event. The resulting afflux appears consistent with the partial blockage of the floodplain, while the increase in velocity is associated with accelerated flow through the proposed bridge openings. The results indicate that the concept design could satisfy the specified impact criteria.

Provided the final design is modelled appropriately and produces a similar or lower level of impact predicted in the proposed scenario modelling presented in WRM (2017) the level of impact is likely to be considered acceptable.

5 References

1. ARR2016 - Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2016, ***Australian Rainfall and Runoff: A Guide to Flood Estimation***, Commonwealth of Australia
2. RHDHV, 2017, ***Hunter River Flood Study (Muswellbrook to Denman): Model Revisions Report***, Royal HaskoningDHV (on behalf Muswellbrook Shire Council), dated 19 October 2017.
3. WorleyParsons, 2014 '***Hunter River Flood Study (Muswellbrook To Denman)***', Report prepared for Muswellbrook Shire Council by WorleyParsons Services Pty Ltd, 8 September 2014.
4. WRM, 2017, ***Mount Pleasant Operation - Rail Modification Flood Assessment***, Report No 0744-09-B3, dated 19 December 2017

MACHEnergy

Attachment 4

Disturbance Area – Biodiversity Development Assessment Report

MACH ENERGY

MOUNT PLEASANT OPERATION

RAIL MODIFICATION

BIODIVERSITY DEVELOPMENT ASSESSMENT REPORT

PREPARED BY
HUNTER ECO

Dr Colin Driscoll
Assessor BAAS17004

May 2018

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

EXECUTIVE SUMMARY

MACH Energy Australia Pty Ltd (MACH Energy) acquired the Mount Pleasant Operation (MPO) from Coal and Allied Operations Pty Ltd (Coal & Allied) on 4 August 2016. MACH Energy commenced construction activities at the MPO in November 2016, in accordance with Development Consent DA 92/97 and EPBC 2011/5795.

The approved MPO includes the construction and operation of an open cut coal mine and associated rail spur and product coal loading infrastructure. The mine is approved to produce up to 10.5 million tonnes per annum of run-of-mine coal. Up to approximately nine trains per day of thermal coal product from the MPO will be transported by rail to the port of Newcastle for export or to domestic customers for use in electricity generation.

MACH Energy is seeking a modification to the approved MPO under Section 75W of the NSW *Environmental Planning and Assessment Act 1979.* The MPO Development Consent DA 92/97 was granted on 22 December 1999. The MPO was also approved under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* in 2012 (EPBC 2011/5795).

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 Modification to obtain approval for future rail and/or conveyor product transport facilities to manage this future interaction.

The Modification would primarily comprise:

- duplication of the approved rail spur, rail loop, conveyor and rail load-out facility and associated services;
- duplication of the Hunter River water supply pump station, water pipeline and associated electricity supply that currently follows the rail spur alignment; and
- demolition and removal of the redundant approved infrastructure within the extent of the Bengalla Mine, once the new rail, product loading and water supply infrastructure has been commissioned and is fully operational.

Components of the Modification traverse existing approved disturbance areas (i.e. within the approved extent of the MPO[1]). These areas are excluded from the additional disturbance areas assessed as part of this assessment.

As part of the Modification, MACH Energy is relinquishing its approval in relation to a portion of the South West Out of Pit Emplacement footprint to restrict the area used for major infrastructure. The biodiversity values of the area potentially available for relinquishment are detailed in a separate Biodiversity Development Assessment Report.

One of the key components of the Modification consists of a rail loop that is located on derived native grassland with scattered trees. The rail line continues east from the loop along Wybong Road for approximately 2 kilometres (km) through a portion of the already approved MPO and/or of the adjacent public road infrastructure. At Overton Road the rail line turns south through a corner of the Bengalla Mine rehabilitated waste emplacement onto agricultural land for a further 3 km until it connects to the existing Muswellbrook-Ulan Rail Line.

[1] As permitted by Development Consent DA 92/97, including areas nominally depicted in Appendix 1 of DA 92/97 and/or the approved Mining Operations Plan.

The rail loop is located on elevated land (approximately 220 m AHD) with the rail spur running across gradually sloping land to an elevation of approximately 150 m AHD at which point it drops onto the Hunter Floodplain for the last 1.5 km.

The water pipeline taking water from the Hunter River will be placed underground for approximately 2.5 km through agricultural land on the Hunter Floodplain where the vegetation is a mix of grazing pasture and cultivated crops. It then continues west on the surface crossing lands associated with the approved MPO. An overhead powerline supplying the pumps at the Hunter River will be located beside the pipeline.

Using the identity of scattered paddock trees, three Plant Community Types were determined to have been present prior to clearing as shown in Table ES-1.

Table ES-1 Plant Community Types

PCT	PCT Name	Zones	Percent Cleared
1605	Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	Derived Native Grassland and Poor Condition	32%
1693	Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains	Derived Native Grassland	64%
1714	River Oak - White Cedar grassy riparian forest of the Dungog area and Liverpool Plains	Low Condition	62%

Use of the Biodiversity Assessment Method credit calculator confirmed the apparent poor condition of the Modification disturbance areas as shown in Table ES-2.

Table ES-2 Vegetation Integrity

Modification component	Plant Community Type	Vegetation Integrity Score	Vegetation Integrity Score threshold	Ecosystem credits required
Rail Loop	1605 low condition	17.8	<17	Yes
Rail Spur and Pipeline/ETL	1605 DNG	2.2	<17	No
	1605 low condition	15.7	<17	No
	1714 low condition	3.9	<17	No
	1693 DNG	0.2	<15	No

Ecosystem credits required for the Rail Loop are shown in Table ES-3.

Table ES-3 Rail Loop Ecosystem Credits

Vegetation Community	PCT	Condition	Clearance Area (ha)	Ecosystem Credits
Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	1605	Low	21.0	141

No ecosystem credits were required for the Rail Spur and Pipeline/ETL as all VI scores were <17 or <15.

No species credits were generated by the BAM Credit Calculator for the Modification.

The Modification includes the relinquishment of approval to clear a portion of the South West Out of Pit Emplacement, which provides higher quality vegetation and habitat compared to the Modification area. Accounting for the areas potentially available for relinquishment, the Modification would result in a net benefit to terrestrial ecology (Hunter Eco, 2018).

1 INTRODUCTION

MACH Energy Australia Pty Ltd (MACH Energy) acquired the Mount Pleasant Operation (MPO) from Coal and Allied Operations Pty Ltd (Coal & Allied) on 4 August 2016. MACH Energy commenced construction activities at the MPO in November 2016, in accordance with Development Consent DA 92/97 and EPBC 2011/5795.

The approved MPO includes the construction and operation of an open cut coal mine and associated rail spur and product coal loading infrastructure. The mine is approved to produce up to 10.5 million tonnes per annum of run-of-mine coal. Up to approximately nine trains per day of thermal coal product from the MPO will be transported by rail to the port of Newcastle for export or to domestic customers for use in electricity generation.

1.1 Project Overview

MACH Energy is seeking a modification to the approved MPO under Section 75W of the NSW *Environmental Planning and Assessment Act 1979.* The MPO Development Consent DA 92/97 was granted on 22 December 1999. The MPO was also approved under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* in 2012 (EPBC 2011/5795).

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 Modification to obtain approval for future rail and/or conveyor product transport facilities to manage this future interaction.

The Modification would primarily comprise:

- duplication of the approved rail spur, rail loop, conveyor and rail load-out facility and associated services;
- duplication of the Hunter River water supply pump station, water pipeline and associated electricity supply that currently follows the rail spur alignment; and
- demolition and removal of the redundant approved infrastructure within the extent of the Bengalla Mine, once the new rail, product loading and water supply infrastructure has been commissioned and is fully operational.

Figure 1 shows the regional location and Figure 2 shows the general arrangement.

The Modification would not alter the number of approved train movements on the rail network or operational workforce of the MPO.

Components of the Modification traverse existing approved disturbance areas (i.e. within the approved extent of the MPO[2]). These areas are excluded from the additional disturbance areas assessed as part of this assessment. The components of the Modification being considered in this assessment are presented in Figure 2.

As part of the Modification, MACH Energy is relinquishing its approval in relation to a portion of the South West Out of Pit Emplacement footprint to restrict the area used for major infrastructure. The biodiversity values of the areas potentially available for relinquishment are detailed in a separate Biodiversity Development Assessment Report (Hunter Eco, 2018).

[2] As permitted by Development Consent DA 92/97, including areas nominally depicted in Appendix 1 of DA 92/97 and/or the approved Mining Operations Plan.

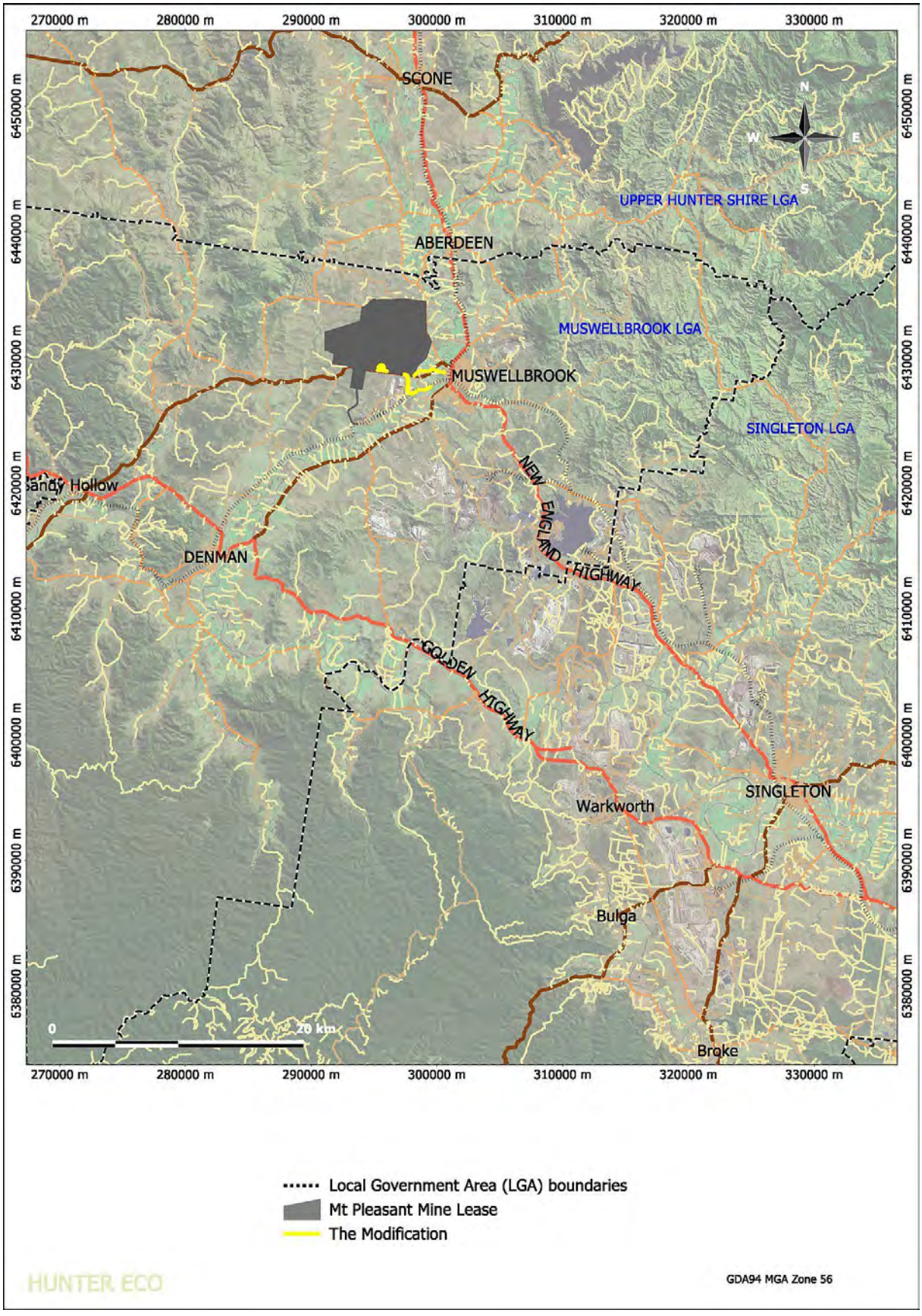

Figure 1 The Regional Location of the Mount Pleasant Mine and Modification Area

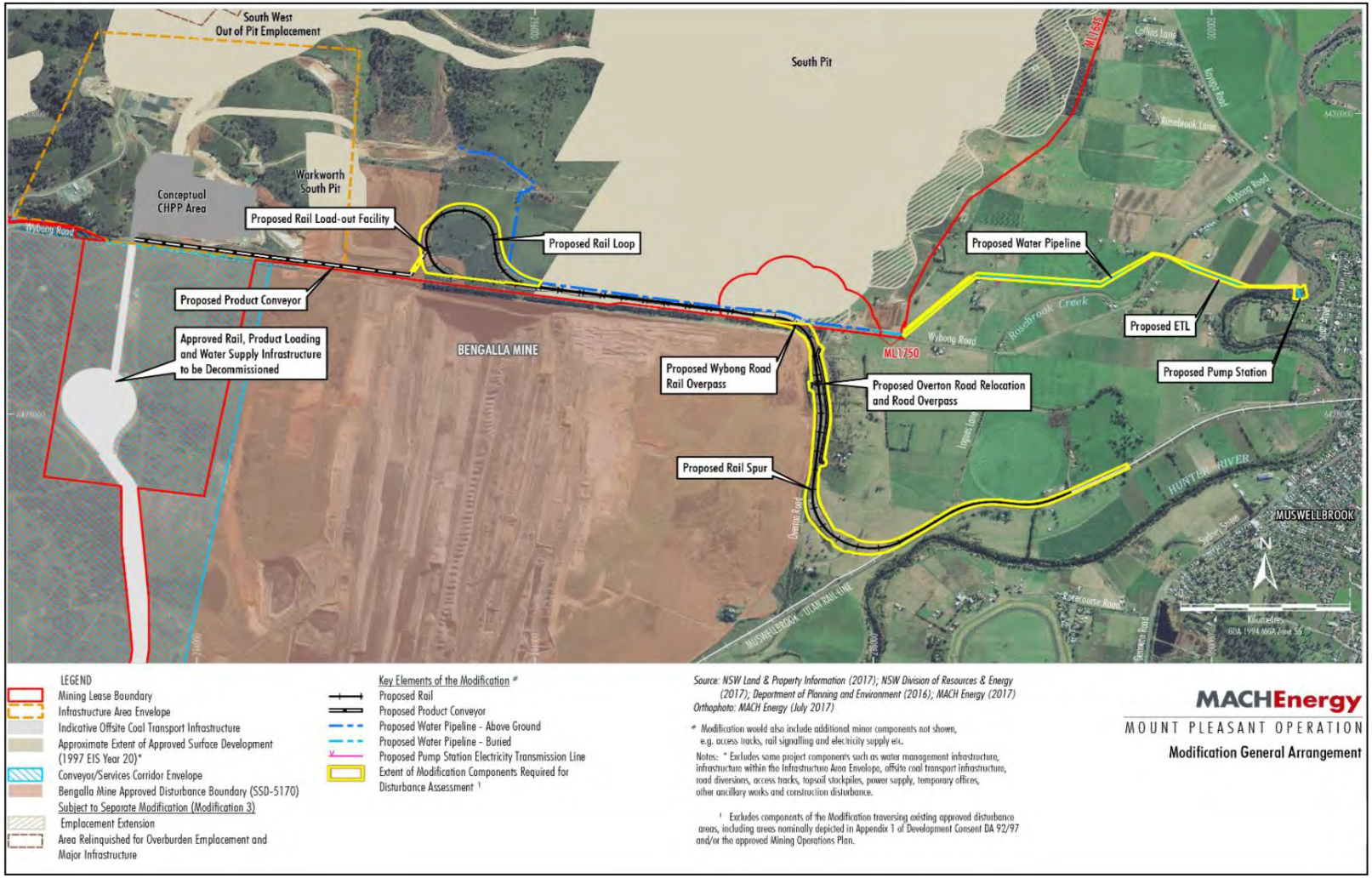

Figure 2 The Modification General Arrangement

1.2 General Description of the Development Site Footprint

One of the key components of the Modification consists of a rail loop that is located on derived native grassland with scattered trees. The rail line continues east from the loop along Wybong Road for approximately 2 kilometres (km) through a portion of the already approved MPO and/or of the adjacent public road infrastructure. At Overton Road the rail line turns south through a corner of the Bengalla Mine rehabilitated waste emplacement onto agricultural land for a further 3 km until it connects to the existing Muswellbrook-Ulan Rail Line.

The rail loop is located on elevated land (approximately 220 m AHD) with the rail spur running across gradually sloping land to an elevation of approximately 150 m AHD at which point it drops onto the Hunter Floodplain for the last 1.5 km.

The water pipeline taking water from the Hunter River will be placed underground for approximately 2.5 km through agricultural land on the Hunter Floodplain where the vegetation is a mix of grazing pasture and cultivated crops. It then continues west on the surface crossing lands associated with the approved MPO. An overhead powerline supplying the pumps at the Hunter River will be located beside the pipeline.

1.3 Assessment Requirements/Approach

The NSW *Biodiversity Conservation Act, 2016* (BC Act) commenced in August 2017 and establishes a new assessment process replacing the previous Framework for Biodiversity Assessment (FBA: NSW Office of Environment and Heritage [OEH] 2014a). The Modification has been assessed in accordance with the *Biodiversity Assessment Method Order, 2017* (BAM: OEH 2017b) established under Section 6.7 of the BC Act. For the purposes of this BDAR, the Modification is assessed as a State Significant Development.

This BDAR has been prepared by Dr Colin Driscoll (Hunter Eco), who is an accredited assessor (assessor accreditation number BAAS17004).

1.4 Structure of this Assessment

The structure of the BDAR follows the requirements in Appendix 10 of the BAM (OEH, 2017b).

1.5 Information Sources Used in this Assessment

This BDAR has been prepared using various data sources as described below.

1.5.1 Field Surveys

Flora and vegetation surveys were conducted by Hunter Eco in 2017 and 2018 with results described in this document and a full report in Appendix 1 of Attachment A. Fauna surveys were conducted by Eco Logical Australia (ELA, 2017) with results summarised in this report and with the full report provided in Appendix 4 of Attachment A.

1.5.2 Published Databases

Published databases used in this assessment include:

- *BioNet Vegetation Classification* (OEH, 2017d);
- *Threatened Biodiversity Data Collection* (OEH, 2017f)[3];
- *BioNet Atlas* (OEH, 2017a)[4]; and
- *Directory of Important Wetlands of Australia* (Department of the Environment and Energy [DEE], 2018a).

[3] This website is titled 'Profiles'.

[4] This website is titled 'Species Sightings Search'

1.5.3 Local Data

It was not necessary use local data or deviate from the OEH databases (OEH, 2017a and 2017c).

1.5.4 BAM Credit Calculator

BAM Credit Calculator Version: 1.2.2.00, Last updated: 22/02/2018 16:00) (OEH, 2018a) was used in this assessment.

2 LANDSCAPE FEATURES

This section provides information on the landscape features in accordance with the BAM (OEH, 2017b). The BAM (OEH, 2017b) refer to 'Subject land' as the land to which the BAM is applied in Stage 1 to assess the biodiversity values of the land (i.e. the landscape features [Section 2], native vegetation [Section 3] and threatened species [Section 4]). For the purpose of this assessment, the 'Subject land' is the same as the 'Development Site Footprint', the area directly impacted on by a proposed development, herein referred to as the Modification.

2.1 Regional Setting

The Modification lies within:

- Muswellbrook Local Government area (Figure 1);
- Hunter Local Land Services area;
- Sydney Basin Bioregion, Hunter sub-region (Figure 3);
- Central Western Slopes Botanical Division; and
- Central Hunter Foothills and Upper Hunter Channels and Floodplain Mitchell landscapes (Figure 6).

2.2 Native Vegetation Cover

Clearing of Hunter Valley vegetation commenced in the early 1800's. The earliest available aerial photographs from 1953 (Figure 5) show that the Modification area and surrounds were almost totally cleared and in much the same condition (with regard to remnant vegetation) as it is currently. It can be concluded that all of the land associated with the Modification has been subject to previous clearance activities and used for agricultural purposes for in excess of 60 years, and most likely much longer.

2.3 Habitat Connectivity Features

The native vegetation extent/habitat connectivity as mapped by site surveys (Hunter Eco 2017) (Appendix 1 of Attachment A) and regional mapping (OEH, 2018b) is shown on Figure 4. Any native vegetation on Figure 4 may facilitate the movement of one or more threatened species across their range.

2.4 Rivers and Streams

Drainage features (and riparian buffer distances based on Strahler stream ordering and the BAM [OEH, 2017b]) is shown on Figure 4 from the Department of Primary Industries – Water (2017). It should be noted that while Rosebrook Creek is mapped as an 8th order stream this appears to be a consequence of each end being connected to the Hunter River. However Rosebrook Creek is an ephemeral floodway, being mostly dry at the time of the field surveys. The portions of the creek intersected by the Modification were incorporated into the adjoining grazing land (Plate 1).

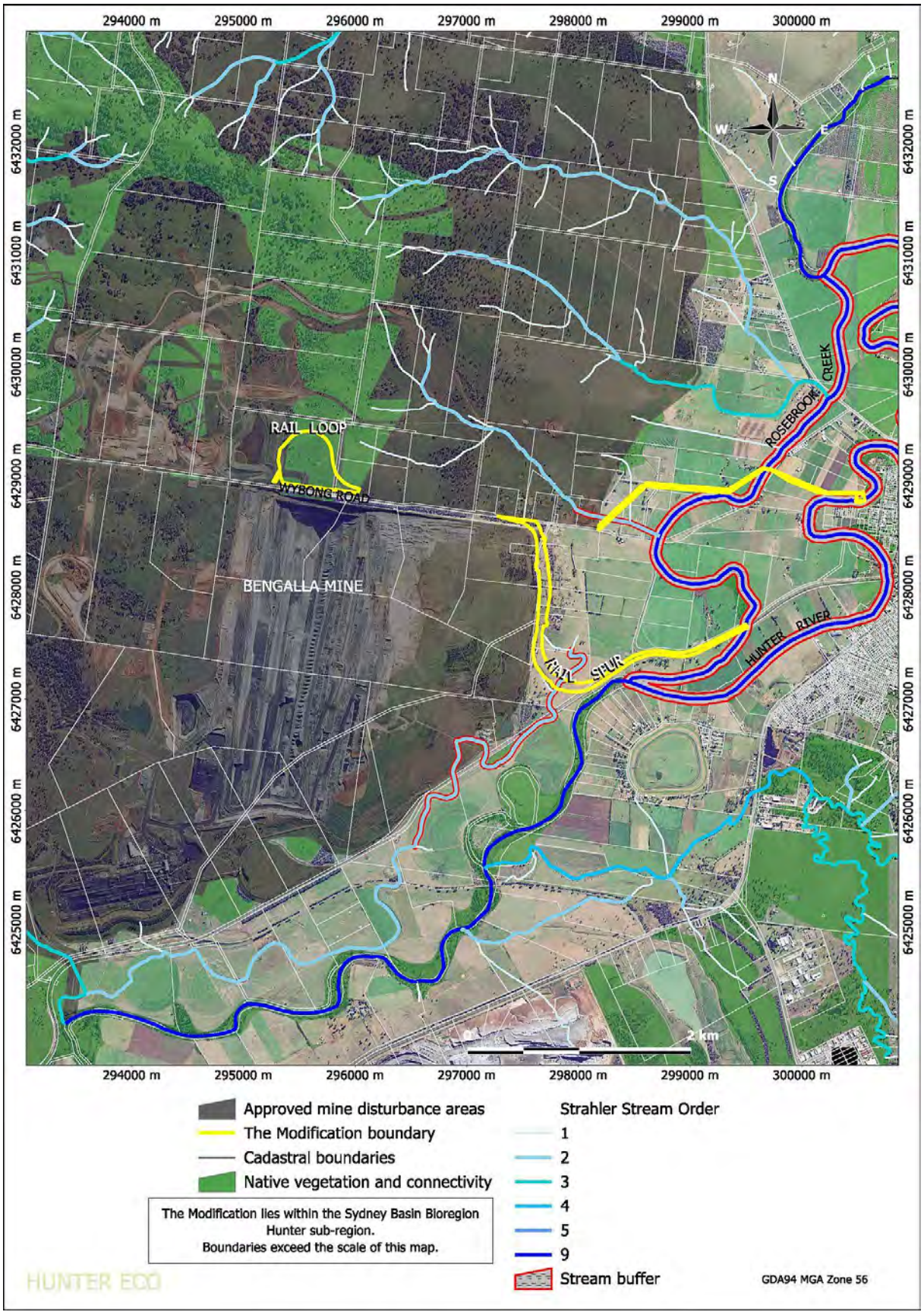

Figure 3 The Modification and Surrounding Native Vegetation, Connectivity and Stream Order

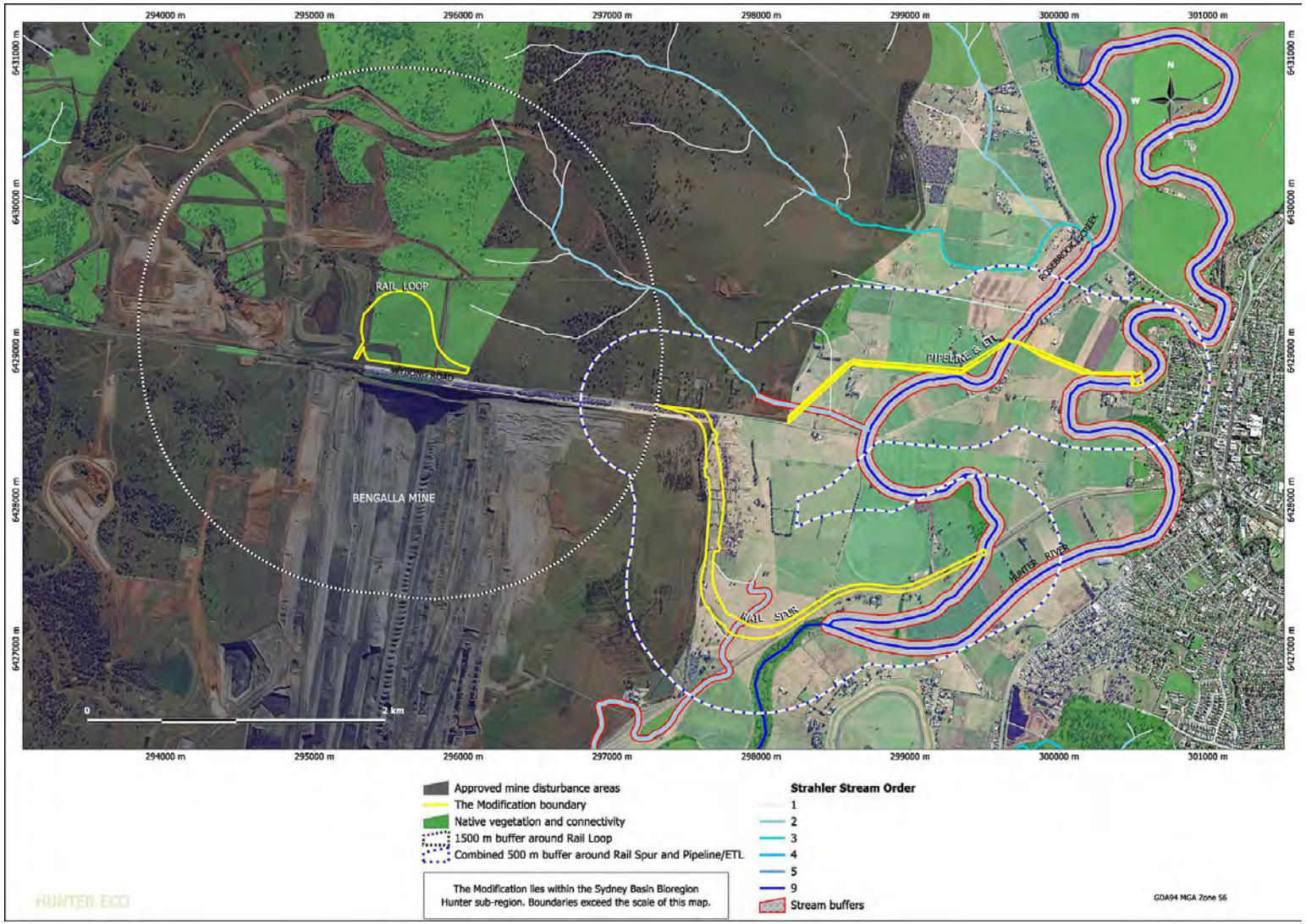

Figure 4 The Modification with Assessment Buffers, Native Vegetation and Stream Order

Figure 5 The Modification Overlaid on a 1953 Aerial Photograph

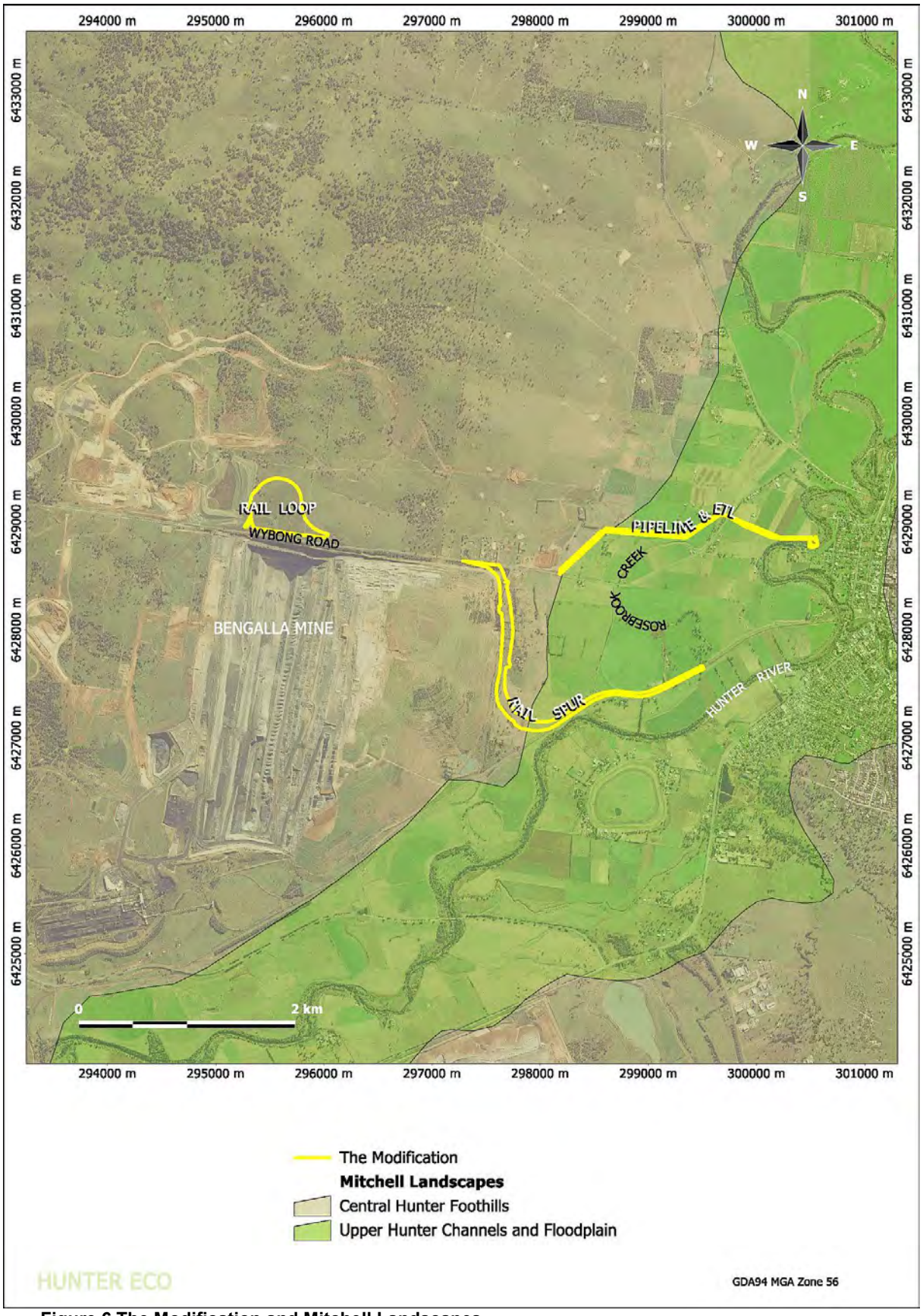

Figure 6 The Modification and Mitchell Landscapes

Plate 1 Looking Across Rosebrook Creek

2.5 Wetlands

There are no important or local wetlands on or, adjacent to the Modification land (Figure 6) (after DEE, 2018a; OEH, 2017e). The closest important wetland is too far away (over 50 km) to be shown on Figure 6.

2.6 Geology

There are no karst, caves, crevices, cliffs or other areas of geological significance on the Modification land or in the vicinity of the Modification.

2.7 Areas of Outstanding Biodiversity Value

There are no Areas of Outstanding Biodiversity Value listed under the NSW *Biodiversity Conservation Regulation, 2017* associated with the Modification.

2.8 Migratory Species Potential Flyways

There are no defined potential flyways for migratory species listed under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) that pass over the Modification land, however, migratory birds could fly over that land similar to most areas in NSW, e.g. Rainbow Bee-eater (*Merops ornatus*).

2.9 Site Context Components

A site-based assessment method described in the BAM (OEH, 2017b) was applied to the Rail Loop component of the Modification due to the compact size and shape of the Development Site Footprint. The Modification is not eligible for the streamline assessment modules described in the BAM (OEH, 2017b). In particular, the scattered trees in the Rail Loop were assessed as not meeting the definition of Paddock Trees on account of there being >50% indigenous species ground cover (BAM Appendix 1 [OEH 2017b]).

The Rail Spur and Water Pipeline with its associated ETL were combined as a single linear-based assessment (OEH, 2017b).

The extent of native vegetation cover is described in Section 2.2. The patch size relative to the vegetation zone is described in Section 3.3.2. There are no additional features required to be assessed by the Secretary as Secretary's Environmental Assessment Requirements (SEARs) were not issued. No SEARs were issued for the Modification.

3 NATIVE VEGETATION

3.1 Plant Community Types

In principle, Plant Community Types (PCT) are determined by comparing floristic content as compiled from floristic plots and transects strategically placed across the disturbance area with PCT descriptions in BioNET.

Floristic plots consisted of a 20m x 20m plot nested in a 50m x 20m plot from which data were collected according to the requirements of the BAM (OEH, 2017b). All flora species present in the 20m x 20m plot were identified and their percentage foliage cover was scored. The number of individuals present was also estimated for species with a cover score of 5% or less. Diameter at Breast Height (DBH) was recorded for any trees within the 50m x 20m plot and tallied against the following intervals: <5, 5−9, 10−19, 20−29, 30−49, 50−79, and 80+ centimetres (cm). Percentage litter cover was determined in five one metre square plots evenly located across the 50m x 20m plot.

Within and around the Modification disturbance area four habitat types were assessed. These are mapped in Figure 7 and described in the following sections. Figure 8 shows the location of the 14 floristic sample plots collected for this assessment. The floristic plot data collected within the Modification disturbance area is provided in Appendix 6.

3.1.1 Native Grassland (21 ha)

Located entirely within the rail loop this area contained mixed cover of native tussock gasses and weeds (Plate 2). From four floristic plots there were 19 weed species and 17 native species. Native species were dominated by the grasses *Aristida ramosa* and *Bothriochloa decipiens* with weed species dominated by *Galenia pubescens, Carthamus lanatus, Hyparrhenia hirta* and *Hedypnois rhagadioloides*. There were four High Threat Weed species: *Galenia pubescens, Carthamus lanatus, Hyparrhenia hirta* and *Opuntia stricta.*

Scattered within the rail loop area were nine large (DBH 50-80 or 80+ cm) Narrow-leaved Ironbark (*Eucalyptus crebra*) trees and the presence of these trees indicated that the grassland was derived from Plant Community Type PCT1605 *Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter*. The derived grassland form of PCT1605 is not a listed threatened community. Pepper trees (*Schinus molle* var. *areira*) and Kurrajong (*Brachychiton populnea*) were also located within the rail loop area. Six trees were observed to contain hollows, providing potential habitat for threatened fauna species (in particular bats and birds). The canopy spread of these trees collectively provides ~0.1 ha of potential threatened fauna habitat.

Plate 2 Rail Loop Grassland

3.1.2 Planted Trees (3 ha)

This was part of the habitat in the Rail Spur corridor area. This habitat consisted of a portion of rehabilitation associated with the Bengalla Mine at the corner of Wybong and Overton Roads (Plate 3), along with windbreaks in the paddocks east of Overton Road (Plate 4).

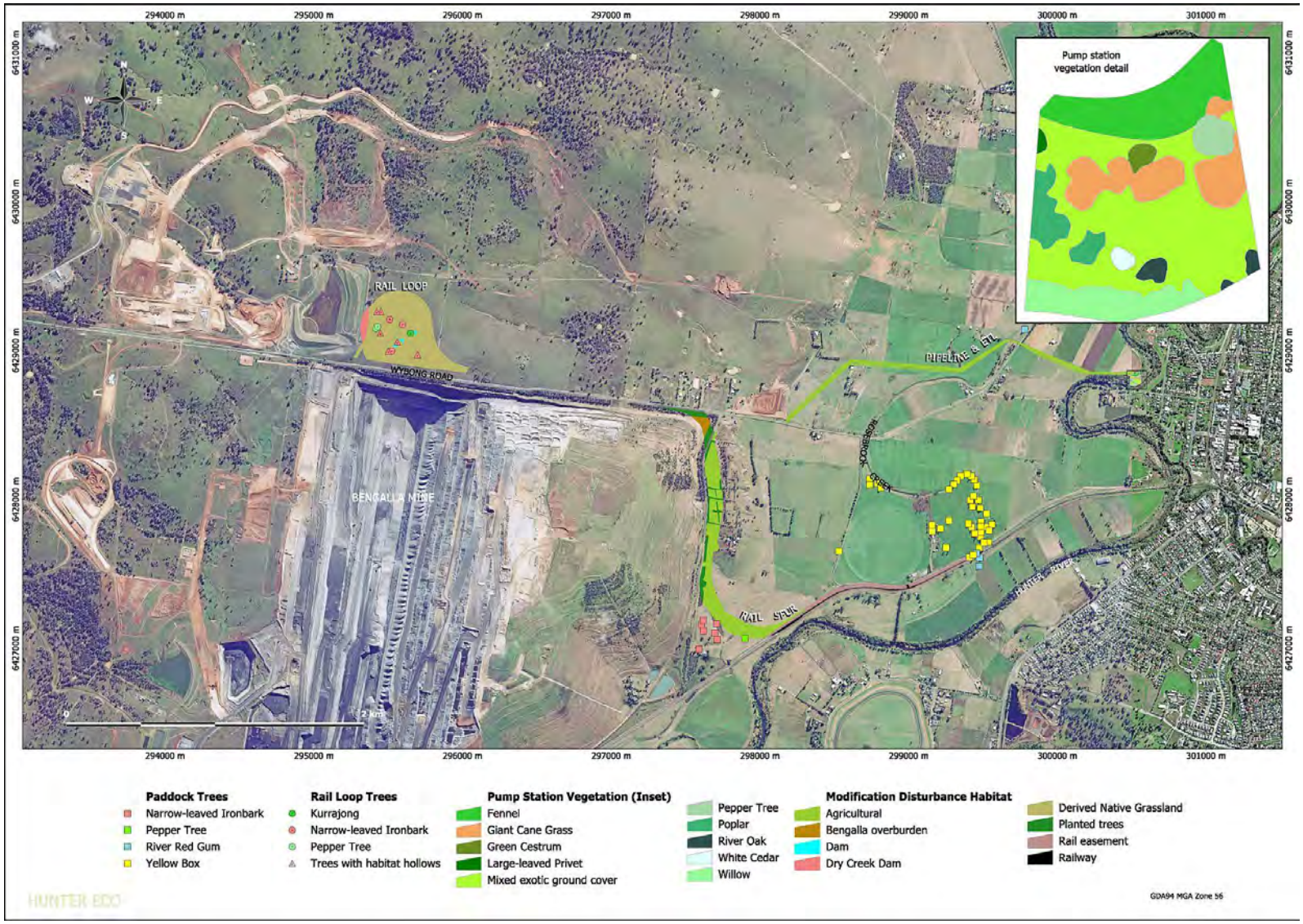

Figure 7 Habitat Types Associated with the Modification

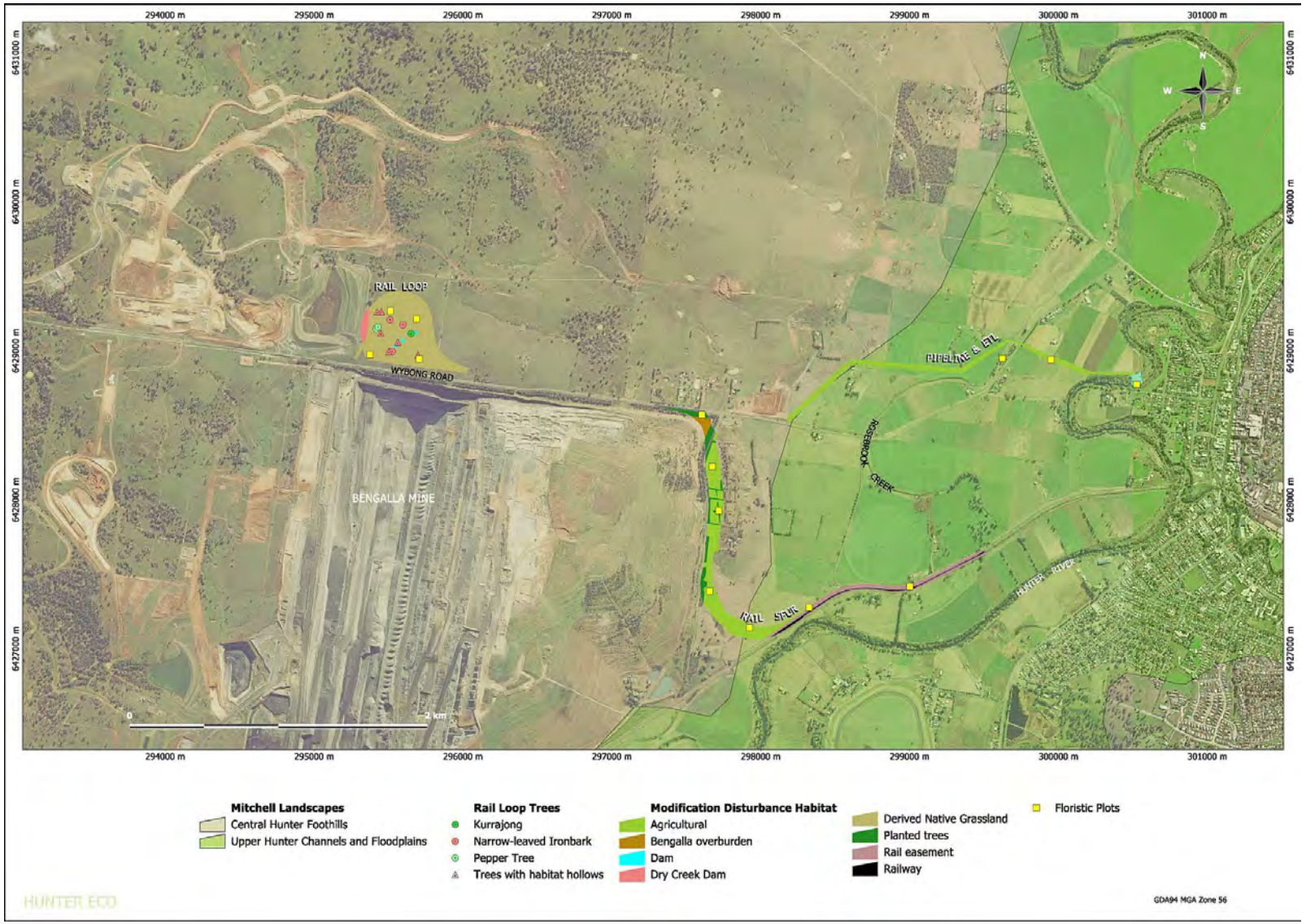

Figure 8 Floristic Plot/Transect Locations

The Bengalla rehabilitation was dominated by Sugar Gum (*Eucalyptus cladocalyx*), a South Australian species planted widely in the Hunter Valley along with Mugga Ironbark (*Eucalyptus sideroxylon*), Slender-leaved Mallee (*Eucalyptus leptophylla*), *Acacia salicina* and *Casuarina glauca*. The windbreaks were dominated by Pepper Tree (*Schinus molle* var. *areira*), Sugar Gum (*Eucalyptus cladocalyx*) and Silky Oak (*Grevillea robusta*). These were single lines of trees in a rectangular mosaic. There were also several Sugar Gum paddock trees in the area.

Several Narrow-leaved Ironbark (*Eucalyptus crebra*) paddock trees around the southern bend in the Rail Spur suggest that the elevated portion would have been derived from PCT1605 *Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter*.

Although consisting mostly of introduced species, this habitat is considered to provide potential habitat for some threatened bird and bat species, albeit marginal and not likely to be critical for survival of any species.

Plate 3 Bengalla Plantation

Plate 4 Paddock Windbreak

3.1.3 Agricultural Land and Rail Infrastructure (21 ha)

This was a part of the habitat in the Rail Spur corridor area and the Pipeline/ETL alignment (agricultural land only). The agricultural land consisted of grazed pasture (Plate 5) and cultivated crops such as Lucerne or Oats. The rail infrastructure area consisted of a narrow strip of land between the railway line and the fenced agricultural land. The strip consisted in part of a formed vehicular track, access points, small buildings and drainage ways. All of the area was part of the original rail construction zone and does not consist of the original land form. The results from five floristic plots showed that out of thirty species recorded, only two were native species (*Boerhavia dominii* and *Portulaca oleracea*), both present as isolated individuals. There were several exotic Hackberry (*Celtis occidentalis*) trees scattered along the rail infrastructure area.

The vegetation within these areas is of a highly disturbed nature and is in extremely poor condition. This habitat is not considered to provide habitat for threatened flora or fauna species.

As noted above, the land through which the elevated portion of the Rail Spur passes would most likely have been derived from PCT1605 *Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter*. At the southern bend, the Rail Spur drops onto the Hunter floodplain on which the Pipeline/ETL is also located. Field inspection of a large patch of trees at the eastern end of the Rail Spur, along Rosebrook Creek, found them to be Yellow Box (*Eucalyptus melliodora*). This, including several scattered paddock trees of the same species, indicated that at this location the floodplain once supported PCT1693 *Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains.*

Plate 5 Rail Spur Heavily Grazed Pasture

3.1.4 Riparian (0.6 ha)

The location for the Hunter River Pump Station, this habitat takes in an area from the Hunter River high bank to the water. Results from a floristic plot and meander survey showed that the vegetation almost entirely consisted of weeds and exotic trees. There were small numbers of River Oak (*Allocasuarina cunninghamii*) and a group of White Cedar (*Melia azedarach*). The river margin was dominated by Weeping Willow (*Salix* sp. [Plate 6]) behind which were Poplar (*Populus nigrans* [Plate 7]), Pepper Tree (*Schinus molle*) and Large-leaved Privet (*Ligustrum lucidum*). There were several large patches of Giant Reed (*Arundo donax*) and Green Cestrum (*Cestrum parqui*). Dominant ground species were the grasses *Melinis repens*, *Bromus sterilis* and *Paspalum urvillei*, along with *Ambrosia tenuifolia, Echium plantagineum, Heliotropium amplexicaule* and *Tradescantia fluminensis*. A large amount of Balloon Vine (*Cardiospermum grandiflorum*) was draped over much of the tree canopy. There were six High Threat Weed species. Figure 8 shows a detailed map of the vegetation within the riparian habitat.

West of the pump station area the vegetation consisted of dense Black Locust (*Robinia pseudoacacia*) trees and African boxthorn (*Lyceum ferocissimum*) while to the east, upstream, the vegetation was similar to that within the pump station area.

Comparing the species content and riparian location at the pump station site with descriptions of PCTs in the NSW BioNET database indicates that the closest match for this habitat type is PCT1714 *River Oak − White Cedar grassy riparian forest of the Dungog area and Liverpool Ranges*. This PCT is noted as containing similar exotic species content to that found at the pump station site (along with River Oak and White Cedar) as well as occurring in the Central Hunter Alluvial Plains landscape. PCT1714 is not a listed threatened ecological community.

The vegetation within the riparian area is of a highly disturbed nature and is in extremely poor condition. Notwithstanding, the Modification would avoid the clearance of mature River Oak and exotic Weeping Willow and Poplar in the vicinity of the proposed pump station in order to conserve potential roosting habitat for threatened Grey-headed Flying Fox.

The ground area of this habitat to be disturbed by the Modification is therefore not considered to provide threatened species habitat.

Plate 6 Pump Station Willow on the Hunter River Bank

Plate 7 Pump Station Poplars and Giant Reed

3.1.5 Threatened Ecological Communities

No threatened ecological communities were present in the Modification disturbance area.

3.2 Plant Community Types Percent Cleared Value

The BAM (OEH 2017b) defines 'Percent Cleared Value' as the percentage of a PCT that has been cleared as a proportion of its pre-1750 extent, as identified in the *BioNet Vegetation Classification* (OEH, 2017d). Table 1 shows the PCT involved in the Modification, their condition class and the percent cleared.

Table 1 Vegetation Zone Data

PCT	PCT Name	Zones	Percent Cleared
1605	Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	Derived Native Grassland and Poor Condition	32%
1693	Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains	Derived Native Grassland	64%
1714	River Oak - White Cedar grassy riparian forest of the Dungog area and Liverpool Plains	Low Condition	62%

3.3 Vegetation Integrity Assessment

3.3.1 Vegetation Zones

Table 1 above shows the vegetation zones used in the assessment of Vegetation Integrity.

3.3.2 Patch Size

The BAM (OEH, 2017b) defines 'Patch Size' as:

> *An area of intact native vegetation that:*
>
> *a) occurs on the development site or biodiversity stewardship site, and*
> *b) includes native vegetation that has a gap of less than 100m from the next area of moderate to good condition native vegetation (or ≤30m for non-woody ecosystems).*
>
> *Patch size may extend onto adjoining land that is not part of the development site or biodiversity stewardship site.*

The BAM (OEH, 2017b) defines '*intact native vegetation*' as:

> *Intact vegetation: vegetation where all tree, shrub, grass and/or forb structural growth form groups expected for a plant community type are present.*

Applying these definitions, the Rail Loop consists of native vegetation whereas the Rail Spur and Pipeline/ETL are located in non-native vegetation.

3.3.3 Vegetation Integrity Score

Table 2 provides the Vegetation Integrity scores derived from the BAM Credit Calculator (OEH, 2018a) along with ecosystem credits assessment thresholds.

Table 2 Vegetation Integrity Scores

Modification component	Plant Community Type	Vegetation Integrity Score	Vegetation Integrity Score threshold	Ecosystem credits required
Rail Loop	1605 low condition	17.8	<17	Yes
Rail Spur and Pipeline/ETL	1605 DNG	2.2	<17	No
	1605 low condition	15.7	<17	No
	1714 low condition	3.9	<17	No
	1693 DNG	0.2	<15	No

3.3.4 Local Data

It was not necessary use local data to deviate from the OEH databases (OEH, 2017a and 2017c).

4 THREATENED SPECIES

Threatened species that are 'ecosystem credit species' and/or 'species credit species' are pre-determined by OEH in the BAM Credit Calculator (OEH, 2018a) and *Threatened Biodiversity Data Collection* (OEH, 2017f). As shown in Table 2 above only Vegetation Integrity score for the Rail Loop assessment exceed the ecosystem credits required threshold which are addressed in section 4.1.

The BAM (OEH, 2017a) states:

> *Threatened species where the likelihood of occurrence of a species or elements of the species' habitat can be predicted by vegetation surrogates and landscape features, or for which targeted survey has a low probability of detection, are identified in the Threatened Biodiversity Data Collection as ecosystem credit species. Targeted survey is not required for these species.*
> ...
> *'Species credit species' are threatened species or components of species habitat that are identified in the Threatened Species Data Collection as requiring assessment for species credits.*

4.1 ECOSYSTEM CREDIT SPECIES - Habitat Suitability Assessment

In accordance with the BAM (OEH, 2017b), assessing the habitat suitability for an ecosystem credit species involves the following steps:

Step 1: Identify threatened species for assessment; and

Step 2: Assessment of the habitat constraints and vagrant species on the Subject land.

These steps are applied below.

4.1.1 Step 1: Identify Ecosystem Species for Assessment

Ecosystem credit species for assessment are listed in Table 3 from the BAM Credit Calculator (OEH, 2018a). Relevant databases and literature were reviewed for additional ecosystem credit species for assessment.

Of the species in Table 3, all have been recorded in the wider locality. Only three ecosystem credit species, the Speckled Warbler, Eastern Bentwing-bat and Eastern Freetail-bat have been recorded in the Modification footprint.

4.1.2 Step 2: Assessment of the Habitat Constraints and Vagrant Species on the Modification Land

The BAM (OEH, 2017b) states:

> *the assessor may opt to undertake an additional assessment of the habitat constraints on the Subject land for the threatened species predicted for assessment.*

The ecosystem credit species identified in the BAM Credit Calculator (OEH, 2018a) for the Rail Spur and Pipeline/ETL components of the Modification were not reviewed because the Vegetation Integrity Score was less than 17 for PCT's 1605 and 1714 and less than 15 for PCT 1693 (Table 2 above) and therefore a calculation of ecosystem credits is not required. No further assessment of ecosystem credit species is required for these components of the Modification.

The ecosystem credit species identified in the BAM Credit Calculator (OEH, 2018a) for the Rail Loop component of the Modification were reviewed because the Vegetation Integrity Score was (just) greater than 17 (17.8) thus requiring calculation of ecosystem credits.

Table 3 Ecosystem Credit Species Drawn from the BAM Credit Calculator and Assessment of Potential Occurrence

Scientific Name	Common Name	Conservation Status		Potential Occurrence as an Ecosystem Credit Species
		BC Act*	EPBC Act*	
Ecosystem Credit Species Requiring Further Consideration				
Birds				
Hieraaetus morphnoides	Little Eagle	V	-	**Possible itinerant.** Foraging over grassland.
Lophoictinia isura	Square-tailed Kite	V	-	**Possible itinerant.** Foraging over grassland.
Chthonicola sagittata	Speckled Warbler	V	-	**Present**.
Bats				
Miniopterus schreibersii oceanensis	Eastern Bentwing- bat	V	-	**Present**. Recorded at the rail loop and Overton Road.
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	**Present**
Pteropus poliocephalus	Grey-headed Flying- fox	V	V	**Possible**. May be an itinerant forager on blossom in the Narrow-leaved Ironbark paddock trees.
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	**Possible**. Will roost in buildings or hollow trees. Will forage over open grassland.
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	**Possible**
Nyctophilus sp.	None Recorded			**Present**
Ecosystem Credit Species Determined Unlikely to Occur				
Birds				
Anthochaera phrygia	Regent Honeyeater	CE	CE	**None.** No woodland habitat and recognised feed trees
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	**None.** No woodland habitat. There is no suitable foraging habitat for these birds in or near the Modification disturbance area.
Calyptorhynchus lathami	Glossy Black- Cockatoo	E	V	**None.** No woodland habitat. Inhabits open forest and woodlands where they feed on the fruit of *Casuarina* or *Allocasuarina* species.
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-	**None**. No woodland habitat
Daphoenositta chrysoptera	Varied Sittella	V	-	**None.** No woodland habitat.

Table 3 Ecosystem Credit Species Drawn from the BAM Credit Calculator and Assessment of Potential Occurrence (Continued)

Scientific Name	Common Name	Conservation Status		Potential Occurrence as an Ecosystem Credit Species
		BC Act*	EPBC Act*	
Dasyurus maculatus	Spotted-tailed Quoll	V	E	**None**. No woodland habitat.
Glossopsitta pusilla	Little Lorikeet	V	-	**None**. No woodland habitat.
Grantiella picta	Painted Honeyeater	V	V	**None**. No woodland habitat.
Haliaeetus leucogaster	White-bellied Sea- Eagle	V	-	**None**. No aquatic foraging habitat.
Lathamus discolor	Swift Parrot	E	CE	**None**. No suitable foraging habitat.
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	-	**None**. No suitable woodland habitat.
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-	**None**. No suitable habitat; occurs in woodland/forest using large patches.
Neophema pulchella	Turquoise Parrot	V	-	**None**. No woodland habitat.
Ninox connivens	Barking Owl	V	-	**None.** Limited to no prey resources. Better habitat elsewhere.
Ninox strenua	Powerful Owl	V	-	**None.** Limited to no prey resources. Better habitat elsewhere.
Petroica boodang	Scarlet Robin	V	-	**None**. No suitable woodland habitat.
Petroica phoenicea	Flame Robin	V	-	**None**. No suitable woodland habitat.
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-	**None**. No woodland habitat.
Tyto novaehollandiae	Masked Owl	V	E	**None.** Limited to no prey resources. Better habitat elsewhere.
Flora				
Pomaderris queenslandica	Scant Pomaderris	E	-	**None**. No suitable moist forest habitat.
Endangered Populations				
Acacia pendula - endangered population	*Acacia pendula* population in the Hunter catchment	E	-	**None**. No *Acacia pendula* present.
Cymbidium canaliculatum - endangered population	*Cymbidium canaliculatum* population in the Hunter Catchment	E	-	**None.** No *Cymbidium canaliculatum* present.

* Current as at December 2017.

4.2 SPECIES CREDIT SPECIES - Habitat Suitability Assessment

Assessing the habitat suitability for a species credit species involves the following steps:

Step 1: Identify species credit species for assessment.
Step 2: Assessment of the habitat constraints for species credit species on the Subject land.
Step 3: Identify candidate species credit species for further assessment.
Step 4: Determine presence or absence of a candidate species credit species.
Step 5: Determine the area or count, and location of suitable habitat for a species credit species.
Step 6: Determine the habitat condition within the species polygon for species assessed by area.

4.2.1 Step 1: Identify Species Credit Species for Assessment

The following databases and reports were reviewed for any nearby potentially occurring threatened species records (including species credit species):

- *BioNet Atlas* (OEH, 2017a);
- Birdlife Australia database search (Birdlife Australia, 2017);
- Atlas of Living Australia (2017);

Table 4 provides a summary of the threatened species records in the locality from survey records or database records. Threatened species records are shown on Figure 9.

Table 4 Species Credit Species from the BAM Calculator and Database Searches

Scientific Name	Common Name	Conservation Status		Credit Type
		BC Act*	EPBC Act*	
Birds				
Anthochaera phrygia	Regent Honeyeater[#]	CE	CE	Ecosystem/Species credit (dependent on mapped breeding habitat)
Burhinus grallarius	Bush Stone-curlew	E	-	Species credit
Callocephalon fimbriatum	Gang-gang Cockatoo[#]	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)
Calyptorhynchus lathami	Glossy Black- Cockatoo[#]	E	V	Ecosystem/Species credit (dependent on the presence of breeding habitat)
Haliaeetus leucogaster	White-bellied Sea- Eagle[#]	V	-	Ecosystem/Species credit (dependent on the presence of breeding and foraging habitat)
Hieraaetus morphnoides	Little Eagle[#]	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)
Lathamus discolor	Swift Parrot[#]	E	CE	Ecosystem/Species credit (dependent on the presence of breeding habitat)
Lophoictinia isura	Square-tailed Kite[#]	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)
Ninox connivens	Barking Owl[#]	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)
Ninox strenua	Powerful Owl[#]	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)

Table 4 Species Credit Species from the BAM Calculator and Database Searches (Continued)

Scientific Name	Common Name	Conservation Status		Credit Type
		BC Act*	EPBC Act*	
Tyto novaehollandiae	Masked Owl#	V	E	Ecosystem/Species credit (dependent on the presence of breeding habitat)
Marsupials				
Cercartetus nanus	Eastern Pygmy Possum	V	-	Species credit
Petrogale penicillata	Brush-tailed Rock-wallaby			Species credit
Phascogale tapoatafa	Brush-tailed Phascogale	V	V	Species credit
Planigale maculata	Common Planigale	V	-	Species credit
Bats				
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Species credit
Miniopterus schreibersii oceanensis	Eastern Bentwing- bat#	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)
Myotis macropus	Southern Myotis	V	-	Species credit
Pteropus poliocephalus	Grey-headed Flying- fox#	V	V	Ecosystem/Species credit (dependent on the presence of breeding habitat)
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	Ecosystem credit
Vespadelus troughtoni	Eastern Cave Bat	V	-	Species credit
Reptiles				
Hoplocephalus bitorquatus	Pale-headed Snake	V	-	Species credit
Amphibians				
Litoria aurea	Green and Golden Bell Frog	E	V	Species credit
Litoria brevipalmata	Green-thighed Frog	V	-	Species credit
Flora				
Pomaderris queenslandica	Scant Pomaderris	E	-	Species credit
Monotaxis macrophylla	Large-leaved Monotaxis	E	-	Species credit
Endangered Populations				
Acacia pendula - endangered population	Acacia pendula population in the Hunter catchment	CE	CE	Species credit
Cymbidium canaliculatum - endangered population	*Cymbidium canaliculatum* population in the Hunter Catchment	E	-	Species credit

* Current as at December 2017.

\# Species were determined to be ecosystem credit species due to the lack of suitable breeding and or foraging habitat within the Disturbance area. Therefore these species are not considered further in species credit assessment.

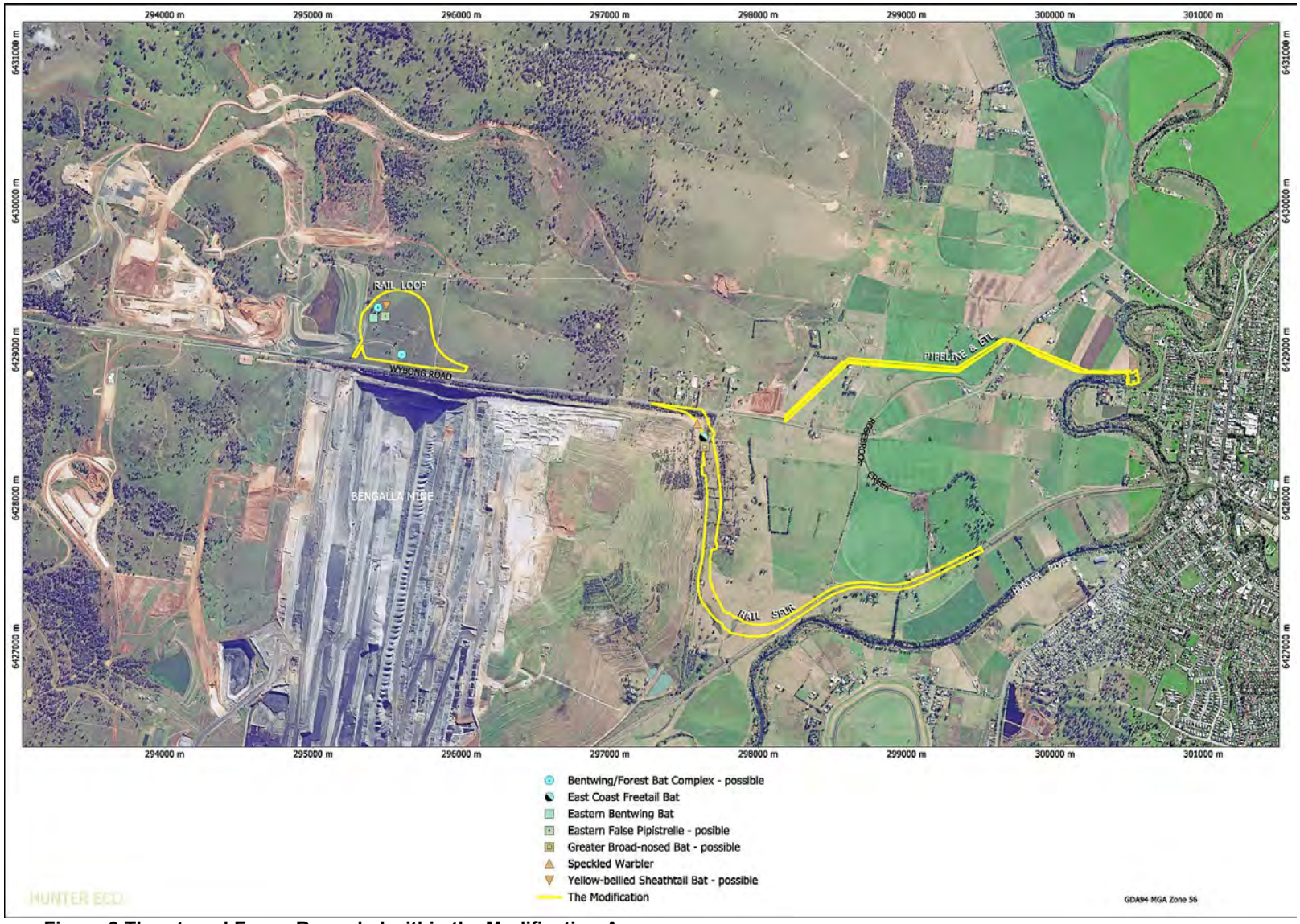

Figure 9 Threatened Fauna Recorded within the Modification Area

4.2.2 Step 2: Assessment of the Habitat Constraints for Species Credit Species on the Modification Land

Habitat constraints are identified in the *Threatened Biodiversity Data Collection* (OEH, 2017f) for some fauna species credit species and the absence of the habitat constraints precludes the species from further assessment (Table 5). Step 2 is not applicable to a species where no habitat constraints are listed for that species in the *Threatened Biodiversity Data Collection* (OEH, 2017f), e.g. threatened flora.

ELA (2017) (Appendix 4 of Attachment A) undertook a field assessment of habitat constraints for the species in Table 4. An assessment of habitat constraints for relevant species is provided in Table 5.

Table 5 Assessment of Species Credit Species Habitat Constraints

Scientific Name	Common Name	Habitat Constraints	Habitat Present
Litoria aurea	Green and Golden Bell Frog	Within 1km of wet areas, swamps or waterbodies	No
Burhinus grallarius	Bush Stone-curlew	Fallen/standing dead timber including logs	No
Chalinolobus dwyeri	Large-eared Pied Bat	Cliffs; Within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, or crevices, or within two kilometres of old mines or tunnels.	No
Cymbidium canaliculatum - endangered population	*Cymbidium canaliculatum* population in the Hunter Catchment	Must be within Hunter catchment as defined by Australia's River Basins (Geoscience Australia, 1997))	Yes
Myotis macropus	Southern Myotis	Hollow bearing trees; Within 200 m of riparian zone; Bridges, caves or artificial structures within 200 m of riparian zone	No
Vespadelus troughtoni	Eastern Cave Bat	Within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, crevices or boulder piles, or within two kilometres of old mines, tunnels, old buildings or sheds.	No
Petrogale penicillata	Brush-tailed Rock-wallaby	Land within 1 km of rocky escarpments, gorges, steep slopes, boulder piles, rock outcrops or clifflines	No
Phascogale tapoatafa	Brush-tailed Phascogale	Hollow bearing trees	Yes

4.2.3 Step 3: Identify Candidate Species Credit Species for Further Assessment

After considering the habitat constraints (Step 2), candidate species credit species for further assessment are listed in Table 6.

No species listed in Table 6 are Serious and Irreversible Impact (SAII) Entities as none have a Biodiversity Risk Rating of 'very high'.

Table 6 Candidate Species Credit Species for Further Assessment

Scientific Name	Common Name	Conservation Status	
		BC Act	EPBC Act
Marsupials			
Cercartetus nanus	Eastern Pygmy-possum	V	-
Phascogale tapoatafa	Brush-tailed Phascogale	V	V
Planigale maculata	Common Planigale	V	-
Bats			
Chalinolobus dwyeri	Large-eared Pied Bat	V	V
Reptiles			
Hoplocephalus bitorquatus	Pale-headed Snake	V	-
Amphibians			
Litoria brevipalmata	Green-thighed Frog	V	-
Flora			
Pomaderris queenslandica	Scant Pomaderris	E	-
Monotaxis macrophylla	Large-leafed Monotaxis	E	-
Endangered Populations			
Acacia pendula - endangered population	Acacia pendula population in the Hunter catchment	CE	CE
Cymbidium canaliculatum - endangered population	Cymbidium canaliculatum population in the Hunter Catchment	E	-

4.2.4 Step 4: Determine Presence or Absence of a Candidate Species Credit Species

ELA (2017) (Appendix 4 of Attachment A) undertook targeted surveys for candidate species credit species (Table 6) to determine presence or absence of the species within the survey period required by the BAM Credit Calculator (OEH, 2018a). The timing, methods and effort are detailed in Appendix 4 of Attachment A.

Threatened Flora

Targeted searches for threatened flora species were undertaken by Hunter Eco (2017) (Appendix 1 of Attachment A) in accordance with the NSW *Guide to Surveying Threatened Plants* (OEH, 2016) in areas of potential habitat. Surveys for threatened flora species were undertaken on 4th and 5th October 2016 (ELA 2016) specifically targeting the threatened orchids *Diuris tricolor* and *Prasophyllum petilum*. While these orchids were confirmed to be flowering in the immediate region none were recorded during this survey.
Monotaxis macrophylla. No suitable habitat for this species as it grows on rocky ridges and hillsides. It is also a fire ephemeral species present for a short time following fire.
Pomaderris queenslandica. No suitable habitat. Found in moist shrubby woodland commonly along ephemeral drainage lines.

No threatened flora species were recorded by Hunter Eco (2017) (Appendix 1 of Attachment A) in the Development Site Footprint.

Koala (Breeding Habitat)

The NSW *Recovery Plan for the Koala* (DECC, 2008) notes that Muswellbrook lies within the Central Coast Management Unit. None of the tree species in or near the Modification were listed as primary, secondary or supplementary feed tree species within this Unit, thus making it unlikely that Koala would use any of the Modification habitats. Nevertheless ELA (2017) (Appendix 4 of Attachment A) included Koala in their fauna field surveys, none of which were recorded.

4.2.5 Step 5: Determine the Area or Count, and Location of Suitable Habitat for a Species Credit Species

Field surveys by ELA (2017) (Appendix 4 of Attachment A), Hunter Eco (2017) and assessment of potentially suitable habitat (Table 7) found that the Modification did not support any potentially suitable habitat for species credit species.

4.2.6 Step 6: Determine the Habitat Condition within the Species Polygon for Species Assessed by Area

Step 6 was not required as the Modification did not support any potentially suitable habitat for species credit species.

4.3 Local Data

It was not necessary use local data to deviate from the OEH databases (OEH, 2017a and OEH, 2017c).

4.4 Expert Reports

No expert reports were required because there were no candidate species credits species that were not surveyed for by ELA (2017) (Appendix 4 of Attachment A) or Hunter Eco (2017).

Table 7 Species Credit Species Drawn from the BAM Credit Calculator and Assessment of Potential Occurrence

Scientific Name	Common Name	Conservation Status		Credit Type	Potential Occurrence as a Species Credit Species
		BC Act	EPBC Act		
Species Credit Species Determined Unlikely to Occur					
Birds					
Burhinus grallarius	Bush Stone-curlew	E	-	Species credit	**None**. Inhabit open forest/woodland having fallen timber and sparse grassy ground layer. The project disturbance area has no suitable habitat for these birds.
Marsupials					
Cercartetus nanus	Eastern Pygmy-possum	V	-	Species credit	**None**. Requires woodland/forest with shrubby understorey. No such habitat was present in or near the project disturbance area.
Planigale maculata	Common Planigale	V	-	Species credit	**Unlikely**. Use a variety of habitats with surface cover, usually close to water.
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	Species credit	**None**. Inhabits rocky escarpments none of which were present
Phascogale tapoatafa	Brush-tailed Phascogale	V	V	Species credit	**Unlikely**. Inhabit dry open sclerophyll forest with a sparse ground cover. No such habitat was present in or near the project disturbance area.
Bats					
Myotis macropus	Southern Myotis	V	-	Species credit	. **Unlikely.** No roosting habitat in the Rail Loop trees as they are >200 m (actually >4 km) from a riparian zone (Hunter River). **Unlikely**. Foraging over the Hunter River which is outside the Modification area
Vespadelus troughtoni	Eastern Cave Bat	V	-	Species credit	**None**. Breeding habitat only. Generally breeds in caves, none of which are in the Modification area.
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Species credit	**Unlikely**. Uses well-timbered areas containing gullies and breeds in sandstone caves and overhangs. No such habitat was present in or near the project disturbance area.

Table 7 Species Credit Species Drawn from the BAM Credit Calculator and Assessment of Potential Occurrence (Continued)

Scientific Name	Common Name	Conservation Status		Credit Type	Potential Occurrence as a Species Credit Species
		BC Act	EPBC Act		
Reptiles					
Litoria aurea	Green and Golden Bell Frog	E	V	Species credit	**None**. No suitable wetland or dam habitat.
Litoria brevipalmata	Green-thighed Frog	V		Species credit	**None**. No suitable forest habitat.
Hoplocephalus bitorquatus	Pale-headed Snake	V	-	Species credit	**Unlikely**. Inhabits dry or moist forest/woodland and in dry areas usually near water. No suitable habitat present in or near the project disturbance area.
Flora					
Pomaderris queenslandica	Scant Pomaderris	E	-	Species credit	**None**. No suitable woodland/forest habitat.
Monotaxis macrophylla	Large-leafed Monotaxis	E	-	Species credit	**None**. No suitable forest habitat.
Endangered Populations					
Acacia pendula - endangered population	Acacia pendula population in the Hunter catchment	CE	CE	Species credit	**None**. No *Acacia pendula* present.
Cymbidium canaliculatum - endangered population	*Cymbidium canaliculatum* population in the Hunter Catchment	E	-	Species credit	**None**. No *Cymbidium canaliculatum* present.
Species / Ecosystem Credit Species Considered in Table 4					
Anthochaera phrygia	Regent Honeyeater	CE	CE	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**None**. The project locality is not located in or near a known breeding area for these birds. Known key breeding areas are Capertee Valley, Bundarra-Barraba. Given the lack of breeding habitat, this species is assessed as an ecosystem credit in Table 3.
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**None**. Requires old growth forest and woodland for breeding. There is no suitable habitat for these birds in or near the project disturbance area. Given the lack of breeding habitat, this species is assessed as an ecosystem credit in Table 3.

Table 7 Species Credit Species Drawn from the BAM Credit Calculator and Assessment of Potential Occurrence (Continued)

Scientific Name	Common Name	Conservation Status		Credit Type	Potential Occurrence as a Species Credit Species
		BC Act	EPBC Act		
Calyptorhynchus lathami	Glossy Black-Cockatoo	E	V	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**None**. Inhabits open forest and woodlands where they feed on the fruit of *Casuarina* or *Allocasuarina* species. Nest in large hollow-bearing eucalypts. Given the lack of breeding habitat, this species is assessed as an ecosystem credit in Table 3.
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**None**. Nest in large emergent eucalypts in woodland or forest. Nests are generally re-used annually and are large and obvious. There were no nests in or near the project area and no suitable woodland/forest habitat. Given the lack of breeding habitat, this species is assessed as an ecosystem credit in Table 3.
Hieraaetus morphnoides	Little Eagle	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**None**. Nests in tall living trees in a remnant woodland patch. There was no remnant patch woodland and no nests in the remnant trees within the rail loop. Given the lack of breeding habitat, this species is assessed as an ecosystem credit in Table 3.
Lathamus discolor	Swift Parrot	E	CE	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**None**. The species breeds in Tasmania. Given the lack of breeding habitat, this species is assessed as an ecosystem credit in Table 3.
Lophoictinia isura	Square-tailed Kite	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**None**. Nest in trees near or along watercourses such as the Hunter River. Given the lack of breeding habitat, this species is assessed as an ecosystem credit in Table 3.
Ninox connivens	Barking Owl	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**None**. Nest in hollows of large old trees. No suitable nest trees were present in or near the project disturbance area. Given the lack of breeding habitat, this species is assessed as an ecosystem credit in Table 3.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**Unlikely**. Potential roosting and breeding habitat in the tall trees at the Hunter River pump station site. These trees will be retained. This species is assessed as an ecosystem credit species in Table 3.
Miniopterus schreibersii oceanensis	Eastern Bent wing-bat	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**None**. Breeds in maternity caves selected for specific temperature and humidity attributes. Given the lack of breeding habitat, this species is assessed as an ecosystem credit in Table 3.

Table 7 Species Credit Species Drawn from the BAM Credit Calculator and Assessment of Potential Occurrence (Continued)

Scientific Name	Common Name	Conservation Status		Credit Type	Potential Occurrence as a Species Credit Species
		BC Act	EPBC Act		
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**None**. Will roost in buildings or hollow trees. Given the lack of breeding habitat, this species is assessed as an ecosystem credit in Table 3.
Ninox strenua	Powerful Owl	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**None**. Nest in hollows of large old trees. No suitable nest trees were present in or near the project disturbance area. Given the lack of breeding habitat, this species is assessed as an ecosystem credit in Table 3.
Tyto novaehollandiae	Masked Owl	V	E	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**None**. Nest in hollows of large old trees. No suitable nest trees were present in or near the project disturbance area. Given the lack of breeding habitat, this species is assessed as an ecosystem credit in Table 3.

5 AVOID AND MINIMISE IMPACTS

5.1 Measures to Avoid and Minimise Impacts

Additional mitigation to be implemented as part of the Modification includes:

- Avoidance of mature River Oak and exotic Weeping Willow and Poplar trees in the vicinity of the proposed pump station;
- Orientating the pump station intake on the Hunter River perpendicular to stream flow so that most fish would be swept across the screen and downstream;
- Operating pump station high velocity pumps so as to ramp water velocity up and down gradually; and
- Minimising the area of native vegetation cleared for construction of the rail where practical.

5.2 Direct Impacts on Native Vegetation and Habitat

5.2.1 Clearance of Habitat and Vegetation

After applying the measures to avoid and/or minimise impacts on biodiversity values (Section 5.1), the Modification would result in the clearance of approximately 21 ha of previously cleared grazing land and 3 ha of planted trees.

No threatened ecological communities listed under the BC Act or EPBC Act would be cleared for the Modification.

5.3 Indirect Impacts on Native Vegetation and Habitat

The Modification is surrounded by active approved mining areas in the case of the rail loop or extensive areas of non-native vegetation in the case of the Rail Spur and Pipeline/ETL. There would be no:

- Inadvertent Impacts on Adjacent Habitat or Vegetation;
- Impacts on Adjacent Habitat or Vegetation from a Change in Land-Use Pattern (Increased Human Activity);
- Reduced Viability of Adjacent Habitat Due to Edge Effects;
- Reduced Viability of Adjacent Habitat Due to Noise, Dust or Light Spill;
- Transport of Weeds and Pathogens from the Site to Adjacent Vegetation;
- Increased Risk of Fauna Starvation, Exposure and Loss of Shade or Shelter;
- Loss of Breeding Habitats;
- Trampling of Threatened Flora Species;
- Inhibition of Nitrogen Fixation and Increased Soil Salinity;
- Fertiliser Drift;
- Rubbish Dumping;
- Wood Collection;
- Bush Rock Removal and Disturbance;
- Increase in Predatory Species Populations;
- Increase in Pest Animal Populations;
- Increased Risk of Fire; or
- Disturbance to Specialist Breeding and Foraging Habitat.

5.4 Prescribed Biodiversity Impacts

The NSW *Biodiversity Conservation Regulation, 2017* identifies actions that are prescribed as impacts to be assessed under the biodiversity offsets scheme. Prescribed Biodiversity Impacts are as follows:

> *(a) the impacts of development on the following habitat of threatened species or ecological communities:*
> *(i) karst, caves, crevices, cliffs and other geological features of significance,*
> *(ii) rocks,*

(iii) human made structures,
(iv) non-native vegetation,

(b) the impacts of development on the connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range,

(c) the impacts of development on movement of threatened species that maintains their lifecycle,

(d) the impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities (including from subsidence or upsidence resulting from underground mining or other development),

(e) the impacts of wind turbine strikes on protected animals,

(f) the impacts of vehicle strikes on threatened species of animals or on animals that are part of a threatened ecological community.

These impacts are assessed below in relation to the Modification.

(a) the impacts of development on the following habitat of threatened species or ecological communities:
(i) karst, caves, crevices, cliffs and other geological features of significance,
(ii) rocks,
(iii) human made structures,
(iv) non-native vegetation,

The Modification is unlikely to result in this Prescribed Biodiversity Impact because:

- there are no karst, caves, crevices, cliffs or other areas of geological significance on the Modification land or within the assessment area surrounding the Modification (Section 2.6);
- there are no threatened species which are likely to be associated with any rocks that occur on the Modification land;
- no human made structures that provide habitat for threatened species would be adversely impacted by the Modification; however
- there are areas of non-native vegetation in the form of a visual screen on Bengalla land at the corner of Wybong and Overton Roads, and at the pump site on the Hunter River banks. Field surveys found no threatened flora in these areas (Hunter Eco 2017) (Appendix 1 of Attachment A) while the threatened Speckled Warbler was recorded in the Bengalla planted vegetation (ELA 2017) (Appendix 4 of Attachment A). Approximately one hectare of this habitat would be lost to the Modification leaving 9 ha of continuous planted strip as habitat for these Speckled Warblers as well as adjacent developing rehabilitation in the larger overburden area.

(b) the impacts of development on the connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range

The Rail Spur and Pipeline/ETL lie in non-native agricultural vegetation (see Figure 4). The Rail Loop is located at the southern edge of remnant native vegetation land-locked by Bengalla Mine to the south and Mt Pleasant Mine to the west and east. This arrangement essentially limits movement to aerial species which the Modification would not impact.

(c) the impacts of development on movement of threatened species that maintains their lifecycle

The Modification would not impact on the movement of threatened species that maintains their lifecycle for the reasons described in (b) above.

(d) the impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities (including from subsidence or upsidence resulting from underground mining or other development)

The Modification would not result in this Prescribed Biodiversity Impact because the Modification would not impact water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities.

(e) the impacts of wind turbine strikes on protected animals

The Modification would not result in this Prescribed Biodiversity Impact because the Modification does not include the use of wind turbines.

(f) the impacts of vehicle strikes on threatened species of animals or on animals that are part of a threatened ecological community

The Modification would not increase the risk of vehicle strike as:

- It would not involve any change to the operational workforce of the approved Mount Pleasant Operation.
- It would not involve any material change to Mount Pleasant Operation approved road transport movements during operations.
- Cumulative traffic generation associated with the Modification and operational activities in 2020/2021 would remain below the operational peak traffic generation that would occur later in the life of the operation.

5.5 Impacts on Commonwealth Threatened Species and Communities

The Modification is unlikely to impact (or significantly impact) any threatened species or communities listed under the EPBC Act as none have been confirmed to occur near the Development Site Footprint A review of threatened species or communities listed under the EPBC Act is provided in Attachment A.

5.6 Impacts on Threatened Species and Communities under the NSW Fisheries Management Act, 1994

No permanently flowing waterways are present within the area to be disturbed by the Modification and the drainage lines are extremely degraded (Bio-Analysis, 2017). Riparian and instream habitats within the area to be disturbed by the Modification are substantially altered by historical and agricultural land use practices (Bio-Analysis, 2017). Surface water in the vicinity of the Modification has moderate to high electrical conductivity, reflecting high salinity in soils and groundwater and the anthropogenic effects of numerous land use practices within the region (Bio-Analysis, 2017).

Measures to Mitigate and Manage Impacts
Measures have been developed as part of the Modification to minimise impacts on threatened aquatic fauna present in the Hunter River and potentially impacted by the proposed pump station. These include:

- Orientating the pump station intake on the Hunter River perpendicular to stream flow so that most fish would be swept across the screen and downstream.
- Operating pump station high velocity pumps so as to ramp water velocity up and down gradually.

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 *Fisheries Management Act, 1994* are predicted to occur in the Hunter River drainage system (Bio-Analysis, 2017).

Bio-Analysis (2017) undertook tests of significance in accordance with the *Fisheries Management Act, 1994* for these species and concluded:

> *"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".*

6 IMPACT SUMMARY

6.1 Serious and Irreversible Impacts

PCT1693 *Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains* identified as previously occurring on the Hunter floodplain area, across which part of the Rail Spur and all of the Pipeline/ETL are located, is a listed Serious and Irreversible Impact (SAII). However the degraded habitat resulted in the BAM Calculator arriving at a VI score of just 0.2 meaning that no further assessment of this habitat was required.

6.2 Impacts on Native Vegetation (Ecosystem Credits)

The BAM (OEH, 2017b) states:

> *The assessor is required to determine an offset for all impacts of development or impacts from the conferral of biodiversity certification on PCTs that are associated with:*
>
> *(b) a vegetation zone that has a vegetation integrity score of ≥ 17 where the PCT is associated with threatened species habitat (as represented by ecosystem credits), or is representative of a vulnerable ecological community*

As described in Section 3.3.3, according to the BAM Credit Calculator (OEH, 2018a) the only ecosystem credits required for the Modification were for the Rail Loop habitat with 141 credits required for PCT1605 *Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter* derived native grassland with a VI score of 17.8 (Table 8).

Table 8 Ecosystem Credits Required for the Rail Loop

Vegetation Community	PCT	Condition	Clearance Area (ha)	Ecosystem Credits
Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	1605	Low	21.0	141

6.3 Impacts on Threatened Species (Species Credits)

No species credits were generated by the BAM Credit Calculator for the Modification.

7 CONCLUSION

The Modification Disturbance Area is highly modified with little to no resemblance to its pre-clearing natural communities having been cleared and grazed or cultivated for well over 50 years. Remaining vegetation is in very poor condition and provides limited habitat for threatened species. No threatened ecological communities or populations occur. The Modification includes the relinquishment of approval to clear a portion of the South West Out of Pit Emplacement, which provides higher quality vegetation and habitat compared to the Modification area (Hunter Eco, 2018).

Accounting for the values of the areas potentially available for relinquishment, the Modification would result in a net benefit to terrestrial ecology.

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ATTACHMENT A MOUNT PLEASANT OPERATION RAIL MODIFICATION TERRESTRIAL ECOLOGY ASSESSMENT

Refer to Appendix G of the *Mount Pleasant Operation – Rail Modification Environmental Assessment* (MACH Energy, 2017)

ATTACHMENT B CREDIT REPORT FOR THE RAIL LOOP

BAM Credit Summary Report

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00009251/BAAS17004/18/00009788	Mt Pleasant MOD4 Rail Loop	24/02/2018
Assessor Name	Report Created	BAM Data version *
Colin Driscoll	30/04/2018	3
Assessor Number	* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.	
BAAS17004		

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

Zone	Vegetation zone name	Vegetation integrity loss / gain	Area (ha)	Constant	Species sensitivity to gain class (for BRW)	Biodiversity risk weighting	Candidate SAII	Ecosystem credits
Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter								
1	1605_Low	17.8	21.0	0.25	High Sensitivity to Potential Gain	1.50		141
							Subtotal	**141**
							Total	**141**

BAM Credit Summary Report

Species credits for threatened species

Vegetation zone name	Habitat condition (HC)	Area (ha) / individual (HL)	Constant	Biodiversity risk weighting	Candidate SAII	Species credits

ATTACHMENT C CREDIT REPORT FOR THE RAIL SPUR AND PIPELINE/ETL

BAM Credit Summary Report

Proposal Details

Assessment Id

00009251/BAAS17004/18/00009330

Proposal Name

Mt Pleasant MOD4 Rail Spur and Pipeline

BAM data last updated *

24/02/2018

Assessor Name

Colin Driscoll

Report Created

30/04/2018

BAM Data version *

3

Assessor Number

BAAS17004

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

Zone	Vegetation zone name	Vegetation integrity loss / gain	Area (ha)	Constant	Species sensitivity to gain class (for BRW)	Biodiversity risk weighting	Candidate SAII	Ecosystem credits
Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter								
1	1605_Derived_native_grass	2.2	9.8	0.25	High Sensitivity to Potential Gain	1.50		0
2	1605_Low	15.7	3.3	0.25	High Sensitivity to Potential Gain	1.50		0
							Subtotal	**0**

BAM Credit Summary Report

River Oak - White Cedar Grassy Riparian Forest of the Dungog Area and Liverpool Ranges								
4	1714_Low	3.9	0.6	0.25	High Sensitivity to Potential Gain	1.75		0
							Subtotal	**0**
Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains								
3	1693_Derived_native_grass	0.2	6.0	0.25	High Sensitivity to Potential Gain	2.00	TRUE	0
							Subtotal	**0**
							Total	**0**

Species credits for threatened species

Vegetation zone name	Habitat condition (HC)	Area (ha) / individual (HL)	Constant	Biodiversity risk weighting	Candidate SAII	Species credits

MACHEnergy

Attachment 5

Relinquishment Area – Biodiversity Development Assessment Report

MACH ENERGY

MOUNT PLEASANT OPERATION

RAIL MODIFICATION

SOUTH EASTERN RELINQUISHMENT AREA

BIODIVERSITY DEVELOPMENT ASSESSMENT REPORT

PREPARED BY
HUNTER ECO

Dr Colin Driscoll
Assessor BAAS17004

May 2018

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

MACH Energy Australia Pty Ltd (MACH Energy) acquired the Mount Pleasant Operation (MPO) from Coal and Allied Operations Pty Ltd (Coal & Allied) on 4 August 2016. MACH Energy commenced construction activities at the MPO in November 2016, in accordance with Development Consent DA 92/97 and EPBC 2011/5795.

The approved MPO includes the construction and operation of an open cut coal mine and associated rail spur and product coal loading infrastructure. The mine is approved to produce up to 10.5 million tonnes per annum of run-of-mine coal. Up to approximately nine trains per day of thermal coal product from the MPO will be transported by rail to the port of Newcastle for export or to domestic customers for use in electricity generation.

MACH Energy is seeking a modification to the approved MPO under section 75W of the New South Wales (NSW) *Environmental Planning and Assessment Act 1979.* The MPO Development Consent DA 92/97 was granted on 22 December 1999. The MPO was also approved under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* in 2012 (EPBC 2011/5795).

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 Modification to obtain approval for future rail and/or conveyor product transport facilities to manage this future interaction.

The Modification would primarily comprise:

- duplication of the approved rail spur, rail loop, conveyor and rail load-out facility and associated services;
- duplication of the Hunter River water supply pump station, water pipeline and associated electricity supply that currently follows the rail spur alignment; and
- demolition and removal of the redundant approved infrastructure within the extent of the Bengalla Mine, once the new rail, product loading and water supply infrastructure has been commissioned and is fully operational.

Components of the Modification traverse existing approved disturbance areas (i.e. within the approved extent of the MPO[1]). These areas are excluded from the additional disturbance areas assessed as part of this assessment.

As part of the Modification, MACH Energy is relinquishing its approval in relation to a portion of the South West Out of Pit Emplacement footprint to restrict the area used for major infrastructure. The biodiversity values of land potentially available for relinquishment are detailed in this Biodiversity Development Assessment Report.

The Subject Land consists of a mosaic of forest, woodland and native grassland. It is sloping land with incised ephemeral drainage lines. There is a Spotted Gum (*Corymbia maculata*) forest in the northern quarter with the remainder being open grassland with scattered paddock trees or groups of trees, predominantly White Box (*Eucalyptus albens*) and Narrow-leaved Ironbark (*Eucalyptus crebra*).

[1] As permitted by Development Consent DA 92/97, including areas nominally depicted in Appendix 1 of DA 92/97 and/or the approved Mining Operations Plan.

Three PCT were identified, two of which were present as both woodland and derived native grassland (DNG): PCT483 *Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley*; PCT1602 *Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter*; and PCT1605 *Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter*.
Of these the following threatened ecological communities were represented:

- PCT483 Listed BC Act, Endangered *White Box Yellow Box Blakely's Red Gum Woodland*; Listed EPBC Act, Critically Endangered *White Box Yellow Box Blakely's Red Gum Woodland*; both in woodland and derived native grassland forms;
- PCT1602 Listed EPBC Act, Critically Endangered *Central Hunter Valley Eucalypt Forest and Woodland*; and
- PCT1605 Listed EPBC Act, Critically Endangered *Central Hunter Valley Eucalypt Forest and Woodland*; woodland form only.

Use of the Biodiversity Assessment Method credit calculator (BAMC) confirmed the condition of the Relinquishment Area as shown in Table ES-1.

Table ES-1 Vegetation Integrity

Plant Community Type and Condition	Vegetation Integrity Score	Vegetation Integrity Score threshold	Ecosystem credits required
483 moderate	32.7	<15	Yes
483 DNG	21.2	<15	Yes
1602 moderate	43.8	<17	Yes
1605 moderate	19.1	<17	Yes
1605 DNG	19.7	<17	Yes

Ecosystem credits required are shown in Table ES-2.

Table ES-2 Ecosystem Credits

Code	Vegetation Community	PCT	Condition	Clearance Area (hectare [ha])	Ecosystem Credits
3b	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	483	DNG	18.0	191
3a	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	483	Moderate	3.0	49
					240
1a	Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	1605	Moderate	2.0	14
1b	Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	1605	DNG	5.0	37
					51
2a	Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter	1602	Good	4.0	79
					79
				Total	**370**

Species credits required are shown in Table ES-3.

Table ES-3 Species Credits

Species and Vegetation zone	Habitat condition	Area (ha)	Species credits
***Burhinus grallarius* / Bush Stone-curlew**			
1602_Good	45.4	4	91
			91
***Haliaeetus leucogaster* / White-bellied Sea-Eagle**			
1602_Good	45.4	4	91
			91
***Hieraaetus morphnoides* / Little Eagle**			
1602_Good	45.4	4	68
483_Derived_native_grass	21.2	18	143
1605_Moderate	19.1	2	14
483_Moderate	32.7	3	37
1605_Derived_native_grass	19.7	5	37
			299
***Lophoictinia isura* / Square-tailed Kite**			
1602_Good	45.4	4	68
483_Derived_native_grass	21.2	18	143
1605_Moderate	19.1	2	14
483_Moderate	32.7	3	37
1605_Derived_native_grass	19.7	5	37
			299
***Petaurus norfolcensis* / Squirrel Glider**			
1602_Good	45.4	4	91
483_Moderate	32.7	3	49
			140
***Phascogale tapoatafa* / Brush-tailed Phascogale**			
1602_Good	45.4	4	91
483_Moderate	32.7	2	33
			124
		Total	**1044**

A separate Biodiversity Development Assessment Report has been prepared for the disturbance areas associated with the Modification.

Comparison between ecosystem credits generated in the BAM Calculator for the Relinquishment Area and the Modification shows that forfeiting development of the entire area available as a Relinquishment Area while developing the Modification will result in a net gain of 229 ecosystem credits.

Comparison between species credits generated in the BAM Calculator for the Relinquishment Area and the Modification shows that forfeiting development of the entire area available as a Relinquishment Area while developing the Modification will result in a net gain of 1044 species credits.

1 INTRODUCTION

MACH Energy Australia Pty Ltd (MACH Energy) acquired the Mount Pleasant Operation (MPO) from Coal and Allied Operations Pty Ltd (Coal & Allied) on 4 August 2016. MACH Energy commenced construction activities at the MPO in November 2016, in accordance with Development Consent DA 92/97 and EPBC 2011/5795.

The approved MPO includes the construction and operation of an open cut coal mine and associated rail spur and product coal loading infrastructure. The mine is approved to produce up to 10.5 million tonnes per annum of run-of-mine coal. Up to approximately nine trains per day of thermal coal product from the MPO will be transported by rail to the port of Newcastle for export or to domestic customers for use in electricity generation.

1.1 Project Overview

MACH Energy is seeking a modification to the approved MPO under section 75W of the New South Wales (NSW) *Environmental Planning and Assessment Act 1979.* The MPO Development Consent DA 92/97 was granted on 22 December 1999. The MPO was also approved under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* in 2012 (EPBC 2011/5795).

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 Modification to obtain approval for future rail and/or conveyor product transport facilities to manage this future interaction.

The Modification would primarily comprise:

- duplication of the approved rail spur, rail loop, conveyor and rail load-out facility and associated services;
- duplication of the Hunter River water supply pump station, water pipeline and associated electricity supply that currently follows the rail spur alignment; and
- demolition and removal of the redundant approved infrastructure within the extent of the Bengalla Mine, once the new rail, product loading and water supply infrastructure has been commissioned and is fully operational.

Figure 1 shows the regional location and Figure 2 shows the general arrangement.

The Modification would not alter the number of approved train movements on the rail network or operational workforce of the MPO.

1.2 Purpose of this Assessment

As part of the Modification, MACH Energy is considering relinquishing its approval in relation to a portion of 32 ha of vegetated habitat from the South West Out of Pit Emplacement footprint (Figure 2), thereby reducing the area approved for major infrastructure. This is a *Biodiversity Development Assessment Report* (BDAR) applying the NSW *Biodiversity Assessment Method Order 2017* (BAM) (Office of the Environment and Heritage [OEH], 2017a) to the land potentially available for relinquishment (the Subject Land and referred to as the "Relinquishment Area"). The purpose being to quantify the habitat values of the Subject Land for comparison against the values of the Modification lands, as presented in a separate BDAR (Hunter Eco, 2018).

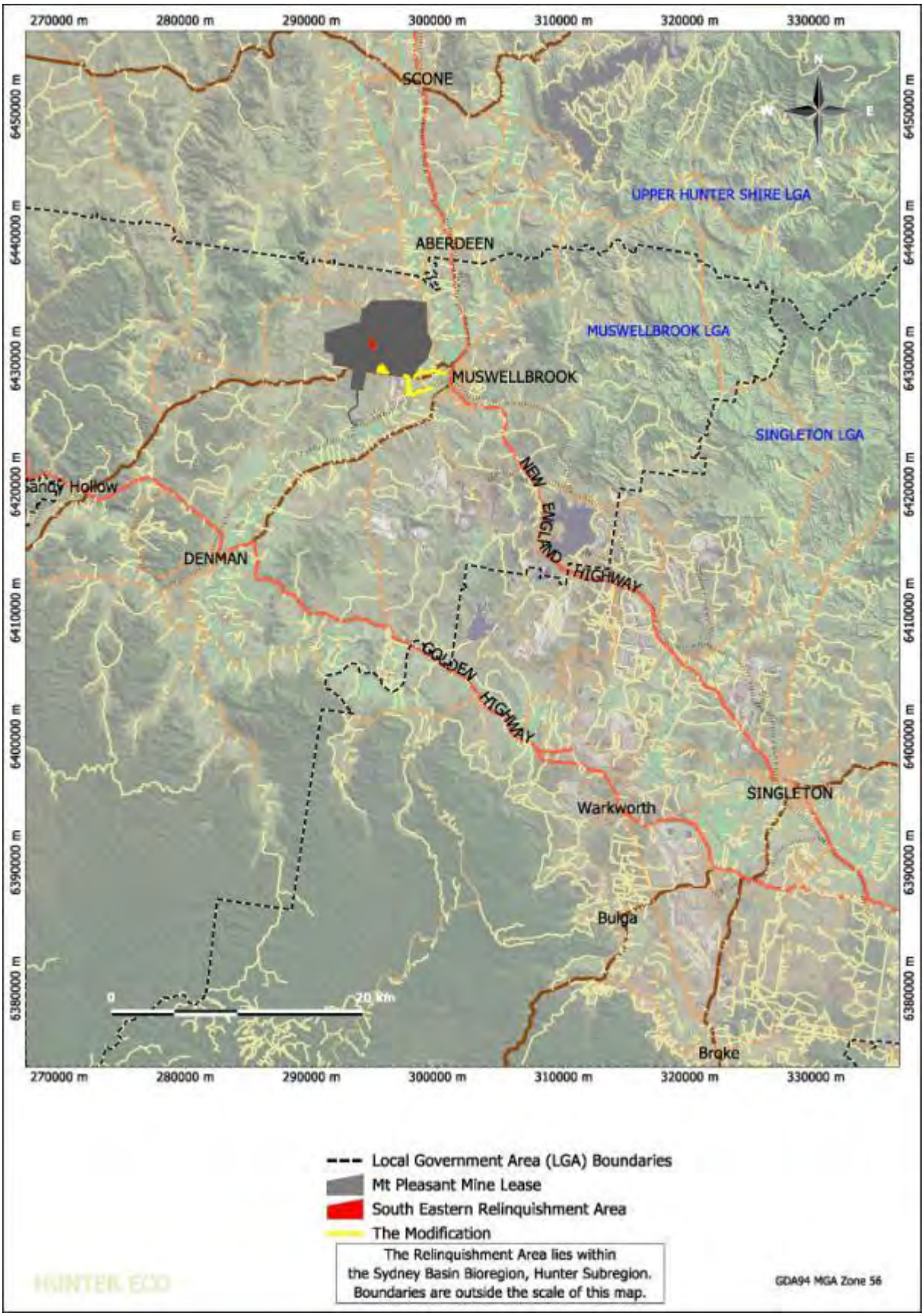


Figure 1 The Regional Location of the Mt Pleasant Mine, Relinquishment Area and Modification Area

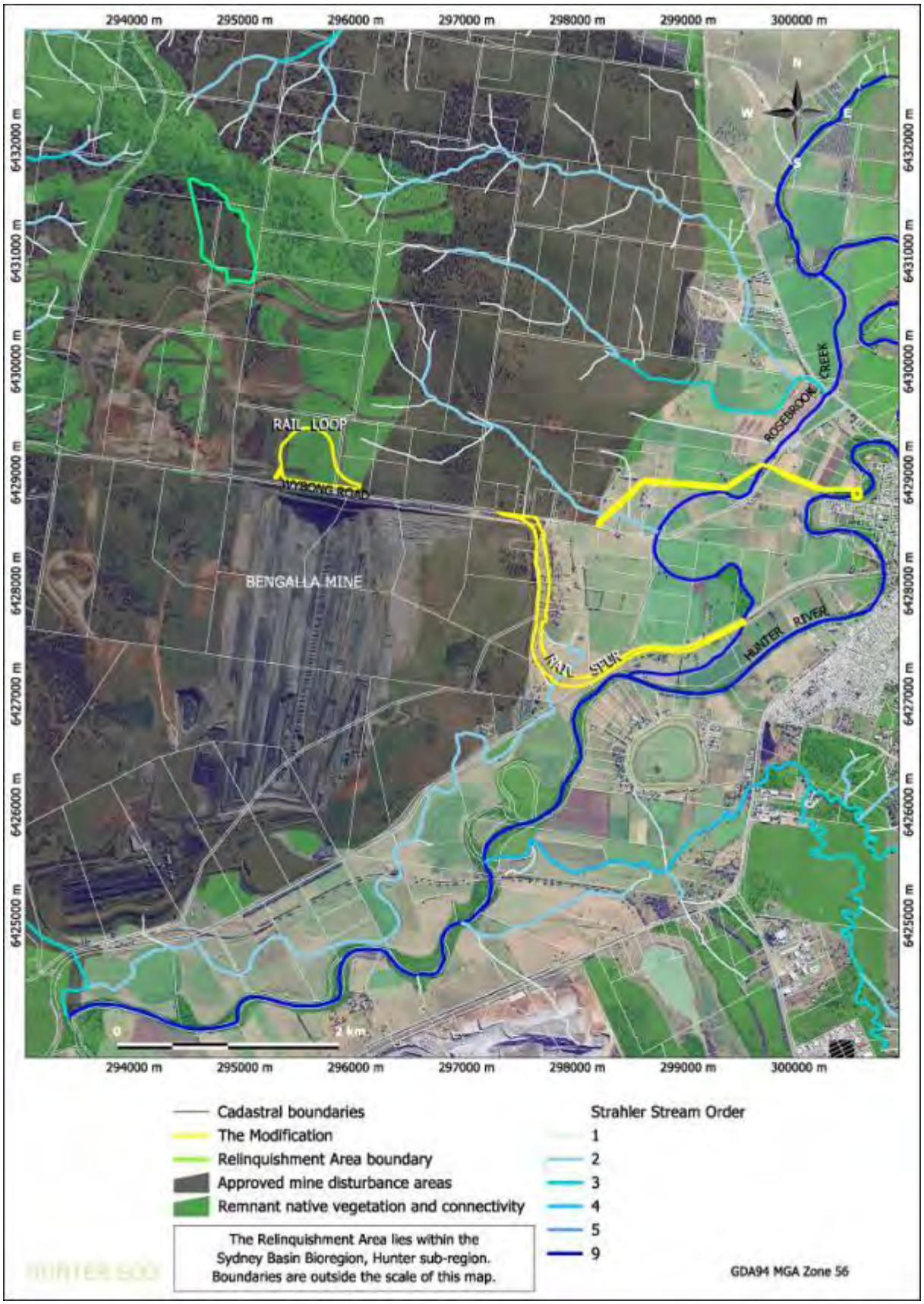


Figure 2 The Modification and Surrounding Native Vegetation, Connectivity and Stream Order

1.3 General Description of the Subject Land

The Subject Land consists of a mosaic of forest, woodland and native grassland. It is sloping land with incised ephemeral drainage lines. There is a Spotted Gum (*Corymbia maculata*) forest in the northern quarter with the remainder being open grassland with scattered paddock trees or groups of trees, predominantly White Box (*Eucalyptus albens*) and Narrow-leaved Ironbark (*Eucalyptus crebra*).

1.4 Assessment Requirements/Approach

The NSW *Biodiversity Conservation Act, 2016* (BC Act) commenced in August 2017 and establishes a new biodiversity offset scheme for NSW. The Subject Land has been assessed in accordance with the *Biodiversity Assessment Method Order, 2017* (OEH, 2017a) established under section 6.7 of the BC Act. For the purposes of this BDAR, the Subject Land is assessed as a State Significant Development.

This BDAR has been prepared by Dr Colin Driscoll (Hunter Eco), who is an accredited assessor (assessor accreditation number BAAS17004).

1.5 Structure of this Assessment

The structure of the BDAR follows the requirements in Appendix 10 of the BAM (OEH, 2017a).

1.6 Information Sources Used in this Assessment

This BDAR has been prepared using various data sources as described below.

1.6.1 Field Surveys

Flora and vegetation surveys were conducted by Hunter Eco in 2017 with results described in this document with the full report provided in Attachment A. Fauna surveys were conducted by Eco Logical Australia (ELA, 2017) and are summarised in this report.

1.6.2 Published Databases

Published databases used in this assessment include:

- *BioNet Vegetation Classification* (OEH, 2017b);
- *BioNet Atlas* (OEH, 2017c)[2];
- *Threatened Biodiversity Data Collection* (OEH, 2017d)[3]; and
- *Directory of Important Wetlands of Australia* (Department of the Environment and Energy [DEE], 2018a).

1.6.3 Local Data

It was not necessary to use local data or deviate from the OEH databases (OEH, 2017b and c).

1.6.4 BAM Credit Calculator

BAM Credit Calculator Version: 1.2.2.00, (Last updated: 22/02/2018 16:00) (OEH, 2017a) was used in this assessment.

[2] This website is titled 'Species Sightings Search'
[3] This website is titled 'Profiles'.

2 LANDSCAPE FEATURES

This section provides information on the landscape features in accordance with requirements of the BAM (OEH, 2017a). The BAM (OEH, 2017a) refer to 'Subject land' as the land to which the BAM is applied in Stage 1 to assess the biodiversity values of the land (i.e. the landscape features [Section 2], native vegetation [Section 3] and threatened species [Section 4]).

2.1 Regional Setting

The Subject Land lies within:

- Muswellbrook Local Government area (Figure 1);
- Hunter Local Land Services area;
- Sydney Basin Bioregion, Hunter sub-region (Figure 2);
- Central Western Slopes Botanical Division; and
- Central Hunter Foothills Mitchell Landscape (Figure 5).

2.2 Habitat Connectivity Features

The native vegetation extent/habitat connectivity as mapped by site surveys (Hunter Eco, 2017) (Attachment A) and regional mapping (Sivertsen et al., 2016) is shown on Figure 3. Any native vegetation on Figure 3 may facilitate the movement of one or more threatened species across their range.

2.3 Native Vegetation Cover

Clearing of Hunter Valley vegetation commenced in the early 1800's. The earliest available aerial photographs from 1953 (Figure 4) show that the Subject Land and surrounds were almost totally cleared. Comparison with current day aerial imagery (Figure 3) shows that there has been some forest regeneration at the northern end of the Subject Land. While clearing has occurred there has been no pasture improvement or cultivation, consequently the Subject Land has a mosaic of native grassland with scattered paddock trees, and patches of woodland/forest.

2.4 Rivers and Streams

Drainage features based on Strahler stream ordering (Department of Industry – Water, 2017) are shown on Figure 3. There are no streams present on the Subject Land, only ephemeral drainage lines.

2.5 Wetlands

There are no important or local wetlands on or, adjacent to the Subject Land (Figure 3) (after DEE, 2018a; OEH, 2017e). The nearest important wetland is over 50 kilometres (km) away and unable to be shown on Figure 3.

2.6 Geology

There are no karst, caves, crevices, cliffs or other areas of geological significance on, or in the vicinity of, the Subject Land.

2.7 Areas of Outstanding Biodiversity Value

There are no Areas of Outstanding Biodiversity Value listed under the NSW *Biodiversity Conservation Regulation, 2017* associated with the Subject Land.

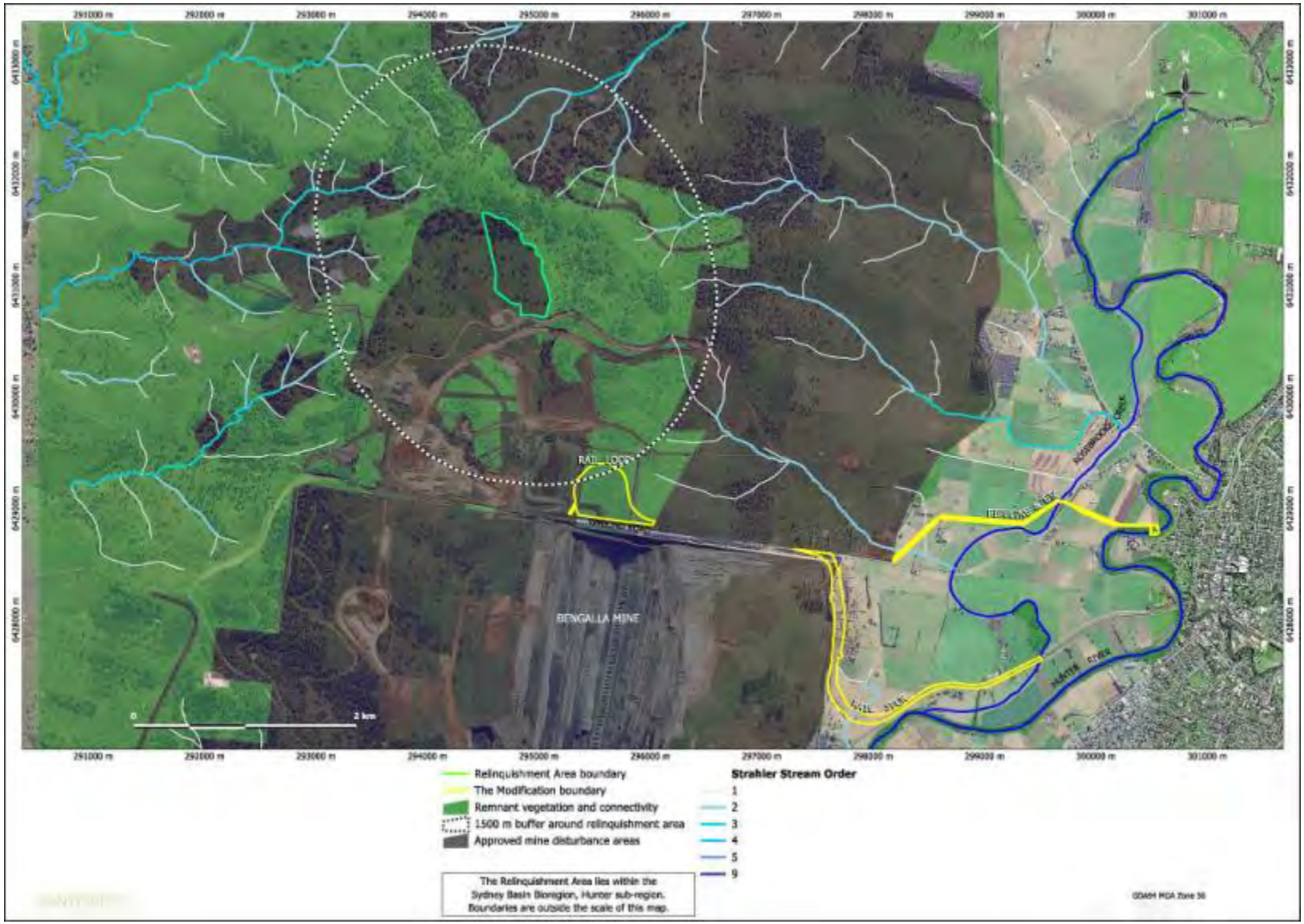


Figure 3 The Relinquishment Area and Modification with Assessment Buffer, Native Vegetation and Stream Order

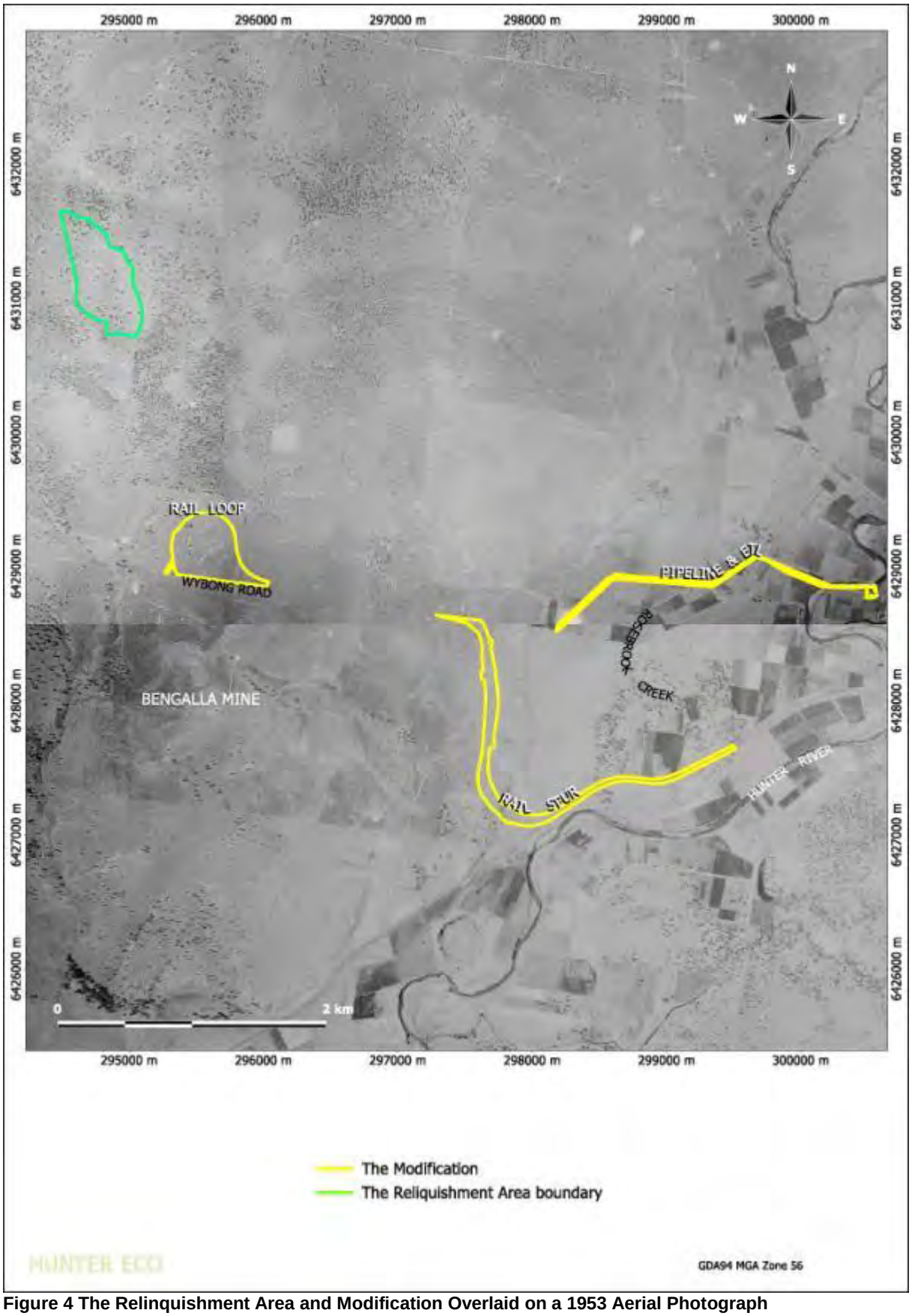


Figure 4 The Relinquishment Area and Modification Overlaid on a 1953 Aerial Photograph

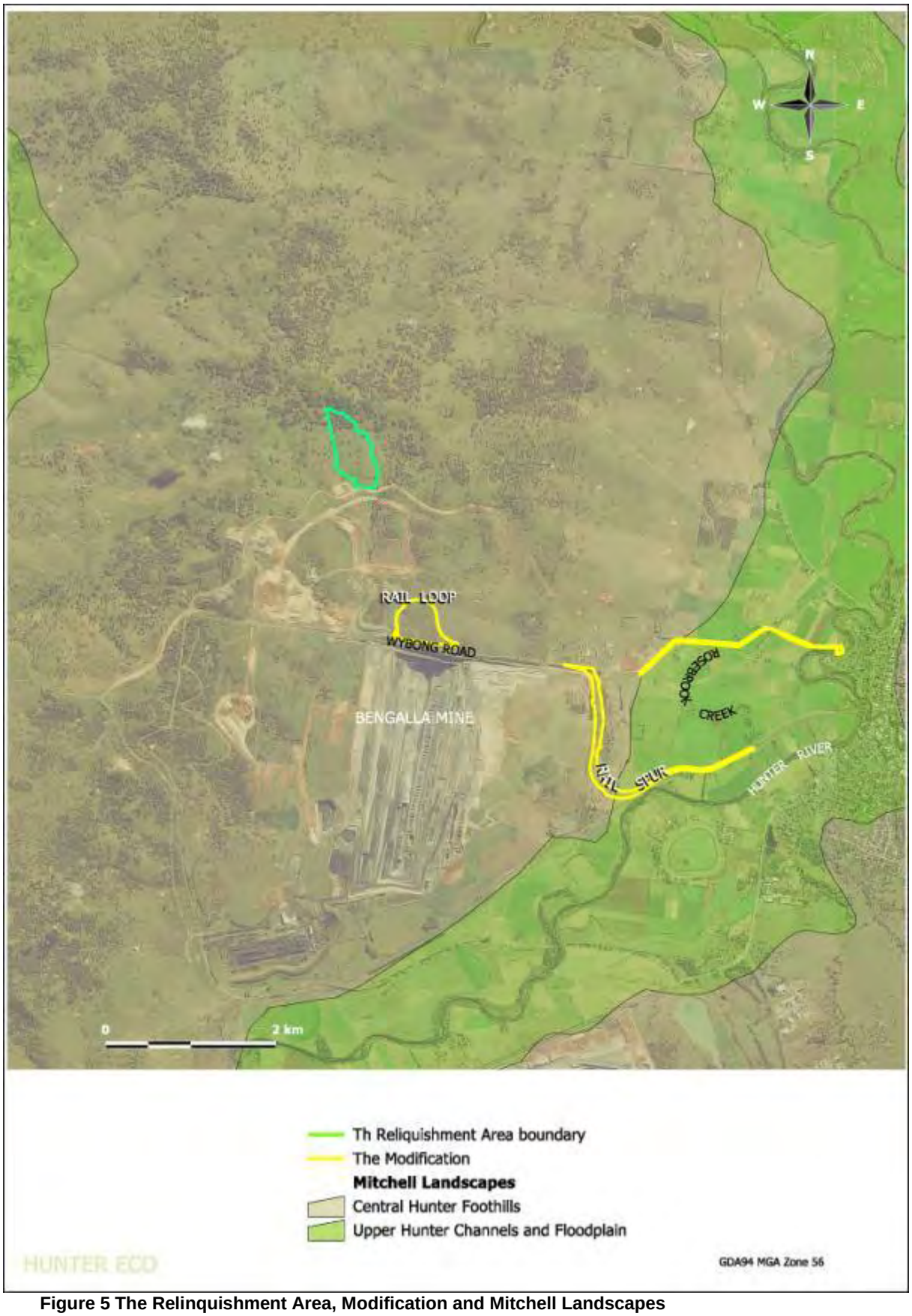


Figure 5 The Relinquishment Area, Modification and Mitchell Landscapes

2.8 Migratory Species Potential Flyways

There are no defined potential flyways for migratory species listed under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) that pass over the Subject Land, however, migratory birds could fly over that land similar to most areas in NSW, e.g. Rainbow Bee-eater (*Merops ornatus*).

2.9 Site Context Components

A site-based assessment method described in the BAM (OEH, 2017a) was applied to the Subject Land. The Subject Land is not eligible for the streamline assessment modules described in the BAM (OEH, 2017a).

The extent of native vegetation cover is described in Section 2.3. The patch size relative to the vegetation zone is described in Section 3.3.2.

There are no additional features required to be assessed by the Secretary as Secretary's Environmental Assessment Requirements (SEARs) were not issued. No SEARs were issued for the Modification.

3 NATIVE VEGETATION

3.1 Plant Community Types

In principle, Plant Community Types (PCT) are determined by comparing floristic content as compiled from floristic plots and transects strategically placed across the disturbance area with PCT descriptions in BioNet.

Floristic plots consisted of a 20m x 20m plot nested in a 50m x 20m plot from which data were collected according to the requirements of the BAM (OEH, 2017a). All flora species present in the 20m x 20m plot were identified and their percentage foliage cover was scored. The number of individuals present was also estimated for species with a cover score of 5% or less. Diameter at Breast Height (DBH) was recorded for any trees within the 50m x 20m plot and tallied against the following intervals: <5, 5–9, 10–19, 20–29, 30–49, 50–79, and 80+ centimetres (cm). Percentage litter cover was determined in five one metre square plots evenly located across the 50m x 20m plot.

Within the Subject Land three PCT were identified, two of which were present as both woodland and derived native grassland (DNG). These PCT are listed in Table 1 and grouped under their Formation and Class (Keith, 2004). A map of the PCT on the Subject Land is provided in Figure 6 and Figure 7 shows the location of the 10 floristic sample plots collected for this assessment. The floristic plot data collected within or near the Subject Land are provided in Attachment B.

Table 1 PCT Identified Across the Subject Land

Code	PCT	PCT Name	Condition	Area (ha)
Dry Sclerophyll Forests (Shrub/grass sub-formation), North-west Slopes Dry Sclerophyll Woodlands				
1a	1605	Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	Moderate	2
1b	1605	Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	DNG	5
Dry Sclerophyll Forests (Shrub/grass sub-formation), Hunter-Macleay Dry Sclerophyll Forests				
2a	1602	Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter	Good	4
Grassy Woodlands, Western Slopes Grassy Woodland				
3a	483	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	Moderate	3
3b	483	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	DNG	18

Figure 6 The Plant Community Types Associated with the Relinquishment Area

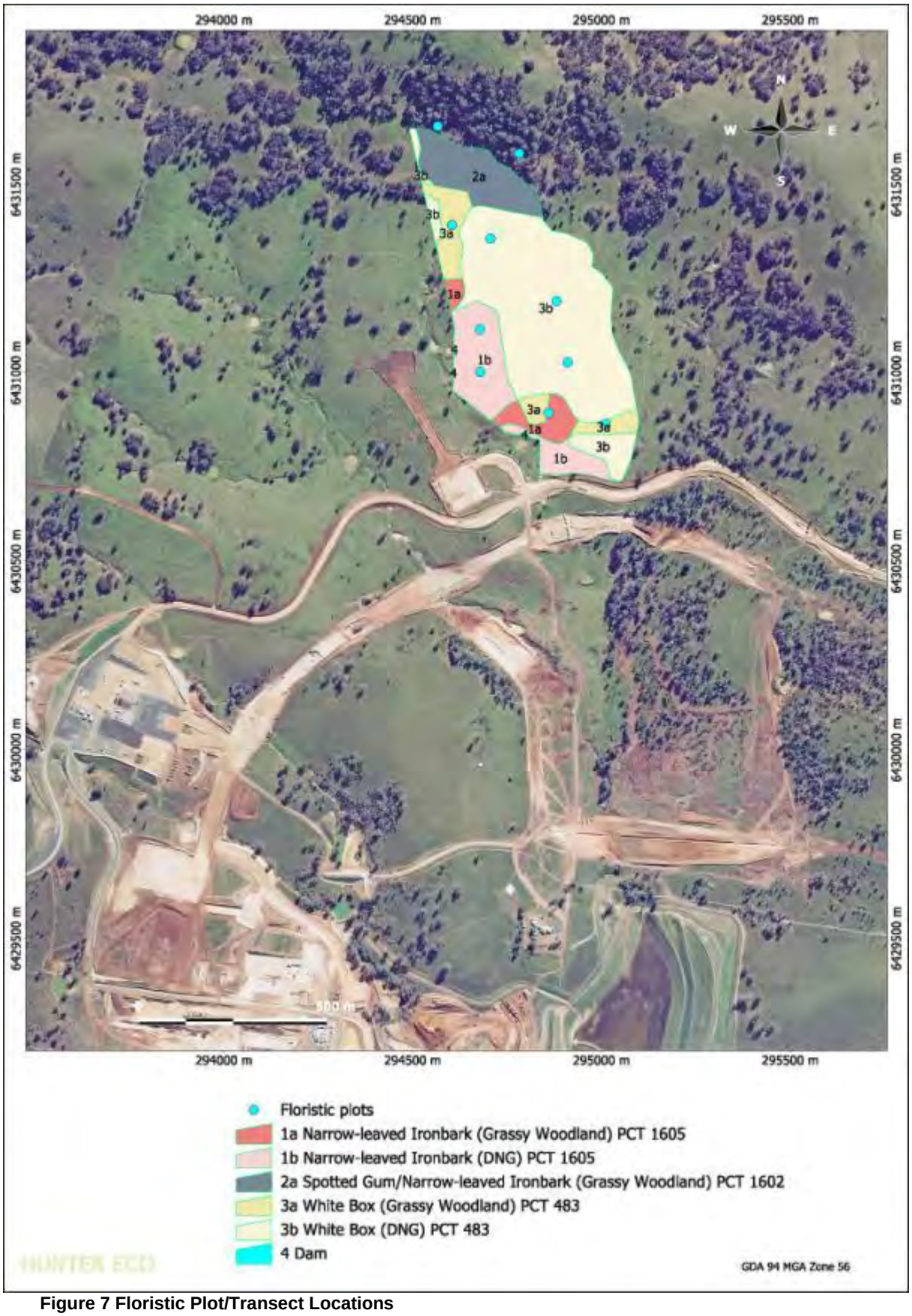


Figure 7 Floristic Plot/Transect Locations

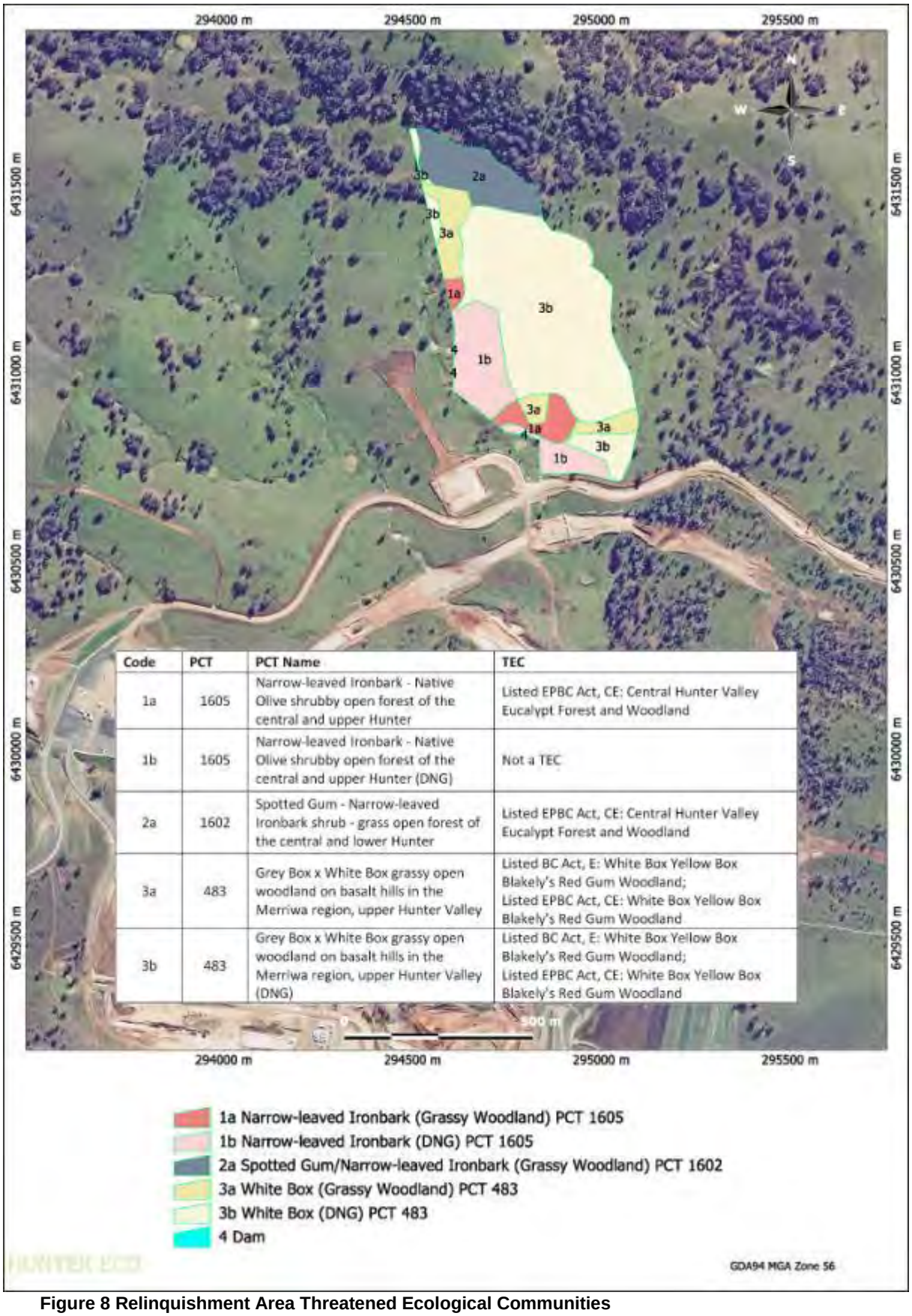
3.1.1 Threatened Ecological Communities

Three PCT's were associated with listed threatened ecological communities listed under the BC Act and/or under the EPBC Act (Table 2 and Figure 8).

Table 2 The PCT Identified Across the Subject Land and their Associated Threatened Ecological Communities

Code	PCT	PCT Name	Condition	Threatened Ecological Community[1]	Area (ha)
Dry Sclerophyll Forests (Shrub/grass sub-formation), North-west Slopes Dry Sclerophyll Woodlands					
1a	1605	Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	Moderate	Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland	2
1b	1605	Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	DNG	Not a Threatened Ecological Community (TEC)	5
Dry Sclerophyll Forests (Shrub/grass sub-formation), Hunter-Macleay Dry Sclerophyll Forests					
2a	1602	Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter	Good	Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland	4
Grassy Woodlands, Western Slopes Grassy Woodland					
3a	483	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	Moderate	Listed BC Act, E: White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, CE: White Box Yellow Box Blakely's Red Gum Woodland	3
3b	483	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	DNG	Listed BC Act, E: White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, CE: White Box Yellow Box Blakely's Red Gum Woodland	18

[1]E = Endangered; CE = Critically Endangered



Code	PCT	PCT Name	TEC
1a	1605	Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland
1b	1605	Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter (DNG)	Not a TEC
2a	1602	Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter	Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland
3a	483	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	Listed BC Act, E: White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, CE: White Box Yellow Box Blakely's Red Gum Woodland
3b	483	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley (DNG)	Listed BC Act, E: White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, CE: White Box Yellow Box Blakely's Red Gum Woodland

Figure 8 Relinquishment Area Threatened Ecological Communities

3.2 Plant Community Types Percent Cleared Value

The BAM (OEH, 2017a) defines 'Percent Cleared Value' as the percentage of a PCT that has been cleared as a proportion of its pre-1750 extent, as identified in the *BioNet Vegetation Classification* (OEH, 2017b). Table 3 shows the PCT involved in the Subject Land, their condition class and the percent cleared.

Table 3 Vegetation Zone Data

PCT	PCT Name	Zones	Percent Cleared
483	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	Derived Native Grassland and Moderate condition	90%
1602	Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter	Moderate condition	54%
1605	Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	Derived Native Grassland and Poor Condition	32%

3.3 Vegetation Integrity Assessment

3.3.1 Vegetation Zones

Table 3 above shows the vegetation zones used in the assessment of Vegetation Integrity.

3.3.2 Patch Size

The BAM (OEH, 2017a) defines 'Patch Size' as:

> *An area of **intact native vegetation** that:*
>
> *a) occurs on the development site or biodiversity stewardship site, and*
>
> *b) includes native vegetation that has a gap of less than 100m from the next area of moderate to good condition native vegetation (or ≤30m for non-woody ecosystems).*
>
> *Patch size may extend onto adjoining land that is not part of the development site or biodiversity stewardship site.*

The BAM (OEH, 2017a) defines '***intact native vegetation***' as:

> *Intact vegetation: vegetation where all tree, shrub, grass and/or forb structural growth form groups expected for a plant community type are present.*

Applying these definitions, the Subject Land consists entirely of native vegetation that extends beyond the assessment boundary.

3.3.3 Vegetation Integrity Score

Table 4 provides the Vegetation Integrity scores derived from the BAM Credit Calculator (OEH, 2018) along with ecosystem credits assessment thresholds.

Table 4 Vegetation Integrity Scores

Plant Community Type and Condition	Vegetation Integrity Score	Vegetation Integrity Score threshold	Ecosystem credits required
483 moderate	32.7	<15	Yes
483 DNG	21.2	<15	Yes
1602 good	43.8	<17	Yes
1605 moderate	19.1	<17	Yes
1605 DNG	19.7	<17	Yes

3.3.4 Local Data

It was not necessary to use local data to deviate from the OEH databases (OEH, 2017b and c).

4 THREATENED SPECIES

Threatened species that are 'ecosystem credit species' and/or 'species credit species' are pre-determined by OEH in the BAM Credit Calculator (OEH, 2018) and *Threatened Biodiversity Data Collection* (OEH, 2017d).

The BAM (OEH, 2017a) states:

> *Threatened species where the likelihood of occurrence of a species or elements of the species' habitat can be predicted by vegetation surrogates and landscape features, or for which targeted survey has a low probability of detection, are identified in the Threatened Biodiversity Data Collection as ecosystem credit species. Targeted survey is not required for these species.*
> …
> *'Species credit species' are threatened species or components of species habitat that are identified in the Threatened Species Data Collection as requiring assessment for species credits*.

4.1 Ecosystem Credit Species - Habitat Suitability Assessment

In accordance with the BAM (OEH, 2017a), assessing the habitat suitability for an ecosystem credit species involves the following steps:

Step 1: Identify threatened species for assessment; and

Step 2: Assessment of the habitat constraints and vagrant species on the Subject Land.

These steps are applied below.

4.1.1 Step 1: Identify Ecosystem Species for Assessment

Ecosystem credit species for assessment are listed in Table 5 drawn from the BAM Credit Calculator (OEH, 2018). Relevant databases and literature was reviewed for additional ecosystem credit species for assessment.

Of the species in Table 5, all have been recorded in the wider locality. Only four ecosystem credit species, the Speckled Warbler, Yellow-bellied Sheath-tailed, Eastern False Pipistrelle[4] and Greater Broad-nosed Bat[5] were recorded within the potential Relinquishment area footprint.

4.1.2 Step 2: Assessment of the Habitat Constraints and Vagrant Species on the Modification Land

The BAM (OEH, 2017a) states*:*

> *the assessor may opt to undertake an additional assessment of the habitat constraints on the Subject land for the threatened species predicted for assessment.*

The ecosystem credit species identified in the BAM Credit Calculator (OEH, 2018) for the Subject Land were reviewed because the Vegetation Integrity Scores exceeded the relevant threshold thus requiring calculation of ecosystem credits.

[4] Species possibly recorded. Unable to be confirmed due to Anabat technology limitations.

Table 5 Ecosystem Credit Species Drawn from the BAM Credit Calculator and Assessment of Potential Occurrence

Scientific Name	Common Name	Conservation Status*		Potential Occurrence as a Ecosystem Credit Species
		BC Act	EPBC Act	
Ecosystem Credit Species Requiring Further Consideration				
Birds				
Anthochaera phrygia	Regent Honeyeater	CE	CE	**Possible** in White Box and Spotted Gum blossom
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	**Likely.** Suitable woodland and forest foraging habitat
Chthonicola sagittata	Speckled Warbler	V	-	**Present**.
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-	**Possible**. Suitable woodland habitat
Daphoenositta chrysoptera	Varied Sittella	V	-	**Possible**. Suitable woodland habitat
Haliaeetus leucogaster	White-bellied Sea- Eagle[#]	V	-	**Possible**. Suitable woodland habitat
Hieraaetus morphnoides	Little Eagle[#]	V	-	**Possible**. Suitable woodland habitat
Glossopsitta pusilla	Little Lorikeet	V	-	**Likely.** Suitable woodland and forest foraging habitat
Lathamus discolor	Swift Parrot	E	CE	**Possible**. Feeding on Eucalypt blossom
Lophoictinia isura	Square-tailed Kite[#]	V	-	**Possible itinerant.** Foraging over grassland
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	-	**Possible** winter visitor
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-	**Possible.** Suitable woodland and forest foraging habitat
Neophema pulchella	Turquoise Parrot	V	-	**Likely.** Suitable woodland and forest foraging habitat
Ninox connivens	Barking Owl	V	-	**Possible**. Foraging and potential roosting habitat
Ninox strenua	Powerful Owl	V	-	**Possible**. Foraging and potential roosting habitat
Petroica boodang	Scarlet Robin	V	-	**Possible.** Suitable woodland and forest foraging habitat
Petroica phoenicea	Flame Robin	V	-	**Possible.** Suitable woodland and forest foraging habitat
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-	**Possible.** Suitable woodland and forest foraging habitat
Tyto novaehollandiae	Masked Owl	V	E	**Possible.** Potentially suitable foraging habitat

Table 5 Ecosystem Credit Species Drawn from the BAM Credit Calculator and Assessment of Potential Occurrence (Continued)

Scientific Name	Common Name	Conservation Status*		Potential Occurrence as a Ecosystem Credit Species
		BC Act	EPBC Act	
Marsupials				
Dasyurus maculatus	Spotted-tailed Quoll	V	E	**Possible** as part of a much larger home range
Bats				
Falsistrellus tasmaniensis	Eastern False Pipistrelle[Δ]	V	-	**Present.**
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	**Likely.** Suitable woodland and forest foraging habitat
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	**Possible**. Foraging and potential roosting habitat
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	**Likely**. Itinerant forager on White Box and Spotted Gum blossom
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	**Present**.
Scoteanax rueppellii	Greater Broad-nosed Bat[Δ]	V	-	**Present.**
Ecosystem Credit Species Determined Unlikely to Occur				
Birds				
Calyptorhynchus lathami	Glossy Black-Cockatoo	E	V	**None.** No *Casuarina* or *Allocasuarina* feed tree species.
Grantiella picta	Painted Honeyeater	V	V	**Unlikely**. Low mistletoe content
Endangered Population				
Cymbidium canaliculatum - endangered population	*Cymbidium canaliculatum* population in the Hunter Catchment	E	-	**None.** No *Cymbidium canaliculatum* present

* Current as at December 2017; V = Vulnerable

Species are considered to be potential species credit species due to the presence of suitable breeding and or foraging habitat within the Relinquishment area. Therefore these species are considered further in species credit assessment.

Δ Species possibly recorded. Unable to be confirmed due to Anabat technology limitations.

4.2 Species Credit Species - Habitat Suitability Assessment

Assessing the habitat suitability for a species credit species involves the following steps:

Step 1: Identify species credit species for assessment.

Step 2: Assessment of the habitat constraints for species credit species on the Subject land.

Step 3: Identify candidate species credit species for further assessment.

Step 4: Determine presence or absence of a candidate species credit species.

Step 5: Determine the area or count, and location of suitable habitat for a species credit species.

Step 6: Determine the habitat condition within the species polygon for species assessed by area.

4.2.1 Step 1: Identify Species Credit Species for Assessment

The following databases and reports were reviewed for any nearby potentially occurring threatened species records (including species credit species):

- *BioNet Atlas* (OEH, 2017c);
- Birdlife Australia database search (Birdlife Australia, 2017);
- Atlas of Living Australia (2017);

Table 6 provides a summary of the threatened species records in the locality from survey records or database records. Threatened species records from the Subject Land are shown on Figure 9.

Table 6 Species Credit Species from the BAM Calculator and Database Searches

Scientific Name	Common Name	Conservation Status		Credit Type
		BC Act	EPBC Act	
Birds				
Anthochaera phrygia	Regent Honeyeater[#]	CE	CE	Ecosystem/Species credit (dependent mapped habitat)
*Burhinus grallarius**	Bush Stone-curlew	E	-	Species credit
Callocephalon fimbriatum	Gang-gang Cockatoo[#]	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)
Calyptorhynchus lathami	Glossy Black-Cockatoo[#]	E	V	Ecosystem/Species credit (dependent on the presence of breeding habitat)
Haliaeetus leucogaster	White-bellied Sea- Eagle	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)
Hieraaetus morphnoides	Little Eagle	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)
Lathamus discolor	Swift Parrot[#]	E	CE	Ecosystem/Species credit (dependent on the presence of breeding habitat)

Table 6 Species Credit Species from the BAM Calculator and Database Searches (Continued)

Scientific Name	Common Name	Conservation Status		Credit Type
		BC Act	EPBC Act	
Birds (Continued)				
Lophoictinia isura	Square-tailed Kite	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)
Ninox connivens	Barking Owl[#]	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)
Ninox strenua	Powerful Owl[#]	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)
Tyto novaehollandiae	Masked Owl[#]	V	E	Ecosystem/Species credit (dependent on the presence of breeding habitat)
Marsupials				
*Petaurus norfolcensis**	Squirrel Glider	E	-	Species credit
*Cercartetus nanus**	Eastern Pygmy Possum	V	-	Species credit
*Petrogale penicillata**	Brush-tailed Rock-wallaby	E	V	Species credit
*Phascogale tapoatafa**	Brush-tailed Phascogale	V	V	Species credit
*Planigale maculate**	Common Planigale	V	-	Species credit
Bats				
*Chalinolobus dwyeri**	Large-eared Pied Bat	V	V	Species credit
Miniopterus schreibersii oceanensis	Eastern Bentwing- bat[#]	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)
*Myotis macropus**	Southern Myotis	V	-	Species credit
Pteropus poliocephalus	Grey-headed Flying-fox[#]	V	V	Ecosystem/Species credit (dependent on the presence of breeding habitat)
Vespadelus troughtoni	Eastern Cave Bat	V	-	Species credit
Reptiles				
Hoplocephalus bitorquatus	Pale-headed Snake	V	-	Species credit
Amphibians				
Litoria aurea	Green and Golden Bell Frog	E	V	Species credit
Litoria brevipalmata	Green-thighed Frog	V	-	Species credit

Table 6 Species Credit Species from the BAM Calculator and Database Searches (Continued)

Scientific Name	Common Name	Conservation Status		Credit Type
		BC Act	EPBC Act	
Flora				
Pomaderris queenslandica	Scant Pomaderris	E	-	Species credit
Monotaxis macrophylla	Large-leaved Monotaxis	E	-	Species credit
Endangered Populations				
Acacia pendula - endangered population	Acacia pendula population in the Hunter catchment	CE	CE	Species credit
Cymbidium canaliculatum - endangered population	*Cymbidium canaliculatum* population in the Hunter Catchment	E	-	Species credit

* Current as at December 2017.

\# Species were determined to be ecosystem credit species due to the lack of suitable breeding and or foraging habitat within the potential Relinquishment area. Therefore these species are not considered further in species credit assessment.

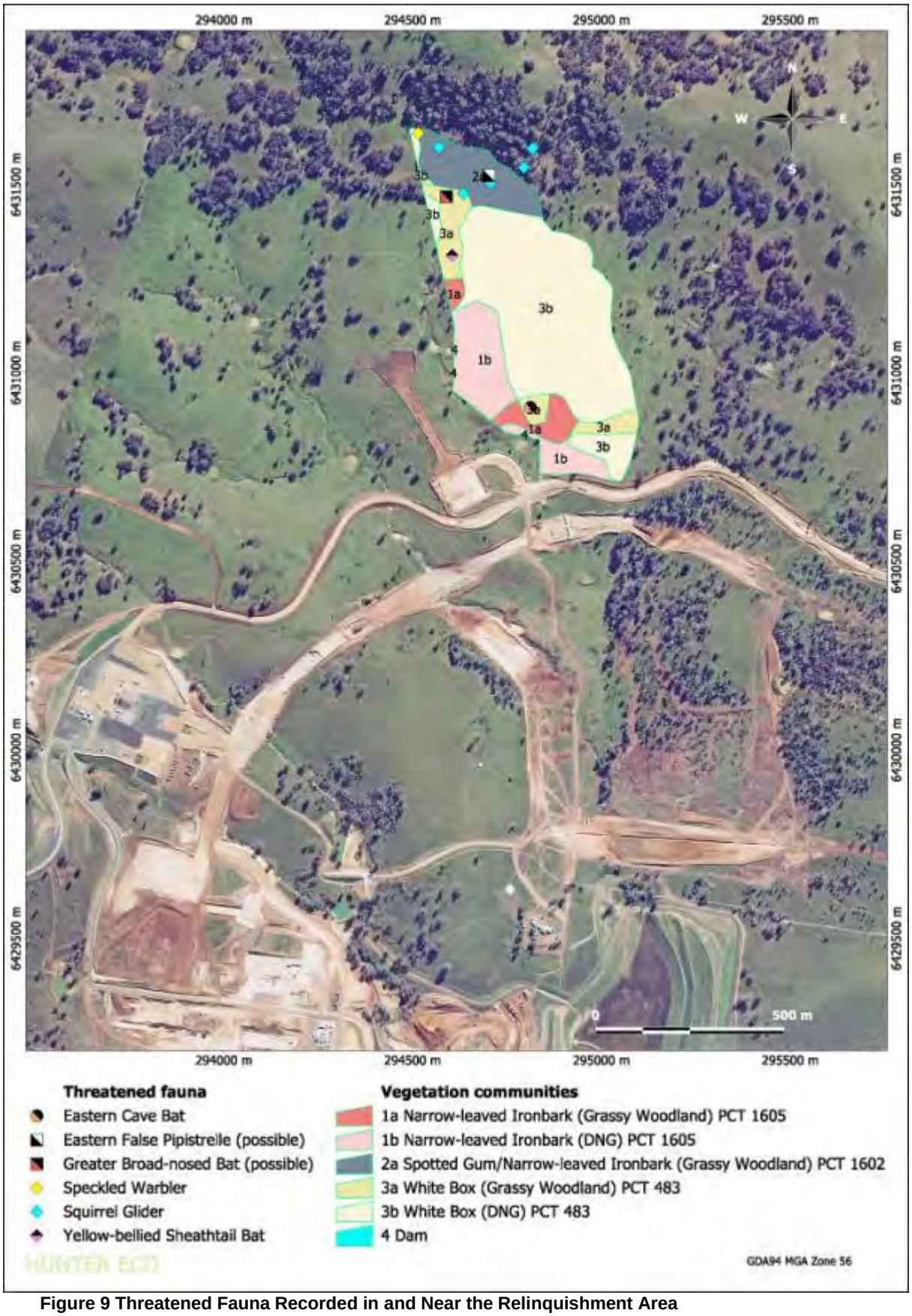


Figure 9 Threatened Fauna Recorded in and Near the Relinquishment Area

4.2.2 Step 2: Assessment of the Habitat Constraints for Species Credit Species on the Subject Land

Habitat constraints are identified in the *Threatened Biodiversity Data Collection* (OEH, 2017d) for some fauna species credit species and the absence of the habitat constraints precludes the species from further assessment (Table 7). Step 2 is not applicable to a species where no habitat constraints are listed for that species in the *Threatened Biodiversity Data Collection* (OEH, 2017d), e.g. threatened flora.

ELA (2017) undertook a field assessment of habitat constraints for the species in Table 7. An assessment of habitat constraints for relevant species is provided in Table 7.

Table 7 Assessment of Species Credit Species Habitat Constraints

Scientific Name	Common Name	Habitat Constraints	Habitat Present
Burhinus grallarius	Bush Stone-curlew	Fallen/standing dead timber including logs.	Yes
Chalinolobus dwyeri	Large-eared Pied Bat	Cliffs; Within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, or crevices, or within two kilometres of old mines or tunnels.	No
Cymbidium canaliculatum - endangered population	*Cymbidium canaliculatum* population in the Hunter Catchment	Must be within Hunter catchment as defined by Australia's River Basins (Geoscience Australia, 1997).	Yes
Litoria aurea	Green and Golden Bell Frog	Semi-permanent/ephemeral wet areas; Within 1 km of wet areas/Swamps; Within 1 km of swamp/Waterbodies; Within 1 km of waterbody.	No
Myotis macropus	Southern Myotis	Hollow bearing trees; Within 200 m of riparian zone; Bridges, caves or artificial structures within 200 m of riparian zone.	No
Vespadelus troughtoni	Eastern Cave Bat	Within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, crevices or boulder piles, or within two kilometres of old mines, tunnels, old buildings or sheds.	No
Petrogale penicillata	Brush-tailed Rock-wallaby	Land within 1 km of rocky escarpments, gorges, steep slopes, boulder piles, rock outcrops or clifflines.	No
Phascogale tapoatafa	Brush-tailed Phascogale	Hollow bearing trees.	Yes

4.2.3 Step 3: Identify Candidate Species Credit Species for Further Assessment

After considering the habitat constraints (Step 2), candidate species credit species for further assessment are listed in Table 8.

Table 8 Candidate Species Credit Species for Further Assessment

Scientific Name	Common Name	Conservation Status	
		BC Act	EPBC Act
Birds			
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	-
Hieraaetus morphnoides	Little Eagle	V	-
Burhinus grallarius	Bush Stone-curlew	E	-
Lophoictinia isura	Square-tailed Kite	V	-
Marsupials			
Petaurus norfolcensis	Squirrel Glider	E	-
Cercartetus nanus	Eastern Pygmy Possum	V	-
Phascogale tapoatafa	Brush-tailed Phascogale	V	V
Planigale maculata	Common Planigale	V	-
Reptiles			
Hoplocephalus bitorquatus	Pale-headed Snake	V	-
Amphibians			
Litoria brevipalmata	Green-thighed Frog	V	-
Flora			
Pomaderris queenslandica	Scant Pomaderris	E	-
Monotaxis macrophylla	Large-leaved Monotaxis	E	-
Endangered Population			
Acacia pendula – endangered population	*Acacia pendula* population in the Hunter catchment	CE	CE
Cymbidium canaliculatum – endangered population	*Cymbidium canaliculatum* population in the Hunter Catchment	E	-

4.2.4 Step 4: Determine Presence or Absence of Candidate Species Credit Species

ELA (2017) undertook targeted surveys for candidate species credit species (Table 6) to determine presence or absence of the species within the survey period required by the BAM Credit Calculator (OEH, 2018). The timing, methods and effort are outlined below.

Threatened Flora

Targeted searches for threatened flora species were undertaken by Hunter Eco (2017) (Attachment A) in accordance with the NSW *Guide to Surveying Threatened Plants* (OEH, 2016) in areas of potential habitat. Surveys for threatened flora species were undertaken on 4th and 5th October 2016 (ELA 2016) specifically targeting the threatened orchids *Diuris tricolor* and *Prasophyllum petilum*. While these orchids were confirmed at the time to be flowering in the immediate region none were recorded during this survey.

Monotaxis macrophylla: No suitable habitat for this species as it grows on rocky ridges and hillsides. It is also a fire ephemeral species present for a short time following fire.

Pomaderris queenslandica: No suitable habitat. Found in moist shrubby woodland commonly along ephemeral drainage lines.

No threatened flora species were recorded by Hunter Eco (2017) (Attachment A) in the Subject Land.

Koala (Breeding Habitat)

The NSW *Recovery Plan for the Koala (Phascolarctos cinereus)* (NSW Department of Environment and Climate Change, 2008) notes that Muswellbrook lies within the Central Coast Management Unit. None of the tree species in or near the Modification were listed as primary, secondary or supplementary feed tree species within this Unit, thus making it unlikely that Koala would use any of the Subject Land habitats. Nevertheless ELA (2017) included Koala in their fauna field surveys, none of which were recorded.

4.2.5 Step 5: Determine the Area or Count, and Location of Suitable Habitat for a Species Credit Species

As a result of the surveys by ELA (2017), credit species with potential to use habitat on the Subject Land are shown in Table 9.

4.2.6 Step 6: Determine the Habitat Condition within the Species Polygon for Species Assessed by Area

Habitat condition of each PCT and zone were determined during field surveys (Hunter Eco, 2017) (Attachment A). Table 10 shows the species credit species, habitat condition (Vegetation Integrity) and the area of habitat for each species. Figure 10 shows the polygons of suitable habitat for the species credit species.

Table 9 Species Credit Species Drawn from the BAM Credit Calculator and Assessment of Potential Occurrence

Scientific Name	Common Name	Conservation Status		Credit Type	Potential Occurrence as a Species Credit Species
		BC Act	EPBC Act		
Species Credit Species Requiring Further Consideration					
Birds					
Lophoictinia isura	Square-tailed Kite	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**Possible**. Nest in trees near or along watercourses such as the nearby Hunter River. This species is also assessed as an ecosystem credit in Table 5.
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**Possible**. Nest in large emergent eucalypts in woodland or forest. Nests are generally re-used annually and are large and obvious. There were no nests in or near the project area and no suitable woodland/forest habitat.
Hieraaetus morphnoides	Little Eagle	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**Possible**. Nests in tall living trees in a remnant woodland patch.
Burhinus grallarius	Bush Stone-curlew	E	-	Species credit	**Possible**. Inhabit open forest/woodland having fallen timber and sparse grassy ground layer.
Marsupials					
Petaurus norfolcensis	Squirrel Glider	E	-	Species credit	**Present.** Relies on large old trees with hollows for breeding and nesting.
Phascogale tapoatafa	Brush-tailed Phascogale	V	V	Species credit	**Possible**. Inhabit dry open sclerophyll forest with a sparse ground cover.
Species Credit Species Determined Unlikely to Occur					
Marsupials					
Cercartetus nanus	Eastern Pygmy-possum	V	-	Species credit	**None.** Requires woodland/forest with shrubby understorey. No such habitat was present in or near the Relinquishment area.
Planigale maculata	Common Planigale	V	-	Species credit	**Unlikely**. Use a variety of habitats with surface cover, usually close to water.
Reptiles					
Hoplocephalus bitorquatus	Pale-headed Snake	V	-	Species credit	**Unlikely**. Inhabits dry or moist forest/woodland and in dry areas usually near water.

Table 9 Species Credit Species Drawn from the BAM Credit Calculator and Assessment of Potential Occurrence (Continued)

Scientific Name	Common Name	Conservation Status		Credit Type	Potential Occurrence as a Species Credit Species
		BC Act	EPBC Act		
Amphibians					
Litoria brevipalmata	Green-thighed Frog	V		Species credit	**None.** No suitable forest habitat.
Bats					
Vespadelus troughtoni	Eastern Cave Bat	V	-	Species credit	**None.** No suitable breeding habitat.
Species / Ecosystem Credit Species Considered in Table 6					
Birds					
Anthochaera phrygia	Regent Honeyeater	CE	CE	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**None**. The project locality is not located in or near a known breeding area for these birds. Known key breeding areas are Capertee Valley, Bundarra-Barraba. Given the lack of breeding habitat, this species is assessed as an ecosystem credit in Table 5.
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**None**. Requires old growth forest and woodland for breeding. Given the lack of breeding habitat, this species is assessed as an ecosystem credit in Table 5.
Calyptorhynchus lathami	Glossy Black-Cockatoo	E	V	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**None**. Inhabits open forest and woodlands where they feed on the fruit of *Casuarina* or *Allocasuarina* species. Nest in large hollow-bearing eucalypts. Given the lack of breeding habitat, this species is assessed as an ecosystem credit in Table 5.
Lathamus discolor	Swift Parrot	E	CE	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**None**. The species breeds in Tasmania. Given the lack of breeding habitat, this species is assessed as an ecosystem credit in Table 6.
Ninox connivens	Barking Owl	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**None**. Nest in hollows of large old trees. No suitable nest trees were present. Given the lack of breeding habitat, this species is assessed as an ecosystem credit in Table 6.

Table 9 Species Credit Species Drawn from the BAM Credit Calculator and Assessment of Potential Occurrence (Continued)

Scientific Name	Common Name	Conservation Status		Credit Type	Potential Occurrence as a Species Credit Species
		BC Act	EPBC Act		
Ninox strenua	Powerful Owl	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**None**. Nest in hollows of large old trees. No suitable nest trees were present. Given the lack of breeding habitat, this species is assessed as an ecosystem credit in Table 6.
Tyto novaehollandiae	Masked Owl	V	E	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**None**. Nest in hollows of large old trees. No suitable nest trees were present in or near the surveyed habitat. Given the lack of breeding habitat, this species is assessed as an ecosystem credit in Table 6.
Bats					
Myotis macropus	Southern Myotis	V	-	Species credit	**Unlikely**. Recorded at the Rail Loop, Overton Road and the riparian Hunter River habitat. However there is no likelihood of breeding in the area as that requires caves or old mine workings.
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**None**. Breeds in caves or old mine workings, none of which were present. Given the lack of breeding habitat, this species is assessed as an ecosystem credit in Table 6.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Ecosystem/Species credit (dependent on the presence of breeding habitat)	**None**. Breeds in large roosting camps generally located near water and none of which were present in the project disturbance area. Suitable habitat does occur along the Hunter River. Given the lack of breeding habitat, this species is assessed as an ecosystem credit in Table 6.

Table 10 Species Credit Species, PCT, Habitat Condition and Area

Species and Vegetation zone	Habitat condition	Area (ha)
***Burhinus grallarius* / Bush Stone-curlew**		
1602_Good	45.4	4
***Haliaeetus leucogaster* / White-bellied Sea-Eagle**		
1602_Good	45.4	4
***Hieraaetus morphnoides* / Little Eagle**		
1602_Good	45.4	4
483_Derived_native_grass	21.2	18
1605_Moderate	19.1	2
483_Moderate	32.7	3
1605_Derived_native_grass	19.7	5
***Lophoictinia isura* / Square-tailed Kite**		
1602_Good	45.4	4
483_Derived_native_grass	21.2	18
1605_Moderate	19.1	2
483_Moderate	32.7	3
1605_Derived_native_grass	19.7	5
***Petaurus norfolcensis* / Squirrel Glider**		
1602_Good	45.4	4
483_Moderate	32.7	3
***Phascogale tapoatafa* / Brush-tailed Phascogale**		
1602_Good	45.4	4
483_Moderate	32.7	2

4.1 Local Data

It was not necessary to use local data to deviate from the OEH databases (OEH, 2017b).

4.2 Expert Reports

No expert reports were required because there were no candidate species credits species (Table 7) that were not surveyed for by ELA (2017).

Figure 10 Relinquishment Area Threatened Fauna PCT Associations

5 AVOID AND MINIMISE IMPACTS

5.1 Measures to Avoid and Minimise Impacts

In relation to the Subject Land, any impact will be avoided because the approved development of this land will be relinquished.

5.2 Direct Impacts on Native Vegetation and Habitat

5.2.1 Clearance of Habitat and Vegetation

There will be no clearance of habitat and vegetation on the portion of the Subject Land selected to be relinquished because the approved development of this land will be relinquished.

5.3 Indirect Impacts on Native Vegetation and Habitat

The Subject Land is adjoined to the south by active approved mining areas. However specific control measures would ensure that there would be no:

- Inadvertent Impacts on Adjacent Habitat or Vegetation;
- Impacts on Adjacent Habitat or Vegetation from a Change in Land-Use Pattern (Increased Human Activity);
- Reduced Viability of Adjacent Habitat Due to Edge Effects;
- Reduced Viability of Adjacent Habitat Due to Noise, Dust or Light Spill;
- Transport of Weeds and Pathogens from the Site to Adjacent Vegetation;
- Increased Risk of Fauna Starvation, Exposure and Loss of Shade or Shelter;
- Loss of Breeding Habitats;
- Trampling of Threatened Flora Species;
- Inhibition of Nitrogen Fixation and Increased Soil Salinity;
- Fertiliser Drift;
- Rubbish Dumping;
- Wood Collection;
- Bush Rock Removal and Disturbance;
- Increase in Predatory Species Populations;
- Increase in Pest Animal Populations;
- Increased Risk of Fire; or
- Disturbance to Specialist Breeding and Foraging Habitat.

5.4 Prescribed Biodiversity Impacts

The NSW *Biodiversity Conservation Regulation, 2017* identifies actions that are prescribed as impacts to be assessed under the biodiversity offsets scheme. Prescribed Biodiversity Impacts are as follows:

> *(a) the impacts of development on the following habitat of threatened species or ecological communities:*
> *(i) karst, caves, crevices, cliffs and other geological features of significance,*
> *(ii) rocks,*
> *(iii) human made structures,*
> *(iv) non-native vegetation,*

(b) the impacts of development on the connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range,

(c) the impacts of development on movement of threatened species that maintains their lifecycle,

(d) the impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities (including from subsidence or upsidence resulting from underground mining or other development),

(e) the impacts of wind turbine strikes on protected animals,

(f) the impacts of vehicle strikes on threatened species of animals or on animals that are part of a threatened ecological community.

These impacts are assessed below in relation to the Modification.

(a) the impacts of development on the following habitat of threatened species or ecological communities:

(i) karst, caves, crevices, cliffs and other geological features of significance,

(ii) rocks,

(iii) human made structures,

(iv) non-native vegetation,

The Subject Land has no Prescribed Biodiversity Impact features:

- there are no karst, caves, crevices, cliffs or other areas of geological significance on the Subject Land or within the immediate surrounds of the Subject Land (Section 2.6);
- there are no threatened species which are likely to be associated with any rocks that occur on the Subject Land;
- no human made structures that provide habitat for threatened species are present on the Subject Land; and
- there are no areas of non-native vegetation.

(b) the impacts of development on the connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range

Because the Subject Land will no longer be developed there will be no change to the current connectivity attributes.

(c) the impacts of development on movement of threatened species that maintains their lifecycle

There would be no impact on the movement of threatened species that maintains their lifecycle for the reasons described in (b) above.

(d) the impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities (including from subsidence or upsidence resulting from underground mining or other development)

The Subject Land would not be developed.

(e) the impacts of wind turbine strikes on protected animals

Not relevant.

(f) the impacts of vehicle strikes on threatened species of animals or on animals that are part of a threatened ecological community

The relinquished development of the Subject Land means a reduction in vehicle activity had the initial approval been acted upon.

5.5 Impacts on Commonwealth Threatened Species and Communities

There will be no impact on Commonwealth species or communities as the Subject Land will not be developed.

5.6 Impacts on Threatened Species and Communities under the NSW *Fisheries Management Act, 1994*

The Subject Land has no waterways meaning there will be no impact on any threatened species or communities listed under the NSW *Fisheries Management Act, 1994*.

5.7 Measures to Mitigate and Manage Impacts

Relinquishment of the development approval for the Subject Land is the ultimate measure to negate any impacts.

6 IMPACT SUMMARY

6.1 Serious and Irreversible Impacts

Relinquishment of the development approval for the selected portion of the Subject Land means that there would be no Serious and Irreversible Impacts.

6.2 Impacts on Native Vegetation (Ecosystem Credits)

The BAM (OEH, 2017a) states:

> *The assessor is required to determine an offset for all impacts of development or impacts from the conferral of biodiversity certification on PCTs that are associated with:*
>
> *(b) a vegetation zone that has a vegetation integrity score of ≥ 17 where the PCT is associated with threatened species habitat (as represented by ecosystem credits), or is representative of a vulnerable ecological community*

The ecosystem credits generated by the BAM Calculator for the Subject Land are shown in Table 11.

Table 11 Ecosystem Credits Generated for the Subject Land

Code	Vegetation Community	PCT	Condition	Clearance Area (ha)	Ecosystem Credits
3b	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	483	DNG	18.0	191
3a	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	483	Moderate	3.0	49
					240
1a	Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	1605	Moderate	2.0	14
1b	Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	1605	DNG	5.0	37
					51
2a	Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter	1602	Good	4.0	79
					79
				Total	**370**

Relinquishment of development approval for the selected portion of the Subject Land means that there would be no impacts on native vegetation (ecosystem credits).

6.3 Impacts on Threatened Species (Species Credits)

The species credits developed in the BAM Calculator for the habitat on the Subject land are shown in Table 12.

Table 12 Species Credits Required for the Relinquishment Area

Species and Vegetation zone	Habitat condition	Area (ha)	Species credits
***Burhinus grallarius* / Bush Stone-curlew**			
1602_Good	45.4	4	91
			91
***Haliaeetus leucogaster* / White-bellied Sea-Eagle**			
1602_Good	45.4	4	91
			91
***Hieraaetus morphnoides* / Little Eagle**			
1602_Good	45.4	4	68
483_Derived_native_grass	21.2	18	143
1605_Moderate	19.1	2	14
483_Moderate	32.7	3	37
1605_Derived_native_grass	19.7	5	37
			299
***Lophoictinia isura* / Square-tailed Kite**			
1602_Good	45.4	4	68
483_Derived_native_grass	21.2	18	143
1605_Moderate	19.1	2	14
483_Moderate	32.7	3	37
1605_Derived_native_grass	19.7	5	37
			299
***Petaurus norfolcensis* / Squirrel Glider**			
1602_Good	45.4	4	91
483_Moderate	32.7	3	49
			140
***Phascogale tapoatafa* / Brush-tailed Phascogale**			
1602_Good	45.4	4	91
483_Moderate	32.7	2	33
			124

Relinquishment of the development approval for the selected portion of the Subject Land means that there would be no impacts on native vegetation and thus on species credit species.

7 CONCLUSION

Table 13 shows the comparison between ecosystem credits generated in the BAM Calculator for the Relinquishment Area and the Modification (Hunter Eco, 2018). Forfeiting development of the entire land available for use as a Relinquishment Area while developing the Modification will result in a net gain of 229 ecosystem credits.

Table 13 Comparison of Ecosystem Credits between the Relinquishment Area and the Modification

		Ecosystem Credits	
Vegetation Community	**PCT**	**Relinquishment Area**	**Modification***
Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	483	240	-
Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	1605	51	141
Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter	1602	79	-
Total Ecosystem Credits		**370**	**141**

*Source Hunter Eco, 2018.

Table 14 shows the comparison between species credits generated in the BAM Calculator for the entire land available for use as a Relinquishment Area and the Modification (Hunter Eco, 2018). Forfeiting development of the entire land available for use as a Relinquishment Area while developing the Modification will result in a net gain of 1044 species credits.

Table 14 Comparison of Species Credits between the Relinquishment Area and the Modification

	Species credits	
Species name	**Relinquishment Area**	**Modification***
Burhinus grallarius / Bush Stone-curlew	91	-
Haliaeetus leucogaster / White-bellied Sea-Eagle	91	-
Hieraaetus morphnoides / Little Eagle	299	-
Lophoictinia isura / Square-tailed Kite	299	-
Petaurus norfolcensis / Squirrel Glider	140	-
Phascogale tapoatafa / Brush-tailed Phascogale	124	-
Total Species Credits	**1044**	**0**

*Source Hunter Eco, 2018.

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ATTACHMENT A MOUNT PLEASANT OPERATION RAIL MODIFICATION TERRESTRIAL ECOLOGY ASSESSMENT

Refer to Appendix G of the *Mount Pleasant Operation – Rail Modification Environmental Assessment* (MACH Energy, 2017)

ATTACHMENT B FLORISTIC LIST

Family Name	Growth Form						
Common Name and Scientific Name	**Fern**	**Forb**	**Grass**	**Other**	**Shrub**	**Tree**	**Weed**
Aizoaceae							
Galenia							
Galenia pubescens							✓
Apocynaceae							
Common Milk Vine							
Marsdenia rostrata				✓			
Narrow-leaved Cotton Bush							
Gomphocarpus fruticosus							✓
Asteraceae							
Cassinia							
Cassinia quinquefaria					✓		
Saffron Thistle							
Carthamus lanatus							✓
Brassicaceae							
Mustard							
Brassica sp.							✓
Peppercress							
Lepidium pseudohyssopifolium		✓					
Cactaceae							
Prickly Pear (common)							
Opuntia stricta							✓
Chenopodiaceae							
Bluebush							
Maireana microphylla					✓		
Creeping Saltbush							
Atriplex semibaccata					✓		
Chloanthaceae							
Bead Bush							
Spartothamnella juncea					✓		
Fabaceae (Faboideae)							
Leafy Templetonia							
Templetonia stenophylla		✓					
Fabaceae (Mimosoideae)							
Kangaroo Thorn							
Acacia paradoxa					✓		
Lomandraceae							
Many-flowered Mat-rush							
Lomandra multiflora subsp. multiflora			✓				
Mat-rush							
Lomandra confertifolia subsp. rubiginosa			✓				
Wattle Mat-rush							
Lomandra filiformis subsp. filiformis			✓				
Loranthaceae							

Family Name	Growth Form						
Common Name and Scientific Name	**Fern**	**Forb**	**Grass**	**Other**	**Shrub**	**Tree**	**Weed**
Mistletoe							
Dendrophthoe glabrescens				✓			
Luzuriagaceae							
Scrambling Lily							
Geitonoplesium cymosum				✓			
Malvaceae							
Paddy's Lucerne							
Sida rhombifolia							✓
Myoporaceae							
Western Boobialla							
Myoporum montanum					✓		
Myrtaceae							
Narrow-leaved Ironbark							
Eucalyptus crebra						✓	
Spotted Gum							
Corymbia maculata						✓	
White Box							
Eucalyptus albens						✓	
Oleaceae							
Native Olive							
Notelaea microcarpa						✓	
Pittosporaceae							
Native Blackthorn							
Bursaria spinosa					✓		
Poaceae							
Barbed Wire Grass							
Cymbopogon refractus			✓				
Purple Wiregrass							
Aristida ramosa			✓				
Slender Bamboo Grass							
Austrostipa verticillata			✓				
Spear Grass							
Austrostipa scabra			✓				
Tall Chloris							
Chloris ventricosa			✓				
Wallaby Grass							
Rytidosperma bipartitum			✓				
Rytidosperma sp.			✓				
Pteridaceae							
Rock Fern							
Cheilanthes sieberi	✓						
Solanaceae							
African Boxthorn							

Family Name	Growth Form						
Common Name and Scientific Name	**Fern**	**Forb**	**Grass**	**Other**	**Shrub**	**Tree**	**Weed**
Lycium ferocissimum							✓
Nightshade							
Solanum campanulatum					✓		
Sterculiaceae							
Kurrajong							
Brachychiton populneus						✓	
Thymelaeaceae							
Rice Flower							
Pimelea curviflora var. sericea		✓					
Verbenaceae							
Common Verbena							
Verbena officinalis							✓
Purpletop							
Verbena bonariensis							✓

ATTACHMENT C FLORISTIC PLOT DATA

Plot	180207P1		180207P2		180207P5		180207P10		180207P9		180207P7		180207P3		180207P4		180207P8		180207P6	
PCT and Condition	1602	Mod	1602	Mod	1605	Poor	1605	DNG	1605	DNG	483	Mod	483	DNG	483	DNG	483	DNG	483	Poor
Family and Species	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**
Aizoaceae																				
**Galenia pubescens*					0.1	1			0.1	1			0.1	1	6				0.1	1
Apocynaceae																				
**Gomphocarpus fruticosus*	0.1	1																		
Marsdenia rostrata	0.1	1																		
Asteraceae																				
**Carthamus lanatus*					20		80		30				0.1	1			70			
Cassinia quinquefaria			0.1	1																
Brassicaceae																				
Brassica sp.																	6			
Lepidium pseudohyssopifolium			0.1	1					0.1	1										
Cactaceae																				
**Opuntia stricta*													0.1	1						
Chenopodiaceae																				
Atriplex semibaccata													0.1	1						
Maireana microphylla					0.1	1			0.2	1			0.1	1	0.1	1	0.1	1	5	1
Chloanthaceae																				
Spartothamnella juncea			0.1	1																
Fabaceae (Faboideae)																				
Templetonia stenophylla			0.1	1																
Fabaceae (Mimosoideae)																				
Acacia paradoxa	0.1	1					0.1	1												
Lomandraceae																				

Plot	180207P1		180207P2		180207P5		180207P10		180207P9		180207P7		180207P3		180207P4		180207P8		180207P6	
PCT and Condition	1602	Mod	1602	Mod	1605	Poor	1605	DNG	1605	DNG	483	Mod	483	DNG	483	DNG	483	DNG	483	Poor
Family and Species	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**
Lomandra confertifolia subsp. *rubiginosa*							25		0.3	1	25						40			
Lomandra filiformis subsp. *filiformis*			0.1	1									0.1	1						
Lomandra multiflora subsp. *multiflora*			0.1	1			0.1	1												
Loranthaceae																				
Dendrophthoe glabrescens											0.1	1								
Luzuriagaceae																				
Geitonoplesium cymosum	0.1	1																		
Malvaceae																				
**Sida rhombifolia*					10				0.1	1	6		0.1	1	4	1				
Myoporaceae																				
Myoporum montanum	0.1	1	1	1							0.1	1								
Myrtaceae																				
Corymbia maculata	80																			
Eucalyptus albens											90		30		6				6	
Eucalyptus crebra					75		4	1	25											
Oleaceae																				
Notelaea microcarpa	15		8																	
Pittosporaceae																				
Bursaria spinosa	6										6									
Poaceae																				
Aristida ramosa	65		40		35		50		40		10		20		20		70		50	
Austrostipa scabra																			6	
Austrostipa verticillata	0.2	1			30		0.5	1	0.2	1	10		15		6		2	1	15	

Plot	180207P1		180207P2		180207P5		180207P10		180207P9		180207P7		180207P3		180207P4		180207P8		180207P6	
PCT and Condition	1602	Mod	1602	Mod	1605	Poor	1605	DNG	1605	DNG	483	Mod	483	DNG	483	DNG	483	DNG	483	Poor
Family and Species	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**	**Cover**	**Count**
Chloris ventricosa									0.1	1										
Cymbopogon refractus			0.1	1																
Rytidosperma bipartitum			0.1	1																
Rytidosperma sp.									0.1	1	6									
Pteridaceae																				
Cheilanthes sieberi							0.1	1												
Solanaceae																				
**Lycium ferocissimum*					0.1	1			0.1	1					0.1	1				
Solanum campanulatum					0.1	1	0.1	1							0.1	1	0.1	1		
Sterculiaceae																				
Brachychiton populneus	0.2	1	0.1	1							0.1	1								
Thymelaeaceae																				
Pimelea curviflora var. *sericea*			0.1	1																
Verbenaceae																				
**Verbena bonariensis*									0.1	1							0.1	1		
**Verbena officinalis*							0.1	1												

ATTACHMENT D PLANT COMMUNITY TYPE DESCRIPTIONS

PCT483 Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley

Open woodland that has been subject to extensive clearing and grazing. Condition was assessed as being moderate to poor as well as cleared areas of derived native grassland. The canopy was dominated by White Box (*Eucalyptus albens*) frequently referred to as a hybrid with Grey Box (*Eucalyptus moluccana*) due to there being smaller fruit and less glaucousness than more typical White Box. A small number of Kurrajong (*Brachychiton populneus*) were also present. There was a sparse shrub cover of *Myoporum montanum*, *Bursaria spinosa* and *Maireana microphylla*. Ground was dominated by the grasses *Aristida ramosa* and *Austrostipa verticillata*, and the sedge *Lomandra confertifolia* subsp. *rubiginosa*. The most abundant weed was *Carthamus lanatus*, along with *Galenia pubescens* and *Opuntia stricta*, all high threat weeds. The presence of regeneration suggests that the community will naturally regenerate with removal of grazing.

PCT1602 Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter

This is a tall forest with the canopy dominated by Spotted Gum (*Corymbia maculata*) along with Kurrajong (*Brachychiton populneus*); condition was assessed as being moderate. The shrub layer consisted of *Myoporum montanum, Bursaria spinosa, Notelaea microcarpa, Acacia paradoxa* and *Cassinia quinquefaria*. The ground was dominated by grasses *Aristida ramosa*, *Austrostipa verticillata* and *Rytidosperma bipartitum*, and herbs *Templetonia stenophylla* and *Pimelea curviflora* var. *sericea*, and sedges *Lomandra filiformis* subsp. *filiformis* and *Lomandra multiflora* subsp. *multiflora*. This is a regenerating forest which will further progress with the removal of grazing.

PCT1605 Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter

Open woodland that has been subject to extensive clearing and grazing. Condition was assessed as being poor as well as cleared areas of derived native grassland. Canopy consisted only of Narrow-leaved Ironbark (*Eucalyptus crebra*). The only shrub present was scattered *Maireana microphylla*. Ground cover was dominated by grasses *Aristida ramosa, Austrostipa verticillata, Chloris ventricosa* and *Rytidosperma* species, and sedges *Lomandra filiformis* subsp. *filiformis* and *Lomandra multiflora* subsp. *multiflora*. The dominant weed was *Carthamus lanatus* along with *Galenia pubescens, Lycium ferocissimum* and *Sida rhombifolia*. There was evidence of regeneration which will progress with removal of grazing.

ATTACHMENT E CREDIT REPORT

BAM Credit Summary Report

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00009251/BAAS17004/18/00009872	Mt Pleasant MOD4 Reliquishement Area Large	24/02/2018
Assessor Name	**Report Created**	**BAM Data version ***
Colin Driscoll	07/06/2018	3
Assessor Number	* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.	
BAAS17004		

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

Zone	Vegetation zone name	Vegetation integrity loss / gain	Area (ha)	Constant	Species sensitivity to gain class (for BRW)	Biodiversity risk weighting	Candidate SAII	Ecosystem credits
Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley								
2	483_Derived_native_grass	21.2	18.0	0.25	High Sensitivity to Potential Gain	2.00	TRUE	191
4	483_Moderate	32.7	3.0	0.25	High Sensitivity to Potential Gain	2.00	TRUE	49
							Subtotal	**240**

Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter								
3	1605_Moderate	19.1	2.0	0.25	High Sensitivity to Potential Gain	1.50		14
5	1605_Derived_native_grass	19.7	5.0	0.25	High Sensitivity to Potential Gain	1.50		37
							Subtotal	**51**
Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter								
1	1602_Good	45.4	4.0	0.25	High Sensitivity to Potential Gain	1.75		79
							Subtotal	**79**
							Total	**370**

Species credits for threatened species

Vegetation zone name	Habitat condition (HC)	Area (ha) / individual (HL)	Constant	Biodiversity risk weighting	Candidate SAII	Species credits
Burhinus grallarius / Bush Stone-curlew (Fauna)						
1602_Good	45.4	4	0.25	2	False	91
					Subtotal	**91**
Haliaeetus leucogaster / White-bellied Sea-Eagle (Fauna)						
1602_Good	45.4	4	0.25	2	N/A	91
					Subtotal	**91**

Hieraaetus morphnoides / Little Eagle (Fauna)						
1602_Good	45.4	4	0.25	1.5	N/A	68
483_Derived_native_grass	21.2	18	0.25	1.5	N/A	143
1605_Moderate	19.1	2	0.25	1.5	N/A	14
483_Moderate	32.7	3	0.25	1.5	N/A	37
1605_Derived_native_grass	19.7	5	0.25	1.5	N/A	37
					Subtotal	**299**
Lophoictinia isura / Square-tailed Kite (Fauna)						
1602_Good	45.4	4	0.25	1.5	N/A	68
483_Derived_native_grass	21.2	18	0.25	1.5	N/A	143
1605_Moderate	19.1	2	0.25	1.5	N/A	14
483_Moderate	32.7	3	0.25	1.5	N/A	37
1605_Derived_native_grass	19.7	5	0.25	1.5	N/A	37
					Subtotal	**299**

Petaurus norfolcensis / Squirrel Glider (Fauna)						
1602_Good	45.4	4	0.25	2	False	91
483_Moderate	32.7	3	0.25	2	False	49
					Subtotal	**140**
Phascogale tapoatafa / Brush-tailed Phascogale (Fauna)						
1602_Good	45.4	4	0.25	2	False	91
483_Moderate	32.7	2	0.25	2	False	33
					Subtotal	**124**

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